Kien Dang (u3939218@anu.edu.au)

Assessing the bio-diverse and carbon forest plantings as one of the land-based mitigation options in Australia

Dang To Kien

Introduction

This essay aims to assess the extent to which biodiverse and carbon forest plantings can be used to mitigate Australia's greenhouse gas emissions. Crucial in this assessment is the question of scale i.e. defining the scale at which can the option generate positive impacts given currently limited investments. In relation to scale, it is essential to understand the ***level of uptake (or rate of adoption) by rural landholders*** as to understand the current interests, and thus reflecting the credibility and feasibility of the option. This essay concludes that biodiverse and carbon forest plantings has a potential to contribute to climate change mitigation; nevertheless, would require to reach out to rural landholders for higher uptake as well as (possibly) demanding stable carbon pricing mechanism to achieve further credibility.

Climate change in Australia and mitigation

Indication of climate change is irrefutable (Climate Commission 2011) and that science/data and observations provided by CSIRO and Bureau of Meteorology (BoM) are of highly credible sources (State of the Climate 2012). The average temperature for the 30-year records from the 1961-1990 indicates temperature anomalies i.e. each decade has been warmer than the previous decade since the 1950s (BoM 2012). Australian average temperatures are projected to rise by 0.6 to 1.5^{0}C by 2030 when compared with the climate of 1980 to 1999 (BoM 2012). Climate models suggest long term drying over southern areas during winter and over southern and eastern areas during spring (BoM & CSIRO 2012). Australia has indicated a strong interest in global mitigation (Garnaut 2008, Jotzo 2012) before the global averge temperature exceeds critical thresholds (Climate Commission 2011). According to Garnaut (2008), the Australia's rural landscapes have been affected significantly by impacts from climate change. A number of land based mitigation options have been proposed and explored their mitigation potential, of which biodiverse and carbon forest plantings has increasingly gained interests.

What is biodiverse and carbon forest plantings?

Biodiverse and carbon forest plantings are the non-harvested sinks with a primary focus of carbon sequestration and associated biodiversity benefits (CSIRO 2009). Other values such as erosion control, shelter for stock (Paul et al 2012) and reducing dryland salinity (Jonson and Freudenberger 2011) have also been studied. Carbon forest plantings (or carbon forestry) has to meet the international definition of a forest i.e. 'minimum of 20 per cent canopy cover, trees greater than two meters in height and a minimum area of 0.2 hectares (CSIRO 2009, p.22). It would also need to meet the international legal definition of a carbon sink i.e. 'a repository into which we can dispose of unwanted waste (CO2) rather than a source with intangible, non-economic benefits' (Aguirre 2009). Article 3.3 of the Kyoto Protocol credits carbon sinks for plantings on areas e.g. agricultural land that had been cleared prior to 1990 that have subsequently been reforested or afforested (Aguirre 2009; Durrant 2011) and meet the permanence requirement i.e. placed a legal contract for 100 years to account for the natural cycles of death and decay of the carbon/forest (CSIRO 2009). As Australia signed the Kyoto Protocol, carbon forest plantings can be counted as offsets against those emissions to meet the agreed target of a 5 per cent reduction of greenhouse gas emissions by 2020 from the 2000 levels (Durrant 2011).

Describe the mitigation option?

Biodiverse and carbon forest plantings is 'the most straightforward way to sequester carbon in the rural landscapes' (CSIRO 2011, p.97) and has the ability to sequester large quantities of carbon (CSIRO 2009 Figure 1-2, see below). The Garnaut report (2008) indicated that carbon forest plantings as one of the rural mitigation options; however it is highly responsive to a carbon price. Australian's carbon pricing mechanism, or Carbon Tax that took effect by July 1, 2012, was seen as the best design policy for climate change mitigation (Jotzo 2012). This pricing policy is 'meant to underpin Australia's commitment of a 5 per cent reduction in emissions by 2020 relative to 2000' (Jotzo 2012, p.1). There would be some economic viabilities (Garnaut 2011) from establishing carbon plantings in areas of lower rainfall and lower land values, and that the rising carbon prices could draw attention from rural landholders. As carbon forest plantings provides substantial low cost abatement for mitigation (Garnaut 2011), this mitigation option can play a part in achieving mitigation potential.

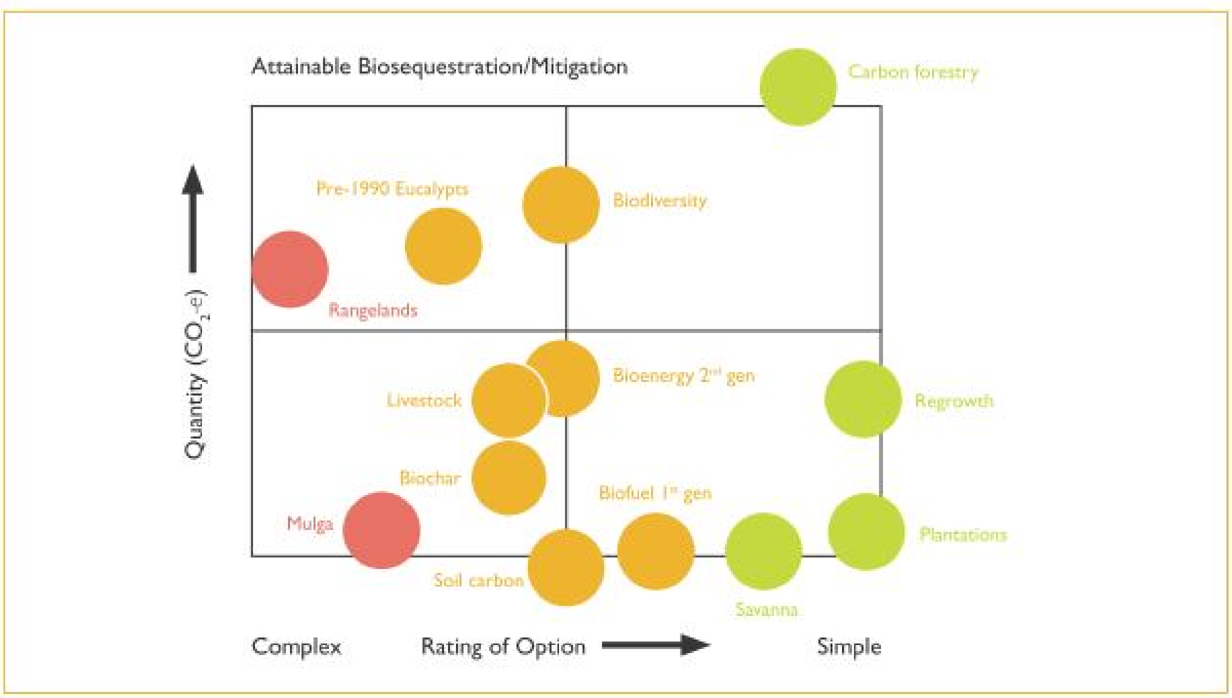

Figure 1-2: Qualitative assessment of the attainable GHG biosequestered/mitigated for each option (for Queensland) plotted against the overall rating for complexity of implementation attributes (maturity of technology, ease of measurement and implementation, impact of co-effects and system certainty) with balls in red being the most difficult and green the least difficult to implement.

Figure 1: Adopted from GHG mitigation CSIRO 2009.

What is the proposed mitigation potential?

The potential of the option is looked at from comparing different estimates over the land area available for planting, and carbon sequestration potential from the proposed profitable areas. Various credible sources have estimated the low and high ranges of mitigation potential from carbon forest plantings as provided in the Table 1 below.

Table 1: Summary of various estimates of carbon plantings mitigation potential.

MtCO2e/yr	Low	High	Average	Comments
Lawson et al. (2008)			6.9 4.2	2007-2050 (CPRS-5 scenario) 2013-2022 (CPRS-5 scenario)
Garnaut (2008)	n/a	143	7.2	In 20 years (plantations)
CSIRO (2009)	-	-	350 (750 with carbon forestry)	2010-2050 incl. 30% risk buffer
Polglase et al. (2011)	-	-	5.2	2010-2050 incl. 30% risk buffer
DCCEE (2011)	1 1.5	2 6		In 2020 (reforestation) In 2020 (avoided deforestation and management regrowth on deforestation land)

Lawson et al (2008) provided results for the CPRS-5 carbon price scenario (at AU$20.88 per tonne CO2-e in 2010) with an assumption that carbon price increases by an average of 4 per cent a year to 2100 that is 5.8 Mha of agricultural land would be economically suitable for afforrestation between 2007 and 2050; of which 47 per cent of this area used for environmental plantings. This potentially could sequester around 296 Mt of CO2-e from 2007-2050 (Lawson et al 2008, p.12). On average, about 6.9 Mt of CO2-e per year would be sequestered.

Garnaut (2008) indicated that carbon farming (plantations) would potentially remove 143 Mt CO2-e for 20 years. This used key assumptions such as using 9.1 Mha of land where returns would be more than AU$100 per ha per year better than the current land use, with water interception less than 150 mm per year and permit price of AU$20 per tonne CO2-e (Garnaut 2008). The difference of this to Lawson et al (2008) is this estimate considers water interception; however accounts only from emissions removal from plantation forests, i.e. not specifiy to environmental/biodiverse plantings. The land potentially available appears higher than one predicted by Lawson et al (2008); yet the total amount of emissions removal deems lower.

CSIRO (2009) provided the Summary Table (p.12) in which predicted the total national potential of forestry (i.e. change land use to carbon forestry with primary goal is carbon sequestration) is 750 Mt CO2-e per year, of which biodiverse plantings account for 350 Mt CO2-e per year (CSIRO 2009), equivalent to a potential of 47.2 Mha. By analyzing a study area in Queensland, Table 9-1 (CSIRO 2009, p. 101) indicated that the mitigation potential cross the total profitable areas was 153 Mt CO2-e; however the likely more realistic scenario i.e. 10 % of farms in the 50% of profitable area if planted biodiverse and carbon forest plantings then about 8 Mt CO2-e per year could be sequestered. The total land area estimated available for carbon plantings by Garnaut (2008) is much smaller than one of CSIRO (2009) given the different profit assumptions. Nevertheless, the scenario 10% of farms for carbon plantings (CSIRO 2009) appears realistic (given areas of greater than 600 mm rainfall zones) despite it is only 5.6% of the predicted Garnaut (2008).

Polglase et al (2011) conducted 105 scenarios to see the impacts of varied assumptions on calculated profitable areas of opportunity and associated rates of carbon sequestration. Their analysis incorporated profitable area, establishment cost, carbon price, water price, soical discount rate and a risk buffer of 30% on the carbon sequestration rate. Some of their results are provided next page. At scenario 11 given the establishment costs (AU$1000/ha) and AU$20/ton C - the CO2-e sequestered is 312 Mt CO2/year over 32 Mha, which is 2.18 times the one from Garnaut (2008). However, the establishment rate deems realistically too cheap and yet did not include water cost. Scenario 95 has had water costs included and yet with similar establishment costs (AU$1000/ha) and AU$20/ton C, the CO2-e sequestered is 95 Mt CO2/year over 9.1 Mha. This scenairo's result though appears more realistic (e.g. inclusive of water cost) and yet establishment cost is still cheap. The estimated land available for plantings deem closed to one from Garnaut (2008); but the carbon sequestration is only 66% of Garnaut's (2008) prediction. Scenario 32 raised the establishment costs up to AU$3000/ha and yet no water costs included, predicting potentially profitable area to only 1 Mha, sequestering 19 Mt CO2-e/year, which is only 13% of Garnaut (2008) prediction.

The Polglase et al (2011)'s results showed that the mitigation potential would be restricted by the key establishment cost of plantings, in few scenarios water costs, and also carbon price amongst other secondary factors. The Garnaut's prediction (2008) implies that there may be the need to convert large areas of land for biodiverse and carbon plantings by which according to Polglase et al (2011) would mean unrealistic. This would deem that the Garnaut (2008) estimate appears optimistic; yet without accounting for realistic costs it is unlikely to be feasible for achieving its mitigation potential. Given the more realistic scenarios such as one from CSIRO (2009) i.e. 10% of each farm (equivalent to 8Mt C/year) and Polglase et al (2011) scenario 32 (equivalent to 19 Mt C/year); they nevertheless would deem not yet highly credible given the unknown adoption rate by rural landholders. Most of the results of mitigation potential, CSIRO

(2009) and Polglase et al (2011), indicated the adoption rate would predominantly be dependent upon the carbon price and establishment cost, which apparently are changing everyday and highly reliant upon political situation.

The Carbon Farming Initiative (CFI) of DCCEE (2011) provided results in the low and high ranges of abatement for Kyoto-related reforestation (p.10) and avoided deforestation and managed regrowth on deforestation lands (p. 11-12), which is relative to other estimates. Yet, DCCEE (2011)'s results did not indicate the current uptake level by landholders either and still referring these estimates would depend on price, accounting rules, costs of generating the abatement credits, policy and participation from other sectors (DCCEE 2011).

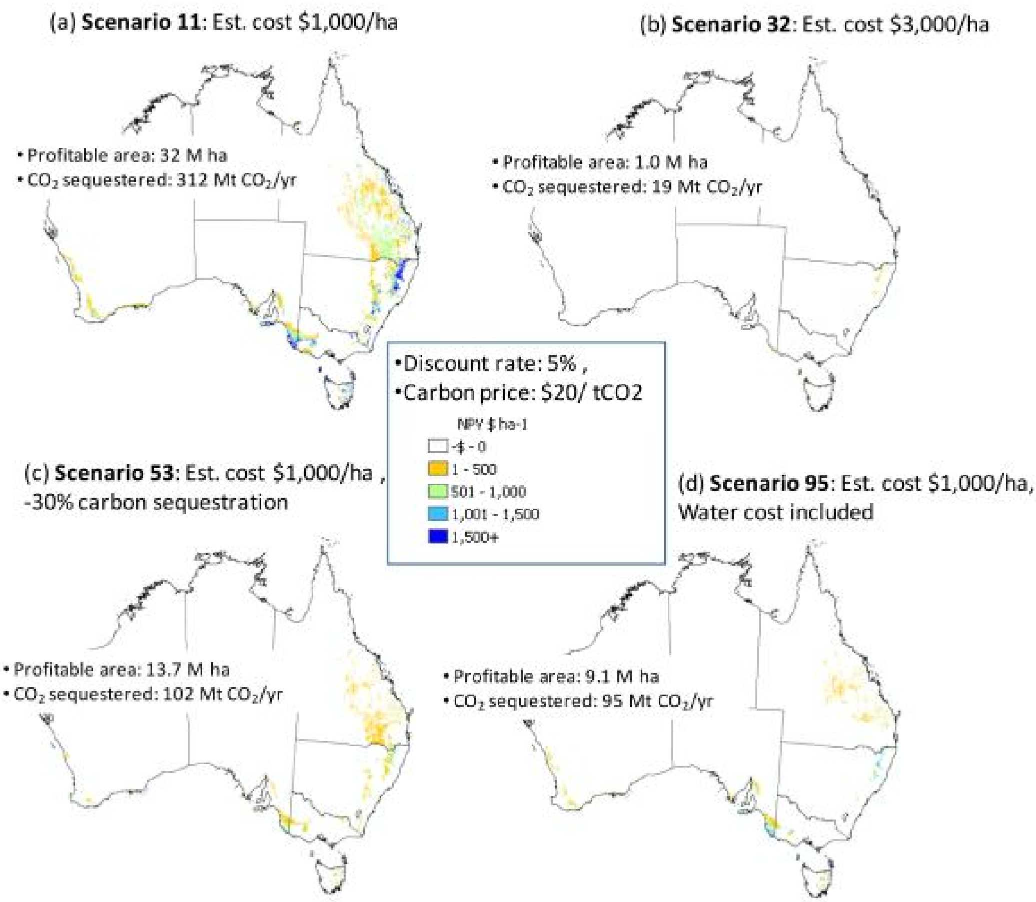

Figure 6. Example results from four scenarios that each use a discount rate of 5% and carbon price of $20 t CO_2^{-1} and: (a) establishment cost of $1,000 ha^{-1}, baseline rate of carbon sequestration, (b) establishment cost of 3,000 ha^{-1}, baseline rate of carbon sequestration, (c) establishment cost of $1,000 ha^{-1}, -30% rate of carbon sequestration, (d) establishment cost of $1,000 ha^{-1}, baseline rate of carbon sequestration, water cost included. The purpose here is to illustrate areas of relative profitability for select scenarios.

Figure 2: Adopted from Polglase et al 2011.

What would be incentives from the mitigation option?

There are a number of incentives from this option. Given that it would provide a substantial low cost abatement, there has already been an incentive from Australian government to invest into this e.g. through

CFI to (possibly) increase the national reputation in reducing GHG emissions by approaching domestic rural landscapes. For industries e.g. coal, electricity, those who are legally obliged to pay a fixed carbon price for the right to emit, may offset (Jotzo 2012, Keenan et al 2012) part of their emissions domestically with rural landholders. Given its low start-up costs of between AU$1000-3000 per hectare, there has already been a small amount of private business (24 firms) whom take interests in afforesting rural land areas with biodiverse plantings, registered under Carbon Pollution Reduction Scheme (CPRS), and possibly driven by a motivation to minimise their carbon footprint for corporate legitimacy, ethical and marketing businesses (Dargusch et al 2010).

An emerging voluntary offset market (see Carbon Offset Guide.com.au) indicates 20 forestry registered (2013, see below) already investing into carbon offsets as the key project type (19/20 retailers and 11/20 accredited Gold Standards VERs and VCUs). This voluntary nature to an extent demonstrates the acceptablity and that associated with certain incentives-driven from the public (yet private sector) of the option. There are other immediate benefits such as erosion control, wind breaks and shelter belts (Paul et al 2012) and reducing dryland salinity (Jonson and Freudenberger 2011), improve water quality, biodiversity and enhancing resilience of natural assets under changing climate (CSIRO 2009). Another incentive is that people seeing this as one way to diversify their income streams. Carbon forest plantings, given it can be established in the lower rainfall and lower land values, can provide more positive returns even with low growth rates typical of these regions (Dargusch et al 2010) besides there would be little to no costs of transport and processing and ongoing management costs compared to other production forests (Garnaut 2011).

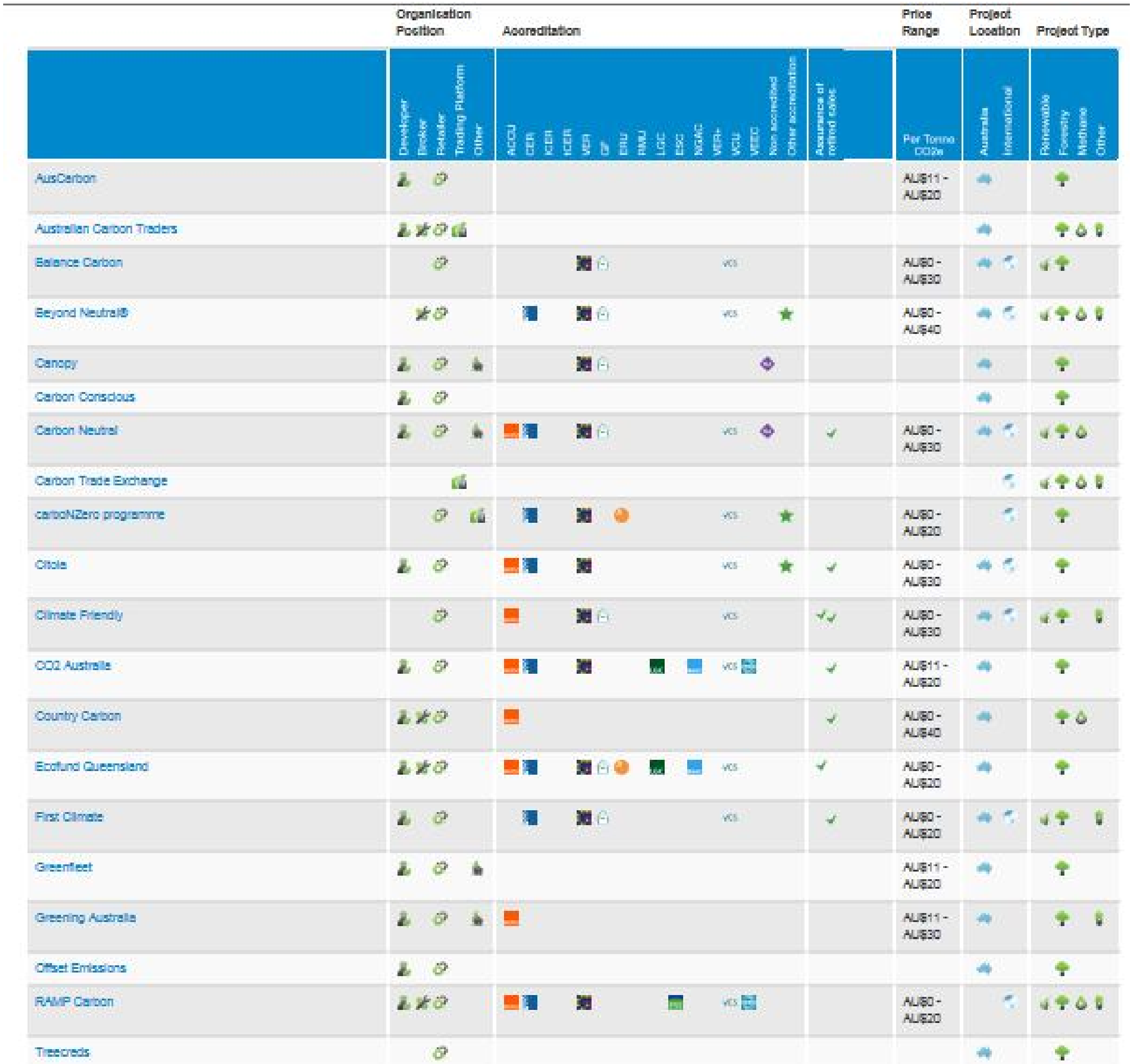

Figure 3: Illustration of companies currently operating carbon offset with carbon plantings indicated as key project type (source: CarbonOffsetGuide.com.au)

What are the obstacles for achieving the mitigation potential?

Despite the numerous incentives, there are obstacles. The most important obstacle is the question of scale i.e. the recent level of uptake by rural landholders appears probably vastly low (from personal observation despite there is not yet any literature studying/surveying the rate of adoption by rural landholders of biodiverse and carbon plantings). Besides the uptake level is highly influenced by establishment costs and maintenance, the carbon price is already low given the latest political decision to proceed ETS earlier dropping to AU$6-10, associated obstacles are the likely loss of other agricultural income (Garnaut 2011), and the broader community attitude (carbon forestry versus food producing land) and other possible risks associated with plantings (CSIRO 2009).

Risks associated with predicted more events of droughts, floods and fires (Climate Commission 2011) in the Australian rural landscapes could restrict people from investing into this. An additional obstacle i.e. legal compliance of a 100-year contract which appears too long for landholders to feel hesistant and or risk themselves what if the frequency and intensity of fire events were likely happening more in the rural areas within 100-year. These types of risks may cause a greater burden financially for landholders to adopt the option.

Ecologically, there are challenges in managing the carbon through its entire cycle; while the impacts of climate change may cause plant stress, fire, pathogens and thus resultant emissions. The technical challenge is that it remains uncertain of a fully comprehensive monitoring, review, and valuation system accounting for carbon in a forest, given the CFI methodology has still been critical and or even the NCAS was critical of its overestimation/underestimation.

Institutionally, in the absence (or immaturity) of a formal carbon compliance scheme this might affect the credibility and thus the uptake level by wider landholders despite there is only some voluntary proaction. My experiences when interviewing rural landholders in Orange, NSW in the past as well as working with other landholders from Vietnam in varied initiatives assumed that landholders may even concern about economic and employment opportunities to be created after carbon plantings which could be another source of obstacle.

At the other form of obstacles, the controvery over this mitigation option would be - even if biodiverse and carbon forest plantings may play a part in mitigation yet would this be credible enough to reduce the overall GHG emissions given the Australian government has not yet pursued a 100% renewable energy (only 20 per cent, see Figure 4 below). Identifying the scale at which can the option generate more positive impacts remains unknown. Many coal companies have exported their emissions overseas (coal mines etc) and the government allows companies to offset (about two third) from overseas carbon credits which paint the controvery even more critical when it boils down to ethical and quality of Australia's efforts in emissions reduction. Should Australia restrict only to domestic reduction i.e. sourcing the offsets internally within Australian boundary remains unanswered.

The potential of this mitigation option is also dependent upon the political situation. The recent change in the political context in Australia i.e. a decision by PM Kevin Rudd to proceed to an early shift to an Emissions Trading Scheme (ETS) has affected the price of carbon. The carbon price was predicted to fall from a fixed $25.40 a tonne in 2014/15 to about $6-$7 a tonne under the floating regime linked to the European ETS. This might affect the uptake (rate of adoption) by landholders. According to the latest news from Get Up (2013), the early move to an ETS by the Government comes at a cost to the Government, dropping about $3.8 billion of expected revenue for the 2014-15 fiscal year. Funds for biodiversity protection will lose $213 million over four years while the Carbon Farming Futures program will lose $144 million. There however expected more money to rescue the coal industry to help their transition. This political uncertainty can affect the adoption rate of biodiverse and carbon forest plantings, and hence its mitigation potential.

Greenhouse gas emission reduction targets Australian Labor Party (ALP): Committed to 5-25pc (pc: per cent) reduction on 2000 levels by 2020, based on the ambition of global agreement and 80pc reduction by 2050 which is in line with the UK and Germany. Signatory to second commitment period of Kyoto Protocol for 2020 reduction and intention to ratify.
Carbon price ALP: Carbon pricing legislated in 2011 along with independent Climate Change Authority, Clean Energy Regulator, and Australian Renewable Energy Agency. Climate Commission established administratively in February 2011 to explain the science of climate change. Announced in July 2013 bringing forward emissions trading scheme to 1 July 2014 and cutting back Energy Security Fund from $4.3 billion to $2.5 billion.
Renewable Energy Target (RET) ALP: Committed to the RET of at least 20pc by 2020 which maintains target of 41,000 GWh large scale renewable energy generation by 2020. Commitment not to review RET until 2016.
Carbon Farming ALP: Set it up and committed $290 million to Carbon Farming Futures and Skills program. $44 million for complementary improvements in Natural Resource Management planning. Adopted new international rules which allow virtually all Carbon Farming Initiative credits to be sold to all polluters in the carbon pricing mechanism.
Biodiversity Fund ALP: Committed over $400 million over six years, down from $1 billion originally allocated.

Figure 4: Adopted from most updated ABC news 'Environment policy: where the parties stand'

Conclusion

Assessing the credibility and feasibility of biodiverse and carbon forest plantings might not be that easy given the mitigation option is highly dependent upon various factors (DCCEE 2011), of which the firm running of the CFI and the higher uptake level by rural landholders deem the critical ones. Mitigation potential estimates from various credible sources are merely one part of the solution; yet translating those estimates into practice (i.e. reality) that would require the magnitude of plantings works which can be enormous; and that depending on the range of other factors as well e.g. amount of plantings to be conducted per year i.e. dependent upon the profitability (i.e. carbon price) and the political situation. It appears that without reaching out to rural landholders for higher uptake and (possibly) demanding stable carbon pricing mechanism to achieve further credibility - this mitigation option has certain potential, yet should be conducted with other mitigation options to reduce Australia's overall greenhouse gas emissions.

Reference

Aguirre, G. J. 2009. Why Cutting Down Trees Is Part of the Problem, but Planting Trees Isn't Always Part of the Solution: How Conceptualizing Forests as Sinks Can Work Against Kyoto. *Oregon Review of International Law* **11** 205-224.

Battaglia, M. 2011. Greenhouse Gas mitigation: sources and sinks in agriculture and forestry. In CSIRO, 2011. *Climate Change: Science and Solutions for Australia*. CSIRO Publishing, Collingwood, Australia

BOM (Bureau of Meteorology) and CSIRO (Commonwealth Scientific and Industrial Research Organisation). 2012. *State of the Climate 2012*. CSIRO Publishing, Collingwood, Australia. Accessed 11th August 2012 from; (http://www.csiro.au/Outcomes/Climate/Understanding/State-of-the-Climate-2012.aspx)

Climate Commission. 2011. *The Critical Decade: climate science, risks and responses.* Climate Commission, Commonwealth of Australia. Accessed 12th August 2012 from; (http://climatecommission.gov.au/report/the-critical-decade/)

CSIRO (Commonwealth Scientific and Industrial Research Organisation). 2009. *An analysis of greenhouse gas mitigation and carbon biosequestration opportunities from rural land use.* CSIRO, St Lucia, Queensland. Accessed 27th June 2012 from; (http://www.csiro.au/Outcomes/Climate/Reducing-GHG/carbon-and-rural-land-use-report.aspx)

Dargusch, P., S. Harrison and J. Herbohn. 2010. How carbon markets have influenced change in the Australian forest industries. *Australian Forestry* **73** 165-170.

Durrant, N. 2011. Legal issues in carbon farming: biosequestration, carbon pricing, and carbon rights. *Climate Law* **2** 515-533.

Garnaut, R. 2008. *The Garnaut Climate Change Review: Final Report*. Chapters 15 and 22. Cambridge University Press, Cambridge, UK. Accessed 1st June 2012 from; (www.garnautreview.org.au)

Garnaut, R. 2011. *Garnaut Climate Change Review: Update 2011*. Chapters 4 and 5. Commonwealth of Australia. Accessed 1st June 2012 from; (www.garnautreview.org.au)

Get Up Action for Australia. 2013. The latest on climate. Accessed 23 July 2013 from; https://www.getup.org.au/campaigns/climate-action-now/where-were-at/the-latest-on-climate?t=dXNlcmlkPTYxNDA1OSxlbWFpbGlkPTIxODU.

Jonson, J. H. and D. Freudenberger. 2011. Restore and Sequester: estimating biomass in native Australian ecosystems for their carbon-funded restoration. *Australian Journal of Botany* **59** 640-653.

Jotzo, F. 2012. Commentary: Australia's carbon price. *Nature Climate Change* **2** 475-476 Macmillan Publishers Limited. Accessed 1st August 2012 from; (http://www.nature.com/nclimate/journal/v2/n7/full/nclimate1607.html)

Keenan, R. J., L. Carispas, A. Foerster, L. Godden and J. Peel. 2012. Commentary: Science and the governance of Australia's climate regime. *Nature Climate Change* **2** 477-478 Macmillan Publishers Limited. Accessed 1st August 2012 from; (http://www.nature.com/nclimate/journal/v2/n7/full/nclimate1608.html)

Paul, K. I., A. Reeson, P. Polglase, N. Crossman, D. Freudenberger, C. Hawkins. 2012. Economic and employment implications of a carbon market for integrated farm forestry and biodiverse environmental plantings. *Land Use Policy* **30** 496-506.

Polglase, P., A. Reeson, C. Hawkins, K. Paul, A. Siggins, J. Turner, D. Crawford, T. Jovanovic, T. Hobbs, K. Opie, J. Carwardine, A. Almeida. 2011. Opportunities for carbon forestry in Australia: Economic assessment and constraints to implementation, *National Research Flagships- Sustainable Agriculture, CSIRO*, pp. 1-18.

UNFCCC (United Nations Framework Convention on Climate Change) 2012. *Kyoto Protocol*. Accessed 11th August 2012 from; (http://unfccc.int/kyoto_protocol/items/2830.php)