The National Greenhouse Accounts and Land Clearing: Do the numbers stack up?

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Andrew Macintosh[1]

Summary

Australia's capacity to meet its Kyoto target is contingent on a reduction in emissions from land clearing. Government projections indicate that if land use change emissions are at their 1990 levels in 2010, Australia's total emissions will be 27 per cent above 1990 levels, meaning Australia will exceed its Kyoto target by 19 per cent.

The National Greenhouse Accounts suggest that between 1990 and 2004 there was a 59 per cent reduction in emissions from land use change, which has ensured that Australia's total emissions have increased by only 2.3 per cent. Approximately 70 per cent of the decline in land use change emissions is attributed to a fall in the rate of land clearing in Queensland. The Federal Government has relied on the decrease in land clearing to justify its claim that Australia 'remains on track' to meet its Kyoto target.

Data published by the Statewide Landcover and Trees Study (SLATS) in Queensland raise doubts about the accuracy of the estimates of land clearing in the National Greenhouse Accounts. For example, the total amount of land clearing in Queensland identified under SLATS between 1989/90 and 2000/01 is approximately 50 per cent higher than the amount estimated by the Federal Government's National Carbon Accounting System (NCAS) between 1990 and 2001. There are also significant differences in the land clearing trends identified by SLATS and NCAS, with peaks in clearing shown in the SLATS data in the late 1990s and early 2000s not evident in NCAS results.

Concerns about the accuracy of the estimates of land clearing in the National Greenhouse Accounts are heightened by the variability in NCAS data, in particular fluctuations in the estimates of land clearing and emissions from land use change in 1990. For example, the estimated rate of land clearing in 1990 in the latest National Greenhouse Gas Inventory (NGGI) is 33 per cent higher than the estimate in the 2000 NGGI.

There is an urgent need for an independent review of NCAS. Until an independent review has certified the accuracy of NCAS, the Federal Government's claims about Australia's performance against its Kyoto target should be treated with skepticism.

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1. Introduction

The Federal Government has developed a complex accounting system to monitor and record the changes in Australia's greenhouse gas emissions. This accounting system, called the Australian National Greenhouse Accounts, is supposed to be prepared in accordance with the rules outlined in the United Nations Framework Convention on Climate Change (UNFCCC), Kyoto Protocol and the decisions of the Conferences of the Parties to these treaties. Of particular relevance is Article 4(1)(a) of the UNFCCC, which requires all Parties to '[d]evelop, periodically update, publish and make available to the Conference of the Parties, in accordance with Article 12, national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, using comparable methodologies to be agreed upon by the Conference of Parties.' Article 12 of the UNFCCC states that the Parties must submit a national inventory of anthropogenic emissions 'to the extent its capacities permit', as well as other information on the steps taken to implement the Convention and the policies and measures introduced to mitigate climate change.

Article 7 of the Protocol builds on the UNFCCC reporting requirements, stating, amongst other things, that:

> [e]ach Party included in Annex I shall incorporate in its national communication, submitted under Article 12 of the Convention, the supplementary information necessary to demonstrate compliance with its commitments under this Protocol … .

The supplementary information required for these purposes must be provided annually and, like the information provided under the UNFCCC, it must be submitted 'in accordance with the relevant decisions of the Conference of the Parties'.[1] The Conferences of the Parties to the UNFCCC and the Protocol have made a number of decisions regarding reporting requirements, including that national inventories for Annex I countries (which includes Australia and other developed countries) be prepared in accordance with the UNFCCC reporting guidelines on annual inventories (UNFCCC reporting guidelines) (SBSTA 2004).[2] The UNFCCC reporting guidelines are based on the Intergovernmental Panel on Climate Change's (IPCC) *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* (IPCC Guidelines), *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* and *Good Practice Guidance for Land Use, Land-Use Change and Forestry*.[3]

Under the UNFCCC reporting guidelines, human-induced greenhouse emissions must be reported in six sectors: energy (including stationary energy and transport); industrial processes; solvent and other product use; agriculture; waste; and land use, land use change and forestry (LULUCF). In Australia, the areas of greatest interest are the energy, agriculture and LULUCF sectors.

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[1] Kyoto Protocol, Article 7(1).

[2] See UNFCCC decision 3, COP (CP) 5 and decision 18/CP.8. See also UNFCCC decisions 3/CP.1, 4/CP.1, 9/CP.2, and 11/CP.4.

[3] Copies of relevant IPCC documents are available at: http://www.ipcc-nggip.iges.or.jp/public/public.htm (10 November 2006).

The reason for the focus on these three categories is that they account for the greatest proportion of Australia's greenhouse emissions, as well as the greatest change in emissions since 1990, which is the baseline year for the targets set under the Kyoto Protocol. The latest National Greenhouse Gas Inventory (NGGI) that was prepared in accordance with the rules governing the Kyoto Protocol indicates that the energy sector accounts for 69 per cent of Australia's emissions, agriculture 16 per cent and LULUCF six per cent (DEH 2006a; 2006b).[4] Since 1990, emissions from the energy sector have increased by 35 per cent, with the majority of this rise coming from stationary energy (43 per cent increase) and transport (23 per cent increase). In comparison, emissions from LULUCF have fallen by 73 per cent (DEH 2006a; 2006b).

The net effect of these divergent trends is that the decline in emissions from LULUCF has largely cancelled out the increases from the energy sector. The National Greenhouse Accounts indicate that, according to the Kyoto rules, Australia's total emissions have increased by only 2.3 per cent between 1990 and 2004, a rise of approximately 12 million tones of carbon dioxide equivalents (CO_2-e) (DEH 2006a; 2006b). This seemingly impressive figure provides the basis for the Federal Government's claim that Australia 'remains on track to meet its Kyoto target' of an average of 108 per cent of 1990 emission levels over the period 2008 to 2012 (Campbell 2005; 2006).[5]

Yet Australia's emissions from all sectors excluding LULUCF rose from 423 Mt CO_2-e in 1990 to 529.2 Mt CO_2-e in 2004, an increase of 25 per cent (DEH 2006a; 2006b). Current projections suggest that Australia's emissions excluding LULUCF will increase by approximately 33 per cent between 1990 and 2010 (DEH 2005b; 2006a; 2006b).

Given the importance the LULUCF sector to Australia's capacity to meet its Kyoto target, it is imperative that the accounting processes relating to this sector are as accurate as possible. However, questions have been raised about the veracity of the estimates of emissions from the LULUCF sector because of discrepancies between the Federal and Queensland Governments' land clearing data.

The object of this paper is to analyse the data on land clearing to determine whether the information presented in the National Greenhouse Accounts is accurate. Section 2 provides some background on the reporting requirements concerning the LULUCF sector, Australia's Kyoto target and the trends in emissions from land use change and forestry. Section 3 describes the system that is used to determine the rate of land clearing for the purposes of the National Greenhouse Accounts. Section 4 compares the land clearing data for Queensland that has been published by the Federal and Queensland Governments. Section 5 reviews potential explanations for the discrepancies identified in the land clearing data. Section 6 discusses the relevance of changes made to Queensland's land clearing laws in 2004 and Section 7 analyses the implications of the findings in the paper.

[4] Different accounting rules apply to the UNFCCC and Kyoto Protocol, meaning that separate emission estimates are compiled for each treaty. Unless otherwise stated, the emission estimates included in this paper are those compiled according to the Kyoto rules.

[5] For details of Australia's target, see Kyoto Protocol, Article 3(7) and Annex B.

2. LULUCF and the Australia Clause

For the purposes of Australia's reporting against its Kyoto target, the most important LULUCF issues are forestry activities and land use change. The relevant forestry activities in this context are reforestation and afforestation that has occurred since 1990.[6] This is due to the operation of Article 3(3) of the Protocol, which states that:

> [t]he net changes in greenhouse gas emissions by sources and removals by sinks resulting from direct human-induced land-use change and forestry activities, limited to afforestation, reforestation and deforestation since 1990, measured as verfiable changes in carbon stocks in each commitment period, shall be used to meet the commitments under this Article of each Party included in Annex I.

'Afforestation' is defined for these purposes as:

> … 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 defined as:

> … 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 that 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.[7]

When analysing Australia's land use change emissions, it is necessary to separate the accounting procedures that apply to the baseline from those that apply to the commitment period. In relation to the baseline, at the dying moments of the negotiations concerning the Kyoto Protocol the Federal Government managed to persuade the other Parties (by threatening not to sign the Protocol) to include an amendment to Article 3.7, which states that:

> [t]hose Parties included in Annex I for whom land-use change and forestry constituted a net source of greenhouse gas emissions in 1990 shall include in their 1990 emissions base year or period the aggregate anthropogenic carbon dioxide equivalent emissions by sources minus removals by sinks in 1990 from land-use change for the purposes of calculating their assigned amount.

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[6] Article 3(4) of the Protocol provides that the Conference of the Parties to the Protocol can decide which land use change and forestry activities, other than those identified in Article 3(3), can be taken into account for the purposes of meeting the emission targets. The Marrakesh Accords state that, amongst other things, these activities include forest management, which is defined as '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' (see UNFCCC, Marrakesh Accords, decision 11/CP.7). For the purposes of this paper, the more relevant issues relate to Article 3(3).

[7] See UNFCCC, Marrakesh Accords, decision 11/CP.7.

This clause, now commonly known as 'the Australia clause', means that Annex I countries can include emissions from land use change in their baseline if land use change and forestry constituted a net source of emissions in 1990. For most Annex I countries, this clause is irrelevant as they were not net emitters of greenhouse gases from the land use change and forestry sector in 1990. However, according to the National Greenhouse Accounts, land use change and forestry was a net source of emissions in Australia in 1990 (DEH 2006a; 2006b; 2006c). More specifically, although there were no relevant forestry sinks, pertinent land use change activities (i.e. forest and grassland conversion) constituted a significant source of emissions. As a result, Australia's 1990 baseline currently includes approximately 129 Mt CO_2-e from land use change emissions, representing 23 per cent of total emissions in that year.

For the purposes of accounting for land use change emissions over the first commitment period, the main requirement is found in Article 3(3) of the Protocol, which states that Annex I countries must include emissions from 'deforestation since 1990' in determining whether they have met their targets. 'Deforestation' is defined for these purposes as 'the direct human-induced conversion of forested land to non-forested land'.[8] Under the Kyoto rules:

> … once a Deforestation activity occurs on a unit of land, that land unit enters the framework for annual accounting of emissions and sinks on a continuing basis, including accounting for any subsequent regrowth (AGO 2002a, p. 19).

This means that the land use change category must account for sources and sinks of emissions from the deliberate conversion of forests to a non-forest condition for the purpose of a change in land use (i.e. forest to a non-forest use), the revision of a deforested unit of land to a forested condition (i.e. regrowth), and any subsequent reclearing of a regrowth forest.[9] Further, while the initial conversion event must be directly caused by human activities, reclearing can be either deliberate or due to natural events (i.e. dieback, drought, bushfires, salinity etc.).

According to the Federal Government, the emissions from land use change have declined significantly over the past 15 years, falling from 129 Mt CO_2-e in 1990 to approximately 53 Mt CO_2-e in 2004 (DEH 2006a; 2006b).[10] There has also been an increase in forest sinks. In 2004, it was estimated that eligible reforestation activities (i.e. post-1990 forestry plantations) sequestered approximately 17.8 Mt of carbon dioxide (DEH 2006a; 2006b). Consequently, the net emissions from LULUCF in 2004 were approximately 35.5 Mt CO_2-e. If these emission levels are maintained through to the end of the first Kyoto commitment period (2008-12), they will constitute a net saving of approximately 93 Mt CO_2-e per year against Australia's target, or 465 Mt CO_2-e over the five years.

[8] UNFCCC, decision 11/CP.7.

[9] Conversion, regrowth and reclearing that occurs as part of forestry operations are not counted as land use change. Relevant forestry operations are generally accounted for as reforestation, afforestation or forest management.

[10] The 2004 result is preliminary. The Commonwealth Department of the Environment and Heritage (DEH) advises that the estimate for 2004 will increase after the data have been confirmed during the following update (DEH 2006a; 2006b).

The fall in emissions from land use change is a product of a decrease in forest conversion and reclearing. That is, a decline in land clearing. According to figures from the National Carbon Accounting System (NCAS), which was established by the Federal Government to monitor sources and sinks of greenhouse emissions from Australian land based systems, approximately 650,000 hectares of eligible forests were cleared in 1990 (DEH 2005a). The equivalent figure for 2003 was 283,000 hectares,[11] meaning that the annual rate of land clearing declined by 367,000 hectares, or almost 60 per cent, over this period (DEH 2005a).[12]

NCAS attributes the majority of the decline in emissions from land use change to a dramatic fall in clearing in Queensland. According to NCAS, the rate of land clearing in Queensland fell from 412,000 hectares in 1990 (which constituted 64 per cent of clearing in Australia) to approximately 145,000 hectares[13] in 2003 (51 per cent of total clearing) (DEH 2005a). These figures indicate that the decline in clearing in Queensland accounted for 73 per cent of the total decrease in land clearing in Australia between 1990 and 2003. Similarly, the most recent data published by the Federal Government show that there was a 59 per cent drop in emissions from land use change in Australia between 1990 and 2004 and that 69 per cent of this decline was due to a decrease in emissions from Queensland (DEH 2006a; 2006e).

As the above figures highlight, Australia's capacity to meet its Kyoto target hinges on the claim that the rate of land clearing has declined significantly since 1990, particularly in Queensland. Australia's total emissions excluding land use change increased by approximately 21 per cent between 1990 and 2004 (DEH 2006a; 2006b). Similarly, Government projections indicate that if land use change emissions are at their 1990 levels in 2010, total emissions will be 27 per cent above 1990 levels, meaning Australia will exceed its Kyoto target by 19 per cent (DEH 2005b).

3. National Carbon Accounting System (NCAS)

NCAS was established by the Federal Government to monitor emissions from land based systems in Australia, including emissions from land use change. The program was initially run by the Australian Greenhouse Office (AGO). When the AGO was abolished as an executive agency in late 2004, responsibility for the operation of NCAS passed to the Department of the Environment and Heritage (DEH).

NCAS's stated aim is to:

> … provide a complete accounting and forecasting capability for human-induced sources and sinks of greenhouse gas emissions from Australian land based systems for developing an optimum greenhouse policy response to

[11] This figure is preliminary and is likely to be revised upward in later updates (DEH 2005a).
[12] A report submitted by the Federal Government to the UNFCCC in 2006 contains a significantly lower estimate of clearing in 1990 (590,843 ha) (DEH 2006d). The report also contains updated national clearing figures for the period 1991 – 2004. However, the clearing data in this report are not disaggregated on a state-by-state basis, making comparisons with the Queensland data impossible. As a result, the older land clearing estimates have been used in this paper.
[13] This figure is preliminary and is likely to be revised upward in later updates (DEH 2005a).

> requirements of the United Nations Framework Convention on Climate Change (UNFCCC) and its instruments (AGO 2002a, p. 9).[14]

To account for emissions from land use change, NCAS uses a model known as FullCAM. The FullCAM model draws on the outputs of a number of programs to provide land use change emission estimates. These programs include: land cover change, land use and management, climate input, crop growth and plant parameters, biomass stock and growth increment, tree parameters, forest growth and parameters, and soil carbon. The most relevant program for current purposes is the land cover change program.

The NCAS land cover change program has two objectives:

- to provide a 30-year monitoring of land cover change continentally commencing in the early 1970s; and

- to provide a multi-temporal, fine resolution data series identifying through time, for any land unit, land cover change (removal of forest cover and forest regrowth) that is attributable to direct human actions (AGO 2002a, p. 19).

By generating data on land clearing, the program provides a basis for estimating land use change emissions in 1990, as well as land use change emissions through to the end of the first Kyoto commitment period.

The NCAS land clearing program uses Landsat remote sensing data to estimate land use change. There are six main stages in the process:

- satellite image capture (185 km by 185 km Landsat (MSS, TM and ETM^+) satellite images that run from 1972);

- geographic registration (i.e. the use of identifiable ground features as reference points to align the image sequence);

- calibration (i.e. the use of a reference image (Landsat ETM^+ national mosaic for the year 2000) to 'adjust spectral characteristics to remove inconsistencies such as illumination caused by sun angle at the time of image capture' (AGO 2002a, p. 20));

- mosaicing (i.e. aggregration of the individual 185 km2 images into a single map of Australia by aligning the images and removing overlaps);

- thresholding (i.e. analysing whether there has been a change in vegetation cover by 'comparing each image pixel to a reference set of spectral characteristics formed by specific band mixes (indices) that represent forest and non-forest conditions' (AGO 2002a, p. 22)); and

[14] NCAS data are also now used for the purposes of national state of the environment reporting (Beeton *et al.* 2006).

- attribution (i.e. determining the cause of change and subsequent land use through the use of a 'combination of automation and visual inspection of the image sequence' (AGO 2002a, p. 20)).[15]

Thresholding is a crucial part of this process as it involves identifying which pixels are classified as forest and non-forest in the land cover image sequence. Initially, pixels are identified as either forest, non-forest or uncertain forest. To do this, reference indices that identify areas of forest are compared with spectral indices of each pixel in the land cover image sequence. The reference indices are based on aerial photographs of known forested areas, which are then compared with Landsat data of the same area and at the same time. From there, the Landsat data spectral bands of the forested area are taken as the reference indices for a particular type of forest and soil type (AGO 2002a, p. 26 – 27).

After the pixels have been identified as either forest, non-forest or uncertain forest, a 'Conditional Probability Network' (CPN) is applied. The CPN seeks to determine whether the classification is logical by comparing previous and subsequent images in a pixel sequence. For example, two consecutive clearing events would be considered illogical. If an illogical classification is identified, the FullCAM model registers an error and the pixel sequence is then manually reviewed. If an area of forest is still classified as uncertain forest after the CPN has been applied, it is determined as non-forest.

The attribution phase in the process involves identifying which change events satisfy the UNFCCC and Kyoto rules for land use change emissions. As discussed, the relevant change events are forest conversions, regrowth and reclearing of regrowth forests. For forest conversions, the vegetation change must be 'deliberately done for the purpose of the change in land use' (DEH 2006c, p. 153). In relation to regrowth and reclearing, the event can be attributable to either human activity or natural events. Forestry operations (i.e. harvesting and plantings) are not defined as land use change under the Kyoto rules unless the land is converted from forest to non-forest condition and there is a subsequent change in the land use (for example, managed forest to pasture). To remove land use change events that do not satisfy the UNFCCC and Kyoto rules, a collection of different masks are applied, relating to such things as fire, land tenure, forest harvesting on private land, salinisation, and drought and growth flushes.

The Government has stated that:

> [d]esign and implementation of the NCAS and the programs contributing to it have been subject to extensive peer review, and each program – including the application of FullCAM – is subject to a Quality Assurance/Quality Control regime (AGO 2002a, p. 18).

The Government has such faith in the quality assurance and quality control regime that it has assured the Parties to the UNFCCC that the potential for 'bias toward the inclusion of false change or toward only change where this is absolutely certain … is insignificant' (DEH 2006c, p. 110). The Government has also indicated that 'key elements of the NCAS development' were considered by 'an expert High Level

[15] See also DEH (2006c).

Steering Committee of senior representatives of State and Commonwealth Governments, academic institutions, CSIRO and industry' (AGO 2002a, p. 16). The oversight and peer review are supposed to 'ensure world's best practice and international credibility' (AGO 2002a, p. 16). Further credibility is supposed to be drawn from the fact that NCAS apparently 'exceeds the minimum requirements' specified in the IPCC Guidelines (AGO 2002a, p. 12).

4. SLATS vs. NCAS

NCAS is not the only system in Australia that collects and records data on the rate of land clearing. The Queensland Department of Natural Resources and Mines (DNRM) has a program called the Statewide Landcover and Trees Study (SLATS) that aims to determine the woody vegetation cover in Queensland and monitor the rate of deforestation. To do this, the program team uses remote sensing (i.e. satellite imagery) and geographic information system (GIS) technologies, combined with field verification. Since its foundation in 1995, it has become one of the leading programs of its type in the world and its outputs are used to identify potential illegal land clearing.

Table 1 below compares the SLATS land clearing data for Queensland against the NCAS data for Queensland and Australia. Land clearing for these purposes includes both forest conversion and reclearing. Figure 1 shows the data for Queensland as a line graph.

Table 1 Comparison between NCAS and SLATS land clearing data (,000 hectares per year), 1990 – 2003

Year	NCAS		SLATS*	Difference (%) for Queensland data***
	Queensland	National	Queensland	
1990	412.2	648.9	730	N/A
1991	319.4	509.9	730	99
1992	308.1	454.7	289	-8
1993	314.4	457.3	289	-7
1994	293.9	433.4	289	-5
1995	244.4	384.5	289	7
1996	247.3	389.4	340.3	38
1997	243.5	385	340.3	39
1998	276.9	430.7	425.2	64
1999	282.3	434.9	425.2	52
2000	291.4	425.7	757.8	164
2001	291.1	426.6	380.2	31
2002	180.4**	312.7**	497.9	111**
2003	144.6**	282.8**	553.9	240**

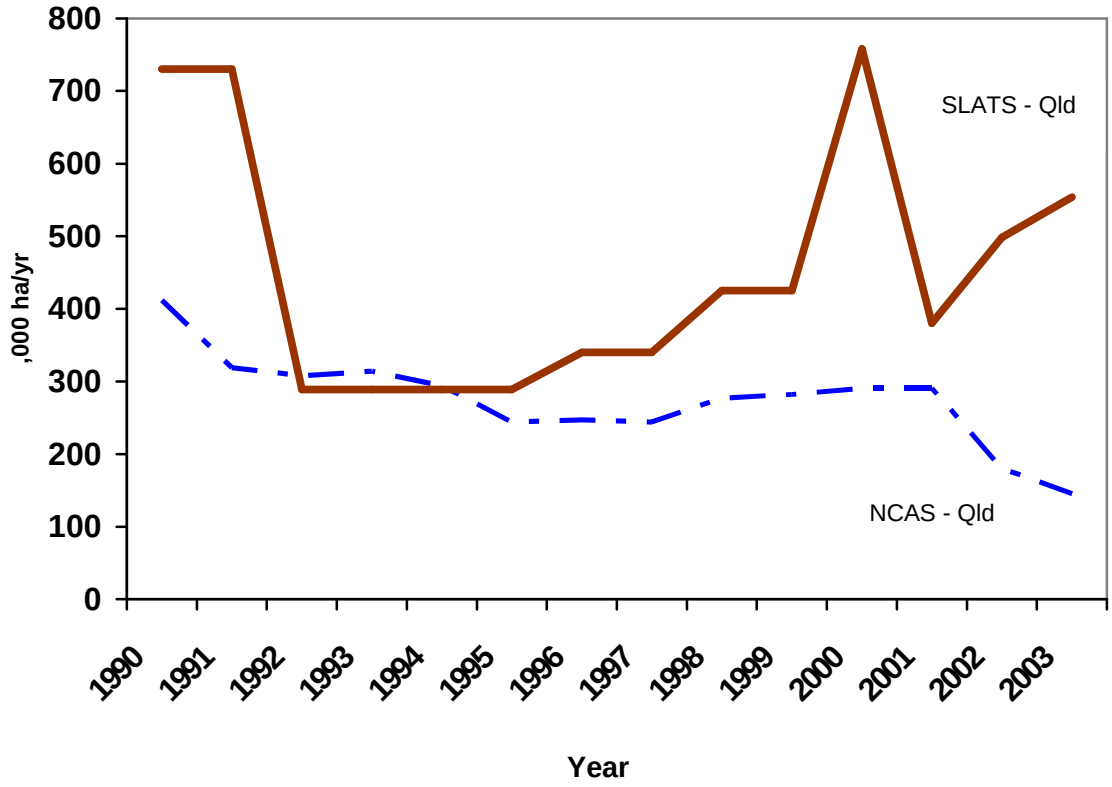
Source: DEH (2005a); DNRM (2005; 2006).

* SLATS results are provided roughly on a financial year basis. NCAS provides results on a calendar year basis. In relation to the SLATS results presented here, 1990 equates to 1989/90, 1991 to 1990/91 and so on.

** These results are preliminary. DEH advises that these estimates will increase when new data are obtained for the following update (DEH 2005a).

*** The percentage difference is calculated by comparing the SLATS estimates for each reporting period with the average from NCAS for the equivalent calendar years. For example, the SLATS estimate for 1990/91 is compared to the annual average provided by NCAS for the 1990 and 1991 calendar years. This approach was adopted to account for the difference in the reporting periods between NCAS and SLATS.

Figure 1 Comparison between NCAS and SLATS land clearing data for Queensland (,000 hectares per year), 1990 – 2003



Source: DEH (2005a); DNRM (2005; 2006).

As Table 1 and Figure 1 show, there are large differences in the data generated by SLATS and NCAS in relation to land clearing in Queensland. This is particularly the case in relation to the figures for the early 1990s and early 2000s. For example, the SLATS estimate of clearing in Queensland in 1990/91 (730,000 ha) is almost twice as large as the annual average provided by NCAS for the 1990 and 1991 calendar years (366,000 ha).[16] Similarly, the SLATS estimate for 1999/00 (758,000 ha) is 164 per cent higher than the annual average provided by NCAS for the 1999 and 2000 calendar years (287,000 ha). Overall, the total amount of land clearing in Queensland identified under SLATS between 1989/90 and 2000/01 (5.29 million ha) is approximately 50 per cent higher than the amount estimated by NCAS between 1990 and 2001 (3.52 million ha).[17] Given the magnitude of the discrepancies, it is not surprising that the SLATS estimates for land clearing in Queensland also exceed the NCAS estimates for the total amount of land clearing in Australia in a number of years. In fact, the NCAS estimates of total land clearing in Australia between 1990 and 2001 (5.38 million ha) are only slightly larger than the SLATS estimates for Queensland between 1989/90 and 2000/01.

Possibly of greater concern than the differences in the numbers generated by NCAS and SLATS is the discrepancy in the trends. NCAS shows the rate of land clearing

[16] The average of the rates provided for 1990 and 1991 is used because NCAS reports on a calendar year basis, while SLATS reports roughly on a financial year basis.
[17] The 2002 and 2003 figures were not included because the NCAS estimates for these years are preliminary.

trending downward during the first half of the 1990s, rising slightly in the late 1990s, stabilising in the early 2000s, then dropping in 2002 and 2003 (noting that the estimates for 2002 and 2003 are preliminary and that they are likely to increase). In contrast, SLATS shows a U-shaped trend through the 1990s with clearing peaks in 1989/90 and 1999/2000, after which the annual clearing rate dropped in 2000/01 before increasing in 2001/02 and 2002/03.

The comparatively high rate of clearing reported under SLATS is supported by the findings from studies conducted by the Queensland Herbarium. For example, research by Wilson *et al.* (2001) found that the annual rate of clearing of remnant vegetation in Queensland between 1997 and 1999 was 446,000 ha/yr, which is around 163,000 ha/yr higher than the SLATS estimate for remnant clearing. This discrepancy can be explained by the differences in the mapping scale and vegetation types covered by SLATS and Wilson *et al.* (2001); the former being concerned only with woody vegetation, the later with all vegetation types including grasslands.

5. Possible reasons for the discrepancies between SLATS and NCAS

There are a number of possible explanations for the discrepancies between the clearing estimates generated by SLATS and NCAS. These include the following.

Kyoto forests vs. woody vegetation

NCAS and SLATS have different definitions of what constitutes land clearing. As discussed, deforestation, or land clearing, is defined for the purposes of the Kyoto rules as 'the direct human-induced conversion of forested land to non-forested land'. 'Forests' are defined under the Kyoto rules as:

> … a minimum area of land of 0.05 – 1.0 hectares with tree crown cover (or equivalent stocking level) of more than 10 – 30 per cent with trees with the potential to reach a minimum height of 2 – 5 metres at maturity *in situ*.[18]

Utilising the flexibility provided under the Kyoto rules, the Federal Government has defined forests as an area with at least 20 per cent crown cover and vegetation with the potential to reach a minimum height of two metres at maturity. The minimum area criterion is still under consideration, but at present NCAS is using 0.2 ha (AGO 2002a; DEH 2005a; 2006c). Consequently, under NCAS, deforestation constitutes the conversion of any area of land of 0.2 ha with crown cover of more than 20 per cent with woody vegetation with the potential to reach two or more metres in height to a non-forest condition and any subsequent reclearing of regrowth forests. Areas that meet this definition are sometimes called 'Kyoto forests'.

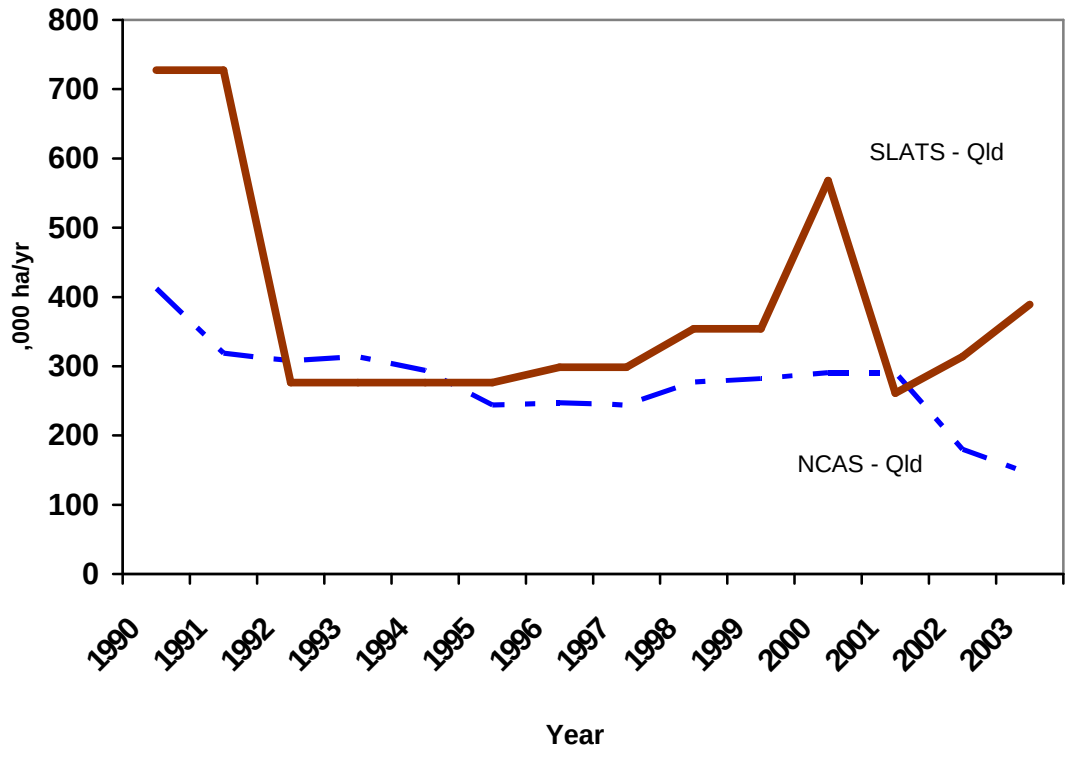
In contrast, SLATS defines land clearing as the removal of any perennial woody vegetation that can be identified using the relevant satellite imagery. The most recent SLATS report indicates that this process results in the detection of woody vegetation change to a minimum threshold of approximately eight per cent foliage projective cover (FPC), which equates to 16 per cent crown cover (DNRM 2006). Depending on the quality of the satellite imagery and whether it is affected by green pastures, the

[18] See UNFCCC, Marrakesh Accords, decision 11/CP.7.

minimum FPC detected in some areas can be higher (i.e. 10 to 12 per cent) (DNRM 2003; 2005; 2006).

This definitional difference appears to account for a significant part of the variance in the results from NCAS and SLATS. Figure 2 shows SLATS land clearing data limited to vegetation with a FPC of greater than or equal to 12 per cent – which approximates the 20 per cent crown cover definition that is used for NCAS[19] – and excluding areas that were not mapped as woody vegetation in 1991 (i.e. young regrowth), and compares these figures with those from NCAS. Although the magnitude of the difference between the SLATS and NCAS figures for the total amount of clearing over the period is reduced, significant discrepancies remain. In particular, the trends evident in the unadjusted SLATS data are still present and there are large differences in the clearing numbers for certain years. Further, because the adjusted SLATS data exclude young regrowth, they probably underestimate the amount of clearing that satisfies the Kyoto Protocol's definition of deforestation.

Figure 2 Comparison between NCAS and Adjusted SLATS land clearing data using 12 per cent FPC



Source: DEH (2005a); DNRM (2005; 2006).

[19] Vegetation with 12 per cent FPC does not directly correspond to forests that meet the Kyoto rules. SLATS uses 12 per cent FPC to approximate vegetation that has 20 per cent crown cover, while noting that 'there is no direct relationship between tree crown cover and woody FPC and generally 20% crown cover could range from 1 – 15% woody FPC, depending on location and vegetation community' (DNRM 2005, p. 24).

Thinning

Another definitional issue concerns thinning, or the partial removal of forest vegetation. Under the NCAS rules, thinning will only be counted if it results in a conversion of forest land to non-forest land. Consequently, if thinning decreases the crown cover of an area from 30 per cent to 25 per cent, it will not constitute deforestation for the purposes of NCAS. SLATS, on the other hand, includes thinning in its estimates of land clearing.

The different treatment of thinning accounts for some of the discrepancy between NCAS and SLATS. However, the amount of thinning identified in SLATS is very small. Between 2001/02 and 2002/03, the annual rate of thinning was 10,000 ha/yr, or around two per cent of the total clearing in Queensland (DNRM 2005). In 2003/04, the rate of clearing dropped to 3,000 ha/yr, which constituted less than one per cent of total clearing (DNRM 2006). Hence, thinning does not provide an adequate answer to the questions surrounding the discrepancies between NCAS and SLATS.

Forest harvesting

Under the rules governing the UNFCCC and Kyoto Protocol, forest harvesting is not included as land use change unless the harvesting results in the conversion of an area from a forested to a non-forested condition and there is a subsequent change in land use – for example, from forestry to cropping or pasture. As discussed, SLATS includes thinning in its estimates of land clearing. It also includes clearing of forestry areas (i.e. state forests (native and plantation) and private plantations that are replanted). However, as with vegetation thinning, the amount of clearing detected under SLATS that has been attributed to forestry is small. According to SLATS, between 1988/99 and 2003/04, clearing for forestry has generally constituted around one per cent of total annual land clearing (or between 3,000 and 8,000 ha/yr) (DNRM 2005; 2006). Consequently, the different treatment of forest harvesting does not provide an adequate explanation of the discrepancies in the land clearing data.

Natural change

As discussed in Section 2, NCAS only counts conversion events that are directly attributable to human actions, while reclearing events can be due to either human or natural causes. Under SLATS, where natural tree death has been detected, it has not been classified as clearing (DNR 1999a; 1999b; DNRM 2003; 2005; 2006). This raises the prospect that NCAS has counted reclearing events due to natural causes that have been excluded from SLATS. This would increase the NCAS estimates compared to those from SLATS.

The extent to which this has occurred is unclear. However, very little natural tree death has been detected under SLATS, suggesting that the impact of this difference in method is likely to be small (DNR 1999; DNRM 2003; 2006). Consequently, the discrepancies in the NCAS and SLATS data are unlikely to be explained by differences in the treatment of natural change events.

Timeframes

There are two issues concerning timeframes. Firstly, there were large gaps in the satellite imagery that was used to generate the SLATS data in the early and mid 1990s. There was a four year gap in the imagery used to generate the estimates for the period 1991 – 1995 (DNR 1999a), and a two year gap in the imagery used to produce the estimates for 1995 – 1997 (DNR 1999b), and 1997 – 1999 (DNR 2000). The gaps in the imagery are likely to have resulted in an under-reporting of land clearing, as the gap allows time for regrowth. This may partly explain the convergence in the data from SLATS and NCAS through the early to mid-1990s.

The second issue related to timeframes is that there are differences in the reporting periods for SLATS and NCAS. SLATS reports roughly on a financial year cycle, while NCAS reports on a calendar year basis. This reduces the ability to make comparisons between NCAS and SLATS data. However, it does not provide an adequate explanation for the differences that have been detected, especially in relation to the trends in the data.

Satellite imagery and interpretation

Both NCAS and SLATS have relied on similar satellite data for the relevant time periods; Landsat MSS, TM and ETM^{+}. However, different methods have been used to process and interpret the information.

The methods used to process and interpret the satellite imagery are likely to be a major cause of the differences between the NCAS and SLATS clearing data. The critical questions are whether these methods are defensible from a scientific perspective and whether the results accurately reflect what has occurred on the ground.

The methods used by NCAS and SLATS have both been subject to peer review and both programs also employ quality assurance and quality control measures to ensure the accuracy of their outputs. However, one important difference between the two is that SLATS has an extensive field verification process.

The land cover change identification process under SLATS has six distinct phases: preliminary change classification based on Landsat data; field verification; correction of preliminary classification on the basis of field observations; peer review of edited classification by a person with first hand field knowledge; cross-check of edited classification by a third party; and a two-fold filtering to ‘remove areas mapped as clearing that were not woody at the earlier date’ and remove ‘clumps of two pixels ($1250m^2$) or less’ (DNRM 2005, p. 10).

In reviewing the data for the period 2001 to 2003, 56 of the 87 scenes that were analysed for the purposes of SLATS were field checked. According to the DNRM, the selected scenes that were field checked ‘accounted for more than 99% of the overall change in the State’ (DNRM 2005, p. 10). Similarly, for the period 1999 to 2001, 57 of the 87 analysed scenes were field checked and these areas accounted for 99.7 per cent of change in vegetation (DNRM 2003). Although only a representative sample of each scene was field checked, this process has probably significantly improved the accuracy of the outputs from SLATS.

Due to the extent of field checking, the verification process under SLATS is more comprehensive than the quality assurance and quality control processes that are used under NCAS in relation to land clearing.[20] This could be a significant cause of the discrepancies in the data.

Another potential cause of the discrepancy is the forest classification system used under NCAS. As discussed, during thresholding, NCAS uses a 'three class determination of forest cover: non-forest, forest and uncertain forest' (AGO 2002a, p. 27). Where areas are classified as uncertain forest, they are determined to be non-forest unless they are confirmed as forest by the CPN application. This approach produces conservative land cover change statistics.

Data from SLATS indicates that land clearing in Queensland has moved into more marginal agricultural areas over the past 15 years (DNRM 2005; 2006). By adopting a conservative method of assessing forest cover, there is a risk that NCAS may not be detecting eligible clearing events in these marginal areas because of differences in vegetation types (for example, tall shrubs and more sparsely distributed trees being incorrectly classified as non-forest). This could introduce a bias in NCAS by lowering estimates of recent clearing, while ensuring higher estimates in 1990 when the majority of clearing was occurring in more fertile areas.

The differences between NCAS and SLATS may also be due to the fact that NCAS excludes gaps in the forest canopy from its calculations of land clearing. That is, it includes as clearing 'only the area of forest canopy loss and not 'gaps' in the forest canopy' (AGO 2002a, p. 27). While the AGO suggested this approach 'provides a conservative (lesser) calculation of area of change' (AGO 2002a, p. 27), it is unclear whether this is significantly different from the methods used for the purposes of SLATS. Moreover, while both the forest classification system and canopy gap exclusion approaches employed under NCAS may provide a partial explanation for why the NCAS estimates of land clearing could be lower than the SLATS estimates, they do not explain the differences in the trends identified in the two systems.

Does it add up?

Although most of the above potential reasons for the discrepancies appear to have some validity, considerable uncertainty remains. Some of the explanations may at least partially account for the relatively low estimates from NCAS in the early 1990s and from 1995 onward. However, they do not appear to provide an adequate explanation for the differences in the trends in the data.

The information published by the Federal Government makes no attempt to explain the variance between the two data sources. The SLATS reports do contain a discussion of NCAS. However, there is no detailed evaluation of NCAS or its land clearing data. For example, the SLATS report on the rate of clearing over the period 2001 to 2003 merely states that:

> … the NCAS uses an independent remote sensing program to give a nationally consistent estimate of forest conversion according to the Kyoto Protocol rules. These rules restrict accounting to a subset of the SLATS broader assessment

[20] On-site field verification is used under NCAS in relation to plantations (DEH 2006c).

> of woody vegetation change, as well as having the objective of strict calendar year change detection. The NCAS and SLATS estimates are therefore not directly comparable. The NCAS framework uses complex modeling to estimate greenhouse gas emissions and sinks for the areas included as "Kyoto lands". Queensland scientists continue to monitor international and national developments in greenhouse accounting and the implications for land management in Queensland (DNRM 2005, p. 4).

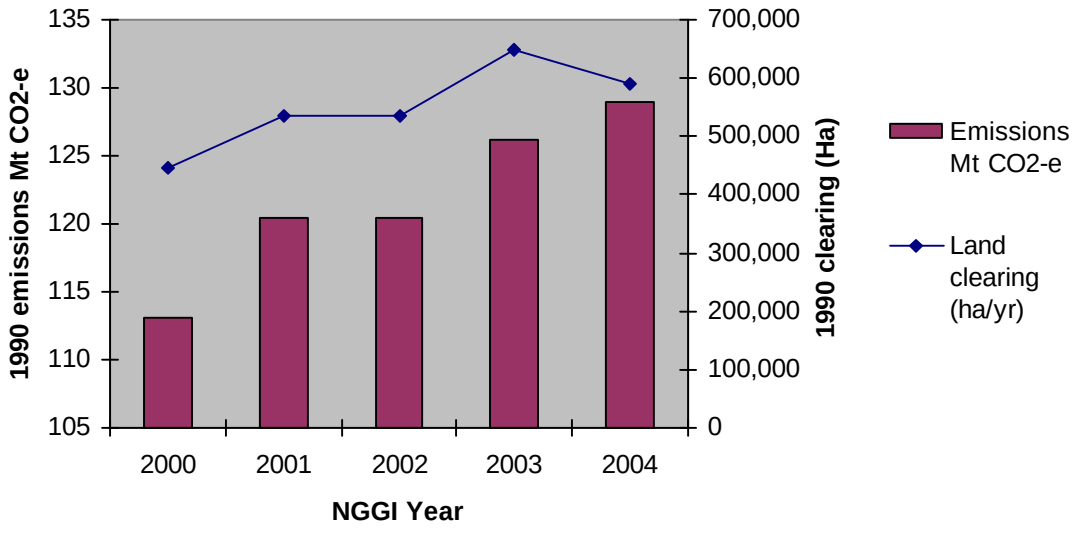
The most recent SLATS report contains a similar statement (DNRM 2006, p. 4).

Despite the Federal Government's claims that NCAS is transparent, the datasets that are used to generate the NCAS land clearing results are not publicly available. For example, there is no publicly available map of the areas that have been classified as Kyoto forests. Similarly, NCAS does not publish maps that identify where clearing is occurring. In contrast, SLATS publishes detailed clearing maps and many of its datasets are either included in its reports or are available on request. Due to the lack of information on NCAS, it is impossible to thoroughly evaluate its outputs against those from SLATS.

The magnitude of the discrepancy between the SLATS and NCAS land clearing data, the differences in the land clearing trends, and the lack of transparency raise a number of questions about the accuracy of NCAS and the Government's claims regarding Australia's greenhouse emissions.

Concerns about the accuracy of NCAS are heightened by the variability in its own results. For example, the estimates of land clearing and emissions from land use change in 1990, the base year for the purposes of commitments under both the UNFCCC and Kyoto Protocol, have fluctuated significantly since the NCAS results were first included in the NGGI in 2000 – see Figure 3.

Figure 3 NCAS estimates of land clearing and emissions from land use change in 1990, as reported in the NGGIs



Source: AGO (2002c; 2003a; 2004) and DEH (2005c; 2006c; 2006d).

The Federal Government has suggested that NCAS is a significant improvement on the previous processes that were used to estimate emissions from land use change. According to the AGO, the 'the NCAS is based on resource inventories, field studies, modeling and extensive multi-temporal remote sensing methods' and it 'provides robust and transparent emissions results' (AGO 2003b, p. iii).[21]

However, as Figure 3 shows, the estimated rate of land clearing in 1990 in the 2003 and 2004 NGGIs is 46 per cent and 33 per cent higher respectively than the estimate in the 2000 NGGI. Similarly, the estimate of land use change emissions in 1990 in the 2004 NGGI is approximately 13 per cent higher than the estimate in the 2000 NGGI. Also, curiously, the 2004 NGGI estimate of land use change emissions in 1990 is higher than the 2003 NGGI estimate even though the 2003 NGGI estimate of land clearing is nine per cent higher than the 2004 NGGI estimate.

Calculating land clearing rates and emissions from land use change are complex tasks, making it inevitable that there will be a degree of uncertainty about the results. However, as early as 2002, the Government indicated that the level of uncertainty associated with its estimates of emissions from forest and grassland conversion were 'low', or less than 20 per cent (AGO 2002c, p. A-42).[22] Government publications also emphasised that the first priority of NCAS was to develop a 1990 baseline estimate of emissions from land use change (AGO 2001). Given these statements, it is hard to explain why the NCAS estimates of land clearing and land use change in 1990 have fluctuated so wildly over a four year period.

6. Does it matter?

Arguably, the apparent anomalies associated with NCAS are likely to be largely irrelevant in determining whether Australia ultimately meets its Kyoto target. This is because changes made by the Queensland Government to the state land clearing laws in 2004 are likely to result in a significant reduction in the clearing of remnant vegetation over the period 2008-12.[23] That is, even if the NCAS figures are inaccurate, the SLATS data indicate that 1990 was a high clearing year and the

[21] In the first report contain results from NCAS over the period 1988 – 1998, the same sentence stated that NCAS provided 'more robust and transparent emissions results' (AGO 2002b, p. iii). The qualifying 'more' was removed from later reports, presumably because the Government had greater confidence in the results (AGO 2003b; DEH 2005a).

[22] Government reports suggest that the uncertainty level for the land use change estimates have not changed significantly since 2002 (AGO 2004; DEH 2006c).

[23] In 2004, the Queensland Parliament passed the *Vegetation Management and Other Legislation Amendment Act 2004* (VMLA Act), which amended several statutes include the *Vegetation Management Act 1999* (VM Act) and *Integrated Planning Act 1997* (IP Act). Amongst other things, the VMLA Act aims to improve the protection for remnant vegetation and reduce greenhouse emissions by phasing out broadscale clearing of remnant vegetation by 31 December 2006 (see section 6). Broadscale clearing applications for freehold land made before 16 May 2003, and for leasehold land made before the commencement of the VMLA Act, must be processed in accordance with the previous processes (see section 27). However, the Act provides for a final ballot of new broadscale clearing applications to be held (see section 15). Regulations have subsequently been made that provide for the allocation of 200,000 hectares of broadscale clearing under the ballot process (see Vegetation Management Regulation 2000, Reg. 5). The new laws will not completely phase out clearing in Queensland. Clearing approvals can still be provided for certain purposes (see, for example, section 22A of the VM Act) and there are a number of exemptions from the approval requirements (see, for example, Schedule 8 of the IP Act).

changes to Queensland's clearing laws should ensure a significantly lower rate of clearing over the first Kyoto commitment period.

However, the conclusion that the changes to Queensland's land clearing laws will ensure that Australia's greenhouse emissions do not exceed its Kyoto target by a substantial amount is contingent on a number of factors. Firstly, the laws must achieve their object of phasing out broadscale clearing of remnant vegetation by 31 December 2006. The history of land clearing laws indicates that there is a significant risk of illegal clearing, particularly if there are favourable farming conditions over the period 2008-12 (AGO 2000).[24] Secondly, any decline in broadscale clearing must not be offset by legal clearing of remnant and regrowth vegetation. While they have been substantially improved, Queensland's clearing laws allow land clearing to continue in a number of circumstances, particularly in relation to regrowth vegetation.[25] For there to be a significant decline in emissions from land use change, legal clearing of both remnant and regrowth vegetation must be kept to a minimum.

In addition, the argument that the changes to Queensland's land clearing laws renders the discrepancies between NCAS and SLATS irrelevant ignores the contribution that past land clearing has on emissions during the Kyoto commitment period. The rate of emissions from land clearing is dependent on the rate at which the carbon stored in the vegetation is emitted. Consequently, errors in the estimates of land clearing in the period prior to 2008 will affect the accuracy of the estimates for emissions from LULUCF over the commitment period.[26]

Australia has an obligation under the UNFCCC to ensure that the information that it submits for the purpose of the convention is accurate and verifiable. Further, as the Federal Government has publicly committed to ensure that Australia meets its Kyoto target, it has an obligation to ensure that the information that it publishes on this issue is as accurate as possible. The fact that the Queensland Government has taken steps to reduce land clearing is not a sufficient reason to ignore the anomalies identified in the NCAS data.

7. Implications

There are significant differences in the land clearing data generated by NCAS and SLATS for Queensland. The SLATS estimates exceed those produced by NCAS for the majority of the period 1990 to 2003 by a significant margin. In fact, the SLATS estimates for Queensland exceed the NCAS estimates for Australia by a sizeable amount in a number of years.

The trends from the SLATS data are also significantly different from those identified in NCAS. NCAS shows a gradual decline in the rate of land clearing in Queensland

[24] It is hoped that SLATS will reduce the risk of illegal clearing.
[25] See, for example, section 22A of the VM Act and Schedule 8, Part 1, Table 4, Items 1A – 1G of the IP Act.
[26] This issue is of only limited significance because of the assumptions that have been made for the purposes of NCAS about post-clearing management practices. It is assumed that 98 per cent of the biomass is burnt six months after the clearing event, leaving only two per cent that decomposes. However, NCAS also assumes that there is residue from the burning that is left to decompose – 10 per cent for stems, five per cent for bark, five per cent for leaf litter, 20 per cent for coarse dead roots and 30 per cent for fine roots (AGO 2002).

between 1990 and the mid-1990s, after which the rate levels out. In contrast, SLATS shows a U-shaped trend in clearing rates between 1990 and 2000, followed by a fall in 2000/01, after which the rates begin to rise again.

An adequate explanation of the discrepancies between NCAS and SLATS has not been provided. Further, there is insufficient publicly available information on NCAS to enable a meaningful comparison between the NCAS and SLATS land clearing results to be carried out. NCAS lacks transparency, making it impenetrable to outsiders and shielding it from criticism.

Given these issues, there is an urgent need for an independent review of NCAS, which amongst other things should attempt to reconcile the land clearing data from NCAS and SLATS. The anomalies in NCAS, its lack of transparency, and the discrepancies between NCAS and SLATS undermine the integrity of Australia's National Greenhouse Accounts and the ability of the general public to hold the Federal Government accountable for Australia's performance against the Kyoto target.

Until an independent review has certified the accuracy of NCAS, the Federal Government's claims about Australia's performance against its Kyoto target should be treated with skepticism.

References

Australian Greenhouse Office (AGO) 2000, *Land Clearing: A Social History*, Commonwealth of Australia, Canberra.

Australian Greenhouse Office (AGO) 2001, *National Carbon Accounting System: Informing Policy and Facilitating Markets – A Progress Report*, Commonwealth of Australia, Canberra.

Australian Greenhouse Office (AGO) 2002a, *Greenhouse Gas Emissions from Land Use Change in Australia: An Integrated Application of the National Carbon Accounting System*, Commonwealth of Australia, Canberra.

Australian Greenhouse Office (AGO) 2002b, *Greenhouse Gas Emissions from Land Use Change in Australia: Results of the National Carbon Accounting System*, Commonwealth of Australia, Canberra.

Australian Greenhouse Office (AGO) 2002c, *National Greenhouse Gas Inventory 2000 with Methodology Supplements*, Commonwealth of Australia, Canberra.

Australian Greenhouse Office (AGO) 2003a, *National Greenhouse Gas Inventory 2001*, Commonwealth of Australia, Canberra.

Australian Greenhouse Office (AGO) 2003b, *Greenhouse Gas Emissions from Land Use Change in Australia: Results of the National Carbon Accounting System 1988 – 2001*, Commonwealth of Australia, Canberra.

Australian Greenhouse Office (AGO) 2004, *National Greenhouse Gas Inventory 2002*, Commonwealth of Australia, Canberra.

Beeton, R., Buckley, K., Jones, G., Morgan, D., Reichelt, R. and Trewin, D. 2006, *Australia State of the Environment 2006*, Commonwealth of Australia, December, Canberra (available at: http://www.deh.gov.au/soe/2006/index.html (6 December 2006)).

Campbell, I. 2005, *Australia remains on track to Kyoto target*, media release, Commonwealth of Australia, 30 November, Canberra (available at: http://www.deh.gov.au/minister/env/2005/mr30nov205.html (10 November 2006)).

Campbell, I. 2006, Greenhouse Accounts show Australia is still on target for 108 per cent, media release, Commonwealth of Australia, 23 May, Canberra (available at: http://www.deh.gov.au/minister/env/2006/mr23may406.html (8 December 2006)).

Department of Natural Resources (DNR) 1999a, *Land Cover Change in Queensland 1991 – 1995*, Queensland Government, Brisbane.

Department of Natural Resources (DNR) 1999b, *Land Cover Change in Queensland 1995 – 1997*, Queensland Government, Brisbane.

Department of Natural Resources (DNR) 2000, *Land Cover Change in Queensland 1997 – 1999*, Queensland Government, Brisbane.

Department of Natural Resources and Mines (DNRM) 2003, *Land Cover Change in Queensland 1999 – 2001*, Queensland Government, Brisbane.

Department of Natural Resources and Mines (DNRM) 2005, *Land Cover Change in Queensland 2001 – 2003, Incorporating 2001 – 2002 and 2002 – 2003 Change Periods: A Statewide Landcover and Trees Study (SLATS) Report*, Queensland Government, Brisbane.

Department of Natural Resources and Mines (DNRM) 2006, *Land Cover Change in Queensland 2003 – 2004: A Statewide Landcover and Trees Study (SLATS) Report*, Queensland Government, Brisbane.

Department of the Environment and Heritage (DEH) 2005a, *Greenhouse Gas Emissions from Land Use Change in Australia: Results of the National Carbon Accounting System 1988 – 2003*, Commonwealth of Australia, Canberra.

Department of the Environment and Heritage (DEH) 2005b, *Tracking to the Kyoto Target 2005: Australia's Greenhouse Emissions Trends 1990 to 2008-12 and 2020*, Commonwealth of Australia, Canberra.

Department of the Environment and Heritage (DEH) 2005c, *National Greenhouse Gas Inventory 2003*, Commonwealth of Australia, Canberra.

Department of the Environment and Heritage (DEH) 2006a, *National Greenhouse Gas Inventory 2004: Accounting for the 108% Target*, Commonwealth of Australia, Canberra.

Department of the Environment and Heritage (DEH) 2006b, *National Greenhouse Gas Inventory: Analysis of Recent Trends and Greenhouse Indicators 1990 to 2004*, Commonwealth of Australia, Canberra.

Department of the Environment and Heritage (DEH) 2006c, *National Inventory Report 2004 – Volume 2: The Australian Government Submission to the UN Framework Convention on Climate Change*, Commonwealth of Australia, Canberra.

Department of the Environment and Heritage (DEH) 2006d, *National Inventory Report 2004 – Volume 3: The Australian Government Submission to the UN Framework Convention on Climate Change*, Commonwealth of Australia, Canberra.

Department of the Environment and Heritage (DEH) 2006e, *Queensland Greenhouse Gas Inventory 2004*, Commonwealth of Australia, Canberra.

Subsidiary Body for Scientific and Technological Advice (SBSTA) 2004, *Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual inventories (following the incorporation of the provisions of decision 13/CP.9)*, United Nations, New York (available at: http://unfccc.int/resource/docs/2004/sbsta/08.pdf (available 10 November 2006)).

Wilson, B., Neldner, V. and Accad, A. 2001, 'The extent and status of remnant vegetation in Queensland and its implications for statewide vegetation management and legislation', *The Rangeland Journal*, Vol. 24(1), pp. 6 – 35.