

The Economics of Interface Wildfires¹

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Abstract

The new Australian Bushfire CRC (Cooperative Research Centre) is a major long-term effort intended to improve the safety of Australian communities by harnessing research for improving wildfire related policy and practice. One of the CRC's projects concerns the development of "Reliable Assessment Methods for the Total Costs of Bushfires and the Benefits of Mitigation". The initial part of this project is the subject of this presentation.

Economic analysis for flood hazard management has a long history and is highly developed for urban areas. Drawing on this extensive material, as well as existing approaches to the economics of fire and the criminological literature on the economics of arson, we are working towards the development of a model for the comprehensive assessment of the economics of interface wildfires. Special attention is paid to the "exceptional" events that contribute most fire losses – and for which suppression is problematic. In addition, the extra costs imposed by arson will be incorporated into the approach. We will be identifying the primary drivers of costs and benefits, and the main opportunities for significant cost savings in the current and likely future Australian fire management environment. Future elements of the project will examine the economic implications of different approaches to fire and fire management, and link the preferred economic model and its outputs with models of fire behaviour and suppression.

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Introduction

An appreciation of the full costs (and benefits) of interface wildfires is needed as a key input to evidence based decision-making on fire mitigation and management. For government agencies, the method needs to be based on the principles of economics rather than financial losses to individuals or areas. Existing fire economics models are generally designed for specific purposes, in particular forestry protection, and do not consider the substantial additional costs of criminal action – reducing their utility for interface fires where a significant proportion of fires may be deliberately lit.

Assessment may be made of disasters that have actually occurred or those risks which have the potential to threaten a community. Another important aim of loss assessments is to enable comparisons of actual or potential fire impacts between places, communities and with other hazards. Understanding of the causal factors that underlie losses provides the ability to synthesise losses for given risks and assists in evaluation of alternative mitigation strategies. The ability to undertake these applications of loss assessment has been hampered by the absence of a standard agreed approach. Many loss assessments fail to consider the principles of economics, further limiting their utility and credibility in the eyes of finance agencies.

This paper reports on the initial stages of a major project “Reliable Assessment Methods for the Total Costs of Bushfires and the Benefits of Mitigation”, to develop an approach for interface-bushfire loss-assessment in Australia. The project is part of the recently established Bushfire Cooperative Research Centre.

The Bushfire CRC

The Cooperative Research Centre (or CRC) program is intended to increase Australian research in the areas covered by CRCs by linking researchers and practitioners from across the nation. (Cooperative Research Centres Association: <http://www.crca.asn.au/> Cooperative Research Centres: <https://www.crc.gov.au/>)

After a lengthy and exhaustive process of discussion between the research and practitioner groups involved, the Bushfire CRC formally commenced operations late 2003 (www.bushfirecrc.com). It is one of the larger CRCs worth approximately AUD100 million over seven years involving 34 organisations with initially 30 research projects based at 20 research institutions. There are four major research themes organised into research Programs plus a Program dedicated to training and education all dedicated to providing the evidence base for better wildfire management for safer communities. These programs may evolve over time. They are:

- Increase understanding of bushfire behaviour and ability to manage (Program A);
- Develop tools for effective, safe, ecologically sound planning and use of fire in landscape (Program B);
- Increase community self-sufficiency in managing the bushfire risk (Program C);
- Develop knowledge to reduce building loss, occupant injury, fire-fighter risks and to maintain the supply of volunteers (Program D);
- Developing more fire researchers and research capacity, and ensuring transfer of knowledge to users (Program E).

This paper reports on initial thinking in one of the projects in Program C.

Economics is an important consideration in most government funded activity, including bushfire management, as a test of whether the expenditure is worthwhile.

Pressure to satisfy such tests is increasing in Australia. In loss assessments economics is frequently confused with any analysis based on money. However, an economic analysis is based on a particular set of principles which are distinct from those used by accounting for example. Non-economic approaches are generally termed financial assessments in the loss assessment literature. In defining economic losses we follow normal Australian and UK practice and include intangible losses, such as social or environmental items. Economic assessment is about (following the principles of cost-benefit analysis:

- All members of a defined society or economy, not individual firms;
- Changes to economic activity in the defined economy, not components within it;
- Market (or depreciated) rather than replacement values;
- Counting all impacts on the economy, both positive and negative.
- Economics is not about distributional effects; nor is it about commercial profit and loss.

Economic Justification

In summary, an economic analysis is concerned with the impact of an event on the economy of the area selected for analysis. Defining this economy in space and time is a key step. If it is defined as the nation, then national economic efficiency becomes the aim, rather than fire damage reduction or fire-fighting cost control per se.

Economic loss assessment is interested in the net change to the economy of a defined area. It counts the losses to the economy in this area as well as the benefits from the event being assessed. Benefits may be insurance, disaster relief funds, and increased local economic activity. To obtain "net economic loss", any benefits to the economy need to be subtracted from the assessed losses. This is one measure of the regional impact of disaster, and is the approach adopted by the U.S. General Accounting Office (GAO). For example, the GAO examined studies of the economic cost of the Sept 11 attacks in New York. The GAO endorsed a report that estimated the loss to New York City at about US\$ 83 billion, offset by US\$ 67 billion of benefits, for a net loss of about US\$ 16 billion (United States General Accounting Office 2002). (This study included amounts for the loss of life.) However, net economic loss may not always be appropriate or politically viable as an indicator of what should be spent on mitigation.

In contrast, a financial analysis is usually undertaken to assess the loss from the perspective of a commercial enterprise (or groups of enterprises). Note that assessments made on the basis of insurance data or assumptions may be quite different for tangible losses than those prepared using economic principles. One reason for this is that household insurance policies value lost items as new ones, rather than at their market (or depreciated) value.

Work on the economics of other hazards

Most effort has gone into the assessment of flood losses and flood mitigation strategies. See for example, BTE (2001) and BTRE (2002), and Handmer et al (2002). The idea of systematic loss assessment was formalised and mandated by the 1936 US Flood Control Act. Partly because of this Act, as well as the existence worldwide of large flood management bureaucracies along with the convenient characteristics of flooding in terms of its reasonably well defined spatial extent and

randomness through time, flooding is the best documented natural hazard (more properly called risk under contemporary Australian terminology, see Emergency Management Australia <http://www.ema.gov.au>). Major research groups have dedicated themselves to developing approaches for economic flood loss assessment in both the United States (e.g. the Corps of Engineers and more recently the FIA (Federal Insurance Administration) and the UK (e.g. Flood Hazard Research Centre and the Department for Environment, Food and Rural Affairs - Defra). Many other groups are active elsewhere, but few use economics as their basis.

It seems reasonable that we should draw on this long experience and on the principles underpinning flood loss assessments for national governments. The fundamental principle is that the assessments should be based on economics – and the US Flood Control Act of 1936 sets out the essentials of cost-benefit analysis. As set out above, this approach can alter the question asked from loss and/or cost minimisation to ‘what is it worth doing?’ And what is it worth doing in terms of the economy? Most work on natural hazard loss assessment has been for urban areas, rendering it broadly comparable to the interface bushfire zone. Some other potentially useful aspects of flood loss assessment are set out below.

Loss assessment for other hazards is undertaken, but for many hazards it is difficult to identify the extent and occurrence probability of the hazard, and the mitigation options may be limited or otherwise problematic. As a result loss assessment to support selection of mitigation strategies is more difficult.

An important principle of flood loss assessment and of cost-benefit analysis is that all costs (and benefits) should be included. Elsewhere in the paper we identify areas receiving little attention in assessments. Traditionally, flood loss assessment classifies loss into two major categories of loss, direct and indirect, which can be further subdivided into tangibles and non-market impacts or intangibles according to whether or not the loss can be valued in conventional economic terms. It is useful to distinguish the two types of tangible loss from intangible losses (note that we follow the traditional UK/Australian classification here):

- *Direct Damages* result from the physical impact of the hazard, for example damages to buildings. They are the most obvious and often largest losses. The minimum of economic principles are needed to evaluate these losses. The principles involved, such as estimating the economic value of assets lost, are common to all evaluations;
- *Indirect Losses* arise as a consequence of the physical impacts of a disaster event, for example disruption of transport when roads are flooded, or loss of manufacturing production from affected businesses. A distinct category of indirect loss is the potential impact of the disaster on financial markets - this would be linked with the cost of rebuilding and of insurance payouts. Such financial impacts are only likely to be severe in the case of an exceptionally large disaster. Indirect losses are more complex to evaluate, particularly because of the need to avoid double counting losses which have already been assessed as direct losses;
- *"Intangibles"* or non-market loss is a catch-all term which simply identifies direct and indirect impacts for which there is no commonly agreed method of evaluation, such as deaths, ill-health, heritage and environmental losses. Methods for estimating these impacts in economic terms are either difficult to apply, experimental, or not generally accepted; but this does not mean that they are

unimportant. Intangibles are often found to be more important than tangible losses, and efforts therefore should be made to assess and include them.

Some risk management measures can be more readily assessed in economic terms than other measures, for example, the direct losses avoided by structural works. Smaller scale alterations to buildings, making them more fire or flood resistant, may be simple to assess - but compliance with the measure has to be estimated. A similar problem arises with other mitigation measures that rely on public response, such as warning systems, or on negotiation, such as land use regulations. Again economic assessments are fairly straightforward. But there is great uncertainty over response and compliance - and the economic outcome will generally hinge upon them.

A variety of approaches to flood loss assessment (including non-economic approaches) have been developed (see also Handmer et al 2002). They can be loosely classified in three groups:

- The averaging approach, based largely on pre-existing average data on losses, e.g. an average loss per flooded property - the least expensive and quickest method Victorian Rapid Appraisal Method (RAM) (Read & Sturgess and Associates 2000);
- The synthetic approach, a detailed assessment based on pre-existing databases covering a range of average building types and contents. Loss tables are often developed theoretically or synthetically - as opposed to being based on experience (manuals from the UK's Flood Hazard Research Centre at Middlesex University, Risk Frontiers);
- The survey or historical approach is based on detailed surveys of a recent event to establish the actual loss. It is difficult to use without a recent flood.

In spite of the amount of work – and volume of publications – loss assessment guides rarely deal with economics or with intangible loss. When they do, they require a very high level of specialist expertise to use, making them expensive to apply in practice. Some inherent problems with most approaches to loss assessment are set out in Handmer (2002).

Arson

It is estimated by the NSW Rural Fire Service that approximately 50 percent of bushfires are deliberately lit (Mayhew 2003) and with bushfires between 1997 and 2002 averaging a cost of \$60 million per annum it is roughly assumed that \$30 million may be attributable to arson (Mayhew 2003). Many more result from negligence, which in some circumstances may result in police action and often require extensive investigation. These sources of ignition can result in major increases in the costs of fires. The nature of arson makes its costs difficult to quantify, and there is little, if any, empirical data on bushfire arsonists in Australia (Kocsis 2002). Not all reports of alleged arson are recorded by police, and police figures are not representative of the true extent of arson. Bushfire arson is an unusual crime in that it is not committed for monetary gain, which is often the case for its urban counterpart. Instead it seems to be a more psychologically based crime.

Bushfire arson has a huge potential for causing widespread damage, but it is difficult to assess exactly how many bushfires are truly a result of arson. Many arsonists strike during high fire risk periods. With a catch cry of 'cold fires leave hot

trails' arson investigation teams like NSW's Strike Force Tronto are utilising forensics, satellite inventory and aerial photography in their efforts to track down bushfire arsonists (McDonnell 2003a). Paradoxically, the increasing investigative technology available and the investigation teams that employ it contribute to the increasing overall costs of bushfire arson.

The more obvious costs resulting from bushfire arson are usually concerned with direct damage i.e. property damage/loss. However this is only part of the picture. It is difficult to apply dollar values to indirect losses (i.e. lost productivity, business disruption) and intangibles (Mayhew 2003) such as water catchment degradation and ecological damage (Institution of Engineers Australia: Victorian Division 1988).

In a 2003 report into the costs of crime in Australia published by the Australian Institute of Criminology, the total costs of dealing with bushfire and urban arson are estimated at \$1.35 billion; a figure which includes 'property loss, and estimates for indirect costs and intangible losses', fire and ambulance services and volunteer hours. (Mayhew 2003) This figure does not include the financial costs of the legal ramifications of urban/bushfire arson i.e. court administration, incarceration, police costs and specialised arson investigation etc. which are subsumed under other costs of dealing with crime. In comparison to the cost of arson, the annual cost of bushfires (regardless of their initial ignition cause) is approximately \$77 million (Bureau of Transport & Regional Economics 2001).

An additional cost associated with bushfires started by arsonists is that they may result in more difficult psychological recovery processes compared with bushfires that have occurred naturally. There are many anecdotal accounts of arsonists who are connected to (or who have been rejected from) fire fighting organisations. This is another facet of arson that has largely unquantified costs. Outcomes of firefighter arson include 'injuries and loss of life to fire fighters, apparatus accidents, the cost of fire suppression, damaged equipment, and negative publicity and possible liability' (Aurnhammer 2002) as well as other direct, indirect and intangible losses associated with bushfires. A selection of firefighter arson related headline from both the U.S. and Australia demonstrate that the problem is not merely a local one:

- CFA Arsonist Jailed (AAP) - Australia
- Firefighter torched school (Lenaghan 2002) – Australia
- Fayette fire chief's arson trial begins (Ove 2004) – US
- Hillcrest volunteer firefighter accused of arson (Lieberman 2004) - US

'At least 17 volunteer firefighters have been charged across Australia with lighting bushfires in the last five years' (McDonnell 2003b) leading up to 2003, yet Australia does not have a national approach to arson or any arson rehabilitation programs. Until the Bushfire CRC the cause of bushfire arson – the arsonists – has received almost no research or resources. Under the CRC there is a research program into the subject.

Opportunities for savings

Opportunities for savings should come from a rigorous appreciation of the costs of fires and the costs and benefits of the full range of approaches to fire management and community safety. Substantial benefits would flow from even a small increase in our ability to screen arsonists and prevent their activities. Preventative planning

through recognition of bushfire prone properties by local Government (Koperberg 2003) would also have a significant payoff through reducing risk as well as possibly reducing the need for service provision.

Assumptions, limitations and uncertainties

Many areas of bushfire assessment and management are the subject of widely different views and estimates – probably more than for other ‘natural’ hazards. The precise nature of the links between many approaches to mitigation and mega-fires is not well established – and it is these fires that generally cause most losses. Importantly, allowance should be made for errors in estimates, forecasts etc. This allowance may be large and a significant part of any economic assessment.

There is nothing unique to wildfire about these uncertainties and potential errors. Every part of the disaster loss assessment process contains inherent uncertainties, especially where assessment rests on assumptions about the loss of assets and behaviour of the fire in question. In some cases uncertainties may be large and irreducible through conventional data collection and analysis (see Handmer 2002). One area where wildfire may be different in degree from for example, floods and cyclones, is the potential cost of emergency response, and the potential costs associated with some hazard reduction measures such as fuel reduction burning.

Towards comprehensive loss assessment

A comprehensive approach to wildfire loss assessment needs to be based on the principles of economics and on other principles central to effective contemporary loss assessment - as widely accepted and practiced in flood loss assessment. The implications of an economic approach are set out above. A central issue in the approach is the spatial extent of the area of assessment, and the difficult problems posed by very large fires. It also needs to be comparable as far as possible with existing approaches and any differences should be set out clearly. Examples of some models already in use are outlined in *Table 1*.

Table 1—*Some existing approaches.*

Model	Description	Pro	Con
Least Cost Plus Loss Pyne, S. J., Andrews, P. L. and Leven, R. D. (1996) 'Fire Economics'. Introduction to Wildland Fire, (2nd Edn), John Wiley & Sons, pp. 425-439.	Fire suppression is only justified by the damage prevented. If more is spent on suppression than the final resource losses amount to, then the fire is often just best left to burn.	Most popular model of fire management Recognises the importance of reducing costs as well as losses	‘Until some calculus existed by which to measure fire damages, the theory could not determine the point at which cumulative costs and losses reached a minimum.’
Adequate Protection Pyne, S. J., Andrews, P. L. and Leven, R. D.	‘The level of investment in fire protection should equal that which a prudent person would be willing to invest for fire insurance.’	Recognises that some losses do occur. Is difficult to apply to ‘lands	Is difficult to apply to ‘lands without a readily calculated

(1996) 'Fire Economics'. Introduction to Wildland Fire, (2nd Edn), John Wiley & Sons, pp. 425-439.		without a readily calculated market value'.	market value'.
Minimum Damage	Aggressive fire suppression: 'losses should not exceed 0.1% of the total acres under protection, and no more than 15% of all fires should reach sizes greater than 10 acres.'	Very simple to administrate.	Aggressive suppression is not always the most desirable approach.
Pyne, S. J., Andrews, P. L. and Leven, R. D. (1996) 'Fire Economics'. Introduction to Wildland Fire, (2nd Edn), John Wiley & Sons, pp. 425-439.			
Intervention/Non Intervention	An evaluation of the Victorian Department of Natural Resources and Environment Fire Management Program (FMP). 'The net benefits of the FMP are determined by subtracting both the cost of the FMP and value of the actual damage caused by bushfires from the value of the potential damage caused by bushfires...'	Proves the worth, in dollar terms, of the Victorian Department of Natural Resources and Environment Fire Management Program.	Is specific to one particular fire management plan. Non-intervention is not an option if the fire threatens the urban interface
Bennetton, J., Cashin, P., Jones, D. and Soligo, J. (1998) 'An economic evaluation of bushfire prevention and suppression', Journal of Agricultural and Resource Economics, 42 (2), pp. 149-175.			

In addition to the principles of economics, the approach should satisfy a number of other criteria drawn from reviews of existing approaches to assessment and the expressed needs of many Australian emergency managers:

- It should support a risk based approach to bushfire management;
- as far as possible it should be designed for practical implementation, rather than for the exclusive use of specialists (see for example;(Handmer, Read & Percovich 2002);
- it should emphasise comparability between different places, fires and approaches to mitigation and fire management. This is so that choices can be made about the allocation of resources and likely returns on investment on a consistent basis;
- it should be equally useful for assessing losses after an event as well as for planning scenarios in the absence of an actual fire;
- it should cover all types of loss not simply those for which measurement is relatively straightforward.

Expanding on the last point, types of loss receiving little attention include:

- intangible costs generally, especially physical and psychological injuries, heritage and environmental damage;
- indirect losses are often poorly assessed;
- Arson – the added costs of the criminal justice system and the potential intangible costs of arson;
- The costs of waste, over-servicing etc;
- The impact of evolving approaches to fire management;
- The incorporation of uncertainties and error.

Comprehensive approaches need to consider the tension between the need to control and extinguish fires, and fire for ecological and fire management reasons.

The approach being developed is based on a modified conventional cost-benefit analysis with the addition of methods to incorporate the areas often ignored as set out above. It will sit within a step-by-step guide to assessment from the initial decision to undertake an assessment, through to presentation of the results and improvement of the datasets and method. The modifications referred to above concern the emphasis on comparability rather than the hugely variable accuracy of each individual assessment. It also refers to the possible incorporation of approaches that do not simply focus on the losses avoided by fire management – as is conventional in disaster loss assessments – and that examine instead the cost effectiveness of different fire management measures where the data is available. One approach would be to document what a particular mitigation strategy can achieve in specified circumstances where these have been established. Expenditure beyond what can be achieved may be an economically inefficient allocation of resources – and can be thought of as over-servicing. Where this is the case it may indicate an area where immediate cost savings are possible at least in theory. The policy significance is that the funds saved can be directed to areas well short of their potential. U.S. reports suggest that one reason for over-servicing, or rather waste, is the commercial nature of some wildfire fighting – where the first priority may be profit rather than suppression (O'Toole 2002) (Mangan 2001).

To help refine and reality test the approach, case studies will be undertaken as it is being developed. At this stage we expect to examine the overall costs of a major interface bushfire, and a major rural fire. In addition, more specific studies will examine the costs of arson, costs and benefits of mitigation and response, and the potential problems of errors and uncertainties in data and predictions. Where appropriate, the benefits induced by the fires or management approaches would be identified.

Economic assessments generally require making assumptions about society and fires many years into the future. An obvious social trend which should be part of any such analysis is the rapid expansion of the urban-rural-bush interface in Australia and the associated steady increase in bushfire risk. Another well documented fire-risk related issue is the strong warming trend in the Australian climate (Karoly, Risbey & Reynolds 2003). Combined with the long period of below average rainfall, this has also increased the fire risk, and it has increased the risk of exceptionally large fires with the costs and trauma they bring. There are many other trends which are probably of relevance. Among other things, these concern issues of community, volunteerism, and changing expectations among people and commerce about who should bear the risk. Ensuring that important trends are identified and as far as possible incorporated into the analysis is part of the project.

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