HAZARD NOTE

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TOPICS IN THIS EDITION | FIRE SEVERITY | LAND MANAGEMENT | MODELLING | PRESCRIBED BURNING

STRENGTHENING FIRE MAPPING FOR IMPROVED FIRE MANAGEMENT AND CARBON ABATEMENT IN NORTHERN AUSTRALIA

ABOUT THIS PROJECT

This research was conducted as part of the *Tools supporting fire management in Northern Australia* project. It is part of a far-reaching program of mostly web-based fire management information, derived from satellites, to assist land managers in fire planning, monitoring and evaluation across very large tracts of land.

AUTHORS

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SUMMARY

A national approach is under development that provides a standardised assessment of fire regimes across Australia's savannas and rangelands. This Savanna Monitoring and Evaluation Reporting Framework will gather all aspects of the research to date and provide users with the ability to monitor their fire management and evaluate its effects, providing a single point to assess and compare the outcomes of fire management across 70 per cent of the continent.

▲ **Above:** AN EARLY DRY SEASON BURN CONDUCTED NEAR DARWIN. PHOTO: NATHAN MADDOCK, BUSHFIRE AND NATURAL HAZARDS CRC.

This research builds on dynamic up-to-date web-based fire mapping which the team has been involved with since 2002. Over the last three years the mapping has become more sophisticated, incorporating actual fire effect, not just basing effects on fire seasonality. Displayed on the North Australia Fire Information (NAFI) website, the information is used for fire management operations, planning and suppression, and is analysed to describe past and present fire regimes.

CONTEXT

Extensive field information and local knowledge provide models of fire effects in the fire prone tropical savannas of northern Australia. Fire modelling can be applied to fire mapping to describe the effects of fire regimes across the whole landscape. This research compares past and present fire regimes to better understand the effects of various fire management practices.

BACKGROUND

Northern Australia is an extensive area with a small population and limited infrastructure. There is considerable summer rain (the wet season) and almost no winter rain (the dry season). In the wet season, grass and trees grow prolifically, producing abundant fine fuel for fires. The temperature is relatively high all year, so that when the rain stops at the end of the wet season, the fine fuels dry quickly and are extremely fire prone – large tracts of the region burn annually. One simple ignition in the latter half of the dry season can create a bushfire that will burn for months, even if the area had burnt in the previous year. However, prescribed burning is very effective at limiting the spread of bushfires.

Fires are monitored through the North Australia Fire Information website. Evaluation of fire regimes is undertaken at a very rudimentary level in most organisations,

SAVANNA MONITORING AND EVALUATION REPORT FRAMEWORK EXAMPLE

This assessment is made to compare a savanna burning project that has an improved fire regime. A baseline period is the 10 (or 15) year period before the project started where fire management was not undertaken properly; the project period is the period since the project started until now. In figure 1, The calculations of various fire metrics for the most recent year (2015 in this example) of the project are compared to the baseline (2000-2009) and the previous project years (2010-2014).

Fire metrics

1. **Area** – The objective is to reduce the total amount of country that is burnt each year.
2. **Time of year (season)** – The objective is to have more country burnt by early season fires and less by late season fires. Late season fires are more likely to kill plants and animals and damage cultural sites.
3. **Long unburnt areas (three or more years)** – Needed to ensure refuges for many species, and are an important factor for biodiversity. Objective is that the total area of long unburnt country increases.

   In figure 2 the total area of long unburnt country is calculated for the baseline, the previous project years (2010-2014), the current year (2015), the difference between the total pre and post project, and a comparison between 2015 and the previous project years (2010-2014).
4. **Patches on long unburnt country** – It is important that not all of the long unburnt country is just in one big patch, as one fire could burn it all.

FIGURE 1: A COMPARISON OF THE % AREA BURNT IN THE EARLY AND LATE DRY SEASON

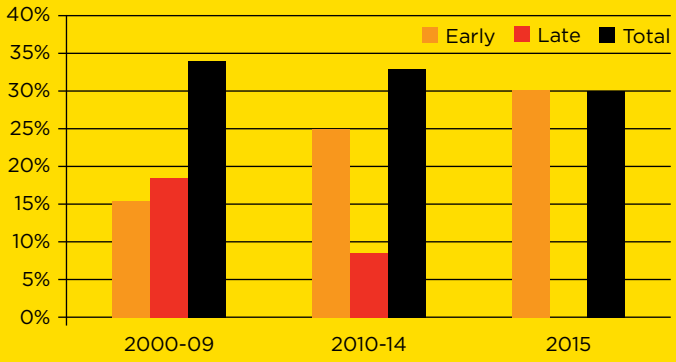
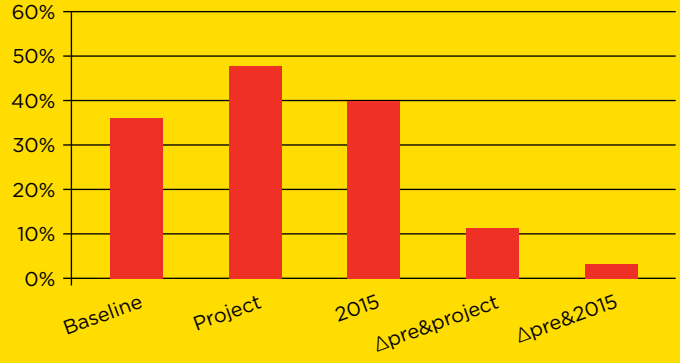


FIGURE 2: THE TOTAL PROPROTION OF LONG UNBURNT (3+ YEARS) AREA



if reported at all, taking into account simple calculations of the area burnt, the seasonality and the frequency of fire.

Some groups such as the Kimberley Land Council, Kakadu National Park and the West Arnhem Land Fire Abatement project provide information to stakeholders regarding the efficacy of their fire management in sophisticated reports that assess the effects of the past year's fire against previous years; and a set of key performance indicators related to ecosystems and biodiversity.

Many other groups in north Australia aspire to this level of sophistication in their own monitoring and evaluation, however, it is analytically demanding, requiring an experienced spatial scientist to derive the various fire layers; create and collate the underlying vegetation or habitat information; and undertake the spatial calculations.

Through an extensive consultation process with many stakeholders, a suite of metrics are being identified, and will be made available to land managers, Indigenous rangers and pastoralists to choose from to meet different reporting requirements.

END-USER STATEMENT

The savanna mapping tools currently available are critical to all aspects of fire management and are used daily by Bushfires NT and stakeholders for planning, mitigation, suppression, monitoring, and evaluation and reporting. The Bushfires Council of the NT, a statutory representative body, has identified ongoing funding for the continuation of products available on the North Australia Fire Information website as one of the highest Territory-wide risks for effective fire management. With the emergence of new industries such as carbon farming, bushfire management is rapidly changing, requiring decisions to be prioritised based on risk. The Savanna Monitoring and Evaluation Report Framework will provide a suite of science-based information to help identify and communicate risk between stakeholders. Bushfires NT wholeheartedly supports the project.

– Andrew Turner, Director of Strategic Services, Bushfires NT

BUSHFIRE AND NATURAL HAZARDS CRC RESEARCH

Sophisticated and informative metrics of fire impacts can only be useful for land management if it can be mapped across the landscape. Since 2014, this study has supported the development of more sophisticated fire mapping and modelling of fire severity, as well as other fire metrics, such as the frequency of wild or managed fire, and fuel age and load.

Fire seasonality in northern Australia provides inferred information regarding the effect of a fire. That is, a fire in the late dry season is generally known to be much hotter than a fire in the early part of the dry season. However, in the middle of the season the ratio of low to high severity is not so clear. Currently, a cut-off date has been selected between the early and the late dry season (31 July), as the early dry season period encompasses the majority of low intensity prescribed burning activities. The 31 July date is a north Australian average derived from years of data. There are as yet no published data that would enable different dates to be applied across different regions of north Australia.

In the savanna burning methodology for greenhouse gas emissions abatement,

The objective is that the number of long unburnt patches (>100ha) increases (see figure 3).

5. **Distance from burnt to long unburnt patches** – Long unburnt areas should be spaced out. The objective is that the distance (maximum and average) between burnt and long unburnt areas decreases. The results of the fire management program have decreased the average distance from burnt to long unburnt patches by more than half in each of the project areas (see figure 4).
6. **Fire frequency (how often an area gets burnt)** – The objective is to reduce the average fire frequency for country in the project area. Fire frequency has increased to near, or greater than, baseline averages. This is due to the increased amount of low intensity, patchy, early dry season fire. Even a high frequency of early dry season fires has shown to have little or no effect on the number and diversity of plant species, compared to a very poor effect from one or two late dry season fires.

FIGURE 3: THE NUMBER OF LONG UNBURNT PATCHES (3+ YEARS)

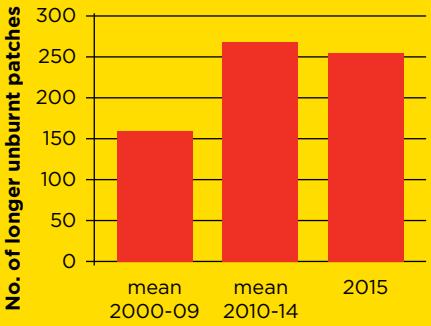


FIGURE 4: THE AVERAGE DISTANCE FROM BURNT TO LONG UNBURNT AREAS

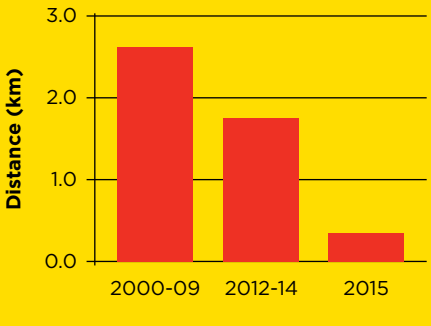
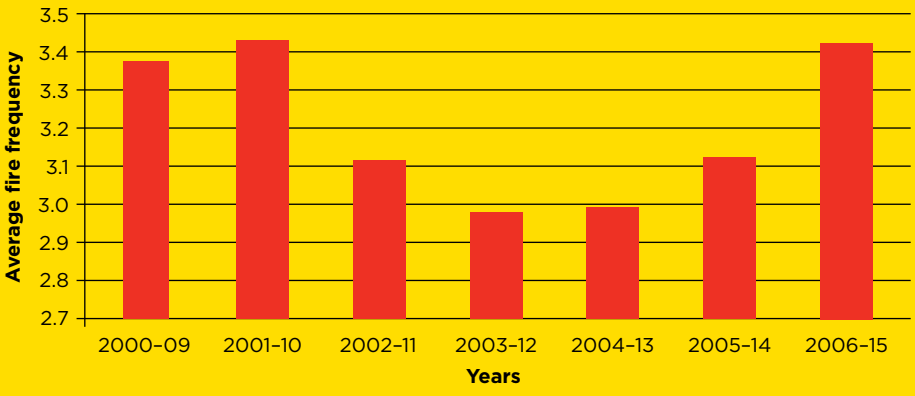


FIGURE 5: THE FREQUENCY OF FIRES



late dry season emissions are nearly double early dry season emissions. The method developed by this research assesses the project area's emissions for the current year, which should be less with improved fire management, compared to a much higher 10 or 15-year baseline period. It calculates the difference, and refers to it as greenhouse gas emissions abatement. Emissions abatement is worth hundreds of thousands of dollars, therefore the seasonal cut-off is crucial to the carbon credits an abatement project can earn.

Fire severity mapping developed through this research is crucial to many of the descriptions of fire effects in savanna and rangeland habitats, and in particular for the development of a new, more appropriate, greenhouse gas emissions abatement methodology. This new methodology would map actual fire effect instead of using fire seasonality, as in the current methodology. Fire severity is currently mapped savanna-wide with overall accuracies of approximately 70 per cent. This is in contrast to burnt area mapping, which achieves accuracy greater than 90 per cent across the savannas. To apply the new savanna burning methodology developed by this research, a similar level of accuracy is required.

RESEARCH FINDINGS

This study has compiled satellite-derived fire and habitat mapping to describe the extent, occurrence and severity of fire at various scales to assess fire effect in various habitats. These models have been developed from extensive long-term field sampling from a suite of permanent sites across the Kimberley, Cape York, the western Top End, and the Gulf of Carpentaria region around the Northern Territory/Queensland border, that describe species change, fuel accumulation and tree growth with respect to fire regimes.

Data from the long-term fire monitoring plots were analysed to look at trends in fire effects on various vegetation communities, indicator plant species and functional groups. The team interpreted the fire history for each site from the biannual plot photographs, including the fire severity based on the scorch height on vegetation.

The analyses indicated a suite of key indicators, significantly affected by different fire metrics, encompassing a range of savanna habitats. Key indicators include:

- **Sandstone uplands,** which are extensive in northern Australia and include the Mitchell Plateau in the Kimberley, the Arnhem Land Plateau in the Top End, and the Heathlands in the far north east of Cape York. These are rugged areas, contain some of the highest biodiversity in the region and comprise a diversity of mainly obligate seeder taxa (species that only grow from seed) mostly with juvenile periods of less than three years, but with a proportion of species requiring longer fire-free intervals for maturation. This leads them to be highly susceptible to short intervals between fires, leading to local extinction, and up to wide-spread extinction if large bushfires occur.
- **Savanna and sandstone trees** occur in woodlands. Small and old trees are vulnerable to intense fires; however, the evidence is unclear on the effects of fire frequency on tree saplings. Diversity of non-eucalypt tree species, that are typically smaller in stature, is relatively susceptible to severe fires. The key indicator species Cypress Pine is a long-lived obligate seeder,

occurring in stands within the savanna matrix, with juvenile periods likely to exceed 10 years. Saplings and adult trees are susceptible to high severity fire.

- **Monsoon rainforests** occur typically in rugged broken terrain, affording some level of fire protection. There are many large resprouter tree species, often fire scarred and hollowed by termites, and hence vulnerable to fire especially on patch boundaries. However, the death of the larger stems releases saplings.

HOW IS THE RESEARCH BEING USED?

The fire mapping information and models developed through this research support various programs including: the CRC's *Enhancing remote north Australia community resilience* project and the Bushfires NT risk and hazard mapping framework, both detailed further below.

The project *Enhancing remote north Australia community resilience* is developing community-based scenario planning workshops. These involve a level of participatory planning that will rely heavily upon a number of mapping tools developed from simple fire metrics such as fire frequency, including the fire severity maps and the many models derived from fire severity mapping.

Risk and hazard mapping by Bushfires NT relies upon the fire mapping information developed within this research. It can be shared with rural fire agencies and other land management agencies, particularly in Queensland, Western Australia and South Australia.

There are many beneficiaries of a new savanna burning methodology, including the federal Department of Environment and Energy, countless Indigenous resource agencies, all the northern land councils, the Indigenous Land Corporation, numerous pastoral lease holders, Queensland Parks and Wildlife Service, the Department of Biodiversity, Conservation and Attractions WA and the Parks and Wildlife Commission NT. Currently northern Australia is generating over $30 million annually in this new carbon sector on over 330,000 km^2, which is still only 40 per cent of the potential extent for these projects. The new methodology will open the industry up to more of these stakeholders, particularly in East Arnhem Land and on Cape York, with a later beginning to the dry season.

The Savanna Monitoring and Evaluation Reporting Framework will gather all aspects of the research to date and provide users with the ability to monitor their fire management and evaluate its effects through time. It will provide a single point to assess and compare the outcomes of fire management across 70 per cent of the continent. See an example of the framework on pages 2 and 3.

▲ **Above:** AN EXAMPLE OF VEGETATION JUST AFTER AN EARLY DRY SEASON BURN. PHOTO: NATHAN MADDOCK, BUSHFIRE AND NATURAL HAZARDS CRC.

FURTHER READING

Murphy B, Edwards A, Meyer C and Russell-Smith J (2015). Carbon Accounting and Savanna Fire Management. Melbourne, CSIRO Publishing

Russell-Smith J, Whitehead P and Cooke P (2009). Managing fire regimes in north Australian savannas – ecology, culture, economy. Rekindling the Wurrk tradition. Canberra, Australia, CSIRO Publishing

FUTURE DIRECTIONS

The Savanna Monitoring and Evaluation Reporting Framework will be developed by a spatial web-enabling business, coordinated through this project. While the conceptual framework and many of the metrics have been determined, the exact funding avenues have not. Please contact the authors if you are interested.

A series of workshops have been undertaken across Queensland, the Northern Territory and Western Australia to determine the content for the framework. As user input is key, the team has designed strategies for projects to further develop user engagement, such as the Natural Disaster Mitigation Program, amongst others.

The Bushfire and Natural Hazards CRC is a national research centre funded by the Australian Government Cooperative Research Centre Program. It was formed in 2013 for an eight-year program to undertake end-user focused research for Australia and New Zealand.