

## 25 Northern Savanna Fire Abatement and Greenhouse Gas Offsets on Indigenous Lands

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Savanna Burning  
Photo: CSIRO Darwin

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## 1. KEY POINTS

Fire management can reduce greenhouse gas emissions from fires in Australia's northern savannas and, with access to markets, a change in emissions may be sold as an offset. Biophysical, economic, and institutional conditions set limits to the possibilities.

An estimated offset of about 5Mt of carbon dioxide equivalent (CO<sub>2</sub>-e) per year could be generated by fire management across Australia's savanna lands, but realistically much of this will be in areas where management is not feasible or cost effective.

The North Australian Indigenous Land and Sea Management Alliance (NAISMA) has prioritised five regions totalling 300,000 km<sup>2</sup> from which it estimates an abatement potential of 1 Mt per year. A further 0.5 Mt per year is possible with further regions. Assuming a carbon price of \$25/t CO<sub>2</sub>-e, the five priority regions may contribute \$25 million annually in potential revenue from fire management. Costs of abatement are estimated to be \$12 per tonne. This makes savanna fire management amongst the cheaper GHG abatement options, and hence is likely to support market interest on the basis of cost effectiveness alone.

Roughly 100 full-time Indigenous positions supporting fire management could be created across Australian Indigenous lands. Other benefits accruing from fire management may be maintenance of biodiversity in areas sensitive to wildfire, easier hunting and harvesting, and overall better landscape management. Active management of country is also likely to enhance Indigenous social and physical health.

Uncoordinated and poorly managed prescribed burning may pose a risk of fire spreading onto other land uses such as conservation properties and pastoral land, and vice versa. Fire management can focus on creating regional mosaics in vegetation, accompanied with property-boundary fire breaks to ensure fire does not carry across different lands. Fire management therefore needs to be organised across multiple landholding groups. This paper performs analysis for the extent of Australia's savannas with the intent of improving natural resource management and social conditions for Indigenous communities in these areas, while accessing funding through carbon markets. The research is also relevant to pastoralists who may be interested in improved fire management under a carbon-inclusive economy.

Sourcing funding from private industry sources and / or carbon markets to fund employment in NRM activities such as fire management is deemed to be desirable in comparison with traditional government supported funding and employment. Distribution of benefits within Indigenous enterprises and communities is likely to introduce major governance challenges.

## 2. FIRE AND GREENHOUSE GAS EMISSIONS IN NORTHERN SAVANNAS

Prior to European settlement, Indigenous people burned their country with smaller fires of lower intensity compared to contemporary burning patterns (1). The result was a mosaic of burned areas and patchy distribution of fuel. Today it is known that strategically implemented prescribed burning in the tropical early dry season can reduce the area burned by large, late dry season fires which carry over large distances.

In tropical savannas, growth is driven by the wet and dry season cycle, and reducing the number of late dry season fires decreases the amount of greenhouse gases emitted. The

resultant fire regime is less intense than that dominated by late season wildfire (1) (2). Several years of empirical studies have been conducted at the West Arnhem Land Fire Abatement (WALFA) project site to estimate the reduction in emissions from fire management (3). The project is currently over-achieving on targets to reduce accountable emissions of the greenhouse gases methane and nitrous oxide by 34%, and a 25% reduction in emissions could be achieved across the entire northern savanna landscapes. Russell-Smith et al. (2) describe a change in fire frequency from 0.4 of the landscape burnt each year, to 0.25 through early dry season prescribed burns.

The WALFA project in the Northern Territory demonstrates the possibility of generating greenhouse gas emission offsets through Indigenous burning practices. This is estimated to reduce emissions by approximately 100,000 t CO<sub>2</sub>-e per year over a 28,000km<sup>2</sup> area compared with the pattern of late-season wildfires it replaces (3). The project generates carbon offset payments of \$1.1m a year, indexed to the 2006 Darwin CPI, for 17 years from Darwin Liquefied Natural Gas (DLNG), and is a negotiated annual payment for ecosystem services rather than the result of trade within a market (4).

In customary economies, Indigenous people in many parts of Australia used landscape fire mainly for hunting and habitat management. There is considerable evidence that burning created habitat mosaics that promoted some vegetation types and animal species adapted to fire, and maintained specialised species assemblages in habitats protected from fire (5). Contractions of fire-sensitive species and declines in native mammal populations followed the withdrawal or relocation of Aboriginal people to settlements (6). Large regions of Australia became vulnerable to very large, high intensity or frequent fires, or both, with significant impacts on biodiversity (7) (8) (9). The outstation movement of the 1980s reinvigorated Aboriginal fire management in limited parts of northern and central Australia (10) (11). In places where human occupation and fire management practices have been maintained, so have many dimensions of ecological integrity (1) (12) (13).

### **3. POTENTIAL DEVELOPMENT AND IMPACTS OF A NORTHERN GREENHOUSE GAS ABATEMENT SCHEME**

#### **3.1 Greenhouse gas accounting and fire abatement**

Savanna fires are a major emission source for Australia, amounting to approximately 1-4% of annual emissions, depending on annual fire activity (14). Nitrous oxide and methane emitted during fire events are accounted for under the Kyoto protocol. The Intergovernmental Panel on Climate Change (IPCC) Guidelines recommend that carbon dioxide emissions from savanna burning not be included in the inventory, since it is assumed that an equivalent amount of carbon dioxide is removed by vegetation regrowth in the following year (15). The current carbon biosequestration (or sink) strength of savannas has been found to range from negligible (16) to weak (storing ~1 t C/ha/year (17)). Available data clearly shows that the sink strength is related to the severity of the fire regime (16) (18), but the overall carbon flux in response to fire management, and baseline conditions across large areas are not known. Murphy et al. (18) show that WALFA would deliver biosequestration of around 5.5 times that from abatement based solely on improved fire management over a 100 year period. However changes in IPCC guidelines are unknown at present, hence for this paper we adhere to the

existing IPCC recommendations and only consider emissions of nitrous oxide and methane from fire emissions.

The offset in GHG emissions from fire management is calculated as the difference between emissions generated under baseline “business-as-usual” conditions, and emissions generated using the new burning regime. For the following calculations the baseline is estimated from fire frequency data from 1997 – 2005. Further refinement of baselines is required, including determining the appropriate number of years required under different climatic scenarios.

A key parameter in estimating the reduction in emissions due to prescribed early burning is the extent to which fire management can alter fire frequency. Any specific location will have biophysical and human infrastructure elements which influence fire frequency. The following analysis follows the assumptions of Russell-Smith et al. (19), where a treated landscape has 65% (0.25 / 0.4) of the fire frequency of a non-treated landscape. Equations and parameters as presented in the Australian National Greenhouse Gas Inventory (NGGI) for agriculture are used to calculate emissions of nitrous oxide and methane in CO<sub>2</sub>-equivalents. The Australian Government parameters are based on broad generalised regional assumptions (15), and do not accurately reflect conditions at individual locations (e.g. variability in available fuel loads). Parameters used are static and regionally-based in our analysis while in reality these are highly spatially and temporally variable.

Equations used to calculate emissions offsets at a property-scale are outlined in Heckbert et al. (20), and are here applied across a map of grid cells at a spatial resolution of 50,000 ha per grid cell. Spatial data were acquired via ACRIS (21) and Australian Government (15) for fire frequency, fuel loads, and burning efficiencies.

The data for ‘average extent of area burnt annually’ [%] is depicted by sub-IBRA regions in Figure 1, showing darker areas with higher extent of area burnt, the darkest values are at 54% of total sub-IBRA area burnt annually. Notably, although national perceptions of fire tend to focus on the peri-urban areas of major cities in the south, the vast majority of fire extent occurs in the north in sparsely populated areas. It is also noted that the time series data shows periods when the extent of area burnt in central Australia is extremely high. These periodic events are therefore not well described by measuring the area burnt as a simple annual average, since it does not account for decadal-scale variability in high rainfall events which drive the extent of fire in central Australian landscapes.

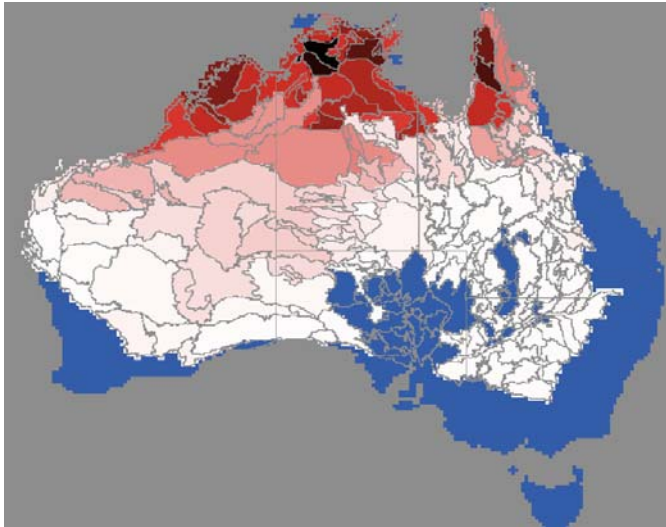


Figure 1: Average annual extent of area burnt [%], by sub-IBRA region, showing extensive areas of northern sub-IBRAS burnt annually., with the darkest shaded regions having an average of 54% of their area burnt each year (darker red = more area burnt, blue = no data or outside scope).

### 3.2 Fire management projects, modelled emissions and offsets

Estimating the GHG abatement potential from fire management was undertaken using GIS fire frequency data and the equations from the NGGI (15). Using this spatial boundary and sets of equations, we can estimate emissions and offsets and make estimates of gross revenue and also infer employment generated from engaging in this type of natural resource management activity. Heckbert et al. (20) used a spatial boundary of 'Indigenous lands' for a similar analysis; however this does not adequately reflect two important points, namely that fire abatement by Indigenous land managers is not constrained to any tenure arrangement *per se* and must be coordinated across a region, and that the overall area of 'Indigenous interest' covers nearly the entire northern savannas (22).

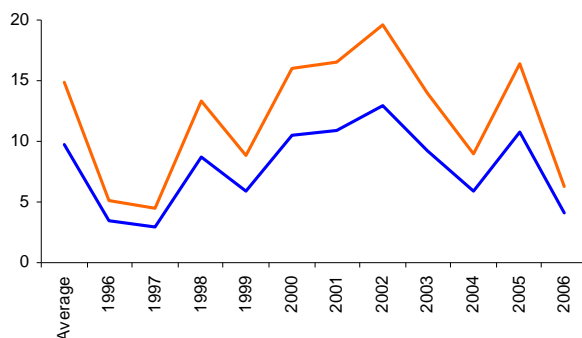


Figure 2: Emissions from savanna burning (red) and reduced emissions through application of fire management, over time.

Time series GIS fire frequency data for the northern savannas was used with the NGGI equations, and modelling was performed to estimate emissions. The time series of modelled emissions is depicted in Figure 2. These modelled outcomes are generated using historical fire frequency data and the NGGI equations in a spatially-explicitly simulation model further

described in Heckbert et al. (20). Annual emissions range from under 5 Mt to nearly 20 Mt, with an average of 14.8Mt across the time series.

Based on assumptions of the efficacy of fire management discussed previously, estimated emissions under a managed landscape are 9.8 Mt, amounting to an offset of 5 Mt of CO<sub>2</sub>-e / yr. However, this value is calculated assuming management is applied across all of Australia's savanna lands, and realistically there are areas where such management is not feasible or is prohibitively costly.

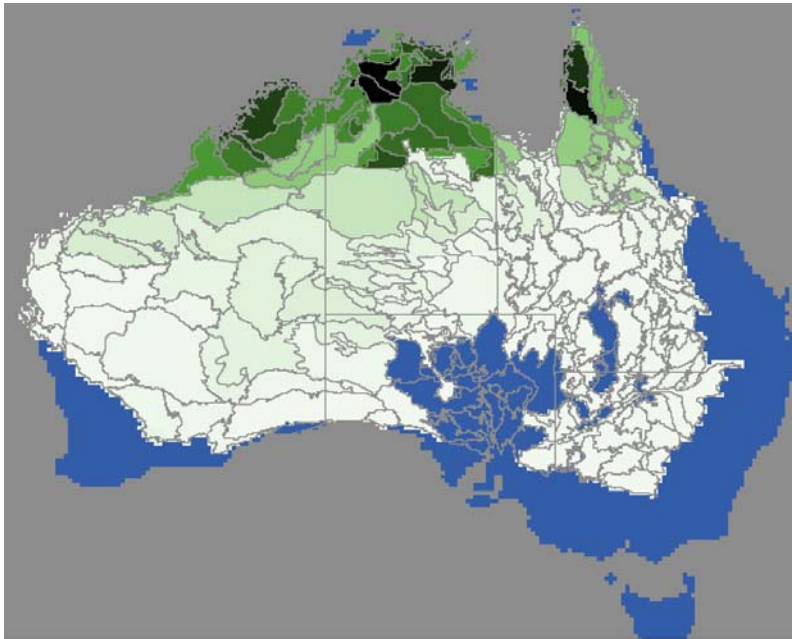


Figure 3: Potential greenhouse gas offsets, revealing the most prospective areas to be the top end of NT, the Kimberley region of WA, and western Cape York (darker green = more potential offsets generated).

A project currently being coordinated by the North Australian Indigenous Land & Sea Management Alliance (NAISMA) has prioritised five prospective regions with a total area of 300,000 km<sup>2</sup>. Collectively, these project areas would provide savanna burning emissions abatement of ~ 1 Mt per year; a further 0.5Mt per year of abatement is possible with further projects in other prospective regions. Assuming a carbon price of \$25/t CO<sub>2</sub>-e, the abatement from the proposed 5 regions amounts to \$25 million annually in potential revenues from fire management, but does not include consideration of costs.

### 3.3 Fire Management Costs

Improved fire management aims to achieve livelihood improvements that accrue from active land management. Although a financial measure should not be the sole consideration of project merit, it does assist in knowing costs associated with start-up and maintenance costs of projects.

Much of the cost is associated with creating a platform from which land and fire management is possible, including the costs of collaborators, basic infrastructure (out-stations, access roads), and less tangible but equally important social capital building. To explore the financial viability of offset generating projects, both revenues and costs are needed to calculate the net

present value of projects, and to calculate the cost per tonne of CO<sub>2</sub>-e abated for comparison to the cost effectiveness of other abatement activities.

The WALFA project may provide an indication of the costs of fire abatement. Its costs are estimated to be \$1.75M per year, with the project delivering mean annual abatement of 147,000 t CO<sub>2</sub>-e over the period 2005-2008. This amounts to a value of \$12 per tonne abated.

The estimate of the cost per tonne is important as, theoretically, fire management will be one of many possible sources of generating offsets in a competitive carbon market. McKinsey & Company (23) have published a marginal abatement cost curve (Figure 4), which gives the cost effectiveness and abatement potential of various abatement or sequestration options. The x axis shows the amount of potential abatement or sequestration from each action in Mt of CO<sub>2</sub>-e; the wider the bars, the greater the abatement potential. The y axis shows the cost per tonne of CO<sub>2</sub>-e; the higher the bars, the higher the unit cost. Those bars with a negative cost represent abatement which is achievable at negative net cost (the bars on the left, below the x axis). These represent technologies such as energy efficiency (e.g. fluorescent light bulbs, etc) which not only reduce emissions but also cost less (due to energy savings over their lifetime). The majority of land-based activities lie on the right hand side of the curve, above the \$0 mark of the y axis. Based on the abatement potential and cost of abatement, savanna burning would appear to be comparable to soil and livestock management options as defined in the cost curve, but is more cost-effective than other options such as afforestation, forest management, reforestation, and others.

From this, we can see that the 1-5 Mt per year abatement possible with savanna fire management is small in comparison to some options (for example reforestation), however the cost effectiveness is very competitive. This means that in a competitive market, abatement from savanna burning would be likely to trade simply based on cost effectiveness.

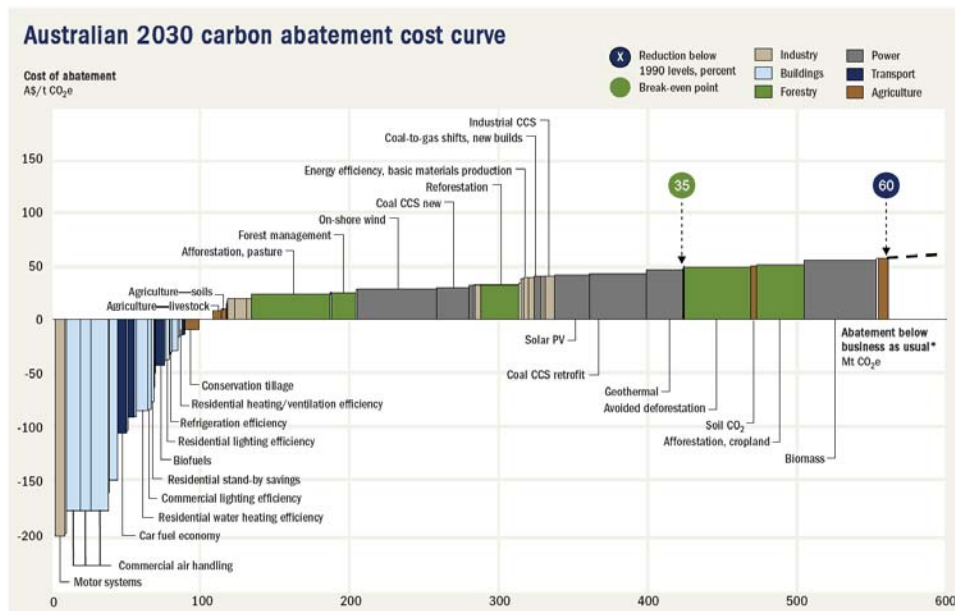


Figure 4: Marginal abatement cost curve for Australia, from McKinsey (23).

Costs will depend on location, and may outweigh revenues in some regions; for example, the Tanami region of north-central NT reveals a gradient of fire frequency from north to south, as rainfall and hence vegetation decreases. It is hypothesised that regions such as this may have a 'boundary' of profitability, where areas in the north pass a benefit-cost analysis, but less frequently burned areas in the south with little existing infrastructure would not. This is the subject of current research, although again it should be highlighted that cost effectiveness is but one measure of project success. Livelihood outcomes from multiple non-market benefits may be viewed to be significantly more important than revenues.

### **3.4 Employment from Fire Management**

There are significant opportunities for employment in fire abatement projects. Employment for Indigenous rangers is one important metric in broader social, cultural and business development agendas. Fire management is one of several natural resource management activities performed by ranger groups. In addition, the broader involvement of communities beyond paid ranger positions, the seasonality of work, and the support of others such as knowledge from elders makes estimation of, which makes estimation of the full-time equivalent (FTE) employment opportunities difficult. However, fire management through burning locally on country, through Indigenous ranger programs including aerial fire management, provides various opportunities for employment. Projects also require support from senior custodians and knowledge holders, researchers, fire management authorities and others.

Heckbert et al. (20) estimate employment opportunities in the order of 490 FTE across all northern savannas, albeit with simplistic assumptions based on potential revenues generated through offsets. Due to the seasonal nature of the jobs, this equates to approximately 1,400 seasonal positions. However, as previously discussed, projects will necessarily be regionally-based and much of the savanna extent will not be suitable for fire management projects for various reasons. Applying modified estimates over the five project areas proposed by NAILSMA suggests that approximately 98 FTEs might be a more realistic number for the next few years. This area clearly requires further research.

## **4. POSITIVE AND INTENDED ACTIVITIES AND OUTCOMES FROM A NORTHERN GREENHOUSE GAS ABATEMENT SCHEME**

Savanna burning is particularly attractive for Indigenous communities because it involves Indigenous people on country being active in traditional land management activities. This is spiritually important (2) (24) (25) (26) and enhances physical and mental health (27) (28).

Indigenous fire management plays a key role in the functioning of the Australian landscape, with ample evidence supporting the role of Indigenous landscape burning regimes in ecosystem functioning (29).

Burning is important for acquiring food in the short term, promoting visibility and attracting animals to freshly burnt areas. In the longer term, Indigenous burning manipulates vegetation and habitat characteristics to promote favoured species (2) (30).

There is a potential for fire management on Indigenous lands to generate greenhouse gas offsets under the proposed Carbon Pollution Reduction Scheme and/or negotiated contracts with energy, mining or philanthropic funding sources. The abatement calculations of 2.6 Mt/yr for the whole of Indigenous-held Australia gives an estimated gross revenue of roughly \$52m/yr, assuming a carbon price of \$20 per tonne CO<sub>2</sub>-e. The costs of fire management are still uncertain.

## **5. NEGATIVE AND UNINTENDED ACTIVITIES AND OUTCOMES ARISING FROM DEVELOPMENT OF A NORTHERN GREENHOUSE GAS ABATEMENT SCHEME**

Although published evidence suggests there will be long term environmental gains from prescribed burning, stakeholders have expressed concerns about the impact of fire on certain fire-sensitive ecosystem types (e.g. species diverse sandstone heathlands) and on pastoral lands (e.g. potential for woody thickening in the absence of intense fires).

In fire-sensitive ecosystems, pre-European fire regimes supported a vast diversity of flora and fauna. Much of this diversity is at risk with the presence of large wildfires which do not promote diversity in habitat types. Unfortunately the cultural perception of fire being linked with destruction does not adequately reflect the importance of fire in maintaining this diversity of habitats. Although any given fire might be detrimental to an individual plant or animal, the habitat created through its proper use is necessary for the species as a whole.

Unskilled and uncoordinated prescribed burns risk spreading onto pastoral land and may disrupt paddock resting and grazing management regimes. Many current conflicts between graziers and Indigenous communities likely arise because of a misunderstanding of the goals of fire management from each perspective. For example, imposing more severe fire regimes may be required to manage for woody thickening or more locally for controlling weedy species. As such there are several goals of using various forms of fire management which may or may not be exclusive of other goals. Fire management that would be eligible for creating offsets would need to be well planned and executed across several properties. This would require additional resources, training and stakeholder coordination activities. Under a coordinated regional fire management plan fire breaks would accompany the broad-scale mosaic burning, following natural barriers, rocky outcrops, sensitive vegetation types, roads, property boundaries and other physical infrastructure. These fire breaks are not necessarily maintained in many current examples of conflicts between pastoralists and Indigenous fire managers, resulting in fire carrying from one land management system to the other. This currently works both ways with examples of each group inflicting incidental damage on others' areas. Existing conflicts will need to be overcome before it is possible to better coordinate fire activities across different land tenures.

## **6. ACTIONS, INCENTIVES OR REGULATIONS FOR AN ABATEMENT SCHEME**

For projects to be effective, they will operate at geographic scales that include all tenures / land managers to realistically address risk issues. This has significant implications for the development of effective, economically sustainable abatement project governance arrangements and coordination.

**The critical role of governance** is discussed in (31), which indicates of some of the legislative and regulatory challenges that will need to be addressed, including the development of robust accounting frameworks. Systematic development of effective 'governance infrastructure' will be required as part of all commercial projects.

Burning continues to be important in areas where Indigenous people have both legal rights and practical means of access to land, and where there are no constraining land uses (4) (32). However, depressed socio-economic conditions and consolidation of populations in towns and larger settlements make it difficult and costly for many Indigenous people to access country (25). **Facilitating access to country is a pre-condition for the success of an offset scheme.**

This can be done two ways, by supporting land managers to travel to country if they live remotely or, more effectively, by providing support for the aspirations of Indigenous communities to live and work at the location of their traditional country. Supporting residence on homelands (out stations) for the purpose of land management enterprises is, in the WALFA case, proving to be a cost effective way of organising effective, in-situ, culturally credible land managers. The benefit of such support is not yet reflected in the Government investment in homelands in this fledgling land management economy. Indeed, recent Northern Territory policy on homelands seeks to rationalise social service, infrastructure and other costs by centralising Indigenous populations in 'growth towns' (33). Continuity of support may come with time though it is at present a mitigating factor in the development of a cost efficient fire and emissions abatement economy.

Customary norms establish who has rights to burn, or to authorise burning, where it occurs and claims to the food produced from burnt land (12) (25). Interpersonal conflicts can develop or be exacerbated when such norms are violated. Competing or contested Native Title claims from opposing Indigenous groups for the same land have also resulted in conflicts, as has the distribution of benefits and costs from enterprises. Issues such as these are common where local customs, traditions and circumstances of social and economic disadvantage are the drivers for doing business in a State and market economy. This intercultural space requires timely, well supported and careful navigation to minimise negative impacts, including conflict. Such issues must be expected in the development of fire abatement enterprises.

**Troubleshooting and conflict resolution processes will be needed alongside participatory development methodologies.**

## **7. CRITICAL KNOWLEDGE GAPS THAT MAY IMPEDE OPTIMUM APPLICATION**

There are critical gaps in knowledge for different landscape types and across the variety of Indigenous communities that, until remedied, will impair pursuit of carbon markets via Indigenous fire management. These include:

- Working knowledge of institutional, legal and other agency influences on local and regional Indigenous decision making
- Comprehensive knowledge of initial infrastructure and social capital requirements for each region and the extent to which these needs will be supported with State and other investment

- Detailed understanding of local aspirations for the long term, including multiple land use options
- Further development of baseline emissions inventories as per the WALFA model, for different regions across fire-prone northern Australia
- Developing enhanced understanding of fire management options for optimising timing of burns for greenhouse gas abatement with other natural resource management goals
- Developing appropriate models of governance for complex fire management projects involving multi-tenure and –stakeholder arrangements
- Developing robust legislative and regulatory mechanisms for advancing savanna burning in State / Territory, national, and international contexts
- Long term consequences for biodiversity of particular fire management regimes, including the improved maintenance of sensitive ecotypes which comes with improved prescribed burning, and also changes in the risks from invasive species
- There is a lack of data on the costs, hence the cost-effectiveness of different fire management regimes and the transport and personnel requirements

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