The human health impact of the 2001-2002 'Black Christmas' bushfires in New South Wales, Australia: an alternative multidisciplinary strategy.

Benjamin John Coghlan *MBBS MPHTM*

Abstract

The Black Christmas bushfires in NSW in the summer of 2001-2002 had an impact on public health beyond the infliction of burns and eye irritation from smoke. This report analyses the failings of fire authorities, both before and during the disaster, that contributed to the enormous cost of the fires – especially the cost to human health. Such failings are largely due to community misunderstanding of the natural function of fire in the environment, and the inability of fire-managers to develop plans that supersede sectional interests. Through an examination of the literature and advice from local experts, a suggested multi-disciplinary management strategy has been developed. This strategy focuses on the need for local determination of planning and brings greater balance to the often conflicting goals of property protection, wildlife conservation, recreational resource defence, and the maintenance of optimal public health through the safeguarding of air and water quality, the moderation of global warming, and the preservation of biodiversity.

Keywords: Black Christmas bushfires, bushfire management strategies, public health, natural resources and conservation

Introduction

On Christmas day, 2001, radar images from the NSW Bureau of Meteorology showed strong westerly winds fanning almost one hundred bushfires raging in the state. The combined smoke created a uniform plume extending far out into the Pacific Ocean. This was the first indication of a crisis that would continue for almost two weeks into the next year, and that would become the longest continuous bushfire emergency in NSW history. It was a disaster that surrounded Sydney in a ring of flames, clouded the city in a haze of smoke, and taxed the resources of the entire state.

Low rainfall in the preceding winter and spring of 2001 combined with a hot December to create a tinder dry NSW coastline. As well, the prevailing synoptic pattern of large circulating low pressure systems drove hot air of low humidity from the parched outback of NSW, fashioning perfect bushfire conditions reminiscent of the weather during the massive 1994 fires.

Arsonists were largely to blame for the multiple outbreaks of fires that erupted state-wide, with authorities estimating that only a few were started by lightening strikes. Fortunately, there was no loss of life, although the economic cost ran into millions of dollars, with additional untold environmental damage and the exposure of an entire population to significant public health risks.

According to Emergency Management Australia (2002a), the NSW government spent $217 million to fight the fire, and a further $80 million dollars went to insurance claims. Approximately 50 people were directly injured by flames and smoke, and a total of 230,000 people were affected. 121 houses were destroyed and 360 people were rendered homeless. Ultimately, 650,000 hectares were burnt. Additional uncalculated multimillion dollar losses were incurred by the tourism, agricultural and forestry industries.

Given the regularity with which Australia is subject to bushfire, this paper will firstly examine their numerous potential public health impacts through a review of the literature; secondly, it will analyse the handling of the Black Christmas bushfires of NSW in 2001-2002 and highlight the issues that need further research; and finally, it will provide a suggested management strategy for use in future events.

Bushfires and health

Bushfires have shaped both the Australian landscape and the national character, fostering the spirit of mateship through fighting nature's wrath, the rural tradition of volunteerism, and the sense of a dislocated population battling to survive in a harsh antipodean world. But bushfires carry the potential for considerable adverse impact on human health. There are well recognised immediate, local effects on those combating the fire, from burns to airway damage from smoke inhalation (Liu et al 1992); there is the displacement of populations and the economic ruination of communities with destruction of housing, property, farmland and stock; and there is psychological trauma that may be delayed and persistent (Sim 2002). There also may be more widespread public health consequences such as the

effects of increased air pollution on climate change and on respiratory disease in distant populations; the contamination of water supplies; the social impact of increasing insurance premiums; the alteration of local ecology; and the unknown costs of a loss of biodiversity. It is on these more general, environmental health problems that this review will focus.

Let us firstly examine the deleterious effects of air pollution on human health. A number of studies, both in Australia and from around the world, have demonstrated consistently that particulate air pollution from burning fossil fuels is harmful, resulting in an increase in morbidity and mortality (Morgan et al 1998; Samet et al 2000). Indeed, the National Resources Defence Council of the United States asserts that up to 64,000 Americans may die prematurely each year from cardiopulmonary causes attributable to, or triggered by, particulate air pollution (NRDC 1996). Locally, the NSW Health Department tells us that 397 Sydney residents die from exposure to air pollution per year (Beder 2001), and the Australian National Environmental Protection Council claims that each 10 $\mu g/m^3$ increase in ambient concentration of particulate pollution is associated with a 3.0% rise in asthma attacks (NEPC 2001).

It seems reasonable, then, to assume that bushfires which generate vast quantities of smoke and airborne debris would lead to similar morbidity and mortality as other causes of respirable particulate pollution. We only have to recall the television images of the Sydney Harbour Bridge shrouded in a dense haze from the Black Christmas bushfires, or the smoke blanketing the skylines of Kuala Lumpur and Singapore during the 1997 Indonesian forest fires, to visualise the extent of the problem. It also seems reasonable to suspect that the Australian population, which has one of the highest prevalence rates of asthma in the world (NACA 1999), may be at additional risk. But does bushfire pollution really constitute a public health problem?

An earlier Australian study looking at the effects of pollution from back-burning in Sydney in 1991, found only a weak link between bushfires and hospital presentations for asthma (Churches and Corbett 1991), while the Cooper et al (1994) report on the 1994 Sydney bushfires failed to demonstrate any rise in asthma periodicity before, during, or after the hazard. Similarly, Jalaludin et al (2000) showed no overall association between peak expiratory flow rates in children with wheeze and levels of particulate matter less than 10 μm (PM10) during the same bushfires.

However, these articles have been criticised for their poor designs and inadequate analysis (Lewis and Corbett 2002). They contrast with a more recent and longer run study from Darwin which concluded that “airborne particulates from bushfires should be considered as equally injurious to human health as those from other sources” (Johnston et al 2002). The overseas experience generally supports this assertion. During the Indonesian forest fires of 1997, where particulate air pollution was far in excess of the Australian experience, a Singapore study reported a 30% increase in outpatient attendances for haze related conditions – though, interestingly, mortality remained unaffected (Emmanuel 2000). At the same time, the Indonesians documented an overall increase in lung related complaints (and mortality in some provinces) that paralleled the air pollution from the forest fires (Aditama 2000).

Evidence from the literature, then, seems to be increasingly supporting at least an increase in short term respiratory morbidity from exposure to bushfire generated air pollution, which is of concern when we consider that large populations are often exposed. The impact on mortality, however, is less clear, while the long-term impact on human health has yet to be determined.

The variability of results in all these studies may reflect a difference in particle size or a difference in the specific nature of the particles people were exposed to in each circumstance. Indeed, an editorial in the New England Journal of Medicine acknowledged that the elements of, and mechanisms by which, fine particles cause disease remains unknown (Ware 2000). Without a true determination of causation, current policy makers can only set (presumed) safe standards for air quality based on particle size.

This current ambiguity is of relevance to multiple sectors of the community. For instance, the cost of industry’s compliance to air pollution standards must be balanced against the savings from health benefits. But these savings are difficult to estimate when information on health effects of particulate pollution remains unclear. Pollution standards may also limit the extent of back-burning by fire preventive managers, although this must be tempered by the risk to public health from inadequate application of fire preventing techniques. Additionally, with some landowners currently seeking compensation from the government for fires that started in national parks and then spread to their properties (Limb 2002a), the government needs to consider the costs of potential litigation from people harmed by airborne pollution from either back-burning or bushfires that may have resulted from poor fire prevention on Crown land.

As well as the direct health effects of pollution produced by bushfires, there are a number of indirect consequences that may impact on even greater numbers of people. The massive scale of forest fires in Indonesia altered hydrologic and oxygen cycles throughout the world. For example, there is an expected reduction in rainfall patterns across South-East Asia, as well as the subcontinent and northern Australia, because of suppressed precipitation in clouds by the atmospheric smoke (US Dept of State 1999). This, in turn, will lead to drought and a further increased risk of fire in the coming seasons. Furthermore, the release of numerous greenhouse gases will add to global warming, a phenomenon which in itself may lead to more extreme weather patterns and an increased incidence of forest fires worldwide, including in the NSW locale (Climate Action Network 2002). A disastrous anthropogenic self-sustaining cycle may already have been set in motion. By virtue of our geographic location and local weather patterns, Australian bushfires do not directly cause significant trans-boundary pollution such as experienced South-East Asia during the 1997 Indonesia forest fires; but smoke from Australian fires has been known to transport insects across the Tasman to New Zealand (Brown 2000); and it is likely that pollution from local bushfires contributes to global environmental and human health problems.

The potential for contamination of water supplies also exists in the aftermath of a bushfire, where loss of vegetation increases sedimentation and ash run-off into catchment areas (Meyer et al 2001). Power failures can also limit the pumping of water into reservoirs. While the quality of drinking water in Sydney was not compromised during the 2001-2002 bushfires, stormwater run-off led to significant polluting of the Harbor and beaches (ABC Online 2002).

Bushfires can have far reaching effects on local ecology. The Nature Conservation Council of NSW informs us that “fire is a key agent of disturbance and change in the Australian environment” (NCCNSW 1999a), and that such changes result in a concurrent decline in biodiversity. This has been highlighted as the most important environmental problem of the next millennium (Commonwealth of Australia 1996). The rise in infectious diseases, the destruction of ecosystems, the loss of potential pharmaceuticals and natural exemplars relevant to human biology, are all outcomes ascribed to loss of biodiversity (Cassis 1998). Unfortunately, Australia has one of the worst records in the world in this regard, and change in the country’s fire regime since European settlement has been implicated as one of the causes (Flannery 1998). Thus, a greater scientific understanding of the effects of fire on specific flora and fauna species, and on the wider ecosystem, is necessary to formulate appropriate modern fire-management policies (Benson 1998). However, the expanding urban-bush interface is making it increasingly difficult to balance the protection of human health and property, and the conservation of biodiversity. This latter fact is one of the main reasons for the substantial costs incurred by public bodies and insurance companies. The 2001/2002 NSW bushfires are estimated to have cost insurance companies nearly $80 million. Not surprisingly then, fire insurance premiums are on the increase, particularly in urban fringe areas, and insurers are rightly demanding a greater involvement in planning to mitigate the costs of fire damage. Research has also been conducted into the economic benefits of fire prevention and fire fighting strategies (Bennetton et al 1997).

Australians must consider bushfires an inevitable feature of our environment and recognize the ongoing need for investigation of the multifaceted nature of the impact of this natural hazard. This, in turn, should allow the formation of fire-management regimes that are ecologically appropriate, offer the best outcomes for public health, and make economic sense.

Analysis

The first indication that the many bushfires circling Sydney in late December, 2001, were of a magnitude beyond that usually experienced in the NSW fire period was provided by the Bureau of Meteorology. From this information, coupled with direct local reports, the fire authorities determined and instituted the necessary operational measures. In this case, the fires were largely beyond metropolitan Sydney and thus were the responsibility of the NSW Rural Fire Service. This agency is headed by a Commissioner tasked with establishing bushfire preventive measures, organizing the fire suppression response by the NSW Rural Fire Service, and coordinating the actions of all other agencies involved during bushfire occurrences. Ultimately, the commissioner answers to the NSW Minister for Emergency Services. Hence, the states are responsible for the management of disasters within their own borders. They can, however, call on Federal assistance via Emergency Management Australia, an office of the Attorney-General, that coordinates physical aid granted to the states during major disasters (EMA 2002b).

Lack of preparation

During the 2001/2002 NSW bushfires, all these agencies played a role. The Commissioner and the Minister for Emergency Services struggled to mount a response sufficient to contain the numerous fires throughout the state, despite having some 9,000 volunteer fire-fighters directly involved in fighting the fires. Consequently, the NSW Fire Brigade was called upon to combat fires on the outskirts of Sydney; inter-state aid was provided in the form of additional fire-fighters from rural based services in Queensland and Victoria; and an aerial water bomber from the USA on lease to Victoria was hired, with an additional two of these helicopters acquired by EMA from America. As the disaster continued and criticism mounted, both federal and state politicians weighed into the debate.

Though the efforts of the fire-fighters ultimately prevailed with no loss of human life and thousands of threatened homes saved, recriminations relating to almost every aspect of the government's response to the disaster were as widespread as the fires.

The state's preparation for the bushfire season was seen as a particular shortcoming, with the issue of back-burning of most concern. Phil Cheney, a CSIRO scientist and bushfire specialist, accused the government of failing to provide adequate back-burning throughout NSW (Wainwright 2002). He claimed that the NSW Rural Fire Service had unwisely assented to the demands of the vocal green voice of the population by placing conservation ahead of fire prevention. This sentiment has been echoed more recently by loggers and Republicans in the United States, where a series of wildfires in the American West late this year sparked similar debate (Madsen 2002). This is indicative of a worldwide difficulty in striking a balance between industry and conservation, sustainable ecology and hazard reduction.

While the Commissioner of the NSW rural fire service, Phil Koperberg (2001), recognizes Cheney's call for hazard reduction, he states that back-burning must be strategically applied not mere broad acre burning. He also claims that sustainable ecology and protection of property are not mutually exclusive, and that appropriate management is best determined by local councils bringing together all viewpoints. To this end, he says, the NSW Government has established local bushfire-management committees in the aftermath of the 1994 bushfires. Such a measure has been recently endorsed by the United Nations International Strategy for Disaster Reduction (2002).

However, in NSW these committees may not in practice truly represent the broad spectrum of views. For instance, the NSW Farmers Association has criticized the NSW Parks and Wildlife Service (NPWS) for having "neglected to back-burn in the winter or take the advice of the local population who have been fighting fires successfully…for 100 years" (Devine 2001). In some regions, angry farmers who lost property and stock are even seeking compensation from the NPWS by challenging their fire preventive practices in the courts. As Hans Peterson of the NSW Farmers Association stated, "they say that they have fire hazard reduction policies….but people with common sense can see it's very little. You just have to breathe the air to know it's not enough" (Devine 2001).

Cheney is convinced that only sound scientific research can point the best way to fire-management - though there are currently less people involved in this field of study than in 1983 after the Ash Wednesday fires and more funding is urgently required (Wainwright 2002). He asserts that a sound model already exists in Western Australia, which has the "nation's most effective and scientific fire-management" (Devine 2001). The key to that state's avoidance of significant bushfires being said to be its extensive program of prescribed burning. Cheney is keen to point out that Parks and Wildlife officers in WA allocate 25% of their time to fire-management compared to only 6-7% in NSW. This is a result of "the mind-set of the population" (Devine 2001). Schauble (2002) concurs: "Instead of accepting fire as part of the country we live in, we tend not to think about it until the flames are lapping at the back fence… Each summer, our failure to think about this symbiotic relationship between man, land and fire, finds expression somewhere on the continent."

Indeed, these latter ideas find validation in the expansion of all Australia's major cities into fire-prone bush as people search for a cheaper and greener alternative without regard to the inherent fire risk. Urban fringe dwellers are often complacent in their preparation: from disregarding land clearance around their homes, to failing to adequately insure their homes. The Insurance Council of Australia estimates that 30% of the population do not insure themselves against fire, while 40% of those that do insure have inadequate levels of coverage (Rao 2002). Given that the individual cannot be relied upon, and given the history and increasing frequency of fires in our country, Glenn Albrecht, an environmental scientist from the University of Newcastle, believes that we must seriously and "systematically consider whether or not people can live safely in these areas" (Limb 2002b). He would establish a mandatory buffer zone between where humans are living and where forested areas

commence. Conversely, Lindsay Johnston of the CSIRO, would not restrict where a person lives; rather, he would minimize the risk through education and responsible development (Limb 2002b). Johnston is currently investigating if housing design and construction can be sufficiently improved to build relatively fire-resistant dwellings. At the very least, then, our urban planning authorities appear to be neglecting their responsibilities (Schauble 2002).

Management structures and resources

The rapid suppression of large bushfires limits the extent of environmental damage and the risk to public health from the generation of pollution. The fire service response is dependent upon management structure and the availability of sufficient fire fighting resources. These aspects of the Black Christmas disaster will now be examined.

The state government cites changes made after 1994 in the infrastructure and management of fire fighting bodies as some of the most significant developments. Rewriting the Bushfires Act has created a flatter, more streamlined organization with clear chains of command and reduced political friction between the two fire services (Wainwright 2002). There is now a joint fire fighting services standing committee allowing the NSW Fire Brigade and the NSW Rural Fire Service to settle differences and plan more effective mutual operations. A speedier system to access Federal assistance was also earmarked as a major advance (EMA 2002c).

While the Minister for Emergency Services, Debus, celebrated the synchronized actions of the metropolitan and rural fire services during the Black Christmas fires, the NSW Fire Brigade Employees Union claimed that problems in coordination still persisted (Wainwright 2002). The union secretary, Chris Read, ridiculed the joint services standing committee, demanding instead a single state fire service with uniform equipment and training (Robinson and Gibbs 2002). But Debus maintains that amalgamation of the volunteer country service with the professional city brigade "would be a culture clash of such profound dimensions that it would take the new organization a generation to recover" (Wainwright 2002). Nonetheless, the discord of opinion within the organization suggests that even the vaunted management structure amendments could be further improved.

The application of expensive technology in the form of helitankers was praised by the media and politicians, including the Prime Minister, for saving numerous houses. John Howard even offered to buy a number of the sky cranes. Conversely, Premier Carr, while admitting that the capacity for aerial bush-fighting was of value, stated that "the experts said that fire fighting on the ground was the way to beat fires" (Crichton and O'Malley 2002). Schauble (2002) went further, accusing the Prime Minister of, once again, blindly following the US and ignoring indigenous solutions in favor of the typical "American response of looking for the biggest and brightest technological solution to disaster".

Technology has the potential to be of more general relevance in the forecasting of bushfire behavior. Although in its infancy, bushfire forecasting has become a great asset to the fire-fighters on the ground, establishing some measure of predictability. Yet "the Australasian Fire Authorities Council described the current level of national fire research as negligible, compared to the cost of controlling the fires" (Darby 2002). As with fire prevention, study into fire behavior has taken a back seat to spending on more tangible assets like fire trucks and stations with perhaps greater political mileage.

In addition to exposing our limited understanding of bushfires, the Black Christmas fires have also raised a number of legal issues. The state reliance on volunteer fire-fighters is traditional and cost-saving for the government, but there is a legal and moral obligation to ensure adequate equipping and training of this volunteer force. The costs to employers who lose part of their workforce often cannot be borne, in some cases necessitating dismissal of employees who failed to attend work because they were fighting fires. The NSW government is considering legislation to protect the jobs of volunteers and even their pay while they fire fight (West and Watson 2002); in contrast, the federal government supports the employers. The Employment Minister, Tony Abbott, did however comment that "employers should be 'understanding enough' to realize volunteer fire-fighters are performing a community service" (Toohey 2002). But this is of little relief to those fire crews on the ground who may agonize over the choice of job, property and community spirit.

Tougher punitive measures against arsonists and a state register of fire-bugs are preventive legal measures being brought in to deter would be offenders (West and Watson 2002). Australia is not generally subject to 'economic arson' as practiced by businesses and slash-and-burn farming in many non-developed countries. Rather, fires are lit by individuals, often young locals. Boredom and social deprivation are seen as inducers and it has been claimed that education and social improvements would

be a better way to reduce fire setting (Canter and Almond 2002). Nonetheless, arson remains a complex psychosocial problem without an obvious pre-emptive strategy.

Positive aspects

One aspect of the Black Christmas fires that was managed without criticism was the maintenance of water quality. An American study has demonstrated the value of using vegetation to avert erosion in areas at risk due to denuding of the natural flora by bushfires (Meyer 2001). This protects water catchment areas from solid waste including heavy metals in the run-off. Sydney Water (2002) employed this measure and also increased the number of water quality monitoring points, the frequency of testing, and the physical protection of dams most subject to ash and debris pollution. Monitoring of recreational water bodies such as the harbor was also undertaken and warnings were issued when it was recognized that significant pollution from stormwater run-off had occurred.

The media was the vehicle used by the government to disseminate warnings of fire risks, and harbor and air pollution. Overseas research has highlighted the benefits to public health of public service announcements including recommendations to stay indoors during times of severe air pollution from wild-land fires (Mott et al 2002). This study also suggested that the use of particulate air cleaners could reduce respiratory morbidity – a measure which has never been trialed in Australia. John Winter, the director of corporate communications for the Rural Fire Service, praised the role of the media during the Black Christmas fires: "They have helped ensure the public gets a clear message about what is going on and how they should prepare for it. And they have provided an information flow from the public to front-line fire-fighters" (Huxley 2002). Nevertheless, allegations of inflammatory reporting and inaccurate information were common. Winter accepts this as an inevitable risk of using the media, but believes that on the whole "they [the media] have been extraordinarily responsible" (Huxley 2002).

"If the success of defeating the fires of 1994 was a miracle, then the bushfires of 2001-2002 should be seen as a triumph of lessons well-learnt and money well spent" (Wainwright 2002). While this holds true for some measures – less than one percent of threatened homes were destroyed, for example – the outcry of sectional interests in the wake of the fires suggests that the overall management of fire fighting in NSW remains imperfect. It is the task of the responsible bodies to heed these warnings and so reduce the negative interactions between our environment and the health of the Australian population.

Management Strategy

The need for management practices to consider and prepare for the multifaceted impact of bushfires was stated in Judge Stretton's Royal Commission report into the 1939 Black Friday bushfires in Victoria. He noted that "the full story of the killing of this small community is one of unpreparedness, because of apathy and ignorance, and perhaps of something worse" (Schauble 2002). His statement acknowledged the European alteration of the Australian bush, our poor understanding of fire ecology, the frequency of arson, and the paramount need for multi-disciplinary planning to mitigate disaster. As the historian Tom Griffiths points out, "That means not just managing a crisis when it happens, it means managing all year round for the crisis that will inevitably happen" (Lee 2002). This report will now address this issue through detailing the best management strategies to employ before, during, and after a bushfire to reduce the risks to human health.

Fire prevention

Hazard reduction

Hazard reduction is a core element in preventing bushfires. Cheney, a senior CSIRO scientist, has said that there are three factors that determine the magnitude and frequency of bushfires: the weather, the amount of fuel available and human behavior (Limb 2002a). Given that we cannot influence the weather in the short term, or limit the actions of all would-be arsonists, the only factor under our control is reduction of the fuel load in the bush through a carefully planned policy of bushfire preventive practices. History supports this assertion: the systematic mosaic burning practice of pre-European aborigines was both a farming technique and a successful wildfire-management strategy (Lee 2002); planned burning employed after Judge Stretton's findings in 1939 somewhat ameliorated the effects of subsequent fires in Victoria; and the NSW Black Christmas bushfires were blamed in part on inadequate back-burning. However, the extent to which this strategy can be applied remains contentious because of its unknown ecological and public health effects. Thus, any policy of back-

burning must be open to change as communities alter priorities and as research provides new information.

Consideration of global issues with local ramifications

Cheney's belief that fuel reduction is the only controllable factor influencing fires ignores the wider consequences of man made environmental change on human health and potentially narrows the focus of management to short-term control measures. Perhaps this example was set with the consuming style of European colonization of Australia and the pre-eminence of agricultural development over conservation (Flannery 1998). Modern parallels are seen in our Federal government's refusal to endorse the Kyoto treaty. While we cannot change the weather on cue, our government has noted "that the balance of evidence suggests a discernible human influence on global climate" (Guest 1997). This is likely to create extremes of weather and more frequent and intense wildfires across the world, including in NSW (Climate Action Network 2002). In this light, the Australian government has an obligation to support global action for global sustainability and so limit anthropogenic fire conditions in rural NSW. (A detailed discussion of this is beyond the scope of this report.)

Health and environmental research

The conservation argument recognizes the varying effects of fire on individual flora and fauna species. Rainforests, for example, are unlikely to survive fire (NCCNSW 1999b), whereas the rock wallaby is at risk because the exclusion of fire has altered its habitat. Scientists are currently cataloguing the optimum frequency, timing and intensity of fires needed for all native plants (Lee 2002). But more funding for research into fire ecology is needed.

The notion that pollution from burning off can elevate morbidity and mortality in an exposed population has already been discussed. While a Darwin study suggested that "airborne particulates from bushfires should be considered as equally injurious to human health as those from other sources" (Johnston et al 2002), a Singapore report after the 1997 Indonesian forest fires where pollution was significantly greater concluded "that health effects … were generally mild" (Emmanuel 2000). One can tentatively conclude, then, that the impact on public health from pollution from smaller, planned fires is likely to be slight and certainly less than an uncontrolled bushfire. Advance warnings to the general community would further reduce any risk. The benefit of public service announcements has already been validated (Mott et al 2002). A safe level of particulate air pollution, however, must still be ascertained. Obviously this is important for health, but also for economic reasons: it has been demonstrated that compliance to smoke emission standards significantly affects prescribed burning costs (Gonzalez-Cabin 1997).

Local Fire-management

The above factors indicate a need for local determination of fire-management - an approach endorsed by the United Nations International Strategy for Disaster Reduction (2002). The NSW authorities have already set up such a system, though it appears that these local fire-management committees are not always functioning as planned. Broad spectrum representation must be mandatory, encompassing the view of local business, conservation groups, national parks and rural fire services, and landowners – thereby circumventing any particular sectional interest. Each committee would have links to specialists, like fire scientists and biologists, who would provide expert advice. Plans must also be posted for public examination to allow any interested parties to voice an opinion. Local committees would be monitored by the Rural Fire Service commissioner to ensure uniformity of structure and confirm that actions are in line with state goals.

In addition, NSW must follow the example of the Western Australia Parks and Wildlife Service in allocating at least 25% of officer's time to fire-management and plan their fire maintenance a minimum of seven years in advance (Devine 2001). There should be a graduated move towards the more developed US federal wildlife policies, which require managers to plan up to a century in advance (Southwest Regional Assessment Group 2000). Alternatively, the state could train specific full-time fire officers to act as advisers to the local fire committees.

Strategies to limit arson

Minimizing arson is extremely difficult. Tougher sentencing makes sense and the NSW government is already working to introduce this. But it is recognized as relatively ineffective for juveniles, who may have a poorly developed sense of consequences, and for people with psychopathology (Canter and Almond 2002). Education is seen as an alternative option. Fire information programs could be run

through schools by the rural fire brigade. Australian psychosocial studies examining the reasons behind bushfire-lighting would be of benefit, and government grants to academic institutions could facilitate such research.

Urban planning, building standards and Insurance

The failings of individuals to adequately prepare for bushfires and the massive resources required to defend an ever increasing urban-bush interface justify strict pre-emptive strategies. Limiting where people live, as suggested by Glenn Albrecht (Limb 2002b), may be an extreme though necessary measure in certain highly fire-prone regions. This idea of fire hazard zoning, first proposed in the 1930's in California, should be implemented (Babbitt 1999). This would allow the establishment of building standards incorporating the emerging fire-proof housing designs from the CSIRO (Limb 2002b) or existing American codes in pyrogenic areas like Lake Tahoe (Babbitt 1999); and it would suitably alter the availability of insurance. Buffer zones between residences and forests could also be created. Community education programs on how to reduce the fire risk of properties and the importance of fire-insurance is advisable.

Satellite mapping

Technologies for mapping vegetation type, fuel load, moisture content and rainfall are improving. This data will provide the means to ascertain high fire-risk regions (North Australian Rural Fire Managers Technical Workshop 1996). Satellite imagery of 'fire-scars' will highlight deficiencies in protective programs and allow improved planning. These tools, however, are in the early days of validation and standardization, and further improvements must be urgently funded. As well, the processing of information and timely delivery to end-users, such as local fire-management committees and Rural Fire Brigade Services, must be streamlined.

Fire fighting

Manpower and resources

Prompt containment of large bushfires reduces environmental damage, risks to public health from greenhouse emissions, and air and water pollution. A rapid response is related to management structure and the availability of sufficient fire fighting resources. Australia is reliant on volunteer fire brigades outside metropolitan areas. For reasons of economy and community cohesion, this tradition must be protected. Government legislation to protect jobs and salaries of volunteer fire-fighters employed by large companies, who take time off to battle bushfires, is needed. Those employed by smaller firms that may not have the capacity to endure the loss of staff, should be encouraged to negotiate arrangements with their employers to guarantee continued employment post-event. A government sponsored education campaign on behalf of volunteer fire-fighters would go a long way to raising community awareness of this issue, achieving, as Tony Abbott said, employers who are "understanding enough" to realize volunteer fire-fighters are performing a community service"(Toohey 2002).

The NSW government has updated fire fighting equipment and improved the quality and regularity of training for volunteer fire-fighters. Nationalizing these standards and improving links between inter-state services, would facilitate coordination of cross-border actions, necessary in major bushfires.

Management Structure

The improvements in management structure legislated after the 1994 Sydney bushfires have resolved failings in infrastructure and enhanced coordination between rural brigades. The Commissioner is now well placed in the central role of managing the input of all agencies involved in fire-management. Amalgamating the city and country brigades is unnecessary given the formation of the joint standing committee which allows planning of harmonized action during bushfires. As the Minister for Emergency Services, Debus, asserts, the vast differences in purpose and expertise between the two services, militates against a successful merger (Wainwright 2002).

Aerial Fire fighting

Helitankers are invaluable in saving homes from incineration and in dampening intense conflagrations to allow ground crews in to contain fires. Australia does not own any of these machines, but has in recent years leased them from the US. However, it is generally accepted that air power is "not a panacea to all the problems" (Wainwright 2002) and that "fire fighting on the ground is the way to beat fires" (Crichton and O'Malley 2002). In the US, where the aerial war is fought in earnest and where the

budget for fighting wild-land fires has risen to US$1 billion, Babbitt (1999) has questioned the "escalating confrontation" between "the contending forces of man and nature". An assessment of the cost effectiveness of sky cranes is needed before Australia spends AU$15 million for just one helicopter. In the long term, a well conducted fire-preventive strategy may eliminate the need for these machines.

Bushfire tolerant policies

The recognition of the natural function of fire on the environment has led to the notion of fire tolerant policies in the America Southwest. Naturally started fires are allowed to run where safety permits, with only light fire fighting intervention (Babbitt 1999). Natural fire-regimes are restored, risks to fire-fighters minimized, and costs are dramatically cheaper than full suppressive efforts – US$35 per acre as compared to US$500-1000 per acre (Babbitt 1999). This policy change should be adopted in Australia, providing the issues of the urban-bush intermix (as mentioned in fire prevention) are resolved - otherwise the dangers to life and property would be prohibitive.

Public warnings

Publicly broadcasted warnings regarding high fire-risk weather conditions, smoke and water quality alerts are a necessary and proven primary public health intervention (Mott et al 2002). Existing measures, such as a rural fire service media liaison office that operates 24 hours a day during a crisis, are adequate. A minor improvement would be to enhance doctor awareness of the potential harm of particulate pollution - particularly medics involved in treating patients most susceptible to the effects of bushfire smoke. The option of using air cleaners to reduce respiratory morbidity may be appropriate for some individuals (Mott et al 2002). This measure must be further explored in the Australian circumstance.

Water safety

Sydney Water's measures to protect the quality of drinking water during the 2001/2002 NSW bushfires included increased water quality monitoring, protection of water reservoirs from solid pollution using nets, and fencing and re-vegetating catchment areas at risk of erosion. Public warnings were issued when there was contamination of Sydney harbor by polluted storm-water run-off. The only required improvement is the installation of back-up generators for water pumps that failed when fires cut the electrical supply (Sydney Water 2002). Theoretically, this could have compromised water quality.

Bushfire predictive technologies

There is a need to develop more accurate bushfire modeling and establish a system of rapidly conveying this information to managers on the ground. This would provide a measure of predictability, improve the suppression of bushfires, and minimize the risk to fire-fighters. Further investment in research, for example infra-red monitoring and computer modeling of fires at Monash University (Bruce 1999), is required.

Post-fire recovery

Insurance and welfare

These important issues are already well served by the Insurance Disaster Response Organization, and the NSW Disaster Response Plan and State Welfare Services. Welfare is also supported by religious organizations like Anglicare.

Land care

Despite our best preventive measures, fires will occur and devastate parts of Australia. There is a need for adequate funding to allow environmental assessment of affected areas, to ensure that regeneration occurs in a manner that suits local needs, and to maintain biodiversity in the interests of human health and conservation. For example, spring burns can have dramatic effects on native fauna with high mortality among young from diminished food availability and increased exposure to feral predators (National Conservation Council of NSW 1999b). Particular measures may be necessary for the preservation of some species of plants and animals.

Psychological trauma

Several Australian studies have shown that bushfires increase psychological morbidity amongst fire-fighters and in communities which have experienced loss (McFarlane and Raphael 1984; McFarlane 1988). In general, these effects are chronic and delayed, and may require ongoing psychological and medical intervention. Overseas studies into non-bushfire disasters have suggested that immediate psychological debriefing after the incident may actually be harmful (Rose et al 2002). The best initial approach to prevent psychological problems may merely be the "prompt provision of practical help and the immediate facilitation and restoration of a sense of community" (de Jong 2001). This could be combined with offers of counseling for those so inclined, and with ensuring that local doctors in fire affected regions are aware of this potential problem.

The evidence in the literature suggests that the introduction of these policies would ensure a more comprehensive approach to fire-management in NSW and Australia, one that would bring a greater balance to the often conflicting goals of property protection, wildlife conservation, recreational resource defense, and the maintenance of optimal public health through the safeguarding of air and water quality, the moderation of global warming, and the preservation of biodiversity.

References

Aditama TY (2000) Impact of haze from forest fire to respiratory health: the Indonesian experience. Respirology, 5:169-74.

ABC Online (2002) Bushfires raise concerns over Sydney water quality. Australian Broadcasting Coorporation, http://abc.net.au/news/newsitems/s454098.htm.

Babbitt B (1999) Making peace with wildland fire. Wildfire, 8:12-17.

Beder S (2001) Every breath you take. Engineers Australia, July:52.

Bennetton J, Cashin P, Jones D, Soligo J (1997) An economic evaluation of bushfire prevention and suppression, Melbourne - Department of Economics, Papers Series No. 598.

Benson J (1998) Fire and vegetation. National Parks Journal, http://dazed.org/npa/npj/199808/npj9808b.htm

Brown J (2000) Black Christmas fires. Weather-Wise.com, http://www.weather-wise.com/fire/blackxmas_2001.htm.

Bruce D (1999) Playing with fire. Monash Magazine Issue 4 Spring/Summer.

Canter D and Almond L (2002) The burning issue: research and strategies for reducing arson, Office of the Deputy Prime Minister of the UK, http://www.odpm.gov.uk/safety/fire/rds/research/arson/pdf/strategy.pdf.

Cassis G (1998) Biodiversity loss: a human health issue. MJA 169:568-9.

Churches T, Corbett S (1991) Asthma and air pollution in Sydney. NSW Public Health Bulletin 8:72-3.

Climate Action Network Australia (2002) Coastal NSW and Sydney – climate change impacts, CANA, http://swiftek.modwest.com/cana/climate_cnsw.html.

Commonwealth of Australia (1996) Australia, state of the environment. An Independent report presented to the Commonwealth Minister for the Environment by the State of the Environment Advisory Council. CSIRO Publishing, Melbourne.

Cooper CW, Mira M, Danforth M, Abraham K, Fasher B, Bolton P (1994) Acute exacerbations of asthma and bushfires. Lancet 343:1509.

Crichton S and O'Malley N (2002) They work marvels but water bombers still under review. The Sydney Morning Herald, http://old.smh.com.au/news/0201/03/national/national7.html.

Darby A (2002) Smoke on the water…the ocean may answer every firey's prayers. The Sydney Morning Herald, http://old.smh.com.au/news/0201/24/national/national5.html.

de Jong, K (2001) Uses and abuses of the concept of trauma: A Response to Summerfield, The Refugee Experience, http://earlybird.qeh.ox.ac.uk/rfgexp/rsp_tre/welcome.htm

Devine M (2001) Managing a burning issue. The Sydney Morning Herald, http://old.smh.com.au/news/0112/30/national/national10.html.

Emergency Management Australia (2002a) Disasters database. Attorney General's Department – Commonwealth of Australia, http://www.ema.gov.au.

Emergency Management Australia (2002b) Disasters - Community Information. Attorney General's Department – Commonwealth of Australia, http://www.ema.gov.au.

Emergency Management Australia (2002c) What is emergency management. Attorney General's Department – Commonwealth of Australia, http://www.ema.gov.au.

Emmanuel SC (2000) Impact to lung health of haze from forest fires: the Singapore experience. Respirology 5:175-82.

Flannery T (1998) Eating the Future – Hypotheses. Australian Broadcasting Corporation, http://www.abc.net.au/science/future/theses/theses3.htm.

Guest C (1997) Special pleading at Kyoto. MJA, 167: 567-8

Gonzalez-Cabin A (1997) Managerial and Institutional Factors affect prescribed burning costs. Forest Science, 43(4): 535-43

Huxley J (2002) Firefighter's friend is not impervious to a bad reception. The Sydney Morning Herald, http://old.smh.com.au/news/0201/07/national/national8.html.

Jalaludin B, Smith M, O'Toole B, Leeder S (2000) Acute effects of bushfires on peak expiratory flow rates in children with wheeze: a time series analysis. Aust. NZ J. Pub. Hlth. 24:174-7.

Johnston FH, Kavanagh AM, Bowman D, Scott R (2002) Exposure to bushfire smoke and asthma: an ecological study. MJA, 176:535-8.

Koperberg P (2001) Cool heads needed in the heat of passion. The Sydney Morning Herald, http://old.smh.com.au/news/0201/07/opinion/opinion2.html.

Lee T (2002) A burning issue. Landline, http://www.abc.net.au/landline/stories/s519892.htm.

Lewis PR, Corbett SJ (2002) Bushfires, air pollution and asthma. MJA, 176:517.

Limb J (2002a) Call for more back-burning to prevent bushfires. Landline, http://www.abc.net.au/landline/stories/s519888.htm.

Limb J (2002b) New standards to make fire-resistant homes. The 7.30 Report, http://www.abc.net.au/7.30/s465915.htm.

Liu D, Tager IB, Balmes JR, Harrison RJ (1992) The effect of smoke inhalation on lung function and airway responsiveness in wildland fire fighters. Am. Rev. Resp. Dis. 146:1469-73.

Madsen K (2002) After a series of tragic fires, loggers go on the offensive. The Environmental Magazine, http://www.enn.com/news/enn - stories/2002/10/10172002/s_48691.asp.

McFarlane AC (1988) The longitudinal course of post-traumatic morbidity: the range of outcomes and their predictors. J. Nerv. Men. Dis. 176:30-39.

McFarlane AC, Raphael B (1984) Ash Wednesday: the effect of a fire. Aust. NZ J. Psychiatry 18:341-51.

Meyer VF, Redente EF, Barbarick KA, Brobst R (2001) Ecosystem restoration: biosolids application affect runoff water quality following forest fire. J. Environmental Quality 30:1528-32.

Morgan G, Corbett S, Wlodarczyk J (1998) Air pollution and hospital admissions in Sydney, Australia, 1990 to 1994. Am. J. Pub. Hlth. 88:1761-66.

Mott JA, Meyer P, Mannino D, Redd SC, Smith EM, Gotway-Crawford C, and E. Chase (2002) Wildland forest fire smoke: health effects and intervention evaluation, Hoopa, California, 1999. West. J. Med. 176:157-62.

National Asthma Council of Australia (1999) A decade of coordinated asthma management in Australia. NAC, http://www.nationalasthma.org.au/publications/cam/camia.html

National Conservation Council of NSW (1999a) Fire and Biodiversity. NCCNSW, http://www.nccnsw.org.au/bushfire/projects/BushfireFactsheets/fab.html.

National Conservation Council of NSW (1999b) Fire ecology and post-fire ecology. NCCNSW, http://www.nccnsw.org.au/bushfire/projects/BushfireFactsheets/fab.html.

National Environmental Protection Council (2001) The need for a PM2.5 standard in Australia. Issues Paper, May, NEPC http://www.nepc.gov.au/pdf/issues_paper.pdf.

National Resources Defence Council (1996) Danger in the air: thousands of early deaths could be averted with cleaner air standards. NRDC, http://nrdc.org/air/pollution/nbreath.asp.

North Australian Rural Fire Managers Technical Workshop (1996) Developing a coordinated approach to fire-management and monitoring across northern Australia: common issues, opportunities. http://www.csu.edu.au/firenet/workshop.html.

Rao, S (2002) Christmas bushfires: were we ready for this? Australian Homepage, http://www.aushomepage.com.au/Article/801/.

Robinson M, Gibbs S (2002) Tensions mar the fight, says union. The Sydney Morning Herald, http://old.smh.com.au/news/0201/04/national/national4.html.

Rose S, Bisson J, Wessely S (2002) Psychological debriefing for preventing post traumatic stress disorder (PTSD). The Cochrane Library, Issue 4. Oxford: Update Software Ltd.

Samet JM, Dominici F, Curriero FC, Curriero FC, Coursac I, Zeger SL (2000) Fine particulate air pollution and mortality in 20 US cities, 1987-1994. New Eng. J. Med. 343:1742-9.

Schauble, J (2002) The danger we must learn to live with. The Sydney Morning Herald, http://old.smh.com.au/news/0201/07/opinion/opinion1.html.

Sim M (2002) Bushfires: are we doing enough to reduce the human impact? Occ. Env. Med. 59:215-6.

Southwest Regional Assessment Group (2000) Preparing for a changing climate: the potential consequences of climate variability and change. A report of the Southwest Regional Assessment Group for the US Global Change Research Program. SGCRP, http://www.usgcrp.gov.

Sydney Water (2002) Quarterly drinking water quality report – fourth quarter 2001/2002. Sydney Water, http://www.sydneywater.com.au/html/your_water/ccr/ccr15/catch_issues.cfm.

Toohey B (2002) Don't spurn the spirit of heroism. The Sydney Morning Herald, http://old.smh.com.au/news/0201/06/national/national8.html.

United Nations International Strategy for Disaster Reduction March (2002) Wildland fire, early warning, and sustainable development: Input paper to the DKKV/WG-2 Expert Meeting, Global Fire Monitoring Centre, http://www.fire.uni-freiburg.de/media/WSSD-Wildland%20Fire%20Statement%20II.pdf.

US Dept of State (1999) Atmospheric smoke found to inhibit rainfall. US Dept of State, International Information Programs, http://usinfo.state.gov/topical/global/environ/latest/99101302.htm.

Wainwright R (2002) Lessons from the ashes. The Sydney Morning Herald, http://old.smh.com.au/news/0201/05/review/review1.html.

Ware JH (2000) Particulate air pollution and mortality – clearing the air. NEJM 343:1798-9.

West A and Watson C (2002) Carr: we'll save jobs of heroes. The Sydney Morning Herald, http://old.smh.com.au/news/0201/06/national/national1.html.