# CARBON MARKETS
and the
# MULGA LANDS
of
# SOUTH WEST QUEENSLAND

INTERIM VERSION FOR REVIEW

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The Carbon Store Pty Ltd
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## Disclaimers

This report is a work-in-progress draft that has not yet been endorsed by South West NRM Ltd. Both the author and South West NRM wish to refine the text further before presenting it to the company's Board of Directors. However, it has been decided to place the report in the public domain, because carbon trading is a matter of high public interest and a field in which policy is changing rapidly.

The information in this document is provided for the purposes of general research and policy development and should not be relied upon for the purpose of particular matters. Legal and other appropriate qualified advice should be obtained before any action or decision is taken on the basis of any material in this report. South West NRM, The Carbon Store Proprietary Ltd and the author do not assume liability of any kind whatsoever resulting from any person's use or reliance upon the contents of this report.

The community of South West Queensland and beyond is invited to make comments and submissions on the report, to swnrm@southwestnrm.org.au at their earliest convenience.

South West NRM
*Achieving sustainable landscapes for rural communities*

Geoff Edwards
Chief Executive Officer
**South West NRM Ltd**
66 Galatea St
Charleville 4470
Queensland Australia
Tel. (+61 0)(7) 4656.8500
www.southwestnrm.org.au

# Background to the Report

South West NRM is a community managed organisation with a brief to facilitate environmental and economic sustainability in south west Queensland by assisting rural landowners to plan and implement natural resource management strategies.

In the recent past carbon trading has become recognised as a potential source, and in some cases, a real source of income for landowners in the region who either retain or increase carbon stored in vegetation on their land. This has significant implications for landscape sustainability and biodiversity conservation.

South West NRM wishes to:

- better understand the potential of the carbon market to support sustainable land and vegetation management
- be able to provide landholders with relevant, up to date and accurate information on carbon market developments which affect natural resource management
- ensure that incomplete information or inadequate resources and tools do not inhibit participation in the carbon market by landholders in the region
- integrate carbon market considerations into the ongoing work of South west NRM, based on the principle that sustained carbon storage is best ensured by sustainable natural resource management.
- ensure that the carbon market driver for increase in biomass in the landscape is harnessed within legislative, policy, planning and program frameworks which facilitate delivery of the widest possible range of economic, biodiversity and landscape benefits

This report has been compiled to help South West NRM progress towards these objectives. It comprises information on current and recent carbon market developments, and suggests some priorities for action by South West NRM. These include

- further consultation and research on, and resolution of the issues raised in this report, and
- filling gaps in the technical and scientific basis for quantification of carbon stored in vegetation and soils in the region

# Executive Summary

Climate change will provide both challenges and opportunities for land managers in the Mulga lands bioregion. Climate impacts from the greenhouse effect will almost certainly include higher average and extreme temperatures, and more severe droughts consistent with the higher temperatures and evaporation rates.

It is less certain whether rainfall in south west Queensland will be more or less on average, but the distribution of rainfall could be affected, with rainfall concentrated into fewer but more extreme precipitation events. Climate scientists are unsure how phenomena such as the El Nino/La Nina cycle will be affected by global temperature rises.

However, responses to the threat of climate change may also provide opportunities. In particular, carbon markets have the potential to provide a powerful financial driver for more sustainable management of land and vegetation in the Mulga lands.

This potential will be realised to a greater or lesser extent over coming decades depending on:

- The policy, regulatory and administrative frameworks establishing and regulating an Australian Emissions Trading Scheme
- The degree to which support is provided to land managers to participate in and benefit from carbon markets
- The future price trajectory for carbon credits
- The ability of land managers, over extended timeframes, to maintain higher levels of carbon in the landscape

The *Minding the Carbon Store* project, implemented by The Carbon Pool Pty Ltd in 2005 and 2006, has proven that carbon market finance can profoundly influence land managers' decisions, in that case resulting in the avoidance of clearing of over twelve thousand hectares of remnant vegetation.

A range of forest and land management activities may attract carbon payments in the future including reforestation, avoided deforestation and management of cropping and grazing land. However, it may be that only a narrow range of activities will do so. The scope of accounting, and therefore of the range of activities which may produce carbon credits, depends on both international and national policy decisions.

At the time of writing, The Rudd Labour Government is actively considering the design details for an Australian emissions trading scheme (AETS) to start in 2010 in Australia. The role, if any, to be played in an AETS by the agricultural and forestry sectors is currently unclear.

Carbon accounting in two main sectors is of direct interest to land managers in the Mulga lands – the Land Use, Land Use Change and Forestry Sector and the Agriculture sector. Land managers may also be affected by carbon pricing in other sectors resulting in increases in price for fuel and electricity, for example.

In its Kyoto Protocol accounting, Australia has only currently committed to account for afforestation, reforestation and deforestation in the Land Use, Land Use Change

and Forestry sector. In the Agriculture sector, Australia accounts for emissions of methane ($CH_4$) and nitrous oxide ($N_2O$). Some emission sources potentially relevant to farmers in the Mulga lands are:

- Enteric fermentation in livestock
- Manure management
- Agricultural soils—emissions from fertiliser application, decay of crop residues and the use of nitrogen-fixing crops and pastures
- Prescribed burning of savannas
- Field burning of agricultural residues

Reduction in emissions from any of these sources may attract carbon credits, or reduce an obligation to buy emission permits, depending on policy development currently being undertaken. This includes through the Garnaut Review, and through the preparation of a Green Paper.

In addition, the Kyoto Protocol allows nations to elect to account for broader management of cropland and grazing land (including storage of soil carbon in these systems), forest management and revegetation (increasing landscape biomass with species which do not meet the definition of forest). Australia has not yet indicated that it will elect to account for any of these activities, and some current indications are that it may not.

These are issues of considerable potential commercial significance to land managers, whose input to the policy debate to date has been limited.

To account for carbon sequestration and greenhouse gas emissions from Land Use, Land Use Change and Forestry, and to support calculation of emissions from agriculture the National Carbon Accounting System (NCAS) has developed the FullCAM model. NCAS analyses and estimates change in biomass carbon stocks based on thresholding and change analysis of satellite imagery and the use of FullCAM's sophisticated soil, productivity and other models and default values.

FullCAM probably represents current global best practice for terrestrial carbon accounting at the national level. However its use at the farm or paddock level, particularly using downloaded default values, may conflict with estimates derived locally through field measurement. FullCAM's aim is to provide an unbiased estimate at the national level, and is unlikely to provide an accurate estimate of carbon stored on an individual site unless locally collected data is used to inform the model.

It is suggested that local data collected by approved methods and independently verified can be used to calibrate and validate national models. This approach would enable differences between national estimates and farm level estimates to be minimised or eliminated. Such differences can have considerable commercial consequences.

There seems to be considerable discrepancy between the National Carbon Accounting System calculations and those of the Queensland Government's Statewide Land and Trees Study (SLATS). It seems desirable that a transparent and collaborative study be undertaken jointly between SLATS and the NCAS to harmonise and refine their methods.

A number of issues which are the direct responsibility of the Queensland Government will also affect outcomes for landowners. These include the following:

Carbon Rights legislation
Currently ownership of Carbon Rights in Queensland is enabled by amendments to the Forestry and Land Titles Acts, with consequent amendments to some other Acts. These legislative changes have the clear effect that an owner of freehold land may transfer ownership (in the form of a *profit a prendre*) of carbon stored in trees and vegetation, carbon sequestration by trees and vegetation, or all parts of trees or vegetation to another party. Leaseholders may also transfer these "natural resource products" but only in respect of "improvements".

However the legislation needs enhancement, including to enable transfer of rights to carbon stored in soil (since vegetation and soils act as a system) and to enable comprehensive carbon accounting as required by national and international standards.

Also, Carbon Rights are only useful to the extent that management of the land can be expected to provide a durable carbon storage outcome.

For this reason it is desirable to be able to have an agreed management plan registered on the land title, so that the changed management leading to the environmental outcome which is sold survives change in land ownership. Given that there is no case law applying to the sale of Carbon Rights in Queensland, the clear ability to have positive and negative covenants regarding land management pursuant to ownership of Carbon Rights seems a desirable outcome.

Stamp Duty is a substantial cost on sale of Carbon Rights, applying at the ad valorem rates of up to 4.25%. If the State Government wishes to encourage the engagement of land managers in sustainable land management rewarded by carbon finance, consideration could be given to waiving Stamp Duty on such transactions.

Issues regarding leasehold land – The natural vegetation on leasehold land remains the property of the Crown. Leaseholders may sell carbon rights only to improvements on the land, which would generally only be plantations established by planting or direct seeding. Retention, management or regeneration of native vegetation are the activities most prospective of returns to landowners but leaseholders are excluded from selling Carbon Rights or carbon credits in relation to vegetation which they do not own.

Survey requirements – While the State Government uses GIS mapping to regulate land use and expects landowners to use GPS technology for compliance, there are very onerous requirements regarding standards for survey of land for the purpose of transfer of a profit a prendre. These may be reasonable for smaller parcels of high value land closer to the coast, but in the Mulga lands, with low land values and extensive land holdings, a more flexible approach may be warranted. This needs to be further explored with the Registrar of Land Titles and the relevant sections of the DNRW.

## *Climate Change and the Mulga Lands of SW Queensland*

The ' Mulga lands' cover a vast and ecologically sensitive tract of arid and semi-arid (200-500 mm mean annual rainfall) Australia where mulga (*Acacia aneura*) and other Acacia species are the dominant vegetation. Silver-leaf ironbark (*Eucalyptus melanophloia*) and other eucalypt species occur on relatively more fertile sites, including on floodplains and watercourses, often with a mulga understorey.

The Mulga lands biogeographic region occurs in Queensland, New South Wales, South Australia, Western Australia and the Northern Territory, occupying 150 million hectares or around 20 per cent of the continent. The Mulga lands cover about 18 million hectares of arid and semi-arid southern Queensland or about 12.5 per cent of the State. They mostly occur on red kandosols and red tenesols, which are coarse-textured soils with poor soil structure and nutrients.

Almost half of the Mulga lands have been cleared, mostly for pasture development but also for cropping. Clearing, usually followed by burning of the cleared biomass has resulted in substantial greenhouse gas emissions and also to significant decreases in soil carbon and nitrogen stocks, leading to a potential decrease in soil fertility and plant productivity.

Despite significant efforts by land managers, policy makers and regulators to promote and implement more sustainable agricultural practices in the Mulga lands, it is arguable that they have been significantly degraded in productive capacity since European settlement.

Early descriptions of these areas are of wooded grasslands, and it is believed that the open woodland structure was maintained by regular burning by aboriginal people which tended to keep mulga regeneration under control and concentrate growth on a small number of larger trees.

An early intervention of the European settlers was to stop regular burning and substitute grazing pressure to reduce fuel loads in the landscape. In the Queensland Mulga lands this led to some "thickening" of the mulga and associated vegetation types, especially in the drier "hard mulga" country in the west of the bioregion. Thickened mulga tends to suppress the herb and grass layer, reducing both biodiversity and soil protection from erosional processes.

A second land management intervention introduced by the European settlers was clearing of woody vegetation to reduce competition with grass and herb layers and to provide fodder. This was done initially by ringbarking and since the introduction of mechanised means, by "pushing", "pulling" and associated practices such as burning of cleared vegetation and blade ploughing.

Trees, shrubs and other deep rooted perennials play a valuable role in bringing subsurface nutrients into the top soil layer, and in addition mulga, as a legume, is important as a nitrogen fixer. Clearing can lead to changes in soil nitrogen cycling, faster decomposition rates, and lower carbon and nitrogen soil concentrations, in turn leading to greater carbon dioxide respiration and further loss of soil carbon.

A third significant intervention has been the development of additional watering points through tapping of artesian sources and construction of water reticulation infrastructure. This, combined with the reduction in dingo numbers, has led to a considerable increase in grazing pressure from domestic stock as well as from

native and feral herbivores, notably including kangaroos, rabbits and goats (total grazing pressure).

Land use intensification, often driven by short sighted public policy (e.g.soldier settlement schemes) has at times exacerbated all the above issues.

The increased pressure from domestic, native and feral herbivores, combined with reductions in soil fertility and soil protection, has led to significant degradation of the land resource base over time. However, it is the interaction of the factors mentioned above, and particularly total grazing pressure, with droughts which have produced the most significant land and vegetation degradation to date.

Economic pressures on land managers, low commodity prices, extreme climate variability and inadequate information have often led to the maintenance of high domestic stock numbers on fragile land well after the onset of the severe drought events which are a feature of the climate in the region. Drought relief measures and other effects of public policy have at times compounded the problem.

Excessive total grazing pressure in drought time has often led to loss of topsoil which is irreplaceable in human lifetimes, replacement of forage species with non-palatable groundcovers and shrubs, and reduction in the ability of land to recover in better seasons.

These concerns are likely to be exacerbated by climate change impacts in the future.

## *Predicted climate change*

There is general (if not unanimous) agreement that global warming is occurring, ands that human activities are contributing to this, but there remains a wide range of views as to how the change will unfold. Many climate models are used or under development, but none yet offer the degree of accuracy at regional and local scales required by policy makers or land managers. However, while local and regional predictions remain coarse and caveat-laden, broader predictions may be of some use to land holders and natural resource managers in the Mulga lands.

### Predictions on a global scale

The Intergovernmental Panel on Climate Change (IPCC) is the international clearing house for the majority of research and analysis being undertaken on climate change. The IPCC's release of a report (IPCC 2007) by its Working Group One entitled "Climate Change 2007 - The Physical Basis" provides an up-to-date view on the science and possible consequences of global climate change.

The report states that global atmospheric concentrations of carbon dioxide, methane and nitrous oxide, the three main human-induced greenhouse gases, have increased markedly as a result of human activities since 1750 and now far exceed pre-industrial values.

The global increases in carbon dioxide concentration (from a pre-industrial revolution value of around 280ppm to 379ppm in 2005) are due primarily to fossil fuel use and land use change (deforestation), while those of methane and nitrous oxide are primarily due to agriculture. Concentrations of methane and nitrous oxide have also increased from 715ppb to 1774ppb and from 217ppb to 319ppb respectively over the same timeframe

Warming of the climate system is considered unequivocal, and is evident from observations of increase in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level.

The IPCC authors report an average global temperature increase from 1850-1899 to 2000-2005 of 0.76$^0$C (the oceans having absorbed 80% of the additional heat from increased thermal forcing), increased atmospheric water vapour, increased melting of the ice caps, snow cover and the Greenland and Antarctic ice sheets, sea level rise of around 3mm per year and an increase in the frequency and severity of droughts, and the frequency of heavy rainfall and extreme temperatures.

Global average surface temperature is predicted to increase by 1.8 - 4.0$^0$C (mean values), with relatively higher increases over land and at higher latitudes, over the period 1980-1999 to 2090-2099. Sea level rise of between 0.18 and 0.59 metres is predicted over the same period, mainly from thermal expansion of the oceans. Dynamic changes in polar ice (e.g.from collapse of Antarctic ice shelves) or more rapid movement of glaciers in the Antarctic or Greenland have not been factored into these predicted rises.

The report notes that effects from current and future anthropogenic (human-caused) greenhouse gas emissions will continue to have an effect for at least a thousand years.

Predictions of the report are based around a range of different scenarios for future greenhouse gas emissions (emission pathways) which result in stabilisation at different levels in the future. This reflects that different climate outcomes will result from action taken now and in coming decades to limit greenhouse gas emissions.

## Predictions on a national scale

"Climate Change 2007 - The Physical Basis" also provides national and to a lesser extent regional projections of future climate change including for Australia (Section 11.7 pages 896-902). Warming is predicted with confidence, particularly inland and in northern Australia. Rainfall for the Mulga lands is not confidently predicted to increase or decrease

The Commonwealth Scientific and Industrial Research Organisation (CSIRO), in conjunction with several Federal, State and academic bodies, leads the research into understanding climate change in Australia.

"Climate Change in Australia – Technical Report 2007" (CSIRO 2007) has the most currency, and is published on the web at:
http://www.climatechangeinaustralia.gov.au/resources.php

The report updates and expands on a previous report from CSIRO published in 2005 "Australian climate change projections for impact assessment and policy application - A review" (Whetton et al 2005). The report is available at
http://www.cmar.csiro.au/e-print/open/whettonph_2005a.pdf

CSIRO's continent-wide interpretation is for a future climate that is warmer, drier and subject to more extreme weather events. However, although there is general consensus that temperatures will rise, there is less degree of certainty with respect to rainfall, although a long term drying trend in south-west Australia is predicted with considerable confidence.

## Predictions for the Mulga Lands

Temperature rises for the Queensland Mulga lands of up to $1.5^0$C by 2030 and up to $5^0$C by 2070 are predicted, with winter rainfall change to be in the range of increase by up to 20% or decrease by up to 60% and summer rainfall to change within the range of 20% increase to 20% decrease (CSIRO 2007).

## Climate change impacts in the Mulga Lands

Several published papers relevant to the Mulga lands of South West Queensland, discuss aspects of climate change. Very few discuss specific impacts (or specific mitigation or adaptation strategies). In the absence of definitive local or regional climate projections, the papers focus on looking at past change, possible future impacts on biodiversity, land condition or production systems, examining adaptation scenarios for the future, or on basic models that allow examination of possible land management and adaptation strategies. Abstracts of some significant papers are at Appendix C.

Broadly, impacts on the Mulga lands are expected to be those associated with greater climatic variability (more droughts and floods), increased average temperatures, higher and more frequent maximum temperatures and higher and less frequent minimum temperatures, and possibly generally drier conditions and rainfall concentrated into fewer more extreme events. Higher temperatures also mean higher evaporation rates and therefore greater severity and impact from droughts including those that are equivalent in duration and rainfall to those currently experienced.

## *Adapting to climate change in the Mulga Lands*

Socially and economically there are significant constraints to the integration of conservation values and sustainable production strategies into current farming systems in the Mulga lands. Short term economic imperatives and limited awareness of the need to manage resources through climatic cycles over decadal timeframes can lead to exploitative management, whether intended or not.

Extensive structural adjustment may already be required in some areas to achieve long term rehabilitation and the establishment of sustainable land and vegetation management systems. This may be beyond the capacity of private individuals and require new economic, community based and governmental approaches to the management of increasingly marginal lands.

Some priorities for integrated NRM actions, even in the absence of climate change, include:

- Planning for and implementation of total grazing pressure management at the property level
- Feral and native animal control
- Changed fire management strategies and practices
- Increasing land manager's ecological understanding of the landscape
- Review of leasehold tenure arrangements including duty of care provisions
- Structural adjustment to achieve optimum land use in relation to land suitability, location and the size of farm management units

Important measures to avoid possible major land degradation events or biodiversity loss in future climate conditions could include:

- Improving access to, and use of, information on climate and weather forecasting and climate change including drought alerts and degradation alerts
- Development and use of more sophisticated risk assessment and decision support tools (e.g. for pasture/shrub/tree/fire/grazing pressure management)
- Improving resource monitoring including remote sensing of land cover and condition
- Implementing total grazing pressure management to achieve safe carrying capacity including in drought conditions
- Facilitating grazier ownership of these issues as well as community engagement
- Changed vegetation management strategies to create higher biomass in the landscape including fodder reserves for drought
- Creation and retention of connecting corridors of native vegetation and refugia areas for native plants and wildlife
- Moving to stock and crop varieties better adapted to higher temperatures
- Improved control of native and feral animals including management for meat production
- Manipulation of mating times and populations in relation to seasonal/climatic conditions
- Breeding programs and R&D for more productive plant and animal systems under changed climate
- Development of water use efficiency strategies to respond to lower water availability
- Development of farm enterprises based on renewable energy (including energy crops), carbon sinks and the provision of other environmental services
- External public or private funding for structural adjustment and provision of environmental services

## *Climate change mitigation options for land managers in the Mulga Lands*

Australia accounts for emissions directly influenced by farmers in two broad sectors – Agriculture and Land Use, Land Use Change and Forestry (LULUCF). These are considered separately below. Reduction in emissions (or increase in sequestration) related to any of the activities detailed below will contribute to climate change mitigation. Some may be rewarded with carbon credits, depending on the details of Australia's national emissions trading scheme expected to be operational in 2010.

### The Agriculture Sector

According to Australia's most recently published (2005) National Greenhouse Gas Inventory emissions from the broad category Agriculture were 87.9Mt (million tonnes) of $CO_2e$, or 16.8% of net national emissions.

Agriculture is the main source of both methane and nitrous oxide emissions, accounting for 58.9% and 84.2% respectively of the net national emissions for these two gases. Greenhouse gas emissions from livestock, which are the sum of the enteric fermentation and manure management subsectors, declined by 5.8% (3.8 Mt) between 1990 and 2005. In contrast, there has been an 18.4% (4.0 Mt) increase in emissions from the remaining *agriculture* subsectors between 1990 and 2005. The net result of these trends is that there has been little change in emissions from

the agriculture sector as a whole (a slight increase of 0.2%) between 1990 (the Kyoto Protocol base year) and 2005.

The sources of greenhouse gas emissions accounted in the Agriculture sector most directly relevant to land managers in the Mulga lands are:

- Enteric fermentation in livestock
- Manure management
- Agricultural soils—emissions from fertiliser application, decay of crop residues and the use of nitrogen-fixing crops and pastures
- Prescribed burning of savannas
- Field burning of agricultural residues

## The Land Use, Land Use Change and Forestry sector.

The net emissions from the land use, land use change and forestry sector were 33.7 Mt CO2-e or 6.0% of net national emissions in 2005. Overall the total land use, land use change and forestry emissions declined by 73.9% (95.2 Mt) from 1990 to 2005. The bulk of these emissions reductions have been the result of lower rates of land clearing in Queensland.

**Forestry**
In 2005, sequestration associated with reforestation was estimated to be approximately 19.6 million tonnes (Mt) of carbon dioxide. This sequestration was by forests established since 1990 on land that was clear of forest at the end of 1989 (to comply with Kyoto requirements).

**Land Use Change (Deforestation)**
Deforestation in Australia was a net source of greenhouse gas emissions from 1990 to 2005 (the most recent year for which inventory information has been published). Net emissions from deforestation in 2005 were estimated to be 53.3 Mt CO2-e, which represents a decline of 75.6 Mt (58.7%) since 1990. Deforestation has decreased substantially since 1990 with consequent reductions in estimated emissions from burning and decay of tree biomass and soil carbon.

Land based emissions (sources) and removals (sinks) of greenhouse gases form a major part of Australia's emissions profile. Around 27 per cent of Australia's human-induced greenhouse gas emissions come from activities such as livestock and crop production, land clearing and forestry. The removal of carbon dioxide from the atmosphere by forests provides an important greenhouse sink.

# *International and Australian carbon credits schemes*

## Carbon Trading

*Emissions trading* is an administrative approach used to control atmospheric pollution by providing economic incentives for achieving reductions in the emissions of the pollutants. Globally, there are active emissions trading programs in several pollutants. For greenhouse gases the largest is the European Union Emission Trading Scheme. Others which seek to limit greenhouse emissions include the New South Wales Greenhouse Gas Reduction Scheme, the California Climate Action Registry, and the Chicago Climate Exchange. In the United States there are also markets to reduce emissions of oxides of sulphur and nitrogen which contribute to acid rain.

Emissions trading in respect of greenhouse gases is usually called "carbon trading" even though it involves a range of pollutants because these are denominated in "carbon dioxide equivalents" or "$CO_2e$". Carbon dioxide is also the most common greenhouse gas.

Carbon Trading is often seen as a superior approach to a carbon tax or direct regulation. It aims to use the efficiency of the market to meet a specific emission reduction target. By comparison, a carbon tax may simply be paid and passed on to consumers without actually causing a reduction in emissions. Critics of emissions trading point to problems of complexity, monitoring, enforcement, and sometimes dispute the initial allocation methods and cap.

Emissions trading has two common forms, namely "cap and trade" and "baseline and credit" systems.

**Cap and Trade**
A central authority (usually a government or international body) sets a limit or *cap* on the amount of a pollutant that can be emitted. Companies or other emitting entities are issued emission permits or allowances and are required to hold an equivalent number to their emissions. The total amount of permits or allowances cannot exceed the cap, limiting total emissions to that level. Excess emissions above the level of permits or allowances held would generally attract a fine or penalty which is set well above the cost of permits, to make compliance attractive.

Permit or allowances can be auctioned, sold or allocated for no payment based on historical emissions levels (referred to as grandfathering). Also caps can be set for all sectors within an economy or certain sectors (e.g.those with relatively stable emission levels or those exposed to competition from entities in nations without emission reduction obligations) can be excluded. Present indications are that the Agriculture sector in Australia may initially be exempted from the Emissions Trading Scheme (ETS) expected to commence in Australia in 2010.

Following initial issuing of permits or allowances, companies that need to increase their emissions must buy permits or allowances from those who pollute less. The transfer of allowances is referred to as a trade. In effect, the buyer is paying a charge for polluting, while the seller is being rewarded for having reduced emissions by more than was needed. Therefore, those that can reduce their emissions most cheaply will do so, achieving the required pollution reduction at the lowest overall cost.

**Baseline and Credit**
In baseline and credit systems emitting entities can earn credits (usually tradeable) by reducing their emissions below an agreed or imposed "baseline". The baseline can be set by negotiation, by reference to best practice, or by reference to current practices. As an example of a baseline and credit approach, the burning of methane from capped landfills currently attracts saleable credits under the Greenhouse Friendly initiative of the Australian Greenhouse Office, because in a "business as usual" case the methane would be emitted to the atmosphere resulting in considerably greater emissions.

Even if agricultural enterprises are exempted from direct obligations to acquire permits for their emissions under an Australian ETS, there may still be opportunities for emission reduction projects under a baseline and credit approach.

For example, enhanced manure management where manure from intensive livestock operations is collected and digested to produce methane for use as a biofuel could be considered to go beyond business as usual and attract credits for the operator. These would be based on the reduction in emissions occurring relative to venting the methane to the atmosphere (the business as usual case).

The opportunities for baseline and credit projects, and whether Agriculture is actually exempted from emission reduction obligations in the early stages of an ETS in Australia depends on a policy development process currently being undertaken under the Rudd Labor Government. This process is to a significant extent influenced by the Garnaut Review, currently being undertaken and headed by Professor Ross Garnaut, an eminent Australian economist.
For information on the review see:
http://www.garnautreview.org.au/CA25734E0016A131/pages/home

### The role of offsets

Some baseline and credit projects under an ETS may be recognised as producing "carbon credits" which have the same value in offsetting emissions as an emission permit or allowance. A possible example is in respect of absorbing (sequestering) carbon dioxide from the atmosphere by the growing of new forests. Roughly a quarter of the live weight of a tree is carbon which has been absorbed from the atmosphere.

While not all tree growth and carbon sequestration necessarily attracts carbon credits (depending on the design of the relevant ETS) reforestation as defined under the Kyoto Protocol is currently accounted for by Australia, and the carbon dioxide sequestered from the atmosphere by Kyoto-eligible forests in Australia helps us to meet our Kyoto target of limiting emissions on average over the period 2008 to 2012 to 108% of 1990 levels.

Carbon credits or offsets may also be generated by emission reduction projects which reduce emissions below business as usual or some other emission benchmark in exempt sectors, again depending on the specific design features of the relevant ETS.

## *UNFCCC and the Kyoto Protocol*

The United Nations Framework Convention on Climate Change (UNFCCC) was signed in 1992 and has since been ratified by 184 countries. These countries have agreed to work together to stabilise concentrations of greenhouse gases in the Earth's atmosphere at a level that will prevent dangerous human-induced interference in the global climate system. The UNFCCC and subsequent decisions regarding its interpretation and implementation represent one of the most complex multilateral agreements ever negotiated.

The Kyoto Protocol, signed in 1997, is the primary mechanism through which the global community is to take concrete steps to reduce greenhouse gas emissions. It entered into force in February 2005, and obliges industrialised countries that have ratified the accord to reduce their emissions of six greenhouse gases, the major contributors being carbon dioxide, methane and nitrous oxide.

The Kyoto Protocol established three trading or "flexibility mechanisms" being Emissions Trading, Joint Implementation and the Clean Development Mechanism.

Emissions Trading and Joint Implementation allow developed nations to trade emission permits under a cap and trade approach, while the Clean Development Mechanism allows projects in developing nations (which do not have an emissions cap) to generate credits called Certified Emission Reductions (CERs) for projects which reduce emissions below a business as usual baseline (a baseline and credit approach).

Overview information on some major overseas carbon trading initiatives is at Appendix B.

## *Current Australian initiatives*

There are two government run schemes currently operating in Australia which facilitate carbon trading. The only mandatory scheme which provides penalties for greenhouse pollution is the NSW Greenhouse Gas Reduction Scheme, while the Commonwealth's Greenhouse Friendly initiative facilitates trading of verified offsets in a voluntary emission reduction framework. These two schemes are described following.

### NSW Greenhouse Gas Reduction Scheme (GGAS)

The NSW Greenhouse Gas Reduction Scheme (GGAS) commenced on 1 January 2003. It was one of the first mandatory greenhouse gas emissions trading schemes in the world, and the first to allow credits from forests. GGAS aims to reduce greenhouse gas emissions associated with the production and use of electricity.

GGAS establishes annual statewide greenhouse gas reduction targets, and then requires individual electricity retailers and certain other parties who buy or sell electricity in NSW to meet mandatory benchmarks based on the size of their share of the electricity market. If these parties, known as benchmark participants, fail to meet their benchmarks, then a penalty is imposed on their emissions above the permitted level. Administering the Scheme is the Independent Pricing and Regulatory Tribunal of NSW (IPART).

Assessing abatement projects, accrediting parties to undertake eligible projects and create abatement certificates, and monitoring compliance with GGAS is the responsibility of the Scheme Administrator. The Scheme Administrator also manages the Greenhouse Registry which records the registration, transfer and retirement of certificates created from abatement projects.

GGAS allows for the generation of abatement certificates in relation to carbon absorbed through reforestation in NSW, using basic definitions identical with those for reforestation under the Kyoto Protocol. That is, reforestation is the direct human induced conversion to forest of land which did not support forest at the end of 1989. A forest is land supporting trees which have a potential crown cover greater that 20%, with a height at maturity greater than 2 metres, and occupying an area greater that 0.2 hectares.

A significant addition requirement for crediting of reforestation is that the applicant for abatement certificates must be in a position to ensure that the credited carbon will remain stored for a minimum of 100 years. The usefulness of this requirement is to help ensure that credits are awarded for sustained carbon storage which is presumably best achieved through sustainable forest and land management.

To help ensure the ongoing carbon storage, the Scheme Administrator registers a Restriction on Use" on the title to the relevant land for a period in excess of 100 years. This enables the Scheme Administrator to prevent harvest or otherwise protect the credited carbon stocks in the case of unintended or illegal impacts.

The price of abatement certificates from the Scheme has declined substantially in recent times, and in particular since the Commonwealth Government announced a firm intention to establish a national ETS (under the former Government by 2011 and under the Rudd Government by 2010).

## Greenhouse Friendly initiative

See http://www.greenhouse.gov.au/greenhousefriendly/index.html

Greenhouse Friendly™ is an Australian Government initiative within the Greenhouse Challenge Plus program framework which aims to reduce greenhouse gas emissions in Australia by:

- providing businesses and consumers with the opportunity to buy and sell greenhouse neutral products and services
- broadening the basis for investment in additional greenhouse gas abatement
- engaging consumers on climate change issues.
- Through Greenhouse Friendly™, Australian businesses can market greenhouse neutral products or services, deliver greenhouse gas abatement and give Australian consumers greater purchasing choice.

It is of particular interest because it is commonly seen as a precursor to the national ETS, and the possibility of Greenhouse Friendly credits being tradable into the future ETS has been mentioned by Commonwealth officials in a recent discussion paper (albeit issued under the former government).

Of particular interest to land managers in the Mulga lands and elsewhere is the acceptance by Greenhouse Friendly of a range of abatement project types, and their processes for project approval, independent third party verification of projects' emission reductions, and approval of the verified abatement (which can then be sold).

These result in the creation of a tradable commodity, generated under rules similar to those applying to Australia in trying to meet our Kyoto target. This is known as Greenhouse Friendly Approved Abatement or in the industry just as Greenhouse Friendly abatement or credits. Prices for this commodity have increased dramatically off a low base in recent times and it is commonly traded at the time of writing at around $AU8-9 per tonne CO2e. Price information for Greenhouse Friendly credits is available on the web site of the Australian Climate Exchange - http://www.climateexchange.com.au/Default.aspx

Demand for Greenhouse Friendly credits is also improving, due to the fact that it is a Commonwealth scheme which gives recognition and approval to offsets to greenhouse gas emissions, in the context of movement towards a national ETS regulated by the Commonwealth. Awareness of climate change has also dramatically increased in recent years, and greenhouse neutrality has become a strong marketing angle and offsetting greenhouse gas emissions has become a way of demonstrating a commitment to environmental sustainability for many companies.

In this context, the quality of offsets has become a major concern for buyers, and the Greenhouse Friendly "brand" is more and more seen as the industry benchmark for rigorously accounted credits.

Because Greenhouse Friendly rules are generally consistent with Kyoto rules applying to Australia, some project types are not currently eligible for approval. For example, because Australia does not account for emissions from forest management activities (including clearfelling old growth as long as the forest area is regrown) landowners can not get credit for improved forest management. The same currently applies to management of rangeland, pastoral and agricultural land even where this results in net carbon sequestration from the atmosphere.

Also, Greenhouse Friendly applies a beyond business as usual test to project activity. This means that where an activity is already accepted as normal investment behaviour and commonly practiced, it will not generate credits.

For example, commercial plantation companies do not get credits under Greenhouse Friendly for carbon sequestration by their plantations if these have been established and are managed for commercial purposes in the absence of carbon finance. The same may apply to landcare plantings which have been undertaken as "farm business as usual". This is notwithstanding that the Australian Government gets credit for these activities in its national Kyoto accounts.

There is no doubt that current modalities and rules will be discussed and tested in the policy development process leading to implementation of the Commonwealth ETS. Currently under Greenhouse Friendly, it is where carbon finance leads to the adoption of new eligible activity or projects that crediting will occur.

For example, where a landowner wants to strategically reforest their property but can not make a business case to do so, and carbon finance makes it economically viable, the landowner is likely be eligible for credits for the difference between the carbon stored in the forest area(s) and the carbon content of the cleared land the forest replaces (subject to meeting other scheme rules). Where carbon finance is not required, there is no eligibility for credits.

## *Possible Australian developments*

There is now bipartisan commitment to the establishment of a Commonwealth operated ETS in Australia, likely to start in 2010. The broad parameters will be established by the Commonwealth following delivery of the final report of the Garnaut Review, and delivery of a Green Paper.

Some elements flagged to date are the possible exclusion of Agriculture from initial coverage by the scheme, the inclusion of credits from reforestation and perhaps, from avoided deforestation. A national ETS could also credit emission reduction projects which go beyond business as usual in agriculture, horticulture and pastoral industries and which produce reductions in Australia's reportable emissions.

## For the Agriculture sector

The following table illustrates some sources of emissions from the Agriculture sector and examples of project types which could reduce them. **Note that the eligibility of either these project types or specific projects under Greenhouse Friendly or the future ETS is not assured.**

| Emission source | Type of project |
|---|---|

| | |
|---|---|
| Enteric fermentation in livestock | Reducing stocking rates<br>Application of anti-methanogens to stock |
| Manure management | Collection and digestion of wastes to produce biofuels |
| Agricultural soils—emissions from fertiliser application, decay of crop residues and the use of nitrogen-fixing crops and pastures | Precision fertiliser application and/or measures to enhance soil fertility and reduce or eliminate chemical fertiliser application |
| Prescribed burning of savannas | Change burning practices to reduce overall fire intensity/impact e.g. burning early in fire season and/or patch burning. |
| Field burning of agricultural residues | Composting or digesting residues |

Table 1. Some agricultural emission sources and project types

There are also opportunities for agricultural enterprises in growing crops and some species of trees for the production of biofuels to displace the use of fossil fuels in transport, machinery and in energy production.

## For the Land Use, Land Use Change and Forestry (LULUCF) sector

In the LULUCF sector, under the Kyodo Protocol, Australia currently accounts for only Afforestation, Reforestation and Deforestation. To define these activities involves first defining a forest. Within the range of values possible, Australia has chosen a potential canopy cover at maturity of >20%, a mature height of the trees of >2 metres, and an area >0.2 hectares to define a forest.

Reforestation is the direct human induced conversion to forest (undertaken since the beginning of 1990) of land that was non-forest at the end of 1989. Direct human induced is defined as planting, direct seeding or the promotion of natural seed sources. Afforestation is the same for most practical purposes, the distinction being simply that the land has been in a non-forest state for longer or has never been forested.

Deforestation is the reverse of reforestation, namely the conversion of land that was forested at the end of 1989 to a non-forest state after the beginning of 1990.

While other project types may be possible, those that are currently confirmed as eligible to generate approved abatement under Greenhouse Friendly are Afforestation and Reforestation, and Avoided Deforestation.

**Afforestation and Reforestation**

Pursuant to the definitions described above, there are large areas of land in the Mulga lands which are eligible for reforestation (having been cleared prior to 1990) and capable of reforestation (in that the land will support tree growth and forest types which will meet the definition of forest). They may also be available for reforestation, depending on the whether the returns from carbon finance plus other benefits such as shade, shelter, biodiversity, salinity abatement, drought

refuge, timber etc outweigh the returns from the current (usually grazing) landuse. Consideration is given in a later section of this report to the scale of potential financial returns from carbon finance.

**Avoided deforestation**

There is limited opportunity for the further clearing of Kyoto-eligible vegetation in the Mulga lands following the ban on broadscale clearing of remnant vegetation in Queensland imposed by the State Government at the end of 1996. While the ban was imposed for a range of reasons mainly related to the conservation of biodiversity and through pressure on the state government from environmental groups, it has had the effect of delivering large cuts in our national greenhouse gas emissions.

Clearing to develop land for grazing was a principal source of such emissions in 1990 (the Kyoto benchmark year) and has declined drastically since. Indeed, this is the main reason that Australia is on track to meet its Kyoto target, almost all other sectors of the economy having generated large increases in greenhouse gas emissions. Many landholders feel (and feel incensed) that these cuts in greenhouse gas emissions have been achieved at their expense.

Prior to the ban coming into force, The Carbon Pool Pty Ltd managed a project to buy back the clearing rights conferred by permits issued in the run up to the ban coming into effect. Because of the pioneering nature of the project, limited demand and low prices for credits at the time, and the short timeframe, only 12,060 hectares were saved from clearing. However, six landowners received significant sums of money (in one case just over a million dollars) in exchange for long term protection of the forest on their land. This project is documented as a case study at Appendix A.

There may still be some opportunity for payment of landowners in the Mulga lands for Avoided Deforestation, to the extent that they still have clearing rights over Kyoto-eligible vegetation. These rights can still exist in cases where the Kyoto-eligible vegetation is mapped as non-remnant by the Queensland Government. The Queensland Government uses a structural and floristic definition to discriminate between remnant and non-remnant vegetation and because of the different definitions used there are likely to be some areas of overlap.

Where landowners have clearing rights over vegetation which they feel is likely to meet the Kyoto definition of forest, that they would normally clear in the course of farm development, and where they may be willing to forgo clearing in order to secure income from carbon finance, they should seek professional advice on commercialisation of this potential opportunity[1]. Among others, the National Carbon Accounting System may be able to assist in determining the status of the vegetation from a Kyoto perspective.

[1] It should be noted that the ability to harvest trees from land is not the same as having the right to clear. Clearing involves a change in land use from forest to grazing or agriculture (deforestation), whereas harvesting only decreases the biomass in land which remains forest. Because Australia currently accounts for deforestation, but not for forest management (such as harvesting), delaying or avoiding harvest of forest is not likely to attract credits.

## *Voluntary markets*

Increasing awareness of the dangers of climate change, increased desire to show corporate environmental responsibility, and community concern about the impact of our current lifestyles have created a significant market for offsets to greenhouse gas emissions outside the regulated markets such as the NSW GGAS.

A significant new industry has emerged to meet the demand for emission offsets, with a range of business models and offset standards. These range from loose arrangements where people donate money to tree planting organisation through to initiatives like Greenhouse Friendly which has a rigorous basis in rules and standards and requires third party independent verification of abatement claims.

The emerging industry is still largely unregulated apart from general legal protection for consumers under the Trade Practices Act and similar protection against fraudulent or misleading conduct. Offset providers have also come under greater media, NGO and community scrutiny and there is a general trend towards greater transparency and acceptance of standards.

The Carbon Offset Guide Australia (http://www.carbonoffsetguide.com.au/) published as a joint initiative of RMIT and the Victorian EPA provides a useful guide to many of the offset providers operating in the voluntary market in Australia.

## *Income generating potential for landowners*

### Current carbon prices and future carbon price trajectory

The current price of most direct interest to landowners is the price of Greenhouse Friendly credits as these are the only Commonwealth approved offsets and the scheme is national in scope. The NSW GGAS mainly applies to abatement providers in NSW and is trading at a discount to Greenhouse Friendly in any case.

The direct experience of the authors is that wholesale quantities of Greenhouse Friendly credits are traded in the vicinity of $8 – 9. Prices quoted on the Carbon Offset Guide tend to reflect prices for retail sales, including down to individual tonnes (for widely varying qualities of offsets).

The future price trajectory of carbon credits is unknowable, because it will be greatly effected by the vigour of international and national responses to climate change in the future and because many details of a Commonwealth ETS are yet to be determined. The discussion following seeks to identify some possibilities, trends and factors which may influence future prices.

Discussions of prices under a Commonwealth ETS commonly consider carbon prices in the vicinity of $30 per tonne $CO_2e$. Whatever the opening price under a mandatory scheme starting in 2010, then the price of Greenhouse Friendly credits will trend upwards towards that value, although this will be particularly the case for any Greenhouse Friendly credits which are approved as "early action" credits and may be used in (are "fungible" in) the regulated market when it commences. This possibility has been flagged by Commonwealth officials for Greenhouse Friendly Abatement approved after the announcement in June 2007 of a commitment by the Howard Government to establishing an emissions trading scheme in Australia.

The price current at the time of writing for European Union Allowances under the European Union Emissions Trading Scheme (EU ETS) is a little above 27 euros (around 44 Australian dollars). The EU ETS aims to deliver cuts sufficient for the EU to meet its Kyoto target, and provides the only discernible (shadow) price for international trading under Kyoto.

It is possible and probably likely that Australia will eventually link to an international market through the Kyoto Protocol Flexibility Mechanisms. In this case credits in Australia will tend to trade at the global price. This will be affected by many factors including capping levels set in the future, engagement by the USA, possession by Russia and some other former Communist nations of excess permits ("hot air" generated by the collapse of these economies since the 2008-2012 caps were negotiated in 1996), the eligibility of avoided deforestation in developing nations, and many other factors.

What is becoming increasingly clear is the acceptance by governments of the need for serious reduction in emissions over coming decades. The Rudd Government has already set a target to reduce emissions by 60% below 1990 levels by 2050, but has declined to set shorter term targets until it receives the final report of the Garnaut Review. Professor Garnaut has recently suggested that the 2050 target should be set at 90% below 1990 levels, and there was a significant group of nations arguing at the 2007 Climate Change Conference in Bali for 25-40% cuts by 2020.

Finally, it is arguable that the first impacts of climate change are becoming discernible. As these effects become more pronounced there will be greater pressure on governments to act on climate change.

Given the factors outlined above it seems likely that there will be sustained upward pressure on credit prices over coming decades, and a price in excess of $50 per tonne of $CO_2e$ in 2020 would not be surprising. It is worth noting that the timeframes involved in reforestation are decadal, and that trees established now will be reaching their peak growth rates some 8 – 15 years in the future.

Financial models for reforestation presented in the following section of this report assume $2 increases (from $8 in 2008) annually until 2010, with the price moving to $25 after the introduction of a national ETS, and further $2 annual increases between 2011 and 2038.

## *Carbon returns*

To estimate returns from carbon markets to landowners across all possible project types and circumstances is beyond the scope of this study. Rather we attempt to model returns from one project type, reforestation, against a range of stated assumptions.

**Results should be regarded as indicative only, and may vary greatly according to specific project types and/or land and vegetation types, and the carbon accounting, risk management and administrative arrangements required by carbon market regulators and/or carbon credit buyers. Commercial service providers will also charge at different rates for the range of services likely to be required.**

The base case presented here is the reforestation of one (1) hectare of land. With reference to applicable Kyoto definitions, this means the direct human induced

conversion[2], since the beginning of 1990, to a forested state of land that did not support forest at the end of 1989. Forest is defined in the Australian context as land supporting trees with a height at maturity of over two metres, with a canopy cover at maturity of over 20%, and with a minimum area of 0.2 hectares.

It is assumed that 10% of the credits arising from vegetation and the land are withheld from sale and managed as a "risk management buffer' or "risk reserve" of credits by a carbon pooling entity. Therefore neither the carbon pooling entity nor the landowner derives financial benefit from these.

It is assumed that all transaction, measurement and administrative costs are met by an organisation acting as a "carbon pool", and that the carbon pool receives 30% of the sale price of carbon credits for providing these services.

The authors do not endorse or recommend these percentages or represent that they are relevant or appropriate to any particular business model. They are used here to illustrate that carbon pooling services may well be required and that risk management is another important consideration and neither will be free of cost.

It is assumed that the cost to the landowner is simply the income foregone from managing the same land for grazing. There may in reality be costs in fencing, direct seeding or planting, preparation of management plans beyond those funded by the carbon pool, thinning of regeneration, fire control measures etc. However since these arise differently (or not at all) in regard to different property, land and vegetation circumstances, they are not quantified here.

Assumptions regarding sequestration rates are outputs (Trees and Debris only) from a FullCAM model run (a plot file) using default values downloaded from the Australian Greenhouse Office for a location outside Charleville.

The results are presented in Figure 1 following.

Carbon returns per hectare appear to compare favourably with those for grazing enterprises in the literature. In its inquiry Report No 29 into *Impacts of Native Vegetation and Biodiversity Regulations* published in 2004, returns from cleared land in Murweh Shire in 2003 were estimated at around $11 per hectare. These returns were projected to change to between $5.80 and $15.40 per hectare in 2040 depending on factors such as productivity gains and change in the terms of trade.

The Net Present Value (NPV) of the carbon cash stream at a 6% discount rate is also superior to that reported in the Productivity Commission report for cleared land in the Murweh Shire which was between $66 and $104 (compared to $393 calculated here).

[2] Direct human induced is further defined as planting, direct seeding or the promotion of natural seed sources. While planting and direct seeding are unambiguous, promotion of natural seed sources is less clear. A range of options could be refraining from further clearing and letting nature take its course, managing stock and fire to encourage natural regeneration, managing stock and fire and natural seed sources to encourage regeneration, and managing stock, fire and natural seed sources and the ensuing regeneration in a structured way according to a management plan which is then attached by covenant to the land title. Where along such a continuum does the regeneration become direct human induced?

***Inflation 2.8% average***

| Year | Sequestration $tCO_2$/ha/annum | Buffer deduction $tCO_2$ | Net sequestration $tCO_2$ | Credit price $AU/$tCO_2$e | Gross rtn on net $CO_2$ $AU | $AU to Pool for trans, Meas. & Verif. Costs | Net Return to growers $AU (nominal) |
|---|---|---|---|---|---|---|---|
| 2009 | *0.0000* | 0.0000 | 0.0000 | *10.00* | 0.00 | 0.00 | **0.00** |
| 2010 | *0.1467* | 0.0147 | 0.1320 | *12.00* | 1.58 | 0.48 | **1.11** |
| 2011 | *0.5867* | 0.0587 | 0.5280 | *25.00* | 13.20 | 3.96 | **9.24** |
| 2012 | *1.1367* | 0.1137 | 1.0230 | *27.00* | 27.62 | 8.29 | **19.33** |
| 2013 | *1.6500* | 0.1650 | 1.4850 | *29.00* | 43.07 | 12.92 | **30.15** |
| 2014 | *1.9800* | 0.1980 | 1.7820 | *31.00* | 55.24 | 16.57 | **38.67** |
| 2015 | *2.2000* | 0.2200 | 1.9800 | *33.00* | 65.34 | 19.60 | **45.74** |
| 2016 | *2.3467* | 0.2347 | 2.1120 | *35.00* | 73.92 | 22.18 | **51.74** |
| 2017 | *2.3467* | 0.2347 | 2.1120 | *37.00* | 78.14 | 23.44 | **54.70** |
| 2018 | *2.3467* | 0.2347 | 2.1120 | *39.00* | 82.37 | 24.71 | **57.66** |
| 2019 | *2.2733* | 0.2273 | 2.0460 | *41.00* | 83.89 | 25.17 | **58.72** |
| 2020 | *2.2000* | 0.2200 | 1.9800 | *43.00* | 85.14 | 25.54 | **59.60** |
| 2021 | *2.1267* | 0.2127 | 1.9140 | *45.00* | 86.13 | 25.84 | **60.29** |
| 2022 | *1.9800* | 0.1980 | 1.7820 | *47.00* | 83.75 | 25.13 | **58.63** |
| 2023 | *1.9433* | 0.1943 | 1.7490 | *49.00* | 85.70 | 25.71 | **59.99** |
| 2024 | 1.8333 | 0.1833 | 1.6500 | *51.00* | 84.15 | 25.25 | **58.90** |
| 2025 | 1.7233 | 0.1723 | 1.5510 | *53.00* | 82.20 | 24.66 | **57.54** |
| 2026 | 1.6500 | 0.1650 | 1.4850 | *55.00* | 81.68 | 24.50 | **57.17** |
| 2027 | 1.5767 | 0.1577 | 1.4190 | *57.00* | 80.88 | 24.26 | **56.62** |
| 2028 | 1.5033 | 0.1503 | 1.3530 | *59.00* | 79.83 | 23.95 | **55.88** |
| 2029 | 1.3933 | 0.1393 | 1.2540 | *61.00* | 76.49 | 22.95 | **53.55** |
| 2030 | 1.3567 | 0.1357 | 1.2210 | *63.00* | 76.92 | 23.08 | **53.85** |
| 2031 | 1.2467 | 0.1247 | 1.1220 | *65.00* | 72.93 | 21.88 | **51.05** |
| 2032 | 1.2467 | 0.1247 | 1.1220 | *67.00* | 75.17 | 22.55 | **52.62** |
| 2033 | 1.1367 | 0.1137 | 1.0230 | *69.00* | 70.59 | 21.18 | **49.41** |
| 2034 | 1.1000 | 0.1100 | 0.9900 | *71.00* | 70.29 | 21.09 | **49.20** |
| 2035 | 1.0267 | 0.1027 | 0.9240 | *73.00* | 67.45 | 20.24 | **47.22** |
| 2036 | 0.9900 | 0.0990 | 0.8910 | *75.00* | 66.82 | 20.05 | **46.78** |
| 2037 | 0.9900 | 0.0990 | 0.8910 | *77.00* | 68.61 | 20.58 | **48.02** |
| 2038 | 0.9167 | 0.0917 | 0.8250 | *79.00* | 65.18 | 19.55 | **45.62** |

**NPV to grower at 6% discount rate:** **$393.00**

**Figure 1.**

## *Carbon Risk Management*

While there has been considerable focus on carbon credits which may be available for sale by land and forest owners in recent years, there has not been enough attention to carbon debits, carbon liabilities and carbon risk. It is arguable that success in the carbon market, particularly in relation to carbon credits from carbon storage in the biosphere (which is reversible), depends on robust risk management.

### Sustained and sustainable carbon storage

While returns from the sale of carbon credits relating to land and vegetation management show considerable potential for significant returns to landholders, it must be borne in mind that there are also risks attached to such a prospect.

In Australia's accounting for Afforestation, Reforestation and Deforestation, land which enters the accounting framework through the occurrence of any of these activities must remain in the national carbon accounts and all future changes in carbon stored on the land (carbon stocks) must be reported. For example, if reforestation is followed by deforestation at any point in the future, debits will accrue in the national accounts.

For this reason it is obviously desirable for the national government to manage the risk that credited carbon storage is not sustained, and ensure that receipt of carbon credits at a sub-national level carries with it the responsibility for possible future emission or re-emission of the credited carbon. Thus, at least until the final policy parameters of a national ETS are know, each carbon credit should be treated as a contingent carbon liability.

A useful approach may be to claim carbon credits only for carbon storage which can be sustained over the long term. This is best achieved by carbon storage through sustainable forest and land management.

If this approach is taken to the LULUCF sector under a national ETS, then the outcome is the refinement of the carbon financial driver (which at a basic level simply supports an increase in biomass in the landscape) into a driver for the implementation of sustainable land use plans and strategies at farm and, importantly, catchment and bioregional scales. These plans are generally consistent with the reversal of the decline in natural vegetation through strategic revegetation.

Thus a primary risk management strategy for landholders (and governments) is to store carbon in the biosphere strategically and in ways which support long term sustainability (economic, social and environmental) of production and natural landscapes.

There may be a strong role for catchment management authorities and similar bodies in accrediting such activities at the farm level as consistent with best practice forest and land management in a bioregional or catchment context.

### Carbon Pooling

A "Carbon Pool" is a new form of business structure which is emerging to support and assist landowners to commercialise carbon credits from forest and land

management. It is essentially an arrangement whereby several or many landowners wishing to commercially benefit from trade in carbon credits register the interest of a carbon pool on the title to their respective parcels of land. This interest is in the form of a Carbon Right (CR). It can be supported by covenants and agreements, and would generally include transfer of the rights and responsibilities associated with change in carbon density in and on all or part of the land over a specified period. This should include both the right to trade carbon credits and responsibility for carbon emissions.

Ownership by the pool of a CR in each parcel of eligible vegetated land allows the pool to sell carbon credits. Returns from the sale of carbon credits can then be paid to each land owner relative to their contribution to the pool, after meeting costs and providing return on investment to the pool manager. A carbon pool could also buy Carbon Rights, forested land, or Forestry Rights outright.

Benefits of pooling to land and forest owners may include:

- Financial returns from dealing in credits
- Risk management against emission penalties on individual properties
- Access to required scientific, legal, administrative and technical services
- Ability of the pool to function over the extended timeframes required

A carbon pool may be a private or public company, a cooperative, an association or partnership, a trust or other legal entity. Its functions are to provide the benefits outlined above in a cost effective manner, to the extent possible maximising returns from dealing in credits. Carbon pools may also vary in the degree to which they are operated by or for land owners, investors, governments or service providers.

A primary risk issue addressed by a carbon pool is that an individual landowner selling carbon credits arising from, for example, reforestation on their land could face the necessity of replacing credits in the future if the credited carbon stocks are re-emitted through wildfire or other unanticipated event. If the price of carbon credits has risen significantly, and if the obligation is to replace all credits lost at that time, significant financial losses could accrue.

To the extent that many properties and projects are pooled across diverse locations and vegetation types, and the pool reserves a proportion of credits from each for risk management purposes, liabilities for impacts on individual properties can be much better managed at the pool level.

In addition to a primary function of risk management for landholders, a carbon pool provides the opportunity for cost-effective provision of the range of services required to transform carbon stored in the landscape into carbon credits in the marketplace. Compliance with the requirements of carbon buyers and carbon market regulators is a non-trivial undertaking, and services are required in the scientific and technical, administrative, legal, risk management and marketing areas. These services can be cost effectively provided to a large client group such as the landowners in a pool.

## *Carbon accounting*

Australia's accounting of greenhouse gas emissions and removals from the Land Use, Land Use Change and Forestry sector is done by the National Carbon

Accounting System (NCAS). The NCAS accounts for these activities through a highly integrated system that combines:

- remotely sensed land cover change (including mapped information from thousands of satellite images)
- land use and management data
- climate and soil data
- greenhouse gas accounting tools, and
- spatial and temporal ecosystem modelling.

The system also has considerable relevance and use in accounting in the Agriculture sector. The NCAS has also produced a Carbon Accounting Toolbox for use at smaller scales including the farm and paddock scales.

NCAS uses Landsat imagery from several dates from 1972 to the present. Comparison between imagery from different years enables the identification of clearing, cultivation, natural dieback, regrowth and other relevant events at a fine scale (down to 25 metres by 25 metres – the size of a Landsat picture element or pixel).

For example, when an area is detected as being deforested, it is assumed that the cleared biomass is burned six months after clearing and most, but not all, of the carbon stored in the biomass is emitted to the atmosphere. The unburnt fraction is modeled as decaying over an extended period into the future, with a minor fraction being converted to charcoal. As a result the emissions from deforestation are accounted as occurring mainly in the year after clearing but persist in decreasing amounts over following decades.

Similar work on detection of deforestation and clearing has been carried out over the last decade by the Queensland Government through the Statewide Land and Trees Study (SLATS). It is interesting, when both studies rely fundamentally on the interpretation of reflectance values of Landsat imagery, that the results are so different. This is of particular relevance to landholders in Queensland who are subject to monitoring for compliance with state vegetation management legislation by SLATS and for carbon accounting purposes by the NCAS.

It would seem useful for more collaborative work to be undertaken between SLATS and NCAS in order to reconcile any differences and to add value to the methodological approaches of both. It is recommended that South West NRM encourage the Queensland Government to provide SLATS data to the NCAS and offer to undertake such a collaborative study.

The Carbon Accounting Toolbox recommended for use by landholders by the Commonwealth enables users to model changes in emissions resulting from cultivation, fire management, fertiliser application, climate variability and reliability etc. It also enable the modeling of a range of land use changes including reforestation with a range of species at any location in Australia, the emissions associated with deforestation over time, and many others.

Users can:

- access carbon accounting data for a range of plant species and land management systems
- access historic climate records

- search all technical reports relating to development of the National Carbon Accounting System.

The Toolbox includes the Full Carbon Accounting Model (FullCAM), that is derived from Australia's National Carbon Accounting System, and all supporting technical documentation. Further information including how to obtain a free copy of the software and supporting material is available at:
http://www.greenhouse.gov.au/ncas/ncat/index.html

The NCAS has been primarily designed to comply with the requirements for terrestrial carbon accounting at the national level detailed in the Intergovernmental Panel on Climate Change's Good Practice Guidance for Land Use, Land Use Change and Forestry accounting (IPCC GPG – LULUCF). This set of documents sets out detailed principles and practices based on good scientific methods for measuring carbon stocks in vegetation and soils.

NCAS, including FullCAM probably represents current global best practice for terrestrial carbon accounting at the national level. However its use at the farm or paddock level, particularly using downloaded default values, may conflict with estimates derived locally through field measurement. FullCAM's aim is to provide an unbiased estimate at the national level, and is unlikely to provide an accurate estimate of carbon stored on an individual site unless locally collected data is used to inform the model.

The IPCC methods are organised in three Tiers of increasing accuracy in measurement. Tier 1 estimates include the use of data collected at the national level such as national forest area, annual timber harvest volumes, timber export volumes etc. Tier 3 methods include field measurement of individual trees or stands of trees.

Tier 1 and 2 methods often rely on broad estimates or models which should be validated or calibrated by reference to measurement, studies and research using Tier 3 type methods. Because Tier 3 methods are typically used at the farm or project scale, the relationship between accounting at the national and project scales is of great importance.

It is suggested that local data collected by approved IPCC Tier 3 methods and subject to independent verification be used to calibrate and validate national models and estimates. This approach would enable differences between national estimates and farm level estimates to be minimised or eliminated. Such differences can have considerable commercial consequences.

## *Legal issues*

While robust and binding legal arrangements are a key part of the process of generating carbon credits arising from land and vegetation, legislation to underpin the process is still rudimentary and fragmented and there is currently little or no "carbon case law".

A national emissions trading scheme in Australia is expected to be introduced in 2010 and it is clear that it will be legislated for and run by the Commonwealth Government. However legislation to underpin the generation of carbon credits from land and forests is to a significant degree the province of State Governments.

Queensland, New South Wales, Victoria, Tasmania, South Australia and Western Australia have already passed laws to allow for recognition of rights which could in general be called Carbon Rights[3] in relation to carbon in vegetation and soils. However in the absence of clear leadership from the Commonwealth on what is required, and because of differences on land and property law in the different jurisdictions, a "railway gauges" situation has arisen with approaches of differing quality, complexity and legal effect in the different States.

Some relevant legal terms and concepts of Australian property law need to be explained in order for a non-specialist reader to understand how physical carbon stored in a tree, forest or soil can be sold as a carbon credit, and a short discussion follows.

Private property is the main form of property relationship in modern capitalist nations such as Australia. Property, in the legal sense, is a relationship with an object rather that the object itself. A private property relationship is generally understood to confer on an owner the right to exclusive ownership and control of an object. However, the nature of the relationship can vary according to the nature of the thing which is owned, which may be tangible (such as land) or intangible (such as a contractual right to a particular benefit). Property relationships may also exist for different periods of time, and differ according to the legal jurisdiction in which they exist and be influenced by the political, social and cultural norms of society.

Most useful things are capable of being owned, but there are constraints placed upon what can be owned by social, cultural and legal factors. For example it is considered unacceptable for a human being to be owned by another. Also, property rights of use, control and possession which exist because of law can be and frequently are also limited by law. For example, ownership of land does not confer unlimited development rights upon the owner, because of development controls imposed by different levels of government.

Because property is a relationship with an object, a range of property interests may exist in relation to a single object. For example, freehold land may be leased to a different party from its owner, while a third party may have a right of access across a defined right of way.

Property can be divided into real and personal property. Real property is essentially land or fixtures on land. Personal property is chattels. Land is considered to be a defined area of the earth's surface, potentially including space above or below, and because it is a defined three dimensional space, it is considered to be indestructible and immovable. Personal property or chattels, on the other hand, are movable, destructible objects.

Both real and personal property can be further divided into tangible and intangible categories. Real, intangible property includes easements and *profits a prendre*. An easement is a form of property conferring certain rights upon the owner in relation to land without ownership of the land itself, such as a "right of way" across the land. Easements are also referred to as "incorporeal hereditaments". A *profit a*

[3] These rights have also been commonly referred to as Carbon Sequestration Rights but the briefer term will be used here, in part because the term can also refer to rights to carbon already stored in trees, rather than just the process of ongoing sequestration.

*prendre* is a similar form of property right and generally confers upon its owner the right to enter land and take away certain defined produce of the land.

Tangible personal property or chattels refers to physical objects (other than land and fixtures to land) capable of ownership and possession. Intangible personal property (also called a "chose in action") is where the owner enjoys the benefit of something but that thing is not in his or her possession.

Finally, given that property is created by law, different forms of property may be distinguished by the legal sphere within which the interest is recognised and/or enforceable. Thus there are common law interests, equitable interests and statutory interests. Statutory interests are of particular relevance in discussion of Carbon Rights, because this form of property is created and defined by statute (presently by State legislation).

## Carbon Rights

Carbon Rights have been differently defined in each Australian State in recent years. It is suggested here that to be useful, a Carbon Right should give its owner two things. These are:

- The enforceable right to ensure that an agreed management plan for the vegetation and soil of the land is carried out, for the term of the Carbon Rights contract, and
- The exclusive right to both the benefits and liabilities associated with storage of carbon on and in the land

Carbon Rights are useful to the extent that management of the land can be expected to provide a durable carbon sequestration and/or storage outcome.

For this reason it is desirable to be able to have an agreed management plan registered on the land title, so that the land and vegetation management which is expected to lead to the desired environmental outcome survives change in land ownership. Legally, this means that the clear ability to have positive and negative covenants (agreements) regarding land management to support ownership of Carbon Rights is highly desirable.

It is important that a Carbon Right cover both vegetation and the land on which it is growing. This is because the land and vegetation function together, and changed management of one is likely to lead to changes in the other. For example, disturbance of the soil before planting trees is often undertaken to maximise tree growth (and therefore carbon absorbtion in the trees). However such soil disturbance may also lead to substantial emissions of carbon from the soil. Accurate and balanced carbon accounting therefore requires accounting of the soil and vegetation together.

It is also important that the owner of a Carbon Right has not just the rights and benefits associated with the sequestration and/or storage of carbon in land and vegetation, but also the responsibilities and liabilities associated with such storage. If the Carbon Right owner had only the rights and benefits he would have the benefit of sequestration as trees grow, but the landowner could be responsible for disbenefits such as emissions of carbon through fire, disease or pest attack, or harvesting.

## Carbon Rights and Carbon Credits

Carbon Rights as described above are clearly a form of real property or rights over land and registrable on land title. In legal jargon they can be characterised as intangible real property (an incorporeal hereditament). Carbon credits are quite different. The term generally means something that can be used to offset or nullify an equivalent greenhouse gas emission and the liability, if any, associated with that emission. It is, in short, a benefit.

However it could take many forms depending on the carbon accounting or carbon trading scheme within which the term has meaning. Other terms can and are used in various current schemes, including a Removal Unit (for sequestration in a developed nation under the Kyoto Protocol), a temporary Certified Emission Reduction (for sequestration in a developing nation under the Kyoto Protocol, Greenhouse Friendly Approved Abatement (under the Greenhouse Friendly initiative, or Abatement Certificate (under the NSW Greenhouse Gas Reduction Scheme).

Carbon credits can also arise in relation to purely contractual arrangements between private parties such as individuals or companies. Where carbon credits have a statutory basis, such as under the NSW Greenhouse Gas Reduction Scheme, they are probably a "stronger" form of property than those created by purely contractual rights. That is, there are likely to be penalties imposed by government for non-compliance with agreed arrangements as well as contractual remedies for damages available to a buyer.

In any case, a carbon credit is essentially intangible personal property (a "chose in action").

A further distinction is that carbon credits are quantifiable (usually denominated in tonnes of CO2e) whereas a Carbon Right is not. A Carbon Right is the right to (and responsibility for) whatever carbon exists in a defined area of land. It is a relationship of ownership, and it is ownership of something which is subject to natural fluctuation, to increase and decrease. This again underlines the importance of agreed management of land and vegetation being locked in by registration on the land title, so that the owner of the Carbon Right can be reasonably confident of sustained increase and/or retention of carbon (rather that arbitrary or unexpected decrease).

A factor to be considered in relation to registering a management plan on a land title is that traditionally it has not been possible to register a positive covenant on a land title, except for those which are for the benefit of governmental or statutory bodies. This has been because common law has strongly tended to repudiate the enforcement of positive obligations on a party who is not a party to the agreement (such as a future owner of land).

Thus Carbon Rights are an area of new law. A Carbon Right will be ineffective unless it provides for positive obligations on the land and forest manager and/or owner over extended timeframes (and therefore binds future owners). It is unsurprising that legislators have struggled, and that administrators of the new carbon law still struggle with interpretation.

## Current Qld legislation

Currently agreements regarding Carbon Rights in Queensland are enabled by relatively recent amendments to the Forestry Act 1959, the Land Act 1994 and the Land Titles Act 1994, with consequent minor amendments to some other Acts. These legislative changes have the effect that an owner (and under some circumstances a lessee) of land may enter into an agreement with another person (called the "benefited person) regarding what is called a "natural resource product". A natural resource product includes any or all of the following:

*"(a) all parts of a tree or vegetation, whether alive or dead, including parts below the ground;*
*(b) carbon stored in a tree or vegetation;*
*(c) carbon sequestration by a tree or vegetation."*

Carbon sequestration is defined as:

*"for a tree or vegetation, includes the process by which the tree or vegetation absorbs carbon dioxide from the atmosphere."*

Legislation provides that:

For leasehold land, the lessee may enter into an agreement only if the natural resource product is owned by the owner as an improvement, within the meaning of the *Land Act 1994*, on the land. This is significant because a planted forest is an "improvement" but natural forest on leasehold land is owned by the Crown.

If the land is mortgaged, the owner may only enter into the agreement with the mortgagee's consent.

An agreement regarding a natural resource product may do one or more of the following:

(a) vest all or part of the natural resource product in the benefited person;
(b) grant the benefited person the right to enter the land to do either or both of the following—
    (i) establish, maintain or harvest the natural resource product;
    (ii) carry out works or activities for the natural resource product;
(c) grant the benefited person the right to deal with the natural resource product.

However, the vesting of natural resource products under such an agreement is expressed not to create an interest in land under the *Land Act 1994* or the *Land Title Act 1994*, and then, somewhat confusingly, the legislation says that the benefited person's rights to the natural resource product under the agreement are a profit a prendre for the *Land Act 1994* or the *Land Title Act 1994* and can therefore be registered on the land title.

It is interesting to note that Queensland is the only State to explicitly include "carbon stored in trees and vegetation" in addition to "carbon sequestration by trees and vegetation". This is presumably because, as Queensland was the State with most land clearing until recently, the framers of the Queensland legislation were more sensitive to the possible value of carbon remaining stored (as distinct from carbon being sequestered over time).

Some possibly significant issues with the Queensland legislation are as follows:

- The legislation is silent on carbon stored in the soil. It is highly desirable to be able to transfer rights to carbon stored in soil along with rights to carbon stored in vegetation, since vegetation and soils act as a system and should be accounted for in an integrated way as required by national and international standards. Current legislation could prevent trade in soil carbon credits where it might otherwise be possible.
- An agreement regarding natural resource products may not extend to having future management of the land and vegetation prescribed in sufficient detail. Specifically, the legislation does not explicitly allow for agreement on a management plan or for an agreed management plan to be effectively bound to the land through registration to the land title. It may be that a very detailed "natural resource product agreement" could take the place of a formal management plan. This should be clarified. Desirably, the law should allow for positive covenants to be registered to support Carbon Rights.
- The meaning of a profit a prendre (in the form of rights to a natural resource product) not being an interest in land could be clarified.

## Approaches adopted in other Australian jurisdictions

New South Wales
In NSW the relevant rights are called Carbon Sequestration Rights and these are in the legal form of a profit a prendre, following amendments to the Conveyancing Act 1919. The amendments also create "Forestry Rights" more generally, and thereby effectively allow forest to be owned and managed separately from the land on which it is growing. Forestry covenants are related to Forestry Rights and can also be registered on land title. These covenants can give the Forestry Rights owner access to the land to plant, maintain and harvest or to maintain or harvest trees on the land. Presumably a Carbon Sequestration Right can be owned separately to the Forestry Right, enabling separate ownership of the land, trees and carbon.

Victoria
In Victoria allowance was made for the separate ownership of forest and the land on which it grows through the *Forestry Rights Act 1996*. This was a new statutory right rather than being based on a profit a prendre. This Act was amended by the *Forestry Rights (Amendment) Act 2001* to provide for the ownership of a Carbon Sequestration Right as a form of Forest Property. A Forest Property Agreement is registrable on land title under the Forestry Rights Act. The amending legislation also allows for a Carbon Rights Agreement to be made with a third party, but this is neither a Forest Property Agreement (and therefore not registrable on the land title) nor an interest in land.

South Australia
The South Australian Parliament passed the *Forest Property Act* in 2000 to allow for the separation of forest as property from the land on which it is growing. The right to commercial exploitation of carbon sequestration by trees is owned by the forest owner. A Forest Property Agreement can be registered on land title which can give the Forest Property owner rights of access to land and the ability to plant, maintain and harvest "forest property" and to exploit the benefits of carbon sequestration by trees on the land. The Forest Property Agreement creates an interest in the nature of a profit a prendre.

Tasmania
In Tasmania the *Forestry Rights Registration Act 1990* provides for the registration of Forestry Rights in the form of a profit a prendre on land title (binding future owners), and similarly for the registration of forestry covenants supporting the Forestry Rights. A Carbon Sequestration Right is a form of Forestry Right. Forestry Rights can give their owner rights of access to land, and rights to establish, maintain or harvest trees on that land.

Western Australia
Western Australia has the most recent Carbon Rights legislation through the *Carbon Rights Act 2003*. The Act creates a new statutory interest in land as a hereditament (a form of intangible real property) which comes into being upon registration. It is unambiguously an interest in land and its proprietor has the legal and commercial rights AND RESPONSIBILITIES associated with carbon absorbtion AND RELEASE occurring on or IN land. The Act also unambiguously allows for both positive and negative covenants to be registered on title to support the Carbon Right.

The West Australian legislation is arguably the best to date. The legal approach is simple but creates a very strong form of new property, allows for ownership of the property to carry both benefits and responsibilities, and allows for enforceable rights to ensure the implementation of agreed management of the land over extended timeframes. It also makes carbon absorption and storage a property of land and the vegetation on land, and therefore better underpins comprehensive carbon accounting and the ability to include soil carbon credits in trade.

## Carbon Contracts

Carbon in the form of Carbon Rights and carbon credits is a new form of property and currently legal knowledge and practice is in what could be characterised as a pioneering phase. Given this, extra caution is required in drafting of contracts for the sale and purchase of either Carbon Rights or carbon credits. A primary aim of such contracts should be to clarify the rights and responsibilities of each party in respect of the land and vegetation, each other, and other relevant entities such as service providers, verifiers, carbon buyers and market regulators.

**The general discussion of contractual issues following is not exhaustive and should not be used as or substituted for competent legal advice. It is intended only as a basis for further discussion which should take into account the characteristics and scale of particular projects or enterprises.**

**Readers should not act in reliance upon this material but rather seek the advice of their legal and other qualified advisers.**

Policies, legislation and regulations regarding the subject matter of Carbon Rights and carbon credit agreements may well be added to or changed in the future. In this context carbon buyers and sellers should be aware that legally binding agreements entered into now may be influenced by such changes, and that qualified legal advice should be obtained before signing any such contracts.

It is suggested that advice should be sought from the Queensland Registrar of Titles on issues regarding the acceptable form and content of natural resource product agreements. For example, it should be clarified whether a management plan for the land and/or vegetation may be included as an annex to the agreement or if the

operative provisions for such a plan should be incorporated in the body of the agreement.

Finally, the difference in nature between Carbon Rights and carbon credits should be borne in mind, as there are likely to be substantially different requirements for sale and purchase under these two types of transaction.

Some likely inclusions in a Carbon Rights contract are as follows:

Basic details
The contract should have a title, such as, in the Queensland context, "Natural Resource Product Agreement" and give the full legal details identifying the Parties to the agreement. Qualified advice should be sought as to the required details which may be different for individuals, companies, partnerships etc. It may be useful to inquire as to whether the agreement should be in the form of a Deed.

Recitals
This should clarify the general intent of the Parties and the need for an agreement, and reference any enabling or authorising legislation.

Term of the agreement
Carbon Rights contracts are likely to need to operate over considerable timeframes because:

- Vegetation grows over long periods of time
- Carbon trading schemes may require guarantees that the carbon will remain stored for considerable periods[4]

The only statutory carbon trading scheme currently operating in Australia, the NSW Greenhouse Gas Reduction Scheme, requires sellers of credits arising from storage of carbon in vegetation and soil to guarantee that the carbon will remain stored for a minimum period of 100 years[5]. The Greenhouse Friendly initiative requires a guarantee that credited carbon will remain stored for seventy years[6].

Therefore if it is desired to claim, for example, carbon stored in a forest up to the thirtieth year following establishment, it may be necessary for the term of a Carbon Rights agreement to be 130 years to provide a basis for meeting the requirement of the NSW Greenhouse Gas Reduction Scheme and 100 years to meet the requirements of Greenhouse Friendly.

Another consideration is that it may be possible to sell carbon sequestration occurring in different years to different buyers. For example a seller wanting to fix a price in order to get a known income over the early years of plantation growth might want to sell the sequestration occurring in the first ten years, but reserve

[4] On the other hand, contracts for the sale and purchase of carbon credits may not need to cover periods longer than the time taken to complete the transaction (although they may stipulate that an underlying Carbon Rights contract must be enforced for longer periods).
[5] 100 years is the period over which the thermal forcing effects of the different greenhouse gases are measured in order to determine their "global warming potential". In this sense a CO2e emission is the thermal forcing caused by an emission of carbon dioxide over 100 years. This is then the unit in the scale in which carbon dioxide is 1, methane is 21 and nitrous oxide is 310.
[6] The seventy year period is based upon two 35 year rotations of Radiata Pine, a commonly planted exotic conifer.

sequestration occurring after that time in anticipation of higher prices in the future. Such an approach could require careful drafting and there could be an open question whether this is consistent with the current statutory approach to Carbon Rights in Queensland.

In any case a specific term to the contract must be specified for the Parties to be clear about the period over which their rights and responsibilities apply. Note that some obligation, such as confidentiality, may be expressed to survive the term of the contract.

Sale and purchase/payment provisions
This needs to clarify exactly what is being sold and purchased, and provide for unambiguous execution of the transaction and clear arrangements for payment, (such payments potentially extending well into the future).

The complexity of these provisions will be determined, among other factors, by:

- the relative contributions of the Parties to effect the vegetation project (including past, ongoing and/or future costs)
- whether returns are also expected from timber production or other sources
- relative contributions to the costs of commercialisation of the Carbon Rights (e.g.legal, administrative, scientific and technical, marketing costs etc)
- allocation of risk between the Parties
- the stage in development and execution of the project, and
- perceptions of current and future carbon prices

Project area
In Queensland a survey plan prepared by a registered surveyor must be lodged with the documents for registration of a *profit a prendre*. See the discussion on survey requirements following.

Approvals
The consent of any mortgagee of the property in which the profit a prendre lies is required under current Queensland legislation. Other consents may also be required, for example internally if either Part is a company. It is also possible that statutory approvals may be required. This may be the case in respect of local government approvals where the land use change is not "as of right", or under some circumstances in respect of leasehold land.

Risk management
Because a Carbon Right is a potentially very valuable interest, and vegetation may be expensive to establish or replace, robust risk management is likely to be in the interest of both Parties. This may take the form of insurance for either or both Parties covering different forms of risk.

A problematic aspect to insurance is that the risk of reversal of carbon storage, potentially decades into the future, is difficult to cover because the future price of carbon credits (and debits) is unknowable.

For this reason it is often suggested that a proportion of carbon be reserved from sale and used as a "risk management buffer". This mechanism is often associated with "pooling" across many properties and projects, as this has the additional

benefit of risk spreading. If such approaches are to be used, this will need to be specified in the agreement.

Carbon accounting
The Parties may wish to include specification of the carbon accounting approaches, methodologies and conventions to be used. This will presumably need to take account of the requirements of the carbon markets into which carbon products are expected to be sold. The interplay between generation of carbon credits for sale, and timber harvesting may deserve special consideration, as it is possible to optimise between timber production and carbon storage (depending on the relative values applying to these) but it is not possible to maximise both.

Rights and obligations of the Parties
The scope of this section will depend, among other things, on whether a management plan for the vegetation project can be annexed to the agreement as registered. There may be some doubt on this point in the current Queensland context. If it is not acceptable then responsibilities for execution of all physical works will need to be spelled out in the body of the contract. These may extend a long way into the future. The same is likely to apply to obligations for commercialising the carbon.

Some other things to be specified may include:

- The right to deal in the Carbon Right and/or carbon credits
- Rights of access to the land affected by the *profit a prendre*
- Rights of remedy if either Party is in breach of their obligations
- Responsibilities to (promptly) pay all relevant taxes, rates and other charges
- Obligations to fund, implement and observe the agreed management plan or land and vegetation management provisions of the contract
- Responsibility to pay costs including Transfer Duty, survey costs, carbon measurement, independent verification, administrative costs etc.
- Issues relating to subcontracting and assignment of responsibilities and rights

## *Survey requirements*

Requirements for survey standards for the range of purposes for which surveys are required are detailed in the Department of Natural Resources and Mines publication Cadastral Survey Requirements Version 4.0 8 November 2005 (http://www.nrw.qld.gov.au/about/policy/documents/2093/pdfs/cadastralsurveyv4.pdf ).

Because a Carbon Right is defined as a *profit a prendre* under both the Land Act 199 4 and the Land Titles Act 1994, a survey plan prepared to the standards detailed in the Cadastral Survey Requirements must be lodged along with the Deed transferring the profit a prendre with the Registrar of Titles if the *profit a prendre* is to be registered on title[7] and if the profit a prendre is not over the whole Lot. The Cadastral Survey Requirements allow for three survey options for a survey plan for a *profit a prendre*. These options are:

- Full Cadastral Survey

[7] See http://www.nrw.qld.gov.au/property/titles/rdpp/pdf/section_19.pdf

- Reduced Survey Standard Survey
- Survey Plan produced by Compilation

Costs of having a survey undertaken by a registered surveyor will very considerably depending on the survey option required to be undertaken. Interested parties should make enquiries beforehand with the survey staff in the land titles registry, as onerous survey requirements could compromise the commercial viability of otherwise profitable dealing in Carbon Rights.

There is likely to be an expectation that a survey to at least the Reduced Survey Standard Survey will need to be undertaken for the registration of large *profit a prendre* areas in the extensive properties common in the Mulga lands. However, the Minister's delegate with responsibility for determining these questions may be able to justify some flexibility, considering the extensive and remote nature of the country.

It is also worth considering that mapping by State agencies for the purpose of administration of State vegetation management legislation, and even including Property Maps of Assessable Vegetation noted on the land title, is often undertaken from desktop GIS, and compliance with administrative and legislative requirements for vegetation management is expected to be possible for landowners using Global Positioning System (GPS) technology.

The placement of monuments (usually wooden survey pegs) to mark the changes in direction of the boundaries of a *profit a prendre* area may also be considered redundant bearing in mind the often long term nature of the *profit a prendre* interest (sometimes over 100 years) and the relatively short service life of a survey peg (around 20 years).

Against such matters of convenience and practicality must be balanced the fact that a *profit a prendre* may represent a commercially valuable asset and could be the subject of dispute. It is therefore important that the parties to a transaction involving such an interest are sufficiently clear about the spatial boundaries and their obligations in observing them (including locating them as and when required). In the extensive Mulga lands properties, this is generally likely to be based on the use of GPS.

## *Transfer Duty on carbon transactions*

Transfer Duty seems likely to be payable on transfers of Carbon Rights in Queensland, because under the *Duties Act 2001*[8] Transfer Duty is payable on the "dutiable value[9]" of "dutiable transactions[10]". Dutiable transactions include transfers of (and agreements for the transfer of) dutiable property[11]. Dutiable property includes "land in Queensland[12]" and a reference to property includes an "interest" in property[13]. This section is footnoted as follows:

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*Acts Interpretation Act 1954*, section 36—

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[8] http://www.legislation.qld.gov.au/LEGISLTN/ACTS/2001/01AC071.pdf
[9] Duties Act 2001 s8(2)
[10] Duties Act 2001 s8(1)
[11] Duties Act 2001 s9(1)(a) and s9(1)(b)
[12] Duties Act 2001 s10(1)(a)
[13] Duties Act 2001 s10(2)

**"interest"**, in relation to land or other property, means—
(a) a legal or equitable estate in the land or other property; or
(b) a right, power or privilege over, or in relation to, the land or other property.

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This would then seem quite clear, and Transfer Duty payable, if not for s61J(4) of the Forestry Act which says that:

..... "the vesting of natural resource product under the agreement does not create an interest in land under the *Land Act 1994* or the *Land Title Act 1994*."

However, since Transfer Duty is not collected under the Land Act 1994 or the Land Title Act 1994, it remains probable that Transfer Duty is payable.

The dutiable value of a dutiable transaction is either the "consideration for the dutiable transaction[14]" or "the unencumbered value of the dutiable property or new right[15]". Where the value of a Carbon Right is agreed in an arm's length transaction the purchase price (consideration) is likely to be seen as close enough to the unencumbered value.

Problems may arise, however, where the Carbon Right is transferred at slight initial consideration but where the parties agree to share the proceeds of future sales of carbon credits. This is quite a likely arrangement, given the lack of foreknowledge of future carbon credit prices. Suppose, for example, that a carbon pool is formed and wishes to attract a large number of landowners to market carbon credits by aggregating their Carbon Rights in the pool. The pool anticipates a carbon price of at least $A20 per tonne CO2e within a few years, which would justify the expense of establishing the pool.

However there is considerable risk to the downside and equally, the carbon price in a few years may be higher than anticipated. Moreover, the price in ten years time is unknowable, let alone in twenty years. The nature of the underlying investment may be in reforestation, however, and the trees will peak in growth rate between ten and twenty years in the future, and continue to absorb carbon dioxide for the next hundred years at least. How then can an arm's length value for the Carbon Rights be determined? What is the "unencumbered value"?

Finally, where a number of dutiable transactions form part of a single arrangement, the transactions must be aggregated for the purpose of calculation of the Transfer Duty payable. For example, if a buyer wanted to purchase a single large parcel of carbon credits, and a selling organisation wanted to aggregate the Carbon Rights from a number of properties in order to be able to generate the required parcel of credits, the aggregation provisions of the Duties Act 2001 would probably apply. This can make a significant difference to the total duty payable, as can be seen from the Table following.

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[14] Duties Act 2001 s11(7)(a)
[15] Duties Act 2001 s11(7)(b)

**Rates of Duty**

Where the transfer duty liability date is on or after 1 July 2006

Standard rates:

| Amount | Duty applicable |
|---|---|
| Not more than $20,000 | $1.50 for every $100 or part $100 |
| More than $20,000 but not more than $50,000 | $300 + $2.25 for every $100 or part $100 over $20,000 |
| More than $50,000 but not more than $100,000 | $975 + $2.75 for every $100 or part $100 over $50,000 |
| More than $100,000 but not more than $250,000 | $2,350 + $3.25 for every $100 or part $100 over $100,000 |
| More than $250,000 but not more than $500,000 | $7,225 + $3.50 for every $100 or part $100 over $250,000 |
| More than $500,000 but not more than $700,000 | $15,975 + $4 for every $100 or part $100 over $500,000 |
| More than $700,000 | $23,975 + $4.50 for every $100 or part $100 over $700,000 |

As can be seen from the above table, Transfer Duty could be a substantial cost on transfer of Carbon Rights. It is payable (if at all) prior to registration of the *profit a prendre* on title, and since it is primarily in the buyer's interest that these rights be registered, it is likely that the buyer would pay the Transfer Duty (although the responsibility for this could be contractually assigned.

Because of the difficulty in calculating an appropriate value for these rights, and because the payment of significant sums in Transfer Duty represents a significant disincentive to carbon transactions in Queensland, it is recommended that representations be made to the Queensland Government through the office of the Minister for Natural Resources and Mines, to waive Transfer Duty on transfers of profits a prendre for Natural Resource Products.

## Stewardship payments

This report does not address general questions about the possibility or desirability of governments providing stewardship payments to landowners for management of their land to provide public benefits. Rather, we address two questions.

1. Is finance from carbon markets likely of itself, to provide better land management outcomes (and if not how can it be better able to do so)?
2. Are there particular circumstances where government(s) can address failure of carbon markets to provide incentives?

Carbon finance can be expected in the future to reward additional carbon storage in managed ecosystems and landscapes. However balanced carbon accounting is also likely to require penalties of some kind for decreased carbon storage in the same ecosystems and landscapes. That is, each carbon credit generated in respect of additional carbon storage is a contingent liability, which will become actual if the credited carbon is re-emitted to the atmosphere.

Given this, it is arguable that the efforts of policy makers should be to ensure that carbon credits are only recognised for carbon storage which is likely to be

sustained over extended timeframes. That is, carbon storage which is the result of economically, ecologically and socially sustainable land and vegetation management.

It could be argued that as long as accurate accounting is kept of both emissions and sequestration, then the time in between carbon absorbtion and emission is not relevant. However this is to neglect the effect of future discount rates on future disbenefits or penalties over the relevant timeframes. That is, if it is possible to obtain a benefit now, knowing that there will be a penalty of equal (or even larger) size some (or many) decades in the future, the effect of future discounting will mean that it is likely the present benefit will be accepted.

For this reason, crediting unsustainable carbon storage may represent a moral hazard.

If this is correct, then we must move from considering carbon credits as simply a driver for the increase of biomass in the landscape to considering them as a reward for sustained increase in carbon storage through sustainable natural resource management. This is, perhaps, the reason why under the NSW Greenhouse Gas Reduction Scheme and the Commonwealth's Greenhouse Friendly initiative minimum timeframes are set for which carbon storage must be guaranteed.

At least two elaborations of these requirements are possible. One is that any landuse change which is legally able to be effected, which is eligible for crediting under the relevant emissions trading scheme, and under which additional carbon is likely to be sustainable stored, should get credits (as the carbon is actually stored). Another is that only economically, socially and environmentally sustainable landuse changes should get carbon credits. That is, carbon crediting should be a driver for best practice sustainable land and vegetation management.

To illustrate the difference between the two approaches, it may be legally possible to establish timber plantations throughout a water catchment for a population centre. However, if this has the effect of reducing already stretched water supplies for civic and agricultural use, should it be allowed, let alone rewarded with carbon finance?

Rather than arguing the merits of either of these positions, it is probably more useful to question how either would be judged, and from a pragmatic perspective it is likely that sustainable landuse in the Australian context is best judged within the context of catchment management principles and planning.

It is suggested that catchment management authorities, committees and similar bodies (depending on their nature and status in the different jurisdictions) have had the mandate, and to a greater or lesser extent the resources, to identify landuse practices and land repair priorities which will lead to sustainable management of natural resources on a catchment-wide basis.

While these catchment strategies and plans may need refinement or elaboration to be appropriate at finer scales, including down to individual farms, it seems they are likely to provide the most appropriate available framework within which to constrain the raw carbon credit financial driver in order to maximise the range of landscape and sustainability benefits while also maintaining agricultural and pastoral production, water yield, and other values.

This then may provide the answer to the first question raised above – namely, that the carbon finance driver needs to be delivered through a nuanced policy framework which discriminates in favour of carbon storage which can be accredited as sustainable, and likely to be sustained, by reference to approved catchment or, as applicable, subcatchment strategies and plans.

If the carbon financial driver can then be harnessed to drive sustainable forestry, agricultural and pastoral production within a catchment management framework, will this be effective across all land tenures in Queensland?

Freehold landowners are currently able to participate in carbon trading in respect of both remnant vegetation and newly established vegetation on their land, at least to the extent that they can sell Carbon Rights to the vegetation. Leaseholders generally face the constraint that the Crown owns the natural vegetation on leasehold land. Holders of term leases face the further constraint that the term of their lease may make then ineligible to generate carbon credits as they may not be able to meet requirements for retention of stored carbon for the length of time required[16].

Therefore, depending on the nature of land and vegetation management projects, holders of various types of leases may be disqualified from direct receipt of carbon finance for certain types of activities or projects. This is illustrated in respect of broad project and lease types in the following table. Note that the table only addresses the question of ownership of the relevant vegetation and land, and not other requirements which may be imposed by carbon trading scheme regulators.

| Project type | Freehold land | Perpetual leasehold | Term leasehold |
|---|---|---|---|
| Reforestation of cleared land | Eligible if other scheme requirements met | Eligible if other scheme requirements met | Eligible if term of lease sufficient to meet storage time requirement and other scheme requirements met |
| Regeneration of natural vegetation | Eligible if other scheme requirements met | Ineligible | Ineligible |
| Avoided deforestation of natural vegetation | Eligible if other scheme requirements met | Ineligible | Ineligible |

Table 2. Eligibility of project types by land tenure and vegetation ownership

Following from the above, it could be that where leaseholders undertake land management which would be eligible to attract carbon credits, but where the relevant vegetation is natural vegetation and owned by the Crown, or where the term of their lease is insufficient to meet carbon market regulators requirements for guarantees of future storage, there may be a role for the State Government as a broker of credits or as a "carbon pool", with payments (of the general nature of

[16] For example under the Commonwealth Greenhouse Friendly rules carbon must be guaranteed to remain stored for at least 70 years.

stewardship payments) being made to landowners based on performance in increasing or maintaining carbon stocks over time.

It is interesting in this context that the Queensland Carbon Offsets Policy flags a clear interest of the Queensland Government in the utilisation of regrowth vegetation on both freehold and leasehold land to generate offsets (carbon credits).

## *Other relevant Qld Govt initiatives*

The Queensland Government announced two initiatives relevant to natural resource managers as part of its Climate Smart policy in 2007. These are:

**Queensland Carbon Offsets Policy**[17]
*"This policy will position Queensland to benefit from all potential offset opportunities that will be available through a proposed national emissions trading scheme. It will also ensure that Queensland industries providing or purchasing carbon offsets are appropriately prepared for any emissions trading scheme introduced. As part of this policy, the government will investigate the potential for regrowth vegetation on freehold and leasehold land to be utilised as a carbon offset."*

**Green Invest**
*"The government has developed a policy framework for the use of environmental offsets (currently excludes carbon) to compensate for any unavoidable negative environmental impacts that might result from development. The government is also establishing an offsets exchange facility called Green Invest as a mechanism to assist developers find offsets for vegetation clearing. Both tools have the potential to facilitate carbon offsetting arrangements. Consultation will occur over the next six months with agricultural, forestry and secondary industrial sectors to examine the application of this scheme to the future carbon market."*

If these initiatives and the consultations undertaken to support them are not complete, it is important that the issues examined in this report are raised with the relevant staff of the Department of Natural Resources and Mines.

## *Pathways for future action*

It is recommended that South West NRM, in the short term:

- Focus on overcoming information constraints
- Lobby to remove policy, regulatory and administrative impediments to participation by land managers in the Mulga lands in an Australian Omissions Trading Scheme
- Work towards a policy and regulatory environment for carbon trading which rewards landowners in the Mulga lands for sustainable high(er) biomass land management regimes.

[17] Climate Smart 2050 – Queensland Climate Change Strategy 2007, A low carbon future http://www.thepremier.qld.gov.au/library/pdf/climate/ClimateSmart_2050.pdf

# Research Plan

## *Forest carbon accounting research*

Two broad approaches are currently undertaken to quantification of carbon stocks in vegetation and soils in the Mulga lands. These are the use of models (such as those which account for the drivers of and constraints to plant growth across the landscape), and a measurement based approach (which relies on field sampling and the development of approaches to individual stand biomass and soil carbon estimation).

These broad approaches are entirely complementary, in that models need calibration and validation by reference to measured values, and measurement based approaches must be extrapolated appropriately to be useful in application. Both approaches are applied spatially and therefore rely on remotely sensed and other spatial information, although often at different scales.

The two approaches can also be characterised as "top down" and "bottom up" in nature. It is important that the approaches are effectively meshed. It seems apparent that where project based measurement follows protocols and standards approved at the national level as suitable to provide ground truthing or validation, it could be used to calibrate the national accounting system.

This may, however, be difficult if the national base year (1990) emissions inventory for the Land Use, Land Use Change and Forestry sector is set in stone along with the methods used to estimate it. This is a policy area which needs further research.

Some specific areas for future research are suggested as:

### Allometric equations

Allometric equations are mathematical expressions which commonly relate easily measured parameters such as tree diameter and/or tree height to other parameters which are more difficult to directly measure such as above-ground tree biomass, or total tree biomass.

There are currently no allometric relationships specifically for Mulga as a species, and biomass studies in Mulga dominated land systems commonly use allometrics developed for woodland eucalypt species by Dr. Bill Burrows, in his former capacity as a research scientist with the Queensland Department of Primary Industries. It therefore seems desirable that a project be undertaken to derive, through destructive sampling, allometric relationship specifically for Mulga. If this is undertaken, sampling should cover the various growth forms of Mulga, and also assess differences in growth and form characteristics and their impact on allometric relationships across rainfall and other environmental gradients.

Expert opinion should also be sought on the adequacy of information and allometric relationships for other major species occurring abundantly in the Mulga lands.

### Thresholding analysis and ground truthing of satellite imagery

Both the National Carbon Accounting System (NCAS) and the Statewide Land and Trees Study (SLATS) approaches to quantification of change in vegetation systems rely to a great degree on the ability to relate the spectral signatures of light

reflected off vegetation (primarily leaves) with indices such as projective foliage cover (PFC) and foliage projective cover (FPC).

Projective foliage cover (the proportion of the land surface covered by tree crowns but including gaps in the tree crowns) is also known as canopy cover or crown cover. It is not directly measurable by satellites such as Landsat as the resolution is not sufficiently fine to detect the outline of individual tree canopies. It is, however, the measure used to define forests under the Kyoto Protocol.

Foliage projective cover is the vertical projection of the branches and foliage of a tree onto the ground, and is therefore much more directly related to what satellite imagery detects. That is, the amount of sunlight intercepted and reflected by the tree canopy is more closely related to the amount of leaf coverage than to the crown cover, which includes within-canopy gaps.

Therefore foliage projective cover (FPC) is what is primarily measured by the study of reflectance from vegetation using optical satellite sensors such as Landsat, and other vegetation indices such as tree basal area (cross sectional area of tree and shrub stems per unit land area) and canopy cover are less directly inferred from FPC. Essentially there is a direct relationship between reflectance values (using appropriate combinations of bands of the spectrum) and degrees of FPC.

Robust quantification of this and other relationships such as FPC with basal area and with canopy cover will depend to a large extent on ground truthing studies, including both ground based work and the use of higher resolution sensors such as aerial photography. Derivation of robust relationships is further complicated by the spectral characteristics of other elements (especially soil) under and between tree canopies. For example, black soil may make accurate discrimination of canopy cover difficult in relation to discrimination of canopy cover over other soil types.

The SLATS program has the benefit of extensive ground truthing through the TRAPS initiative. It is recommended that the NCAS, SLATS and TRAPS methodologies and data be subject to independent peer review and/or that collaborative work be undertaken to harmonise the approaches of the two systems.

### Changed management and carbon fluxes

Studies are needed to quantify carbon fluxes and change in carbon stocks in relation to changed management of grazing pressure, fire, trees, shrubs and herbage at a range of representative sites. This information should be used to validate models such as FullCAM in order to better enable predictions to underpin carbon investment decisions.

## *Research on other carbon market factors*

It is recommended that immediate action research and consultation should be undertaken using the discussion in the present report. These discussion areas could form topics for seminars to gain the views of a range of government, industry and community stakeholders.

### Carbon rights legislation

Consultation, particularly on the issues raised in relation to the current Queensland Carbon Rights legislation, should be undertaken through the Centre of Excellence on Climate Change within the Queensland Department of Natural Resources and Mines, and the Office of the Minister.

Material on the subject in this report should also be made available to the Garnaut Review and the Commonwealth Department of Climate change, Emissions Trading Division.

## Contractual arrangements including Land and Forest Management Plans

The unambiguous ability to register an agreed land and forest management plan on a land title to secure carbon sequestration and storage outcomes seems a pre-requisite to useful Carbon Rights. Consultation as above for Carbon Rights legislation should be undertaken and in addition direct consultation with the office of the Queensland Registrar of Titles would be useful to clarify current administrative requirements.

## Transfer Duty

Current applicability of Transfer Duty to transfers of Carbon Rights (Natural Resource Products) should be ascertained from the Queensland Office of State Revenue.

## Survey Requirements

Survey requirements should be discussed with relevant stakeholders including the Registrar of Titles and the survey unit within his office, the Centre of Excellence on Climate Change, compliance and regulatory staff involved in administration of vegetation management laws, industry and the surveying profession.

# Appendix A. 'Minding the Carbon Store' case study

**Introduction**

The primary objective of the 'Minding the Carbon Store' (MTCS) project was to reduce greenhouse gas emissions by reducing the clearing of remnant native woodlands and forests in Queensland. This led to the creation of a tradable greenhouse emission offset under the Australian Government's *Greenhouse Friendly* initiative.

The project also demonstrated and promoted Avoided Deforestation as a greenhouse emission reduction project type to the global community of interest on climate change policy.

The opportunity to undertake the project arose from two government initiatives:

- The Greenhouse Friendly initiative under the Greenhouse Challenge Plus program of the Australian Greenhouse Office allows for the approval of greenhouse gas abatement projects and independent verification of greenhouse gas abatement. Greenhouse Friendly has rigorous requirements regarding additionality (abatement is "beyond business as usual"), permanence and the use of carbon accounting methodologies. It allows for banking and trade of such verified abatement.

- The Queensland Government has capped further clearing of remnant vegetation, issued permits for clearing of 500,000 hectares under the cap, and banned broadscale clearing of remnant vegetation from the end of 2006.

In the course of the project:

- Landholders with broadscale clearing permits for remnant vegetation were offered substantial financial inducement not to exercise their permits.
- Approval for the project was obtained under the Greenhouse Friendly initiative.
- Verification of the project's greenhouse emission abatement under the Greenhouse Friendly initiative.
- Abatement was secured under rigorous contractual arrangements which ensure that the land is protected from being cleared in the future.
- A carbon pooling approach with retention of a risk management buffer was used to underpin guaranteed permanent retention of credited carbon stocks.

The MTCS project was managed by The Carbon Pool Pty Ltd, an Australian company established in 2001 to deal in the emerging markets for carbon credits generated through sustainable reforestation and forest management.

***Kyoto Accounting for Deforestation***

Under Articles 3.3 and 3.7 of the Kyoto Protocol, emissions from human-induced deforestation are accounted within land units and vegetation that met the definition of forest at the end of 1989 and was or is converted from forest to non-forest after that date.

Australia's current definition of forest comprises a minimum of 20% crown cover, vegetation with a minimum potential height of 2m, and covering areas of not less than 0.2 hectares.

***Queensland Tree-Clearing Legislation***
In 2003, the Queensland Government announced its intention to pass, and subsequently passed, legislation (the *Vegetation Management and Other Legislation Amendment Act 2004*) to end broadscale clearing of remnant vegetation from the end of 2006. A cap on all permits for broadscale clearing of remnant vegetation of 500,000 hectares was also imposed. All permits issued under this cap expired on or before midnight on 31st December 2006, after which broadscale clearing of remnant vegetation in Queensland became illegal.

***Carbon Rights Legislation in Queensland***
Following amendments to the *Forestry Act 1959* through the *Forestry and Land Title Amendment Act 2001*, owners of freehold land may agree to the registration of the interest of another party to carbon already stored in remnant vegetation as a *Natural Resource Product* of their land. This gives the purchasing party a property right to the stored carbon in the form of a *profit a prendre*. A Natural Resource Product may include carbon already stored in a tree or vegetation as well as the process of carbon sequestration by trees or vegetation.

***The Greenhouse Friendly Initiative***
The Greenhouse Friendly Initiative is part of the Greenhouse Challenge Plus program of the Australian Greenhouse Office. Greenhouse Challenge Plus supports voluntary action by Australian companies to reduce greenhouse emissions. Members of Greenhouse Challenge Plus include most large Australian industrial and commercial companies, including many energy and emission intensive enterprises.

Members of Greenhouse Challenge Plus commit to measuring, managing and minimising their greenhouse gas emissions. The Greenhouse Friendly initiative offers them the opportunity of buying (and selling) verified emission offsets, as one of a range of emission reduction opportunities.

Greenhouse Friendly has detailed rules and guidelines requiring scientifically rigorous accounting for greenhouse gas abatement, and independent expert verification of the processes and methodologies used. Once verified, abatement can be traded between companies, acquitted against Greenhouse Challenge inventories, or “banked” for later use under the program.

***Estimation of Eligible Carbon Stocks and Emissions Profiles.***
Carbon stocks were estimated through on-ground field sampling within the area of Kyoto-eligible vegetation for each (protected) permit area and for the pooled permit areas. Measurements, usually of tree basal area, were analysed to provide estimates of carbon stored in the vegetation to a known level of certainty. Trading was underpinned by a high level of statistical certainty that there is more carbon stored than is traded.

Modelling of the emissions which would have resulted from clearing used the National Carbon Accounting System Project Toolbox. At a late stage in the project the National Carbon Accounting System undertook its own calculation of the carbon stocks in the permit areas, and these figures were used in the final carbon accounts for the project. This ensured full consistency with Australia’s system for estimating emissions and sequestration resulting from Land Use Change and Forestry activities in our National Greenhouse Gas Inventory.

***The Project Information System***
The Carbon Pool Pty Ltd implemented and will maintain and update a secure and comprehensive geographic information system regarding land and vegetation involved in the project to support assessment of eligibility, estimation of carbon stocks and to enable ongoing monitoring.

Monitoring over time will be based on interpretation of remotely sensed imagery such as Landsat data. This monitoring and annual reporting are also subject to Independent Verification.

***Eligibility Criteria***

The eligibility criteria used by The Carbon Pool were as follows:

*Land areas must include vegetation eligible as forest under Kyoto definitions*

- The vegetation can be demonstrated to have had minimum 20% canopy cover at the end of 1989
- The vegetation must have a potential height of at least two metres
- Vegetation must be in patches greater than 0.2 hectare in area, and (for reasons of detectability) a minimum width of 10 metres.

*Landowners must be willing and able to transfer the "carbon rights" to natural vegetation on their land*

- Land must be freehold (and may possibly include perpetual leasehold land as discussed earlier)
- Landowner must be willing to execute a carbon rights contract. This "runs with the land" binding subsequent owners for a term of 120 years and includes requirements to not clear the vegetation or intentionally reduce carbon stocks, transfer of the carbon rights, agreed land and vegetation management, and agreements about rights and obligations
- All proprietors of relevant registered interests in the land, including mortgage providers must give their consent in writing.

*Landowner is able to provide evidence of actual intent to clear*

Evidence of intent to clear may include one or more items demonstrating -

- Effort and expenditure to secure the clearing permit
- Financial analysis supporting the decision to clear
- Past history of action on clearing permits held
- Communications and/or quotes from clearing contractors
- Financial preparations made for clearing activity which may include communications to and/or from financial institutions, bank finance details or changes to loan/overdraft arrangements, etc
- Other preparations made for clearing activity including part or full payments to relevant equipment and/or service providers (e.g. equipment purchase or repair, bookings with clearing contractors etc)
- Documented decision-making process e.g. company board minutes.

***Securing the Carbon***
A Carbon Pooling Deed between The Carbon Pool Pty Ltd and the landholders provided the basis for a confident expectation of the protected carbon being sustainably stored.

In order to ensure that the abatement is additional and permanent, parties to the deed agreed that:

- The land subject to the Deed will not be cleared for at least 120 years from the time the Deed is signed.
- The tree-clearing permit upon which the agreement is based will not be relinquished until expiry.
- The land will be regenerated following any intentional or unintentional reduction in carbon stocks (e.g.wildfire).
- The land will be managed sustainably, while allowing for ongoing pastoral production.

***Carbon pooling***
Carbon Rights were purchased and will be managed by The Carbon Pool Pty Ltd. The Carbon Pool Pty Ltd is a private company established to aggregate Carbon Rights and deal in ”carbon credits” under both mandatory and voluntary emissions trading arrangements. Aggregation (pooling) spreads risk across the landscape through the geographical dispersion of properties and the presence of diverse vegetation types.

In addition a buffer of 20% of verified abatement was reserved to manage the risk of losses from, for example, fire, pests, drought and climate change impacts across the pool over the next 120 years.

***Sustainable Forest and Land Management***
It was considered important that landholders retain the capacity for long-term financial returns from the land so there is an incentive for ongoing management. It was anticipated that grazing will be the primary ongoing economic use for land protected from clearing through the project. Sustainable grazing and sustainable land management practices (eg controlled burns) will reduce fuel loads, lowering the risk of intense wildfires that may cause both a long-term decrease in carbon stocks and potential risk to life and property.

Ongoing pastoral production will also provide financial resources to undertake other desirable management works (e.g. weed, feral animal and erosion control) agreed by the landholder. Arrangements to ensure sustainable forest and land management form part of the legal agreement over each protected area for 120 years.

# Appendix B. Overseas carbon trading schemes

## *European Union Emissions Trading Scheme (EU ETS)*

The **European Union Emission Trading Scheme** (EU ETS) is the largest multi-national, greenhouse gas emissions trading scheme in the world. Large emitters of carbon dioxide within the EU must monitor and annually report their CO2 emissions, and they are obliged every year to surrender emission allowances (EUAs) to their national government that is equivalent to their CO2 emissions in that year.

EU Member States agree national emission caps, allocate allowances to their emitters, track and validate the actual emissions against the relevant assigned amount, and require the allowances to be retired after the end of each year.

Installations may get the allowances for free from the government, or may purchase them from others (installations, traders, government). If an installation has received more allowances than it needs, it may sell them.

Operators within the ETS can trade their allowances by selling privately, over the counter, using a broker or trading on the spot market of one of Europe's climate exchanges.

The EU ETS is linked to the markets established under the Kyoto Protocol, and allows participants to use carbon credits in the form of Certified Emission Reductions (CERs) or Emission Reduction Units (ERUs) to comply with its obligations.

EU governments must make sure that the total amount of allowances issued to installations is less than the amount that would have been emitted under a business-as-usual scenario. The total quantity to be allocated by each Member State is defined in the Member State National Allocation Plan (NAP) (equivalent to its Kyoto carbon account.)

The scheme, in which all 15 member states participated, commenced operation on 1 January 2005. The EU ETS second phase (2008-12) expanded the scope significantly. All greenhouse gases, and not only $CO_2$ are included, Clean Development Mechanism and Joint Implementation credits are eligible credits and Aviation emissions are expected to be included from 2010. The Commission wishes the post-2012 ETS to include all greenhouse gases and all sectors, including aviation, maritime transport and forestry.

Currently, the EU does not allow $CO_2$ credits from forest projects (e.g. reducing $CO_2$ by planting trees). While some governments and industry representatives lobby for their inclusion, this is opposed by some environmental NGOs as well as the EU commission itself. They argue that forest based activities have too many scientific uncertainties over their permanence and make an inferior long-term contribution to climate change compared to reducing emissions from industrial sources.

## *California Climate Action Registry (CCAR)*

The California Climate Action Registry was established by statute as a non-profit voluntary registry for greenhouse gas emissions. The purpose of the Registry is to help companies and organisations with operations in California to establish

emissions baselines against which any future GHG emission reduction requirements may be applied.

The Registry encourages voluntary actions to increase energy efficiency and decrease GHG emissions. Using any year from 1990 forward as a base year, participants can record their GHG emissions inventory. The State of California, in turn, will offer its best efforts to ensure that participants receive appropriate consideration for early actions in the event of any future state, federal or international GHG regulatory scheme.

The Registry has developed a General Protocol and additional industry-specific protocols which give guidance on how to inventory GHG emissions for participation in the Registry. These protocols include what to measure, how to measure, the back-up data required, and certification requirements.

Participants agree to register their GHG emissions for all operations in California, and are encouraged to report nationwide. Both gross emissions and efficiency metrics are recorded. The Registry requires the inclusion of all direct GHG emissions, along with indirect GHG emissions from electricity use.

The Registry requires the reporting of only CO2 emissions for the first three years of participation, although participants are encouraged to report the remaining five GHGs covered in the Kyoto protocol (CH4, N2O, HFCs, PFCs, and SF6). The reporting of all six gases is required after three years of Registry participation.

The Registry:

- Enables the voluntary recording of greenhouse gas emissions
- Enable independent verification of reported and actual emissions
- Maintains records of all certified emissions baselines and reports
- Uses industry-specific reporting metrics
- Encourages voluntary actions to increase energy efficiency and reduce emissions
- Provide participants with referrals to approved service providers
- Recognises, publicises, and promotes participants
- Recruits broad participation
- Report to the Governor and Legislature

CCAR allows for the recognition of emission reductions from forestry projects including both reforestation and improved forest management, but these are believed to be currently limited in geographical scope to California.

## *Regional Greenhouse Gas Initiative (RGGI)*

The Regional Greenhouse Gas Initiative (RGGI) is a cooperative effort by ten Northeast and Mid-Atlantic states in the U.S. to design a regional cap-and-trade program initially covering carbon dioxide emissions from power plants in the region. In the future, RGGI may be extended to include other sources of greenhouse gas emissions, and greenhouse gases other than CO2.

A parallel effort to reduce emissions in the Northeast is the New England Governors/Eastern Canadian Premiers Climate Change Action Plan, which calls for a reduction in greenhouse gas emissions to 10% below 1990 levels by 2020. In addition, the Northeast States for Coordinated Air Use Management (NESCAUM) is

building a Regional Greenhouse Gas Registry (RGGR) to help track emissions in the region. This effort is similar to that of the California Climate Action Registry.

## *Chicago Climate Exchange (CCX)*

The Chicago Climate Exchange (CCX), launched in 2003, is a voluntary but legally binding carbon trading system to reduce emissions of all six major greenhouse gases.

CCX Members make a voluntary but legally binding commitment to meet annual GHG emission reduction targets. Those who reduce below the targets have surplus allowances to sell or bank while those who emit above the targets comply by purchasing CCX Carbon Financial Instrument® (CFI™) contracts.

**CFI Contracts, the CCX Tradable Commodity**
Each CFI contract represents 100 metric tons $CO_2e$. CFI contracts can be either Exchange Allowances or Exchange Offsets. Exchange Allowances are issued to emitting Members in accordance with their emission baseline and the CCX Emission Reduction Schedule. Exchange Offsets are generated by qualifying offset projects.

**Agricultural Soil Carbon Offsets**
CCX has developed standards and rules for issuing Carbon Financial Instrument® (CFI™) contracts for soil carbon sequestration activities in the agricultural sector. Eligible agricultural soil carbon sequestration projects include continuous conservation tillage and grass planting.

**Basic Specifications:**
Conservation tillage: Minimum five year contractual commitment (2006-2010) to continuous no-till, strip till or ridge till on enrolled acres.
Grass planting: projects initiated on or after January 1, 1999 in CCX eligible counties may qualify.
Soil carbon sequestration projects must be enrolled through a CCX-registered Offset Aggregator.
All projects must be independently verified by a CCX-approved verifier.
CCX Carbon Financial Instrument® (CFI™) contracts are issued at a standardised rate of $CO_2$ per acre per year to land managers who commit to continuous conservation tillage and/or maintenance grass cover plantings.

**Forestry Carbon Emission Offsets**
CCX has developed simple, standardised rules for issuing Carbon Financial Instrument® (CFI™) contracts for forest carbon sequestration. Eligible projects include forestation and forest enrichment, urban tree planting, and, in specified regions, combined forestation and forest conservation projects.
**Basic Specifications:**
Forestation and forest enrichment projects initiated on or after January 1, 1990 on unforested or degraded forest land may qualify.
Qualifying projects may earn offsets during the years 2003-2010.
For specified locations, forest conservation projects may be eligible if they are undertaken in conjunction with forestation on a contiguous site.
Demonstration that entity-wide forest holdings are sustainably managed.
Demonstration of long-term commitment to maintain carbon stocks in forestry.
Use of approved methods to quantify carbon stocks.
Where required, carbon stocks must be independently verified by a CCX-approved verifier.

CFI contracts are issued to forest enrichment projects on unforested or degraded forest land (including urban tree planting) at a rate based on the annual increase in the carbon stocks of above-ground, living biomass. Forest conservation credits for combined conservation and forestation projects on contiguous sites are credited on the basis of avoided deforestation rates specified for eligible geographic regions. Quantification methods for forest carbon stocks vary by project size.

# Appendix C. Mulga Lands climate-related paper abstracts and links

### Global change and the mulga woodlands of southwest Queensland: greenhouse gas emissions, impacts, and adaptation

Howden, S.M., Moore, J.L., McKeon, G.M., Carter, J.O.

The possibility of trading greenhouse gas emission permits as a result of the Kyoto Protocol has spurred interest in developing land-based sinks for greenhouse gases. Extensive grazing lands that have the potential to develop substantial woody biomass are one obvious candidate for such activities. However, such activities need to consider the possible impacts on existing grazing and the possible impacts of continuing CO2 build up in the atmosphere and resultant climate change. We used simulation models to investigate these issues in the mulga (Acacia aneura) woodlands of southwest Queensland. The simulation results suggest that this system can be managed to act as either a net source or a net sink of greenhouse gases under current climate and CO2 and under a range of global change scenarios. The key component in determining source or sink status is the management of the woody mulga. The most effective means of permanently increasing carbon stores and hence reducing net emissions is to exclude both burning and grazing. There are combinations of management regimes, such as excluding fire with light grazing, which, on average, allows productive grazing but transient carbon storage. The effects of increased CO2 on ecosystem carbon stores were unexpected. Carbon stores increased (7-17%) with doubling of CO2 only in those simulations where burning did not occur, but decreased when burnt. This occurred because the substantial increases in grass growth with doubling of CO2 (34-56%) enabled more fires, killing off the establishing cohorts needed to ensure continued carbon accumulation. On average, the doubling of atmospheric CO2 concentration increased grass growth by 44%, which is identical with mean literature values, suggesting that this result may be applicable in other ecosystems where fire has a similar function. A sensitivity analysis of the CO2 response of mulga showed only minor impacts. We discuss additional uncertainties and shortcomings.

*Environment International*, 27, 161–166

### The dynamics of grazed woodlands in southwest Queensland, Australia and their effect on greenhouse gas emissions

J.L. Moore, S.M. Howden, G.M. McKeon, J.O. Carter, J.C. Scanlan

**Abstract**
This study outlines the development of an approach to evaluate the sources, sinks, and magnitudes of greenhouse gas emissions from a grazed semiarid rangeland dominated by mulga (Acacia aneura) and how these emissions may be altered by changes in management. This paper describes the modification of an existing pasture production model (GRASP) to include a gas emission component and a dynamic tree growth and population model. An exploratory study was completed to investigate the likely impact of changes in burning practices and stock management on emissions. This study indicates that there is a fundamental conflict between maintaining agricultural productivity and reducing greenhouse gas emissions on a given unit of land. Greater agricultural productivity is allied with

the system being an emissions source while production declines and the system becomes a net emissions sink as mulga density increases. Effective management for sheep production results in the system acting as a net source (_60–200 kg CO2 equivalents/ha/year). The magnitude of the source depends on the management strategies used to maintain the productivity of the system and is largely determined by starting density and average density of the mulga over the simulation period. Prior to European settlement, it is believed that the Mulga lands were burnt almost annually. Simulations indicate that such a management approach results in the system acting as a small net sink with an average net absorption of greenhouse gases of 14 kg CO2 equivalents/ha/year through minimal growth of mulga stands. In contrast, the suppression of fire and the introduction of grazing results in thickening of mulga stands and the system can act as a significant net sink absorbing an average of 1000 kg CO2 equivalents/ha/year. Although dense mulga will render the land largely useless for grazing, land in this region is relatively inexpensive and could possibly be developed as a cost-effective carbon offset for greenhouse gas emissions elsewhere. These results also provide support for the hypothesis that changes in land management, and particularly, suppression of fire is chiefly responsible for the observed increases in mulga density over the past century.

**Climate Change in Queensland's Grazing Lands. I. Approaches and Climatic Trends.**

*GM Mckeon, WB Hall, SJ Crimp, SM Howden, RC Stone and DA Jones*

**Abstract**
Climate change is an important global issue but is yet to be recognised as such by many rangelands users. This paper reviews some of the uncertainties relating to pre-instrumental and future climate change and documents current trends and fluctuations in climate of Queensland's grazing lands. Analysis of daily climate surfaces for Queensland's pastoral/cropping zone shows high variability in annual rainfall which is influenced by the El Nino-Southern Oscillation (ENSO) phenomenon. This relationship, when examined using moving windows, has changed during this century with the 1930-40s being a period of low correlation. Minimum temperatures taken from the climate surfaces also changed, showing a significant ($P<0.01$) increase over time especially in May. Over the 40 years since 1957, annual minimum temperatures have increased by l.0°C for the pastoral/cropping zone and coastal sub-zone, winter minimum temperatures by 1.2°C for the pastoral/cropping zone (1.3°C for the coastal sub-zone), summer minimum temperatures by 0.7°C for the pastoral/cropping zone and coastal sub-zone, and May minimum temperatures by 2.8°C for the pastoral/cropping zone (3.0°C for the coastal sub-zone). Consistent significant trends in vapour pressure (increasing, $P<0.001$) and solar radiation (decreasing, $P<0.05$) also occurred in May. The mechanisms for the identified climate trends and unusual behaviour of ENS0 are the subject of speculation with attribution of causes to natural variability or the enhanced greenhouse effect being unresolved. Continued monitoring of these trends and fluctuations will be important for the future management of Queensland's grazing lands with this analysis highlighting the need for discrimination of trends from natural variability. In terms of grazing management and degradation processes, this work also highlights that general changes in climate averages may disguise important variation at yearly and decadal time scales.

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**Herbage Production Following Rainfall Redistribution in a Semi-Arid Mulga (Acacia Aneura) Woodland in Western New South Wales.**

*JC Noble, RSB Greene and WJ Muller*

**Abstract**
The effects of stocking rate (nominally ranging from 0.3 up to 0.8 dry sheep equivalents per ha) on rainfall redistribution, soil-water storage and herbage production were studied in three contiguous geomorphic zones (run-off, interception and run-on zones) in a semi-arid mulga (Acacia aneura) woodland in western New South Wales. The amount of rainfall redistribution increased directly with rainfall but there was no significant effect of stocking rate on the amount of soil-water stored in various zones. while soil-water storage differed little between zones following a minor rainfall event (11.9 mm), it was significantly higher ($P < 0.001$) in the run-on zone following a major rainfall event (42.7 mm). The interception zone was by far the most productive herbage zone contributing a significantly ($P < 0.01$) disproportionate amount of forage (c. 90% of total paddock production at low stocking rates) despite this zone only occupying a relatively small proportion (c. 12%) of landscape catenae. Herbage in the interception zone principally comprised palatable C3 perennial grasses such as Thyridolepis mitchelliana (mulga grass) and Monachather paradoxa (bandicoot grass). Experimental manipulation confirmed the fundamental importance of rainfall redistribution as a landscape process mediating herbage production in these semi-arid plant communities. Dry matter production by Eragrostis eriopoda (woollybutt) was significantly enhanced ($P < 0.05$) in the run-off zone when incident rainfall was retained in situ by metal barriers. Conversely, production by Thyridolepis mitchelliana in the lower interception zone was significantly depressed ($P < 0.01$) where similar barriers prevented access by overland flow. The results are discussed in the context of developing conservative management strategies designed to maintain effective landscape processes in these extensive ecosystems.

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**Kirschbaum, M.U.F., Harms, B., Mathers, N.J., Dalal, R.C. (2007). Soil carbon and nitrogen changes after clearing mulga (*Acacia aneura*) vegetation in Queensland, Australia. Observations, simulations and scenario analysis. *Soil Biology and Biochemistry* (Submitted)**.

**Abstract.**

In the work reported here we examine the changes in soil carbon and nitrogen that are observed after converting a stand of nitrogen-fixing mulga trees (*Acacia aneura*) to buffel grass (*Cenchrus ciliaris*) pasture that contained no nitrogen-fixing legumes. A range of previously reported field measurements were compared against the output of CenW 3.1, a reformulated version of the CENTURY model.

The model successfully reproduced the observed patterns of soil carbon, C:N ratios and nitrogen mineralisation rates under mulga vegetation. This included relatively small changes in carbon concentration down to 1 metre, fairly low C:N ratios of around 11-13 across all soil depths, substantial nitrogen mineralisation rates to a depth of 90 cm and, after clearing, an on-going decrease in soil organic carbon and nitrogen stocks.

Interpretation of experimental observations was made difficult by the addition of a large amount of 'dead' organic matter from killed mulga roots after clearance. This material may be excluded through sieving (to 2 mm) in measurements taken shortly after tree removal, but may be included in later-year sampling as the partly decomposed material might be able to pass through sieves. For the site carbon budget, changes in live biomass and surface litter significantly outweighed the small changes in soil organic carbon, and changes in decaying coarse roots were quantitatively more important than changes in other organic carbon pools.

Modelled nitrogen mineralisation rates were lower under buffel grass than those under mulga and showed significant year-to-year variations that were in line with varying rainfall, but displayed no consistent trend over time after clearing. This relative constancy was caused by compensating effects of slightly reduced nitrogen stocks, on the one hand, but increasing organic-matter quality on the other as the initial organic matter originating from lignin-rich mulga litter was gradually replaced by buffel-grass derived material with lower lignin concentration. A scenario analysis showed that soil carbon and nitrogen trends could be affected by changing the nitrogen budget through inclusion of legumes or cessation of nutrient removal by grazing animals. The inclusion of legumes was needed to halt the decline in soil nitrogen and to ensure the long-term maintenance, or increase, in nitrogen stocks.

Keywords: CenW; deforestation; mulga; land-use change; model; soil carbon; soil nitrogen.

**Range Assess modelling framework – Mulga Lands case study**

http://svc237.bne113v.server-web.com/crc/ecarbon/publications/range/range_assess_ch6-7-8.pdf

**Study of Fodder Harvesting in Mulga Regional Ecosystems**

http://www.nrsm.uq.edu.au/crisis/docs/StudyOfFodderHarvesting.pdf