Learning Lessons from an Exceptional Period of Fires in Central Australia: 1999 to 2002

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Abstract

The arid interior of Australia has a highly variable climate and over the 3-year period from 1999 to 2002 it received above-average rainfall. The rain contributed to a build-up of biomass and widespread fires. The previous period of exceptional rainfall and fires occurred in the mid1970s and fire ecologists have been anticipating the inevitable return of such an event. This paper will report on 5 aspects of this most recent period of exceptional fires.

The first aspect summarises the fire regime characteristics over the past 3 years in contrast to the previous 20 years. It represents the first spatially explicit fire record of such an event. Past fire history databases failed to adequately record and describe the fire events of the mid1970s due to the limited availability of suitable satellite images.

The second aspect describes the dramatic increase in the use and understanding of satellite information by land managers. Daily hotspot maps of active fires became a widely used and demanded product for pastoral land managers. It represented a significant change in the acceptance of external information by many land managers.

The third aspect discusses the fires in an ecological context. More than 500,000 km², or 70% of the arid zone of Australia's Northern Territory was burnt during the past 3 years. In addition, large areas of the arid regions of South Australia and Western Australia were also burnt. The significance of these fires to issues of biomass burning and carbon credits is largely unknown, however their significance to the ecological integrity of the region is more certain. Hot fires that burn large continuous areas are undesirable and, more importantly, two fires with a short fire interval are known to disadvantage many plant species. Approximately 13% of the region was burnt twice during the 3 year period. It is likely that fires may have contributed to a loss of both plant and animal species from many areas. Our plans are to create appropriate fire history maps to be used by conservation and other land management agencies to direct field surveys in targeted areas.

The fourth aspect focuses on the issue of active fire management. Fire management on Parks and Reserves in central Australia has been based on a patch-burning strategy developed over the past 20 years. Many of the parks have experienced large-scale wildfires during the past 2 years, despite plans and burning programs designed to prevent such occurrences. A review of the programs will discuss reasons for the success and failures and suggest new ideas to help managers' cope with future events of this magnitude.

The fifth aspect describes some the social conflicts that developed as uncontrolled fires crossed land tenure boundaries. Although lightning started many fires, the majority of fires were human-initiated roadside ignitions. Significant costs were incurred by pastoral land

managers associated with fire suppression, plus damage to infrastructure and loss of pasture. Public awareness programs using a variety of media, including television and newspapers attempted to reduce the uncontrolled ignitions and minimise these conflicts.

Introduction

The paper reports on 5 aspects of the 1999 to 2002 period of exceptional fires in central Australia. The emphasis is **Learning Lessons**; information for land managers to improve their knowledge and understanding of fire and be prepared for the next period of exceptional fires. Each section has two components; a summary of the topic, and lessons learned.

Fire Regimes and Fire History Databases

The occurrence of fires in the arid area of central Australia is rainfall dependent. Increased rainfall contributes to increased grass growth and increased fires. This positive relationship is similar to the tropical savanna regions of northern Australia and contrasts to the negative relationships in temperate regions of southern Australia, where recent fires that threatened Sydney and Canberra were associated with drought conditions.

Periods of above average rainfall, high fuel loads and widespread fires have occurred in central Australia at regular but widely spaced intervals; the early 1920s and 1950s, the mid 1970s (Griffin and Friedel 1985) and most recently the start of the 21st century. An analysis of fire reports for central Australia during the 1970s identified that fire occurrence was linked to 2 to 3 years of above average rainfall (Griffin *et al*. 1983). Subsequently evidence to support this relationship was apparent in sub-regions of central Australia (Allan and Southgate, 2002) where above-average rainfall occurred but was not widespread across the arid region. However the most recent period of above-average rainfall for the 3 year period of July 1999 to June 2002 (Fig. 1) was widespread across arid Australia and large areas were burnt in NT, WA, and SA (see http://www.rss.dola.wa.gov.au).

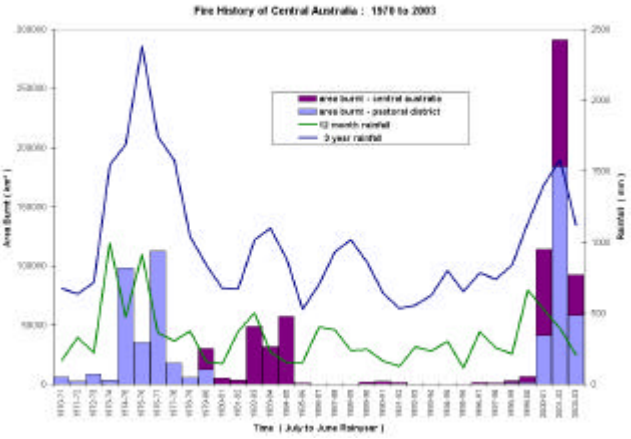

Figure 1. Area of central Australia burnt between July 1970 and June 2003, in relation to annual and 3 year cumulative rainfall. BFC fire reports for the 1970-1980 period were confined to the pastoral district, whereas subsequent records derived from satellite data cover all of central Australia (NT south of –20°). This fire history for 2000-2003 was clipped to the pastoral area for comparison.

In contrast to the mid1970s, satellite images were available to record the recent fires. The 1970s fire reports provided a valuable record and insight into the previous period of exceptional fires, but were limited by a lack of spatial information, including patterns and patchiness. Satellite images did not become regularly available in Australia until 1979 and many of the mid1970s fire patterns were unable to be discriminated. Subsequently, satellite images have been used to map areas burnt in central Australia for the past 20 years (Allan and Griffin, 1986), however the latest mapping represents the first spatially explicit fire record of a period of exceptional fires in arid Australia.

NOAA AVHRR, MODIS, Landsat and SPOT satellite images were used to map burnt areas with a high temporal frequency (Fig. 2). MODIS images provided the opportunity for spatial updates every 2-3 days if required. Monthly summaries of area burnt in comparison to rainfall totals illustrate the fire and rainfall association (Fig. 3). The period from October 1999 to May 2000 was the initial phase of grass growth and fuel accumulation. Subsequent fires in July to October 2000 were mainly in the spinifex landscapes of the Tanami desert. A second season of good rainfall (October 2000 to March 2001) compounded the fuel accumulation and increased the occurrence of fires in the pastoral region. A third period of good rainfall (October 2001 to February 2002) contributed to more fuel accumulation and allowed rapid recovery of fuel loads in previously burnt areas. The continued occurrence of fire ignitions through the rain-free period of March to November 2002 caused many areas to be burnt a second time, especially in buffel grass (*Cenchrus ciliaris*) fuels.

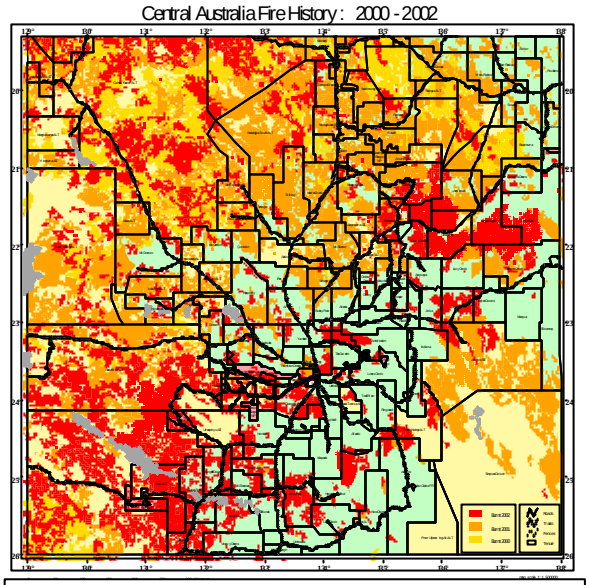

Figure 2. Areas burnt in central Australia during the period of Jan 2000 to Dec 2002. The map covers 612,725 km² of the southern NT (south of –20°).

Lessons

Satellite data provides an invaluable tool for monitoring fire events, but nonetheless it is scale dependent. Many fires were not mapped or difficult to discriminate, as a function of size of the fire, vegetation and soil conditions, resolution of available satellite data, timing of the fire with respect to clouds, rainfall and post-fire vegetation recovery. It is also difficult to separate the areal extent of adjacent fires that occurred within the same interval of satellite passes. From an ecological perspective the fire effect may not be significantly different, however it hinders the maintenance of accurate records of the number of fires.

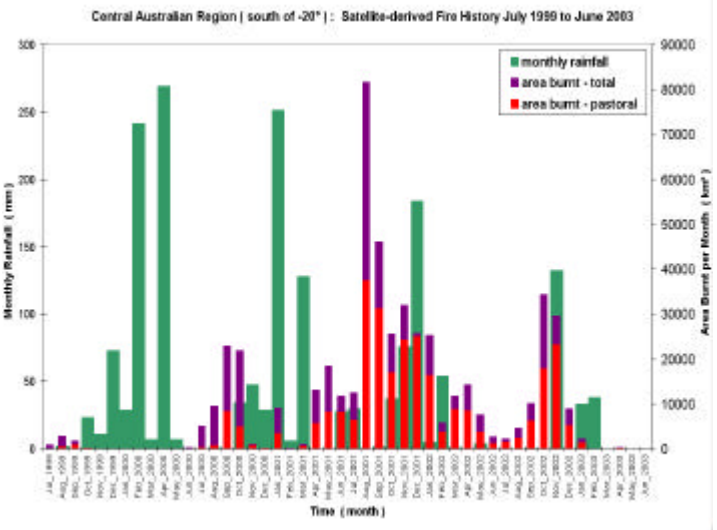

Figure 3. Monthly summary of area burnt in comparison to rainfall for central Australia region (612,725 km²) and central pastoral lands of the region (subset of 365,621 km², excluding the western and simpson deserts).

Additional research and access to more satellite data will help address this issue. Field verification and feedback from land mangers are being undertaken by BFCNT and Centralian Land Management Association's Environmental Management System program on 15 pastoral properties in central Australia. BFCNT joined the international GOFC/GOLD-Fire Monitoring and Mapping Implementation Team (see http://modarch.gsfc.nasa.gov/MODIS/LAND/VAL/CEOS_WGCV/index.html) which is

focused on the detection and validation of burnt areas. Fire history data from Landsat images will be used to validate automated mapping algorithms developed for MODIS images.

Technological Advances in Fire Monitoring

The use of satellite images is not limited to mapping burnt areas but provides the opportunity to monitor active fires (Allan *et al.* 2002). The ability to access a variety of satellite products enabled the development of fire monitoring programs with demands for timely distribution of information. A daily hotspot map of active fire locations, combined with up-to-date fire history information of areas burnt became a widely used and demanded product. It represented an increased acceptance of external information by many land managers.

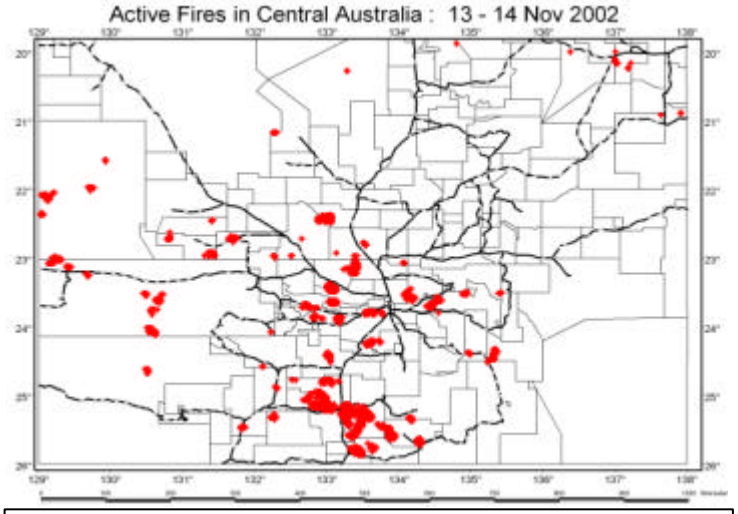

Figure 4. Active fires detected as "hotspots" by NOAA AVHRR satellites during the night of 13-14 November 2002.

The BFCNT struggled to meet the information demands during the most active fire periods when more than 40 fires/day were being monitored and suppression activities were being coordinated (Fig. 4). However it was possible to continually develop and refine map products as the BFCNT collated, interpreted and distributed information from a variety of sources to the land managers. There was a willingness to accept information without an understanding of its source. This caused some frustration due to variability in the timeliness of data, principally associated with satellite characteristics and image availability. For example, the optimum timing of 3 or 4 satellites relative to a particular fire could provide a timely image of the area burnt, a visual impression of active fire fronts and smoke plumes, and the overnight position of hotspots. Unfortunately this would set high expectations, but satellite positions and weather conditions on subsequent days could combine to limit information to a scattering of hotspots.

Due to these demands for timely fire information it was possible for Australian's fire community to influence NASA. Communication schedules with NASA's deep space satellites were modified to minimise blackouts of direct broadcasts from the Terra-1 MODIS sensor over central and southeastern Australia to ensure continuity of satellite images and hotspot data. (see http://earthobservatory.nasa.gov/Study/Sentinel).

Lessons

The demand for information by land managers can change rapidly. Consequently there is a need for an extension program to increase land managers' understanding of satellite-derived fire information. It must address the benefits and limitations but needs to be dynamic in a rapidly changing environment. A review of fire monitoring information for the tropical savannas of northern Australia (Allan *et al.* 2002) is already outdated.

Recent developments provide an opportunity for land managers to access the information directly and created customised map products themselves. This includes TS CRC's fire monitoring website (http://eon.ntu.edu.au/tefi/dbconnect.jsp), DOLA WA website and

FireFax service (http://www.rss.dola.wa.gov.au), QDNRM Active Fire website and email service (http://www.longpaddock.qld.gov.au/SatelliteFireMonitor), CSIRO Sentinel Internet Site (http://www.sentinel.csiro.au/website/trial2/viewer.htm), and NASA's global fire monitoring (http://rapidfire.sci.gsfc.nasa.gov/production). However there is still a role for fire agencies to provide the link between source data and land manager. The collation and refinement of information and its customisation for individual land managers proved valuable for the understanding and use of the information. Subsequently BFCNT's program to provide GIS capabilities and databases to pastoralists has been well received but not widely applied.

Ecological Impact of Fires

More than 500,000 km², or 70% of the arid zone of Australia's Northern Territory was burnt during the 3 years of 2000-2002. In addition, large areas of the arid regions of South Australia and Western Australia were also burnt. Although fire is recognised as a natural feature of the Australia landscape, there is uncertainty about the ecological effect of these fires, especially large areas of burnt country. Satellite-derived fire history data is invaluable to identify and monitor large fire events. The fire history shows that large fires are rarely the result of a single ignition. In September 2001, 11 separate fires in the Davenport Ranges region combined to burn 35,000 km² of pastoral, Aboriginal and conservation land, including more than 95% of the Davenport Ranges National Park. (Fig. 5).

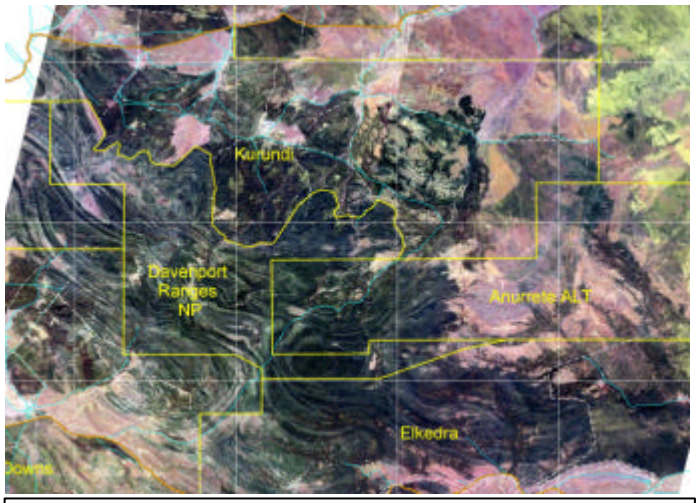

Figure 5. Spot © Quicklook Image of the Davenport Ranges on 5 Sept 2001. The black areas were burnt during the preceding 3 week period by a combination of 11 individual fires. The area of the image is 120 km x 85 km.

The patterning of the fires influences their ecological impact. Unburnt patches within burnt areas are known to be beneficial for species persistence and survival (McAlpin 2001). The patchiness of fires and the proportion of biomass burned varied with season and curing state of the fuel load. Observations in 2000 indicated that fires left many unburnt islands within the fire perimeter. This contrasted to many fires in 2002 that were more homogeneous and frequently consumed all the woody biomass, rather than just killing most trees and shrubs. The majority of fires occurred in spinifex-dominated vegetation communities, but significant areas of Acacia woodlands, principally mulga, were also burnt. General biomass values of ground fuel are known for the major vegetation communities in central Australia. However the woody component of the fuel loads has not been reported, nor information on the proportion consumed during fires of varying intensity. Using previously reported biomass values for major vegetation communities of central Australia (Griffin et al. 1983), the amount of biomass burnt for the period of July 1999- June 2003 approaches 150 million tonnes.

Multiple fires on the same patch of land within a short space of time are known to have significant ecological effects on some vegetation communities, especially obligate-seeding species, such as mulga (*Acacia aneura*) (Griffin *et al*. 1983). The effect of short-fire intervals on other vegetation communities in the arid zone is less well known. The AVHRR-derived fire history from WA DOLA indicates that 13% of central Australia burnt twice in 3 years.

Despite the limitation of this spatial resolution of this dataset (Yates and Russell-Smith 2002), the results were confirmed in the Haasts Bluff area 200km west of Alice Springs. More detailed mapping using Landsat quicklooks images available from the ACRES website identified 9.2% of the study area burnt more than once, including areas burnt 3 times in 3 years (Boyd Wright, *pers. comm.*).

Buffel grass (*Cenchrus ciliaris*) has spread throughout central Australia since the 1970s and there is uncertainty about its longterm ecological impact. Fuel loads in buffel grass can exceed 5000 kg/ha. Although very flammable when cured, its rapid recovery after fire contributes to its competitive advantage as an introduced pasture species. The health and density of trees and shrubs has declined in areas of buffel grass areas near Alice Springs (Miller, 2003). The impact is related to competition for moisture and nutrients, most significant to recruitment success and growth of juvenile plants, and an increased fire frequency, most significant to survival of mature plants. Within the nutrient rich alluvial landscape near Alice Springs, which are prone to high roadside ignition rates, both the NT Fire and Rescue Service and BFCNT have reported patches of buffel grass burnt 2 or 3 times within the 2000-2002 period. Observations from park rangers and ecologists in central Australia report a significant expansion of buffel grass during the past 3 years.

Lessons

During periods of high fire incidence the BFCNT's role was limited to fire monitoring and suppression activities. Assessment of ecological impacts requires collaboration with other agencies and has been identified as a research priority for the new Desert Knowledge Cooperative Research Centre. It is likely that fires may have contributed to a loss of both plant and animal species from many areas. Appropriate fire history maps should be used by conservation and other land management agencies to direct field surveys. This should include studies to assess the effect of fire timing in relation to rainfall and the patchiness of the fires; the patterning of burnt and unburnt areas.

The significance of central Australia's fires to issues of biomass burning and greenhouse emissions is unknown. Collaboration is required to advance our understanding. Approaches used in the tropical savannas (Russell-Smith *et al*. 2003) need testing in central Australia.

The use of fire to manage of buffel grass communities remains uncertain. It has potential to expand throughout the arid zone (Miller 2003) and alter fire regimes. Management plans on the Northern Territory's Park estate are evolving and further studies are required.

Active Fire Management and Fire Suppresion

Active fire management is the process of using fire for fire protection and ecosystem management. Control burning and hazard reduction burning are common terms in Australia. Fire management on Parks and Reserves in central Australia has been based on a patch-burning strategy (Saxon 1984) designed to create a mosaic of differing fire ages and fuel states to restrict large wildfires and provide a diversity of habitat states. Many parks experienced large wildfires during the past 2 years that identified limitations of the strategy and the burning programs during periods of above-average rainfall and high fuel loads.

The fire management program at Uluru–Kata Tjuta National Park was different from other NT parks. There is a sustained commitment by the joint managers of the Aboriginal national park to implementing the patch burning strategy adopted in the 1980s and more individuals are involved in burning programs. It had been adapted to reflect the findings of scientific

research and the recommendations of experienced Anangu ecologists actively involved in fire management. Throughout the 1990s the focus was on re-establishing a mosaic of spinifex age classes as an essential element of maintaining biodiversity, in particular adapting the strategy to support vulnerable fauna species.

Fire management teams of four to eight were led by experienced traditional owners of the land and included younger Anangu community members and rangers, who could learn from this experience and bring their own training and skills in fire management to the work. The Anangu understanding of fire combined with a clear commitment of the traditional owners allowed for controlled patch burning to be regularly carried out between April and September, and when circumstances allowed at other times of the year consistent with traditional knowledge.

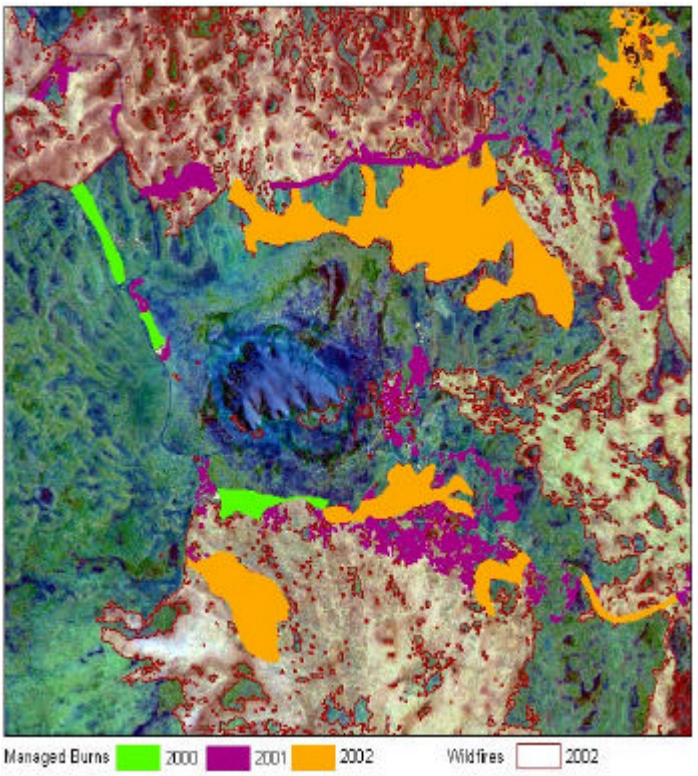

Fig. 6. Strategic management burns were invaluable for restricting wildfires in 2002 from impacting on the sensitive vegetation communities and critical fauna habitat surrounding Uluru. Image area is 25km x 25km .

Following the above average rainfall between 1999 and 2001 the strategy was re-assessed for the capacity of the patchwork to limit the extent and impact of wildfires which were inevitable. In large areas of mature spinifex a series of linear burns were conducted by walking across sand dune country to create linked firebreaks to exclude wildfires and provide a framework for further patch burning if conditions for traditional burning allowed (Fig. 6). Areas of maturing spinifex were targeted for further mosaic burning, however the continual green flush of vegetation during 2000 and 2001 made it was difficult to get fire to spread in areas burnt in the last decade, despite the obvious fire risk that was developing.

April to November 2002 was one of the longest dry periods on record. As the months progressed wildfires spread into the Park from areas greater than 80 km away and patches of regenerating spinifex country burnt throughout 1990s began to carry fire. By November only areas burnt in 2001, including the narrow linear burns would not carry fire. Other age classes had inhibited the spread of wildfire to varying extents until September.

Many pastoralists also struggled with the demands of fire management / fire preparation in competition with cattle management and station maintenance. In many cases insufficient priority was given to fuel management; breaks and tracks were not graded, or re-graded after good rainfalls. The period of high fire danger coincided with high pasture quality and high cattle prices, and effort was focused on managing and turning off cattle for income. Very few pastoralists undertook control burning operations.

Fires suppression activities created staff management issues associated with the need for additional staff and resources, stand-down time and assigning priorities during period of high fire incidence. Some fires threatened public safety and required the declaration of emergency status and implementation of an "Incident Management System" by Police and Emergency Services with support from other government departments. On several occasions the declaration of an "incident" was delayed due to inexperience and although it proved valuable, a more timely response would have been beneficial.

Lessons:
Patch burning is the key to maintaining biodiversity, but following periods of above average rainfall, it has a limited capacity to help to restrict the spread of wildfires. Therefore the strategy must change to a focus of excluding wildfire from particular areas in order to maintain the patch burning framework and avoid an homogenisation of fire ages and vegetation communities. It is important to change the scale of activities. Patch sizes need to increase and it was important to establish linear breaks to connect patches, areas of naturally low fuel and traditional firebreaks. There is a need to exclude fire, rather than to inhibit fire spread. Experience proved that gaps between patches made containment and suppression activities difficult. The timing of burning operations also need to change. It was important to burn when the curing conditions were appropriate and not to be constrained by typical seasonal patterns. It was important to take advantage of fuel moisture to restrict fire spread.

There was a need for an increased commitment to fire activities. During the period of April to November 2002 staff at Uluru–Kata Tjuta National Park were involved in 101 days of fire activity, that was a mix of active fire management and fire suppression within and surrounding the Park. PWCNT also recognised the need for greater staff involvement in hazard reduction / controlled burning operations. Ranger staff had been unable to schedule and complete the optimum amount of burning. Non-ranger staff were encouraged to undertake Level 1 Fire training as a prerequisite to providing assistance to controlled burning programs, and wildfire suppression.

A review of Incident Management Systems (IMS) and fire debriefs established a greater understanding between agencies, including other organisations and individuals such as tourist resorts and land managers. It facilitated the establishment of compatible radio communications and fire fighting equipment and increased the availability of trained and experienced fire fighters through training programs. It recognised the problem of a loss of experience due to a highly transient population in central Australia. It also recognised the issue of smoke management along major highways and within tourist areas and the potential detrimental effect on international and national tourism.

Social Conflicts
The proliferation of fire activity over a 3 year period emphasised existing social conflicts in the rural community and raised new ones. The issue of fires spreading from Aboriginal and conservation lands onto pastoral properties always existed and has been manifesting over the last 20-30 years as more of central Australian land holdings have been transferred to Aboriginal freehold or Aboriginal-managed estate. Since the Land Rights Act of 1974 the area of Aboriginal controlled land in central Australia has increased by 50,000 km², which previously was either pastoral land or vacant crown land. The area of conservation reserves has increased by 5900 km². Changes to the matrix of land use have contributed to tension across boundaries with new neighbours. Rightly or wrongly, pastoral managers cast aspersions at fire management programs on neighbouring properties, especially ungrazed

lands. In some instances it is too much fire but at other times it is not enough. However from 2001 to 2002 many wildfires spread unimpeded across tenure boundaries.

The key source of conflict was human-initiated ignitions along roads and tracks, especially by individuals without authority. The vast majority of the complaints and reports were directed at travelling Aboriginal people, the reports coming from both pastoral and Aboriginal land managers and owners. Significant costs were incurred by pastoral land managers associated with fire suppression, plus damage to infrastructure and loss of pasture. Several wildfires contributed to unreconciled disputes and antagonism between neighbours, with one incident known to result in litigation. It must also be acknowledged that these conflict were not always between pastoral and Aboriginal or conservation land managers. Conflicts within the respective major landholder groups were not uncommon and, in some cases, the most contentious.

However, the conflict over wildfire ignitions and impact peaked on Saturday 22 September 2001 with an article in the Weekend Australian newspaper headlined, "Scheming blacks behind fires: farmers" (Toohey 2001). The accusation that fire was being used purposely to further a political process and the use of the term "terrorism" in the article further inflamed the debate in both rural locations and the political arena.

In response to the public outcry a two pronged approach to the issue was implemented; education and enforcement. A coordinated program was established by the Central Land Council and BFCNT. Officers visited communities and schools to raise wildfire-related issues at community meetings. "Fire Can Kill" television adverts and posters were produced through Imparja Media directly targeting Aboriginal communities and people. The overall fire management issue and threat was promoted through regular radio, television and print mediums. The NT Police became very pro-active in both reminding the community of the threat of wildfires and responded to reports of roadside ignitions with the prosecution of a number of offenders.

Lessons

Addressing social conflicts requires a whole of community involvement. It must be recognised that conflicts will still remain: pastoral versus Aboriginal, pastoralist versus pastoralist; Aboriginal versus Aboriginal, and not forgetting conservation lands and mining tenements. Several successful Regional Fire Management strategies were developed to coordinate neighbouring groups of land managers in areas with persistent tensions. The strategies were only effective when individual parties recognised that a coordinated approach was required to prevent a re-occurrence of widespread and devastating fires but still allowed for disagreements over respective land use practices to remain.

There is a need to involve individuals prepared to participate in joint programs that minimise conflicts and maintain cooperation. It is also important to focus limited resources on areas with maximum potential and effect. The program hopes to avoid "No Win" situations, until more successes are achieved and greater peer pressure can assist.

A cooperative and professional relationship with the media is critical. While recognising freedom of expression and the press, articles in newspapers expressing more extreme views are less likely to assist in cooperation and the resolution of conflicts.

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