Title: Greenhouse gas management in northern Australian savannas: opportunities and risks for Indigenous land management

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Statement of Authorship:

“I declare that this thesis my own work and has not been submitted in any form for any other degree or diploma at any university or other institute of tertiary education. Information derived from the published and unpublished work of others has been acknowledged in the text and list of references.”

Signed: Date: 05/05/2011
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Related publications:


Thesis Note: The contents of this thesis describe the current state of climate change policy as of 5th of May 2011, the date of submission. Policy settings around climate change are rapidly evolving at the international and national level, therefore the author acknowledges and alerts the reader that many of the issues and points raised in this thesis may become outdated in a short period of time.
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Abstract

The management of greenhouse gas emissions is an increasingly important focus of land management in northern Australia. Indigenous people own and/or manage much of the tropical savanna estate across WA, NT and Queensland and are well placed to provide services in the form of greenhouse gas sequestration and abatement. The emerging carbon offsets market provides new livelihood opportunities for Indigenous people such as through savanna fire abatement, forest management and avoided deforestation, grazing land management and revegetation. How these opportunities are realised will be strongly influenced by climate change policy developments at the international and national levels and the quality of science underpinning offset estimation and verification. In particular, a framework to replace the Kyoto Protocol post 2012 should seek a more comprehensive approach to accounting for land based mitigation activities, and permit greenhouse gas accounting rules and definitions that are more regionally appropriate to the tropical savannas. Further uncertainty surrounds the introduction of a carbon price into Australian climate change policy, and the future of domestic offsets under the proposed Carbon Farming Initiative. It is important that stakeholders in northern Australia understand the implications of negotiations at the national and international level and the risks associated with different policy scenarios. Similarly, climate change policy needs to manage the goal of emissions reduction with Indigenous aspirations, making necessary the full engagement of Indigenous land managers in the planning and implementation phases of policy development and offset projects. Ethically, it is important that government agencies seeking to meet emissions reductions targets through constraining land use development, adequately support and compensate Indigenous people for any opportunity costs associated with development forgone on their lands. This thesis examines the current settings and future scenarios for climate change policy in savannas of northern Australia, and explores some of the opportunities and risks for Indigenous land managers wishing to engage in the carbon offset market.
Chapter 1: Introduction

Climate change poses many new challenges for land management in the 21st century. On the one hand, the likely impacts of climate change such as increasing annual temperatures, changes in rainfall patterns and increased severe weather events will require ongoing adaptation and risk management to reduce vulnerabilities in the land use sector (ACG 2005). On the other hand, land management is becoming increasingly important in mitigation efforts through the reduction of greenhouse gas (GHG) emissions and uptake of carbon by natural ecosystems (Garnaut 2011). Approximately 26% of global greenhouse gas emissions come from land-use activities such as land clearing, forestry and agriculture (Herzog 2009). Therefore, reducing GHG emissions through better land use practices and curbing deforestation is necessary to avoid dangerous levels of carbon dioxide concentrations in the atmosphere. Carbon dioxide levels are currently 391 parts per million (ppm) and are rapidly increasing further beyond the 350 ppm level considered to be the upper safety limit for climate stability (NOAA & ESRL 2011). Biosequestration whereby carbon is taken out of the atmosphere through biological processes such as plant growth is the only natural pathway for reducing CO₂ concentrations in the atmosphere (Garnaut 2011). Approximately 2043 Gigatonnes (Gt) of carbon is stored in vegetation and soils worldwide, more than double the total amount of carbon that exists in the atmosphere (Prentice 2001). As such, the land use sector is situated to play an important role in mitigation efforts and take advantage of new opportunities for carbon sequestration such as the planting of new forests and improved management of existing terrestrial ecosystems. However, land based sequestration will be limited by an ecosystems capacity to absorb carbon, as all ecosystems will eventually reach saturation levels. As a result, the land sector offers more short to medium term mitigation options that should not replace parallel direct efforts to curb emissions from fossil fuel use.

Current Policy Framework

Climate change policy is inevitably complex, requiring global reductions in intensity GHG emissions across all sectors of society to be met through regionally appropriate solutions to mitigation and adaptation. At the international level, the Kyoto Protocol that
evolved out of the United Nations Framework Convention on Climate Change (UNFCCC) recognises the role of the land based sector in emissions reductions and the potential to incentivise carbon sequestration in land use activities (UNFCCC 2010a). The protocol allows for countries to meet their national emissions reductions targets in small part by deducting the amount of carbon sequestered within the Land Use, Land Use Change and Forestry (LULUCF) sector. Similarly, recent negotiations of the UNFCCC have focused strongly on developing a policy mechanism known as Reducing Emissions from Deforestation and Degradation (REDD) to curb deforestation in developing countries and financially reward stakeholders for maintaining carbon stocks as an environmental service (UN-DESA 2009). On a domestic level, the Australian Federal Government has proposed a Carbon Farming Initiative that aims to promote a broader ranging supply of domestic carbon offsets to both voluntary and regulatory carbon markets (DCCEE 2010a). However, the future of land based carbon offsets will be influenced by changes at the international level as the Kyoto Protocol expires in 2012, and the outcome at a national level on a carbon price being introduced by Australia. A replacement to the Kyoto Protocol will have important implications for greenhouse gas accounting and how countries will be allowed to meet their greenhouse gas reduction targets through land use activities. Similarly, the role of domestic offsets under a future carbon tax or emissions trading scheme will need careful planning so as to not produce perverse outcomes such as the conversion of existing forests to monocultural carbon plantings or for large scale biofuel development. Such outcomes would unnecessarily diminish the opportunities for landholders to engage in a carbon market and have negative environmental consequences.

Eady et al. (2009) suggested that Australia has the opportunity to offset a significant proportion of its greenhouse gas emissions through carbon sequestration and changing land use practices. The tropical savanna region of northern Australia is of particular importance for GHG sequestration/mitigation, covering a third of the continent and containing approximately 30% of total terrestrial carbon stocks (Andersen & Heckbert 2009). Savannas are characterized by frequent disturbances such as fire and drought, with savanna burning contributing 3% of Australia’s total greenhouse gas emissions profile (Andersen & Heckbert 2009). The abatement of emissions from savanna burning and management of these stocks is considered integral to emissions reductions in the Northern Territory, whereby the Territory Government has committed to remove four million
tonnes of carbon per year through land management based offsets (NT Climate Change policy 2009). Although fire abatement has attracted the most attention as a carbon offset activity (Russell-Smith 2009), there are other important opportunities for offsets in savanna regions, such as reducing fire severity for enhanced woody regrowth, forest management and avoided deforestation, reforestation and revegetation, and grazing management. Given the extent of largely intact native forests and woodlands in the savanna region, recognizing their in situ carbon value could have important co-benefits to broader Natural Resource Management (NRM) goals such as biodiversity and soil health (Harper et al. 2007; Williams 2005). Financial recognition of the environmental benefit of savannas will be an important influence on the future of the northern Australia landscape.

**Indigenous Opportunities**

Indigenous people in northern Australia are well situated to provide carbon sequestration and GHG abatement services. One reason is that much of the carbon stored in northern Australia occurs on Indigenous-owned land whilst large areas of what was once carbon rich forests and woodlands on non-Indigenous held land has already been cleared for agricultural development (Law & Blanch 2009). Furthermore, many of the GHG emissions arising from northern Australia from savanna wildfires, which Indigenous people have a long history of managing through traditional fire management practices (Whitehead et al. 2008). Much work has been done in recent decades on the development of Indigenous NRM groups and other institutions with capacity for land management. Where livelihood opportunities for remote Indigenous communities are limited, Indigenous land management is becoming increasingly regarded by Indigenous organizations and governments alike as one of the most important and beneficial livelihood options in northern Australia (Putnis et al. 2007; Morrison 2007). Indeed, opportunities to manage “country” is seen as a culturally appropriate form of development for many Indigenous people delivering important environmental, cultural, social, education, health, employment and economic development outcomes (Altman et al. 2007; Ganasheraja 2009; Putnis et al. 2007). This has been demonstrated in many NRM programs such as ‘Caring for Country’ and the Indigenous Protected Area (IPA) Program whereby customary obligations to country are compatible with the goals and aspirations of broader NRM goals (Garnett & Sithole 2007). Until recently, much of the natural and cultural resource management undertaken by Indigenous people has been funded through
government grants such as the Natural Heritage Trust (NHT) and or resourced through the Community Development Employment Program (CDEP) (Law et al. 2007). Engaging in the carbon market offers the potential to access larger sources of funding that may also be more consistent than more short term funding programs provided by government agencies (Whitehead et al. 2008; Putnis et al. 2007).

Thesis outline

This thesis examines the implications of evolving climate change policy on Indigenous land managers in northern Australia wishing to engage in a carbon market. In order for climate change policy to be effective in northern Australia, it is critical that it is underpinned by the science of carbon dynamics and greenhouse gas emissions in the context of tropical savannas. Chapter One describes the ecology of tropical savannas and reviews the current scientific literature available on the carbon cycle in northern Australia, focusing on the natural and human induced influences on carbon storage, uptake and release. The focus on tropical savannas is most relevant for Indigenous people, as this is the most dominant biome across Indigenous Freehold and Native Title lands that also offer the most opportunity for carbon abatement. In the NT and WA in particular, these landscapes are largely intact and thus have a capacity to be managed for beneficial carbon outcomes (Woinarski et al. 2008). Climate change policy has largely been developed at the international level under the UNFCCC and the associated Kyoto Protocol. As a result many of the GHG accounting provisions are quite broad and generic, posing significant issues when considered in the more regional context of northern Australia. Chapter Two examines the issues associated with Australia’s adoption of the Kyoto Protocol in 2007 and the opportunities and challenges for the treatment of savannas in post-Kyoto agreements and future national and regional policies. With an understanding of the current science and policy frameworks, Chapter Three discusses the risks and opportunities for Indigenous land managers to engage in carbon markets. In particular it explores what available carbon offset options exist for Indigenous land managers, and some of the ethical issues likely to arise for land use on Indigenous lands in a carbon constrained world.
Chapter 2: Carbon science in Northern Australia

Introduction

Indigenous Freehold and Native Title lands across Northern Australia are typically dominated by savanna ecosystems. Savannas describe tropical landscapes comprised of dense grassy understorey with scattered trees (Tropical Savannas CRC 2009). Savannas cover one fifth of the world’s land surface and provide crucial ecosystem services to much of the world's human population, either directly or indirectly (Sankaran et al. 2005). They play an important role in the global carbon cycle and their effective management is critical for mitigating climate change (Sankaran et al. 2005). Designing international, national and regional climate change policies that enhance the uptake of carbon and reduce greenhouse gas emissions must have a firm understanding of the science of savanna dynamics and the carbon cycle.

Greenhouse gas accounting requires knowledge of three main topics; carbon stocks, carbon sequestration and greenhouse gas emissions. Savannas in northern Australia cover a vast area of approximately 1.9 million square kilometers, and as a result are substantial reservoirs of carbon (Tropical Savannas CRC 2009). They are also characterised by frequent disturbances such as fire and droughts, which have impacts on carbon stocks and greenhouse gas emissions. Much of the savanna landscape has become degraded over the past century largely due to changes in management regimes after colonisation, and there is strong evidence to suggest that intervention could enhance carbon sequestration rates and reduce greenhouse gas emissions (Williams et al. 2004; Whitehead et al. 2008; Dyer et al. 2009). This chapter gives a broad overview of savannas, explains key concepts in relation to the carbon cycle and reviews the current state of knowledge on carbon and greenhouse gas emissions.

Savannas Background

Tropical savannas represent a major terrestrial biome covering approximately 20% of the world’s land surface and are responsible for one third of all primary production from terrestrial vegetation (Grace et al. 2006). The majority of savannas occur within the seasonal tropics, where the distinct dry and wet seasons influence a range of ecological processes (Hutley & Setterfield 2007). They are characterised by a discontinuous tree or
shrub layer over a continuous understorey typically comprised of grasses with a C4 photosynthetic pathway (Higgins *et al.* 2000). The co-dominance of trees and grasses means that savannas can not be neatly categorised as grassland or forest, but reflect a “dynamic tree-grass ratio” that is largely driven by frequent disturbance processes such as fire and herbivory (Scholes & Archer 1997). For instance, frequent intense fires may drive the ecosystem towards a grassland due to higher mortality of both juvenile and mature trees, whilst grazing may lead to woody thickening and a shift towards more closed forest (Prior *et al.* 2006; Walker *et al.* 1981). Rainfall and moisture availability are also critical drivers of structure and function of savannas, with an explosive increase in plant biomass evident at the onset of the wet season (Singh 1994). Situated in the seasonal tropics, savannas are also subject to the impacts of cyclones, floods and drought, and these can have significant impacts on a regional scale. Although the specific drivers of savanna structure and function will differ spatially and through time, it is often this dynamic interaction of disturbance events within the climatic and biological setting that creates a type of meta-stable ecosystem (Scholes & Archer 1997; Prior *et al.* 2006).

Australian savannas cover approximately 25% of the continent in the tropical and subtropical zones, and range from the Kimberley in the north west through the Top End to Cape York in the north east (Devi Kanniah *et al.* 2010). In Australia, the structure, function and dynamics of savannas is driven largely by soil texture and annual rainfall variations, fire and herbivory (Williams *et al.* 1996; Devi Kanniah *et al.* 2010). A distinct rainfall gradient from 2000 mm in the north to less than 500 mm in the south sees woody species abundance and productivity decline with decreasing rainfall (Russell-Smith *et al.* 2009). Generally this pattern is reflected by the occurrence of Eucalyptus dominated open forest in the coastal and subcoastal regions to woodlands in the semi-arid regions and open woodlands in the arid interior (Williams & Cook 2001). Fire plays a major role in northern Australian savannas, with more than 35 million hectares burnt each year between March and December, typically towards the end of the dry season (AGO 2007; Russell-Smith *et al.* 2007). The timing, intensity, and frequency of fire regimes are highly variable across the landscape depending upon the land tenure and the management objectives of each land use group (Dyer *et al.* 2001). Australian savannas also experience frequent tropical cyclones in coastal and subcoastal areas, having extensive and profound impacts on savanna tree dynamics and other ecological processes (Cook & Goyens 2008). Other
disturbance effects on savanna dynamics in northern Australia include widespread cattle grazing, droughts and floods, invasive species and land use change.

**Savannas and the carbon cycle**

Savanna ecosystems play an important role in the global carbon cycle, due to their large extent, and the frequency of fire and other disturbances that significantly influence atmospheric chemistry (Grace *et al.* 2006). Although at an ecosystem level savannas are not seen as productive and carbon rich as other biomes such as tropical rainforests (Grace *et al.* 2006), on a landscape scale their management is critical to reduce greenhouse gas emissions and enhance carbon stocks in vegetation and soils (Cook *et al.* 2005). Carbon stocks in savannas have been estimated to hold globally approximately 326 Giga tonnes (Gt) of carbon, or about 15% of total terrestrial carbon (Grace *et al.* 2006). Changes to the tree-grass balance of tropical savannas through natural and human disturbances has been identified as having a significant impact on the global carbon cycle, and savannas have been estimated to sequester 0.5Gt carbon per year globally (Scholes & van der Merwe 1996; Scurlock & Hall 2002). Despite this, much of the attention in scientific and policy circles has focused on the more carbon dense moist forests of the tropics and designing policies to reduce rates of deforestation and forest degradation. However carbon stocks in savannas are also under threat, through both natural disturbance events such as cyclones, floods and droughts, and human land management decisions such as fire regimes, cattle grazing, and land clearing (Lehmann 2010). Understanding the carbon cycle in the context of savannas in northern Australia is critical in order to design appropriate policies to manage greenhouse gas emissions and mitigate against climate change (Cook *et al.* 2010).

The movement of carbon between the atmosphere and the terrestrial biological system is complex and dynamic, and is affected by a combination of biological and management processes (see fig 1.) (Richards 2001). Carbon dioxide is absorbed from the atmosphere during photosynthesis and is converted to carbon which is stored in the form of plant biomass or woody material. This process is known as Gross Primary Productivity (GPP) and describes the amount of CO$_2$ converted to plant carbohydrates through photosynthesis (Chapin *et al.* 2002). About half of the GPP is then rereleased back into the atmosphere as CO$_2$ or water through plant respiration, leaving an amount of carbon described as Net Primary Production (NPP). This carbon either remains stored in the trees or moves
through different pools within the ecosystem and may be released back to the atmosphere by decomposers such as bacteria and fungi, or by herbivory (Devi Kanniah 2010). The carbon that is left in the ecosystem after both plant respiration and herbivory and decomposition processes is described as Net Ecosystem Productivity (NEP) and is commonly used to describe the amount of carbon sequestered in the medium term in an ecosystem (Devi Kanniah 2010). A more accurate value for the amount of long term carbon sequestered in an ecosystem is when the effect of disturbances such as fire can also be deducted from the NEP, leaving a more realistic value known as Net Biome Productivity (NBP) (Williams et al. 2004).

Carbon pools can be defined at different scales but typically refer to an aboveground biomass pool consisting of stem, branches, leaves, litter, a belowground biomass pool consisting of fine and coarse root material, and a soil carbon pool (Richards et al. 2001). It is the balance between the input of carbon into the system largely through plant primary production and the output of carbon through respiration, decomposition or disturbances such as fires that determines whether an ecosystem is acting as a net carbon sink or a net carbon source. The amount of total carbon stored in an ecosystem at a particular point in time is known as the carbon stock and is commonly expressed as tonnes of carbon per hectare (tC/ha). The rate at which carbon is converted from carbon dioxide through photosynthesis into biomass is described as the sequestration rate and is often expressed as tC/ha per year (tC/ha/yr), either as an NEP or NBP value (Williams et al. 2004).

The loss of carbon through fire or other disturbance events or respiration releases the carbon back into the atmosphere either as carbon dioxide or methane emissions. Other greenhouse gas emissions, mainly methane and nitrous oxide emissions are also exchanging between the atmosphere and the terrestrial ecosystem through biological and chemical processes. The overall balance of carbon in an ecosystem is described as a ‘sink’ if there is a net uptake of carbon, or a ‘source’ if there is a net loss of carbon. Some confusion exists around the use of the term ‘sink’ to describe carbon stocks, however under the International Panel on Climate Change (IPCC), a ‘sink’ only refers to the sequestration of carbon from forest growth (Henry et al. 2005).
<table>
<thead>
<tr>
<th><strong>Box 1: Key Concepts (Williams et al. 2004; Devi Kanniah 2010; UNFCCC 2008)</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Aboveground biomass:</strong> All living plant material above the soil including stem, branches, leaves, litter, coarse woody debris.</td>
</tr>
<tr>
<td><strong>Aboveground carbon:</strong> Often used interchangeably with biomass, but expresses only the amount of carbon stored in plant material, which is roughly half of the dry biomass.</td>
</tr>
<tr>
<td><strong>Carbon Pool:</strong> A conceptual reservoir that has the capacity to store or release carbon, for example a soil carbon pool.</td>
</tr>
<tr>
<td><strong>Carbon Stocks:</strong> The total amount of carbon in situ in an ecosystem or land unit. Commonly expressed as tonnes of carbon per hectare (tC/ha).</td>
</tr>
<tr>
<td><strong>Carbon Flux:</strong> The transfer of carbon between pools, commonly expressed as a rate over time (e.g. g cm(^{-2}) s(^{-1})).</td>
</tr>
<tr>
<td><strong>Carbon Sequestration:</strong> The uptake of carbon out of atmospheric carbon dioxide into plant woody material through photosynthesis. Expressed commonly as tonnes of carbon per hectare per year (tC/ha/yr).</td>
</tr>
<tr>
<td><strong>Carbon Sink:</strong> A land unit or ecosystem that has a net uptake of carbon.</td>
</tr>
<tr>
<td><strong>Carbon Source:</strong> A land unit or ecosystem that has a net loss of carbon.</td>
</tr>
<tr>
<td><strong>Net Primary Productivity (NPP):</strong> The net flux of carbon into plants through photosynthesis after accounting for plant respiration.</td>
</tr>
<tr>
<td><strong>Net Ecosystem Productivity (NEP):</strong> NPP minus heterotrophic respiration, a measure of sequestration.</td>
</tr>
<tr>
<td><strong>Net Biome Productivity (NBP):</strong> NEP minus the impacts on carbon of disturbances, a long term measure of sequestration.</td>
</tr>
</tbody>
</table>
Carbon Stocks in Northern Australian Savannas

Several recent studies have attempted to estimate the carbon stocks stored in native vegetation and soils in northern Australian savannas. Given the dynamic nature of carbon as it is affected by human and natural factors both temporally and spatially, estimating stocks is complex and difficult to ascertain with certainty. The best method for measuring stocks is through destructive sampling whereby the forest is cut down and weighed. Given the adverse impacts of this form of measurement across the landscape, typically carbon stocks are modelled using allometric equations or other inventory methods of estimating biomass carbon. Using the Full Carbon Accounting Model (FullCAM), a study by Law & Garnett (2010) estimated above and below ground carbon stocks to reflect long term average plant productivity in the Northern Territory, with carbon levels being influenced by vegetation type and climatic factors such as the rainfall gradient. The highest above and below ground carbon stocks tend to occur in Eucalyptus open forest in areas with a Mean Annual Rainfall (MAR) of above 1000mm and range from 150-235 tonnes of carbon per hectare. This corresponds with an estimate of total carbon stocks in eucalyptus...
open forests by Chen et al. (2003) of 204±53 tC/ha. As basal area decreases into Eucalyptus woodland and Eucalyptus open woodland, carbon stocks can be between 50-150 tC/ha. These estimates include the total carbon stocks held within all pools, both below and aboveground biomass and soil carbon. Aboveground carbon stocks of a eucalyptus savanna have been estimated by Cook et al. (2005) to be 50 tC/ha. Very few studies have estimated carbon stocks in the soil pool. However, Chen et al. (2003) found soil carbon levels to be approximately 74% of total carbon stocks.

There has been much attention given recently to the potential for Indigenous land managers to engage in carbon markets through the management of carbon stocks and emissions reductions in northern Australia (Heckbert 2009; Whitehead et al. 2008). Indeed, such options are desirable for many Indigenous communities for social, cultural and economic reasons, and the extensive area under their management places them in an important service delivery role. Carbon stocks on Indigenous lands are likely to be higher in the higher rainfall savanna regions, and thus there may be more opportunities for these communities. Using data from a previous study by Law & Garnett (2010), figure 2 shows the potential total carbon stocks for Indigenous lands in the Northern Territory. Carbon stocks are highest in the northern part of the Northern Territory and decrease steadily away from the coast and south into the arid interior. The highest levels of carbon (150-235tC/ha) are found in north east Arnhem land, the northern coastline including Kakadu National Park and Adelaide and Mary River region, the Tiwi Islands and other offshore islands. Medium levels of carbon (50-150tC/ha) are found throughout the Victoria River District and low levels in the arid interior (<10tC/ha). Indeed, most of the carbon stocks in northern Australia occur on Indigenous-owned land while large areas of what once was carbon rich forests and woodlands on non-Indigenous held land has already been cleared for agricultural development (Law and Blanch 2009).
Savannas may have considerable scope to be managed for sequestration of carbon, to act as carbon sinks rather than sources of emissions (Grace et al. 2006). The recent State of the Forests report (MPIGA 2008) estimates that the dominant savanna vegetation type of Tropical Eucalypt Woodlands/Grasslands have experienced a net increase in total above and belowground carbon stocks of 4.7 Million tonnes of carbon (MtC) between 1989 and 2004. Similarly, Burrows et al. (2002) estimates that savanna woodlands across Queensland could be acting as a significant carbon sink, sequestering 18-35MtC/yr or 0.53tC/ha/yr. Much of this increase is thought to come from widespread woody
thickening, as a result of altered fire regimes and livestock grazing (Burrows et al. 2002). However, such thickening is likely to be highly spatially variable, and currently there is insufficient empirical evidence to infer widespread increases in biomass across the savannas (Murphy et al. 2009). Other studies have suggested that under well managed fire regimes, the tropical savannas can act as a weak sink (see table 1). For example, Chen et al. (2003) estimates savannas to be a weak sink of -3tC/ha/yr in terms of Net Ecosystem Productivity (NEP), whilst Williams et al. (2004) suggests that once the impacts of frequent fire are considered a Net Biome Productivity (NBP) value is closer to -1tC/ha/yr. However, Cook & Goyen (2008) caution that these studies may not take into account the impacts of less frequent disturbance events such as cyclones, and that many of these estimates may be a result of vegetation recovery post-cyclone. Similarly, Murphy et al. (2009) found carbon stocks to be much more stable with a modest sequestration potential of 6.1tC/ha over a 100 year period under a well managed fire regime. Murphy et al. (2009) also suggests that determining the exact current carbon balance of savannas is perhaps less important than determining whether certain fire management regimes can shift the carbon flux in a desirable direction.
Table 1: Summary of previous studies of carbon stocks and carbon sequestration in savannas in northern Australia

<table>
<thead>
<tr>
<th>Source</th>
<th>Vegetation Type*</th>
<th>Carbon Stocks</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>Aboveground</td>
<td>Belowground</td>
</tr>
<tr>
<td>NCAT FullCAM (Law &amp; Garnett 2010)</td>
<td>EOW</td>
<td>40 ± 15 tC/ha</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>EW</td>
<td>61 ± 19 tC/ha</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>EOF</td>
<td>158 ± 23 tC/ha</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chen <em>et al.</em> 2003</td>
<td>EOF</td>
<td>204±53tC/ha</td>
<td>32tC/ha</td>
<td>21tC/ha</td>
</tr>
<tr>
<td>Cook <em>et al.</em> 2005</td>
<td>EOF</td>
<td></td>
<td>12-58tC/ha</td>
<td></td>
</tr>
<tr>
<td>Burrows <em>et al.</em> 2002</td>
<td>EW</td>
<td>36.98-43.72tC/ha</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Burrows <em>et al.</em> 2002</td>
<td>EW</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chen <em>et al.</em> 2003</td>
<td>EOF</td>
<td></td>
<td>-3.8tC/ha/yr (NEP)</td>
<td></td>
</tr>
<tr>
<td>Williams <em>et al.</em> 2004</td>
<td>EOF</td>
<td></td>
<td>-1tC/ha/yr (NBP)</td>
<td></td>
</tr>
<tr>
<td>Eamus <em>et al.</em> (2001)</td>
<td>EOF</td>
<td></td>
<td>-2.8 tC/ha/yr (NEP)</td>
<td></td>
</tr>
<tr>
<td>Cook <em>et al.</em> (2005)</td>
<td>EOF</td>
<td></td>
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<td>Beringer <em>et al.</em> (2007)</td>
<td>EOF</td>
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<tr>
<td>Lehmann et al. (2009)</td>
<td>EW-EOF</td>
<td>-0.1tC/ha/yr</td>
<td></td>
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<tr>
<td>Murphy et al. (2009)</td>
<td>EW-EOF</td>
<td>-0.06tC/ha/yr</td>
<td></td>
<td></td>
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</tbody>
</table>

* Vegetation types are approximate considering the differences in definitions and classifications used by the authors. EOW = Eucalyptus Open Woodland, EOF = Eucalyptus Open Forest and EW = Eucalyptus Woodland.

** The negative ‘-’ denotes an increase in carbon in the ecosystem.

### Greenhouse gas emissions in savannas

The frequency of fire, herbivory and other disturbances characteristic of savanna landscapes results in the release of large amounts of greenhouse gas emissions. Savanna burning alone contributes between 1-4% of the nation’s annual greenhouse gas emissions depending on the year (Heckbert et al. 2009). For the Northern Territory, savanna burning is the major source of emissions, ranging from a third to a half of total annual greenhouse gas emissions depending on the year (NT government 2009). Such figures take into account the emissions of methane and nitrous oxide only, as the IPCC assumes that carbon dioxide emitted through biomass fires is reabsorbed by plant production during the wet season (Henry et al. 2005). However, it is unlikely that this assumption holds true across the Australian savanna landscape, where CO2 emissions are much more substantial, particularly under fire regimes with more frequent intense wildfires (Hurst et al. 1994; Cook & Meyer 2009). Nonetheless, the importance of savanna fire management for reducing emissions is widely recognized, and many projects have been established to reduce the occurrence of large scale intense wildfires, particularly through the reestablishment of traditional Indigenous burning practices (Cook & Meyer 2009).

Reducing fire frequency and intensity can reduce emissions by encouraging the decomposition of litter through more emissions benign biological pathways, and promote an increase in woody biomass carbon stocks (Cook & Meyer 2009; Murphy et al. 2009).

Savannas in northern Australia are also subject to other anthropogenic causes of greenhouse gas emissions, in particular land use change and grazing or enteric fermentation. For example, land clearing in the Northern Territory is estimated to have
emitted 1.15 million tones of greenhouse gases in 2006, representing approximately 7% of the total emissions for that year for the Territory (DCC 2008a). The conversion of native savanna vegetation to another land use such as improved pasture can result in greenhouse gas emissions ranging from 50 to over 200 tonnes of CO$_2$ per hectare (NT Government 2008). The percentage of total carbon lost through the clearing and burning of biomass is variable across vegetation types, but in most savanna woodlands and forests a loss of 61-71% of total carbon stocks is likely (Law & Garnett 2009). The degree to which the carbon stocks recover depends upon the subsequent land use, but most agricultural land use scenarios will not return to previous levels held by the initial savanna vegetation (Law & Garnett 2009). Pastoralism is the most extensive land use in the savannas, and as such methane emissions from cattle are significant, releasing 2.4 million tonnes of CO$_2$ in the Northern Territory in 2006 (DCC 2008a). The management of cattle grazing for emissions reductions is not straightforward. It has been shown that grazing can reduce fire frequency and lead to woody thickening, but under heavy grazing can lead to significant losses in soil carbon (Gifford & Howden 2001; Holt 1997). Furthermore, although not currently accounted for in greenhouse gas accounts, feral animals such as buffalos in northern Australia are likely to contribute to further methane emissions and degradation of carbon stocks.

Soil Carbon

Soils contain more than three times the amount of carbon present in the atmosphere and contain two thirds of all carbon in terrestrial ecosystems (Chen et al. 2005). The IPCC 2007 4th Assessment report states that annual emissions of carbon dioxide from soils are an order of magnitude greater than all combined anthropogenic emissions from other sources (IPCC 2007). Carbon stocks in soils are a balance of the inputs from biomass pools such as litter and dead roots, and outputs as CO$_2$ and methane fluxes (Chen et al. 2005).

Although there may be considerable potential for enhancing soil carbon stocks in north Australian savannas and reducing soil based emissions, there are many uncertainties surrounding soil carbon processes such as the impacts of different land management regimes and the role of charcoal from savanna fires (Walcott et al. 2009). Similarly, measuring and monitoring soil carbon is inherently difficult due to the high level of spatial and temporal variability, the different forms of carbon available in soils and their permanence, and the cost and effort required in securing and processing soil samples.
(ENRC 2010). Chen et al. (2003) found soil carbon stocks to be approximately 74% of total carbon stocks with an annual soil carbon efflux of 14.3 tonnes of carbon per hectare per year. Reducing fire intensity and frequency has the potential to increase carbon stocks (Chen et al. 2005). However, there is yet enough understanding of the role of black carbon in the form of charcoal from fires acting as long term stores of carbon, and this may tell a different story (Lehmann et al. 2008).

**Measuring Carbon in Savannas**

With the development of carbon markets, it is critical that carbon stocks and fluxes can be monitored through time. In order to estimate carbon stocks and fluxes across the Australian continent, the Australian Greenhouse Office developed the National Carbon Accounting System (NCAS) and its associated National Carbon Accounting Toolbox (NCAT). The NCAT is an integration of a range of models that model carbon cycles associated with biomass, litter, and soil pools in forest and agricultural systems on a spatial scale of one hectare (Richards et al. 2005). The tool is capable of carbon accounting for different land activities such as afforestation, reforestation and deforestation, and estimates carbon exchanges, uptake and loss between the terrestrial biological system and the atmosphere. However, as the model has largely been developed in south eastern Australia in biomes outside of the savannas, there is the need for further refinement of the NCAT to account for the unique characteristics of the savannas of northern Australia (Leidloff et al. 2009). In particular, further work needs to occur to ensure the model is adequately parameterised for the impacts of fire on savanna biomass and soil carbon (Law & Garnett 2010). It will also be important to refine the aboveground biomass models used in the NCAT to better reflect vegetation types in the Northern Territory (Leidloff et al. 2009). Such improvement will be critical for realizing the true carbon benefits of offset projects and understanding risks.

**Conclusion**

In order for Australia to play its part in mitigating against climate change, managing carbon stocks and emissions from land use in savannas is crucial. Carbon in savannas is highly dynamic and influenced by disturbances such as fire, herbivory as well as climatic influences such as rainfall. Studies on carbon stocks show that carbon is highly variable across the landscape, but is highest in higher rainfall zones closer to the coast. Similarly,
the balance of carbon across the savannas will move between a sink and a source depending on the management regime. Indigenous held lands are important reservoirs of carbon and as such Indigenous land managers play an important role in managing savannas to be a weak carbon sink. However, there remain many knowledge gaps in relation to estimating carbon in the savannas, in particular the paucity of soil carbon data and the need for further refinement of the NCAT to reflect savanna conditions. The development of good carbon policy for northern Australia needs a firm understanding of the science of the carbon cycle in relation to the tropical savannas. This is particularly important for negotiating positive outcomes at the international and national level that reflect the unique characteristics of northern Australia and are not heavily biased towards biomes of southeastern Australia.

**Conclusion Box:**

- The management of savannas in northern Australia is critical for reducing greenhouse gas emissions and increasing carbon stocks
- Disturbances such as fire, drought, cyclones, herbivory are important drivers of change in carbon in savannas
- Carbon stocks reflect plant productivity and range from 5tC/ha in the arid regions to 150-250tC/ha in higher rainfall open forests
- Carbon stocks on Indigenous lands are higher in the higher rainfall areas such as Arnhem Land and the Tiwi Islands in the Northern Territory
- The majority of carbon usually resides in the soil carbon pool however soil carbon is difficult to measure and monitor change
- Studies on sequestration rates show how carbon is highly dynamic and savannas may range from sinks to sources spatially and temporally
- Savannas can be managed to be a weak sink with a sequestration potential of 6.1tC/ha over 100 years.
- Indigenous people are important managers of carbon in northern Australia
- Further refinement of carbon models and understanding of soil carbon dynamics will be important for future carbon policy and markets
Chapter 3: Greenhouse gas policy and accounting

Introduction

The current policy setting for dealing with greenhouse gas emissions in savanna landscapes in Australia has come about from negotiations at the international level that have been adapted to at the national and regional scale. There is currently a high degree of greenhouse gas policy uncertainty at both the international level as the world struggles to negotiate a post-Kyoto framework, and at the national level as a multi-party committee of the national Parliament currently discusses the introduction of a carbon price. Five years have passed since the Australian Journal of Botany released the special issue on carbon policy in savannas. Although many points that were raised there are still salient, it is important to understand the current policy settings. This chapter examines the issues associated with Australia’s adoption of the Kyoto Protocol in 2007 and the opportunities and challenges for the treatment of savannas in post-Kyoto agreements and future national policy.

Savannas and the Kyoto Protocol

The Australian Federal Government is required to report on its annual greenhouse gas emissions as part of its obligations under the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol (DCC 2009a). Two sets of accounts or inventories are submitted for each, with slightly different reporting and accounting requirements for the UNFCCC and the Kyoto Protocol. The Australian “National Inventory Report 2008” meets the requirements of the UNFCCC and reports Australia’s total net emissions for the year 2008 and yearly trends from 1990 to 2008, whilst the “National Greenhouse Gas Inventory” provides a summary of emissions and removals to meet the requirements of the Kyoto Protocol account (DCC 2008b). Both of the accounts report on six sectors; energy, transport, industrial processes, agriculture, solvent and other product use, waste and Land Use, Land Use Change and Forestry (LULUCF). Estimates of emissions are made by the Department of Climate Change and Energy Efficiency (DCCEE) using the Australian Greenhouse Emissions Information System (AGEIS) and for LULUCF, the National Carbon Accounting System (NCAS)(DCCEE 2010b). The
most significant differences in the two sets of GHG accounts are with the treatment of terrestrial carbon and the accounting requirements for LULUCF (DCCEE 2010b). Accounting for LULUCF is much more complex than other sectors and has been perhaps the most controversial political element to international negotiations (Fry 2002). Under the UNFCCC, all emissions and removals from LULUCF are reported as part of Australia’s total emissions, whereas under the Kyoto Protocol only specified land use change activities are included (UNFCCC 2008). When all emissions and removals from LULUCF on managed lands are accounted for under the UNFCCC, the sector may move from a net source to a net sink depending on the year and due to inter-annual climate variability and natural disturbances (DCCEE 2010b).

In 2007, Australia ratified the Kyoto Protocol, committing to reduce its annual greenhouse gas emissions to 8% above 1990 levels between the 2008-2012 commitment period (DCC 2009). This means Australia must not emit above its initial assigned amount of 2,990,378.53 Gigagrams of carbon dioxide equivalents (CO2-e) over the five year commitment period (Talberg 2009). The Kyoto protocol allows an Annex I country such as Australia to meet this target through either direct emissions reductions or by increasing the initial assigned amount through Kyoto mechanisms or LULUCF activities (see figure 3) (Talberg 2009). The three Kyoto mechanisms are Joint Implementation whereby a country commits to an emissions reduction project in another Annex I country, Clean Development Mechanism where a country commits to an emissions reduction project in a non-Annex I country, or through emissions trading between parties (UNFCCC 2008). Similarly, a country may increase its allowable level of emissions through LULUCF activities that may reduce greenhouse gases from the atmosphere, and this sector is particularly important for Australia to meet its target (Talberg 2009). Furthermore, a country that is likely to come well under its target is eligible to sell ‘Kyoto units’, thus reducing its own assigned amount to its minimum threshold (UNFCCC 2008). At the end of the commitment period, Australia’s total emissions from all sources except LULUCF (known as Annex A emissions) will be compared to its assigned amount, which is the initial assigned amount plus or minus any credits or debits incurred through LULUCF or Kyoto mechanisms (Talberg 2009). The Kyoto Protocol has several articles that are of particular importance for accounting for changes in carbon stocks and greenhouse gas emissions from land based activities in savannas; Articles 3.1, 3.3, 3.4 and 3.7.
Land use classification

Carbon accounting in savannas is covered in both the Agriculture and the LULUCF sectors, a separation that has implications for the methodologies used for different land use activities (Henry et al. 2005). One distinction is how savannas are defined under each sector and classified into different zones. Under Agriculture, savannas in the NT and WA are broadly stratified into woodlands or grasslands, and these are defined based on the IBRA agroecological zones (AEZ’s) (see figure 4) (DCCEE 2010b). The methods for classifying Queensland have not yet been fully developed. AEZ 1 and 2 are defined as woodlands, whilst AEZ 5 and 11 in the arid interior are defined as grasslands. This distinction is important for the methodology used for calculating emissions from savanna burning, as different emissions factors apply to grasslands and woodlands, and the coarse resolution of two categories does not allow for fine scale estimates of fuel load changes across vegetation types (Russell-Smith et al 2009).

Under LULUCF, the savannas encompass a broader range of land use categories; forest lands, croplands, grasslands, wetlands, settlements and ‘Other’ category (see figure 5)
Land use categories with the exception of forest are derived from the Land Use Mapping program from the Australian Bureau of Rural Sciences. Much of Indigenous land in northern Australia is classified as ‘other’, which is the only category that is considered unmanaged and as such Australia does not report on emissions and removals from this category, other than savanna burning. This is a peculiar anomaly in greenhouse gas accounting, as in reality much of these lands are in fact managed and such a classification is ethically controversial and seems to reflect older paradigms of ‘wilderness’ and ‘noble savages’ no longer commonly accepted in contemporary Australia. Similarly, wetlands are a voluntary reporting category and at current, Australia does not report on emissions and removals from this land use (DCCEE 2008b). This is primarily due to the current lack of appropriate inventory methodologies available for estimating GHG fluxes in wetlands (IISD & WI 1999).

Figure 4: Savanna classification in the Agriculture sector under Australia’s GHG accounting framework
N.B. AEZ 1 & 2 = woodland, AEZ 5 & 11 = grassland (DCCEE 2010b)
Agricultural emissions in savannas

Agriculture is considered an Annex A sector which means that only emissions are accounted for, not any removals that may occur through better management (DCCEE 2010b). The Agriculture sector also only accounts for methane (CH4) and nitrous oxide (N2O) and covers prescribed burning of savannas, enteric fermentation from livestock, manure management, methane from decay of organic matter, agricultural soils and field burning of agricultural residues (DCCEE 2010b). All fires in savannas landscapes are considered anthropogenic as recommended by the IPCC, which means both wildfires and human-induced fire emissions are accounted for (Henry et al. 2005). However, the inclusion of prescribed burning of savannas in the category of Agriculture means that only methane and nitrous oxide from these fires are accounted for, and under the Kyoto accounts CO2 emissions are not reported, although they are reported under grasslands in the UNFCCC accounts (DCCEE 2010b). This is based on the IPCC assumption that carbon is resequestered in regrowth following fire, however this is highly dependent on
the intensity and frequency of a savanna fire regime and is unlikely to be true across the landscape (Murphy et al. 2009; UNFCCC 2008). Furthermore, unlike LULUCF, the Agriculture sector does not require spatially explicit reporting of emissions and instead uses country specific emissions factors and parameters (Russell-Smith et al. 2009). The current methodology used for calculating emissions does not recognise changing seasonality, thus a fire early in the dry season may have a similar emissions estimate to one occurring late in the dry season. This has important implications for recognizing the value of Indigenous fire management for emissions abatement, however this methodology is currently under review and likely to be updated in the near future (M. Meyer pers. comm 2010). The 2006 IPCC Good Practice Guidelines for LULUCF recommends the future integration of LULUCF and Agriculture into one new category called Agriculture, Forestry and other Land Use (AFOLU), in order to allow for consistent use of data between sectors and consistent treatment of greenhouse gases.

In committing to the Kyoto Protocol Australia is required to account for all LULUCF activities listed under Article 3.3, namely deforestation, reforestation and Afforestation (Talberg 2009). Deforestation occurs when there is a human-induced permanent change from forest to non-forest, whilst Reforestation and Afforestation refers to the conversion of non-forested land to forested land (UNFCCC 2008). Under article 3.3 only land use change is reported, so if a harvested forest is replanted immediately after then it will remain in the forestlands category and not be picked up as a deforestation emission (Henry et al. 2005). Reforestation refers to the planting of forests on land cleared before 1990 whilst Afforestation describes the planting of a forest on land that has not previously been forested or for a period of at least 50 years. However, both of these activities are reported using the same methodology and treated as one for accounting purposes (UNFCCC 2008). Article 3.3 activities are monitored using the National Carbon Accounting System (NCAS) that uses annual remote sensed data to detect change in land use and forest cover across the continent (Richards 2005). Emissions and removals from Article 3.3 activities are added or subtracted from Australia’s initial assigned amount. For example if Australia experiences net removals from LULUCF through reforestation and Afforestation, then it is eligible to increase its allowable emissions level, whereas if through deforestation Australia is a net emitter then it must cancel Kyoto units and is not able to increase its initial assigned amount (DCC 2008b). Australia is unique in that it is permitted to use a net-net accounting approach for Article 3.3 activities, whereby the
emissions and removals in the commitment period (5 years) are subtracted from 5 times the emissions and removals that occurred in the base year 1990 (Hohne et al. 2007; MacIntosh 2003). All other countries however must use a gross-net accounting approach whereby only the commitment period emissions and removals can be used against their targets (Hohne et al. 2007). This was known as the politically controversial ‘Australia Clause’ or Article 3.7 of the protocol, and was negotiated due to the 1990 base year being a particularly high year for land clearing in Australia (MacIntosh 2003).

Article 3.4 of the Kyoto Protocol allows Annex I Parties to elect additional human-induced land based activities to be used in the LULUCF sector for the first commitment period (UNFCCC 2010a). These activities include forest management, cropland management, grazing land management, and revegetation. Forest management refers to the adoption of stewardship practices that deliver ecological, economic and social functions in a sustainable manner (UNFCCC 2008). Cropland management refers to management practices on croplands that are set aside temporarily for production, whilst grazing land management is the management of vegetation and livestock in a sustainable manner (UNFCCC 2008). Revegetation refers to the management of non-forest vegetation greater than 0.05 hectares in order to increase carbon stocks (UNFCCC 2008). The Australian Government determined not to elect any Article 3.4 activities in the first commitment period, due to the susceptibility of the Australian continent to dramatic fluctuations in climatic and disturbance events such as wildfire and drought (DEH 2005). It was determined that the inclusion of Article 3.4 activities would have a greater negative risk, as positive gains in carbon accrue incrementally over time, whilst losses in carbon can occur rapidly through single events such as wildfire (DEH 2005). Furthermore, the baseline year of 1990 was a period of above average rainfall and as such the effects of drought on tree dieback and soil carbon would be more obvious in the first commitment period. Comparing total Australian emissions under the UNFCCC reporting requirements compared to the requirements of the Kyoto protocol gives some indication of the impact of excluding article 3.4. For example in 2008, a total of 618MtCO2e were emitted under the UNFCCC which accounts for all emissions and removals, whilst a total of 576.2 Mt CO2-e emissions were reported under the Kyoto Protocol when only Article 3.3 activities were included in LULUCF (DCCEE 2010b).
The degree to which land use change is detected under Article 3.3 is dependent upon the definition of a forest. Under the Kyoto protocol Australia has defined a forest as greater than 2 metres in height, greater than 20% canopy cover and greater than 0.2 ha (DCC 2008b). The definition is consistent with the forest definition used by the National Forest Inventory, however also applies a minimum area criterion that can be detected from the resolution of the remote sensed Landsat imagery. The application of this minimum area criterion has a profound impact on the area considered ‘forest’ in northern Australian savannas (see figure 6)(MPIGA 2008). As a result much of the woodlands in northern Australia fall under the grassland category. In theory such a reduced area of forest extent increases the available area of land that is Kyoto compliant for re/afforestation, offering the potential for woodlands to be managed towards meeting a forest definition by increasing biomass through woody thickening. However, there may be biophysical constraints to this and undesirable biodiversity impacts. On the other hand, if an NFI forest extent is adopted then this offers more opportunity for future engagement with forest management activities under article 3.4, but also constrains land clearing. This definition also does not distinguish between native forests and monocultural tree plantations, and may lead to the conversion of native forests to plantations under the auspices of carbon offsetting (GFC & CEESP 2009). Although the forest definition is fixed for the first commitment period, the UNFCCC Subsidiary Body for Scientific and Technology Advice (SBSTA) is considering using biome specific forest definitions for the second commitment period (UNFCCC 2010b). This approach would potentially allow Australia to use a different forest definition for northern Australia that would be more appropriate for savannas that does not impact on definitions of forests in south eastern Australia with different characteristics.

At the Conference of the Parties 11 (COP11) in Montreal in 2005, a policy mechanism was suggested that would incentivise developing countries in the next commitment period post 2012 to retain their forests as critical carbon sinks (Parker et al. 2009). At COP13 in Bali in 2007, the Bali Action Plan mandated that Parties negotiate a REDD instrument that would be agreed upon in Copenhagen at COP15 and come into effect in a post 2012 global climate change framework (UN-REDD 2009). REDD stands for Reducing Emissions from Deforestation and Degradation (REDD) and is based on the notion that developed countries could offset their own emissions by financing developing countries to conserve their forests. The overall objective of REDD+ is to slow, halt and eventually
reverse deforestation in developing countries. Degradation describes the impacts caused by overexploitation, exotic species invasion, pollution, fires or other factors on a forests ability to provide ecosystem services (Millenium Ecosystem Assessment 2005). REDD+ stems from the concept of payments for environmental services (PES), whereby forest owners and users receive performance-based payments to reduce carbon emissions and increase removals through better forest management and reforestation (Wunder 2007). PES projects attempt to address the market failures that exist in neoclassical economics by valuing the ecosystem services of forests (Wunder 2007).

By placing forests in the emerging carbon market, funding for conservation will potentially exceed any previous financing for forests. Since the COP13 decision, two programs have been established to prepare communities for a REDD+ framework; the UN-REDD programme and the World Bank’s Forest Carbon Partnership Facility (UN-REDD 2009; GFC & CEESP 2009). The main aim of these programmes is to establish whether the carefully structured payments and capacity support can be effective in reducing emissions and maintaining and improving forest ecosystem services generally (UN-REDD 2009). The recent COP16 draft text commits to a fund for REDD projects, however this still remains an opportunity only for developing countries. Although the Australian Government has committed to the FCP, as well as developing several bilateral REDD projects with Papua New Guinea and Indonesia, it has not committed direct funds for avoided deforestation in Australia (DCCEE 2010c).
Figure 6: Differences in forest extent according to the definition used by the DCCEE compared to the definition used by the NFI (State of the Forests 2008)

Future Policy Options

As Australia currently considers the adoption of a carbon price, either through some form of emissions trading or a carbon tax, there is much uncertainty about how land management will be used for emissions reductions and as a source of greenhouse gas offsets. If the adoption of an emissions trading scheme or a tax comes to fruition there will be the need for clear accounting rules. In the Garnaut Review (2009), it was recommended that an emissions trading scheme would move towards comprehensive accounting of land based activities beyond the current activities included in Article 3.3 of the Kyoto Protocol. However, the Federal Government’s Carbon Pollution Reduction Scheme (CPRS) white paper stated that it would maintain the current Kyoto accounting
rules in a future scheme with the exclusion of deforestation (Australian Government 2008) (see Table 2). It also stated that the Agricultural sector would be left out of an emissions trading scheme for now, although it did make specific mention that opportunities for savanna burning would be negotiated and developed with Aboriginal communities. Other activities such as those included in Article 3.4 could be traded as domestic offsets in the voluntary carbon market and acknowledged by the National Carbon Offset Standard (NCOS) and more recently the Carbon Farming Initiative (CFI)(DCCEE 2009a). In the absence of an ETS, there are also moves at the international stage to make article 3.4 activities compulsory for a second commitment period of the Kyoto Protocol post 2012 (Schlamandinger 2007). In addition, more comprehensive accounting may seek to include broader land use categories such as wetlands that may be another opportunity for northern Indigenous communities. As a result it is important to understand the risks and opportunities associated with the adoption of these different activities for Aboriginal communities and the Federal Government itself.

Table 2: Land Use Activities and Greenhouse Gas accounting under three different approaches; the Kyoto accounts, the Garnaut review, and under the Carbon Pollution Reduction Scheme (CPRS)

<table>
<thead>
<tr>
<th>Kyoto Article</th>
<th>Activity</th>
<th>Kyoto Accounts</th>
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<th>CPRS approach</th>
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<td>Y</td>
<td>NCOS/CFI</td>
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<td>Y</td>
<td>NCOS/CFI</td>
</tr>
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<td>Grazing land management</td>
<td>N</td>
<td>Y</td>
<td>NCOS/CFI</td>
</tr>
<tr>
<td>3.4</td>
<td>Crop land management</td>
<td>N</td>
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<td>NCOS/CFI</td>
</tr>
<tr>
<td>3.4</td>
<td>Revegetation</td>
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<td>Y</td>
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<td>CH₄ &amp; N₂O</td>
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<td>NCOS/CFI</td>
</tr>
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</table>
**State and Territory Carbon Policy**

In the absence of clear national carbon policy in the form of an emissions trading scheme or carbon tax, it has been important for state and territory agencies to develop policies to support the development of the carbon offset industry. The Northern Territory Climate Change Policy emphasises the role of land management as the main source of emissions abatement and carbon sequestration (NT Government 2009). In particular, it notes the important role of protecting carbon stocks in the NT by introducing native vegetation management legislation and reducing land clearing rates. The management of savanna burning is also key to meeting its target of carbon neutrality for government agency operations by 2020, with the aim of achieving 500 000 tonne reductions per year through the carbon market. In order to achieve these targets, a Northern Territory Offsets Policy is being developed, camel control programs and vegetation and soil monitoring programs are being established (NT Government 2010). Similarly Western Australia are developing an offsets policy and support the role of carbon sequestration in the Western Australian Greenhouse Strategy 2004 (WA Greenhouse TaskForce 2004). WA also has a Carbon Rights Act 2002 that allows landowners to register proprietary ownership of carbon sequestration rights. Queensland have also developed a climate change strategy, however the focus is more upon ecosystems along the eastern seaboard such as rainforests and the Great Barrier Reef rather than savannas (QOCC 2008). However, a working paper released in 2010 entitled “Capturing Carbon in the rural landscape” identifies the importance of savanna burning and carbon sequestration (DERM 2010). Although these policies will be important in the short term, they will need to be flexible to be able to adapt to fast changing international and national policy frameworks.
Conclusion

The future of carbon policy will be strongly influenced by outcomes at future international negotiations around the treatment of terrestrial carbon in greenhouse gas accounting frameworks. The ratification of the Kyoto Protocol has established the current framework of accounting for emissions and removals from land based activities in savanna landscapes. Savannas are unique in that they fall across both the Agriculture and LULUCF sectors, resulting in arbitrary distinctions. In particular the types of greenhouse gas emissions reported and the classification of savanna lands have implications for the development of carbon policy to support an offsets market. Future accounting frameworks post 2012 should aim to converge these categories into one for consistency. Similarly the savannas are a unique biome and the current definition of a forest does not recognise the vast extent of woodlands, thus a biome specific definition should be considered more closely in the next commitment period. Although Australia currently accounts only for Article 3.3 activities, there are moves at the international stage to include broader activities in accounting. It will be important for Australia to understand the specific implications of mandatory reporting of Article 3.4 activities. On the one hand, there remain significant risks associated with increasing frequency of natural disturbances such as wildfire and drought under climate change that can have negative impacts on carbon stocks. On the other hand, inclusion of these activities will potentially provide more economic opportunities for landowners to undertake carbon positive land management activities, as well as provide more transparency and trust in terrestrial carbon accounting. Resolving this issue depends on the definitions adopted and treatment of anthropogenic and non-anthropogenic disturbances. This is not straightforward as the simple exclusion of non-anthropogenic disturbances from accounting may create a disincentive to undertake management interventions such as planned burning altogether.

Conclusion Box:

- Greenhouse Gas Accounting for Savannas falls across both Agriculture and LULUCF sectors
- The Agriculture and LULUCF sector have different methods and requirements for accounting and these should aim to converge in future policy
- Australia has only committed to Article 3.3 activities under the Kyoto Protocol of
reforestation/Afforestation and deforestation

- Forest management, grazing land management and revegetation under Article 3.4 are not at this stage included in Australia’s accounting of greenhouse gas emissions
- The forest definition used by Australia results in a very limited forest extent in the savannas compared to the definition used by the National Forest Inventory (NFI)
- A biome specific forest definition may be more suitable for the savannas
- Much of Indigenous land currently falls under “Other” land which is considered unmanaged and is not reported on in the LULUCF category
- Future agreements and national policies should seek more comprehensive accounting
Chapter 4: Opportunities and risks for Indigenous involvement in carbon markets

Introduction

The evolving carbon offset industry offers many new opportunities and poses some new risks to Indigenous land managers in Northern Australia. As the Federal Government prepared the CPRS to only cover activities listed under Article 3.3, they developed the national carbon offset standard (NCOS) that would allow for offsets from uncovered sources such as deforestation and savanna burning. However, when the CPRS failed to pass through both houses of government in early 2010 it left a void in the offsets market whereby Kyoto-eligible units could not be recognized under NCOS. To address this issue the government resolved to establish a Carbon Farming Initiative (CFI) which would combine both Kyoto and non-Kyoto activities into one policy framework. The CFI opens the door for broader inclusion of land management activities in the one framework, such as those listed under Article 3.4 of the Kyoto protocol. Although non-Kyoto units will still only be tradeable in voluntary markets and thus attract a lower price than Kyoto units, there is now greater recognition of offsets beyond forestation. The CFI recognizes the potential from forest management, avoided deforestation, revegetation, grazing land management and savanna burning, and this will promote credibility in voluntary offset markets as well as overseas compliance markets. Whilst other studies (Heckbert et al. 2009; NAILSMA 2010) have looked at Indigenous opportunities in the carbon market, they have not assessed the full range of available offsets. In anticipation of the CFI and ongoing changes at the international and national level, it is important to understand the opportunities and risks from different offset options for Indigenous communities in northern Australia. Indeed the carbon offset industry offers important livelihood opportunities for Indigenous people, with a potential estimated income of $52 million per year and the creation of 1,029 jobs (Heckbert et al. 2009).
Offset opportunities on Indigenous Lands

Reforestation/Afforestation

The only activities that are eligible for Kyoto Removal Units (RMUs) that can count towards Australia’s emissions targets are reforestation and afforestation. As such carbon credits from re/afforestation projects are likely to receive a higher price than other activities as the demand for Kyoto-recognised abatement credits is higher and can be traded in international compliance markets (DCCEE 2010a). To be eligible, an area of land must be able to grow a forest that meets the Kyoto definition, it must have been cleared before 1990, and any harvesting or disturbances must be reported as a loss of carbon (Heckbert et al. 2009). Heckbert et al. (2009) examined the potential for carbon offsets from reforestation on a 1,000 hectare property near Bundaberg, Queensland. Where the forest was managed for carbon only, an estimated 12tCO2e/ha/year could be sequestered, or 6 tCO2e/ha/year when managed for timber as well as carbon. For such an activity to be economically positive, a carbon price would need to be $27/tCO2e for the unharvested forest or $21/tCO2e for the harvested forest. Similarly, Harper et al. (2007) estimate forest sinks to be profitable once a carbon price reaches $25 a tonne of CO2e to offset costs of establishment and management.

Opportunities for re/afforestation are lower in northern Australia than the rest of the country, due to the comparatively low rate of land clearing prior to 1990. Nonetheless there may be some opportunity particularly in Queensland for establishing forests on cleared land, although it may not be Kyoto-compliant (Polglase 2009). A study by Polglase (2008) assessed the benefits of reforestation for biodiversity outcomes, and found northern Australia to have the least need for reforestation. Contrasting with Heckbert et al. (2009) environmental plantings in northern Australia were found to have relatively low growth rates, in the range of 0-5 tCO2e/ha/year. However, hardwood plantations managed for carbon such as African Mahogany (Khaya senegalensis), are likely to have much higher carbon sequestration rates in the range of 6 to 20 tonnes of CO2e/ha/year due to being managed for maximum growth and with improved genetic stock (Polglase et al. 2008). However, such results assume a level of neglect of environmental plantings compared to managed plantations, and take no account of the resilience of native species to fire and other disturbances, nor the associated biodiversity benefits of native forest plantings.
Revegetation

The CFI identifies the potential for revegetation projects to generate carbon offsets as non-Kyoto units in the voluntary market (DCCEE 2010a). Unlike re/afforestation and forest management, revegetation projects are not constrained by forest definitions and aim to increase carbon stocks in degraded vegetation (UNFCCC 2008). Although few studies have specifically looked into this activity as an offsets option for northern Australia, there may be significant potential for active rehabilitation of semi-arid shrubland and grasslands that have been degraded through erosion, overstocking, invasive species and feral animals (Harper et al. 2007). In particular, rehabilitating degraded lands by increasing the production of woody vegetation, grass and litter will have important benefits for soil carbon pools (Ash et al. 1996). The restoration or replanting of native vegetation will also have important biodiversity benefits and provide erosion control through increased soil binding and increasing soil moisture (QOCC 2008). The Garnaut Review (2008) estimates that at a $20 tonne CO\textsubscript{2} price could lead to a ten fold increase in the income for landowners in the rangelands if current grazing practices were replaced with restoration practices. However, such optimism may be based on unrealistically high estimates of soil carbon sequestration rates (Gifford & McIvor in CSIRO). In reality, realizing the economic potential of such projects may be difficult due to the likely low rates of sequestration in these regions and high transaction costs associated with management, monitoring and trading (Baker et al. 2007). Furthermore, the high climatic variability experienced in the rangelands results in significant year to year variation in carbon uptake and release and thus may be a difficult barrier to overcome in a carbon market (Gifford & McIvor 2009).

Forest Management

Forest management is a potential offset option to boost recognition and income from sequestration processes as a result of savanna burning and other management practices. The Northern Territory Climate Change policy recognizes the potential of more effective land management and revegetation to realize the carbon carrying capacity of the savannas, estimating a potential 4 Mt CO\textsubscript{2} -e to be sequestered pa by 2020 (NT government 2009). More broadly, Roxburgh (2009) estimates that 21 MtCO\textsubscript{2}e could be sequestered each year through reducing harvesting and better management of native eucalyptus forest across Australia. In northern Australia however, the management of fire is more relevant for
increasing carbon stocks than reducing harvesting, and the value of the sequestered carbon may be more than that provided by the non-CO2 abatement that is currently credited (Murphy et al. 2009). Furthermore, other land management practices may be recognized under forest management such as weed and feral animal control (Cowie 2008; Bradshaw & Gorman 2008). Cook et al. (2010) however caution the use of forest management as an offset activity, as although carbon stocks may increase over a period, they may reach saturation point within a few decades and yet would still need to be managed in perpetuity. Although current rules for offsetting require demonstrating this long term permanence of carbon stocks, the financial gains would decrease over time due to decreasing sequestration rates. In such circumstances there may be other reasons for undertaking this type of land use decision, such as biodiversity or other socio-cultural benefits. However, the recent submission on Forest Management (FM) to the UNFCCC by the Federal Government implies that only forests with a focus on wood production will be considered as FM lands under a future international agreement (Australian Government 2011). If this definition of FM lands were to be accepted then there may be foregone opportunities for FM in savanna landscapes.

**Avoided Deforestation**

The conversion of forests to other land use such as improved pasture for grazing releases CO2 from above and below ground biomass, soil carbon pools and the release of non-CO2 gases from biomass burning post-clearing (Raison et al. 2009). The National Carbon Accounting Toolbox estimates that land clearing in savannas results in emissions of on average 222 t CO2-e/ha for open forests, 169 t CO2-e/ha for woodland and 140 t CO2-e/ha for open woodland (Law & Blanch 2008). Given the extent of intact forests occurring on Indigenous lands in northern Australia, there may be important opportunities for avoided deforestation as a carbon offset. Providing opportunities for avoided deforestation has an ethical basis, as it should aim to recognise the foregone opportunity costs of other forms of land use development and the significant environmental service that avoiding deforestation provides the nation (Law & Blanch 2008). Under the current accounting rules, this may only be an opportunity for areas of Indigenous land that meet the current forest definition as described in chapter 3. The development of an avoided deforestation methodology is necessary to compliment the opportunities available to developing countries under the REDD mechanism (Van Oosterzee & Garnett 2008). Although
Australia is considered an Annex I ‘developed’ country, Indigenous communities from an economic and social opportunity point of view are more akin to a developing country yet are excluded from involvement in REDD (J. Morrison pers comm. 2009). REDD is seen by its proponents as way to strengthen local livelihoods and improve carbon sequestration and biodiversity outcomes, yet it also poses risks where weak governance exists. Under the proposed CPRS, deforestation was to be excluded despite being accounted for under Article 3.3 of the Kyoto Protocol (Australian Government 2008).

The proposed CFI has stated its openness to the inclusion of avoided deforestation as a recognised offset, however the conditions are likely to be highly restrictive and dependent upon the development of an appropriate methodology (PCA 2011). The only recognised REDD offset on the voluntary market in Australia currently exists in Tasmania, whereby carbon credits are generated for landowners that have protected 7,666 hectares of native forests over selective logging and land use change (REDD forests 2011). The project applies a methodology for avoided deforestation that has been developed under the Verified Carbon Standard (VCS), which requires demonstrating additionality, defining the scope of the project and ensuring no leakage of emissions occurs (VCS 2011a). Although there are currently four VCS methodologies that deal with avoided deforestation, none of these methodologies are suitable for the treatment of avoided deforestation in an Australian savannas context (VCS 2011a). An appropriate methodology should be developed under the CFI that will allow Indigenous landowners to benefit from avoided deforestation. Given that much of the savanna woodlands falls outside the Australian Kyoto ‘forest’ definition, there should also be opportunities for recognising ‘avoided conversion of non-forest land’, which is currently being considered by the Verified Carbon Standard Association (VCS 2011b). The CFI legislation has recognised the importance of this by identifying ‘avoided de-vegetation’ as a potentially viable offset under the scheme (PCA 2011).

According to the Australian Government, the main difficulty with recognising avoided deforestation as an offset is proving additionality, specifically proving that the forest would have been cleared if it were not for the offset project (DCCEE 2010a). However, this issue is not unresolvable, as the same issues exist in crediting REDD schemes and have been the focus of much research and debate at the international level (see Parker et al. 2009). Providing financial incentives for avoiding deforestation is likely to be stronger
than the imposition of financial penalties on landholders seeking to clear land for agricultural development. It is also avoids the equity issues that could arise should Indigenous people be refused permits to clear land in the future whilst non-Indigenous people have profited from clearing their land in the past. The NT Climate Change policy (2010) states that it will become a low land clearing jurisdiction that protects the carbon bank and contains the rate of land clearing through native vegetation legislation. Whilst such a move is welcome, it does raise ethical questions if the Territory’s greenhouse gas reduction ambitions constrain development on Indigenous lands, particularly given that Indigenous people have contributed little to the problem of climate change in the first place. If the carbon retained and managed on Indigenous lands can be adequately recognised through the CFI or other policy settings, then this may be more desirable for Indigenous landholders who seek to strengthen and revitalize traditional land management practices (Whitehead et al. 2008). In most cases, such credits will not be permissible under the Kyoto provisions for reduced deforestation as there will not be additionality, i.e. more carbon stored than would have occurred otherwise, by keeping the forests in place. However, it could be argued that where regional planning laws allow for clearing provided it satisfies regulations of biodiversity, water and soil conservation, then voluntary restraint from the permitted clearing could be argued as reduced deforestation and thus could attract international carbon credits (Law & Garnett 2011).

**Grazing Land Management**

Pastoralism remains an important livelihood option for some traditional owner groups in northern Australia, and the Indigenous Land Corporation has partnered with Territory and State governments to enhance the viability of managed livestock grazing on Indigenous lands (Heckbert et al. 2009). Carbon offsets from grazing land management is seen as a potential important additional source of income for these lands. Achieving carbon sequestration through grazing land management overlaps with the management activities of revegetation, as it requires controlling stocking rates, fire management, woody vegetation management and rehabilitation (Baker et al. 2007). Overgrazing is the single greatest cause of degradation in rangeland landscapes, and is a major source of carbon dioxide and methane emissions (Oldeman et al. 1991). Therefore controlling stocking numbers and employing tactical grazing methods that correspond to climatic variability is important for managing carbon. Harper et al. (2007) estimated potential carbon
sequestration across leasehold land in Western Australia as a result of different levels of reduced animal stocking, including removal and management of feral animals. Carbon gains ranged from 5 to 25 Mt CO$_2$-e in soil carbon, and 25-60 Mt CO$_2$-e of biomass carbon across the study area. However, there remains difficulties in the monitoring and measurement of carbon fluxes, particularly in the soil carbon pool, making offsets from this land use activity difficult to realise (Heckbert et al. 2007).

One option is to award carbon credits to projects that undergo land management changes that are known to have a positive impact on carbon storage, rather than measuring actual increases which are highly spatially and temporally variable (ENRC 2010). However, management changes will differ depending on rangeland type, for example while reducing grazing on Mitchell grasslands may improve soil carbon stocks, grazing in woodlands may increase carbon stocks in aboveground biomass in the early stages (Gifford & McIvor 2009). In any case, it is likely that achieving gains in carbon will necessary lead to a long term reduction in domestic animal numbers which may not necessarily be offset by the income from a carbon market (Gifford & McIvor 2009). Extending the possibilities of grazing land management to include management of feral animals and invasive plant species, however, may be a ‘no regrets’ initiative that leads to emissions cuts and other economic and ecological gain (Nous Group 2010).

**Savanna Burning**

Savanna burning is the most likely form of offsets that Indigenous people will wish to engage with, largely due to the success of the West Arnhem Land Fire Abatement Scheme (WALFA), but also for its relevance to customary management practices (Whitehead et al. 2008). Indeed, much research has already been undertaken around the accounting, management, governance and institutional requirements of savanna burning for engaging with the offsets market, that only a brief discussion will be provided here (Russell-Smith et al. 2009; Whitehead et al. 2008; Garnaut 2008). The North Australian Indigenous Land and Sea Management Alliance (NAILSMA) is currently coordinating the development of more landscape scale savanna burning projects across northern Australia that will engage with the carbon market (NAILSMA 2010). Although currently projects such as WALFA can only engage in the voluntary market, early indications are that large scale emissions abatement can be achieved at $15$ tCO2e, making it an economically attractive option
(Whitehead et al. 2008). In the development of the CPRS the treatment of liabilities from savanna burning projects was considered an issue. At the time, Whitehead et al. (2009) suggested that the most favourable option for savanna burning under any future ETS is for fire managers to attract no liabilities but still be eligible as an offset to both covered and uncovered sectors. Furthermore, projects will be more viable if they are at larger regional spatial scales than small-scale family based, in order to manage and buffer against the risk of extreme year to year variation in emissions reductions and demonstrating consistent performance to markets (Whitehead et al. 2008). The CFI will incorporate a risk of reversal buffer whereby credits are withheld from the project as an insurance against carbon loss through natural or human induced causes (PCA 2011).

**Wetland management**

Wetlands are currently not a reporting category under the Kyoto protocol for Australia, however the IPCC Good Practice Guidelines recommend their inclusion in future commitments (IPCC 2006). Wetlands throughout northern Australia such as Arnhem Land and within Kakadu National Park, are managed by Indigenous communities, particularly through the use of fire (Yibarbuk 1998; Whitehead et al. 2003). One of the significant threats to wetlands in northern Australia is from saline intrusion, as a result of levee degradation from feral animals as well as rising sea levels (Steffen et al. 2009). Although many of the threats to these wetlands are viewed in the context of biodiversity conservation and maintaining cultural traditions, there may also be important benefits for greenhouse gas mitigation. However, the processes that drive greenhouse gas fluxes in wetland environments are complex, and it is uncertain from the current state of the knowledge how harmonious the relationship between managing for biodiversity and managing for greenhouse gases will be. Although some studies have assessed the impacts of wetting and drying cycles on methane emissions in southern Australian floodplains (Boon et al. 1997), little research has explored the nature of this cycle in northern wetlands. More research into GHG fluxes in northern wetlands will be an important prerequisite before this type of offset can be assessed and realised.

**A ‘whole of landscape’ approach to carbon offsetting**

Many of the carbon offsets described above are likely to overlap one another under broader NRM systems across the landscape. For instance the processes of managing
emissions from savanna burning also have the potential for enhancing carbon stocks in forests and non-forest vegetation, which may also be lands subject to grazing. The delineation of offsets into these narrow categories is primarily to simplify accounting and to ensure that double counting does not occur across the landscape. Although avoiding double counting is important, in the savannas it is critical that a whole of system view of GHG management is adopted where multiple activities can be credited provided they are all additional to one another (Cook et al. 2010)(see figure 7). The Garnaut Review (2008) warns that without comprehensive monitoring, reporting and recognition of emissions from land use, perverse incentives and accounting loopholes are more likely to occur. For instance, without recognition of avoided deforestation, there may be more of an incentive to clear land for other carbon credit purposes such as bioenergy (Garnaut 2008). Similarly, recognising credits for carbon sequestration from fire management would make offsets projects more viable and move towards proper valuation of the ecosystem service provided beyond methane and nitrous oxide emissions abatement (Murphy et al. 2009).

Emissions reductions may also just be one component of a broader NRM project for a region that contributes to biodiversity and ecosystem protection and supports local livelihoods, and such co-benefits should be recognized and permitted in a carbon market (NAILSMA 2010). Under the original proposal for the CFI framework, offset projects that may have had existing government support or receive assistance through other conservation measures, were to be ineligible under the scheme due to the difficulty of demonstrating ‘financial additionality’ (DCCEE 2010a). The current CFI legislation has now simplified the conditions of financial additionality to allow for projects with multiple income streams (PCA 2011). This is an important development, as multiple income streams are often necessary for a project to occur, particularly as government funding may support other aspects of a project such as capacity building distinct from direct operations such as fire management. Furthermore, it does not stand true that any conservation actions lead to positive emissions benefits. May (2010) notes that most existing Indigenous land management groups are under-resourced and reliant on small grants, which do not cover wages, or management and infrastructure costs. Projects that deliver multiple benefits such as biodiversity and social outcomes may attract a higher price from buyers seeking competitive recognition for best practice carbon offsetting. Rather than relying on the marketing ability of Indigenous groups to demonstrate these broader benefits to an offsets market, they could eventually to be quantifiable in a similar approach used by the
Victorian Government’s EcoMarkets. Moving away from a single focus on carbon, ecomarkets attempts to take a ‘whole of landscape’ approach to offsetting, whereby each individual offset project is scored based on its broad environmental benefits such as water quality and stream health, landscape connectivity, biodiversity and carbon and then traded in a market (DSE 2011). Under the CFI a ‘positive list’ of projects that deliver such multiple benefits is now likely to occur (PCA 2011). This recognition of broader NRM and social outcomes should no doubt benefit Indigenous based offsets, and align with the more ‘holistic’ perspectives of many Indigenous people managing ‘country’ (May 2010).

![Diagram of a whole system GHG crediting approach for an offset project in the savannas](image)

**Figure 7: Example of a whole system GHG crediting approach for an offset project in the savannas**

**Managing carbon goals with Indigenous aspirations**

In some cases, management of areas of land for carbon purposes may pose particular problems for Indigenous people. One such conflict may be that woody thickening may be undesirable as it hampers access to traditional hunting areas (Bradshaw & Gorman 2007). Similarly, management of feral animals such as buffalos and horses that leads to degraded vegetation and soil erosion poses difficulties due to differing cultural perspectives on their eradication (Bowman & Robinson (2002; Robinson *et al.* 2005). For example, Robinson
et al. (2005) found that in Kakadu National Park, many Jawoyn Indigenous people would like to see increases in buffalo numbers as they are an important food source yet agree with the need to reduce feral pig numbers as they are perceived as a threat to their land. Navigating these issues are not new to land management, where it is common for different stakeholders to hold opposing views on the future of the landscape, but it highlights the need for an adaptive and participatory approach to developing an offset project’s management actions.

Moreover, entering land into a carbon offset agreement requires long term commitment to ensure retention of carbon stocks, which inevitably constrains future land use decisions. Furthermore, permanence will be a potential barrier to Native Title groups wishing to engage in a carbon offset market. In many circumstances such long term planning is desirable, such as generating carbon offsets within an Indigenous Protected Area (IPA). Whitehead et al. (2008) also suggest there may be difficulties in joining aspirations of Indigenous land managers with the commercial aspects of the carbon market. In particular, balancing the cultural and spiritual motivations for traditional fire management with the financial and scientific incentives of emissions reductions may in some cases be difficult to achieve. On the other hand, such activities provide one of the few livelihood opportunities to allow Indigenous people to return to country and revitalize customary traditional land management practices (NAILSMA 2010). It is therefore critical that projects are developed with strong Indigenous involvement and that the policy framework is loose enough to allow customary institutions to evolve and adapt to the unique circumstances of the local context. Indeed with a changing climate, such an adaptive approach will be necessary and the role of Indigenous knowledge should be adequately recognized in achieving mitigation outcomes (Green et al. 2009).

Indigenous and forest dependent communities globally are deeply concerned about the future of the carbon offset market, seeing the potential for another top down approach to conservation that will further marginalise them and degrade their rights to land, resources and customs (Lovera 2009). Throughout the UNFCCC Conference of the Parties (COP) 15 and COP16, Indigenous people and NGO’s emphasised the need for national governments to ensure carbon offset projects were embodied with the rights outlined under the UN Declaration of the rights of Indigenous People. A major tenet in this declaration is the right to free, prior and informed consent over projects that occur on
traditional lands. Globally, over 1.6 billion people directly depend on forest resources in some way for their livelihoods, and much of the current extent of forest cover occurs on Indigenous lands (UN-DESA 2009). It is necessary that carbon offset projects do not lead to a protected areas ‘fence and fines’ approach to conservation that alienates people from their traditional livelihoods, intensifying the competition for resources and degradation of surrounding lands (Borrini-Feyerabend et al. 2004). Instead policies should support community based approaches to conservation and emissions reductions that strengthen livelihoods and allow Indigenous people to protect forests and woodlands through their own traditional knowledge, practices and beliefs (Gadgil et al. 1993). The positives of such an approach are recognized by the Convention on Biological Diversity that states that ‘management should be decentralized to the lowest appropriate level’ so as to increase the responsibility, sense of ownership and accountability, and use of local knowledge (Borrini-Feyerabend et al. 2004). In many ways, Indigenous people in northern Australia are better situated to realise the benefits of the carbon market than in other countries where there are much higher risks of loss of access to land and weakened tenure rights, corruption and concentration of power by elites, and distorted local economic systems (Lovera 2009). For instance, the Aboriginal Land Rights (Northern Territory) Act 1976 provides a legal framework that is more capable of dealing with issues of informed consent to be dealt with through land councils. Nonetheless, offset policy in northern Australia should aim to adhere to similar standards to that advised for REDD projects in developing countries (see table 3).

Table 3: Environmental and Social Standards for REDD
(adapted from CCBA & Care International 2010)

<table>
<thead>
<tr>
<th>Principle</th>
<th>Description</th>
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<tr>
<td>1</td>
<td>Rights to lands, territories and resources are recognized and respected by the REDD program</td>
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<tr>
<td>2</td>
<td>The benefits of the REDD program are shared equitably among all relevant rights. Holders and stakeholders.</td>
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<tr>
<td>3</td>
<td>The REDD program improves long-term livelihood security and well-being of Indigenous Peoples and local communities with special attention to the most vulnerable people.</td>
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<td></td>
<td>The REDD program contributes to broader sustainable development and good governance objectives.</td>
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<tr>
<td>5</td>
<td>The REDD program maintains and enhances biodiversity and ecosystem services.</td>
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<tr>
<td>6</td>
<td>All relevant rights holders and stakeholders participate fully and effectively in the REDD program.</td>
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<tr>
<td>7</td>
<td>All rights holders and stakeholders have timely access to appropriate and accurate information to enable informed decision-making and good governance of the REDD program.</td>
</tr>
<tr>
<td>8</td>
<td>The REDD program complies with applicable local and national laws and international treaties, conventions and agreements.</td>
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</table>

**Conclusion**

The carbon offset industry offers important opportunities for Indigenous livelihoods to manage for carbon and emissions abatement. Although for northern Australia, savanna burning is the most attractive offset option, there may be other opportunities in forest management, avoided deforestation, revegetation, and grazing land management. The CFI gives more recognition to activities in the voluntary market that are non Kyoto offsets, creating new opportunities for Indigenous landholders beyond Kyoto eligible reforestation activities. For the Northern Territory and north Western Australia however, forestation opportunities may be limited due to the low degree of historical land clearing. As such, it is important to develop recognition of avoided deforestation and forest management offsets, so that Indigenous communities with higher carbon stocks can generate benefits similar to that of the REDD scheme in developing countries. For Indigenous communities in the semi-arid and arid rangelands, additional income from revegetation and grazing land management offsets may be an important contribution to broader NRM strategies. The boundaries of land use activities in savannas is much more difficult to define than southern Australia, therefore multiple carbon offsetting activities should be recognised and credited where possible. This is particularly important for the recognition of carbon
sequestration in forest management and revegetation as a result of savanna burning management. Despite these opportunities, there may be cultural barriers for Indigenous involvement in all offsets, where the goals of emissions reductions and carbon sequestration do not align with Indigenous aspirations. It is important that carbon offset projects and policy frameworks permit a strong involvement from Indigenous people in the planning and implementation phases, and that their rights are clearly defined and strengthened. Moreover, it is important that climate change policies do not become yet another form of ‘green imperialism’ by imposing government agendas on Indigenous people (May 2010).

**Conclusion Box**

- The Carbon Farming Initiative allows for a broader range of offsets to be generated from land use activities on Indigenous held land
- Re/Afforestation likely to generate better prices but may be limited in potential for northern Australia
- Savanna Burning offers most potential for Indigenous groups as a marketable offset but is more likely to be viable at regional spatial scales
- Avoided deforestation is an important opportunity for Indigenous people that would also be ethically responsible climate change policy
- Sequestration from forest management and avoided deforestation should be coupled with emissions abatement from savanna burning to recognise full offset benefits
- Revegetation and grazing land management may offer important additional forms of income for existing land use activities
- There remains important considerations of managing carbon goals with Indigenous aspirations
- Indigenous aspirations for land use should not be unnecessarily constrained by a low carbon economy and adequate alternative development pathways should be facilitated
Chapter 5: Conclusion

Finding a way forward for climate change policy in northern Australia

The management of savannas in northern Australia is becoming increasingly focussed on greenhouse gas abatement and carbon sequestration, and Indigenous people are situated to play an important service delivery role, and in many cases already demonstrating their capacity to do so (Race 2004; Whitehead 2008). Indeed, land management activities have a significant influence on the global carbon cycle, not only as a source of emissions but as one of the few means of reducing GHG concentrations in the atmosphere through biosequestration. The recent update of the Garnaut Review (2011), acknowledges that there needs to be “greater incentives for countries to reduce emissions and increase biosequestration across a broader range of land management activities.” For northern Australia, carbon offset markets may provide payments for environmental services that open up new opportunities for landholders beyond traditional forms of agricultural development. Such opportunities are particularly important for Indigenous communities, where existing livelihood options are limited and land management is mostly perceived as a culturally appropriate and positive form of development. Furthermore, well-developed climate change policies can also lead to broader NRM benefits such as protection of biodiversity and improved soil health.

Carbon stocks on Indigenous Freehold and Native Title lands in northern Australia are comparatively high compared to non-Indigenous land, much of which has been cleared for agriculture. In particular, high rainfall areas such as the Tiwi Islands and Arnhem land range from 150-250 tC/ha. Although carbon stocks are not currently recognized in climate change policy frameworks such as the Kyoto protocol, there are important opportunities for Indigenous people to be financially compensated for avoiding deforestation on their lands. However, savannas are characterised by disturbances such as fire, drought, cyclones and herbivory, and therefore can range spatially and temporally between a sink and a source. The ongoing management of savanna forests and woodlands is crucial to maintain these stocks and enhance sequestration. Similarly, there may be important gains from management in the soil carbon pool, where most of the carbon resides, and which is likely to be influenced by different fire intensities. For true recognition of the benefits of carbon land management in markets, there needs to be further refinement of existing carbon models and a greater understanding of soil carbon dynamics.
Current greenhouse gas accounting rules under the UNFCCC Kyoto protocol have been designed at an international level. As such, many of the definitions and rules are regionally inappropriate. The current forest definition adopted by Australia under the protocol excludes much of the woody vegetation found in the tropical savannas, despite being considered forest under other definitions such as the National Forest Inventory. Similarly, much of Indigenous land in northern Australia is classified as ‘other’ land, which is the only category that is considered unmanaged and emissions and removals are not reported on from this category. The reporting of emissions and removals from savannas is further complicated by the manner in which different land use activities are reported under the different UNFCCC sectors of Agriculture and LULUCF. A future agreement to replace the Kyoto protocol should consider converging these categories to ensure more consistent accounting. More specific definitions should also be available to different biomes to adequately reflect the differences in biophysical and management conditions. Under the Kyoto Protocol, Australia has only committed to Article 3.3 activities of re/afforestation and deforestation. A future international agreement and national policies should seek more comprehensive accounting for forest management, grazing land management and revegetation activities.

To date, savanna fire abatement projects such as in West Arnhem land have demonstrated success as a viable carbon offset and livelihood opportunity for remote Indigenous communities. However, there are further opportunities for Indigenous people by recognising the biosequestration benefits from revegetation, forest management and avoided deforestation. For Indigenous held land in more semi-arid regions, revegetation and grazing land management may also offer important additional forms of income for existing land use activities. The carbon farming initiative may provide a policy platform for these activities to be recognized by voluntary markets, though this will depend on the development of appropriate methodologies and a whole of system view of greenhouse gas management being adopted whereby multiple activities can be credited. Importantly, projects that deliver multiple benefits may attract a higher price from buyers seeking competitive recognition for best practice carbon offsetting. Nonetheless, there remains important considerations of managing carbon goals with Indigenous aspirations, making necessary the full engagement of Indigenous land managers in the planning and implementation phases of climate change policies and offset projects. Ethically, it is important that Indigenous land owners are not expected to forgo opportunities to benefit
from land ownership in order to deal with a problem they did not create. As such it is important that climate change policies can encourage alternative development pathways rather than simply constraining land use development, whilst still contributing to the emissions reduction targets of government agencies.

The future of carbon offset markets and Indigenous involvement will largely depend on the outcomes of negotiations over a framework to replace the Kyoto protocol after 2012, and the legislation of a carbon price in Australia. In the interim, regional and national policies should aim to continue to support and develop the capacity of Indigenous institutions to undertake land management activities. However, as future engagement with offset markets will be determined largely by climate change policies developed at the international and national level, it is important that they do not create perverse outcomes and unnecessarily block opportunities for better land management. To avoid this, policy instruments must be left loose enough to be defined and structured at a regional level that is more appropriate to the environmental, social and economic conditions. Critical to this is that regional actors understand the often complex developments that occur in international climate change negotiations, so that they can adequately represent their regions concerns and identify issues before it is too late.

Future policy design and implementation for climate change policy should aim to consider the following key attributes in order to favour Indigenous participation in offset markets:

- Savannas of northern Australia are well placed to provide greenhouse gas abatement and carbon sequestration services that are currently not fully realized

- Indigenous people are well placed to provide these services with appropriate support and capacity building

- Moving towards comprehensive accounting across all lands including Article 3.4 activities will offer more potential for Indigenous landholders in generating international carbon credits

- Participation in carbon markets should remain voluntary for Indigenous groups
- Close collaboration with Indigenous groups to ensure proper understanding of the tradeoffs of different management options (eg. Biodiversity conservation versus carbon management versus traditional fire management)

- Indigenous knowledge should be recognised as an important asset to be integrated into carbon management plans

- Proper financial recognition of foregone land use development on Indigenous lands in the form of avoided deforestation carbon credits

- Multiple crediting of offset activities to allow for recognition of all sequestration/abatement management actions occurring on a property

- The socio-cultural benefits of Indigenous carbon projects to be recognised under ‘positive lists’ within offset schemes and attract a higher price in offsets markets

- Definitions developed in national and international policy such as forest definitions and land use categories, should not unnecessarily limit Indigenous involvement in offsets markets

- Carbon offset projects eligibility should not be judged simply on whether there is existing financial support for projects, but whether carbon finance would enhance greenhouse gas abatement outcomes

- Facilitating that the goals of carbon sequestration is balanced with other broader NRM goals such as biodiversity conservation

Key priorities for action:

- Development of an avoided deforestation methodology that is applicable and relevant to woody vegetation in Australian savannas

- ‘Whole of system’ greenhouse gas accounting methodologies for savanna projects with potential multiple sequestration/abatement activities, with particular focus on existing projects such as WALFA

- Addressing ‘additionality’ and ‘permanence’ issues for carbon projects on Indigenous lands with consideration of the socio-cultural context these projects take place within
Greater recognition and support for capacity building groups for the Indigenous carbon offset industry such as the National Indigenous Climate Change Forum
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