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Assessing policy and carbon price settings for incentivising reforestation activities in a carbon market: An Australian perspective

Michael Rooney[a], Keryn I. Paul[b,*]

[a] Carbon Interactions, Canberra, ACT 2601, Australia
[b] CSIRO Agriculture and CSIRO Land and Water, GPO Box 1700, ACT 2601, Australia

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ABSTRACT

Policy makers often seek to incentivise reforestation to achieve either carbon abatement and/or the provision of other co-benefits such as landscape remediation, biodiversity, and social outcomes. But where incentives are for carbon abatement alone, uptake is often slower than expected, with previous estimates of economic viability for reforestation often overlooking some economic and technical barriers. Management of revegetation projects (e.g. species mix, configuration in belts or blocks and density of stocking) influences not only rates of sequestration of carbon (and therefore expected revenue from carbon markets), but also establishment and maintenance costs. These management factors were considered via a sensitivity analysis of a financial cash flow model of different scenarios of revegetation projects with respect to scale of operation of projects, quantification methodology applied, and type of payment contract.

Results reinforced that policy makers seeking to incentivise revegetation for carbon abatement in addition to co-benefits such as landscape remediation may require additional crediting for these co-benefits as projects are often unviable with carbon payments alone. For example, simple linear tree plantings are likely to be most competitive in a market based solely on carbon abatement, while blocks of mixed-species biodiversity plantings would be uncompetitive given their relatively low rates of carbon sequestration and high establishment costs. Economic viability of revegetation projects may also be enhanced through: aggregation of projects to increase economies of scale; carbon markets allowing flexibility in approaches for quantification (e.g. application of calibrated models, or undertaking of direct field sampling), and; facilitating payment contracts that provide upfront capital through forward contracts.

1. Introduction

Reforestation is an important tool in the mitigation of climate change, creating a carbon sink by absorbing and storing carbon dioxide. In countries such as Australia where there are vast amounts of cleared land available for reforestation (e.g. 1–5 Mha), these projects offer the highest potential for abatement from the land sector (Battaglia et al., 2004).

Well-planned reforestation projects involving complex biodiverse carbon system may also deliver positive environmental and social outcomes (Bradshaw et al., 2013; George et al., 2012; Jonson, 2010; Standish and Hulvey, 2014). However, there is evidence that payments for carbon alone are insufficient to make many reforestation projects with such co-benefits viable (e.g. Bradshaw et al., 2013; Lin et al., 2013; Lindenmayer et al., 2012; Montagnini and Nair, 2004; Paul et al., 2016). It has been argued (Chenost et al., 2010; Ebeling and Vallejo, 2011; Mitchell et al., 2012; Thomas et al., 2010; Torres et al., 2010) that barriers to establishment of reforestation include: (i) high transaction costs, at least partly attributable to technical complexities in methodologies, (ii) financial constraints such as high upfront capital costs and non-linear project returns, (iii) complex governance and legal issues, and; (iv) physical and political risks associated with the long term (often > 15 year) nature of reforestation projects.

In Australia, over the four years of operation of a domestic offsets market (Emissions Reduction Fund and the Carbon Farming Initiative), despite the registration of planted reforestation projects comprising almost 17% of abatement projects registered (Clean Energy Regulator, 2016), these have generated < 4% of issued Australian carbon credit units (ACCUs). This low level of activity for reforestation is consistent with the Clean Development Mechanism (CDM) and other carbon markets where reforestation has fallen far behind original expectations (Chenost et al., 2010; Ebeling and Vallejo, 2011; Thomas et al., 2010; Torres et al., 2010).

Trade-offs exist between carbon sequestration and other

* Corresponding author.
E-mail address: Keryn.Paul@csiro.au (K.I. Paul).

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environmental benefits such as biodiversity, with these trade-offs being influenced by the type of reforestation established; namely species mix (monoculture or mixed-species), stand density (ranging from sparse to dense), and configuration (ranging from narrow belts to large-scale blocks) (Paul et al., 2016). Simple monoculture plantings of eucalypts trees established in dense narrow belts may provide the highest rates of sequestration of carbon in young plantings (Paul et al., 2015a,b). However these are unlikely to provide the same biodiversity outcomes as blocks of complex biodiverse carbon plantings (Paul et al., 2016). Understanding these trade-offs, and their relationship to project viability, is important to policy makers seeking to incentivise reforestation for multiple goals (Bryan and Crossman, 2013; Bryan, 2013). These trade-offs, and the barriers to establishment of some types of revegetation projects, are likely to differ based on the six factors outlined below.

1.1. Types of reforestation

The type of reforestation project has an impact on both cost of establishment and maintenance. For example, complex mixed-species plantings are characterised by large numbers of species, and often relatively complex planning and implementation costs. There are also quite different revenue outcomes between the types of reforestation, with Paul et al. (2015a,b) showing that young (< 15 year old) monoculture mallee eucalypt plantings generally capture more carbon more quickly than complex mixed-species plantings.

1.2. Spatial configuration

In regions of low-to-medium mean annual rainfall, young (< 15 year old) narrow linear plantings, or belts, generally have higher rates of sequestration of biomass carbon than block plantings established in the same site quality (Paul et al., 2013b, 2016). Spatial configurations of plantings also have impacts on the on-going agricultural productivity of land, and therefore a different opportunity cost (Paul et al., 2016). While narrow linear plantings may co-exist (and indeed even benefit, e.g. via provision of shelter belts) with agricultural production, block plantings require full assessment of the cost of lost agricultural production opportunities. These differences may be offset to some extent by the value of land being planted, with block plantings often being established in areas that are relatively non-productive (e.g. eroded gullies).

1.3. Site quality and stand density

Density of stocking of individual trees (and/or shrubs) within the stand also influences the rate of sequestration of biomass carbon (Paul et al., 2016), with significantly higher rates observed in dense relative to sparse plantings established in the same site quality (Paul et al., 2015a,b). However, there is often confounding of stocking density with site quality, which in Australia, is largely governed by the mean annual rainfall (Paul et al., 2008, 2016). In regions of relatively low rainfall ($< 550\ \mathrm{mm\ yr^{-1}}$), stand densities are generally much lower than what could be supported in regions of higher rainfall. In addition to differences in revenue from carbon sequestration, the site quality may also influence establishment and maintenance costs. For example, in many highly productive regions (e.g. wet tropics), weed control costs are paramount, and yet, in many regions of lower productivity weed control costs may be negligible.

1.4. Scale of reforestation projects

The scale of the reforestation project will also influence economic feasibility (Cacho et al., 2013). Costs per hectare are likely to be relatively low in large scale projects managed by aggregators of multiple plantings on various properties. This is because of efficient business structures in place due to: (i) relatively low risks, e.g. low contracting risk when spread across a number of small contracts aggregated together, and low fire risks when spread across a number of geographically isolated plantings, (ii) being able to invest on the basis of an on-going and long-term venture, and; (iii) economies of scale for legal and administrative costs associated with business development and sales, governance, land access, and regulatory compliance (Torres et al., 2010; Cacho et al., 2013; Pearson et al., 2014). While previous continental- or regional-scale studies investigated the potential spatial scale of activity that a particular carbon price may incentivise (Lawson et al., 2008; Polglase et al., 2013; Evans et al., 2015), impacts of individual project-scale on viability is perhaps just as important.

1.5. Carbon quantification methods

Participation in carbon markets requires adherence to approved methodologies for accounting for carbon abatement (e.g. Australian Government − ComLaw, 2013, 2014). In Australia, carbon accounting methodologies for reforestation have been developed to allow the use of: (i) modelling, using the same generic national- or regional-based parameter defaults as applied in the carbon accounting model used in the national greenhouse gas inventory- FullCAM (Brack et al., 2006; Waterworth et al., 2007; Waterworth and Richards, 2008); (ii) field sampling to calibrate FullCAM to a specific project, or; (iii) direct field sampling for stem diameter inventories, and then application of allometric equations for estimation of biomass based on stem diameter. While these methodologies have been developed specifically for Australia, the general approaches used are equivalent to those used under international schemes. Importantly, quantification approaches are likely to impact not just project implementation costs, but also revenue via the direct impact on abatement estimates. Hence, the approach used will greatly impact economic viability, yet we know of no existing studies which have quantified such effects.

1.6. Payment contracts

Given a reforestation project provides non-linear long term returns, the terms of payment may be a large barrier to establishment (Mitchell et al., 2012). Methods for securing upfront capital for project establishment may range from negotiating the pre-purchase of credits with an investor, debt funding, grant funding, equity, and joint venture project investments. In the latter, the land owner and a project developer working with multiple land owners (e.g. carbon aggregator) share the costs, returns and risks from a project. A global survey (Peters-Stanley et al., 2013) indicated that nearly 90% of afforestation and reforestation projects were supported by up-front payments, with investors using these forward payments to offset against the cost of financing the transaction. The method and extent of such upfront payment may impact the economic viability due to differences in cash-flow, and costs of legal and governance arrangements.

The objective of this study was to provide general guidance to policy makers seeking to target incentives for planted reforestation projects to attain carbon abatement as well as other environmental benefits such as biodiversity outcomes. This was achieved by building on previous work assessing the economic viability of reforestation in Australia at national-scales (Lawson et al., 2008; Polglase et al., 2013; Evans et al., 2015) and project-scales (Paul et al., 2013a; Reeson et al., 2015) by expanding the range of factors considered. A sensitivity analysis was applied to a long term financial cash flow model to quantify impacts of: (i) type of reforestation project; (ii) spatial configuration; (iii) site quality and stand densities; (iv) project scale; (v) quantification method applied; and (vi) payment contracts, or the extent of upfront payment. While this study is generic, and does not provide evidence of economic viability for any one specific circumstance, the financial model developed may prove a valuable analysis tool to project developers where project specific inputs are available.