Burning to reduce fuels: the benefits and risks of a public health protection strategy

We need to burn, but it is not a cure-all and the side effects can be serious

Fire disasters are one of many serious and escalating environmental health problems that the world, and Australia in particular, is now facing.[1] During the black summer of 2019–2020, population exposure to bushfire smoke was almost an order of magnitude greater than that documented for any of the fire seasons for at least the previous two decades, and it was estimated to be responsible for more than 400 premature deaths.[2] The fires themselves, including firefighting-related accidents and injuries, claimed a further 33 lives.[3] Furthermore, the trauma experienced by communities affected by the fires, including serious risks to life, homes and livelihoods, will have ongoing psychological, physical health, social and economic impacts.[4]

As a society, we have a long history of identifying and responding to public health challenges with many notable successes, such as the control of vaccine-preventable diseases. For complex system-wide health threats, the mitigation of harm and promotion of health and safety requires integrated multifaceted approaches that work together to achieve a population level benefit.[5] This is especially the case with bushfires, where the most important interventions for public health protection are not found within the disciplines of health and medicine, but rather in fire ecology, climate science, land management, and urban planning.[6] Deliberate landscape burning to reduce fuels is one of many strategies used to reduce the harms caused by bushfires (Box). The widely accepted overarching principle underlying the practice is to save life and property, with the protection of human life being paramount.[19] All public health interventions are associated with costs, which need to be balanced against their benefits. Such costs include the direct costs of implementation, the opportunity costs of selecting one intervention over another, and the costs relating to adverse impacts caused by the intervention. Characterisation of the safety and effectiveness of interventions is central to public health practice.[20]

While it is widely accepted that fuels management is central to bushfire management, there are multiple, and sometimes competing, perspectives on when and how it should be done.[21] From the perspective of health protection, as distinct from other outcomes such as biodiversity, what is the evidence for the effectiveness of fuel reduction burning, its technical constraints and adverse impacts?

Evidence for the effectiveness of fuel reduction burning

Prescribed fire impacts can be evaluated against many possible end points. These include associations with fire severity, total area of land burned, fire suppressibility, reduction in the loss of critical assets such as houses, reduction in the loss of human life, and protection of heritage and natural values.[10,22] A recent detailed evidence review concluded that prescribed burning can effectively reduce the severity of future fires, although the effect is restricted to fire-adapted and frequently burnt vegetation and is temporary in nature — generally less than 5 years, depending on the rate of regrowth of vegetation.[10] There is also clear evidence that fuel reduction burning influences the geographic area of uncontrolled bushfires relative to the area burnt by prescribed fires, a concept known as leverage.[16] Leverage is the unit reduction of unplanned fire area associated with one unit of previous planned fire. The leverage achieved by prescribed fires varies by geographic region and vegetation type from between 10% and 45% in southern parts of Australia and up to 100% in tropical savannas.[7] This means that in southern parts of Australia, land managers have to substantially increase the total area of land burned to achieve a meaningful reduction in the area burned by bushfires.[8]

How well does modification of fire severity and a reduction in the area burned by bushfires translate into the protection of human life and property? These are much more difficult outcomes to investigate. Evaluating housing loss data following major fire disasters has identified some patterns. For example, fuel treatments that are very close to settlements are more effective in protecting homes than those that are more distant,[8,19] but there is an even greater influence of fuels in the immediate surroundings of a property (ie, domestic gardens) than of fuels in adjoining tracts of native vegetation.[8] Although fuel management at the urban interface is more challenging and, therefore, more expensive to implement per unit area burned than fuel reduction burning in more remote vegetation, modelling studies demonstrate that it is also more cost effective.[23] There do not appear to be any empirical studies attempting to estimate the extent to which fuel reduction burning reduces the risk to

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An explanation of terms relating to deliberate landscape burning

Terms	Definitions
Deliberate landscape burning	The deliberate (also called prescribed or planned) burning of landscapes is an ancient human practice that remains integral to many cultural, agricultural and land management practices throughout the world.[7] It is done for a multitude of reasons, including fire risk mitigation,[8] regeneration of eucalypt forests in silviculture,[9] removal of biomass waste in agriculture,[10] cultural or traditional burning by Indigenous peoples,[11] and for ecological or biodiversity outcomes.[12,13]
Fuel reduction burning	Fuel reduction (also called hazard reduction) burning is the deliberate use of fire to reduce or modify fuel loads to reduce the hazard associated with future bushfires.[14]
Fuels management	Deliberate burning is one of several methods for managing fuel loads. Other techniques include the mechanical modification and removal of fuels, urban and peri-urban design to reduce flammability in and around settlements, garden design and low flammable green fire breaks, and herbivory (ie, the strategic use of browsing or grazing by livestock or native animals in the creation of marsupial lawns).[13,15–17]
Back burning	Back burning is the term used to describe the use of intentionally set fires to contain bushfires or protect assets during emergency firefighting operations.[18]

human life. However, the modelling of fire behaviour under different prescribed burning regimes suggests that incremental protection of both life and property can be achieved, depending on local circumstances and the extent of the fuel management conducted.[24]

Main technical constraints

Most serious loss of property and human life occurs during relatively uncommon severe bushfire disasters driven by extreme fire weather, rather than with more typical annual summer bushfires that are an integral feature of southern Australian forested environments.[25] However, the effectiveness of fuel reduction burning in moderating the extent, severity and suppressibility of future bushfires is reduced by severe fire weather conditions.[8] Under extreme conditions, highly intense fires that burn the foliage in the treetops, known as crown fires, are more likely to happen regardless of underlying fuel loads. In these circumstances, fire is more likely to spread through spotting by firebrands, such as wind-blown burning embers, well ahead of the fire front than by spread through continuous ground level fuels.[8] Another important limitation is that elective burning is only possible in certain habitats. Fire cannot be set in vegetation that is normally too moist to burn, such as wet sclerophyll forests or rainforests. When such habitats become unnaturally dry after extended periods of drought, for example, they represent a severe fire hazard and are too dangerous to burn electively.[26] A further biophysical and economic constraint is the ability to carry out sufficient burning to achieve a meaningful outcome for protection of life and property. Opportunities to burn are constrained. Burning needs to be conducted during safe weather windows, when the risk of the fire escaping control is very low. However, they cannot be conducted during rainy periods, as the vegetation needs to be dry enough to burn. A simulation study in Tasmania illustrated that burning an adequate area of land is close to impossible, even given unlimited financial resources, because optimal burning conditions are infrequent.[26] Further, there is evidence that the available weather windows for planned burning are changing with climate change, although this might influence the season of burning more than the absolute number of days with suitable weather.[27] Finally, it is more difficult to safely conduct elective burns in places where there is a mosaic of infrastructure, homes and communities, even though burning in these regions is likely to confer greater protection of homes and lives from later bushfires. This is the major reason why burning close to human settlements and infrastructure is a challenging and relatively more costly exercise.

Evidence on harms

In the case of prescribed burning, the most serious adverse events are in two arenas. The first is the risk of the burns turning into uncontrolled bushfires, and the second is the harmful air pollution generated by fires. Escaped burns are extremely uncommon relative to the huge amount of planned burning conducted, but can have some serious consequences including loss of homes and, potentially, life.[28] Smoke production, on the other hand, is integral to every fire and can travel long distances. Its health impacts have been very well characterised, from common symptoms, such as irritation of mucosal surfaces, to exacerbations of chronic diseases precipitating admissions to hospital and, occasionally, deaths in high risk individuals.[29] The two risks are very different in nature. At an individual level, a direct encounter with an uncontrolled bushfire is far more dangerous and lethal than living in smoke haze. However, at the population level, the impacts of smoke on life and health life are much greater because so many more people are affected.[30] In Western Australia, the annual health costs of smoke from prescribed burning over a 15-year period was estimated to be at least $6 million, marginally higher than the impacts of smoke from bushfires over the same period. In places such as Sydney, with a large population and more frequent serious air quality impacts, the health and economic costs from smoke from prescribed burns can be much higher.[31] For example, in 2016, smoke from fuel reduction burns near Sydney was estimated to have caused 87 hospital admissions and 14 excess deaths over 6 days.[32]

Finding the balance

In summary, there is evidence for benefits from fuel reduction burning, particularly in terms of increasing the suppressibility of future fires, reducing the total area burned by bushfires, and reducing property loss and risk to life, depending on the fire weather conditions at the time of the fire. However, it is only implementable for some vegetation types, during particular weather windows, and is more challenging to conduct close to human settlements where the benefit is greatest. There is a risk of harm from escaped fires, but this risk is carefully managed and escapes are rare. The greatest public health harm is caused by smoke emissions. All smoke exposure will cause minor symptoms in most people and exacerbations of illness in many individuals, and smoke exposure affecting very large populations will predictably cost lives.[33] The question that has not been explicitly resolved in fire management in Australia is where to draw the line on the level of inevitable population harm that justifies the anticipated benefit, while maintaining the overarching principle of protecting life. The need for clear frameworks for decision making in prescribed burning is recognised.[34] Explicitly incorporating the entire health burden associated with fuel reduction burning into decision making should drive a strategic shift towards a greater uptake of safer, non-polluting, bushfire protection strategies and more effective approaches for managing and reducing the harm from smoke when burns are conducted. This is especially important at and near the urban interface where greater implementation costs would be offset by major health and economic savings.[20]

Conclusions

Fuel reduction burning has a crucial and central role in bushfire risk mitigation. However, it is insufficient on its own, impossible to implement in all settings, and can cause serious harm including loss of life. Greater uptake of safer and more permanent mitigation strategies, especially at the urban rural interface, is therefore crucial to achieve the greatest overall public health protection. Smoke from planned and unplanned fires is an inherent part of the Australian environment. As we continue to respond to the rapidly changing climate and the associated increasing bushfire risk, it is imperative that agencies responsible for land and fire management, health, and environmental protection collaborate to more effectively manage, mitigate and adapt to this important but unavoidable environmental health hazard.

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