LULUCF offsets and Australia's 2020 abatement task

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I. Introduction

In the lead up to the third conference of the parties (COP3) to the United Nations Framework Convention on Climate Change (UNFCCC) at Kyoto in 1997, there was fierce debate about the comparability of developed country mitigation commitments. The European Union and the United States, amongst others, had suggested that all developed countries should adopt flat-rate emission reduction targets in what was to become the Kyoto Protocol's first commitment period (2008-2012). Australia was amongst a group that argued that this approach was inequitable because the costs of meeting these targets would not be uniform. To account for this, Australia sought differentiated targets, where mitigation obligations would be set having regard to the costs of fulfilling them.

Due to its dependence on coal-fired electricity generation and emissions-intensive industries, Australia claimed it would suffer relatively large economic losses in reducing its emissions and, therefore, its mitigation commitment should be less onerous than other parties. As Alexander Downer, the then Australian foreign minister explained:

> … an Australian should not have to shoulder more of the economic burden for greenhouse gas abatement than say a European, American or Japanese. We are talking about an "equality of effort".[1]

Australia's claims for a more generous target were bolstered by a series of studies published by the Australian Bureau of Agricultural and Resource Economics (ABARE), which warned of the dangers of uniform commitments and the large economic costs Australia would incur in meeting mitigation obligations.[2] In the absence of emissions trading, ABARE predicted that cutting Australia's emissions from fossil fuel combustion to 1990 levels by 2010 would reduce real gross national expenditure (GNE) by 2.6% in 2010, significantly above the projected losses in most other industrialised countries.[3] In its words:

> Owing to significant differences in economic structures and trading patterns, uniform emission abatement targets do not lead to uniform economic costs between Annex I regions … the projected economic costs for Australia, Norway, New Zealand and Japan are many times higher than those projected for the other Annex I regions.[4]

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[1] Alexander Downer, *Australia and Climate Change*, Address by the Hon Alexander Downer, MP, Minister for Foreign Affairs, to the Global Emissions Agreements and Australian Business Seminar, 7 July, Melbourne (Canberra: Commonwealth of Australia, 1997).

[2] ABARE and the Department of Foreign Affairs and Trade, *Global Climate Change: Economic Dimensions of a Cooperative International Policy Response beyond 2000* (Canberra: Commonwealth of Australia, 1995); Stephen Brown, Danielle Donovan, Brian Fisher, Kevin Hanslow, Mike Hinchy, Marny Matthewson, Cain Polidano, Vivek Tulpulé and Simon Wear, *The Economic Impact of International Climate Change Policy*, ABARE Research Report 97.4 (Canberra: Commonwealth of Australia, 1997); ABARE, *International climate change policy: economic implications for Australia*, ABARE Current Issues No. 2 (Canberra: Commonwealth of Australia, 1997); and ABARE, *International climate change policy: economic implications for Japan*, ABARE Current Issues No. 3 (Canberra: Commonwealth of Australia, 1997).

[3] Brown et al., *The Economic Impact of International Climate Change Policy*, supra, note 2.

[4] Brown et al., *The Economic Impact of International Climate Change Policy*, supra, note 2, at 5.

The final agreement that was reached in Kyoto reflected Australia's concerns. The quantified emission limitation and reduction obligations (QELROs) specified in Annex B to the Kyoto Protocol are differentiated, with Australia having the second most generous QELRO behind Iceland (108% of 1990 levels over the first commitment period).

While it was pushing for a generous QELRO, the Australian Government also sought accommodating accounting rules for terrestrial carbon stocks and fluxes (known as "land use, land-use change and forestry" (LULUCF)). The LULUCF concession it received, Article 3.7(2) (known colloquially as the "Australia clause"), rendered invalid the notion that meeting its mitigation target would be economically onerous. This provision allows Annex B parties with net emissions from LULUCF in 1990 to include deforestation emissions in their base year emissions estimate. By artificially inflating Australia's base year emissions, Article 3.7(2) effectively converted Australia's 108% target into the equivalent of a 142% increase on 1990 levels using the standard accounting rules.[5] The LULUCF offset Australia will receive courtesy of this provision is the primary reason it will meet, or come very close to meeting, its Kyoto obligations without importing foreign permits.

History is currently repeating itself in the negotiations surrounding the post-2012 international climate regime. Australia has again argued that mitigation commitments should be determined having regard to the comparability of economic effort.[6] The Australian Government has also claimed that Australia is likely to incur greater costs than most other industrialised countries in meeting any given mitigation target that is expressed as a percentage reduction off 1990 emission levels.[7] Its primary evidence in mounting this argument has been the Australian Department of Treasury's *Australia's Low Pollution Future: The Economics of Climate Change Mitigation* (Treasury Report).[8] Like the Kyoto studies before it,[9] the Treasury Report projects that LULUCF

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[5] Andrew Macintosh, *Reducing emissions from deforestation and forest degradation in developing countries: A cautionary tale from Australia* (Canberra: The Australia Institute, 2010); and Department of Climate Change and Energy Efficiency, *Australian Greenhouse Emissions Inventory System (AGEIS)* (Canberra: Commonwealth of Australia, 2010), available at <www.climatechange.gov.au/en/climate-change/emissions.aspx> (last accessed 24 January 2011).

[6] Australian Government, *Economic cost as an indicator for comparable effort: Submission to the AWG-KP and AWG-LCA* (Canberra: Commonwealth of Australia, 2009), at 1-2; and Greg Combet, *Australia in a climate changed world – Moving forward to Cancun and beyond, Address by the Hon. Greg Combet, Australian Minister for Climate Change and Energy Efficiency at the Crawford School Forum, Australian National University, 30 November 2010* (Canberra: Commonwealth of Australia, 2010).

[7] Ibid.

[8] Department of Treasury, *Australia's Low Pollution Future: The Economics of Climate Change Mitigation* (Canberra: Commonwealth of Australia, 2008).

[9] The tendency to overlook or significantly underestimate the role of LULUCF was a feature of all major reports commissioned by the Australian Government on the economic impact of the Kyoto Protocol, both before and after COP3. For relevant pre-COP3 reports, see references in note 2. The main post-COP3 reports were Stephen Brown, Darren Kennedy, Cain Polidano, Kate Woffenden, Guy Jakeman, Brett Graham, Frank Jotzo and Brain Fisher, *Economic Impacts of the Kyoto Protocol: Accounting for the three major greenhouse gases*, ABARE Research Report 99.6 (Canberra: Commonwealth of Australia, 1999); ABARE, *COP7: The economic implications of the Kyoto Protocol for Australia* (Canberra: Commonwealth of Australia, 2002); and Warwick McKibbin, *Modelling Results for the Kyoto Protocol: Report to the Australian Greenhouse Office* (Canberra: Commonwealth of Australia, 2002). The ABARE report of 1999 did not model the effects of the Australia clause. The ABARE and McKibbin reports of 2002 both included LULUCF projections based on Article 3.3 activities but they are likely to have underestimated the offsets obtained via these activities by ~70%, or 45 $MtCO_2$-e/yr.

offsets will play a relatively minor role in Australia's 2012-2020 abatement task. Meanwhile, in the negotiations, the Australian Government is seeking changes to the accounting rules to enable it to gain greater access to LULUCF offsets and has indicated that it plans to use LULUCF "as fully as possible" to meet its target.[10]

The purpose of this report is to analyse the role that LULUCF could play in Australia in the post-2012 regime. It evaluates the LULUCF opportunities that were overlooked in the Treasury Report, which are divided into two groups: those that are available under the existing accounting rules; and those that are likely to arise with the proposed amendments to the accounting framework. Section II discusses the Treasury Report and its LULUCF offset projections. Section III analyses the potential sources of additional LULUCF offsets under the existing rules. Section IV reviews the proposed rule changes and how they might affect Australia's abatement task and Section V provides a conclusion.

II. The Treasury Report

The Treasury Report analysed the costs associated with meeting mitigation targets under four scenarios: two based on a multi-stage emission entitlement allocation approach (CPRS-5 and CPRS-15) and two based on a modified contraction-and-convergence model (Garnaut-10 and Garnaut-25). For current purposes, it is sufficient to confine the discussion to the CPRS-5 scenario, under which it was assumed that the international community agrees to stabilise the atmospheric concentration of greenhouse gases at ~550 ppm in 2100 and Australia undertakes to reduce its emissions by 5% on 2000 levels by 2020 (4% on 1990 levels). Australia has submitted a mitigation pledge range of 5%-25% cuts on 2000 levels by 2020 under the Copenhagen Accord, with 5% representing its unconditional target.[11] At this point in time, it appears unlikely that Australia will move beyond its unconditional pledge without a significant shift in the negotiating positions of other major emitters.[12]

Under the CPRS-5's multi-stage emission entitlement allocation method, mitigation obligations for countries and relevant political unions were determined on the basis of an assumed rate of divergence from a projected reference case emission scenario.[13] All countries and unions had the same rate of divergence from their reference scenario but they were assumed to take on mitigation obligations at different dates. Annex B countries adopt mitigation obligations from 2010 and non-Annex B countries take on targets at different times depending on their capacities and responsibility for past emissions. The costs associated with meeting the targets determined using this method were analysed using two computable general equilibrium models, ABARE's Global Trade and Environment Model (GTEM)[14] and Warwick McKibbin and Peter Wilcoxen's

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[10] International Institute for Sustainable Development, "Annex I Emission Reductions (AWG-KP)", 12 (468) *Earth Negotiations Bulletin* (2010), 3.
[11] UNFCCC Secretariat, *Information provided by Annex I Parties relating to Appendix I of the Copenhagen Accord*, (UNFCCC, 2010), available at <http://unfccc.int/home/items/5262.php> (last accessed 10 December 2010).
[12] Combet, *Australia in a climate changed world*, supra, note 6.
[13] Department of Treasury, *Australia's Low Pollution Future*, supra, note 8.
[14] Hom Pant, *GTEM: Global Trade and Environment Model* (Canberra: ABARE, 2007).

G-Cubed model.[15] Emission targets for selected countries and unions under the CPRS-5 scenario, and the estimated GNP losses associated with meeting them, are shown in Table 1. Also shown are the pledges made by the respective countries and unions under the Copenhagen Accord.

Table 1: CPRS-5 and Copenhagen Accord mitigation targets for selected countries and political unions in 2020, and associated CPRS-5 GNP costs (GTEM estimates only)

Country/region	Mitigation target (% change on 1990)	GNP cost (% change from reference)	Copenhagen Accord pledge
Australia	-4	-1.1	5-25% cut on 2000
Canada	11	-1.1	20% cut on 2006
Japan	-21	-0.2	25% on 1990
EU-25	-34	-0.4	20-30% cut on 1990[b]
Russia & CIS[a]	-25	-3.6	15-25% cut on 1990[c]
United States	5	-0.3	17% cut on 2005
World		-0.7	

a. CIS refers to Commonwealth of Independent States.
b. The pledge made by the European Union covers its 27 member states (EU-27).
c. The pledge made by Russia does not cover any other CIS member, participant or associate.
Sources: Department of Treasury, *Australia's Low Pollution Future*, supra, note 8; and UNFCCC Secretariat, *Information provided by Annex I Parties relating to Appendix I of the Copenhagen Accord*, supra, note 11.

According to the Treasury Report, Australia's GNP losses associated with cutting its emissions by 5% by 2020 will be larger than those incurred by most other developed countries in meeting equivalent CPRS-5 mitigation obligations. Only Russia (and other CIS member states) and Canada are likely to incur similar or higher costs. As the Australian Government has stated:

> The analysis shows that Australia faces high economic costs, relative to most other developed countries, due to its large share of emission- and energy-intensive industries and a dominance of low-cost coal in electricity generation.[16]

Similar to the modelling that was undertaken for the purposes of the Kyoto Protocol, in the Treasury Report, LULUCF plays a relatively limited roll in Australia's 2012-2020 abatement task. This was partly due to the Department of Treasury's assumption that the existing LULUCF accounting rules would continue to apply in the post-2012 era. Under the Kyoto Protocol, Australia has not elected any of the voluntary LULUCF activities under Article 3.4: grazing land management, cropland management, forest management and revegetation. Due to this, the only LULUCF activities that are counted towards Australia's QELRO in the first commitment period are those outlined in Article 3.3: afforestration and reforestation (A/R), and deforestation (or land-use change (LUC)). The Department of Treasury assumed this would continue to be the case beyond 2012. The other crucial assumption underpinning the Treasury Report was that

[15] Warwick McKibbin and Peter Wilcoxen, "The Theoretical and Empirical Structure of the G-Cubed Model", 16(1) *Economic Modelling* (1998), 123.
[16] Australian Government, *Economic cost as an indicator for comparable effort*, supra, note 6, at 3-4.

Australia's proposed emissions trading scheme, the Carbon Pollution Reduction Scheme (CPRS), would be introduced in 2010 and that it would reflect the design features outlined in the CPRS Green Paper (the original version of the CPRS), under which A/R operators could elect to be covered by the scheme and deforestation was excluded entirely.[17] It was conservatively assumed that no further measures would be introduced by government to promote LULUCF abatement.

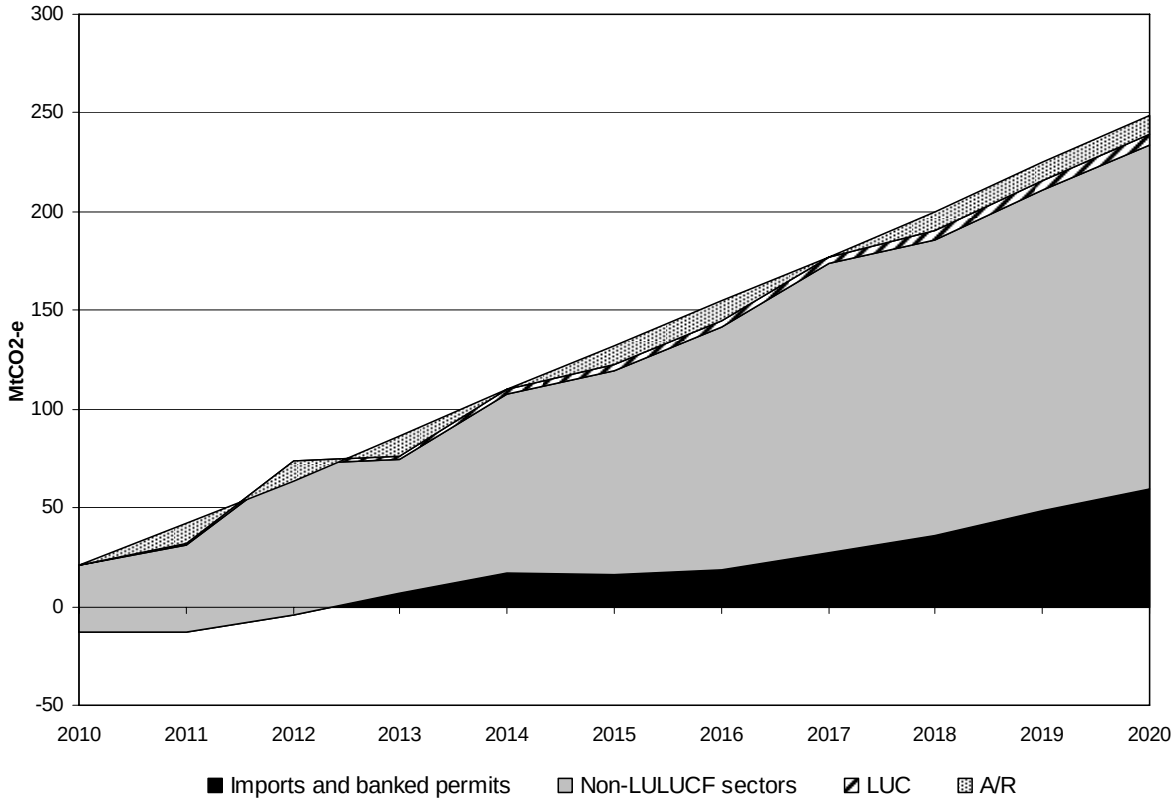
The Department of Treasury's assumptions ensured that LULUCF played a small part of the abatement effort to 2020 (Figure 1). In the Treasury Report's reference case, deforestation emissions were projected to stabilise at 44 $MtCO_2$-e/yr for the entirety of the 21st century, down from just over 70 $MtCO_2$-e in 2000 (and 132 $MtCO_2$-e in 1990).[18] Removals from A/R were projected to hover between 0 $MtCO_2$-e/yr and 20 $MtCO_2$-e/yr over the period 2010-2020, and between -10 $MtCO_2$-e/yr and 20 $MtCO_2$-e/yr for the remainder of the century. Under the CPRS-5 scenario, in 2020, Australia's emissions were projected to be 189 $MtCO_2$-e below the reference case and a further 60 $MtCO_2$-e of abatement was forecast from imported credits and banked permits. Only 2% of the total 2020 abatement task was forecast to come from a decline in net deforestation emissions, which were projected to fall from 44 $MtCO_2$-e in 2010 to 39 $MtCO_2$-e in 2020. A/R was projected to be responsible for another 4%, meaning the total LULUCF contribution to Australia's abatement task in 2020 was 6%.[19]

[17] Department of Treasury, *Australia's Low Pollution Future*, supra, note 8; and Department of Climate Change, *Carbon Pollution Reduction Scheme: Green Paper* (Canberra: Commonwealth of Australia, 2008).

[18] The Treasury Report estimate of deforestation in 1990 was 136.5 $MtCO_2$-e. This has since been revised downwards in Australia's Kyoto accounts to 132 $MtCO_2$-e. Department of Climate Change and Energy Efficiency, *AGEIS*, supra, note 5.

[19] A/R and LUC shares of Australia's cumulative abatement task over the period 2010-2020 were forecast to be 4% and 2% respectively, the same as the 2020 share.

Figure 1: CPRS-5 projected abatement from A/R, LUC, non-LULUCF sectors and imports/banked permits, 2010-2020



Source: Department of Treasury, *Australia's Low Pollution Future*, supra, note 8.

The Treasury Report potentially significantly underestimates LULUCF's contribution to Australia's abatement task. This is attributable to two issues: conservative assumptions regarding the deforestation offsets that could be generated under the existing Kyoto accounting rules; and proposed changes to the international accounting rules that could create substantial new opportunities for LULUCF abatement.

III. Deforestation offsets under the existing accounting rules

Unlike the Treasury Report's forecasts for most sectors, including A/R, the deforestation emissions projections were not a product of economic modelling. The reference scenario projection of 44 $MtCO_2$-e for the period 2010-2100 was a simple extrapolation from the Australian Government's deforestation emissions estimate for the first commitment period.[20] The mitigation scenario projection was a "guesstimate", under which net deforestation emissions

[20] Department of Treasury, *Australia's Low Pollution Future*, supra, note 8; and Department of Climate Change, *Land Use Change Sector: Greenhouse Gas Emissions Projections 2007* (Canberra: Commonwealth of Australia, 2008).

were assumed to decline linearly from 44 $MtCO_2$-e in 2010, to 24 $MtCO_2$-e in 2050 and to zero in 2100. While deforestation emissions are volatile and difficult to forecast,[21] these projections are conservative and potentially significantly underestimate the deforestation abatement Australia could realise between 2012 and 2020.

Under Articles 3.3 and 3.7(2) of the Kyoto Protocol, Australia is required to account for emissions from deforestation; the direct human-induced conversion of land that was Kyoto-complying forest on 31 December 1989 to non-forest land (i.e. forest to a non-forest use). Once a land unit is deforested, it is also required to account for all subsequent carbon stock changes and non-CO_2 greenhouse gas emissions on the land unit, irrespective of whether they are attributable to an anthropogenic (i.e. reclearing) or non-anthropogenic (e.g. regrowth, fires, dieback, pest invasion) cause. Due to these rules, Australia has a number of options for reducing its net deforestation emissions, including reducing forest conversion and promoting the regeneration of forests on deforested land units.

Between 1990 and 2008, approximately 6 Mha of Kyoto forests were cleared in Australia, releasing ~1.3 $GtCO_2$-e.[22] Most of this (~85%) occurred in Queensland and New South Wales, primarily for agriculture.[23] In the 1990s, the relevant state governments introduced laws to curb forest conversion but it was not until 2003 that real progress was made. Between 2003 and 2006, changes were made to the vegetation management laws in these jurisdictions with the objective of ending broad-scale clearing of remnant native vegetation.[24] In 2008, the Australian Government estimated that these measures would reduce net deforestation emissions by 28 $MtCO_2$-e/yr over the first commitment period.[25] However, due to uncertainties associated with implementation, this estimate was adjusted to 24 $MtCO_2$-e/yr, providing the basis for the 44 $MtCO_2$-e/yr projection used in the Treasury Report's reference scenario.[26]

At the time this initial assessment was undertaken, the environmental effectiveness of the new vegetation management laws was unclear. The legislative regimes were in their infancy and the available data did not provide a clear indication of likely future trends in native vegetation removal. Since then, new data have emerged that suggests that, in Queensland at least (which has accounted for ~70% of post-1990 deforestation), the new legislative regime has produced a sharp decline in woody vegetation clearing and potentially broken the nexus between vegetation removal, commodity prices and rainfall (Figure 2). A continuation in this downward trend in

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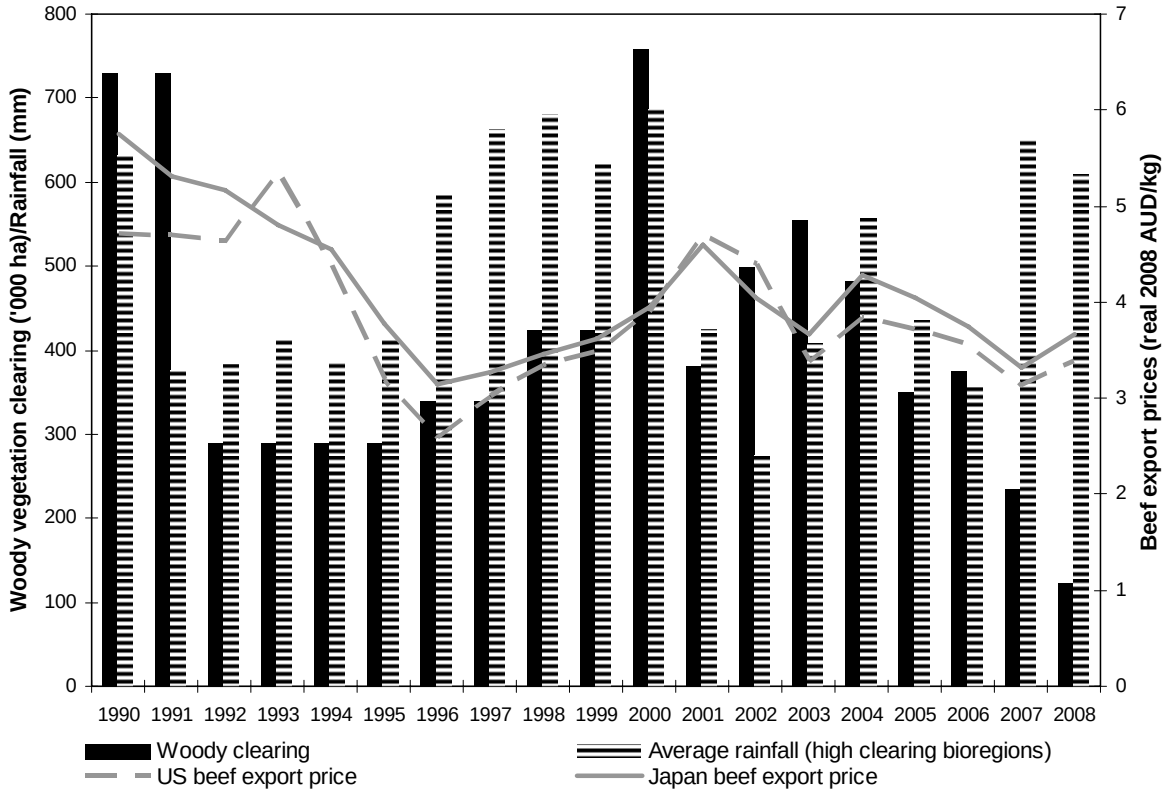
[21] Macintosh, *Reducing emissions from deforestation and forest degradation in developing countries*, supra, note 5.
[22] Department of Climate Change and Energy Efficiency, *AGEIS*, supra, note 5; Department of Climate Change, *National Carbon Accounting System – LULUCF: Activity Table: Australia* (Canberra: Commonwealth of Australia, 2008); and Australian Government, *National Carbon Accounting System Forest Cover* (Canberra: Commonwealth of Australia, 2010).
[23] Ibid. Australia is comprised of six states and two mainland self-governing territories: New South Wales, Queensland, South Australia, Tasmania, Victoria, Western Australia, Northern Territory and the Australian Capital Territory.
[24] Macintosh, *Reducing emissions from deforestation and forest degradation in developing countries*, supra, note 5.
[25] Department of Climate Change, *Land Use Change Sector: Greenhouse Gas Emissions Projections 2007*, supra, note 20.
[26] Department of Treasury, *Australia's Low Pollution Future*, supra, note 8.

vegetation clearing is likely to be matched by similar trends in deforestation, leading to the generation of additional deforestation offsets that were not accounted for in the Treasury Report.

Figure 2: Trends in Queensland woody vegetation clearing ('000 ha), average rainfall in high clearing Queensland bioregions (Brigalow Belt North and South, Desert Uplands and Mulga Lands) and beef export prices (Japan and United States) (real 2008 AUD/kg), 1990 to 2008



Sources: ABARE, *Australian Commodity Statistics 2010* (Canberra: Commonwealth of Australia, 2010); Australian Bureau of Meteorology, *Climate Data Online* (Canberra: Commonwealth of Australia, 2011), available at <http://www.bom.gov.au/climate/data/> (last accessed 9 February 2011); and Queensland Department of Environment and Resource Management, *Land cover change in Queensland 2007-08: A Statewide Landcover and Trees Study (SLATS) Report* (Brisbane: Queensland Government, 2009).

The prospects of deforestation offsets being an important contributor to the 2012-2020 abatement effort were further enhanced in April 2009, when the Queensland Government tighten its vegetation management laws. These changes placed new restrictions on the removal of high-value regrowth vegetation that has not been cleared since 31 December 1989 and native vegetation adjacent to regrowth watercourses in the so-called "priority" Great Barrier Reef catchments (Burdekin, Mackay-Whitsundays and Wet Tropics).[27] Prior to the changes, less than

[27] Queensland Department of Environment and Resource Management, *Regrowth vegetation code – on freehold and Indigenous land and leasehold land for agriculture and grazing (Version 1)* (Brisbane: Queensland Government, 2009); and Queensland Department of Environment and Resource Management, *Regulations for clearing regrowth*

240,000 ha out of an estimated 33 Mha of regrowth vegetation in Queensland was subject to clearing regulations. The Queensland Government has stated that the new laws will protect an additional 1 Mha of regrowth vegetation and subject a total of 2.3 Mha of regrowth to "minimum standards and best land management practice".[28] The reductions in net emissions that could arise from these changes are uncertain, although they are likely to be at least 2 $MtCO_2$-e/yr over the period 2010 to 2050.[29]

The main benefit of the existing vegetation management regimes in Queensland and New South Wales for the purposes of Australia's greenhouse accounts is that they reduce emissions from forest conversion. The other area of deforestation abatement potential lies in promoting biosequestration in deforested land units. The attraction of pursuing abatement opportunities in deforested land units stems from the magnitude and low cost of the potential offsets. Due to the extent of deforestation since 1990, Australia now has ~6 Mha of "active" deforested land units from which it can generate at least 1.3 $GtCO_2$-e of offsets by re-sequestering the carbon lost in the initial clearing events. Unlike A/R projects, regrowth forests on deforested land units do not have to be directly human-induced in order to generate credits under the Kyoto accounting rules. This can reduce the establishment and management costs associated with these forests. A large proportion of deforestation since 1990 has also occurred in marginal agricultural areas, ensuring that the opportunity cost of modifying or stopping agricultural production on these land units is likely to be low.[30]

Australian governments are alive to the opportunities for abatement in deforested land units. The final version of the CPRS provided for the generation of credits from, amongst other things, regrowth forests and soil carbon on deforested land units.[31] The Government also indicated that, subject to the development of robust methodologies, it would consider providing credits for avoided deforestation. In the lead up to the 2010 federal election, the CPRS was shelved, with the Government indicating that it would not be introduced until at least the end of 2012.[32] Soon after, it announced that a "Carbon Farming Initiative" would be established to promote LULUCF

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vegetation (Brisbane: Queensland Government, 2010), available at <www.derm.qld.gov.au/vegetation/regrowth_vegetation_regulations.html> (last accessed 21 December 2010).

[28] Queensland Department of Environment and Resource Management, *Capturing Carbon in the Rural Landscape: Opportunities for Queensland* (Brisbane: Queensland Government, 2010), at 22.

[29] Conservatively assumes the new restrictions effectively prevent the removal of 0.5 Mha of qualifying "Kyoto forest" regrowth that would otherwise have been cleared over the period 2010-2050. If these areas had been cleared, it was assumed they would have released 45 tC/ha. Potential additional sequestration removals associated with avoided clearing were not included, primarily because a large proportion of the relevant land units would not be classified as deforested for the purposes of Australia's Kyoto accounts (i.e. high-value regrowth is defined as mature native vegetation that has not been cleared since 31 December 1989).

[30] Australian Government, *National Carbon Accounting System Forest Cover*, supra, note 22; and The Nous Group, *Outback carbon: An assessment of carbon storage, sequestration and greenhouse gas emissions in remote Australia*, Report for Pew Environment Group-Australia and The Nature Conservancy (Canberra: The Nous Group, 2010).

[31] Soil carbon credits would only be available from 2013. See Australian Government, *Details of Proposed CPRS Changes* (Canberra: Commonwealth of Australia, 2009), available at <http://www.climatechange.gov.au/minister/previous/wong/2009/media-releases/November/mr20091124.aspx> (last accessed 13 January 2011).

[32] Andrew Macintosh, Deb Wilkinson and Richard Denniss, "Climate Change" in Chris Aulich and Mark Evans, *The Rudd Government: Australian Commonwealth Administration 2007-2010* (Canberra: ANU E-press, 2010).

abatement.[33] At the time of writing, the details of the Carbon Farming Initiative were still being finalised but the broad intent of the scheme is to establish a framework for the certification of LULUCF offset credits to facilitate their exchange in voluntary markets and international and domestic compliance markets. The material released by the Government suggests that the initiative will cover regrowth forests and soil carbon on deforested land units and avoided deforestation.[34] Ultimately, the Government is intending to link this initiative with a future carbon pricing mechanism, which it is in the process of negotiating through a Multi-Party Climate Change Committee compromising representatives from different political parties and independent members of Parliament.

To further promote LULUCF abatement, the Australian Government has invested $16.1 million over four years to develop a new software package that will allow landholders to evaluate the likely carbon benefits of selected activities. The Queensland Government has also allocated $3.5 million for the development of a similar web-based tool as part of the Carbon Accumulation through Ecosystem Recovery (CATER) project.[35] All of these initiatives are laying the foundations for Australia to take advantage of its extensive deforestation abatement opportunities.

Table 2 contains estimates of the theoretical maximum deforestation offsets that Australia could generate in 2020, and over the period 2012-2100, and compares these to the projections in the Treasury Report's reference and CPRS-5 scenarios. The theoretical maximums do not account for the costs of abatement or the social and political issues associated with realising deforestation abatement opportunities. Notwithstanding this, the magnitude of the potential and current policy settings suggest deforestation offsets will play a more significant role in Australia's 2012-2020 abatement task than forecast in the Treasury Report.

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[33] Australian Labor Party, *Carbon Farming Initiative* (Canberra: Australian Labor Party, 2010), available at <http://www.alp.org.au/agenda/more---policies/carbon-farming-initiative/> (last accessed 13 January 2011).
[34] Department of Climate Change and Energy Efficiency, *Design of the Carbon Farming Initiative: Consultation Paper* (Canberra: Commonwealth of Australia, 2010); Australian Government, *Carbon Credits (Carbon Farming Initiative) Bill 2011 – Exposure Draft* (Canberra: Commonwealth of Australia, 2010); and Michael Rooney (Department of Climate Change and Energy Efficiency, pers. comms., 13 January 2011).
[35] Queensland Department of Environment and Resource Management, *Capturing Carbon in the Rural Landscape*, supra, note 28.

Table 2: Theoretical maximum deforestation offsets, 2020 and cumulative from 2012 to 2100, existing Kyoto rules ($MtCO_2$)

Treasury Report reference scenario, 2020	
Net deforestation emissions	44
Deforestation offsets	88
Treasury Report CPRS-5 scenario, 2020	
Net deforestation emissions	39
Deforestation offsets	93
Theoretical maximum deforestation offsets in 2020[a]	
Emissions from forest conversion	0
Net emissions from deforested land units	-24
Net deforestation emissions	-24
Deforestation offsets	155
Theoretical maximum cumulative deforestation offsets, 2012 to 2100[a]	
Emissions from forest conversion	0
Net emissions from deforested land units	-1289
Deforestation offsets	12997

a. Assumes complete cessation of forest conversion and regrowth clearing on deforested land units (estimate of 6 Mha) in 2012. Also assumes that landholders cease any activities that might inhibit regrowth and/or take measures to encourage regrowth on deforested land units from 2012. As a result of these changes in land management, the estimated carbon lost through deforestation (mean 59 tC/ha) was assumed to be recovered over 100 years, with the annual increment in the relevant carbon pools (aboveground and belowground biomass, dead wood, litter and soil) declining linearly over that period. It was conservatively assumed that no additional carbon could be sequestered on deforested land units. Sources: Department of Treasury, *Australia's Low Pollution Future*, supra, note 8; Australian Government, *National Inventory Report 2008* (Canberra: Commonwealth of Australia, 2010); Rob Fensham and Gordon Guymer, "Carbon accumulation through ecosystem recovery", 12 *Environmental Science & Policy* (2009), 367; Yin Chan, Annette Cowie, Georgina Kelly, Bhupinderpal Singh and Peter Slavich, *Scoping Paper: Soil Organic Carbon Sequestration Potential for Agriculture in NSW* (Sydney: NSW Department of Primary Industries, New South Wales Government, 2008); Australian Greenhouse Office, *Australian Methodology for the Estimation of Greenhouse Gas Emissions and Sinks 2003: Land Use, Land Use Change and Forestry* (Canberra: Commonwealth of Australia, 2005); Xiaoyong Chen, Lindsay Hutley and Derek Eamus, "Carbon balance of a tropical savanna of northern Australia", 137 *Oecologia* (2003), 399; Adrian Webb (ed), *Pre-clearing Soil Carbon Levels in Australia*, National Carbon Accounting System Technical Report No. 12 (Canberra: Commonwealth of Australia, 2002); Richard Conant, Keith Paustian and Edward Elliott, "Grassland Management and Conversion into Grassland: Effects on Soil Carbon", 11(2) *Ecological Applications* (2001), 343; Gemma Woldendorp and Rodney Keenan, "Coarse woody debris in Australian forest ecosystems: A review", 30 *Austral Ecology* (2005), 834; and author estimates.

IV. Proposed changes to the international LULUCF rules

Changes have been proposed to the international accounting rules that could enable Australia to access significant additional LULUCF offsets. The three most important of the proposed amendments are:

- the exclusion of emissions associated with major natural disturbances (known as the "force majeure" clause);
- the use of a baseline-and-credit system for forest management accounting; and
- the adoption of an "emissions-to-atmosphere" approach for harvested wood products.

1. Symmetrical exclusion of major natural disturbances – force majeure

The carbon flux associated with LULUCF activities is generally characterised by extended periods of gradual sequestration punctuated by short periods of rapid emissions. Apart from human activities, the other cause of rapid carbon stock losses is major natural disturbances (large wildfires, droughts, pest outbreaks etc.).[36] The unpredictability of major natural disturbances, combined with the length of the commitment period under the Kyoto Protocol, creates difficulties for countries wanting to pursue abatement opportunities associated with LULUCF activities. Increases in the terrestrial carbon stock that are induced by management changes could be rapidly reversed in the commitment period, leading to the country incurring debits that must be offset by abatement in other sectors or the importation of foreign permits.

Australia is vulnerable to the effects of natural disturbances, especially wildfires. On average, around 50 Mha are affected by fire in Australia each year, mostly in the northern parts of the continent.[37] These fires include both prescribed burns, which are generally low intensity fires that remove only fine litter from forests, and wildfires that can be of very high intensity. Wildfires affect around 850,000 ha of forests each year and, in extreme cases, can have a marked effect on Australia's greenhouse accounts.[38] This occurred in the 2002-03 fire season when wildfires burnt around 3 Mha of forest in New South Wales, Victoria and the Australian Capital Territory.[39] As Figure 3 shows, these fires triggered a significant increase in net emissions from Australia's forest lands (UNFCCC accounting). Emissions from fires on Australia's forest lands in the 1990s averaged 0.7 $MtCO_2$-e/yr but, in 2003, they were 189 $MtCO_2$-e. This spike in fire-related emissions helped push Australia's total emissions (UNFCCC accounting) to 681 $MtCO_2$-e, well above the 1990-2008 average of 549 $MtCO_2$-e. The risk that bushfires could

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[36] Josep Canadell, Miko Kirschbaum, Werner Kurz, María-José Sanz, Bernhard Schlamadinger and Yoshiki Yamagata, "Factoring out natural and indirect human effects on terrestrial carbon sources and sinks", 10 *Environmental Science & Policy* (2007), 370; and Josep Canadell and Michael Raupach, "Managing Forests for Climate Change Mitigation", 320 *Science* (2008), 1456.

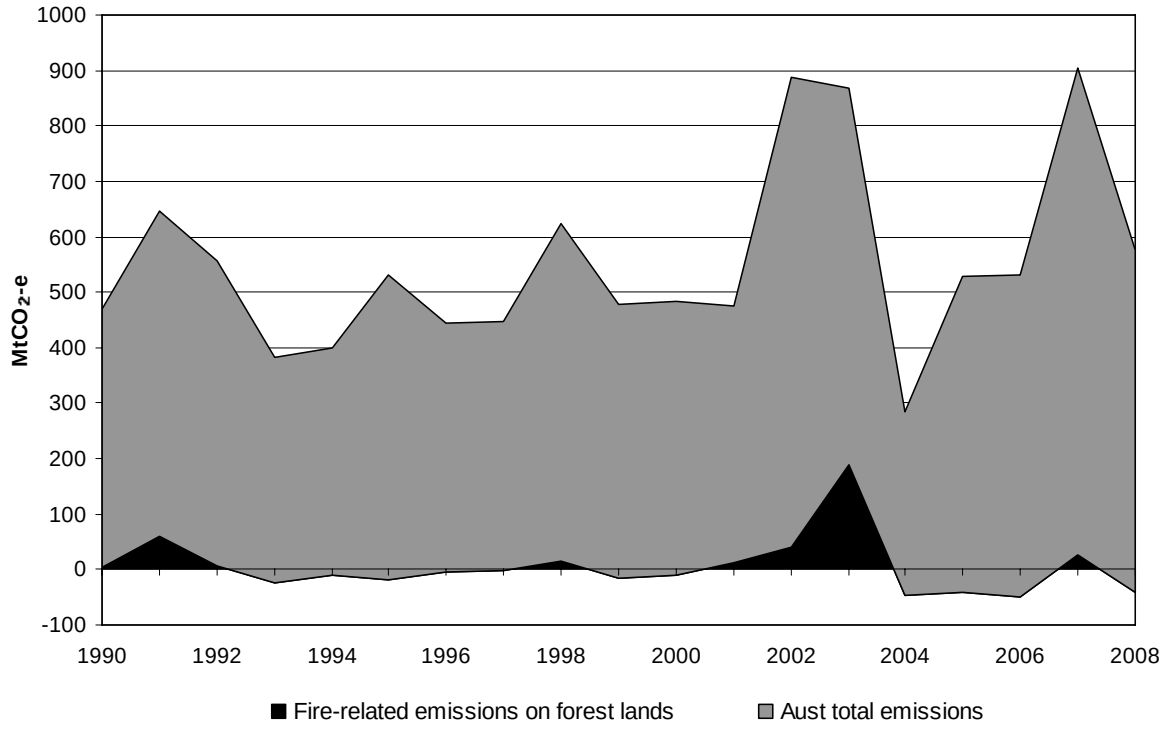
[37] Stuart Ellis, Peter Kanowski and Rob Whelan, *National Inquiry on Bushfire Mitigation and Management* (Canberra: Council of Australian Governments, 2004).

[38] Australian Government, *National Inventory Report 2008* (Canberra: Commonwealth of Australia, 2010).

[39] Ellis et al., *National Inquiry on Bushfire Mitigation and Management*, supra, note 37; Australian Government, *National Inventory Report 2008*, supra, note 38.

cause an inconvenient increase in emissions during the commitment period was one of the reasons Australia decided not to elect any Article 3.4 activities in the first commitment period.[40] Due to this decision, Australia's exposure to major natural disturbance risks under the Kyoto Protocol is confined to A/R and deforested land units.[41]

Figure 3: Net emissions from fires on forest lands, and Australia's total emissions, 1990 to 2008, UNFCCC accounting



Source: Department of Climate Change and Energy Efficiency, *AGEIS*, supra, note 5.

In order to nullify the risks posed by major natural disturbances, Australia and a number of other countries have proposed that parties be given the option of excluding emissions and removals associated with major disturbance events. Under this proposal, a country could choose to exclude from its national total the CO_2 and non-CO_2 greenhouse gas emissions from a "major natural disturbance" on Article 3.3 and Article 3.4 lands. Parties taking up this option would then be required to exclude any subsequent CO_2 removals on the affected lands until the same amount of CO_2 is sequestered as was released in the initial disturbance event. If land-use change occurs after a major natural disturbance, all of the initial emissions and subsequent removals would be counted. Similarly, parties would be required to account for any future anthropogenic emissions

[40] Australian Government, *Carbon Pollution Reduction Scheme: Australia's Low Pollution Future – White Paper* (Canberra: Commonwealth of Australia, 2008); and Australian Government, *Land Use, Land-Use Change and Forestry (LULUCF) Sector: Submission to the AWG-KP and AWG-LCA* (Canberra: Commonwealth of Australia, 2008).

[41] A/R exposure is limited by the harvest sub-rule.

on land units subject to a major disturbance event (e.g. emissions from salvage logging following a bushfire).

What might constitute a major natural disturbance is currently unclear, although the Australian Government has stipulated that the impacts of such an event must go beyond the normal levels of natural variability. In its words:

> … natural disturbances which form part of Parties' usual levels of variability, such as minor fires and pest activity should be accounted for and should be a part of Parties' emissions projections.[42]

The separation of natural variability from major natural disturbances is of particular importance to Australia, which has a highly variable climate. Droughts are a common feature of the landscape, with major declines in precipitation being recorded in large parts of the continent roughly every 7 to 15 years.[43] These events can have a noticeable effect on emissions and removals from managed lands, as was demonstrated in 2002 when drought resulted in a large release of carbon from Australia's cropland and grassland areas.[44] Given the nature of the Australian climate, a question arises as to whether droughts should qualify as a major natural disturbance and, if so, when. The Australian Government's position on this point appears to be that, in the event of a "major drought", Article 3.3 and 3.4 lands could be excluded.[45] Consistent with this approach, within the international negotiations, it has been proposed that major natural disturbances be defined as a kind of "force majeure", or an extraordinary event or circumstance that is "beyond the control of, and not materially influenced by" the country.[46] It has also been mooted that, in order to trigger access to the option of symmetrically excluding emissions, the annual emissions and removals associated with the event must exceed a set percentage of the country's base year emissions.[47]

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[42] Australian Government, *Land Use, Land-Use Change and Forestry (LULUCF) Sector: Submission to the AWG-KP and AWG-LCA*, supra, note 40, at 3.
[43] Ronald Heathcote, "Drought in Australia: Still a Problem of Perception?", 16(4) *GeoJournal* (1988), 387; Australian Bureau of Meteorology, *Special Climate Statement 9: An exceptionally dry decade in parts of southern and eastern Australia: October 1996 – September 2006* (Canberra: Commonwealth of Australia, 10 October 2006); Australian Bureau of Meteorology, *Special Climate Statement 14: Six years of widespread drought in southern and eastern Australia November 2001 – October 2007* (Canberra: Commonwealth of Australia, 1 November 2007); Australian Bureau of Meteorology, *Special Climate Statement 16: Long-term rainfall deficiencies continue in southern Australia while wet conditions dominate the north* (Canbera: Commonwealth of Australia, 10 October 2008); and Australian Bureau of Meteorology, *Drought Statement Archive: For the 1, 8 and 13-year periods ending 31st March 2010* (Canberra: Commonwealth of Australia, 8 April 2010).
[44] Australian Government, *National Inventory Report 2008*, supra, note 38.
[45] Australian Government, *Land Use, Land-Use Change and Forestry (LULUCF): Informal Data Submission* (Canberra: Commonwealth of Australia, 2009).
[46] UNFCCC Secretariat, *Document to facilitate negotiations among Parties*, FCCC/KP/AWG/2010/6/Add.2 (Bonn: UNFCCC, 29 April 2010), at 5; and UNFCCC Secretariat, *Consideration of further commitments for Annex I Parties under the Kyoto Protocol*, FCCC/KP/AWG/2010/CRP.2 (Bonn: UNFCCC, 6 August 2010).
[47] Ibid.

2. Baseline-and-credit system for forest management accounting

Under the Kyoto accounting rules, emissions and removals associated with forest management are accounted for on a gross-net basis (carbon stock changes on forest management lands during the commitment period). There are also two caps that apply to the use of forest management credits. First, if the Article 3.3 activities constitute a net source of emissions in the commitment period, forest management credits can be used to offset these emissions but the offset is capped at 9 MtC times five.[48] Second, if there are surplus forest management credits remaining after Article 3.3 emissions have been offset, these can be added to any credits obtained from Joint Implementation forest management projects (i.e. Emission Reduction Units) and counted towards the country's QELRO up to a prescribed limit.[49]

A number of proposals have been put forward to modify these rules, one of which involves the use of a baseline-and-credit system. Under this proposal, reference levels would be set for net forest management emissions for each relevant developed country. The credits and debits that are recorded during the commitment period would be calculated by subtracting the reference level from the reported emissions. Parties whose net forest management emissions are higher than the reference level would incur debits and those whose emissions are below the reference level would receive credits.

The rationale behind the baseline-and-credit proposal is that the use of reference levels could limit the capacity of countries to obtain credits for changes in forest carbon stocks and fluxes that are unrelated to direct management actions taken after 1990. Under the existing gross-net accounting rule, countries can earn credits for fluctuations that are due to age-class, natural (climate variability and natural disturbance) and indirect human-induced (CO_2 fertilisation) factors. A baseline-and-credit system could prevent this by setting reference levels that account for these factors, thereby ensuring that forest management credits and debits reflect only the post-1990 direct anthropogenic influence.

3. Harvested wood products

The existing forest accounting rules assume that the carbon stored in wood products is released into the atmosphere in the year of harvest (instantaneous oxidation). The rationale behind this rule is that it is simple, avoids the difficulties associated with tracking the lifecycle of wood

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[48] If the area subject to deforestation is offset by an equal area of A/R, the net effect on the climate system over time will largely be neutral (assuming equivalency in forest and soil types). However, deforestation results in a near-instantaneous release of a large amount of carbon, while A/R removes a relatively small amount each year over a longer period of time. The parties to the Kyoto Protocol agreed that this natural cycle could lead to unduly harsh outcomes for some parties (they would incur net debits in the first commitment period and have to wait for latter periods to earn the equivalent A/R credits). The forest management offsetting rule and associated 9 MtC cap was designed to deal with this issue. See Niklas Höhne, Sina Wartman, Anke Herold and Annette Freibauer, "The rules for land use, land use change and forestry under the Kyoto Protocol – lessons learned for the future climate negotiations', 10 *Environmental Science & Policy* (2007), 353.

[49] This rule was designed to prevent countries from receiving excessive windfall credits as a result of natural, indirect human-induced and age-class effects. See Bernhard Schlamadinger et al., "A synopsis of land use, land-use change and forestry (LULUCF) under the Kyoto Protocol and Marrakech Accords", 10 *Environmental Science & Policy* (2007), 271.

products and ensures consistency amongst all parties. While convenient, the rule is a fiction as carbon is stored in wood products for varying lengths of time depending on the nature of the product and wood type. As a result, countries are required to record forestry-related emissions under Articles 3.3, 3.4 (forestry management, if it is elected), 6 (Joint Implementation forestry projects) and 12 (Clean Development Mechanism (CDM) forestry projects) where none occur. This leads to false accounting and diminishes the incentive for countries to promote the production and use of long-lived wood products as a substitute for more carbon intensive ones.[50]

There have been debates over the merits of different harvested wood products accounting methods for a number of years, with several parties advocating changes to ensure the accounts better reflect the actual pattern and timing of emissions and removals.[51] New Zealand has been one of the leading proponents of change, arguing that the current method be replaced with its "emissions-to-atmosphere" approach. The basic elements of this proposal are as follows.

- Unless there is no better data, emissions would be accounted for when they occur using a method based on the average lifetime of different wood products and byproducts. Under this approach, all carbon removed from a forest area would be allocated to specific product and byproduct categories (e.g. timber, paper, fuelwood). Annual wood product emissions would then be calculated using country-specific or default internationally-agreed lifetimes for these categories of products and byproducts.

- Responsibility for wood product emissions would lie with the wood producing country (i.e. all emissions from a forest area would remain with the producing country even if the wood products and byproducts are exported).[52]

- Harvested wood product emissions would only be counted if they are derived from a forest area that is covered under the Kyoto Protocol. This could cover emissions associated with CDM forestry projects.

The Australian Government has long advocated for a change to harvested wood product accounting, suggesting that the rules should "more accurately reflect *what the atmosphere sees*".[53] Initially, it argued that the rules should account for wood product emissions when and *where* they occur.[54] More recently, it has thrown its support behind the emissions-to-atmosphere

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[50] Mario Tonosaki, "Harvested wood products accounting in the post Kyoto commitment period", 55 *Journal of Wood Science* (2009), 390.
[51] Bo Lim, Sandra Brown and Bernhard Schlamadinger, "Carbon accounting for forest harvesting and wood products: review and evaluation of different approaches", 2 *Environmental Science & Policy* (1999), 207; Tonosaki, "Harvested wood products accounting in the post Kyoto commitment period", supra, note 50; Justin Ford-Robertson, *Implications of Harvested Wood Products Accounting: Analysis of issues raised by Parties to the UNFCCC and Development of a Simple Decay Approach* (Rotorua: New Zealand Ministry of Agriculture and Forestry, 2003); and Carly Green, Valerio Avitabile, Edward Farrell and Kenneth Byrne, "Reporting harvested wood products in national greenhouse gas inventories: Implications for Ireland", 30(2) *Biomass and Bioenergy* (2006), 105.
[52] This is different from the methodology used by Australia in its UNFCCC accounts, whereby emissions from exported wood products are excluded and emissions from import wood products are included in the national total. See Australian Government, *National Inventory Report 2008*, supra, note 38.
[53] Australian Government, *Land Use, Land-Use Change and Forestry (LULUCF) Sector: Submission to the AWG-KP and AWG-LCA*, supra, note 40, at 7.
[54] Ibid.

approach, signaling that it is willing to compromise on the calls for emissions to be recorded at the place they occur.[55]

4. The merits of the proposed rule changes

There is considerable theoretical merit in all three of the proposed rule changes. The major natural disturbance rule would ensure that countries are not unfairly penalised for factors that are beyond their control and allow greater access to cheap sources of LULUCF abatement, a number of which could produce important co-benefits. The baseline-and-credit and emissions-to-atmosphere proposals could improve forest accounting by providing more accurate estimates of the direct anthropogenic influence on forest-related carbon stocks and fluxes, thereby facilitating access to cost-effective abatement in forestry activities.

While the rule changes offer a number of potential benefits, they are not risk free nor do they resolve all of the issues associated with LULUCF offsets. The main outstanding issues can be placed in three broad categories: scientific uncertainty; measurement and attribution uncertainty; and effort free offsets.

a. Scientific uncertainty

There is evidence that reforestation and revegetation projects, if carried out in temperate regions such as Australia, may produce "little to no climate benefits".[56] This is a product of the fact that, while sequestering carbon in trees has a cooling effect on the Earth's climate, forests absorb more solar radiation than grasslands and croplands (i.e. forests have a lower albedo). The reduced reflectivity of the land surface that results from reforestation and revegetation produces warming, which can offset (potentially completely) the cooling effect from biosequestration.

The potential for biophysical effects to negate the carbon-cycle benefits of certain LULUCF projects has been known for several years. Despite this, little has been done to incorporate this knowledge into the international accounting rules. The proposed rule changes do not rectify this situation and, by facilitating greater access to LULUCF abatement, they could exacerbate the severity of any false accounting that arises from reliance on forest regeneration projects. This is of particular importance to Australia because of its intention to rely on A/R and regrowth on deforested land units for a significant proportion of its short- to medium-term abatement.

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[55] Australian Government, *Land Use, Land-Use Change and Forestry (LULUCF): Submission to the AWG-KP and AWG-LCA* (Canberra: Commonwealth of Australia, 2009).

[56] Govindasamy Bala, Ken Caldeira, Mike Wickett, Tom Philips, David Lobell, Christine Delire and Art Mirin, "Combined climate and carbon-cycle effects of large-scale deforestation", 104(16) *Proceedings of the National Academy of Sciences (PNAS)* (2007), 6550 at 6550. See also Govindasamy Bala, Ken Caldeira, Art Mirin, Mike Wickett, Christine Delire and Tom Philips, "Biophysical effects of CO_2 fertilization on global climate", 5 *Tellus 58B* (2006), 620; Gordon Bonan, "Forests and climate change: forcings, feedbacks, and the climate benefits of forests", 320 *Science* (2008), 1444; and Canadell and Raupach, "Managing Forests for Climate Change Mitigation", supra, note 36.

b. Measurement and attribution uncertainty

Measuring terrestrial CO_2 and non-CO_2 emissions and removals is notoriously difficult and subject to a relatively high degree of uncertainty. Progress has been made in this field over recent years but scientific and technological gaps remain.[57] The measurement uncertainty gives rise to risks of inaccurate accounting, which can lead to credits and debits being recorded that do not reflect changes in carbon stocks and fluxes.

The accounting risks associated with LULUCF activities are magnified by the need to separate direct human-induced factors from natural, indirect human-induced and age-class effects.[58] The proposed rule changes partially address some of the issues associated with attribution. However, the framework will still fail to provide a complete and accurate record of the direct anthropogenic influence on terrestrial carbon stocks. This is due to unresolved problems with the existing rules, which include the following.

- Article 3.3 allows countries to claim credit for natural regrowth on deforested land units, which is inconsistent with the commitment in Article 4 of the UNFCCC to mitigate climate change by "addressing anthropogenic emissions by sources and removals by sinks".

- Coverage of Article 3.4 activities will still be optional, allowing countries to preferentially include and exclude activities.

- Article 3.4 activities (other than forest management) will be accounted for using a net-net methodology, whereby net emissions in the base year are subtracted from net emissions in the commitment period. The reliability of this method is dependent on how well the base year reflects "normal" conditions and long-term natural and indirect human influences.[59] The length of the commitment period is also crucial; the shorter the period the less reliable the trend line is as a proxy for the anthropogenic influence. At present, it appears the second commitment period (if there is one) is likely to be between 5-8 years in length, which may not be long enough to factor out inter-annual variability.

- The definition of "forest management" is ambiguous, allowing parties to choose between different interpretations of the phrase. Due to this, there is the potential for parties to

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[57] Ruth DeFries, Frédéric Achard, Sandra Brown, Martin Herold, Daniel Murdiyarso, Bernhard Schlamadinger and Carlos de Souza Jr., "Earth observations for estimating greenhouse gas emissions from deforestation in developing countries", 10 *Environmental Science & Policy* (2007), 385; Kenneth Denman et al., "Couplings Between Changes in the Climate System and Biogeochemistry", in S Solomon, D Qin, M Manning, Z Chen, M Marquis, K Avery, M Tignor and H Miller (eds.), *Climate Change 2007: The Physical Science Basis* (Cambridge: Cambridge University Press, 2007); and Anatoly Shvidenko, Dmitry Schepaschenko, Ian McCallum and Sten Nilsson, "Can the uncertainty of full carbon accounting of forest ecosystems be made acceptable to policymakers?", 103 *Climatic Change* (2010), 137.

[58] Canadell et al., "Factoring out natural and indirect human effects on terrestrial carbon sources and sinks', supra, note 36.

[59] The IPCC Guidelines allow for alternative base years to be used if the single base year is abnormal. See Simon Eggleston, Leandro Buendia, Kyoko Miwa, Todd Ngara and Kiyoto Tanabe (eds), *2006 IPCC Guidelines for National Greenhouse Gas Inventories* (Hayama, Japan: Institute for Global Environmental Strategies, 2006).

preferentially exclude forest areas that are sources and include sink areas to maximise LULUCF offsets.[60]

- The legacy of Article 3.7(2) will continue in the post-2012 era, allowing a small number of parties (particularly Australia) to access LULUCF offsets by reducing their net deforestation emissions below those recorded in 1990.

In addition to these issues, there is the potential for problems to arise with the administration of the proposed amendments. For example, the benefits of a baseline-and-credit system for forest management rely on the reference level accurately incorporating natural, indirect human-induced and age-class effects, or its capacity to be adjusted *ex post* to account for these factors. If the baselines do not accurately reflect these factors, false credits or debits will be attributed to parties. Similarly, there is a risk of inaccuracies stemming from the application of the force majeure and emissions-to-atmosphere rules, both as a result of intentional actions and inadvertent errors. These risks are exacerbated by the complexity of LULUCF measurement and accounting, which diminish the chances of detection and correction.

c. Effort free offsets

The proposed changes to the LULUCF accounting rules will open up opportunities for countries like Australia to claim credit for emissions reductions and enhanced removals that entail no additional economic effort (here called "effort free offsets").[61] The problems associated with effort free offsets stem from the ad hoc way in which mitigation targets are set, which allows countries to advance different arguments as to why their interests should be given priority over others. Several parties, including Australia, believe that economic effort should be used to determine the comparability of mitigation obligations. The reliance on economic effort means that, if the capacity to access effort free offsets is not taken into account, there is the potential for parties to receive overly generous QELROs (or to "get away with" unambitious mitigation pledges).

Effort free offsets can also affect the integrity of a party's credits. This has been demonstrated with the hot air credits from former Eastern Bloc countries, particularly Russia and the

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[60] Eggleston et al. (eds), *2006 IPCC Guidelines for National Greenhouse Gas Inventories*, supra, note 59; and Höhne et al., "The rules for land use, land use change and forestry under the Kyoto Protocol – lessons learned for the future climate negotiations", supra, note 48.

[61] "Effort free offsets" are occasionally referred to as "hot air" or "windfall credits". The phrase "effort free offsets" is preferred here because "hot air" is often associated exclusively with surplus assigned amount units (AAUs) from Russia, the Ukraine and other former Eastern Bloc countries, and the phrase "windfall credits" is often used to refer to LULUCF credits that are earned without *any action* on behalf of land managers (as opposed to any *additional action* related to the mitigation of climate change). See Bernhard Schlamadinger and Gregg Marland, *Land Use and Global Climate Change: Forests, Land Management, and the Kyoto Protocol* (Arlington: Pew Center on Global Climate Change, 2000); Schlamadinger et al., "A synopsis of land use, land-use change and forestry (LULUCF) under the Kyoto Protocol and Marrakech Accords", supra, note 48; Mustafa Babiker, Henry Jacoby, John Reilly and David Reiner, "The evolution of a climate regime: Kyoto to Marrakesh and beyond", 5 *Environmental Science and Policy* (2002), 195; and Andreas Löschel and Zhong Xiang Zhang, "The Economic and Environmental Implications of the US Repudiation of the Kyoto Protocol and the Subsequent Deals in Bonn and Marrakech", 138(4) *Review of World Economics* (2002), 711.

Ukraine.[62] In order to entice a number of these countries into the Kyoto Protocol, they were given targets in the first commitment period that were above their projected reference level emissions. This has resulted in these countries having a large surplus of assigned amount units (AAUs) that do not reflect direct abatement efforts. Concerns about the integrity of these AAUs have led other countries to place restrictions and bans on their use.[63] The magnitude of the units that could be carried over from the first commitment period (estimated to be 7-11 $GtCO_2$-e) has also led to calls for some or all of the hot air credits to be cancelled.[64]

The hot air credits of Russia and the Ukraine are similar to the offset that Australia will receive in the first commitment period via Article 3.7(2). A large proportion of the reduction in deforestation emissions in Australia since 1990 has been achieved with no additional economic effort. Deforestation emissions were unusually high in 1990 as a result of high commodity prices and high rainfall in agricultural areas in Queensland and New South Wales. With the onset of drought and falling commodity prices in the early- to mid-1990s, deforestation rates declined. By 1995, prior to the Kyoto Protocol, deforestation emissions had fallen by 46%, from 132 $MtCO_2$-e to 71 $MtCO_2$-e (UNFCCC accounting).[65] Since then, measures have been put in place to curb deforestation, most notably the land clearing laws that were progressively introduced in Queensland and New South Wales over the period 1995 to 2009. There was an opportunity cost associated with these regulatory changes but not one that can be attributed to climate policy. These legislatively changes were introduced primarily for land degradation purposes and, in all likelihood, they would have been instituted in the absence of climate change (i.e. they involved no additional effort above what would have occurred anyway).[66]

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[62] For discussion of these hot air credits and their impact on the Kyoto Protocol, see Babiker et al., "The evolution of a climate regime: Kyoto to Marrakesh and beyond", supra, note 61; Löschel and Zhang, "The Economic and Environmental Implications of the US Repudiation of the Kyoto Protocol", supra, note 61; and Edwin Woerdman, "Hot Air Trading under the Kyoto Protocol: An Environmental Problem or Not?", 14(3) *European Environmental Law Review* (2005), 71.

[63] The use of AAUs is restricted in the New Zealand and European emissions trading schemes. The Australian Government also proposed to prohibit the use of AAUs in the early stages of its CPRS. See Australian Government, *CPRS White Paper*, supra, note 40.

[64] UNFCCC Secretariat, *Compilation of pledges for emission reductions and related assumptions provided by Parties to date and the associated emissions reductions: update July 2010*, FCCC/KP/AWG/2010/INF.2/Rev.1 (Bonn: UNFCCC, 4 August 2010); and *Report of the Ad Hoc Working Group on Further Commitments for Annex I Parties under the Kyoto Protocol on its Thirteenth Session, held in Bonn from 2 to 6 August 2010*, FCCC/KP/AWG/2010/11 (Bonn: UNFCCC, 2 September 2010).

[65] Department of Climate Change and Energy Efficiency, *AGEIS*, supra, note 5; and Macintosh, *Reducing emissions from deforestation and forest degradation in developing countries*, supra, note 5.

[66] This is evident from relevant legislative and policy instruments - see, for example, *Native Vegetation Act 2003* (NSW); *Vegetation Management Act 1999* (Qld); *Vegetation Management and Other Legislation Amendment Act 2004* (Qld); *Vegetation Management Bill 1999: Explanatory Notes*; *Vegetation Management and Other Legislation Amendment Bill 2004: Explanatory Notes*; Australian Government and Queensland Government, *Natural Heritage Trust Bilateral Agreement 1997*; Australian Government and Queensland Government, *Natural Heritage Trust Bilateral Agreement 2004*; and Australian Government, *National Strategy for the Conservation of Australia's Biological Diversity* (Canberra: Commonwealth of Australia, 1996). People who were directly involved in the introduction of the reforms have also suggested that this was the case (Peter Cosier, pers comms, 13 Nov 2009; Phillip Gibbons, pers comms, 13 November 2009; Hon Peter Beattie, pers. comms., 13 November 2009).

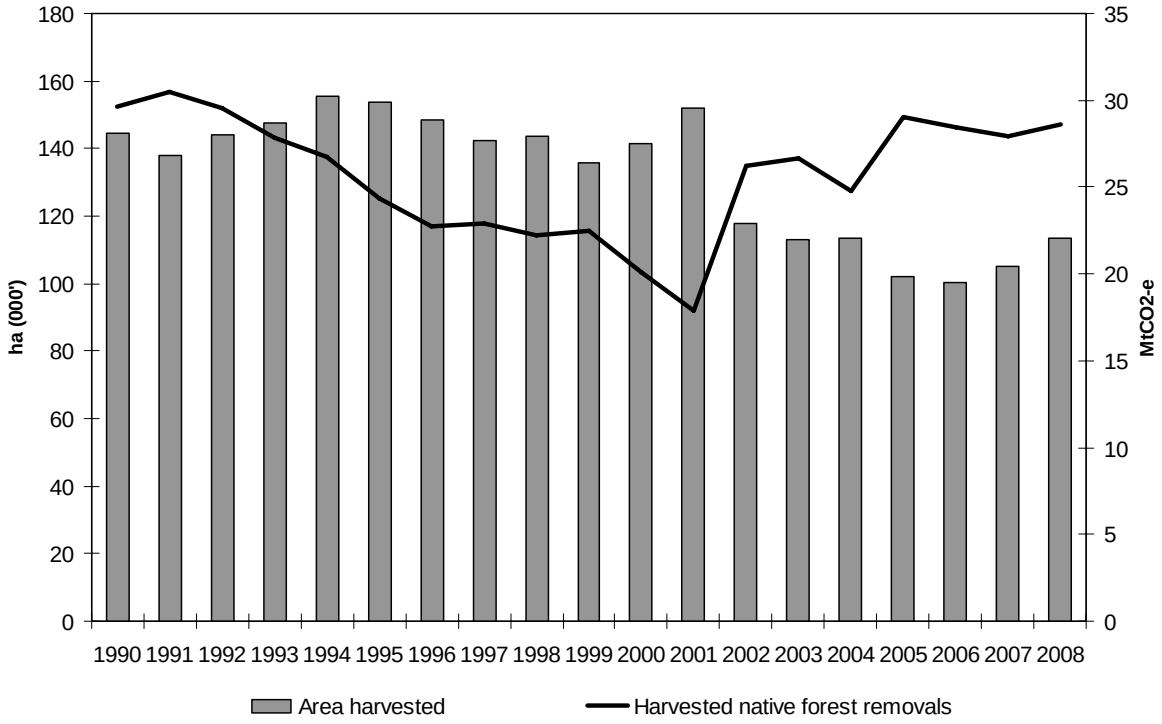
In the 2013-2020 period, Australia could receive another tranche of effort free offsets through forest management. During the late 1980s and 1990s, there were protracted disputes in a number of Australian states about the logging of native forests. Conservationists sought an end to the logging of high conservation value forests, while the forestry industry was looking for greater resource security.[67] The federal and state governments tried to resolve these issues by preparing 20-year strategic plans, known as Regional Forest Agreements (RFA), which provided for the creation of a comprehensive, adequate and representative forest reserve system and the delineation of other areas that would be set aside for the forestry industry. The RFA process and other related initiatives[68] resulted in a substantial increase in forestry reserves (the area of native forests in formal reserves more than doubled between 1990 and 2007) and reductions in allowable native forest harvest volumes, both of which will lead to an increase in forest carbon stocks over time.[69] Already, the impact of these policy initiatives can be seen in the decline that has occurred since 2001 in the area of native forests that are harvested and the corresponding increase in removals from harvested native forests (Figure 4).

[67] Judith Ajani, *The Forest Wars* (Melbourne: Melbourne University Press, 2007).

[68] There were a number of related initiatives that increased forest protection and raised forest management standards. For example, while a regional forest agreement was initiated but never finalised for Queensland, in 1999, the Queensland Government agreed to add 425,000 ha of forest to the conservation reserve system, phase out native forest harvesting in south-east Queensland and reduce harvesting in western region forests. Similarly, in 2001, the Western Australian Government announced it would end harvesting of old-growth forests, thereby adding to the forest protection provided under the Western Australian RFA. Likewise, the Tasmanian RFA allowed for the logging of a significant number of high conservation forests, leading to ongoing community disputes about the optimal use of the state's forest resources. These tensions were partially addressed by the Tasmanian Community Forest Agreement of 2005, which resulted in the addition of 170,000 ha to conservation reserves. This agreement was later formalised in amendments to the Tasmanian RFA.

[69] John Davidson, Stuart Davey, Sharan Singh, Mark Parsons, Belinda Stokes and Adam Gerrand, *The Changing Face of Australia's Forests* (Canberra: Australian Bureau of Rural Sciences, 2008); and Montreal Process Implementation Group for Australia, *Australia's State of the Forests Report: Five-yearly report 2008* (Canberra: Australian Bureau of Rural Sciences, 2008).

Figure 4: Australian "harvested native forests", area harvested (ha 000') and net removals, 1990 to 2008, UNFCCC accounting



Sources: Department of Climate Change and Energy Efficiency, *AGEIS*, supra, note 5; and Australian Government, *National Inventory Report 2008*, supra, note 38.

Under the international accounting rules, the effects of any direct forest management measures introduced after 1990 are supposed to be accounted for and can be claimed as abatement. By extension, this means that the forest management reference level for Australia should be an estimate of the emissions and removals from forest management under business-as-usual (BAU) conditions (i.e. excluding any measures introduced after 1990 that could affect net emissions). In keeping with this approach, as part of the international negotiations, the Australian Government has submitted a proposed reference level for the period 2013-2020 of -9.16 $MtCO_2$-e/yr, which it describes as a BAU projection.[70] The use of this forest management reference level would enable Australia to claim credit for the increase in forest carbon stocks arising from the RFA and RFA-related processes. Similar to the impacts of the Australia clause in the first commitment period, these credits would entail no additional economic effort; the forest policy changes were made for biodiversity, heritage, social and economic reasons and would have been introduced in the absence of concerns about climate change.

[70] Australian Government, *Data on forest management: submission by Australia* (Canberra: Commonwealth of Australia, 2009); and *Cancun Agreements, CMP.6, Land use, land-use change and forestry*, GE.10-70907, available at <http://unfccc.int/meetings/cop_16/items/5571.php> (last accessed 13 January 2011).

5. The implications for the abatement task

A number of previous studies have found that there is "immense" potential for abatement from Article 3.4 activities in Australia.[71] The methodology and accounting rules applied in these studies differ significantly, making comparisons and extrapolations difficult. Noting this, Table 3 contains estimates of the theoretical maximum offsets that Australia could generate from Article 3.4 activities, excluding revegetation, in 2020 and over the period 2012-2100. These estimates were devised using a relatively simple method, particularly for cropland and grazing land management, and are subject to large uncertainties.[72] They do not reflect likely outcomes rather maximum theoretical obtainable offsets under optimum conditions. The proposed changes to the accounting rules could enable Australia to access some of this potential, thereby reducing the economic effort required to meet its mitigation target.

Table 3: Theoretical maximum Article 3.4 offsets, excluding revegetation, in 2020 and cumulative from 2012 to 2100[a]

	Area in 2008 (Mha)	Potential max. offsets in 2020 ($MtCO_2$-e/yr)	Potential max. cumulative offsets to 2100 ($MtCO_2$-e)
Forest management[b]	15	54	2562
Cropland management	22	24	597
Grazing land management	436	127	3200
Total[c]	**473**	**202**	**6335**

a. The method used to devise these estimates is described in Appendix A.
b. This estimate is confined to harvested native forests (it excludes pre-1990 plantations and fuelwood consumption) and it assumes the instantaneous oxidation of the carbon in harvested wood products.
c. Totals may not add up due to rounding.
Sources: see Appendix A.

Of all the areas opened up by the proposed rule changes, forest management is where Australia stands to obtain the greatest benefit. With protection against major disturbance events, Australia will be in a position to claim the effort free offsets associated with the forest policy changes of the 1990s and 2000s. Analysis undertaken using a Tier 2 model (see Appendix A) suggests that

[71] Ross Garnaut, *Garnaut Climate Change Review* (Melbourne: Cambridge University Press, 2008), at 559. See also Kenton Lawson, Kevin Burns, Kah Low, Edwina Heyhoe and Helal Ahammad, *Analysing the economic potential of forestry for carbon sequestration under alternative carbon price paths* (Canberra: ABARE, 2008); Brendan Mackey, Heather Keith, Sandra Berry and David Lindenmayer, *Green Carbon: The Role of Natural Forests in Carbon Storage* (Canberra: ANU E-Press, 2008); Heather Keith, Brendan Mackey and David Lindenmayer, "Re-evaluation of forest biomass carbon stocks and lessons from the world's most carbon-dense forests", 106(28) *Proceedings of the National Academy of Sciences (PNAS)* (2009), 11635; Sandra Eady, Mike Grundy, Michael Battaglia and Brian Keating (eds), *An Analysis of Greenhouse Gas Mitigation and Carbon Sequestration Opportunities from Rural Land Use* (St Lucia, Queensland: Commonwealth Scientific and Industrial Research Organisation, 2009); and The Nous Group, *Outback carbon*, supra, note 30.
[72] The method is described in Appendix A.

the offsets associated with these changes are likely to amount to ~12 $MtCO_2$-e/yr in 2020.[73] Additional low- or zero-cost forest management offset credits may also flow from ongoing changes in the structure of the forestry industry. Since the mid- to late-1970s, there has been a shift away from native forests to plantations for wood supply in the Australian forestry sector, which has been brought about by market forces and non-climate related policy measures.[74] By the late 2000s, plantation timber supplied in excess of 80% of the Australian wood processing industry's raw material and current projections suggest that wood supply from plantations will increase by 44% over the coming decade as new plantation areas reach maturity.[75] While the plantation sector has experienced growth, the native forest sector has contracted in response to policy changes, poor market conditions and wildfires.[76] Even in the absence of additional climate measures, the changing structure of the forestry sector, and long-standing community opposition to native forest logging, are likely to bring about further declines in the harvesting of native forests.[77] This, in turn, would increase forest management offsets, despite the fact that it would require little or no additional economic effort beyond what would have occurred under normal circumstances.

The immediate impact of the adoption of the emissions-to-atmosphere approach would be to increase claimable removals from forest management and A/R as the carbon stored in longer-lived wood products would no longer be assumed to be instantly released into the atmosphere. For harvested native forests alone, these accounting effects would create ~10 $MtCO_2$-e/yr of credits in the short- to medium-term. Presumably, if the rule change is made, the forest management reference level would be adjusted to account for the harvested wood products carbon pool, thereby cancelling out the accounting impacts. This is not the case for harvested wood products from post-1990 plantations (A/R), where the emissions-to-atmosphere approach will provide immediate accounting benefits.

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[73] This estimate is based on the assumption that roundwood removals from native forests average 8 million m^3/yr over the period 2009-2100, compared to 11.25 m^3/yr in the reference case. It also assumes the instantaneous oxidation of the carbon in harvested wood products.

[74] Judith Ajani, "Australia's Transition from Native Forests to Plantations: The Implications for Woodchips, Pulpmills, Tax Breaks and Climate Change", 15(3) *Agenda* (2008); Kah Low and Sinniah Mahendrarajah, *Future directions for the Australian forestry industry* (Canberra: ABARE, 2010); and National Institute of Economic and Industry Research (NIEIR), *Opportunities, issues and implications for a transition of the Victorian wood products industry from native forests to plantations*, Report for the Australian Conservation Foundation and the Wilderness Society (Melbourne: NIEIR, 2010), available at <http://www.wilderness.org.au/pdf/nieir-report> (last accessed 17 January 2011).

[75] Mark Parsons, Ian Frakes and Mijo Gavran, *Australia's Plantation Log Supply 2005-2049* (Canberra: Australian Bureau of Rural Sciences, 2007).

[76] Ajani, "Australia's Transition from Native Forests to Plantations", supra, note 74; and Low and Mahendrarajah, *Future directions for the Australian forestry industry*, supra, note 74.

[77] This thesis is supported by recent events in Tasmania and Victoria. In Tasmania, forestry and conservation groups agreed on a statement of principles in October 2010 that provides for the cessation of logging in high conservation value forests and the transition of the industry out of public native forests into plantations. See *Tasmanian Forests Statement of Principles to Lead to an Agreement*, October 2010 (available at <http://www.et.org.au/system/files/userfiles/final-Principles-signed.pdf> (last accessed 12 January 2011)). At the time of writing, the Victorian Government was working on establishing a similar process for its forests, involving a negotiated outcome between conservationists and the forestry industry.

In addition to the accounting impacts, the emissions-to-atmosphere rule could also create opportunities for abatement through the substitution of wood for more carbon-intensive products, particularly in the construction industry. The plantation sector is likely to be the major beneficiary in these effects because of the projected increase in plantation production, larger emissions associated with harvesting native forests and probable nature of the new markets (i.e. demand is likely to come from the construction industry where the preference is generally for softwood – Australia's native forests provide mostly hardwoods).[78] The impact of these market changes on Australia's abatement task to 2020 however, is likely to be relatively small because of the limitations of wood as a construction material and the fact that the substitution of wood for alternative products is not always associated with net emission reductions.[79]

There has been extensive discussion in Australia about the potentially large amounts of carbon that could be sequestered in soils in cropland and grazing lands. The insertion of the force majeure clause would enable Australia to pursue these opportunities without the fear of being held liable for naturally-induced fluctuations in carbon stocks. Despite this, it appears unlikely that, in the absence of land-use change, soil carbon sequestration in agricultural landscapes will be a large source of abatement in the short- to medium-term. There is a marked lack of data on soil carbon stocks and flows in these areas and related deficiencies in monitoring systems.[80] These information and technological gaps make it difficult to measure removals and emissions with accuracy and are an impediment to the creation of cost-effective policy mechanisms. The available research also suggests that the opportunities for the long-term enhancement of soil organic carbon in many agricultural landscapes are limited.[81] The Australian Government has acknowledged this in the international negotiations, stating:

> There remain significant information gaps about the potential to achieve and sustain increases in soil carbon in Australian agricultural systems. … Australia's experience shows there is evidence that gradual soil carbon increases could be achieved in high rainfall regions. Research to date indicates that in low rainfall grazing regions and cropping systems, sustained increases are unlikely. There are also risks that gains in any land systems could be rapidly lost through change in land use and management (e.g. a change from pasture to crop) and due to drought.[82]

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[78] Parsons, Frakes and Gavran, *Australia's Plantation Log Supply 2005-2049*, supra, note 75; and Low and Mahendrarajah, *Future directions for the Australian forestry industry*, supra, note 74.
[79] Low and Mahendrarajah, *Future directions for the Australian forestry industry*, supra, note 74; and Bernhard Schlamadinger and Gregg Marland, "Net effect of forest harvest on CO2 emissions to the atmosphere: a sensitivity analysis on the influence of time", 2 *Tellus 51B* (1999), 314.
[80] Roger Gifford and John McIvor, "Rehabilitate overgrazed rangelands, restoring soil and vegetation carbon-balance", in Eady et al. (eds), *An Analysis of Greenhouse Gas Mitigation and Carbon Sequestration Opportunities from Rural Land Use*, supra, note 71.
[81] Ibid.
[82] Australian Government, *Land Use, Land-Use Change and Forestry (LULUCF): Submission to the AWG-KP and AWG-LCA*, supra, note 55, at 11.

Far greater potential lies in measures that promote sub-forest revegetation and improved fire management on grazing lands.[83] Sub-forest revegetation measures would seek to enhance carbon stocks in woody vegetation while enabling landholders to continue to use the land for grazing purposes. The revegetation of grazing lands could substantially increase carbon stocks on grazing lands but there is uncertainty about the magnitude of the removals that could be achieved by these means. This uncertainty stems from the paucity of data on the carbon stocks on grazing lands, the effect of these types of changes, measurement limitations, and problems associated with policy design and ensuring permanence. An additional complicating factor is that there is evidence of a long-term "greening" of Australia's rangelands involving an increase in woody vegetation cover.[84] As grazing land management and revegetation are accounted for on a net-net basis, there is the potential for these changes in woody vegetation to generate windfall credits.

Improved fire management on grazing lands is another way Australia could take advantage of the new accounting rules to access cheap sources of abatement. If a country elects to include grazing land management in its Kyoto accounts, CO_2 emissions associated with prescribed burns and wildfires on grazing lands are required to be reported.[85] In Australia, fires in grazing lands (especially savannas) are a significant source of emissions (~12 $MtCO_2$-e /yr on average).[86] Research suggests that CO_2 emissions associated with fires on grazing lands could be significantly reduced by promoting greater prescribed burning of savannas at the beginning of northern Australia's dry season (May-September). It has been estimated that these types of management changes could generate emission reductions of 5.4 $MtCO_2$-e/yr by 2020 at a cost of AU$12.50/$tCO_2$-e.[87]

V. Conclusion

Since the international climate change negotiations began in the early 1990s, they have been defined by repetition and glacial progress. A multitude of factors – including the global nature of the problem, unwieldy nature of the UNFCCC process, distant and uncertain benefits of mitigation, public ignorance of the nature of climate risks, importance of fossil fuels to the functioning of modern economies, lack of cheap substitutes for fossil energy, differences in values, and power of the fossil fuel lobby – have made most major emitters reluctant to make short-term national sacrifices for longer-term global gains. In seeking to shape the international regime to their best advantage, parties have adopted similar positions and employed similar tactics throughout the history of the negotiations. This has produced repeated stalemates and a sense of "groundhog day" about the negotiating sessions and outcomes.

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[83] Reforestation (plantations and environmental plantings) on grazing lands is excluded from this discussion as it is covered by the existing A/R rules and was included in the Treasury modelling. Allowing natural regrowth on grazing lands would not qualify as reforestation and, therefore, would be ineligible for credits.

[84] Gifford and McIvor, "Rehabilitate overgrazed rangelands, restoring soil and vegetation carbon-balance", supra, note 80; and Randall Donohue, Tim McIvor and Michael Roderick, "Climate-related trends in Australian vegetation cover as inferred from satellite observations, 1981-2006", 15(4) *Global Change Biology* (2009), 1025.

[85] The associated CH_4 and N_2O emissions are reported in the "Agricultural Sector" of the accounts.

[86] Australian Government, *National Inventory Report 2008*, supra, note 38.

[87] The Nous Group, *Outback carbon*, supra, note 30.

Australia's approach to the international climate negotiations mirrors the broader trend. The Australian Government aggressively defended its economic and political interests in the Kyoto negotiations by seeking generous targets, flexibility mechanisms to lower economic costs and accommodating LULUCF accounting rules. To support its position, it relied upon economic modelling that showed Australia would suffer greater economic losses than most other developed countries in reducing its emissions. These tactics were successful and Australia secured the second most generous QELRO, which was then watered down by Article 3.7(2).

In the post-2012 negotiations, Australia has, in many ways, replicated the approach it took to the Kyoto Protocol. Once again, it has argued for lower targets than most other industrialised countries and bolstered its case with modelling data from the Treasury Report. As occurred in the Kyoto modelling studies, the Treasury Report downplays the potentially large role that LULUCF could play in Australia's 2012-2020 abatement task. The maximum theoretical LULUCF offsets that Australia could obtain by 2020 were estimated here to be in the order of 360 $MtCO_2$-e/yr, excluding both A/R and revegetation. When the CPRS-5 estimate of A/R is added, the total becomes 370 $MtCO_2$-e/yr. This compares to the total CPRS-5 LULUCF offset estimate of 103 $MtCO_2$-e/yr in 2020. Put another way, the estimates devised here suggest that the total maximum theoretical abatement in LULUCF activities in 2020, excluding both A/R and revegetation, is likely to be ~273 $MtCO_2$-e/yr, which is more than Australia's total abatement task in 2020 under the CPRS-5 scenario (249 $MtCO_2$-e).

What proportion of the theoretical LULUCF abatement potential is obtainable at an acceptable cost prior to 2020 is uncertain. Some of it could be realised with little or no additional economic effort; effort free offsets from forest management alone are likely to be at least 12 $MtCO_2$-e/yr by 2020. Beyond this, the magnitude of LULUCF abatement will depend on a collection of economic, political, social and environmental factors on which there is little information and that are difficult to predict. While noting the degree of uncertainty, current domestic policy settings and the proposed amendments to the international accounting framework suggest that LULUCF will play a more prominent role in Australia's 2012-2020 abatement task than forecast in the Treasury Report. Greater exploitation of LULUCF abatement opportunities is likely to significantly reduce the economic effort required to meet any given mitigation target and, if the rationale behind Australia's negotiating position is followed, would support an increase in its mitigation pledge.

Appendix A Method used to devise Article 3.4 abatement estimates in Table 3

Forest management

A Tier 2 model was constructed to project emissions and removals from forest management under a BAU scenario and a "cessation of harvesting" mitigation scenario. The model was based on the Tier 2 method used to estimate harvested native forest carbon fluxes in Australia's *National Inventory Reports* prior to 2010.[88] Key methodological issues associated with the model were as follows.

- The relevant forests were confined to harvested native forests, as defined in Australia's *National Inventory Reports*.[89] Pre-1990 plantations and fuelwood consumption were excluded. Harvested native forests cover an area of 14.9 Mha and are divided into six broad forest types: rainforests, tall dense eucalypt forests, medium dense eucalyptus forests, medium sparse eucalyptus forests, cypress pine forests and other forests.

- The model did not account for major natural disturbances or inter-annual variability due to climate or fires.

- Removals across relevant forest types were estimated using forest type-specific age-weighted growth rates, which were derived from Australia's *National Inventory Report 2008*.[90] All forest areas greater than 200 years of age were assumed to be at their carbon carrying capacity.[91]

- Harvest slash and harvested wood product emissions were projected using estimates of annual roundwood removals derived from ABARE data[92] and the key parameters outlined in Table A1. Harvested wood product emissions were estimated using both an instantaneous oxidation assumption and the emissions-to-atmosphere approach. The harvested wood product emissions under the emissions-to-atmosphere approach were

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[88] See, for example, Australian Government, *National Inventory Report 2005* (Canberra: Commonwealth of Australia, 2007); Australian Government, *National Inventory Report 2006* (Canberra: Commonwealth of Australia, 2008); and Australian Government, *National Inventory Report 2007* (Canberra: Commonwealth of Australia, 2009). See also Australian Greenhouse Office, *Australian Methodology for the Estimation of Greenhouse Gas Emissions and Sinks 2003: Land Use, Land Use Change and Forestry* (Canberra: Commonwealth of Australia, 2005).
[89] Australian Government, *National Inventory Report 2008*, supra, note 38.
[90] Australian Government, *National Inventory Report 2008*, supra, note 38.
[91] For discussion of the carbon carrying capacity and carbon sequestration potential of Australia's forests, see Mackey et al., *Green Carbon: The Role of Natural Forests in Carbon Storage*, supra, note 71; and Stephen Roxburgh, "Increase carbon stocks in pre-1990 eucalypt forests", in Eady et al. (eds), *An Analysis of Greenhouse Gas Mitigation and Carbon Sequestration Opportunities from Rural Land Use*, supra, note 71.
[92] Rhonda Treadwell, *The Australian Forestry Sector – Its Size and Characteristics*, Bureau of Agricultural Economics, Occasional Paper No. 66 (Canberra: Commonwealth of Australia, 1982); Moazzem Hossain, Leng Sar and Nick Samuel, *Long Term Consumption Projections for Forest Products: Implications for Trade and Sector Development*, ABARE, Discussion Paper 89.6 (Canberra: Commonwealth of Australia, 1989); ABARE, *Australian Commodity Statistics* (Canberra: Commonwealth of Australia, 2009); and ABARE, *Australian Forest and Wood Products Statistics* (Canberra: Commonwealth of Australia, 2010).

estimated using a replica of the model described in Australian Greenhouse Office (2005),[93] which was adjusted to include wood exports and exclude wood imports.

- In both the BAU and mitigation scenarios, harvesting in rainforests was assumed to cease in 1990, at which time these forests were assumed to be an average of 25% below their carbon carrying capacity. The carbon sequestration potential of these forests was assumed to be realised over 50 years (1990 to 2039), with the average annual carbon increment in all relevant carbon pools declining linearly over this period. These assumptions were derived from data in Australia's *National Inventory Report 2008*.[94]

Table A1: Key harvest slash and wood product emission parameters

Description	Value
Stemwood biomass to aboveground biomass expansion factor	1.46
Stemwood biomass to belowground biomass expansion factor	1.37
Root:shoot ratio	0.25
Fraction of carbon dioxide that is carbon	0.27
Basic density (kg/m^3)	650
Carbon fraction of aboveground biomass	0.50
Carbon fraction of belowground biomass	0.45

Sources: Peter Snowdon, Derek Eamus, Philip Gibbons, Partap Khanna, Heather Keith, John Raison and Miko Kirschbaum, *Synthesis of Allometrics, Review of Root Biomass and Design of Future Woody Biomass Sampling Strategies*, NCAS Technical Report No. 17 (Canberra: Commonwealth of Australia, 2000); Australian Government, *National Inventory Report 2005*, supra, note 88; Australian Government, *National Inventory Report 2007*, supra, note 88; Australian Government, *National Inventory Report 2008*, supra, note 38.

- In the BAU scenario:
  - the model considered only aboveground and belowground biomass, harvest slash and harvested wood product emissions (other than in relation to rainforests) (i.e. in commercially harvested forests, it was assumed that emissions and removals related to the dead wood, litter and soil organic carbon pools were roughly equal over the harvesting cycle);[95]
  - it was assumed that the forest reserves that were created through the RFA and RFA-related processes remained in commercial production; and
  - for the period 2000-2100, roundwood removals were assumed to average 11.25 million m^3 per year.

[93] Australian Greenhouse Office, *Australian Methodology for the Estimation of Greenhouse Gas Emissions and Sinks 2003: Land Use, Land Use Change and Forestry*, supra, note 88.
[94] Australian Government, *National Inventory Report 2008*, supra, note 38.
[95] Changes in the dead biomass carbon pools that were associated with harvest slash and harvested wood products were included in the model.

- The key assumptions underlying the mitigation scenario were as follows.

  - The carbon carrying capacity of all forest types (including rainforests) was estimated using data on aboveground biomass growth rates, biomass partitioning, turnover rates and soil, litter and deadwood carbon pools from Australia's *National Inventory Report 2008*[96] and *Australia's State of the Forests Report 2008*,[97] and Snowdon et al. (2000), Keith et al. (2000), Ximenes et al. (2004), Woldendorp and Keenan (2005) and Montagu et al. (2005) (see Table A2).[98] These estimates are likely to significantly underestimate the true carbon carrying capacity of Australia's forests.[99] They were adopted for current purposes to ensure conservative outputs and the greatest possible consistency with Australia's forest accounting method.

  - It was conservatively assumed that 2.3 Mha of the new reserves created by the RFA and RFA-related processes were an average of 20% below their carbon carrying capacity in 2010. The remaining new reserves were assumed to be at their carbon carrying capacity. The carbon sequestration potential of the RFA reserves was assumed to be realised over 100 years, with the average annual carbon increment in all relevant carbon pools declining linearly over this period.

  - Harvesting of all forest areas was assumed to cease in 2012. Forest areas, other than rainforests, old-growth and RFA reserve areas, were assumed to be an average of 40% below their carbon carrying capacity in 2012, consistent with Kirschbaum (1997), Snowdon et al. (2000), Dean et al. (2003) and Mackay et al. (2008) .[100] The carbon sequestration potential of these forests was assumed to be

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[96] Australian Government, *National Inventory Report 2008*, supra, note 38.
[97] Montreal Process Implementation Group for Australia, *Australia's State of the Forests Report*, supra, note 69.
[98] Peter Snowdon, Derek Eamus, Philip Gibbons, Partap Khanna, Heather Keith, John Raison and Miko Kirschbaum, *Synthesis of Allometrics, Review of Root Biomass and Design of Future Woody Biomass Sampling Strategies*, NCAS Technical Report No. 17 (Canberra: Commonwealth of Australia, 2000); Heather Keith, Damien Barrett and Rod Keenan, *Review of Allometric Relationships for Estimating Woody Biomass for New South Wales, the Australian Capital Territory, Victoria, Tasmania and South Australia*, NCAS Technical Report No. 5b (Canberra: Commonwealth of Australia, 2000); Fabiano de Aquino Ximenes, W. David Gardner and John Marchant, *Total Biomass Measurement and Recovery of Biomass in Log Products in Spotted Gum (Corymbia maculata) Forests of SE NSW*, NCAS Technical Report No. 47 (Canberra: Commonwealth of Australia, 2004); Gemma Woldendorp and Rodney Keenan, "Coarse woody debris in Australian forest ecosystems: A review", 30 *Austral Ecology* (2005), 834; and Kelvin Montague, Kate Düttmer, Craig Barton and Annette Cowie, "Developing general allometric relationships for regional estimates of carbon sequestration – an example using *Eucalyptus pilularis* from seven contrasting sites", 204 *Forest Ecology and Management* (2005), 113.
[99] Mackey et al., *Green Carbon: The Role of Natural Forests in Carbon Storage*, supra, note 71.
[100] Miko Kirschbaum, "Key uncertainties in the contribution of Australia's managed forests to the national greenhouse gas inventory", 9(3) *Climate Change Newsletter* (1997), 8; Snowdon et al., *Synthesis of Allometrics, Review of Root Biomass and Design of Future Woody Biomass Sampling Strategies*, supra, note 98; Christopher Dean, Stephen Roxburgh and Brendan Mackey, "Growth Modelling of Eucalyptus regnans for Carbon Accounting at the Landscape Scale", in Ana Amaro, David Reed and Paula Soares (eds), *Modelling Forest Systems* (Oxford: CAB International, 2003); and Mackey et al., *Green Carbon: The Role of Natural Forests in Carbon Storage*, supra, note 71. See also William Keeton, Mykola Chernyaysky, Georg Gratzer, Magdalena Main-Knorn, M Shpylchak and Yurii Bihun, "Structural characteristics and aboveground biomass of old-growth spruce-fir stands in the eastern Carpathian mountains, Ukraine", 144(1) *Plant Biosystems* (2010), 148.

realised over 150 years, with the average annual carbon increment in all relevant carbon pools declining linearly over this period.

Table A2: Estimated mean carbon carrying capacity of Australian managed forests

Forest type	Carbon carrying capacity			
	Live biomass	Soil	Dead wood and litter	Total[a]
Rainforests	117	99	16	232
Tall dense eucalypt forests	403	343	93	840
Medium dense eucalypt forests	191	178	41	409
Medium sparse eucalypt forests	63	49	12	124
Cypress pine forests	66	69	12	147
Other forests	60	59	11	130
All forest type mean	199	177	43	419

a. Totals may not add up due to rounding.
Sources: Australian Government, *National Inventory Report 2008*, supra, note 38; Montreal Process Implementation Group for Australia, *Australia's State of the Forests Report*, supra, note 69; Snowdon et al., *Synthesis of Allometrics, Review of Root Biomass and Design of Future Woody Biomass Sampling Strategies*, supra, note 98; Keith et al., *Review of Allometric Relationships*, supra, note 97; Ximenes et al., *Total Biomass Measurement and Recovery of Biomass in Log Products in Spotted Gum (Corymbia maculata) Forests of SE NSW*, supra, note 98; Woldendorp and Keenan, "Coarse woody debris in Australian forest ecosystems: A review", supra, note 98; and Montague et al., "Developing general allometric relationships for regional estimates of carbon sequestration", supra, note 98.

Cropland management

The cropland management estimate assumes a cropland area of 21.7 Mha, no change in land use and the available sequestration potential is confined to soil organic carbon enhancements. The average soil carbon sequestration potential of these lands was assumed to be 7.5 tC/ha, which could be realised in 40 years.[101] The annual soil carbon increment commenced at 0.35 tC/ha in 2013 and declined thereafter to near zero in 2052.

Grazing land management

The grazing land management estimate assumes a total grazing land area of 436 Mha, no change in land use and the available sequestration potential is confined to soil organic carbon enhancements (i.e. it excludes the possibility of revegetation and other abatement options). 40% of the total grazing land area was assumed to be degraded and the average soil carbon sequestration potential of these lands was assumed to be 5 tC/ha, which could be realised in 40 years. The annual soil carbon increment on these lands commenced at 0.24 tC/ha in 2013 and

[101] This assumption was based on data from Ram Dalal, Jeff Baldock, Mike Bell and Peter Grace, "Build soil carbon storage and mitigate nitrous oxide and methane emissions for cropped land", in Eady et al. (eds), *An Analysis of Greenhouse Gas Mitigation and Carbon Sequestration Opportunities from Rural Land Use*, supra, note 71; Yin Chan, Annette Cowie, Georgina Kelly, Bhupinderpal Singh and Peter Slavich, *Scoping Paper: Soil Organic Carbon Sequestration Potential for Agriculture in NSW* (Sydney: NSW Department of Primary Industries, New South Wales Government, 2008); and Australian Government, *National Inventory Report 2008*, supra, note 38.

declined thereafter to near zero in 2052.[102] It was assumed that the soil carbon sequestration potential on all other grazing lands was zero.

[102] These assumptions were based on data from Gifford and McIvor, "Rehabilitate overgrazed rangelands, restoring soil and vegetation carbon-balance", supra, note 80; Chan et al., *Scoping Paper: Soil Organic Carbon Sequestration Potential for Agriculture in NSW*, supra, note 101; Richard Conant, Keith Paustian and Edward Elliott, "Grassland Management and Conversion into Grassland: Effects on Soil Carbon", 11(2) *Ecological Applications* (2001), 343; and Australian Government, *National Inventory Report 2008*, supra, note 38.