

Capturing carbon in the rural landscape: Opportunities for Queensland



A Premier's Council on Climate Change report

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Premier's Council on Climate Change

The Premier's Council on Climate Change first met in March 2008 to provide the Queensland Government with high-level strategic advice on climate change issues and actions.

The Council is chaired by the Premier of Queensland, the Hon Anna Bligh MP, with the Minister for Climate Change and Sustainability, the Hon Kate Jones MP, acting as Deputy Chair.

The Council's membership comprises eminent persons drawn from a range of sectors relevant to climate change.

The Council provides advice to the Queensland Government on a long term climate change strategy for Queensland that:

- is informed by the best available knowledge about measures that Queenslanders can take, collectively and individually, to address climate change
- provides practical solutions to the problems that climate change poses for Queensland communities, industries and the environment
- maintains and enhances, where possible, Queensland's economic competitiveness
- generates new growth opportunities through innovation.

The work program of the Premier's Council on Climate Change is facilitated by a number of working groups comprised of Council members.

Working papers are prepared at the request of Council for the purpose of providing the Queensland Government with advice on specific climate change policy topics.

This paper was sponsored by Peter Cosier and Peter Kenny of the Science and Technology Working Group and was prepared with the assistance of staff from the Office of Climate Change.

The views expressed in this paper are those of the Council and do not represent Queensland Government policy.

Executive summary

Rural land use is of particular significance to Queensland's climate change response. Over 80 per cent of the state's land area is used by primary industries, generating a total production value of \$13 billion. Importantly, approximately 40 per cent of the state's greenhouse gas emissions come from the primary industries sector.

The 2008 Garnaut Climate Change Review identified the significant potential for changed rural land use to reduce Australia's emissions.

Modelling undertaken by the Australian Bureau of Agricultural and Resource Economics shows that agriculture will face higher input costs under the proposed national Carbon Pollution Reduction Scheme (CPRS)¹ but also highlights the potential new income streams available to rural landholders from emerging carbon markets².

In October 2008, the Premier's Council on Climate Change resolved to consider the potential of rural land use in Queensland to capture emissions, with a view to providing the Queensland Government with advice on policy and investment priorities.

To inform Council considerations, CSIRO was commissioned to provide an expert assessment of the quantity of carbon which can be saved through various rural land use options, their technological maturity and the other benefits that they might deliver for Queensland.

In their groundbreaking report, *An Analysis of Greenhouse Gas Mitigation and Carbon Biosequestration Opportunities from Rural Land Use*, CSIRO show that rural land use in Queensland has the technical potential to capture a substantial proportion of the state's greenhouse gas emissions.

Carbon Capture Potential

CSIRO estimated that emissions savings of 140Mt CO₂-e/year could be attained from changed rural land use over the next 40 to 50 years. Given that Queensland's total emissions in 2007 were 181.6Mt CO₂-e, this is equivalent to almost 80 per cent of the state's annual emissions.

It should be noted that this CSIRO estimate is based on an assumption of a concerted effort to: overcome remaining technical, measurement and policy barriers; manage competing land use issues; and, encourage shifts in land management practices.

Most of the abatement opportunity lies in increased forestry activity such as carbon forestry, the management of regrowth vegetation and biodiversity plantings. Forestry activity has the potential to capture 105Mt CO₂-e/year of carbon, equivalent to almost 60 per cent of Queensland's emissions.

Forestry activity can provide significant sequestration benefits over the next 40 to 50 years, after which the carbon capture benefits will reduce as saturation points are reached.

Other land use changes can deliver ongoing reductions in emissions providing remaining technical and measurement barriers can be overcome.

Changed agricultural processes have a combined potential to achieve carbon savings of 26Mt CO₂-e/year, equivalent to approximately 14 per cent of the state's emissions. These processes (which include the rehabilitation of grazing lands, livestock emissions reduction, managed burning of savanna grasslands and building soil carbon in cropland) have the clear benefit of not displacing current land use activity.

The production of feedstock for biofuels and biochar has the potential to provide a reduction in greenhouse gases of approximately 9Mt CO₂-e/year, or approximately five per cent of Queensland's annual emissions, once remaining obstacles to commercialisation of second generation (non-food) feedstocks are resolved. These options can be produced from a wide range of feedstocks and therefore complement many of the other land use options considered in the report.

Readiness

The opportunities that are 'most ready' to implement include carbon forestry, regrowth vegetation, timber plantations and managed savanna grassland burning.

Much of the forestry related activity, which accounts for 75 per cent of the biosequestration potential in Queensland, will be eligible for carbon credits under the proposed CPRS legislation.

Other processes, such as building soil carbon in cropland and rangeland management, are currently ineligible. While their potential for biosequestration might not be as great as forestry related activities, the opportunity to contribute to other economic and landscape health outcomes warrants further investigation.

Making the most of this potential

Many of these options require new research investment before they could be integrated in carbon market frameworks. For example, the option of rehabilitating grazing lands will require substantial investment in data gathering and the development of accurate methods to measure and monitor carbon stocks.

Other options such as biodiversity plantings, second and third generation biofuels and reduced logging in eucalypt forests also require further investment to ensure measurement or technical feasibility.

The potential scale of terrestrial carbon described in the CSIRO report, both to Queensland and Australia more broadly, also demands a greater understanding of the co-benefits and risks that might flow from broad scale land use change from the new carbon economy. There is a need for further assessment of the effects on food and fibre production, on-farm incomes, regional economic development, water flow and quality, and biodiversity.

If not well managed, broad scale land use change could lead to adverse effects on these environmental and social assets.

However, with foresight and planning, a price on carbon stored in the landscape can become a critical tool in the fight against climate change. It can also provide a catalyst for breathing new life into the restoration of our rural landscapes and provide a new source of income for Queensland farmers.

While not replacing the need for strong action to reduce emissions across all sectors, the CSIRO report demonstrates that rural land use has a vital role to play in an overall carbon pollution reduction strategy over the next few decades while other emission reduction technologies come on line.

Queensland has the opportunity to make a significant contribution to Australia's efforts to help stabilise the world's climate system through rural land use change.

A further working paper on these current and emerging policy challenges will be considered at the next meeting of the Premier's Council on Climate Change. The paper will identify the research and policy development priorities to optimise environmental and economic benefits for Queensland rural land use from carbon markets.

Introduction

Purpose of this paper

The Premier's Council on Climate Change observed that the 2008 Garnaut Climate Change Review had identified the potential to significantly reduce Australia's emissions profile through changed rural land use³.

The Council noted that this potential may be of particular significance to Queensland's climate change response. It requested work to analyse the Garnaut findings against the latest science and the features of Queensland's terrestrial landscape.

The Council requested this information with a view to providing advice to the Queensland Government on policy development and investment priorities to increase carbon savings through rural land use.

To this end, CSIRO was commissioned to undertake a contemporary scientific assessment of the carbon capture potential from rural land use nationally and in Queensland. This interim working paper provides a summary of the findings of the resulting CSIRO report, *An Analysis of Greenhouse Gas Mitigation and Carbon Biosequestration Opportunities from Rural Land Use*.

This interim paper also includes contextual information on Queensland's rural sector and information about how rural land use processes are currently treated under the Kyoto Protocol rules and under the proposed national Carbon Pollution Reduction Scheme (CPRS). The implications of CSIRO findings for future policy development will be more fully considered in a final working paper.

Carbon in the rural landscape

The way in which rural land is managed can have a significant impact on the concentration of greenhouse gases in the earth's atmosphere.

The extent and type of forest and vegetation cover, the degree to which soil is tilled or otherwise disturbed, stocking rates and the feed that is provided to ruminant livestock can all affect greenhouse gas levels. Rural land also supports crops, such as sugar cane, that can be converted into bio-fuels to replace emissions-intensive fossil fuels.

The removal of carbon dioxide from the atmosphere by plants and its storage in vegetation and soils is referred to as biosequestration. As plants grow, they absorb carbon dioxide from the atmosphere and convert it into carbohydrates, some of which are stored in the plants themselves and in soil. Once plants are fully-grown, their carbon storage capacity is saturated and little further absorption occurs. When plants die the decaying plant material releases carbon back into the atmosphere.

Since the industrial revolution, approximately a third of human induced carbon dioxide emissions have resulted from land use change. This includes the clearing of forests for cropping and grazing, conversion of grasslands to croplands and the loss of soil carbon from continual tillage⁴. Methane and nitrous oxide are also greenhouse gases and increased emissions come primarily from livestock and fertilizers used in cropping.

Natural disturbances, such as drought, fire or cyclones can cause damage to vegetation and soils and also result in greenhouse gas emissions.

Reasons to focus on rural land use

There are a number of compelling reasons to more closely investigate the role which rural land use can play in Queensland's climate change response.

Identifying untapped opportunity

In his landmark review of climate change, Professor Ross Garnaut identified that the rural sector in Australia could play a significant role in reducing emissions and sequestering greenhouse gases. He suggested that the creation of carbon markets could drive an "alternative future" for the rural sector and radically reduce the cost of climate change mitigation in Australia.⁵

Garnaut suggested a vision in which carbon markets provide incentives for rural landholders to sequester carbon in soil and vegetation, and to pursue other opportunities for reducing emissions, such as the production of biofuels and the effective management of fire regimes. In this vision, the realisation of biosequestration opportunities could "favourably transform the economic prospects of large parts of remote rural Australia"⁶.

Garnaut noted that this potential to sequester carbon through changed land use would bring a range of additional consequences, some likely to have positive outcomes (habitat restoration and new income streams), while others may be negative (competition for land and water for food production).

Since the release of the Garnaut Climate Change Review there has been considerable stakeholder commentary about the potential to change rural land use in Australia to capture large quantities of carbon⁷.

The introduction of the Carbon Pollution Reduction Scheme from 2011 will deliver additional income stream options for some landholders. Landholders will be able to apply to become accredited forest entities and receive saleable permits for carbon sequestered in forests that meet Kyoto Protocol requirements. Voluntary carbon markets also present opportunities for reforestation and other carbon capture or reduction activities to attract income.

Queensland may be particularly well placed to exploit these carbon market opportunities. The agricultural and forestry sectors comprise a significant proportion of the Queensland economy⁸ and the state has an enormous land area (144 million hectares) which is under agricultural activity⁹.

Vast tracts of rural land are under state ownership and are leased for grazing or cultivation purposes¹⁰. There is evidence to suggest that a significant proportion of rangelands used for grazing may be in a degraded condition, presenting opportunities to enhance carbon storage¹¹.

Queensland may have much to gain from broad inclusion of the rural land use sector in national and international carbon trading frameworks, and from adopting a range of incentives and regulations aimed at promoting biosequestration in the rural landscape.

Addressing knowledge gaps

The Garnaut Climate Change Review estimated a potential for sizeable gains in greenhouse gas emissions reduction and removal across a range of land use processes. However, Garnaut cautioned that the estimations were "... calculated in the context of uncertainty and will in many cases not be easy to realise without substantial investments in proving and developing systems"¹².

There are significant challenges in carbon measurement associated with rural land use change. Some of the measurement that has been done to date is of limited relevance to Queensland because it was carried out for northern hemisphere conditions where there are significantly different vegetation and soil types and climate variability¹³.

The potential for carbon storage varies across different ecosystems, climatic conditions and soil types. Carbon in vegetation and soil fluctuates over time, due to long term weather patterns such as droughts. The further drying that is anticipated as a result of climate change will further affect carbon storage capacity.

All of these factors can make it challenging to get an accurate picture of the carbon sequestration potential from different land use changes. Investment in further research is needed to resolve these measurements and accounting difficulties.

In addition to biophysical constraints, there is a need to better understand the social and environmental co-benefits and costs that might flow from broad scale land use change. These will vary across locations.

Environmental costs may include the loss of biodiversity and water flow from large-scale carbon forestry activity. Social costs may include the loss of agricultural production (particularly from Queensland's limited arable cropland); changes to local employment patterns and land ownership; and forgone opportunities for future alternative land uses.

Benefits may include, for example, ecosystem recovery and improved water quality from biodiversity plantings, improved agricultural productivity from rangelands management, or new business opportunities for remote Indigenous communities from managed savanna grassland burns.

The CSIRO report makes a significant contribution to the further investigation of these remaining knowledge gaps and uncertainties, and provides guidance on future research priorities.

Realising key policy opportunities

The carbon accounting frameworks to be negotiated in the next commitment period of the Kyoto Protocol will shape Queensland's contribution to the global mitigation effort and greatly influence the rural sector's ability to take advantage of carbon markets.

The current Kyoto commitment period is 2008-12. Information about the treatment of each of the land use processes under the current Kyoto rules can be found at Appendix 2.

A new international framework needs to be ratified by 2012. The negotiation of the next commitment period is currently underway, with major rounds of negotiations throughout 2009.

These negotiations will culminate in the United Nations Climate Change Conference in Copenhagen in December 2009.

The Australian Government has indicated its intention to introduce a domestic emissions trading scheme, the Carbon Pollution Reduction Scheme (CPRS), by 2011 as its central policy mechanism for achieving national emissions reduction targets. While much of the architecture of the scheme has been developed, there are opportunities to influence the details, including the regulations, which are to be finalised in late 2009.

The Australian Government has indicated that only those carbon sources and sinks that are counted under Australia's Kyoto Protocol national account will be included in the CPRS¹⁴. This highlights the importance to Queensland's interest of the national positions adopted at international negotiations.

The possibility of future coverage of the agricultural sector under the CPRS from 2015 also creates an imperative to better understand the relative efficacy of various land use changes in reducing emissions.

The currency of these policy developments makes the CSIRO's review of the Garnaut estimates a timely exercise.

Features of Queensland's rural land use sector

Value and size of the sector

Rural industries are a significant component of Queensland's economy. In 2006–07, primary industries contributed around six per cent of the Queensland economy¹⁵. The total value of commodities from primary industries (including first order processing) is forecast to be worth more than \$13 billion in 2008–09¹⁶. Queensland's major primary industries are beef, sugar, lifestyle horticulture, fruit and nuts, cereal grain, vegetables, poultry, fisheries and forestry¹⁷.

The vast majority (83 per cent) of the state's land area is under agricultural activity. This land is primarily used for livestock grazing, with less than two per cent of agricultural land being utilised for cropping¹⁸. While there has been some increase over the last decade in the area of land planted for timber production, particularly for hardwood timber, the plantation area remains a small proportion (0.2%) of the state's farmland area¹⁹.

State rural leasehold land covers approximately 115 million hectares, or 63 per cent, of Queensland, mostly in the north and west of the state²⁰. Indigenous land holdings account for between three and five per cent of Queensland's land area²¹.

There are considerable variations in the terrestrial landscape across Queensland, reflecting differences in rainfall and other climatic conditions, soil types and native vegetation. There are also variations in market opportunities influenced by competing land use pressures, proximity to markets and the like.

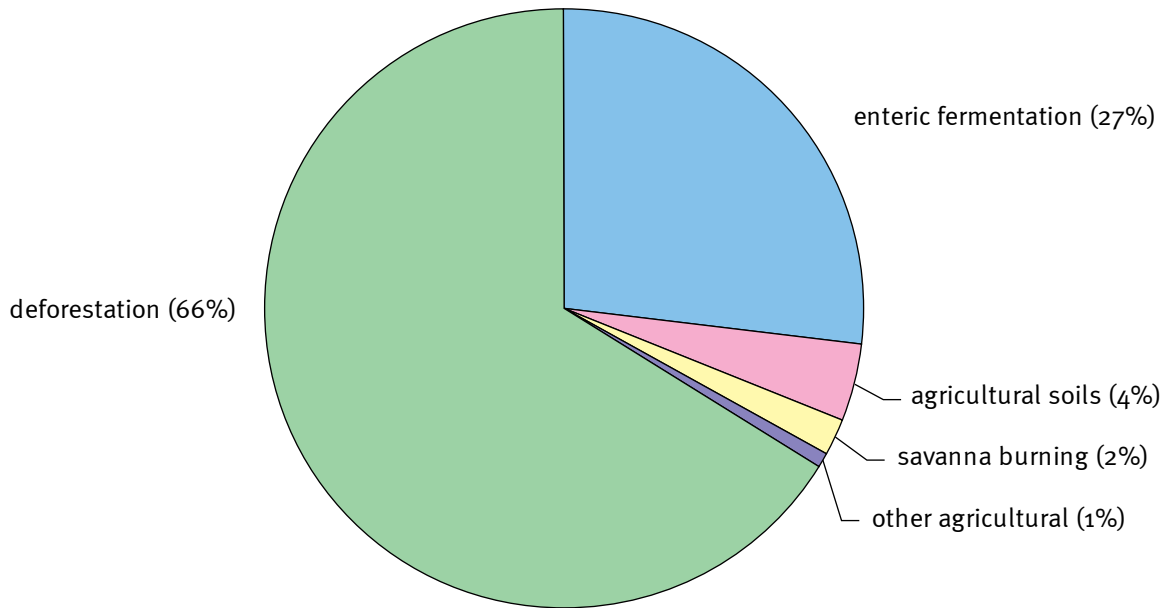
Accordingly, the main opportunities for sequestering carbon through rural land use will vary by region. An assessment of the main opportunities in each Queensland region is outlined in Appendix 3.

Emissions from rural land use

Queensland's net greenhouse gas emissions from primary industries were 76 million tonnes (Mt) of CO₂-e in 2007²². This represents approximately 42 per cent of Queensland's total greenhouse gas emissions. This net figure includes emissions from cropping, livestock production, and land use change such as land clearing (deforestation) for pastures and crops. It also includes the carbon that was sequestered through the planting of Kyoto compliant forests.

Figure 1 demonstrates the proportion of the state's rural land use emissions that are contributed by the various land use processes considered in the CSIRO report.

Figure 1 - 2007 Rural Land Greenhouse Gas Emissions (%)



In 2007, emissions from land clearing alone were 49.7Mt CO₂-e, representing 66 per cent of total sector emissions. The remaining emissions were from livestock (enteric fermentation), crop production (agricultural soils), burning of savannas and agricultural residues - totalling 26.4Mt. The planting of Kyoto compliant forests sequestered 0.3Mt CO₂-e in 2007.ⁱ

Although progress has been made in reducing deforestation, it is still the most significant source of emissions from rural land use. Since 1990, emissions from landclearing have declined by 42 per cent, and the phasing out of broadscale clearing of remnant vegetation that began in 2006 will further reduce emissions. The State-wide Landcover and Trees Study Report for 2006-07 showed that clearing rates had already reduced by 37 per cent on the previous year²³. The Department of Climate Change estimates that the phase-out will reduce total landclearing emissions by 20Mt CO₂-e per year for the current Kyoto accounting period (2008-2012)²⁴.

The phasing out of broadscale clearing of remnant vegetation in Queensland has delivered a one-off gain that will help Australia meet its Kyoto Protocol commitment of 108 per cent of 1990 emissions. This is despite the growth in greenhouse gas emissions in other sectors, such as energy, over the same period.

ⁱ Refer to Appendix 2 for an explanation of forestry activity that is included in Australia's national greenhouse accounts.

The ongoing clearing of regrowth vegetation and clearing for other purposes still comprises one of Queensland's largest sources of land based emissions. The Department of Climate Change estimates that ongoing clearing in Queensland will produce 22.5Mt of CO₂-e per year over the current Kyoto accounting period (2008-12).²⁵

Methane emissions from enteric fermentation (produced when plant material consumed by animals such as cattle and sheep is broken down in the gut under anaerobic conditions) were 20.8Mt CO₂-e in 2007. Nitrous oxide emissions, primarily from the application of nitrogenous fertilizers, were 3.1Mt CO₂-e in 2007.

Savanna burning includes naturally-caused wildfires and deliberate burning for pasture management, fuel reduction and habitat conservation. Emissions from savanna burning were 1.2Mt CO₂-e in 2007.

These figures on rural land use emissions were calculated based on Kyoto accounting rules. They do not capture the full carbon cycle from rural land use, including from on-farm soil management and from vegetation that is not Kyoto compliant.

Potential carbon savings from rural land use

The assessment approach

The CSIRO report *An Analysis of Carbon Conservation Opportunities in Queensland* examines the potential to capture carbon or to reduce emissions from 12 different land use processes. They include vegetation management, forestry activities, soil management and livestock management. The report builds on the 'first cut' assessment of these rural land use processes provided in the Garnaut Climate Change Review.

In addition to the processes considered by Garnaut, the CSIRO report examines biochar and biodiversity plantings, given the significant level of public interest in their potential to deliver carbon capture and other benefits. A brief description of the 12 processes is provided in Appendix 1.

CSIRO drew together state and national experts in each field of science to consider the latest research data and reach a consensus position on the biosequestration potential of each process. The CSIRO report drew upon contemporary research and scientific data and applied it to Queensland's specific climatic and terrestrial conditions.

CSIRO points out that the available research data was incomplete in many cases, and that only estimations of the carbon savings potential of some land use processes can be reached at this time. In addition, forestry processes will reach a saturation point within a time frame of 40 to 50 years, at which time they will arrive at their full carbon carrying capacity.

CSIRO provides three estimates in relation to each land use process – the **potential**, the **attainable** and the **base** carbon storage or reduction that can be achieved. The technical **potential** carbon saving is 'theoretical' and represents the maximum biophysical possibility.

The attainable carbon saving reflects a 'concerted effort' scenario. It assumes that concerted effort is made to overcome the technology and measurement barriers, and to make supporting policy adjustments and changes in land management. The attainable estimations do not take into account the social or attitudinal factors that might affect the level of adoption of specific land use changes at a property level. The **base** carbon saving is a 'business as usual' picture, assuming that concerted efforts are not taken to overcome existing policy and technological constraints, or to promote land management change.

The report authors had to take account of many variables in moving from the potential to the base estimates of sequestration, and elements of this assessment were necessarily subjective. However the outcome provides a valuable 'order of magnitude' comparison of the potential sequestration and other benefits which each process could deliver.

Despite gaps in existing knowledge, the CSIRO report delivers a sound and contemporary 'second cut' assessment of biosequestration potential in Queensland and Australia. It provides estimates of adequate certainty for the purpose of comparing the relative merit of land use options to guide policy and investment decisions.

The quantity of carbon

Table 1 from the CSIRO report (represented below) provides an overview of the estimates of the technical **potential** carbon savings from each of the land use processes. It includes estimates at both a national and a state level and provides a comparison with the findings in the Garnaut Climate Change Review. It includes the estimates of the carbon savings that may be **attainable** in Queensland. Overall estimates are provided for the broad sub-sectors of forestry, agriculture and bioenergy.

Table 1 – Annual GHG sequestration/mitigation (Mt CO₂-e) both nationally and within Queensland over a 40 year time horizon (2010-2050) using estimates from Garnaut (2008) and independent analysis (shaded options are subset of another option or compete for resources with another option and are not included in total figures)²⁶

Option	Garnaut (2008)	Estimates from this study (Mt CO ₂ -e/yr)		
		National Potential	Queensland	
			Potential	Attainable
AGRICULTURE				
Rehabilitate overgrazed <i>rangelands</i> , restoring soil and vegetation C-balance	286	100*	35	18
Rehabilitate mulga lands, restoring soil and vegetation C-balance (subset of <i>rangelands</i>)	250	20*	4	2
Mitigation of emissions from <i>savanna</i> burning (Kyoto-compliant gases) ^{***}	5	13*	2	1
<i>Build soil carbon</i> storage and mitigate N ₂ O emissions for cropped land (land use change not considered)	68	25*	4	0.4
Reduce <i>livestock</i> enteric emissions and structural change in industry ^{***}	16	26	11	7
GHG sequestration/mitigation for Agriculture (accounting for overlap of options)		164	52	26
FORESTRY				
Change land use to <i>carbon forestry</i> (primary goal is carbon sequestration)	143	750*	153	77
Biodiversity - Implement <i>biodiversity</i> plantings as carbon sink (primary goal is promotion of native biodiversity; subset of <i>carbon forestry</i>)	Not estimated	350	56	28
Carbon storage in post-1990 <i>plantations</i> (primary goal is commercial biomass harvest; competes for resources with <i>carbon forestry</i>)	50	400	97	2
Increase carbon banks in <i>pre-1990 eucalypt</i> forests	136	47*	21	21**
Carbon positive management of <i>regrowth</i> vegetation and remnant forest (reduce land clearing)	63	56	38	7
GHG sequestration/mitigation for Forestry (accounting for overlap of options)		853	212	105
BIOENERGY^{***}				
Substitution of fossil fuels with biofuel/bioelectricity from <i>1st gen. biomass</i> resources	44	Not estimated	5	1
Substitution of fossil fuels with biofuel/bioelectricity from <i>2nd gen. biomass</i> resources	(mix of 1 st , 2 nd gen sources)	Not estimated	24	8
Stabilise organic carbon in <i>biochar</i> and store in soil (sugar cane biomass only; competes for resources with <i>2nd gen. biomass</i>)	Not estimated	9	8	4
GHG sequestration/mitigation for Bioenergy (accounting for overlap of options)		Not estimated	29	9
Total GHG sequestration/mitigation for Queensland (accounting for overlap of options)			293	140

* Where estimates are significantly different between the Garnaut Review and this study the reason is often definitional and related to the area of land, however in some instances the estimated carbon sequestration rates also varied.

** The potential and attainable are equal in this instance as the forest is an existing resource.

*** These options will be continuous in their sequestration/mitigation while other options will saturate over time.

The CSIRO assessment suggests an overall sequestration potential for Australia similar to that estimated by Garnaut, although there were variations in respect to specific land uses. For options such as carbon forestry, the CSIRO assessment is considerably higher than Garnaut's, while rangelands rehabilitation is considerably lower. These differences reflect definitional changes and more recent research used for the CSIRO analysis.

After considering the overlaps and competition between land uses, CSIRO estimated a total biophysical sequestration potential for Queensland of 293Mt CO₂-e per year. The report estimates that 140Mt CO₂-e per year of this could be attainable. This is a significant amount when compared with Queensland's total greenhouse gas emissions of 181.6 Mt CO₂-e for the year 2007²⁷.

The CSIRO assessment clearly demonstrates that there is significant untapped opportunity to capture carbon in the rural landscape over the next few decades. This large potential for sequestration highlights the centrality of rural land management decisions to the state's climate change response.

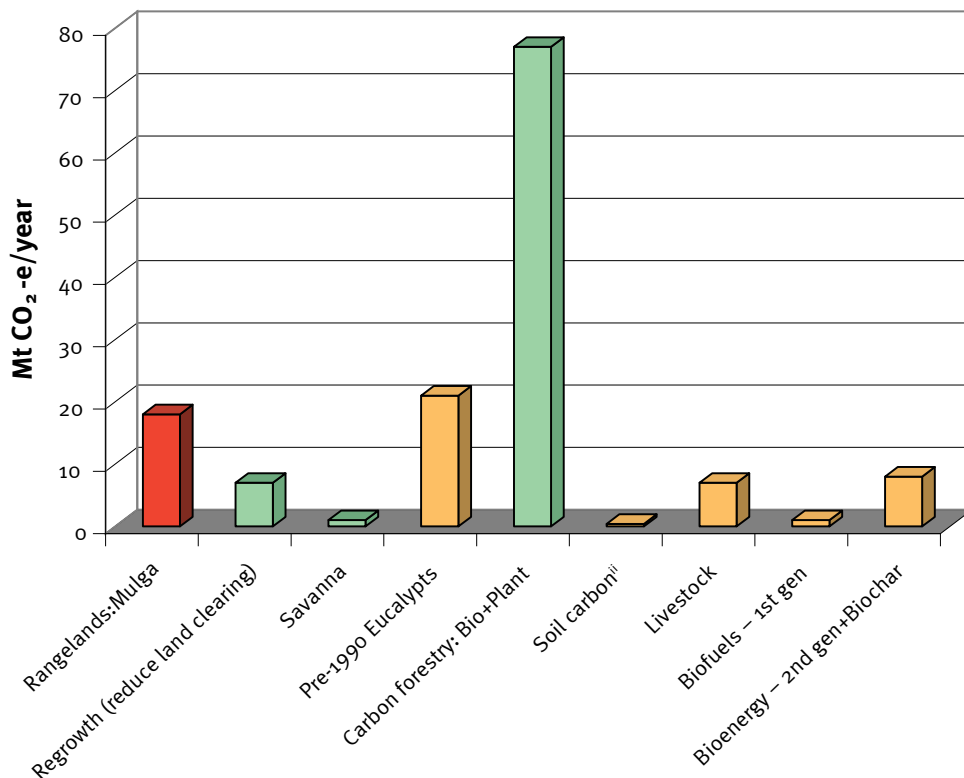


Relative potential of land use options

The potential for each land use option to sequester carbon or to reduce emissions is not the only relevant consideration in assessing the relative benefits of land use change processes. Other factors include: technological readiness; measurement certainties; and, social and environmental co-benefits and risks. These factors are all relevant considerations in deciding on investment and policy development priorities.

In addition to assessing the quantum of carbon saving achievable from each option, CSIRO endeavoured to add value by factoring in a qualitative assessment of these additional considerations. This assessment considered the maturity of the science and technology, the measurement feasibility, the ease of implementation, the stability and certainty of the carbon capture or emissions reduction, and the social and other environmental benefits.

Figure 2 Attainable quantity of GHG biosequestration/mitigation delivered for Queensland with options combined where there are direct overlaps, bars in red being the most difficult and green the least difficult to implementⁱⁱ.²⁸



ii The soil carbon figure is based on residue and fertiliser management in cropping systems and does not include soil carbon change associated with changes from pastures to trees.

Figure 2 provides an indication of both the amount of carbon savings attainable from each option and the relative difficulty in achieving these savings, based on these other considerations.

The colouring in Figure 2 reflects an assessment of the considerations of readiness for implementation. The options that are coloured green are those that can be realised now or with little further investment. The options that are coloured orange are those that have some remaining barriers to implementation. These will require relatively greater investment to resolve remaining scientific uncertainties, technological and measurement issues. The options that are coloured red are those that face the greatest barriers to realisation, particularly in relation to their potential to be utilised within carbon markets.

While the assessments represented in Figure 2 include some necessarily subjective judgements, it provides a practical indication of the ‘front runner’ opportunities for Queensland and of those that are worthy of closer investigation.

The leading opportunities for carbon savings

Some land use options emerge more favourably from the CSIRO assessment. These are the options that can save a high quantity of carbon and have a high rating for other factors – i.e. have relatively few technical and other barriers to implementation.

These rural land use processes include **carbon forestry** and **regrowth** vegetation through reduced land clearing. These options could be seen as the ‘low hanging fruit’ for the rural land use sector requiring low levels of investment for significant return in carbon capture. Regrowth vegetation has high sequestration potential and some of this potential could be realised in carbon marketsⁱⁱⁱ.

The process of managed savanna burning also emerges as relatively favourable. Although it delivers lower carbon savings than carbon forestry and regrowth, it rates highly for implementation and measurement feasibility.

iii To be recognised for eligible reforestation under the proposed CPRS, regrowth vegetation will need to be compatible with Kyoto Protocol reforestation definitions and relevant accounting rules See Appendix 2.

Other options have the potential to sequester or reduce emissions in sizeable quantities, but have higher measurement, technical or other barriers to overcome before these benefits can be fully realised.

The options of restoring cleared lands with **biodiversity plantings** and increasing carbon banks in **pre-1990 eucalypts** require further investigation of carbon sequestration rates for Queensland species and of variations across different regional ecosystems in order to allow accurate measurement.

Options such as producing second and third generation feedstocks for **biofuel** and **biochar** will require relatively higher levels of investment in order to overcome remaining technical and commercialisation barriers. However, unlike the forestry options, these processes have the benefit of providing an ongoing source of carbon saving as they will not reach saturation points over time.

Biofuel and biochar can be used with almost any source of biomass and can complement many of the other land use options considered in the report.

The CSIRO assessment highlights “... the dominating effect that a strong carbon price could have on converting land use over to carbon forestry”²⁹. Broad scale land use change to take up some of these leading opportunities may result in a range of environmental and socio-economic impacts.

Carbon forestry may deliver a range of environmental co-benefits such as ecosystem recovery and water quality improvements, particularly when it takes the form of biodiversity plantings or regrowth of native vegetation.

However there has been considerable public debate about the potential of carbon forestry and other options, such as first generation biofuel feedstock production, to displace food production. Recent modelling undertaken by the Australian Bureau of Agricultural and Resource Economics (ABARE) found the carbon price that will flow from the Carbon Pollution Reduction Scheme is likely to drive a significant expansion in forestry activity, but that this is not likely to replace high value agricultural land³⁰. The CSIRO analysis was based on an assumption of 4.6 per cent of Queensland’s land area being converted, and suggests that some grazing and broadacre cropping could be displaced³¹.

This highlights the need for further evaluation of the possible effects on food production and regional economies and employment that may flow from a conversion of agricultural land to carbon forestry. Planning and policy mechanisms to integrate carbon forestry opportunities into agricultural production systems will need to address any potential impact on regional communities and individual landowners.

Investment in evaluating and managing these effects will be worthwhile given the high sequestration values that can be achieved from carbon forestry.

Options more difficult to realise

Some options emerge from the CSIRO assessment with a low overall rating for ease of implementation and measurement in carbon terms. These options include rehabilitating overgrazed rangelands, including mulga, to restore soil and vegetation carbon.

These options deliver relatively low sequestration returns by land area. They are also hindered by a lack of reliable data, large spatial variations in carbon storage, huge fluctuations due to climate, and significant measurement difficulties. For these reasons these options would, at this stage, be difficult to bring into carbon markets.

The process of building soil carbon and reducing nitrogen emissions from cropland faces some similar measurement complexities and has relatively lower carbon saving potential.

Measures to improve the carbon balance in these land uses may nonetheless deliver a number of significant co-benefits such as improved productivity and ecosystem recovery. In addition, these options have the benefit of avoiding the displacement of agricultural activity.

The mitigation of emissions from livestock faces substantial measurement and technological challenges. Nonetheless, progress on reducing livestock emissions will remain a priority given the substantial proportion of agricultural sector emissions caused by livestock, and the possibility of future inclusion in a Carbon Pollution Reduction Scheme.

Carbon savings may be achieved from these processes, but these savings are some way off being able to be measured and verified. The options in this group will require much higher levels of investment in further research and development, relative to their carbon saving potential.

It is worth noting that through its Climate Change Research Program, the Australian Government has recently committed over \$97 million to primary industry research and demonstration projects aimed at reducing carbon, improving soil management and assisting producers to adapt to climate change. Much of this research will focus on resolving the technical and measurement uncertainties for agricultural processes that are identified in the CSIRO report.



Next steps

The CSIRO report delivers a contemporary scientific assessment of the potential for terrestrial carbon savings in Queensland. This assessment of the biosequestration options provides sound guidance on investment and policy development priorities for Queensland. The report can inform decisions about Queensland's response to new national and international carbon accounting frameworks.

Rural land use has the potential to sequester a large proportion of Queensland's emissions, at least until saturation points are reached. The reports findings point to "...the clear potential for better and altered land management to be a part of the carbon management policy for Queensland"³².

The further realisation of this potential will require changes to policy settings at state, national and international levels, and the development of further technical expertise.

The CSIRO report points to a range of research priorities.

- Further biophysical research to narrow the remaining uncertainties about sequestration rates, yields over time and saturation points. There are strong arguments for focusing research investment on those land use options, such as biodiversity plantings, that will deliver the greatest sequestration and other benefits for Queensland and which are relatively ready to implement.
- Further research on the economics of land management including the costs and benefits associated with different carbon market scenarios and investigation of the environmental and social co-benefits and impacts of broadscale land use change.

- Analysis of the policy settings required to deliver land use outcomes that balance sequestration, food production, and other environmental and social considerations. This would include an analysis of the interaction of the CPRS, the voluntary carbon market, other market incentives for environmental services, and existing land use planning and regulatory frameworks.
- Research to develop a better understanding of the drivers of, and barriers to, adoption of carbon saving land use practices by landholders.

Subject to Council's endorsement, a final working paper on 'Carbon capture in the rural landscape' will be developed for the next Council meeting.

This final paper will provide the following.

- A summary of the current state of play in policy development and research activity at a national and state level.
- An analysis of the associated opportunities and risks to food and fibre production, regional economies, water quality and biodiversity.
- An outline of research priorities for preparing Queensland's rural sector for participation in emerging carbon markets.
- An analysis of the policy opportunities for maximising carbon capture and associated environmental and economic benefits from rural land use in Queensland – including consideration of regional strategies, incentives and regulatory changes.
- A framework to develop and harness the significant biosequestration opportunities in Queensland.

The paper will include recommendations to the Queensland Government about priority actions to reduce rural land use emissions and position Queensland to participate effectively in emerging carbon markets.

Recommendations

It is recommended that the Premier's Council on Climate Change:

- accept the interim Working Paper *Capturing Carbon in the Rural Landscape: Opportunities for Queensland*
- note the contents of the CSIRO report *An Analysis of Greenhouse Gas Mitigation and Carbon Biosequestration Opportunities from Rural Land Use*
- request the development of a final working paper on carbon capture in rural land use, to include an analysis of the policy implications of the scientific advice provided by CSIRO, and to develop recommendations on priority actions in the area of biosequestration.



Appendix 1 – Summary of each sequestration option

1. Carbon forestry

Estimated annual carbon sequestration for Queensland over a 40 year period (2010–2050) from carbon forestry³³

Net potential (bio-physical) (Mt CO ₂ -e/yr)	Net attainable (Mt CO ₂ -e/yr)
153	77

Description

‘Carbon forestry’ refers to the planting of vegetation for the primary goal of carbon sequestration and can include monocultural or mixed plantings.

Carbon plantings are Kyoto compliant forests which attract payments for carbon sequestration. They might be anywhere in the landscape – the primary driver being a carbon market. The report considers the amount of carbon that can be sequestered in this vegetation.

For the purposes of the CSIRO assessment, the options of biodiversity plantings and plantations are dealt with as a subset of carbon forestry.

2. Biodiversity plantings

Estimated annual carbon sequestration for Queensland for a 40 year period (2010–2050) from implementing biodiversity plantings as carbon sink³⁴

Net potential (bio-physical) (Mt CO ₂ -e/yr)	Net attainable (Mt CO ₂ -e/yr)
56	28

Description

This option refers to the replanting of vegetation that offers biodiversity as well as carbon sequestration benefits. The figures above are a subset for those of carbon forestry.

Carbon markets may promote planting of monocultures of fast growing tree species for maximum carbon sequestration. Monocultures are generally not good for local biodiversity or for downstream water availability. Biodiversity plantings have, however, the dual benefits of carbon sequestration and biodiversity services.

3. Plantations

Estimated annual carbon sequestration for Queensland over a 40 year period (2010-2050) by maintaining and expanding post-1990 plantations³⁵

Net potential (bio-physical) (Mt CO ₂ -e/yr)	Net attainable (Mt CO ₂ -e/yr)
97	2

Description

This option refers to the land use option of maintaining and expanding forests that are planted for the primary purpose of timber production. These plantings also provide sequestration benefits. The figures above are a subset of those for carbon forestry.

The forests covered in this assessment include only those plantations that were established post-1990, and new plantations specifically for hardwood and softwood timber production. Gains in carbon occur due to incremental growth of existing forests, replanting of recently harvested forests, and the planting of new forests. Losses of carbon occur when forests are harvested or due to natural disturbances including fire, heatwaves, drought and disease.

Although carbon is stored in the timber end product, this is currently not accounted for and it is assumed as lost when harvested. The Queensland Government supports the Australian Government's international negotiations for recognition of carbon stored in harvested wood products in Kyoto compliant forests³⁶.

4. Regrowth

Estimated annual carbon sequestration for Queensland over a 40 year period (2010-2050) from reduced clearing of regrowth vegetation and remnant forest³⁷

Net potential (bio-physical) (Mt CO ₂ -e/yr)	Net attainable (Mt CO ₂ -e/yr)
38	7

Description

This option examines the greenhouse gas emissions reduction that could be achieved if clearing of regrowth vegetation was reduced.

The clearing of regrowth vegetation results in the release of carbon dioxide from the above and below ground components of the trees, and the loss of soil carbon. If the cleared trees are heaped and burnt, there are also direct emissions of methane and nitrous oxide.

The net 'potential' referred to above is based on the rate of clearing in 2006-07 which is estimated to represent the maximum clearing rate with the cessation of broad scale land clearing on 31 December 2006. This potential is 'academic' as there are a range of considerations that would prevent a complete realisation of each option. Base emissions savings for regrowth have not been estimated because there are many factors and complex interactions that could determine future rates of regrowth clearing³⁸.

5. Pre-1990 Eucalypts

Estimated annual carbon sequestration for Queensland over a 40 year period (2010–2050) from increasing the balance of carbon banks in pre-1990 native forests³⁹

Net potential (bio-physical) (Mt CO ₂ -e/yr)	Net attainable (Mt CO ₂ -e/yr)
21	21

Description

This option refers to native eucalypt forests that were established prior to 1990.

Native eucalypt forests could be managed for carbon if harvesting was ceased. A study by Mackey et al (2008)⁴⁰ included estimates of carbon sequestration that could be realised if all timber harvesting was ceased in native forests managed for timber production.

The calculation represents a first attempt at quantifying the magnitude of these numbers for Australian native forests. There are still many uncertainties, including knowledge deficiencies and little existing data on the losses of carbon due to harvesting. There are also spatial and temporal changes in the carbon carrying capacity of forests that are not well understood.

6. Savanna burning

Estimated annual greenhouse gas emissions reductions for Queensland over a 40 year period (2010–2050) by managing the burning of savanna country⁴¹

Net potential (bio-physical) (Mt CO ₂ -e/yr)	Net attainable (Mt CO ₂ -e/yr)
2	1

Description

This option examines the potential to reduce greenhouse gas emissions through managed fire regimes in savanna grassland areas.

The tropical savannas of northern Australia are the continent's most fire-prone biome. Savanna burning contributes three per cent of Australia's total accountable greenhouse gas emissions and about one per cent of Queensland's. A large proportion of burning in northern Australia is the result of uncontrolled, relatively high intensity wildfires that occur late in the dry season. There is very significant potential for using strategic, prescribed burning early in the dry season to reduce the intensity and extent of savanna burning and reduce greenhouse gas emissions.

Currently only methane and nitrous oxide are accounted for, as it is assumed that a similar amount of carbon dioxide is sequestered as the vegetation regrows. However, measuring carbon dioxide would improve the accuracy and certainty about carbon conservation from managing fire in savannas.

7. Biofuel

Estimated annual greenhouse gas emissions reductions for Queensland over a 40 year period (2010-2050) through the substitution of fossil fuels with biofuels⁴²

	Net potential (bio-physical) (Mt CO ₂ -e/yr)	Net attainable (Mt CO ₂ -e/yr)
1 st generation*	5	1
2 nd and 3 rd generation [#]	24	8

Description

Biofuels are any liquid, gaseous or solid fuel produced from animal or organic matter (such as soybean oil, sugar, bagasse [sugar cane fibre left after milling], animal fat or wood). Biofuels and bioelectricity can be used to replace fossil fuels.

Although there are emissions as the fuel is consumed, it has come from biomass, which absorbed carbon as it was growing, as opposed to fossil fuels, which release additional carbon into the atmosphere from underground.

First, second and third generation refers to different technological pathways to producing biofuels. First generation biofuels are those already at a commercial enterprise stage. Currently these are sugar cane, starch crops and oilseed crops which are also human food sources.

Second generation biofuel production has been demonstrated but is not yet commercial. In future it could use algae and waste from crop production (such as stalks or stubble, rather than the seed or plantation harvest residues). Third generation biofuels are those at the conceptual planning stage. Second and third generation biofuels can be drawn from non-human food feedstocks and will address concerns about the displacement of productive farm land that are associated with first generation biofuels.

Feedstocks for biofuels can also be used to produce biochar. For the purposes of the CSIRO assessment, biochar is treated as a subset of second generation biofuels.

8. Biochar

Estimated annual carbon sequestration for Queensland over a 40 year period (2010-2050) from stabilising organic carbon in biochar and storing in soil (sugar cane biomass only)⁴³

Net potential (bio-physical) (Mt CO ₂ -e/yr)	Net attainable (Mt CO ₂ -e/yr)
8	4

Description

This option considers the potential to sequester carbon in biochar and store it in soil. For the purposes of this assessment it is treated as a subset of second generation biofuels, as it draws upon the same feedstock.

Only the biochar that could be produced from sugarcane biomass (as a major feedstock available in Queensland) was considered for the purposes of the report.

Biochar is a charcoal-like material produced from the pyrolysis of biomass (heating to between 350-600°C under limited oxygen). The process converts 'unstable' (easily-decomposable) organic matter into a highly stable (i.e. biologically and chemically recalcitrant) form of carbon. Biochar can result in the net removal of carbon from the atmosphere and, in some circumstances, can improve agricultural production.

Biochar is the solid by-product resulting from bioenergy production. The pyrolysis conditions can be optimised for bioenergy or biochar production. Biochar qualities can also be tailored for desired properties (e.g. high stability, high adsorptive capacity, high nutrient content) through selection of feedstock and processing conditions. Ideally, waste products that would otherwise end up in landfill are the most desired sources for biochar production. That is, it would be not advisable to convert otherwise valuable materials (e.g. high quality wood or compost) into biochar as they have qualities that make them more suitable for other usage if not pyrolysed. Conversely, waste feedstocks need to be checked to ensure that they are free of toxins such as heavy metals.

9. Livestock

Estimated annual greenhouse gas emissions reductions over a forty year period (2010–2050) from reducing livestock enteric and from industry structural changes⁴⁴

Net potential (bio-physical) (Mt CO ₂ -e/yr)	Net attainable (Mt CO ₂ -e/yr)
11	7

Description

This option assesses the potential to reduce emissions from livestock (cattle and sheep) through improved management practices and industry structural changes.

Livestock produce methane when plant material is broken down by bacteria in the gut under anaerobic conditions (enteric fermentation). Methane and nitrous oxide are also emitted from the decomposition of manure. Livestock emissions in Queensland are predominantly methane, with only three per cent being nitrous oxide. Almost all methane (94 per cent) in livestock agriculture originates from enteric fermentation (95 per cent of it originating from cattle and 2.6 per cent from sheep).

This assessment looks predominantly at the savings of methane emissions from cattle, although many of the assumptions made about cattle also apply to sheep. There is no single, high impact strategy currently available that could have a significant impact by 2015 without major policy and research intervention. Rather, a cocktail approach of better management practices and dietary additives, tailored to specific components of the industry, is the best option for meaningful reductions (10–20 per cent) in enteric methane in the short term. In the longer term, greater reductions in GHG emissions could be achieved, but this would require significant technological development and dietary change.

10. Soil Carbon

Estimated annual greenhouse gas emissions reductions for Queensland over a 40 year period (2010–2050) from building soil carbon storage and mitigating nitrous oxide emissions for cropped land⁴⁵

Net potential (bio-physical) (Mt CO ₂ -e/yr)	Net attainable (Mt CO ₂ -e/yr)
4	0.4

Description

This option examines the potential to build soil carbon through improved management of cropland and reduce emissions through reducing the use of nitrogen based fertilisers.

Carbon sequestration in the soil requires the removal of carbon dioxide from the atmosphere through plant biomass, and returning or retaining that plant biomass in the soil. This also includes consumed plant products such as manure. Historically, land use change from native grasslands, woodlands and forests to more intensive cropping and pastures has led to a loss of soil carbon. Croplands considered in this assessment include grain crops, grain-pasture, cotton and sugarcane. Potential soil carbon stocks depend on the soil types and fluctuate with climatic conditions.

Better management of fertilizer in cropping reduces the nitrous oxide emissions from fertilizer application. Better management of fertilizer application and conversion from cropland to permanent pasture or forest provides the greatest opportunity for increasing soil carbon, but this has to be weighed against food production issues.

11. Rangelands (including mulga)

Estimated annual carbon sequestration potential for Queensland over a 40 year period (2010–2050) from rehabilitating overgrazed rangelands, restoring soil and vegetation carbon balance⁴⁶

Net potential (bio-physical) (Mt CO ₂ -e/yr)	Net attainable (Mt CO ₂ -e/yr)
35	18

Description

This option examines the potential to improve soil and vegetation carbon through the rehabilitation of overgrazed rangelands, including mulga country.

Rangelands are regarded as extensive permanent lands grazed by livestock that largely consist of native vegetation or include sown pastures such as buffel grass. Such lands lie in both tropical and temperate zones of Australia. The mulga lands (i.e. where mulga dominates or contributes significantly to the biomass) are a subset of these rangelands.

Carbon is lost from vegetation and soil when rangelands are over utilized, resulting in loss of permanent plants and soil erosion (although areas where soil is deposited can gain carbon). A well recognised study of the condition of rangelands in Queensland indicated that around 40 per cent of the state's rangelands were degraded (and not all of that would be able to be restored)⁴⁷. There are very few studies globally that measure the carbon that can be sequestered by natural pastures when grazing animals are removed, and only one in Australia (in the alpine region), so this assessment is based on limited information.

Appendix 2 – Treatment of biosequestration processes under current Kyoto rules and under proposed CPRS

Kyoto Protocol

The Kyoto Protocol, adopted in 1997, commits Parties to limit or reduce their greenhouse gas emissions to a specified level during the period 2008-12. Every year, each Party prepares accounts for greenhouse gas emissions from across sectors (including Energy, Industrial Processes, Waste, Agriculture, and Land Use, Land Use Change and Forestry). This paper focuses on Land Use, Land Use Change and Forestry (LULUCF) activities. Some activities including deforestation, reforestation and afforestation **must** be included in developed countries' accounting against their emissions target – these are outlined in Article 3.3. Parties may also **choose** to account for additional activities set out in Article 3.4 for the first commitment period. These include forest management, revegetation, cropland management and grazing land management.

Definition of a Forest

Under the Kyoto Protocol, Parties had to define a 'forest' (from within guidelines). Australia's definition of a 'forest' for Kyoto Protocol accounting purposes is a forest of trees with a minimum area of 0.2ha, a minimum of 20 per cent crown cover and a potential tree height of at least 2 metres.

The mandatory activities under Article 3.3

Afforestation is the direct human-induced conversion of land that has not been forested for a period of at least 50 years to forested land through planting, seeding and/or the human-induced promotion of natural seed sources.

Reforestation is the direct human-induced conversion of non-forested land to forested land through planting, seeding and/or the human-induced promotion of natural seed sources, on land that was forested but has been converted to non-forested land. For the first commitment period, reforestation activities will be limited to reforestation occurring on those lands that did not contain forest on 31 December 1989.

The term 'human-induced' in afforestation and reforestation does not include allowing a forest to regrow naturally. However, direct human-induced methods to establish and promote regrowth vegetation (before it grows into a forest) could be considered a Kyoto eligible reforestation activity, as it complies with the requirement for human-induced promotion of natural seed sources.

Deforestation is the direct human-induced conversion of forested land to non-forested land.

The voluntary activities under Article 3.4

There are four voluntary activities (listed below) that countries may elect to count towards their emissions target during the first commitment period.

Forest management is a system of practices for stewardship and use of forest land aimed at fulfilling relevant ecological (including biological diversity), economic and social functions of the forest in a sustainable manner.

Revegetation is a direct human-induced activity to increase carbon stocks on sites through the establishment of vegetation that covers a minimum area of 0.05 hectares and does not meet the definitions of afforestation and reforestation.

Cropland management is the system of practices on land on which agricultural crops are grown and on land that is set aside or temporarily not being used for crop production.

Grazing land management is the system of practices on land used for livestock production aimed at manipulating the amount and type of vegetation and livestock produced.

Australia has elected not to include these activities largely because of the risk that drought or bushfire could result in significant emissions from these sources during the Kyoto commitment period.

Carbon Pollution Reduction Scheme

The Carbon Pollution Reduction Scheme (CPRS) is the tool chosen by the Australian Government to reduce national greenhouse gas emissions. It sets an emissions reductions target and uses a market based approach to meet that target by enabling businesses to find the most cost effective way of reducing emissions. The broader the 'coverage' of industries included in the scheme, the further the 'burden' of reducing emissions is spread.

A general principle of the scheme is to cover all sources of emission and sinks recorded in Australia's National Greenhouse Accounts for Kyoto purposes. Direct obligations under the CPRS are likely to apply to a relatively small number of businesses (those with direct emissions of 25,000 tonnes CO₂-e or more per annum). Recognising that there are measurement and compliance cost issues regarding coverage of the agriculture sector (which includes many smaller businesses), the Australian Government has stated that a decision on whether to include agriculture will not occur until 2013 and, if agriculture is included, it will happen from 2015.

Reforestation and afforestation activities can be included in the CPRS on a voluntary basis. The options in this paper are carbon forestry, plantations and biodiversity plantings, provided they are compatible with Kyoto rules. There is potential for some regrowth to be used for reforestation projects if it meets CPRS requirements.

Deforestation (emissions from land clearing) will not be covered in the CPRS.

National Carbon Offset Standard

The draft National Carbon Offset Standard was released for public comment by the Australian Government in December 2008. The Standard is designed to provide confidence for consumers of voluntary offsets (those not covered by the CPRS).

Summary of options and their Kyoto and CPRS eligibility

Table 2 – Summary of the Kyoto eligibility and coverage under the CPRS of each option in the paper

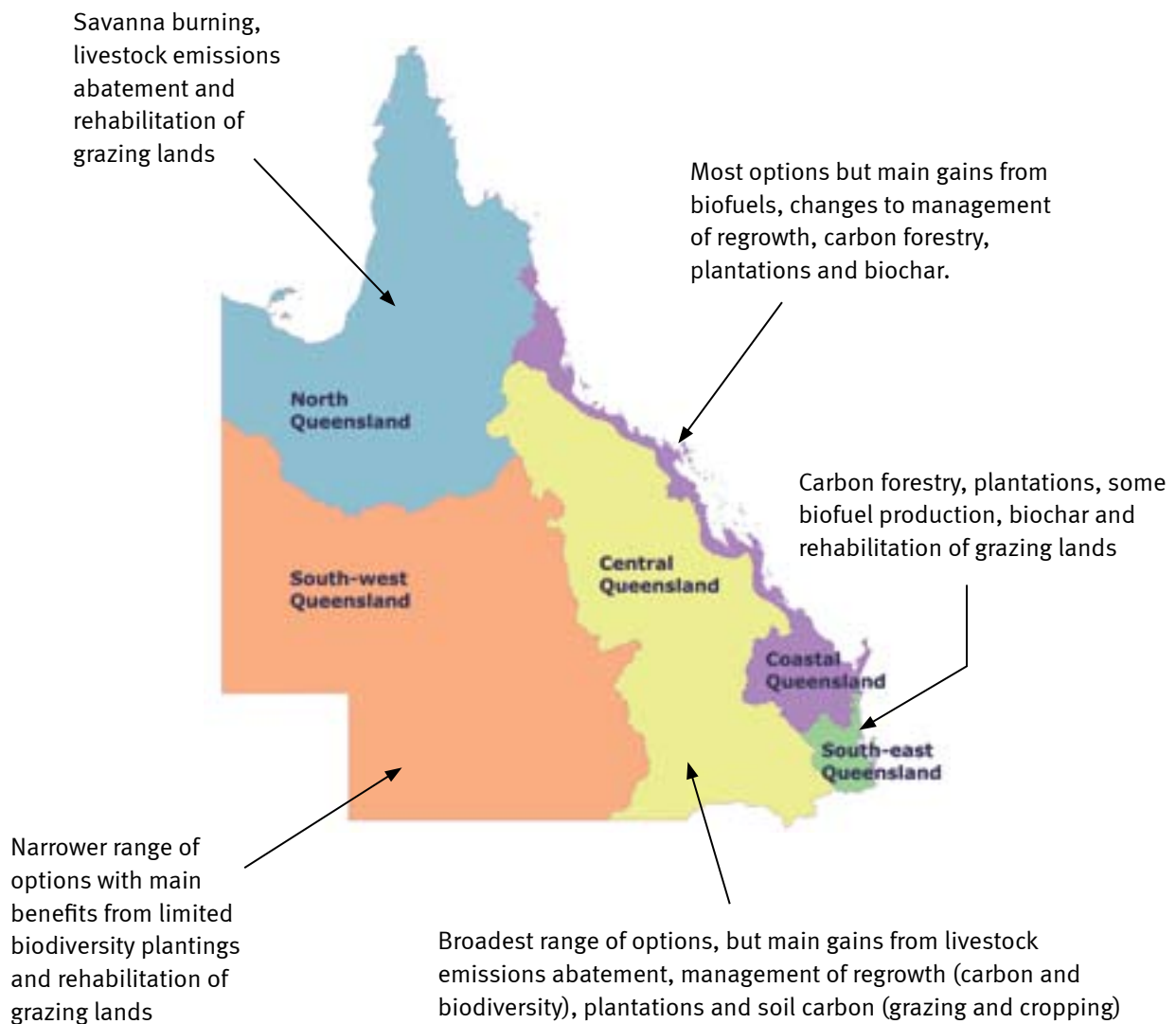
Option	Included in Australia's Kyoto Accounts	Coverage under the CPRS
Rangelands Rehabilitate rangelands and restore soil and vegetation carbon	Not eligible under Kyoto (due to non selection of Article 3.4)	Not covered because not included in Kyoto accounts for 2008-12
Mulga Rehabilitate mulga country and restore soil and vegetation carbon	Not eligible under Article 3.4 of Kyoto (due to non selection of Article 3.4)	Not covered because not included in Kyoto accounts for 2008-12
Regrowth Reduce land clearing	Regrowth on land cleared of forest since 1990 is counted in the deforestation account under Kyoto Could be eligible as reforestation or afforestation under Article 3.3 if subsequently established using human-induced methods Natural regrowth forest on land that was clear of forest on 1/1/1990, is not Kyoto eligible under Article 3.3 i.e. not human induced	Deforestation (land clearing) will not be covered. Potential voluntary coverage as reforestation if it meets CPRS requirements
Biodiversity Biodiversity plantings as carbon sinks	Kyoto eligible under Article 3.3 (afforestation and reforestation) if established since 1990 on land that was clear of forest at 1990	Voluntary coverage as reforestation if it meets the definition of a forest and meets Kyoto Protocol reforestation requirements
Savanna burning Reduce emissions from savanna burning	Nitrous oxide and methane emissions from the agriculture sector are counted under Kyoto	Not covered, but the Australian Government has committed to work with Indigenous Australians on the potential of savanna burning as an offset
Pre-1990 Eucalypt forests Increase balance of carbon banks in pre-1990 eucalypt forests	Not eligible under Kyoto Article 3.3 because the forests existed on 1/1/1990 nor under Article 3.4 (due to Australia's non-selection of Article 3.4)	Not covered because not included in Kyoto accounts for 2008-12
Plantations Maintain and expand plantations (primary goal is commercial biomass harvest)	Kyoto eligible under Article 3.3 (afforestation and reforestation) if established since 1990 on land that was clear of forest at 1990	Covered on a voluntary opt-in basis as reforestation
Carbon forestry Change land use to carbon plantings	Kyoto eligible under Article 3.3 (afforestation and reforestation) if established since 1990 on land that was clear of forest at 1990	Covered on a voluntary opt-in basis as reforestation
Soil carbon Build soil carbon and reduce nitrous oxide emissions from fertilizer use in cropping	Not eligible under Kyoto (due to non selection of Article 3.4)	Not covered because not included in Kyoto accounts for 2008-12

Option	Included in Australia's Kyoto Accounts	Coverage under the CPRS
Livestock Reduce methane emissions from livestock	Methane emissions from the agriculture sector are counted under Kyoto	Not covered as agriculture not included until decision made in 2013, with possible inclusion from 2015
Biofuel Substitute fossil fuels with production of biofuels and bioenergy	Greenhouse gas emissions from use of fossil fuels are counted under Kyoto (energy sector) Non-CO ² emissions from combustion of biofuels and biomass for energy are counted	Combustion of biofuels and biomass for energy treated as producing zero emissions can be considered under the Renewable Energy Target; reduces emissions from use of fossil fuels
Biochar Stabilise organic carbon in biochar (from sugar cane) and store in soil	International rules do not provide methodologies for accounting for biochar in national inventories	Currently not included in the CPRS

Appendix 3 – Options by region

The CSIRO report identifies the land use processes (carbon capture and emissions reduction opportunities) of greatest relevance for each region. These are reflected in Figure 3.

Figure 3 – Terrestrial carbon management options by region⁴⁸



Footnotes

- 1 Tulloh, C., Ahammad, H., Mi, R. and Ford, M., 2009, 'Effects of the Carbon Pollution Reduction Scheme on the economic value of farm production', *ABARE issues insights: June 2009*, viewed 18 May 2009, <http://www.abareconomics.com/publications_html/ins/insights_09/a6.pdf>.
- 2 Burns, K., Vedi, J., Heyhoe, E. and Ahammad, H., 2009, 'Opportunities for forestry under the Carbon Pollution Reduction Scheme (CPRS): an examination of some key factors', *ABARE issues insights: March 2009*, viewed 21 May 2009, <http://www.abare.gov.au/publications_html/ins/insights_09/a1.pdf>, p.14.
- 3 Garnaut, R., 2008, *The Garnaut Climate Change Review*, Cambridge University Press, Cambridge, p.531.
- 4 Solomon, S., Qin, D., Manning, M., Chen, Z., Marquis, M., Averyt, K.B., Tignor, M. and Miller, H.L. (eds), 2007, 'IPCC Fourth Assessment Report: Working Group I Report "The Physical Science Basis"', Cambridge University Press, Cambridge and New York, p.996.
- 5 Garnaut, R., *op.cit.*
- 6 *ibid*, p.531.
- 7 Toohey, B., 2009, 'Land of carbon-cutting opportunity', *Australian Financial Review*, 21 March, p.29.
- 8 Department of Primary Industries & Fisheries, 2008, *Prospects for Queensland's primary industries 2007-08 : September 2007 Forecasting, analysis & trends*. The State of Queensland (Department of Primary Industries & Fisheries), Brisbane.
- 9 Australian Bureau of Statistics, 2006, 7123.3.55.001 - *Agricultural State Profile, Queensland, 2004-05*, Australian Bureau of Statistics, viewed 7 April 2009, <<http://www.abs.gov.au/AUSSTATS/abs@.nsf/Latestproducts/D085226E582B7D72CA2571D8001F5A38?opendocument>>.
- 10 Department of Natural Resources and Water, 2007, *Delbessie Agreement (State Rural Leasehold Land Strategy)*, The State of Queensland (Department of Natural Resources and Water), Brisbane.
- 11 See, for example, Tohill J.C. and Gillies C., 1992, *The pasture lands of northern Australia: their condition, productivity and sustainability*. Tropical Grassland Society of Australia, Occasional Publication No 5; and Queensland Government, 2008, *State of the Environment 2007*, viewed 14 May 2009, <<http://www.epa.qld.gov.au/register/p02256ay.pdf>>
- 12 Garnaut, *op.cit.* p.542.
- 13 CSIRO, 2009, *An Analysis of Greenhouse Gas Mitigation and Carbon Biosequestration Opportunities from Rural Land Use*, CSIRO, St Lucia; and Metz, B., Davidson, O.R., Bosch, P.R., Dave, R., Meyer, L.A. (eds), 2007, 'IPCC Fourth Assessment Report: Working Group III Report "Climate Change 2007: Mitigation of Climate Change"', Cambridge University Press, Cambridge and New York, p.851.
- 14 *Carbon Pollution Reduction Scheme: Australia's Low Pollution Future*, 2008, White Paper, Commonwealth of Australia, p.6-50.
- 15 Department of Primary Industries & Fisheries, *op.cit.*
- 16 *ibid*.
- 17 *ibid*.
- 18 Australian Bureau of Statistics, *op.cit.*
- 19 ABARE, *op.cit.* p.2.
- 20 Department of Natural Resources and Water, *op.cit.*
- 21 Indigenous Land Corporation, 2008, 'Regional Indigenous Land Strategy 2007-12: Queensland' viewed 7 April 2009, <http://www.ilc.gov.au/webdata/resources/files/QLD_RILS_170608.PDF>.
- 22 Department of Climate Change, 2009, *State and Territory Greenhouse Gas Inventories 2007*, Commonwealth of Australia (Department of Climate Change).
- 23 Department of Climate Change, 2009, *State and Territory Greenhouse Gas Inventories 2007*. Australian Government. Department of Natural Resources and Water, 2009, *Landcover Change in Queensland 2006-07. Statewide Landcover and Trees Study Report*
- 24 Department of Climate Change, 2008, *Land Use Change Sector Greenhouse Gas Emissions Projections 2007*, viewed 7 April 2009, <<http://www.climatechange.gov.au/projections/pubs/landusechange2007.pdf>>, p.7.
- 25 *ibid*
- 26 CSIRO, *op.cit.* p.17.
- 27 Department of Climate Change, 2009, *State and Territory Greenhouse Gas Inventories 2007*, Commonwealth of Australia (Department of Climate Change), Canberra.
- 28 CSIRO, *op.cit.* p.27.
- 29 CSIRO, *op.cit.* p.28.
- 30 ABARE, *op.cit.* p.14.
- 31 CSIRO, *op.cit.* p.28.
- 32 CSIRO, *op.cit.* p.16.
- 33 CSIRO, *op.cit.* p.17.
- 34 CSIRO, *op.cit.* p.17.
- 35 CSIRO, *op.cit.* p.17.
- 36 Queensland Government, 2008, *Carbon Pollution Reduction Scheme Green Paper Submission*, September 2008, p10.
- 37 CSIRO, *op.cit.* p.17.
- 38 CSIRO, *op.cit.* p.34.
- 39 CSIRO, *op.cit.* p.17.
- 40 Mackey, B.G., Keith, H., Berry, S.L., Linder Mayer, D.B., 2008, *Green Carbon: The Role of Natural forests in Carbon Storage*, 'Part 1: A Green Carbon Account of Australia's South-Eastern Eucalypt Forests and Policy Implications', ANU E Press, Canberra.
- 41 CSIRO, *op.cit.* p.17.
- 42 CSIRO, *op.cit.* p.17.
- 43 CSIRO, *op.cit.* p.17.
- 44 CSIRO, *op.cit.* p.17.
- 45 CSIRO, *op.cit.* p.17.
- 46 CSIRO, *op.cit.* p.17.
- 47 Tohill and Gillies, *op.cit.*
- 48 CSIRO, *op.cit.* p.25.