Dr Thomas Duff
Bushfire Scientist
University of Melbourne

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Dear Senate Finance and Public Administration Committees ,

I am a scientist based at the University of Melbourne, my research has focused on topics including forest flammability, fuel dynamics and fire modelling. My research projects have been funded predominantly by the Victorian Government and the Bushfire and Natural Hazards Cooperative Research Centre. Prior to my science career I worked in forest management in Victoria, where my role included fire response and planning. I am currently on parental leave, and was on leave during the 2019/20 fire season.

The 2019/20 posed particular challenges to management, in-part due to the need for the fire agencies to make decisions with limited or uncertain information. Fire scientists have been undertaking research in Australia for many years, however there are some topics where the needs of land managers are not being addressed by the research community. In particular, applied research to improve operational practices has relatively little attention in comparison to exploratory or descriptive research.

Fire preparedness and response activities require information to make informed decisions. Here, I present fire current research gaps that are limiting our ability to minimise bushfire impacts and improve performance.

This submission relates to the specific terms of reference:

(a) advice provided to the Federal Government, prior to the bushfires, about the level of bushfire risk this fire season, how and why those risks differed from historical norms, and measures that should be taken to reduce that risk in the future;

(d) the adequacy of the Federal Government's existing measures and policies to reduce future bushfire risk, including in relation to assessing, mitigating and adapting to expected climate change impacts, land use planning and management, hazard reduction, Indigenous fire practices, support for firefighters and other disaster mitigation measures;

(e) best practice funding models and policy measures to reduce future bushfire risk, both within Australia and internationally; and

(g) the role and process of advising Government and the federal Parliament of scientific advice;

I would be happy to engage further on these points presented here.

Yours sincerely,

Dr Thomas Duff

Challenge 1 – The link between dryness and fire behaviour is poorly understood

Context

The substantial rainfall deficit over much of Australia prior to the 2019/2020 summer was a major contributor to the large scale-growth and difficulty of suppression of bushfires. The general link between bushfires and rainfall deficit has been well established in research, however there is limited understanding of the mechanisms of how dry landscapes affect fire behaviour. This poses substantial challenges for preparedness as the there are no reliable tools to predict where damaging fires are likely, or the nature of the fires that do occur. This is a limit on the accuracy of seasonal fire forecasting and consequent reliability of advice.

Key points

Research has not developed reliable indicators that can provide managers an expectation of fire behaviour based on landscape dryness.

An understanding of dryness / fire links is critical for estimating future fire potential under climate change

Vegetation landscapes spend a large proportion of the year in a 'wet' state where they are too damp to burn. They will become flammable when prolonged dry weather allows the fuel to dry out. Transitions of different parts of the landscape to a flammable state can not be reliably measured or predicted. There can be vast differences between the amount of drying needed to induce flammability for different vegetation communities.

Little is known about how fire risk reduces after rain occurs during the dry season– as occurred in the 2019/20 fire season. This is critical for allocating fire response and recovery resources during a fire.

There is anecdotal evidence that fire behaviour is different (e.g. pyrocumulus, mass ember ignitions) when conditions are extremely dry and this affects the potential for spread and difficulty of suppression. There are no reliable indicators to measure or predict this.

The fire simulation systems used by agencies to identify parts of the landscape at risk are not designed to predict the drought driven fire complexes of 2019/20. This means that risk maps developed using computer simulations may not accurately represent long-term risk.

Factors that have made resolving this challenge difficult

Exceptionally dry years are infrequent. This means that short term research projects (e.g. a University research grant) have a low likelihood of observing how the landscape changes for drought conditions.

Fire behaviour under extreme conditions can only be observed during fires. This means the only opportunity to collect data is during bushfires.

The data that is collected on bushfires in different states varies in type, quality and availability. Not all information that is collected during fires (i.e. for planning firefighting) is consistently archived.

Field experimentation to determine how forests burn is extremely limited in Australia. This means the understanding of fire behaviour is not advancing. Costs are prohibitive to University

researchers and fire agencies have limited research staff. Field research has predominantly focused on mixed eucalypt forests and grasslands. Drought tolerant and 'wet' vegetation communities have had comparatively little attention.

Australian fire simulation systems rely on models of landscape dryness that have not been shown to reliable for discriminating potential fire behaviour, and have limited consideration of the effect of landscape dryness or vegetation community.

Recommendations

Establish structures to increase the amount of operational research focused on practical outcomes. Increased operational research will allow links between dryness and fire potential to be identified. This would entail increased field based research and data collection during bushfires and planned burns.

Invest in research to better understand weather / fuel dryness links. This will enable improved drought metrics to be developed for use in fire simulation systems. This would greatly enhance fire agencies to identify levels of risk in the landscape, enhancing medium and long term preparedness.

Establish nation-wide systems to collect and store observations during fires. This will greatly enhance our ability develop models that can be used to predict how fires will behave. This is particularly important under extreme conditions where experimentation is not an option. A national approach would maximise the information available when exceptional events occur – such as with the 2019/20 fire season.

Challenge 2. The optimal way to apply hazard reduction methods is poorly understood

Context

Hazard reduction burning is the primary way land managers are able to manipulate vegetation fuels at landscape scales. However there is no consensus on how, when and where hazard reduction burns should be applied. This lack of consensus exists in both the land management and scientific communities. The conflicting information in relation to burning means that it is unclear whether preparedness activities are optimal.

Key points

There is no consensus in published scientific literature on the effectiveness of burning in reducing risk. It is not uncommon that different studies have contradictory recommendations for the same area.

Fire simulation systems are often used to evaluate estimate optimal approaches to burning by land managers. The representations of how vegetation fuels are impacted by burning, how they recover and how subsequent wildfires behave in these models have limited data supporting them. Consequently it is unclear how well fire simulations used for evaluating hazard reduction strategies represent reality.

Assessments of what occurs when bushfires intercept burns are not routine. There is no agreed set of information to collect when a burn interception occurs (i.e. changes in fire behaviour, changes in fire exposure to nearby assets, changes in exposure to firefighters).

Research has typically focused on analysing landscape scale historic data. There has been limited recent attention to evaluating or improving on-ground burning practices and methods.

Factors that have made resolving this challenge difficult

The data available for evaluating burns is limited and highly variable in quality. Mapped fire perimeters are common, and for more recent years, there may be fire severity information. This is not necessarily suitable for evaluating whether burns are meeting objectives. Older burn information is generally poorer in quality and may be inaccurate.

Very little field research is being done into burn practices or evaluating outcomes when bushfires occur.

Most practices used for conducting burns are based on practitioner experience and training. There is very little data to support best practice.

There is no consensus on how to evaluate success of burning. Detailed objectives (in terms of desired burn results and what the intended effect will be on future fire behaviour) are not commonly documented. At landscape scales, the metrics of burn success vary between studies (e.g. houses saved, average fire size, fire severity)

There has been comparatively little research evaluating how fuels recover after being burnt at different fire seventies. This means it is unclear how long a burnt area will effect bushfire behaviour.

The most common way of evaluating vegetation fuels (fuel hazard assessment) provides little detail that can be used to understand fuel dynamics.

Research case studies of fire events are common. Fires are a function of fuel and weather and these can change greatly. Case studies of single events may not reflect the effectiveness of hazard reduction burns under other conditions.

Recommendations

Investment in the development of national structures and practices for the collection and collation of data in all matters related to hazard reduction burning. This will support the development of knowledge of how burns interact with bushfires. This includes establishing long term studies to allow fuel recovery to be quantified.

Invest in applied research to on hazard reduction burn practices. Field research is critical to improving burn practices, outcomes and safety. Given the large number of burns currently being undertaken, there is the potential to get a large amount of valuable information with limited investment. This could include adaptive-management style experimentation and data collection, and post burn monitoring of fuel changes.

The development of an agreed approaches to evaluating the impacts of fires and hazard reduction burns that are consistent between land management and research communities. This will allow appropriate metrics to be used for judging the performance of strategic burning programs. It is likely that this would need to include values other than houses burnt – including the value of private assets, smoke impacts, ecosystem services, infrastructure and agricultural productivity.

Challenge 3. The climatic variability and the way it applies to burning is poorly understood

Context

Over the 2019/20 fire season, the amount of hazard reduction burning that fire agencies had achieved was a common focus in the media. However, hazard reduction burning can only be done when the landscape is dry enough to burn, but when conditions are so severe that fires will escape. The periods of the year where burning can be done – typically autumn and spring in SE Australia is described as the burn window. There has been very little research into Australian burn windows and there are no robust approaches in operational use that can be used to identify or forecast opportunities for burning. There is evidence of a greater likelihood of more severe bushfire seasons with climate change, it is unclear whether this will be associated with fewer opportunities for hazard reduction.

Key points

The amount of burning that can be done is dependent on seasonal weather. This varies greatly from year to year.

There is no reliable way that weather information can be used to identify or predict opportunities for burning. Detecting suitable conditions for burning is highly reliant on field visits. This means burn windows cannot be reliably forecast (i.e. days ahead) and potential future long term burn window trends are unclear (i.e. changes in opportunities with climate change).

Fire modelling has focused on how fires spread in bad fire weather. There has been little recent work evaluating fire behaviour in mild conditions and wet landscapes – i.e. as with bushfires, our knowledge of burns is also limited by our inability to link landscape dryness to fire behaviour.

Burn windows may be short, so it is very important to be able to identify them so that the limited time available for burning can be maximised.

Factors that have made resolving this challenge difficult

Landscape dryness metrics (drought indices) used in Australia have been shown to be poor indicators of flammability or potential fire behaviour.

The nature of the vegetation community plays a large role in defining fire behaviour. The effect of vegetation is poorly quantified, particularly in very wet or very arid communities

Management agencies use ‘prescriptions’ to limit when burning occurs. These are constraints relating to weather or fuel that typically describe the maximum safe burning conditions. The prescriptions in use do not appear to be have be defined through researcher

Fire agencies are reliant on experienced staff for safe and effective burning. There has been no research to develop decision support tools using measurements and data to supplement this.

Recommendations

Invest in research to identify linkages between weather, vegetation communities and landscape flammability. It is particularly important to ensure that real fire outcomes are considered rather than solely weather based substitutes (such as the current drought indices)

Encourage field based research to determine constraints on successfully achieving intended hazard reduction outcomes. Detailed data collection during hazard reduction burns will enable the constraints on burning to be identified. In particular, information about lighting attempts, lighting patterns and burn outcomes will enable suitable burning conditions to be defined. Successful identification of constraints will allow better guidance to be provided to practitioners and allow the forecasting of burn opportunities.

Invest in research to evaluate interactions between burn window length and variability and projected climate change. Long term fire risk management strategies have been developed by land management agencies, however successful implementation necessitates recognition how opportunities may differ with a changed climate.

Challenge 4. We do not have consistent measures for evaluating the effectiveness of fire preparedness and response

Context

Preparing for bushfires requires investment in wide range of areas including fire detection, education, hazard reduction, suppression resources and recovery. This can be highly complex, for example when considering suppression resources, it is necessary to allocate funds to a combination of personnel, tankers, waterbombing helicopters, heavy machinery and aircraft. Despite the high level of investment, there has been little objective evaluation of the best way to allocate preparedness resources. Likewise, during bushfires, there has been little objective evaluation of how effective different fire suppression strategies are. As a result, we are unable to determine how efficient our fire practices are or identify opportunities for improvement.

Key points

Operational research (i.e. minimising costs and optimising approaches) has had little attention in Australia in comparison to other parts of the world. For example, in the US, the expenditure on every bushfire is analysed and firefighting performance is evaluated.

The allocation of fire management resources is a highly complex field – particularly as there may be synergies between different strategies (e.g. supporting line construction with aircraft). However, even small improvements in efficiency can result in large gains given the high levels of expenditure.

There are few criteria for assessing firefighting efforts and the outcomes of bushfires are not routinely evaluated. Not having criteria for assessing outcomes of fire management means that there are no benchmarks for comparing performance with. This makes it difficult to improve practices, and it means that successful results can not be celebrated.

Decisions about resource allocation are predominantly based on expertise and traditional practice.

There can be public pressure to focus on particular fire management strategies (for example large air tankers). Without assessment criteria, decisions cannot be justified.

The forestry industry is currently relied on to provide heavy machinery for firefighting. Transitions in the structure of the industry – such as the planned phasing out of native forest harvesting – is likely to affect firefighting capacity, but it unclear to what extent.

Factors that have made resolving this challenge difficult

The economics of operational fire research has not traditionally been an area of focus in Australia. Fire agencies have generally focused on applied method development and Universities are only beginning to address the field. As a result the field is immature.

Data are not routinely retained and archived during fires. Effective analysis requires detailed fire information and information about resource use, allocations, logistics, deployments, costs. This information is not readily available.

Some of the data necessary for analysis are not made available to the public. Researchers outside fire agencies may not understand what information may be available on application.

Fire management performance is not typically evaluated for individual fires. Some metrics are summarised and reported on (e.g. average time to attend incidents), however to improve practice – a higher level of detail to feedback is necessary.

Recommendations

Enhanced data collection and retention by fire agencies is recommended. This will greatly enhance the potential for identified improvement opportunities. A national approach will greatly enhance the leverage of information collected

That a suite of metrics for evaluating fire management performance on fires be developed. This will allow managers to evaluate strategies and take an adaptive management approach. This should be consistent nationally

That research into the assessment fire management practices be prioritised. Given the high levels of funds invested in fire preparedness and response, small efficiency gains can have high returns in improving outcomes. This means that the research could be cost neutral to the overall fire budget. As little research that has occurred to-date, early gains could be expected to be large.

Challenge 5. Research being undertaken is not necessarily meeting fire agency needs.

Context

There has been a substantial amount of fire research undertaken in past decades in Australia, however not all the needs of fire agencies are being met. In recent decades, most government agencies have reduced their capacity for applied fire research. Australian universities have increased the amount of fire research they do, particularly focusing on globally relevant large scale problems. Fire management agencies have substantial challenges in taking University research products and applying them to support decision making.

Key points

In recent decades fire agencies have reduced their capacity to undertake practical field based research on topics relating to burning, fire preparedness and response.

Universities incentivise their researchers to publish globally relevant results in international journals. This means that there may be limited incentives to solve practical local problems that would be useful for management agencies.

Universities have extremely limited funding for their own research. As a result fire research is reliant on project grants from government and private sources. Grants are typically short term (3 years or less); this can make long term planning challenging. The majority of grants would fund fewer than one researcher.

The Bushfire Natural Hazards CRC was intended to encourage cooperation between Universities and fire agencies through project grants. The structure of projects meant that outcomes were not necessarily things that could be operationally applied. In particular, projects were on standard short funding term cycles, the level of investment per project made field focused projects challenging, and there was a preference for highly novel topics rather than practice improvment.

Factors that have made resolving this challenge difficult

University projects are typically funded on short term cycles (3 years). This limits their ability to plan or invest for the long term.

Universities conducting long term research are reliant on data that is already available. The standard of data varies greatly depending on topic and jurisdiction. This limits what research questions can be asked.

The research needs of management agencies may be highly local (e.g. how a particular vegetation community behaves when burnt), which makes them unattractive to universities who have a focus on globally ranked journal publication.

Universities do not have the infrastructure, equipment or personnel for undertaking large scale fire experiments or measurements. Such experiments can only be done with agency cooperation.

It can be challenging for Universities to get access to fire agency, staff resources and activities. Collaborative research is highly dependent on relationships between key staff. These can be vulnerable if particular people move positions within organisations. A lack of effective communication between university and operational agency staff can mean that university researchers may not full understand the detail of applied problems.

A good research outcome for a university project is the demonstration (and publication) of a relationship. However, for practical use, fire agencies need the relationships to be defined to a level that outcomes are robust when applied in real settings. This may take substantially more work; the competitive nature of academic research positions mean that there is a disincentive for academics to invest more effort that absolutely necessary to achieve publication.

The outcome of an academic study may be an algorithm. For this to be useful to a management agency, there needs to be substantial additional development to create tools. Tool development (for example developing a fire simulator) can be costly and requires specialist skills.

Recommendations

Provide support for increased research capacity by fire agencies. This would enable them to conduct their own research where necessary, and would enhance the quality of university partnerships by fostering improved communication

That long-term monitoring and data curation practices be established by fire agencies. This would provide valuable information that would be beyond a university's typical capacity to collect. The design of protocols could be developed in collaboration with researchers external to agencies.

The development of practices that promote cooperation between states. This would increase data leverage and replication and, as a consequence, the quality of science.

Develop structures to facilitate the integration of researchers into management agencies. This could provide for improved practices, continual improvement and adaptive management.