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Short communication

Carbon accumulation through ecosystem recovery

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ABSTRACT

A market has emerged for carbon sequestered through reforestation. The opportunity to restore ecosystems through this market rather than establish plantations is demonstrated by an Australian case study. In the state of Queensland there are vast areas that have been cleared relatively recently and could be restored to ecosystems with high resilience and important biodiversity values with appropriate management. In order to foster opportunities for carbon accumulation through ecosystem recovery spatially explicit information on sequestration rates, management recommendations, and clear definitions of ancillary biodiversity benefits need to be defined.

Carbon trading schemes are one of the policy options to address the problem of atmospheric climate change. Through this market the growth of woody plants presents real opportunities not only for carbon sequestration but also for nature conservation (Bekessy and Wintle, 2008). In some landscapes where deforestation has been relatively recent, and subsequent land-use relatively benign, the restoration of previously cleared forest is possible with appropriate management. Natural regrowth has numerous advantages over typical forestry plantations as a carbon store because it (1) does not require the intensive effort of planting; (2) involves tree species naturally adapted to the site, which should result in more resilience to disturbance; and (3) has the additional benefit of restoring mature vegetation, approximating the original vegetation, thus restoring ecosystems and biodiversity in fragmented landscapes. However, while the carbon market provides opportunities for the restoration of habitat, it needs to be clearly informed and directed by conservation science. The Australian state of Queensland is a region where the synergy between carbon sequestration and nature conservation has great potential. This paper defines the elements that are required for carbon accumulation through ecosystem recovery (CATER), not only to nurture the opportunities for biodiversity conservation, but also to generate accurate and transparent carbon accounting and sound prescription for minimising risks.

The structure of the Kyoto Protocol is likely to form the basis for accredited international trading schemes with provision to account for emissions from Land Use, Land Use Change and Forestry (LULUCF). The United Nations Convention on Climate Change and the Kyoto Protocol distinguish between Annex I countries (developed countries including Australia) and non-Annexe 1 countries. Annex I countries cannot trade carbon sequestered by reforestation as Removal Units (RMUs) with other countries unless that country is reporting a net sink for the entire LULUCF sector. This does not preclude the trading of carbon through registered reforestation projects within a country and the guidelines for this market are being developed through the Australian emissions trading scheme (Carbon Pollution Reduction Scheme, DCC, 2008a), which adheres to the Kyoto framework. From the Marrakesh Accords, which provide definitions to support the Kyoto Protocol, reforestation is defined as 'the direct human-induced conversion of non-forested land to forested land through planting, seeding and/or the human-induced promotion of natural seed sources. For the first commitment period,

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reforestation is land that did not contain a forest on the 31 December 1989′ (UNFCC, 2006). For a definition of 'forest' Australia has nominated greater than 20% canopy cover, more than 2 m height and greater than 0.2 ha in area (DCC, 2008b). Large areas of facilitated 'ecosystem recovery' after clearing would seem to meet the definition of reforestation under the Kyoto Protocol and could be included within an emissions trading scheme. Key factors that will affect the uptake of CATER are the way that trading schemes deal with leakage (i.e. how sequestration in one part of an enterprise or sector may affect emissions in another part), payment structures (i.e. pay on sequestration or by some averaging of predicted sequestration rates) and the permanence of carbon sinks. These issues are not unique to CATER but are also relevant to plantation forestry. CATER is not solely dependent on a formal carbon trading scheme as defined by the Kyoto Protocol. A voluntary market is also emerging and this market, in particular, will be motivated, not only by carbon offsetting, but will also be responsive to subsidiary biodiversity values.

Eastern and southern Australia has a history of extensive clearing of native vegetation, in contrast to much the rest of the continent where vegetation clearance has been far less extensive (Fig. 1). In the state of Queensland, 87% of clearing has been in sub-humid or semi-arid environments (Table 1), mostly conducted to increase the productivity of pasture, generally for cattle grazing rather than sheep. Most clearing has been relatively recent, such as within a vast region known as the Brigalow Belt (31 million ha) where clearing has occurred at about 1% per annum between 1956 and 1993 (Fensham and Fairfax, 2003). Clearing of the woodland and forest for pastoralism generally occurred by 'chaining' whereby an enormous chain is dragged between two bulldozers, levering trees out of the ground as it passes. Typically the overturned trees were then pushed into heaps and burnt, removing most of the woody biomass from the site. The operation haphazardly leaves small trees and shrubs less than about one metre tall. Following the burning operation, sites were usually sown with introduced African pasture grasses. The elimination of the original vegetation is often incomplete, and regrowth can occur from remaining small trees and shrubs, from natural seed banks and the vegetative suckering resulting from root stocks. The recurrent clearing of woody regrowth is standard practice and an ongoing necessity to eliminate recovering natural vegetation and to maximize pastoral production. In southern Australia where most clearing occurred in the first century of land settlement (Fig. 1), reclearing, fertilization and exotic grasses have extinguished opportunities for natural regrowth (Dorrough and Moxham, 2005).

An assessment of satellite remote-sensed data from Queensland (Appendix A), indicates that there are vast areas that could be reforested by the recovery of regrowth vegetation (Table 1). It is estimated that approximately 78% of these lands meet the 'reforestation' definition of the Kyoto Protocol. Assuming that they could accumulate carbon to the levels they stored prior to clearing, the potential carbon sink of these cleared areas ranges from low values of 20 t C ha^{-1} in semi-arid areas to values up to 500 t C ha^{-1} in productive *Eucalyptus* forest in humid areas (Table 2). The time for recovery of forest carbon to levels of uncleared vegetation is not known exactly but if estimated at 70 years (Vargas et al., 2008), accrual rates would be between 1 and 26 t CO_2 eq ha^{-1} yr^{-1} depending on ecosystem productivity. These are underestimates of total carbon sink potential because they do not include dead wood (Brown, 2002) which will continue to accumulate carbon after the live component has matured, and below-ground sinks

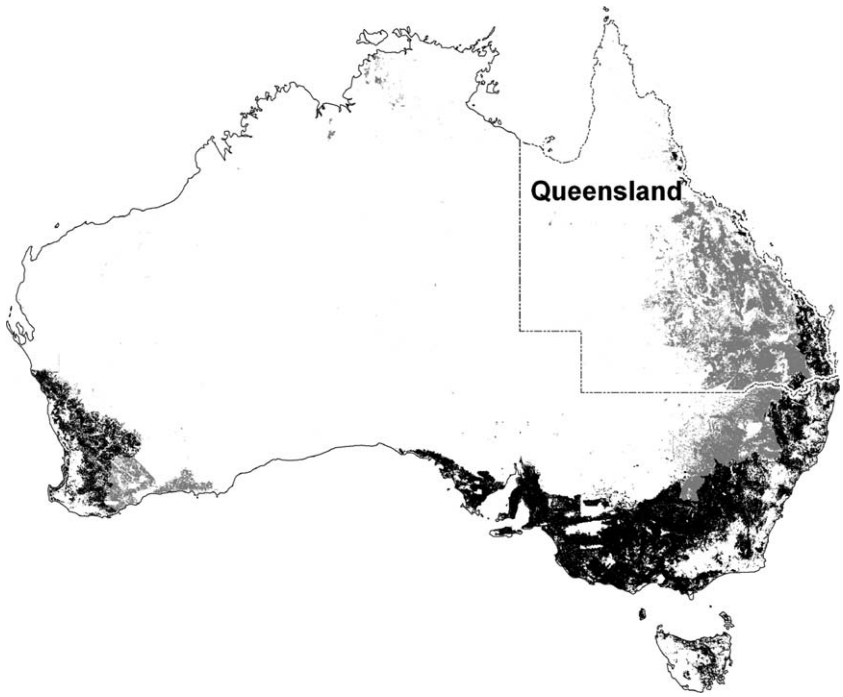

Fig. 1 – Map coverage showing the distribution of cleared landscapes assigned to pre-1950 clearing (black) and post-1950 clearing (grey) generalised for the bioregions of Australia (Thackway and Cresswell, 1995).