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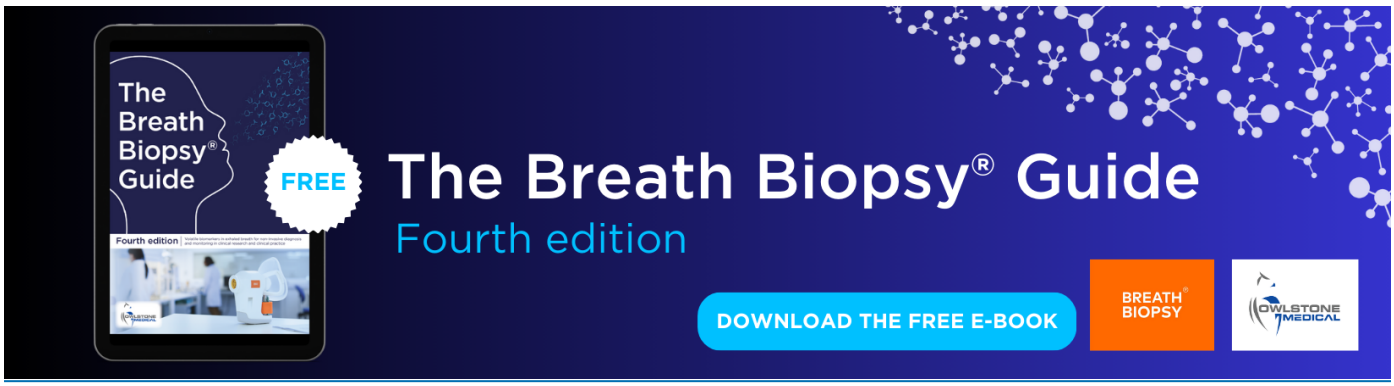

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Responding to bushfire risk: the need for transformative adaptation

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Abstract
The 2009 'Black Saturday' bushfires led to 172 civilian deaths, and were proclaimed as one of Australia's worst natural disasters. The Victorian Bushfires Royal Commission was set up in the wake of the fires to investigate the circumstances surrounding the death of each fatality. Here, results from an analysis undertaken for the Commission to examine the household preparedness policy 'Prepare, Stay and Defend, or Leave Early' ('Stay or Go'), plus an examination of the Commission's recommendations, are explored in the broader context of adaptation to bushfire. We find Victoria ill adapted to complex bushfire risk events like Black Saturday due to changing settlement patterns and the known vulnerabilities of populations living in fire prone areas, and increasingly in the future due to the influence of climate change extending fire seasons and their severity. We suggest that uncertainty needs to be better acknowledged and managed in fire risk situations, and that the responsibility for fire preparedness should be more justly distributed. We suggest that a transformation in adaptation is required to effectively manage complex bushfire risk events like Black Saturday, and provide four key ways in which transformation in bushfire preparedness could be achieved.

Keywords: emergency management, evidence-based policy, climate change, adaptation, transformation

1. Introduction

7 February 2009 was predicted to be the worst fire danger day ever in the Australian state of Victoria. The 'Black Saturday' bushfires that day saw 172 civilian lives lost and costs estimated at over $3.5 billion. The Victorian Bushfires Royal Commission was established to investigate the causes and responses to the bushfires. The enquiry made 67 recommendations designed to '*minimize the risk of a similar tragedy occurring in the future*' (Parliament of Victoria 2010a: 1). As well as holding implications for Victorian and Australian emergency management, the Commission's investigations are of wider interest to the international fire-management community. A similar bushfire safety policy to that followed in Victoria is already used in southern France and northern Spain; and the Californian FIRESCOPE programme has considered how a similar safety strategy, titled 'stay-and-defend', might work in the Californian context. Past academic work in this journal has considered how the US might learn from the Australian experience of bushfire preparedness (Stephens *et al* 2009, Pyne 2009).

Central to the Commission's task was to examine the Victorian bushfire safety policy 'Prepare, Stay and Defend, or Leave Early', colloquially known as 'Stay or Go'. 'Stay or Go' is based on evidence of past fire events (Handmer and Tibbits 2005), including the Wilson House Survival Meter (Wilson and Ferguson 1986) and to some extent the predictive fire danger categories in the McArthur Fire Danger Meter (McArthur 1973). The authors of this letter were tasked by the Commission to examine the empirical basis for 'Stay or

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Go'. To do so, access was provided by the Commission to the confidential records of circumstances surrounding each fatality. This large and detailed fatality dataset contained telephone and SMS records, forensic evidence, and police interviews with friends and family for each fatality. A coding scheme was developed to examine the vulnerabilities, preparedness, intentions, actions and demographic details of each fatality; as well as quantify the defendability of the buildings they occupied. The methodology and detailed results of this examination are presented elsewhere (Handmer *et al* 2010). This letter is instead an examination of the evidence from the fatality dataset together with the Commission's recommendations, in the broader context of adaptation to bushfire risk.

1.1. Routine, non-routine and complex risk

Handmer and Dovers (2007) suggest a typology for emergency management which leads from 'routine' to 'non-routine' to 'complex' risk (table 1), as a way of structuring problems and thinking through solutions.

Commission evidence suggests the 'Stay or Go' policy is reasonably well adapted to the 'routine' and even 'non-routine' bushfire risk. The Commission found that in these situations '*the central tenets of the Stay or Go policy remain sound*' (Parliament of Victoria 2010a: 5). The success of the policy is rather different in light of a 'complex' event like Black Saturday, however. Householder actions, agency decision-making and longer-term management issues all fell short of what the policy required. For example, less than half of the fatalities had made a clear fire plan (a central tenet of 'Stay or Go'). Fire plans that did exist were of variable quality; some of them contained fatal flaws like planning to shelter in a bathroom (people in bathrooms or other small rooms are likely to be unaware of what is happening to the rest of the house and usually have no way of escaping if the house catches fire). There was no evidence of households having made contingency arrangements in case their preferred fire plan actions could not be carried out. Agency decision-making on the day did not adapt to deal with the changed risk. Although the state Premier and Chief Fire Officer warned that the fire danger index on the day would possibly be the highest ever, there was minimal alteration to high-level fire-management procedures besides normal practice for an extreme weather day. Longer-term management issues such as a lack of warnings or weak building and planning codes, as well as more intangible issues such as cultural connections to place and the psychology of engaging with fire risk, also played a role in the Black Saturday fires. This evidence (expanded upon in more detail below) suggests that at present, we are ill adapted to complex bushfire risk events like Black Saturday.

1.2. Transformative adaptation to manage complex risk

We reiterate the concerns of Crompton *et al* (2010) in recognizing the need for adaptation to reduce vulnerability to current bushfire risk. In the face of climate change increasing the likelihood of bushfire risk events with complex management attributes (e.g. see Clarke *et al* 2011), the need for adaptation is even more acute. Stafford-Smith *et al* (2011) argue that where there are both long lead times in adaptation decision-making, and long-term consequences arising from adaptation decision-making (as with bushfire management), transformative adaptation may be required.

The concept of transformative climate change adaptation has been the subject of increasing scholarship (e.g. Olsson *et al* 2006, Nelson 2009, Pelling 2010, O'Brien 2012) and policy interest (e.g. IPCC 2011). It has been defined as 'the altering of fundamental attributes of a system (including value systems; regulatory, legislative, or bureaucratic regimes; financial institutions; and technological or biological systems)' (IPCC 2011). O'Brien (2012) elaborates that components of transformation may include technological innovation, institutional reforms, behavioural shifts and cultural changes. Nelson (2009) and Pelling (2010) emphasize how transformative adaptation goes beyond managing the risk posed by the environment. Instead, transformation calls for a re-evaluation of how people conceive of themselves and others in both their relationship with the environment, but also within wider political processes. Transformative adaptation is particularly concerned with the deeper and less visible root causes of vulnerability, stemming from within the social, cultural, political and economic spheres (Pelling 2010). These activities will likely involve deep questioning of the status quo—by threatening cherished values, beliefs and identities—and is thus both a confronting and challenging process (O'Brien 2012). We argue here for a transformation in adaptation to bushfires to effectively manage complex bushfire risk events like Black Saturday; and suggest four key ways in which transformation could occur.

2. The dynamic nature of risk

A combination of location, climate and vegetation make Victoria exceptionally vulnerable to fire. Royal Commissions investigating bushfires have made recommendations from the early days of European settlement in Victoria. For example, the Black Friday fires (1939) saw the establishment of a fire fighting system of local volunteers (the Country Fire Authority); and more recently, the Bushfire Review Committee following the Ash Wednesday fires (1983) recommended changes leading to the Emergency Management Act 1986, designed to provide a legislative foundation for emergency management by taking an all-hazards, all-agencies coordinated approach to emergency management (Parliament of Victoria 2010b). 'Stay or Go' is therefore founded on significant experience of managing bushfire (Handmer and Tibbits 2005). However, the experience of Black Saturday indicates that the bushfire risk is being transformed from historical experience through both the increased exposure of people living in fire prone bush and the known vulnerabilities of those people; and will be increasingly influenced by climate-changed meteorological conditions.

Table 1. Emergency management typology by attributes (adapted from Handmer and Dovers 2007).

	Attributes					Example
Typology	Scale	Uncertainty	Visibility	Problem solving approach (Funtowicz and Ravetz 1993)	Management attributes (e.g. tractability)	Bushfire characteristics
Routine	Modest and well defined in space and time. Small impact	Known and quantified	Recognized, but low visibility	'Applied science'	Known, anticipated and well practised by experienced agencies	Typical of many of the fires across Victoria in most seasons (e.g. Cape Conran; see ABC 2009)
Non-routine	May be large, but defined	Known, but less quantified	High visibility	'Professional consultancy'	Medium. Flexibility needed. Many sectors and agencies involved.	Fires with severe impacts but which are largely controllable (e.g. Alpine Fires; see DSE 2003)
Complex	Large and/or ill defined in space and time and may appear unbounded. Possibly irreversible	Large or unknown in many dimensions. May not be quantifiable	Often very high profile with intense and long lasting political and media interest	'Post-normal science'	Low. Often well outside previous experience. Need for constant evaluation and learning. Whole of society involved.	Fires with extremely severe impacts where control and previous experience are limited (e.g. Black Saturday 2009)

2.1. People at risk

Changing settlement patterns are influencing the level of risk experienced, particularly through a rapidly increasing peri-urban fringe development trend (in part driven by amenity migrants and housing affordability; Burnley and Murphy 2004). Understanding the changing bush-settlement interface is important, as increasing building damage losses due to bushfire at present is largely driven by increasing numbers of dwellings in close proximity to the bush (Crompton *et al* 2010). The socio-demographics of the population at risk may have also changed. Whilst historical fatality dataset studies had limited access to detailed socio-demographic data, this fatality dataset highlighted how many of the fatalities (44%) were particularly vulnerable due to age (either 70 or over, or under 12) and/or had a chronic and/or acute disability. Note that these vulnerabilities were sometimes compounded—2% of fatalities had both a chronic and an acute disability; and a further 9% had a chronic disability and were 70 or over. A further factor influencing people at risk is the potential defendability of the building chosen for protection by people from fire. Again, this is not known for historical fatality datasets, but the Black Saturday data shows that questions were raised by forensic experts over the potential defendability of buildings occupied by almost a third (32%) of fatalities.

Bushfire preparedness requires some awareness of fire risk and knowledge of what to do in a bushfire situation. This is not to advocate a knowledge deficit model of communication (Wynne 1991) or to denigrate the roles of values, attitudes and norms in responding to risk. However, to survive a bushfire, people must know that the area is at risk of fire, and know of strategies to manage their personal risk. Yet just under a quarter of fatalities did not have even a general awareness that they were located in a bushfire risk area, whilst 39% lacked basic knowledge of how to mitigate fire risk. 'Stay or Go' advocates householders have knowledge about household fire fighting based on historically successful management techniques (Handmer and Tibbits 2005). This means proactive defence focused on extinguishing small ember fires, using the house for protection from radiant heat and smoke as the fire front passes whilst extinguishing any ember attacks from inside the home, before a return outside to put out spot fires—a historically successful method of household fire fighting. Many people also appeared to expect a warning directly from an official about the fire, but only 9% of fatalities received this. The Black Saturday fires' speed and intensity, combined with multiple fire fronts and fire directions, meant many people were taken by surprise by the fire or were prevented from fully implementing and carrying out their fire defence plans. Council assisting the Commission, Jack Rush QC, remarked: *'what we are calling on people to do is to fight fires in situations where we would not put our most experienced firefighters'* (Parliament of Victoria 2009).

2.2. Meteorological factors

Whilst the Commission did not find the fires represented a '*shift change that sets them apart from what Victoria has experienced from time to time in the past'* (Parliament of Victoria 2010b: 19), the meteorological conditions on the day were certainly outside the realm of previous bushfire management experience. Preceding the fires was a decade-long drought with a string of the hottest years on record, coupled with the most severe heatwave on record the week before. The weather conditions on the day broke temperature and humidity records (Karoly 2009). The changed risk due to meteorological factors was recognized by the state's bushfire agency Chief Fire Officer: *'the situation is quite clearly in a weather sense for tomorrow that we are in almost uncharted territory'* (Rees 2009).

The Forest Fire Danger Index (FFDI) includes a number of meteorological variables, and is designed on a 0–100 scale. FFDI ratings of 50 and above describe an 'extreme' fire that will burn so fast and hot that suppression is very difficult, and becomes impossible towards the top of the scale. Higher FFDI values than 100 are possible if weather conditions are particularly extreme. On Black Saturday this 'top' FFDI rating was exceeded across the state, with ratings of 120–190 recorded (Karoly 2009). Although there is no detectable greenhouse-gas-driven climatic change signal in losses from the Black Saturday fires (Crompton *et al* 2010), climate change will alter the wildfire risk into the future. Climate change will bring increased desiccation to Victoria (Alexander and Arblaster 2009). Clarke *et al* (2011) found some indication of an earlier fire season by 2050; and strong agreement for both an earlier fire season, and more severe fire weather, by 2100. Climate change is also projected to significantly increase heat wave frequency and duration (Alexander and Arblaster 2009), with attendant health implications of such heat waves on the capacity of fire fighters and householders to respond to fire risk.

3. Dealing with uncertainty

There are inherent uncertainties and difficulties associated with fire risk assessment and prediction. Physical modelling projections can be useful to assess risk, and indeed, the Black Saturday experience demonstrated the skill of meteorological prediction. On-the-day local forecasts from the Bureau of Meteorology tracked the timing of the predicted wind change which caused the fires to spread into much more densely populated areas to within minutes of its occurrence.

There are limits to such approaches though. For example, models struggle to reproduce spotting behaviour (wind blown embers starting new fires in front of the main fire) or to accurately capture the effects of local topography and micro-scale fire front induced meteorological conditions. Models work within the bounds of physical data inputs, and will never be able to account for deliberate fuel-load reduction burns in front of the main fire carried out without official permission (as happened during Black Saturday), or to account for arsonists. Uncertainty can be reduced, though not eliminated, through management techniques based on scientific knowledge of fire and fuel. Uncertainty inevitably increases as fire weather conditions become more severe (consider the spotting behaviour in two scenarios: a 'routine'

fire at <100 m, compared to Black Saturday where spotting was >25 km; and the uncertainty relative to each scenario for projecting the potential spatial spread of fire).

Different types of knowledge besides the physical sciences can help in the management of uncertainty. Fire policy needs to be informed by ethics, law, economics, management, sociology and psychology. Fire plans again provide an exemplary case here. As an integral part of 'Stay or Go', householders should have a written plan of action for days of high fire danger. Yet whilst the idea of householder plans has intuitive appeal for fire risk management, post-fire social science research indicates a wide gap between householder intentions and actions: a survey undertaken in a high fire risk area found 60% of people indicated they would leave early if a Code Red fire danger day was predicted, in line with agency advice. However, following a Code Red day, surveys indicated less than 2% of people had actually left (Whittaker and Handmer 2010). This is consistent with the fatality dataset, which contained evidence for fire plans not accounting for everyday weekend activities (a birthday party), ill-formed intentions in fire plans (no definite shelter destination, or trigger to leave) and exceptional circumstances preventing evacuation (a frail elderly relative ill on the day and unable to move). Peoples' daily lives are complex and these situations—far from being exceptions—reflect the everyday lived experiences of people living in fire prone areas likely to experience several severe bushfire alerts each year. Different types of knowledge can help to elucidate these kinds of experiences, to better manage fire risk.

Management practices also need to change to deal with uncertainty. For example, although the timing window of the wind change impacting the Churchill fire was well predicted by the Australian Bureau of Meteorology, the uncertainty in the information was not well managed leading to unnecessary risks to communities and fire fighters (Parliament of Victoria 2010b). The capacity to make decisions and allocate resources in situations of very large uncertainty is essential during a major fire. This involves making appropriate use of the limited information available, and making precautionary decisions where information is lacking or of doubtful reliability. Section 2.2 illustrates how the state's bushfire agency Chief Fire Officer warned that the day would see extra-ordinary weather. Despite this, neither the standard agency advice to the public nor operating procedures for volunteer fire fighters were changed.

4. Shared responsibility

Sharing the responsibility for risk management with those at risk has long been a mantra of Australian bushfire agencies. However, the fatality dataset shows the risk was disproportionately loaded onto householders, even though many of these people were particularly vulnerable due to their age, disability or their high hazard location: as detailed in section 2.1, 44% of the fatalities were aged 70 or over or under 12, and/or had a disability; whilst forensic experts questioned the potential defendability of buildings occupied by 32% of fatalities.

Fire agencies have considerable specialist information and expertise that they should proactively share with households and communities at risk. Agencies do share this information, but in a generalized form emphasizing household choice in dealing with fire risk. But generalized information fails to take into consideration the variable adaptive capacity of different households; for example, for reasons of knowledge, economics, geographical location, health, number of occupants or employment.

Fire agencies also need to engage communities in ways that are specifically targeted to different groups. For example, the fatality dataset has multiple cases of last minute disagreements between household members over whether to 'Stay or Go'. These were gendered with males wanting to stay and females wanting to leave, leading to people changing their plans at the last minute or failing to commit to an effective course of action in time. Earlier research has found similar evidence (Proudley 2008) but agencies have not addressed this issue.

The Commission suggests shared responsibility for fire safety extends to recommendations for building and planning. Recommendation 46, that a voluntary retreat and resettlement strategy should be implemented in areas of 'unacceptably high bushfire risk' (Parliament of Victoria 2010a: 33) has brought the strongest negative reaction of all the recommendations. However, there has been little discussion about what constitutes unacceptable risk. Identifying these areas should be a priority, especially as some locations could probably be modified to bring them out of the unacceptable category (for example, by: grading slopes around properties, making buildings more fire resistant through installing roof sprinkler systems, vegetation management and improving fire-safe access), leaving a smaller area to be covered by the Recommendation.

5. Pathways to transformative adaptation

Victoria is ill adapted to complex bushfire risk events, characterized by the attributes outlined in table 1. This is due to changing settlement patterns, especially along the peri-urban fringe; the known vulnerabilities of populations living in fire prone areas stemming from a lack of basic knowledge of fire, low levels of preparedness and/or due to physical or mental disabilities; and climate change driving a trend towards greater desiccation and hotter temperatures, influencing both fire risk and fire fighting abilities. We argue that transformative adaptation is required to effectively manage complex bushfire risk events like Black Saturday.

A disaster can temporarily create a window of opportunity for both novel and traditional forms of socio-political action at multi-spatial scales (Pelling and Dill 2010). The opportunity exists then—albeit briefly—for directed transformation: 'fundamental and deliberate adaptive change in situations where the current ecological, social, or economic conditions have become untenable or undesirable' (Nelson *et al* 2007: 397). The intention of directed transformation is

not to dictate a particular pathway for change (which is neither achievable nor desirable; Nelson 2009), but rather to open up possibilities to enable more sustainable futures to emerge (O'Brien 2012). Transformation in managing bushfire risk could begin by focusing on the following four areas within a whole of society context:

(1) *Diminish the hazard*.
Fire hazard could be reduced through prevention of initial ignition (altering electrical power distribution systems to reduce the risk of fire ignition from arcing cables during extreme fire danger days; psychological work on arson prevention) and through fuel reduction.

(2) *Reduce the exposure of infrastructure and buildings*.
This might include avoiding very high hazard areas for vulnerable uses (e.g. no housing at the top of steep, north facing, forested ridges) and improving building codes to make houses safer in extreme conditions.

(3) *Reduce the vulnerability of people*.
This could be addressed through agencies taking more responsibility for vulnerability reduction, especially by acknowledging and addressing individual vulnerabilities (e.g. accepting the lived realities of elderly and disabled people living in bushfire prone areas and supporting the development of fire plans which take their needs into account); engaging communities and other stakeholders in the development of fire planning and management, to support long-term resilience for living in bushfire prone areas (see Walker *et al* 2004); through formal fire safety training, including mental preparedness training, for those at risk.

(4) *Increase the adaptive capacity of institutions*.
Institutional change needs to occur both through mechanisms such as insurance (e.g. insurers requiring risk reduction measures as a precondition for cover) but also in changing ways of thinking within institutions in situations of very high fire risk. Examples of good practice include the Tasmania Fire Service policy of focusing on the protection of lives and critical infrastructure rather than conventional fire fighting when extreme fire danger is predicted.

'Nesting' these sorts of transformations both in time (by creating pathways with continual re-evaluation and learning) and process (through incremental decision-making embedded in longer-term transformative pathways; see Stafford-Smith *et al* 2011) will act to avoid path-dependency maladaptation later (Barnett and O'Neill 2010).

Transformation requires deep shifts in the ways in which people and organizations perceive themselves in the world (Pelling 2010), and the threat to cherished values, beliefs and identities makes this a confronting and challenging process (O'Brien 2012). Initial moves towards transformative adaptation to Victorian bushfire risk are happening—the vigorous resistance to specific Commission recommendations shows that this is a difficult task. However, a transformation in fire risk management is well needed if we are to follow the Commission's premise of avoiding a similar tragedy occurring again.

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