

BUSHFIRE MANAGEMENT: WHY, WHERE AND HOW ECONOMICS MATTER?

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Abstract

Bushfires destroy existing resources while fire prevention and suppression require resources that have alternative uses. Consequently, bushfire threat alters resource allocation affecting the well being (welfare status in the language of economics) of society. This paper explores the potential of using an economic framework to improve bushfire management through better use of scarce resources.

The effect of bushfires on the resource base and associated socio-economic impacts, resource allocation for fire management and public policy issues are some areas of interest for economic analysts. The uncertainty of the potential damage from unmanaged fire events and the impact of infrequent and massive fire events on regional economies are some of the challenges for analysts attempting to introduce economic thinking into fire management decision-making.

Economics provides a standard framework for valuing human suffering and other resources affected by bushfires. Impact assessment of major bushfire events on regional economies, and resource allocation for different programs are also areas where economic methodologies can help by better allocation of scarce resources.

Introduction

Bushfires remain as an inevitable natural event in many parts of the Australian landscape due to climate, the nature of forest ecosystems and the existence of many ignition sources (McCormick 2002; Dovers *et al.* 2004; McGee and Russell 2004). Frequent and prolonged drought and ever increasing human interaction with the natural environment has increased the threat of bushfire throughout the country. Bushfires produce distinct impacts on the resource base of the society, affecting economic behaviour. This paper attempts to explore the potential of using economic frameworks to improve the use of scarce resources to enhance bushfire management. Economic analysis not only provides a framework for analysing the behaviour of society, but is also able to provide guidelines for the best use of scarce resources.

Bushfire and Economics

Bushfires destroy available resources for production and consumption and demand scarce resources to be allocated for fire management. Consequently, society needs to allocate resources for the best social outcome. We present here a discussion on important issues associated with bushfires that are related to the concerns of economic analysis.

Bushfire and resource base of the society

The damages incurred by the sudden onset of any destructive event primarily include productive capital such as infrastructure and may effectively destroy the means of production as well as stocks (Pelling *et al.* 2002). Bushfires interfere with the productive capital stocks, natural resources and environmental services affecting production and consumption possibilities. Replacing or repairing affected capital stocks requires resources that would have otherwise been allocated for other productive purposes or consumption. The average annual damage costs from disastrous bushfires in Australia are estimated at \$ 77 million (BTE 2001). This figure does not include the financial losses caused by a large number of small-scale bushfire events every year. In addition to the direct financial costs of damage to assets and productive resources, intangible damage to the environmental resources and services such as water yield and quality, effect on the leisure and recreation are also an important part of the economic losses from bushfires. During the period from 1967 to 1999 bushfire accounted for 39 per cent of the fatalities and 57 per cent of the injuries associated with natural disasters in Australia over the same period (BTE 2001).

Reducing the risk of bushfire requires a considerable amount of financial and non-financial resources that could otherwise be made available for alternative uses. For example, the Country Fire Authority of Victoria (CFA) that involves with fire management programs in Victoria alone had an operational budget of \$186.5 million for the financial year 2003/04. The CFA employs 1100 paid staff while drawing on the services of 58, 000 volunteer fire fighter to meet its human resources requirement (CFA 2005). Department of Sustainability and Environment of Victoria spent \$ 34 million on fire management program for the financial year 2002/03 (DSE 2003). During the 2002-03 bushfire season state and territory government spent more than \$ 251 million on fire suppression activities.

Fire authorities in states and territories have deployed over 140 aircrafts at a total cost of over \$ 110 million during the same fire season (Ellis *et al.* 2004).

The expanding cities and increasing desire to live close to nature enhances the threat of bushfire to human life. The increasing understanding of the importance of environmental resources and services also increases the community expectation on bushfire suppression. Thus investment in prevention programs and acquiring effective suppression capabilities are important requirements resulting in an increasing demand for resources.

Issues associated with bushfire management

The public good nature of the “provision of fire protection” often requires government to provide the service and raised the required resources through the tax system. It is impossible for larger communities to organise themselves for receiving required protection and therefore the government has to decide the level of protection. Market forces are not the best way of deciding the level of protection as profit maximising producers are not able to run continuing fire services due to free rider problems. Thus the provision of bushfire control and the appropriate level of protection are to be decided through alternative approaches, for example, the political system. The process of political decision-making is subjected to the influence of pressure groups that lean toward government failure to provide efficient levels of fire management services required by society or individual communities.

The risk of damage to property and life is high in isolated and remote communities. These communities may not be able to acquire larger equipment with limited resources available. However, such large investments may be necessary for adequate fire protection. The provision of aerial fire suppression is one example that required federal level resource allocation due to very high capital outlay for initial investment. Thus the government faces the issue of providing adequate protection for everyone while choosing a suitable approach for financing the fire management services is an important social concern. These areas are of interest for policy makers as inherent characteristics of fire management services could yield inefficient resource uses.

The resources allocated for fire suppression should have alternative uses that benefit the majority of society rather than smaller communities or wealthy individuals. Thus the decision to provide publicly funded fire suppression services for private property protection is an important concern since such government intervention may induce private individuals to ignore the risk associated with bushfire at their decision making process.

Fire management activities such as fuel reduction burning produces ‘public bad’ such as smoke and haze that can cause health and visibility problems and lowers the air quality in urban centres (Loomis *et al.* 2004; Loureiro *et al.* 2004). Fuel reduction burning to protect remote communities can result poor air quality and visibility from smoke and haze affecting urban population. The elderly and asthmatic individuals are more likely to suffer from ill health and associated problems due to the poor air quality. Fuel reduction burning also runs the risk of escaping from control and causing large scale bushfires. Fire escapes from fuel reduction burnings can produce unexpected fire events resulting in huge losses as well as build up fuel level increasing the risk of catastrophic fire (McCormick 2002; Sanders 1995). The decisions on the adoption of such activities are of an important concern of public policy making process.

Social and economic impact of bushfire

Bushfire events can produce serious indirect effects on regional economies in addition to direct economic losses. For example, the social and economic cost of the 2003 bushfires across Gippsland and the North East Region of Victoria (in terms of loss of income and production) is estimated at \$ 121 million for the first six months (Gangemi *et al.* 2003). Areas that depend highly on the tourism industry could have been affected from the disruption of tourist attractions resulting in long-term consequences. On the other hand, there may also be positive impacts such as business expansion due to the increase in construction financed by insurance payouts and government payments.

Taking tourism as an example, loss of employment due to diverted tourist flows towards another attraction is a gain for another region resulting in economic benefits. These changes are transfers from one region of the economy to another from a national economic perspective. However, such changes can make rather big difference to the lives of the people in the region of concern. Those who are unemployed may not be able to move freely to other areas due to associated socio-economic factors. In many cases, authorities may have to divert resources for recovery programs. For example, the Victorian government allocated \$ 86 million to support recovery programs after severe fire damage in the Gippsland region during the 2003 fire season (Whittaker and Mercer 2004). Thus the economic and social impacts of bushfire are also of important concern for policy-making which thus affects resource allocation.

Economic Studies of Bushfire Management in Australia

Researchers have attempted to examine the economic aspects of bushfire management in Australia. Luke and McArthur (1978), Hatch and Jarret (1985) and Mulers (1985) are some of the initial work that examines the economic aspects of bushfire in Australia. Loane and Gould (1986) analysed the costs and benefits of introducing aerial fire suppression capabilities which provided evidence for public debate on the issue. Benefits and cost of using aerial suppression is estimated and results indicate a positive saving for several types of large and small aircrafts and helicopters under certain conditions. Bennetton *et al.* (1998) presents an economic evaluation of the Fire Management Program (FMP) of the Victorian Department of Natural Resources and Environment, responsible for the prevention and suppression of fires on public land in the state of the Victoria. The analysis estimates probable damage from fire incidences by representative year with and without the presence of public FMP in Victoria using a fire simulation model. The results of the cost benefit analysis show the ratio of benefits to costs in an average year to be approximately 24 to 1 indicating every dollar of public resources allocated brings 24 dollars worth of benefits in terms of assets not destroyed by bushfire. The use of the fire simulation model to generate information on the probable damage under alternative scenarios is an important aspect of the study.

Bureau of Transport Economics (BTE) has examined the economic cost of disaster level bush fire events in Australia. It shows that Australia experiences disaster type bushfire events frequently and bushfire is the most dangerous natural hazard in terms of risk to human life (BTE 2001). The study presents a methodological approach to estimating the economic cost of disasters and has applied it to bushfire events. The report firstly identifies the difference between the financial and economic analysis secondly separates the direct and indirect costs, as well as tangible and intangible costs of disasters. When estimating the economic effect of a bushfire event, it has not identified the beneficial effect of fire events. The methodologies developed remain more general for economic loss assessment of disaster level events. However, most of the methodological approaches suggested can be used in valuing the economic impact of a bushfire incidence.

Challenges in the Use of Economic Analysis in Bushfire Management

Bushfires produce large impacts on the environment, producing intangible costs and benefits to society. The social benefits and costs of intangible impacts of bushfire are not expressed in money value and it is therefore difficult to introduce in economic analysis. The use of economic analysis in the presence of a larger magnitude of intangible benefits and costs only produces incomplete information. Decisions made on the basis of incomplete information may not be socially and politically acceptable. Incomplete information on the costs and benefits of bushfire prevent the use of economic analysis to make fire management decisions based on economic efficiency criteria.

In the economic way of thinking, a cost avoided from an action is a benefit of that action. The economic benefits of fire suppression derive from the damage averted from suppression activities (Handmer *et al.* 2002; de Mendonca *et al.* 2004). However, damage averted from fire suppression is impossible to identify under normal circumstances. Spread of fire depends on the number of different variables such as climate, environment, topography, fuel build up etc. (i.e. Li and Magill 2001). Thus, potential damage from any fire can only be elicited using a fire simulation modelling approach. Instead, actual damage from fire is more visible and easy to assess though it may not be a simple process to complete. Thus, the use of economic efficiency measures such as cost benefit analysis in decision making remains a difficult task in fire management.

Suppression of a small fire may require much larger resources than the value of the protected resources. Such action is not economically justified. However, any small bushfire could develop into a disastrous fire bringing devastating economic losses if unattended at an early stage. Bushfire events could also result in devastating economic decline in regional communities due to the change of economic activities in that area. Thus the viability of economic analysis itself on decision-making may not be applicable on all occasions.

Economics for Bushfire Management

It is required to incorporate economic information in fire management decisions as bushfire interacts with the resource base and produces serious economic impacts on affected communities. Nevertheless, operational difficulties limit the use of economics in bushfire management. Thus, identification of appropriate analytical frameworks and limits to their use is useful for efficient allocation of scarce resources in bushfire management.

Valuing the resources affected from bushfire

Social decision-making on bushfire management should be based on economic costs and benefits of bushfire rather than the financial cost for individuals. The economic costs of bushfire include the opportunity cost of resources use in fire management and the social value of resources affected. Thus, it is required to estimate the economic cost and benefits of bushfire using standard economic frameworks focusing on the real value of resources.

(1)Valuing the resources used for fire suppression

Resources used in bushfire management include capital and human resources involved with bushfire management programs. Resources that are used for public expenditure could be used to produce other goods and services instead, that is the opportunity cost of public expenditure. The direct budgetary outlay for fire management and associated services could be considered as an identical measure of the opportunity cost of the resources allocated. With the presence of an efficient market, and if the use of resources does not affect the market equilibrium, then the financial cost of resources used can be considered as opportunity cost of the resources forgone (Broadman *et al.* 2001). Volunteers are highly involved in the human resources associated for fire management programs. However, unless the services of volunteers are not available for fire management agencies, remuneration of paid workers can be considered as the cost of the human resources involved with fire management activities.

(2)Valuing the damage to the assets and outputs

Bushfires affect assets that and the damage to any asset results in loss of return over the lifetime of that asset. The economic cost of damages to a capital asset is the sum of the discounted present values of the flow of economic returns that would have been produced by the asset. Estimation of the value of damage to houses requires further attention. The estimation of the value of a damaged house from real estate prices for the region could not be justified as house prices are highly influenced by land price. The use of a replacement price or the cost of building a similar house can also be questioned as the level of the satisfaction generated from the new house must be higher than that of the used house due to the depreciation while the opposite may be the case for others. Thus, both of these measures are not acceptable as a reasonable measure of the value of a lost house. Alternatively, net present value of the expected rental income over the life of the house could be used as an appropriate measure of the value of the damaged house.

Bushfires destroy timber resources, crops, pastures and livestock products. The economic value of the damaged products should be valued using the shadow prices that represent the real value of the outputs concerned. The damage to timber depends on the intensity of the fire and the maturity of the trees and thus there will be a salvage value of timber. The economic loss from the damage to the timber is therefore equal to the difference of the net present value of the expected income, less the salvage value of the resources. Value of damage to the crop, pasture and livestock products also required being valued using shadow prices that reflect the actual resource cost of the output.

(3)Valuing environmental cost and benefits of fire

The natural environment not only provides sources of material inputs for the economic system but it also provides life support services for people in the form of a breathable atmosphere and a liveable climatic regime, variety of amenity services including recreation, wild life observation, etc. and act as waste receptor service (Freeman III, 2003). Bushfires interact with such services that are being produced by wild land affecting the use and non-use value. On the other hand, bushfires produce some positive effects on the environment that have economic values for society.

Valuation of costs and the benefits of environmental impacts require the use of non-market valuation approaches, most widely favoured in Environmental Economics. The valuation of environmental damage is useful to complete a more accurate cost benefit analysis of alternative policies, to demonstrate the relative importance of environmental consequences and to make environmental damages more palpable (Glover and Jessup 1999). Since non-market valuation studies require time, resource and expertise, appropriate use of information generated in the existing studies may be used for estimating cost and benefits of individual events.

(4)Valuing the effect on human life

The estimates of the financial value of human life and cost of injuries will be useful in evaluating or comparing alternative programs proposed to reduce risk of death and injuries from bushfire. Thus, the use of value assigned for human life from other studies could be an acceptable approach in assessing the impact of a fire management program. There are also techniques developed for valuing human injuries through the additional cost of treatment and loss income from the affected period. Such estimates have to be used for the estimation of the cost of injuries though they are lower bound estimates as there is no consideration given for the suffering from injuries.

Economic impact assessment

Economic impact assessments evaluates the regional effects of actions on prices, outputs, employment and other economic factors focusing on how those effects are distributed across the region. The assessment of a bushfire impact on the regional economy provides an insight to the consequences or potential consequences of a bushfire

event in the area. In the assessment, the use of economic frameworks would provide a common basis for valuing the impact, giving wider acceptance by policy makers, politicians and communities. Such information would help decision makers to design recovery programs after bushfire disasters in regional communities (Handmer *et al.* 2002). Information on the possible economic impacts of bushfire on regional economies would also be useful for political decision making for justifying new mitigation strategies for remote communities.

Allocation of resources on fire management programs

Economic methodology can provide a conceptual framework for decision-makers to allocate resources for specific management programs to achieve socially desired objectives.

(1) Optimum resource allocation

The objective of bushfire management is to minimise the total resources loss from damage and suppression efforts. Enhanced preparedness for bushfire events help to reduce the damage from the destruction that comes at an extra cost for the society. Economic framework can be adopted to identify the optimal resource allocation for fire management that minimise the net resource outlay from the society.

Russell (1970) presents a graphical model to identify the best level of adjustment through the identification of minimum sum of the adjustment cost and expected losses from damage. A similar methods known as least cost plus loss (C + L) approach and cost plus net value change (C + NVC) exists for forest fire management to identify the least level of resources for fire management programs. Both approaches that attempt to identify the level of resources to be allocated for bush fire management programs could be adopted at resources allocation on bushfire management.

(2) Provision of additional resource on fire management programs

Fire management programs require additional resources for expanding their capacities to meet challenges ahead. Then the policymakers face the question of the magnitude of the expected return or net saving of resources from the unit investment as a means of justifying the intended investment. Analytical tools such as Cost Benefit Analysis (CBA) used in economic analysis would be an appropriate methodology for answering similar concerns of policy makers.

(3) Identifying alternative approaches for bushfire suppression

Fire managers can use economic tools to make informed choices among alternative fire suppression technologies. Such decisions fall largely within the fire managers' realm allowing greater economic concerns in their decision-making. Fire managers would also be able to optimise the resource use allowing them to provide most of the service from the available resources. CBA framework or Cost plus Loss approaches are important analytical tools that could be used in assisting fire managers' decision on the use of alternative suppression strategies.

Concluding Remarks

The occurrence of bushfires produces distinct impacts on the resource, affecting economic behaviour of the society. Bushfires destroy existing resources, while fire management program requires allocating resources that have alternative uses. Consequently, the presence of bushfire threats affects the economic well being of society by altering resource allocation. This paper attempts to explore the potential of using economic frameworks to improve bushfire management for better use of scarce resources.

The discussion shows that the effect of bushfires on the resource base of society and associated socio-economic impacts, and resource allocation for fire management are areas of concern for economists. The paper identifies several challenges of using a conventional economic framework to enhance fire management decision-making. The benefits of fire suppression derive from the value of the damage averted and it remains difficult to estimate the extent of the potential damage. The introduction of infrequent and massive fire events and impact of such events on regional economies into the fire management decision-making remains a challenge for the analyst.

In spite of the challenges analysts face, the use of an economic approach is more acceptable from a social decision making perspective as it is concerned with the net effect on society rather than individuals or groups of individuals. The paper shows a number of areas where economics can contribute to fire management decision-making. Economics can provide a standard framework for valuing human suffering and resources affected by bushfires especially the intangibles to reflect their true social values. Economic methodologies can also help with better allocation of scarce resources in fire management through the assessment of major bushfire events on regional economies and resource allocation for different fire management programs.

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