Science in Motion: integrating scientific knowledge into bushfire risk mitigation in southwest Victoria

Dr Timothy Neale and Dr Jessica K. Weir, Western Sydney University, and Professor Stephen Dovers, Australian National University, discuss the interface between science, policy and practice through a case study of bushfire risk mitigation. ®

ABSTRACT

Scientific knowledge and scientific uncertainties play a significant role in the mitigation of natural hazard risk. As such, the natural hazards sector is often represented as 'science-led' or 'research-led'. However, in actuality, relationships between scientific research, policy and practice are neither simple nor linear, and there are presently few studies that focus on the layers of practitioners who find themselves mediating these relationships. In order to provide insight into the integration of scientific knowledge, this paper considers the findings of a case study of bushfire practitioners in the Barwon-Otway area of southwest Victoria. This region has recently been the site of multi-agency efforts to reduce the residual bushfire risk using the PHOENIX RapidFire bushfire simulator. The paper concludes by posing several questions relevant to this and other risk mitigation contexts.

Introduction

Both natural hazards management and social research into natural hazards are typically driven by ideas and debates about human life and property. How do we reduce their exposure, and increase their resilience, to inevitable and unpredictable hazard events? In this, policies and practices have been a significant focus, while the layers of practitioners and decision makers (or simply 'practitioners') who mediate between official policy, actual practice and scientific innovation have had relatively little attention. Frequently, in studies of the sector, individuals are conflated with an agency or sector and actual practices are conflated with policy guidelines. There are many possible explanations for this research gap, but the result is that insights into the crucial relationship between physical science, policy and practice within the sector generally emerge only in extraordinary circumstances, such as when we celebrate a technological breakthrough or in the aftermath of a disaster. The first situation can perpetuate the idea that using new scientific evidence, or transitioning to a new policy, is a smooth process. The second situation often leads to an emphasis on short-term culpability rather than the long-term causes (see Eburn & Dovers 2015).

Two widespread misconceptions shape how we understand the relationships between policy, practitioners and physical science. The first is the 'pipeline model,' which suggests there is a linear relationship between science and policy; one gives answers to the other's questions (Jasanoff 2003). However, in reality, decisions about both research and policy priorities are social and political, rather than being deduced from empirical analysis. As political scientist Brian Head has suggested (2008, p.1), there are three forms of knowledge that lead to 'evidence-based policy'. These are systematic scientific research, program management experience, and political judgement. In short, empirical research (or 'science'), regulations and practice are interdependent and contingent (Hunt & Shackley 1999). Having 'policy-relevant' research or near-perfect predictions of future conditions will not make a significant difference where there are robust institutional limitations on the integration and use of new knowledge (Bosomworth 2015, Howes *et al.* 2015).

The second misconception is the assumed direct relationship between policy and actual practice. As researchers and practitioners know, this relationship is more often an elastic one, shaped by the capacities, affordances, and limitations of a given situation (Hickey *et al.* 2013). It is evident that policies are sometimes unachievable (whether due to resource shortfalls, shifting priorities, or other factors) and are often vague. Statutory objects stated in enabling legislation are typically very broad, allowing for further specification in subsidiary policy or regulations, and for flexibility in implementation and definition at the appropriate level of governance. What fire and emergency managers are meant to achieve is inevitably uncertain (Eburn & Dovers 2014), which allows judgement to be applied, but also leaves room for argument over the relative success or failure of practice. Additionally, history indicates that innovation in hazard management often requires practice to move ahead of policy, as practitioners test options better fitted to emergent research and current circumstances. In such a context, personal and professional experience, and the local knowledge of members of the community, are all necessary supplements to official rules and available evidence.

So, though it is not uncommon to hear that good science provides good evidence for good policy, these 'good' things are neither unambiguous in their qualities nor their sequence in actuality (Sarewitz 2004). Researchers, policy makers and practitioners all begin their work *in medias res* – or 'in the middle of things' – encountering an existing world of received wisdom, diverse incentives, and institutional cultures. For each, the parameters of enquiry and action may be beyond their control, strong evidence may not influence policy makers, or effective policy may face problems too urgent to wait on greater certainty. In fact, in devising and implementing strategies to reduce the probabilities and consequences of future events, risk mitigation is rife with uncertainties. In some cases their negotiation may present little obstacle, whereas in others the spectrum of 'known unknowns' may have to embraced rather than overcome (Neale & Weir 2015).

The recent history of bushfire risk mitigation in Victoria is an exemplar of the asynchronous rhythms of science, policy and practice, made possible by institutional and political factors outside the influence of any one agency or individual. Victoria is among the world's worst regions for disastrous fires (Gill, Stephens & Carey 2013, p. 493), a fact that has elicited an evolving series of policy responses including, after the 2009 Black Saturday fires, a commitment to treat five per cent of public lands with prescribed burning annually.[1] While implementing this policy, the Department of Environment, Land, Water & Planning (DELWP, formerly DEPI) has also piloted a new strategy to measure and plan bushfire risk mitigation using a two-dimensional bushfire simulator (PHOENIX RapidFire, or 'PHOENIX'), building on a history of model development and science-policy interaction. The research project focused on one specific pilot region, the Barwon-Otway area of southwest Victoria to assess how new forms of scientific knowledge were being assimilated into mitigation policy and practice. This forms one of three case studies, developed to support practitioners to explain, justify and discuss risk mitigation practices to sector professionals, the public, the media, and others.[2]

Case study and method

The Barwon-Otway area consists of over one million hectares of high bushfire hazard area in southwest Victoria. In the past two decades, its eastern coast has increasingly become a destination for tourists. This significantly increases the population during the bushfire season along the forested coastal corridor most exposed to high-intensity landscape fires between Torquay and Wye River.[3] Since 2009, the area has been used by the DELWP, in collaboration with other agencies and local governments, as a pilot site to investigate a 'risk-based' alternative strategy to the established mitigation policy (DEPI 2014). To simplify significantly (see Ackland *et al.* 2014), the alternative involves simulations and comparisons.

First is the generation of loss estimates from three suites of bushfires simulated within PHOENIX. Fires under 'worst case' (i.e. FFDI 130) weather conditions are simulated in landscapes in which there is:

- no history of planned or unplanned fire
- all public land has been burnt
- accidental fires and prescribed burning treatments have occurred.

Given the model can predict house losses from fire intensity, the three suites can be compared to reveal the baseline risk, the benefit of mitigation, and the residual risk. A more complex arrangement, also trialled, compared multiple asset losses across multiple suites of scenarios. In the words of one expert review, these techniques represent 'world's best practice' (Burrows *et al.* 2014) and provide a scientific method to both test and demonstrate the efficacy of forms of mitigation such as prescribed burning.

This case study was chosen in the anticipation that bushfire practitioners involved in this area would offer insights into the integration of science into policy and practice. To this end, 22 practitioners from the area were interviewed in November 2014 and October 2015. A brief summary is presented of their reflections on the integration of scientific knowledge and the primary uncertainties they encountered.

Integrating science

> *'It's the old saying, "all models are wrong but some of them are useful"'* Barwon-Otway practitioner.[4]

Social studies suggest that scientific models tend to be treated as 'truth machines' and as instigators, rather than participants in change. However, the practitioners in this study were cautious to identify both the limits and pitfalls of modelling and the many conditions that were necessary for its use. This meant, for example, being careful to describe the suites of simulations as 'quite good' or 'better than useful,' while also maintaining a clear enthusiasm to quantify risk; 'before PHOENIX,' as one said, 'we had nothing to gauge the effectiveness or the efficiency of our planned burn program'. Consequently, the availability of spatial datasets was cited as a condition of possibility for the new strategies, including meteorological and fire behaviour data relating to historical exemplars and also data on flora and fauna distribution and other

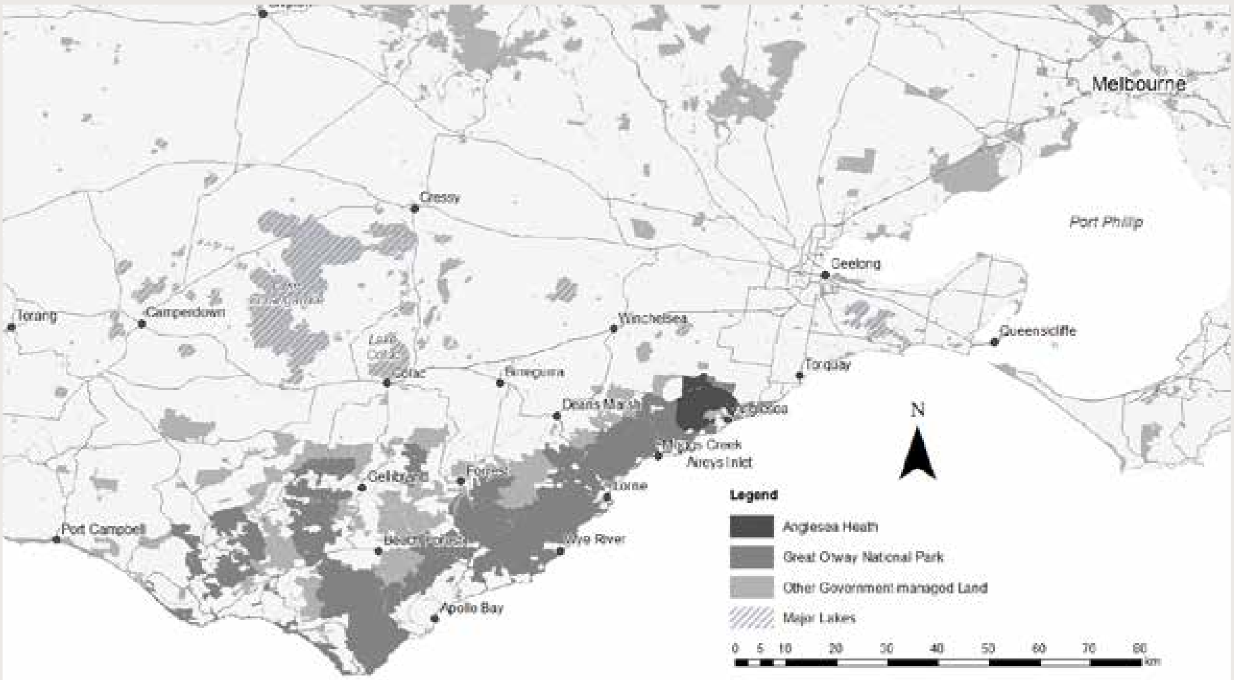
1 With the endorsement of the Inspector-General for Emergency Management, the Victorian Government has moved to a version of the risk-based approach outlined in this paper.

2 For more on the project see: www.bnhcrc.com.au/research/economics-policy-and-decision-making/232.

3 This paper and the research it draws on were completed prior to the Wye River fire in December 2015.

4 All quotes, unless otherwise noted, are from interviews with practitioners (not named).

Figure 1: Map of the Barwon-Otway area showing public lands managed by government agencies.



Source: Andrew Edwards

inputs. The successful integration of the model, and the confidence expressed in it, were linked to separate initiatives across multiple agencies.

Perhaps just as important as the model was the construction of what several described as a 'learning space' within which planning could be developed. This involved three factors. First was the existence of both formal and informal links between multiple agencies, providing the mandate for collaboration and the social conditions for it to occur. While prior initiatives were cited as important (e.g. Integrated Fire Management Planning), specific personal relationships were also frequently mentioned. 'If you have the rapport and the relationship, it works,' as one noted. Second, practitioners identified the influence of personal links with researchers and research institutions developed over several years. As one stated, 'it's not automatic that scientists and policy makers and practitioners will communicate'. Third, the pilot involved community and sector stakeholders in knowledge exchange, including an advisory group convened in multiple workshops over 18-24 months to provide feedback on model outputs. These three factors elicited a collaborative atmosphere in which 'having a go' was encouraged, to quote one, even if 'the science isn't perfect by any stretch of the imagination'. The alternative, it was openly acknowledged, was an approach in which '[we] would be just doing something and be guessing that it works'.

Institutional particularities within bushfire agencies were also reported as crucial to creating change. The most important was the leadership of senior managers and what some labelled a 'generational change'. Such agencies are typically conservative institutions, in that the management of natural hazards can lead to conditions in which established policies and practices are preferred (Rayner, Lach & Ingram 2005). To 'take the risk' of making changes, one noted, 'you've got to fight through some fairly strong headwinds'. In this instance, the position of multiple senior figures at both state and regional levels was seen as decisive, fostering interest in the model-based approach within agencies and among policy makers. The compliments to this were, on the one hand, individuals both inside and outside these agencies who were resistant and, on the other, 'a new generation of fire managers willing to try stuff'. None of these groups were simply homogenous, as, for example, the 'new generation' had a variety of tertiary qualifications and expressed diverse opinions about prescribed burning, management priorities, resident responsibilities, and other important issues. Nonetheless, what they shared was an enthusiasm for the search for alternative ways of measuring and managing risk.

Managing uncertainties

Encountering and managing uncertainties is a key aspect of natural hazards management. In this instance, practitioners identified uncertainties which illustrated both the value and limits of modelling. One of the key purposes of the Barwon-Otway pilot was to investigate how assets and values beyond human life and property, such as flora and fauna, natural resources, and social values, could be incorporated into risk calculation. Unsurprisingly, while most practitioners indicated they were confident they understood risk to 'a discrete element' such as houses, where spatial data and causal relations were clear, discussions of other impacts brought up significant

An area recently treated with prescribed burning at Moggs Creek, Surf Coast, Victoria.

uncertainties. 'The ecological stuff is, of course, a minefield of uncertainty,' for example, due to deficits in understandings of surrogacy between species. Several practitioners indicated that 'all [measures] are laden with assumptions and errors and biases,' but testing and constructing such data was a necessary part of progress requiring significant ongoing effort and investment. Assets and values other than human life must be *countable* to 'count' in such contexts. As one practitioner concluded, 'The key will be to be able to get [all] metrics right so that people can make informed decisions around what we're doing'.

At the same time, 'the unpredictability of how people will react and what they will do' during bushfires is the most significant uncertainty they face. 'The big unknown is people' in both modelling and management, more generally. This is paradoxical, in that though human life is the central concern of policy makers and practitioners alike, in a 'worst case' bushfire 'people will lose lives as a result of decisions that they made... [and less] as a result of activities that we did or didn't do'.

This is not to suggest practitioners did not think they could not affect the loss of human life, but that it is simultaneously the most important, least calculable, and least controllable variable in their work. As such, many practitioners identified how their own professional and local knowledge are necessary supplements, used to 'ground truth' modelling and inform decision-making. Several participants noted that, while agencies have historically been reluctant to release scientific assessments of risk, explicit modelling might help increase bushfire awareness. Such information is imperative to reducing risk to the public and, to a lesser extent, professional risk to themselves. The ethic, as one noted, should be 'about being open and transparent with the public'.

The third key uncertainty relates to the context in which the capacities of science can be actualised. As practitioners stated, natural hazards risk management is necessarily a politicised field. It is shaped by a mix of policy settings, community expectations, and institutional cultures. Bushfire management, for example, is affected by both internal factors, such as institutional conservatism, and external factors, such as responses by policy makers and the public to climate change, research into the effects of smoke, government expenditure, and many other factors. Notably, practitioners identified the modelling strategies as, to quote one, 'giving us something to stand on' in this changeable context. Several pointed out that though the use of PHOENIX generated a wealth of new questions. It also gave new ways of speaking 'up' convincingly to policy makers and 'out' to stakeholders.

Concluding questions

For the Barwon-Otway practitioners in this study, the transition to a risk mitigation strategy more attuned to current scientific research was neither driven solely by technology, nor was it inevitable. Its conditions of possibility were at once technical, cultural, political, and institutional, shaped by forces both for and against change. Overall, even participants who expressed contrasting views about the efficacy of prescribed burning described the transition very positively in its having provided a different basis for decision-making. As one stated, '[now] the effectiveness of the overall program can be based around something that's a little bit more objective.' Given the Victorian Government's 'brave and positive' commitment to expand the model-based strategy in mid-2016 (Penman 2015), it is worth concluding with several questions about the use of scientific knowledge now raised by this work.

The purpose of making various assets and values measurable was to produce data concerning the benefit of agency efforts. Here was a method for estimating how many species will likely be negatively affected if there is no prescribed burning, for instance, or how many houses will likely be lost if a burning program is increased or reduced. Almost all practitioners identified the multiple practical benefits of such 'objective' measures to the planning and justification, though several also noted how such measures revealed the limits of government intervention as such. If, on the one hand, suites of simulations quantified the risk removed by agencies, it also, on the other, revealed the extent to which the risk in the landscape is beyond their efforts.

So, as the strategy is extended, how will explicit quantification reshape the distribution of responsibilities between agencies and communities? Notably, while the previous policy focused upon an area target, the risk-based approach contains no explicit benchmarks. The hope, several stated, was that the revelation of residual risk would 'start a conversation' about the distribution of responsibility.

The PHOENIX simulations are highly technical, generated using datasets and parameters whose selection and limitations are not easily explained. This complexity, combined with both the commitment of many practitioners to greater transparency, and the public interest in bushfire, raises two further questions. How much of the data generated in such scientific assessments should agencies release? How much effort should agencies devote to disseminating this information? While, as Eburn and Handmer argue (2012, p. 19), there 'is no legal impediment to releasing reasonably accurate hazard information,' there are clear disincentives to releasing information that may vary in its rigour, has the potential to harm at-risk communities financially, or reflects negatively on government departments. As bushfires and their socionatural and socioeconomic costs become more severe in fire-prone regions due to climate change (Hughes & Steffen 2013), these are likely to become key questions for everyone engaged in the interface between scientific research, policy and practice.

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