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Published in:
Conservation Letters

DOI:
10.1111/j.1755-263X.2009.00090.x

Published: 01/04/2010

Document Version
Publisher's PDF, also known as Version of record

POLICY PERSPECTIVE

Catching the baby: accounting for biodiversity and the ecosystem sector in emissions trading

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Keywords
Afforestation; agriculture; Convention on Biological Diversity; carbon trading; Copenhagen; deforestation; Kyoto; REDD.

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Received: 6 October 2009; accepted 1 December 2009.

doi: 10.1111/j.1755-263X.2009.00090.x

Abstract

The agriculture, forestry, and other land-use sector is a crucial sector, second only to the energy sector, in fighting climate change, and provides an important greenhouse gas abatement opportunity for the world. Recently, released figures for Australia, for example, suggest that agriculture, forestry, and other land-uses, which depend on healthy functioning ecosystems, could abate as much as three quarters of the country's emissions. The United Nations Framework Convention on Climate Change was concerned primarily with ecosystems and humankind, but the Kyoto Protocol of the Convention forfeited the potential of using agriculture, forestry, and other land-uses for global climate mitigation. This had the effect of decoupling biodiversity and ecosystems from carbon pollution reduction and climate change considerations. The Australian Carbon Pollution Reduction Scheme, one of the first emission trading schemes in the world to follow Kyoto "rules," excludes the agriculture, forestry, and other land-use sector, apart from plantation reforestation, potentially creating perverse incentives that themselves can turn into threatening ecological processes. We use Australia and its emerging emissions trading scheme as a case study of the potential effects of this decoupling, and demonstrate the potential impacts on a landscape-scale regional greenhouse gas abatement and carbon sequestration project.

Introduction

The services provided by healthy, biodiverse ecosystems are the foundation for human well-being (Secretariat of the Convention on Biological Diversity 2006). Biodiversity is a necessary component of functioning ecosystems, which in turn provide essential services to humanity such as food, shelter, water quality, the diversity of life, and a climate that nurtures life (Millennium Ecosystem Assessment 2005). The relationship between economic production and biodiversity conservation is largely inseparable (Steffen *et al.* 2009) so that any risks to ecosystems and biodiversity are also investment risks to the global finance sector (Biodiversity & Ecosystem Services Work Stream 2008). Without early, vigorous, and ongoing climate change mitigation measures, there is a high probability of more severe climate change and the associated risk of much higher future rates of biodiversity loss than those already experienced (Steffen *et al.* 2009).

It is not possible to avoid dangerous climate change without taking into account the natural and agricultural ecosystems of the planet: each year, tropical forests draw down 15% of global emissions (Trumper *et al.* 2009), while deforestation and agricultural emissions are responsible for over 20% of global emissions (McKinsey & Company 2009). Protecting and manipulating biodiversity also offers an opportunity to influence positively carbon sequestration in forested ecosystems (Díaz *et al.* 2009). Agriculture could offset from 5% to 14% of global annual carbon dioxide emissions, with costs

ranging between US$20 to US$100 per tonne of carbon dioxide equivalent (CO_2-e), from improved cropland and grazing land management, and restoration of degraded lands and cultivated organic soils (Smith *et al.* 2008). This compares favorably with an estimated cost of US$730 per tonne of CO_2-e for abating and mitigating emissions from industrial projects, amounting to about US$20 trillion in total (Hansen *et al.* 2008).

The agriculture, forestry, and other land-use sector (IPCC 2006) provides an abatement opportunity, and is second only to the energy sector in the potential to mitigate greenhouse gas emissions (McKinsey & Company 2009). Agriculture, forestry, and other land-use comprise a third of the global abatement opportunity and about half the cost-effective mitigation available between now and 2030 (McKinsey & Company 2009). In the context of current policy on climate change and greenhouse gas abatement, however, it is difficult to provide an economic value to this sector. One reasons is that biodiversity, and hence ecosystems (natural, agricultural, and forest), and climate change mitigation are rarely considered together (Díaz *et al.* 2009). Here, we consider this discordance, examine its possible outcomes in the case of Australia's emerging emissions trading scheme, and provide policy recommendations.

Ecosystems and Kyoto

Concerns about the increasing loss of biodiversity globally motivated the Convention on Biological Diversity which, together with the United Nations Framework Convention on Climate Change, was adopted at the United Nations Conference on Environment and Development in Rio de Janeiro in 1992. Although the two conventions are intrinsically linked (UNEP 2004), integration of the conventions remains in its formative stages; it was not until 2003 that a formal report on the interlinkages between biodiversity and climate change within the framework of the Convention on Biological Diversity was forthcoming (Secretariat of the Convention on Biological Diversity 2006). In 2008, a decision at the ninth meeting of the Conference of the Parties to the Convention on Biodiversity stressed the importance of the role of biodiversity in climate mitigation and adaptation activities, and resulted in a second formal report (Secretariat of the Convention on Biological Diversity 2009).

The Convention on Climate Change, under which the Kyoto Protocol sits, is concerned primarily with the adverse effects of anthropogenic climate change on both natural ecosystems and humankind (United Nations 1992). As well as ensuring that food production and economic development can "proceed in a sustainable manner," the Objective, at Article 2 of the Convention, is to ensure stabilization of greenhouse gases in the atmosphere at a concentration, and within a time frame, "to allow ecosystems to adapt naturally to climate change" (United Nations 1992, p. 4).

Tropical deforestation, which accounted for most of the agriculture, forestry, and other land-use sector's and around a quarter of all anthropogenic carbon emissions in the 1980s and 1990s (Laurance 2007), is a major focus for global climate mitigation. But negotiations leading to the Convention's Kyoto Protocol forfeited using the full potential of the agriculture, forestry, and other land-use sector to mitigate climate change. Only narrowly defined afforestation (the direct human-induced conversion of land that has not contained a forest for at least 50 years to forested land), and reforestation (the direct human-induced conversion of nonforested land as of 31 December 1989 to forested land) (UNFCCC 2002) were permitted within the Protocol's Clean Development Mechanism (Schlamadinger *et al.* 2007). This new market mechanism, which allows emission-reduction projects in developing countries to earn carbon credits, can be used by industrialized countries to meet part of their emissions reduction targets (Robledo & Blaser 2008). Avoided deforestation was not included in agreements until later, as discussed below.

Most of the resistance to providing incentives for the agriculture, forestry, and other land-use sector to manage carbon better is political rather than technical (Havemann 2009), and an analysis of European opposition to forests in the lead up to Kyoto is best explained as taking an opportunistic blow at United States'-led consumption (Fearnside 2001). Political sides were taken in the lead up to the Kyoto Protocol, with the European environment movement broadly "against" the inclusion of forests in the Protocol, while the U.S. environment movement was "for" forests (Fearnside 2001). The debate was, and remains, closely tied to the differing views of the potential of offsets in mitigating climate change. Instead of seeing offsets working together with abatement as a way of driving deeper cuts earlier, the Europeans objected to the possibility that the United States and other wealthy countries, including Australia, could buy their way out of making cuts by making investments in ecosystems, and thus make no real effort to reduce their energy emissions (Laurance 2007).

The opportunity to use the Kyoto Protocol to correct the failure of not properly valuing forests was lost. Business-as-usual measures such as philanthropy, government action (e.g., legislation and the creation of national parks), and international development aid continue to fail. Since the Kyoto Protocol was signed, about 130 million hectares of forest (mostly rainforest) have

been destroyed (FAO 2006). Using conservative figures (FAO 2006) and assuming around 200 t C per ha in these forests (Ramankutty *et al.* 2007), this amounts to about 117.5 Gt CO_2-e, (about 195 times Australia's yearly CO_2-e emissions). Excluding forests from the Kyoto equations has instead added to the certain, permanent, and massive loss of biodiversity and ecosystem services in exchange for no gain for climate and no influence whatsoever on U.S. consumption patterns (van Oosterzee & Garnett 2008), effectively throwing the baby out with the bathwater by discarding the very thing that it was essential to keep.

Largely as a result of this continuing loss of forest and climate change mitigation potential, tropical deforestation gained attention again at the 2005 Conference of the Parties to the Convention on Climate Change when the governments of Papua New Guinea and Costa Rica, supported by eight other parties, proposed a mechanism of financially compensating countries for reducing emissions from deforestation and land degradation (REDD) (Parker *et al.* 2009). At the thirteenth session of the Conference of the Parties in Bali in 2007, a decision was made to consider and stimulate action on REDD (UNFCCC 2008b) in the lead up to the fifteenth Conference of the Parties in Copenhagen in December 2009, where a framework for climate change mitigation beyond 2012 is to be negotiated. More recently, a plus symbol ("+") has been added, indicating that REDD+ projects consider conservation with enhancement of carbon stocks. This draws attention to a future REDD mechanism which would recognize that REDD+ simultaneously addresses conserving biodiversity, ecosystem services, and climate change (Parker *et al.* 2009).

While REDD has come to focus on developing countries, deforestation continues in industrialized countries such as Australia (Macintosh 2007), and in other biomes such as the boreal forests (Bradshaw *et al.* 2009).

Decoupling biodiversity from climate change—the Australian case

Excluding the agriculture, forestry, and other land-use sector from the Kyoto Protocol has decoupled ecosystems and their biodiversity from carbon pollution reduction and climate change considerations, leading to some discordant policy. Here we focus on Australia and its emerging emissions trading scheme, the Carbon Pollution Reduction Scheme, as a case in point. If passed through the Australian Parliament before the 2009 Copenhagen Conference of the Parties, Australia would have been the first country to have implemented an emissions trading scheme using the framework of the Kyoto Protocol. Other countries that are using the Kyoto Protocol as a framework to develop emissions trading schemes, albeit in different stages of development, include Canada, Japan, and New Zealand (Garnaut 2008).

The main predicted effects of climate change in Australia include sea level rise at the upper end of forecast projections of about 0.8 m by 2100, recurring severe droughts and continuing drying trends in major parts of the continent, increases in heat waves, floods, and bushfires, and increasingly acidic and hotter oceans (Steffen *et al.* 2009). Impacts on biodiversity from these effects are likely to include changes in migratory patterns of species, interaction with other disturbance regimes such as fire and grazing, resulting in increasing woody plant density over large areas, and disruption of forest composition due to fragmentation, resulting in reduced species dispersal (Gitay *et al.* 2002).

In Australia, deforestation accounted for 129 Mt CO_2–e, or 23% of Australia's total emissions in the 1990 base year (Macintosh 2007). In 1999, Australia was the fifth highest deforester in the world (Steffen *et al.* 2009). Australian Treasury figures show land-use change (clearing of forests and woodlands) still accounts for 74 Mt CO_2-e per annum, equivalent to 13% of Australia's emissions using 2005 figures, and agriculture currently accounts for 15% of Australia's total emissions (Australian Government 2008). Despite these high figures, avoidance of deforestation and land degradation (REDD activities) and avoided emissions and improved sequestration from agriculture cannot be traded within the current model of the emissions trading scheme because it follows Kyoto "rules" (Australian Government 2008) which specifically exclude the agriculture, forestry, and other land-use sector. In Australia, only reforestation will be included as an allowable activity for the issue of carbon credits.

Given the high contribution to total emissions, the agriculture, forestry, and other land-use sector could potentially transform Australia's mitigation effort and influence global mitigation effort (Garnaut 2008). A recent Commonwealth Scientific and Industrial Research Organisation study (Eady *et al.* 2009), which assessed greenhouse gas abatement potential through change in rural land-use, demonstrated for the state of Queensland that the overall attainable greenhouse gas abatement was 140 Mt CO_2–e per year, or 77% of that state's emissions. National estimates, where available, suggest a similar outcome (Eady *et al.* 2009).

While the abatement potential from activities such as reforestation is high, caution is required in how this is implemented, as mitigation efforts could themselves turn into threatening ecological processes (Steffen *et al.* 2009). The draft Carbon Pollution Reduction Scheme will allow reforestation in the form of the planting of

monoculture or mixed plantations of any species (Commonwealth of Australia 2009) for carbon or for biofuels, for instance, which could lead toward highly simplified industrial landscapes with low biodiversity when compared with native mixed plantations (Hartley 2002; Sayer *et al.* 2004; Marcot 2007; Keenan *et al.* 2009). Such industrial landscapes would have deleterious outcomes for biodiversity because they would not provide the space and opportunities for natural ecosystems to self-adapt and reorganize, and would deny the maintenance of fundamental ecosystem processes that underpin vital ecosystem services (Steffen *et al.* 2009).

One of the challenges to incorporating the agriculture, forestry, and other land-use sector under the Convention on Climate Change and its Kyoto Protocol is the lack of regionally differentiated management approaches, since climate change causes regionally differentiated impacts that require local knowledge to manage effectively (Steffen *et al.* 2009). The response to climate change also requires regionally specific technical solutions and management approaches, and incurs regionally different transaction costs (Robledo & Blaser 2008).

Regional approaches to natural resource management have been evolving across the globe for several decades, and are appropriate to effective landscape-scale management of natural resources (Dale *et al*. 2008). A region in the Australian context refers to a landscape-scale area, such as described in the Interim Biogeographic Regionalisation of Australia (Commonwealth of Australia 2004), and used to define Natural Resource Management regions. By 2000, Australia had an emerging regionalism of international significance (Dale & Bellamy 1998), and has increased its capacity for regional natural resource management through its regional natural resource planning and management system (Dale *et al.* 2008).

This institutional framework could be adapted for managing the landscape-scale impacts of climate change, including the management of the co-benefits of carbon sequestration. Natural resource management carried out at the regional scale through Natural Resource Management Plans already contributes to sustainable economic development by integrating economic, social, and environmental policies across regions through on-ground implementation (Williams *et al.* 2005). Regional Natural Resource Management is already an important institutional response to managing the threats to Australia's biodiversity (Steffen *et al.* 2009). A key finding of the Assessment of Australia's Terrestrial Biodiversity 2008 (Department of the Environment Water Heritage and the Arts 2009) is that the strengthening and consolidation of the regional delivery model for Natural Resource Management has assisted delivery of biodiversity outcomes. Natural Resource Management regions provide a geographical basis for the assessment of biodiversity and the consequent reporting on state and trend (Wentworth Group 2009) including in the Australian State of the Environment Reports (Beeton *et al.* 2006).

A pilot scheme has been developed for the Wet Tropics Region in northeastern Australia which demonstrates how the Natural Resource Management activities of Australia's existing regional Natural Resource Management bodies can be aggregated for both regional and larger-scale delivery of climate mitigation and abatement (Figure 1). The Degree Celsius Wet Tropics Biocarbon Sequestration and Abatement Project aggregates multiple "small-scale" subprojects which are too small to be profitable by themselves in the carbon market, considering the transaction costs. Project activities include avoided deforestation, avoided degradation, reforestation, and agricultural land management through fertilizer reduction. Aggregating carbon abatement and sequestration activities using native species also improves biodiversity and water quality outcomes across the region. By using the existing accredited regional Natural Resource Management plan as the framework for the aggregation of carbon sequestration activities for the market, the Wet Tropics Project could deliver complementary biodiversity, sustainable agriculture, water quality, and community benefits (Wentworth Group 2009). The Project used existing methodologies of the Clean Development Mechanism of the United Nations Framework Convention on Climate Change (e.g., UNFCCC 2008a) and of the Inter-Governmental Panel on Climate Change (IPCC 2006). The nitrous oxide emission calculation guidelines of the Inter-Governmental Panel on Climate Change (Volume 4, Intergovernmental Panel on Climate Change 2006) were used to calculate the abatement effect of reduced use of fertilizers on agricultural land. The National Carbon Accounting Toolbox FullCAM program (Department of the Environment and Heritage 2005; Richards & Evans 2009) was used to model reforestation and avoided deforestation and forest degradation activities.

In Australia, investment in natural resources is at least two orders of magnitude smaller than that in physical capital, partly due to the inability to establish markets (Steffen *et al.* 2009). Currently, regional Natural Resource Management bodies are supported to invest in actions that uphold national and state governments' priorities, but they lack resources to implement initiatives and follow them through to completion. They also are subject to short-term, erratic funding cycles due to the shifting politics of both state and federal governments. This constrains actions that help build resilient regional landscapes (Robins & Dovers 2007). The benefits from aggregating multiple Natural Resource Management activities of landholders and trading the resultant credits in carbon

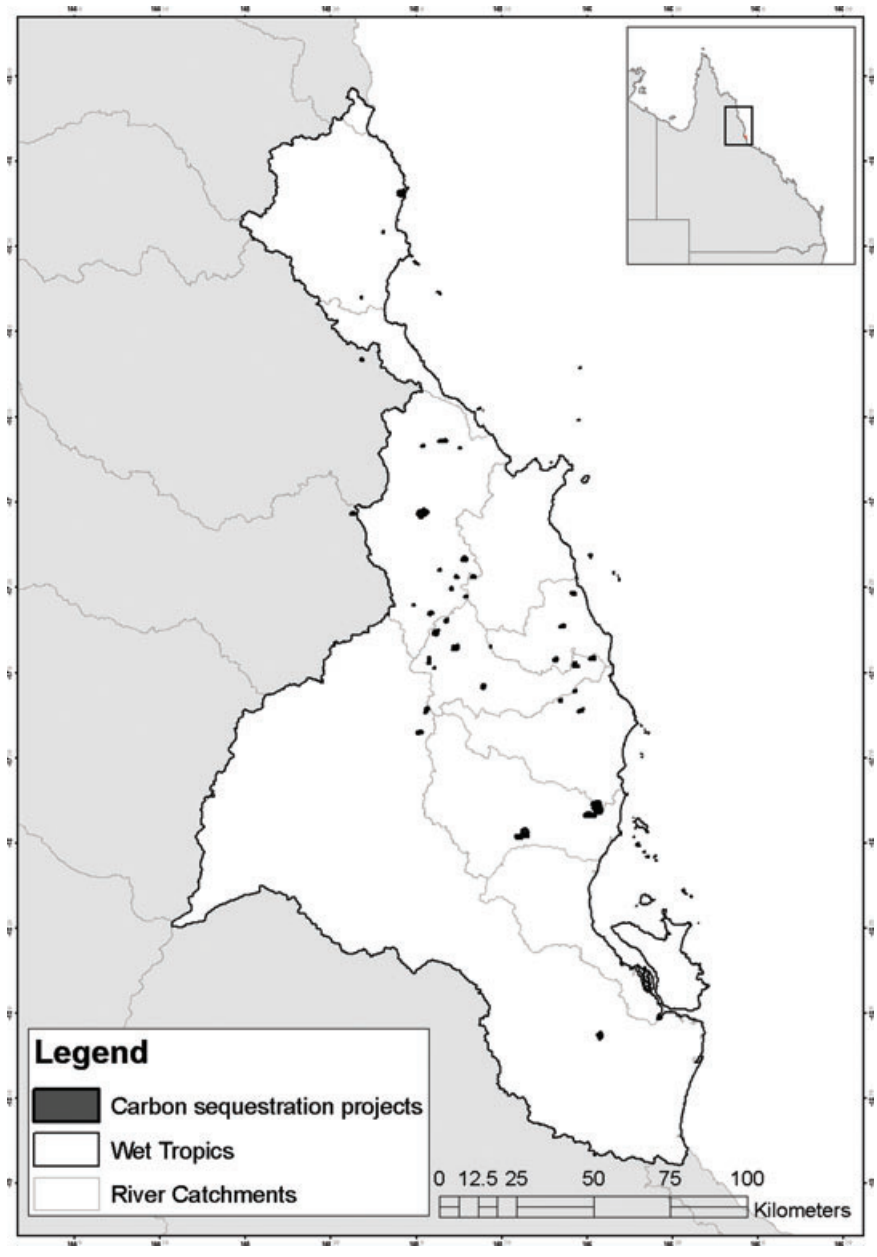

Figure 1 Australian Wet Tropics Natural Resource Management Region showing locations of current carbon sequestration projects.

markets could be a strong driver of investment in natural resource management groups on a consistent basis.

Activities conducted by landholders could potentially earn money for both the Natural Resource Management groups and for the landholders and contribute to reducing deforestation and degradation, increasing reforestation and improving agricultural practices. The on-going deforestation rate of both remnant and nonremnant regrowth forests in the Wet Tropics is between 990 and 1,700 ha per year, equivalent to a release of at least 4.5×10^5 t CO_2-e per year. By putting a carbon monetary value on these nonremnant, unprotected forests, farmers would have an incentive to retain them and thereby reduce the emissions caused by clearing them. In the Wet Tropics, forest practices such as logging are degrading biodiverse remnant forests. Degradation in the form of logging of remnant forests for timber is also an on-going practice and, based on recent trends in submitting notices of intention to log (unpublished data from Dept of Environment and Resource Management

database sources, first half 2009), the potential savings in avoided degradation in the Wet Tropics could be over 1.2×10^6 t CO_2-e per year, if landholders who intend to log choose to retain their trees to sell the carbon sequestration benefits. By contrast, historic data show that reforestation using environmental plantings is occurring at about 40 ha per year, which is small compared to the area being cleared (at least 990 ha per year). This is less than 1% of the potential sequestration benefits of avoided deforestation and degradation, but with financial incentives to plant, the reforestation rates would increase.

Sugarcane plantations cover over 180,000 ha of the Wet Tropics region (McDonald & Weston 2004), and lie in the catchment of the Great Barrier Reef. The average application of nitrogenous fertilizers to sugarcane was estimated to be 200 kg per ha. The emissions from these fertilizers averaged 5×10^5 t CO_2-e per year, averaged over 10 years of records (N. Preece, unpublished data; see Appendix S1). The Wet Tropics carbon project would help to reduce this application rate by 20% or more by encouraging farmers to trade the difference in emissions. Landholders in the region have shown strong interest in measures to reduce their fertilizer use and trade the reduced resultant emissions.

The Wet Tropics project, when it was being planned in 2006 and 2007 and until the introduction of the Carbon Pollution Reduction Scheme Bill, was intended to meet all the requirements of the Voluntary Carbon Standard (Voluntary Carbon Standard Association 2007) for sale of carbon credits on the international carbon trading market. The Carbon Pollution Reduction Scheme, in the form it had when we reviewed it, would have the effect of disintegrating the Wet Tropics Project's coherent approach by replacing it with an assortment of disconnected approaches, which mostly ignore the potential of the agriculture, forestry, and other land-use sector in carbon mitigation. Only reforestation is included under the proposed Scheme. Avoided deforestation and degradation are treated differently. While both are excluded from the Scheme, deforestation is counted as part of Australia's Kyoto accounts and cannot be traded in the international carbon markets. Avoided degradation is not counted toward Australia's Kyoto accounts and could be traded in international carbon markets. Agriculture, including offsets such as fertilizer reduction, is not to be considered until 2013 for possible inclusion in the CPRS in 2015.

Contradicting the trends at home, Australia has proposed to the United Nations Framework Convention on Climate Change a forest carbon market mechanism for developing countries, which would include REDD, reforestation, and afforestation. The mechanism is designed to ensure "environmental integrity, and to not create perverse outcomes, including for biodiversity" (Australian Government 2009), something Australia has not considered for its own emissions trading scheme.

Conclusions

Excluding ecosystems from the Kyoto Protocol decoupled ecosystems and biodiversity from carbon and climate change considerations, and ignored the substantial synergies that exist between them. The integration of biodiversity into climate mitigation and adaptation activities including emissions trading schemes needs to occur rapidly in order to reduce the continuing destruction of rainforests, which has added to certain, permanent loss of biodiversity.

Landscape-scale management and institutional frameworks for natural resource management already exist. These could also become frameworks for managing carbon abatement with simultaneous biodiversity and water quality services. The agriculture, forestry, and other land use sector could be integrated into such frameworks using accepted international methodologies for measuring carbon benefits.

Acknowledgments

We thank G. Kay for his substantial input into the Wet Tropics project, M. Berwick for supporting the project, and Dr. Corey Bradshaw for valuable comments on various drafts of the article. We also thank four anonymous reviewers for their valuable comments.

Supporting Information

Additional Supporting Information may be found in the online version of this article:

Appendix S1. Nitrous Oxide from Sugarcane Crops Methods for calculation.

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Editor: Dr. Corey Bradshaw

