An Economic Analysis of Bushfires Management Programs

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Introduction

Bushfire remains an inevitable natural event in many parts of the landscape of Australia due to climatic conditions, the nature of forest ecosystem and the existence of many ignition sources (Cheney, 1995; Dovers, et al. 2004). Effects of bushfire on the resource base are twofold. Firstly, fire destroys productive assets like forests, farms and environmental resources. Secondly, strategies to provide protection from fire danger consume existing resources that have alternative uses (Ganewatta and Handmer, 2006). An attempt to minimise the total resource loss jointly from the fire management strategies and destruction allows society to utilise scare resources for the most efficient outcome. Allocating scare resources for fire management strategies requires information on the extent of economic losses from bushfires and the efficiency of alternatives. Thus information on the effectiveness of fire management strategies based on the true social cost of the resources involved is needed to achieve socially acceptable and economically efficient fire management. Nevertheless, there is no agreed approach for estimating economic losses from bushfires, nor much work done to evaluate the economic efficiency of different management strategies.

The poster proposes approaches to assess the economic effects of bushfires on local and state economies and sets out models to evaluate the economic efficiency of two key bushfire management strategies: pre-suppression and suppression. The first model arises from questions concerning the value of pre-suppression (before the fire) fuel reduction activities, and the estimation of an economically optimal resource allocation for pre-suppression. The fuel reduction burning aims to reduce losses from a major fire event. To determine how the budget should be allocated, a modification of the Cost plus Net Value Change model is being used. This model has the advantage that each of the influencing parameters is easy to adjust or even change for different areas in Australia. The second model allows straightforward comparisons of approaches to bushfire suppression, through a fire simulation model. The simulation allows comparisons of

alternative strategies under similar fire conditions. The economic utility in suppression of fire engines, dozers and aircraft is evaluated using Cost Benefit Analysis and a Cost plus Loss framework.

Review of the Literature

Though not many, several authors have attempted to estimate economic losses from fires and evaluate economic efficiency of fire management strategies. Mules (1985) carried out an Input-Output analysis of the extensive South Australian bushfires of 1983, finding that the direct economic losses for the agriculture and forestry sectors had significant flow-on effects to other sectors of the State's economy. More recently, the Bureau of Transport Economics 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). Methodological approach developed in this study to estimate economic cost of a disaster is then applied for bushfire events. The report first identifies the difference of the financial and economic analysis, and second it distinguishes direct and indirect cost as well as tangible and intangible costs of disaster. In estimating the economic effect of 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 bushfires.

The literature on the economic benefits of fuel reduction burning focuses on partial impacts like changes in tourist arrivals to areas where fuel reduction burning has been conducted and does not look at the overall picture. For example, Loomis et al. (2003) examines effects of fuel reduction burning on the impacts of wildfires while Gonzalez-Caban et al. (2003) evaluates the economic value of improved deer hunting resulting from fuel reduction burning in Southern California. They

examined the effects of fuel reduction burning on sediment in watersheds in south California using a multiple regression analysis. Prestemon et al. (2001) considered the overall increasing costs related to wildfires and developed a wildfire public welfare maximization function, to calculate the optimal amount of fuel reduction burning in a specific area in Florida. The Cost plus Loss (C + L) and Cost plus Net Value Change (C + NVC) approaches (i.e. Donovan and Rideout, 2003) are widely accepted as a tool in fuel reduction burning decision.

Bennetton, et al. (1998) presents an economic evaluation of Fire Management Program in public lands in Victoria using Cost Benefit Analysis approach. An important aspect of this study is that the use of a fire simulation model helps to generate information on the probable damage under alternative scenarios - which may rarely be experienced in practice - enabling estimates of the benefit of every dollar spent on fire management. Loane and Gould (1986) conducted a Cost-Benefit analysis of the aerial suppression of bushfires in Victoria. This is the only attempt that examines the economic efficiency of alternative fire management strategies in Australia.

Valuing the Resources Affected from Bushfire

Social decision-making on bushfire management should be based on economic costs and benefits of bushfires 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. Bushfires result in damage to capital assets, forestry and agriculture, wild flora and fauna, infrastructure, environmental resources and services and cause human injuries and fatalities. The use of standard economic framework provides estimates of cost and benefits of bushfires based on real value of resources involved.

The effects of bushfire on a community not only come from the direct effect to the resource base but there is an indirect cost associated with the damage through the loss of economic activities.

Additional resources pumped into the affected area as insurance payments or other government assistances may enhance some of the economic activities of the affected region. On the other hand, bushfire damage to a remote area could affect the entire economy of the local community through the loss of income for small businesses due to lowering expenditure of farming sector, loss of tourism activities etc. and resulting unemployment. Economic impact assessment 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 bushfire impacts on regional economies provides insights on the consequences or potential consequences of bushfires. In the assessment, the use of an economic framework would provide a common basis for valuing the impact giving wider acceptance for policy makers, politicians and communities.

Fuel Reduction Burning in Fire Management

Fuel reduction burning is the most used pre-suppression activity in Australia and is becoming more prevalent as a tool to mitigate the potentially damaging effects of increased fuel loads and also to restore natural ecosystem processes. However, the use of fuel reduction burning is contentious and is currently the focus of serious debate among policy-makers, land managers and the public. The questions asked in our current research concern the economically optimal level of expenditure for pre-suppression considering the potential damage of a major fire event, and whether an increase in the level of prescribed burning would have an influence on the economic impact of the fires. The question can be expanded by asking whether there would have been a reduction in suppression expenditure if the pre-suppression activities had been greater. It is also important to include the low risk of a fuel reduction burn turning into a major wildfire event.

To determine the optimal levels of pre-suppression which in turn minimizes the Net Value Change (NVC) factor, it is necessary to estimate first the amount of damage a major fire event might

cause, by using two to three different scenarios to give an upper, a middle and a lower range of potential damages and distribute the fire management budget in an economically optimal way, using the modification of the Cost plus Net Value Change model, that the potential damages are minimized. In this model it is assumed that an increase in the level of pre-suppression and suppression leads to a decrease in the overall losses. NVC is dependent on the level of pre-suppression and suppression, because the level of pre-suppression determines the level of suppression through the NVC function. A decrease in NVC means that the losses that occur due to a wildfire decrease. NVC is defined as the benefits minus the losses, and this definition holds the assumption that the losses always outweigh the benefits as it is assumed in this model. This is why an increase in the level of pre-suppression or suppression expenditure results in a decrease of NVC, because such an increase implies a decrease in the losses resulting from the fire.

Economic Efficiency of Alternative Fire Suppression Approaches

If fire suppression aims to minimise the total loss of resources, managers often face the dilemma in choosing from the alternative suppression approaches available (i.e. hand crew, fire engines, dozers, aircrafts and combination of them) considering the cost of operation and also the potential benefits resulting from the use of selected approach. Fire managers have to balance the trade off between the costs of a specific suppression approach with the potential damage that could be avoided by adopting that particular approach, and then compare the results across alternative suppression approaches that are available to them. We present a framework to evaluate economic efficiency of alternative suppression approaches using a methodological tools based on Cost Benefit Analysis and Cost plus Loss Analysis.

The comparison of alternatives requires gauging the performance of different suppression methods under similar fire conditions. The performance of each of suppression strategy is examined using a simple simulation model developed to represent fire spread and suppression as it is hard to

obtain information required for the analysis from field observation. From the simulated suppression approaches we are able to generate estimates for cost of suppression, as well as the value saved from the suppression action and the extent of damage for each suppression strategy. These estimates are then used to calculate net benefits and cost plus loss for each suppression strategy. Each suppression approach including a combination of different resources were evaluated separately with maximum capabilities for each alternative that could have been used with the limited resources available for fire suppression.

The results of the analysis show that the use of ground suppression resources (i.e. fire engines, dozers and combination of them with hand crew) aided with initial aerial support are economically efficient in fire suppression. The use of aircrafts for initial attack until ground resources reach the fire event produces the best outcome in fire suppression. Sole uses of aircrafts are economically acceptable in the event that other suppression resources are not able to reach the fire event within a reasonably short time period. The analysis provides economic underpinnings for the conventional understanding on the usefulness of aircrafts and their contemporary use in fire management in Australia.

The simulation model used in the analysis to estimate the damage avoided from fire highly affects on the outcome of the analysis. In order to add to the explanatory power of our economic framework, future analysis may consider adopting a more complicated fire simulation model to generate the costs of suppression, the benefits from damage avoided and also the expected damage for alternative suppression strategies. Once established these estimates could be used to generate more comprehensive net benefits and cost plus loss estimates to assist fire managers making comparison of alternatives under more realistic fire conditions.

Summary

Bushfires that remain as an inevitable natural event in many part of Australia destroy existing resources while suppression programs require allocating resources that have alternative uses. Despite the frequency and severity of bushfires, there is no agreed approach for estimating economic losses from fires or no attempt made for evaluating the economic efficiency of alternative suppression strategies. The poster proposes approaches to assess the economic impacts of bushfires on local and state economies and sets out models to allocate resource for fuel reduction burning and to evaluate the economic efficiency of different suppression strategies available for fire managers.

Social decision-making on bushfire management should be based on economic cost and benefits rather than financial cost for individuals. Economic costs of bushfire include the opportunity cost of resources use in fire management and social value of resources affected. Bushfire results in injuries and fatalities to humans and damages to capital assets, forest and agricultural productions, wild flora and fauna, infrastructure, environmental resources and services. Thus, estimates of the economic cost and benefits of bushfires can be generated using standard economic framework for valuing resources based on preferences. The approach also considers that the effects of bushfires on a community not only come from the direct impacts on the resource base, but the indirect costs associated with the loss of economic activities.

Fuel reduction burning is the most used pre-suppression activity in Australia and is becoming more prevalent as a tool to mitigate the potentially damaging effects of increased fuel loads and also to restore natural ecosystem processes. The questions addressed in the poster concern the economically optimal level of expenditure for pre-suppression considering the potential damage of a major fire event, and whether an increase in fuel reduction burning would have an influence on the economic impact of the fires. The poster presents a modification of the Cost plus Net Value

Change model, which in turn minimizes Net Value Change and potential damages, to determine optimal level of pre-suppression in fire management for a given region.

The poster also presents a framework for economic evaluation of alternative fire suppression strategies. The methodological tools used are based on Cost Benefit Analysis and the Cost plus Loss approach. The comparison was made with the maximum capability of each suppression approach that could have been used with the available resources for fire suppression. The results of the analysis show that the use of ground suppression resources aided with initial aerial support are economically efficient in fire suppression. The analysis provides economic underpinnings for the conventional understanding on the usefulness of aircrafts and their contemporary use in fire management in Australia.

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