Greening Australia

Carbon Farming: landscape links & carbon sinks

A report on research and measurement of carbon sequestration in biodiverse native plantings in Habitat 141°

Produced by Greening Australia via funding provided by ALCOA

Disclaimer: Please note that the information presented relates to the potential income generated from ACCUs as a result of an environmental planting. It does not provide information regarding the cost, risk or potential financial returns from such a planting. Advice regarding the financial returns from a CFI project investment should be sought from a licensed source.

Carbon Farming: Sinks or Swim?

Alcoa Partnership Research Project

What's the project about?

In Victoria, the Alcoa Revegetation Assistance Program has helped establish biodiverse native plantations using various methods, including direct-seeding. Alcoa Australia recognizes the potential of native plantings to function as biodiverse carbon sinks across the landscape, in sequestering carbon as above-ground biomass as well as increasing soil carbon stores over time.

Overall, the project aims to improve the predictive understanding of on-farm carbon sequestration from biodiverse native plantings.

Specifically, this project provides the opportunity to revisit selected sites established over recent years across Greening Australia's Habitat 141 landscape and undertake study of: individual species and whole site establishment success in direct-seeding and carbon sequestration over time.

How do we measure carbon?

Carbon storage potential of vegetation may be measured using either modelled data or via direct measurement in the field. Modelled estimates are obtained using the Government tool called the Reforestation Modelling Tool (RMT), and generally provides a conservative estimate of the carbon sequestration potential of a particular locality. For this project, direct measurement of sites was undertaken using the latest direct-measurement techniques developed by CSIRO as a result of extensive on-ground research.

The in-field vegetation assessment required each stem (tree) to be identified by species, then measured using forestry techniques and analyzed using CSIRO allometric equations which allowed us to determine the amount of carbon sequestered, for the given age of the planting. Typically, over 2,000 stems are measured across a plantation to provide the data on carbon sequestration at the site. We can use this detailed outcome to make comparisons against the predictions made by the Australian Government carbon modelling tool (RMT).

Where are we working?

The carbon sites are located in the H141° Project area, a nationally significant connectivity corridor along the SA-Vic border linking the Mallee in the north to the coast in the south. Representative of the diverse range of habitats, soil types and climatic variation found across the H141° project landscape, the sites are located at Hotspur and Gazette in the Green Triangle region; Nurcoung and Edenhope in the Wimmera; and Glenlee in the Mallee.

Why measure trees for carbon using this method?

In a novel approach to carbon assessment and monitoring, permanent plots have been established at the sites to allow for ongoing long-term monitoring of individual trees. This is an established forestry technique, but is relatively unknown in carbon assessment and native revegetation projects. Whilst more involved, this allows for high quality, detailed data to be gathered for carbon assessment.

Traditionally, measurement of different aged stands provides an 'age for time' substitution, and can be subject to environmental variability. There is great scope to pursue further research opportunities with this project, taking a long-term approach to carbon measurements; an area of research that has not been applied at scale in this field with biodiverse native plantings.

What are the benefits of direct measurement?

With increased awareness and focus on climate change, and ways to mitigate or offset greenhouse gas emissions, tree planting and native vegetation is in the spotlight as a way to sequester carbon at scale across the landscape. It is important to gain the best and most accurate understanding of how much carbon can actually be stored at a wide variety of sites, in different climatic and ecological zones.

Uptake by landholders of carbon farming (such as through the Federal Government's Carbon Farming Initiative) as an additional source of income is dependent upon accurate assessment and modelling of carbon yield potential.

Where a methodology, such as a direct-measurement technique, can provide accurate, increased carbon yields relative to conservative modelling, there is potentially greater incentives and benefits to participating in carbon markets in the future.

Greening Australia

What is the Carbon Farming Initiative?

The Carbon Farming Initiative is a carbon offset scheme with potential benefits for primary producers, while also assisting the environment by reducing greenhouse gas emissions. Participation in the CFI is voluntary; farmers and landholders can choose whether or not to be involved.

The federal Government introduced a carbon price in July 2012, with obligations for businesses that generate more than 25,000 tonnes of greenhouse gasses per year to reduce their greenhouse gas emissions or offset their emissions via carbon credits (Australian Carbon Credit Units, or ACCUs). Each ACCU represents one tonne of carbon dioxide equivalents (CO_2-e). The current price is $23/tonne CO_2-e. Any transactions that occur via this process take place in what is called the ***compliance*** market.

ACCUs can also be bought by individuals and organizations wishing to voluntarily offset their emissions. This is referred to as the ***voluntary*** carbon market.

What does it mean for land managers?

Farmers and land managers can generate ACCUs that can then be sold to other businesses wishing to offset their own carbon pollution through the compliance market or the voluntary market. There are several opportunities for primary producers to participate in the CFI, including environmental tree plantings, livestock emissions reductions, soil carbon sequestration and crop management.

The Federal Government has an 'approved list' of methodologies that can be undertaken to generate credits in the compliance market. Non-CFI approved methodologies may be used to generate credits for the voluntary market. For a full list of approved methodologies visit http://www.climatechange.gov.au/reducing-carbon/carbon-farming-initiative/methodologies/methodology-determinations

At the moment the CFI-approved methodology most suited to broad acre farming (cropping and/or grazing) enterprises in Habitat 141° is *Permanent environmental plantings of native species*, which is the focus of this document. As this methodology has been approved, ACCUs generated from environmental plantings can be sold in either the compliance or voluntary market.

Additional CFI methodologies have been approved or are in development. Information on other CFI schemes relevant to Habitat 141° have also been produced by Greening Australia with other projects and are available on request, or through other farm advisory and extension networks.

How can this report help?

In addition to over 30 years experience of tree planting experience throughout Australia, Greening Australia has also developed considerable knowledge around the carbon sequestration potential of native trees and shrubs. This report provides comprehensive information about using robust scientific methods to gain a better understanding of the carbon storage potential of native biodiverse plantings in the H141 project area.

Disclaimer: Please note that the information presented relates to the potential income generated from ACCUs as a result of an environmental planting. It does not provide information regarding the cost, risk or potential financial returns from such a planting. Advice regarding the financial returns from a CFI project investment should be sought from a licensed source.

Greening Australia

Greening Australia

Snapshot: Carbon Sequestration via Environmental Plantings

What does it mean?

Trees remove CO_2 from the atmosphere through the process of photosynthesis and store (sequester) carbon in their leaves, branches, trunk and roots. The rate of carbon storage from environmental planting is calculated as the change in forest carbon stocks (through growth, natural decay and disturbance), minus emissions resulting from project activities.

What are the rules?

An environmental planting is defined as planting or direct seeding of species native to the local area. These permanent (100 years) environmental plantings must have, or have the potential to attain a crown cover of at least 20% and a height of at least 2 metres. The site must be minimum of 0.2 ha and must be planted on land that was devoid of forest for at least five years prior to undertaking the project.

Under the CFI, the following standards apply:

- Vegetation must be established through direct-seeding or tube-stock plantings (i.e. projects can't be established using regeneration techniques).
- There must be no harvesting of wood products from the planting, with the exception of firewood for personal use to a maximum of 10% of debris/year.
- Some thinning may be allowed to promote forest health, provided that the biomass is retained on site, and the forest continues to meet the requirements of the guidelines.
- The plantings must consist of Australian native species, native to the local area; these plantings may take the form of a mix of tree and under-storey species, or single species if monocultures occur naturally in the area.
- Grazing within the planting area must be prevented in the first 3 years after tree planting or seeding (to allow the trees to establish). Any grazing after this time must not prevent tree establishment in the project area.
- The planting must be established on land that has been clear or partially clear of forest for the five years prior to tree planting or seeding (since 1 July 2007). If the area would convert to forest without the project, no additional abatement would be generated through reforestation, so no abatement could be claimed.
- The establishment area must not require invasive native scrub species or woody biomass to be cleared prior to planting or direct seeding unless it is a weed species and law mandates its removal.

How can I learn more?

The CFI Permanent Environmental Plantings methodology report can be accessed from: http://www.climatechange.gov.au/reducing-carbon/carbon-farming-initiative/methodologies/methodology-determinations/environmental

What have we found?

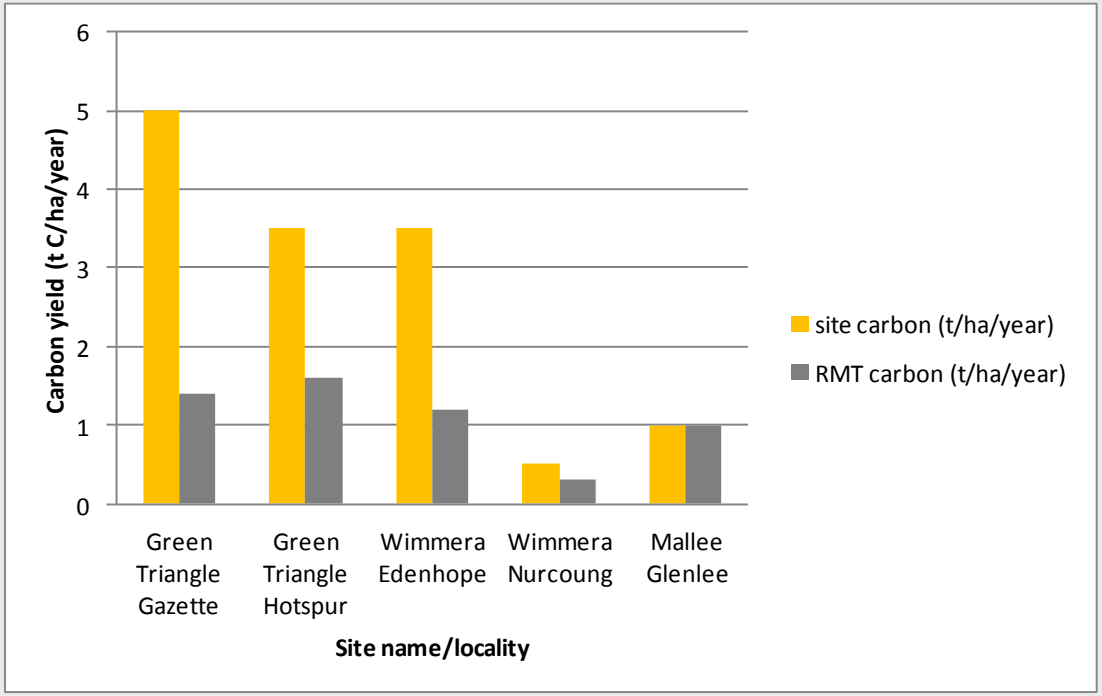
The project's data provide a snap-hot of carbon sequestration potential of native plantings across the Habitat 141° landscape. There are striking differences when the yields from direct measurement protocols are compared with those derived from the Reforestation Modelling Tool.

Generally, the trend is for higher carbon yields for the sites in southern, high rainfall areas, although the site at Edenhope is a notable exception to this trend, performing comparably to the Hotspur site. The growth rates, and hence yield, at Hotspur may be negatively affected by competition from the adjacent blue gum plantation.

The direct-measurement yields and the RMT are more closely aligned for the northern sites, whereas in the south, yields gained by direct measurement are many times those estimated by the model.

The graph below shows a comparison of direct measurement yields (yellow) and RMT outputs (grey) for each site.

Carbon yields (tonnes/ha/year) - direct measurement & RMT data all sites



Greening Australia

Greening Australia

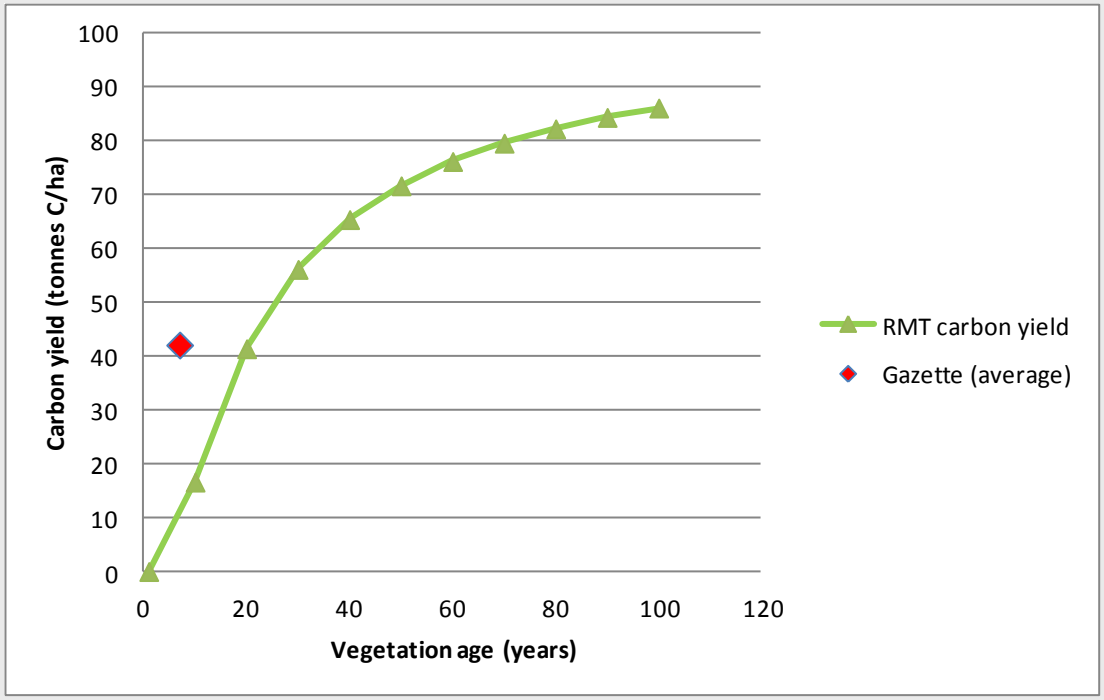
Green Triangle—Gazette

Located within the Green Triangle, a region well-known for plantation timber production, the Gazette site is characterized by volcanic clay soils and recent alluvial deposits, high rainfall (~800 mm), and a temperate climate. The carbon yield assessment at Gazette indicates that the total amount of carbon sequestered by the trees on site is approximately **36.5 tonne/ha**. The planting is seven years old, which gives an accumulation rate of greater than **five tonnes of carbon per hectare per year**. By comparison, the RMT output indicates that a seven year old direct-seeded, mixed species plantation at the equivalent location would sequester approximately 10 tonnes/ha, or just over 1.4 tonne/ha/year.

To convert these numbers into carbon dioxide-equivalent units, we estimate the site has currently sequestered **134 tonnes of CO_2-equivalent greenhouse gases/ha.**

The graph below shows tree carbon sequestration per hectare as a function of age—the RMT estimate curve is shown in green, and the direct-measured carbon sequestration of these 7-year-old trees is a red point.

Gazette carbon yield (tonnes/ha) versus age (years)



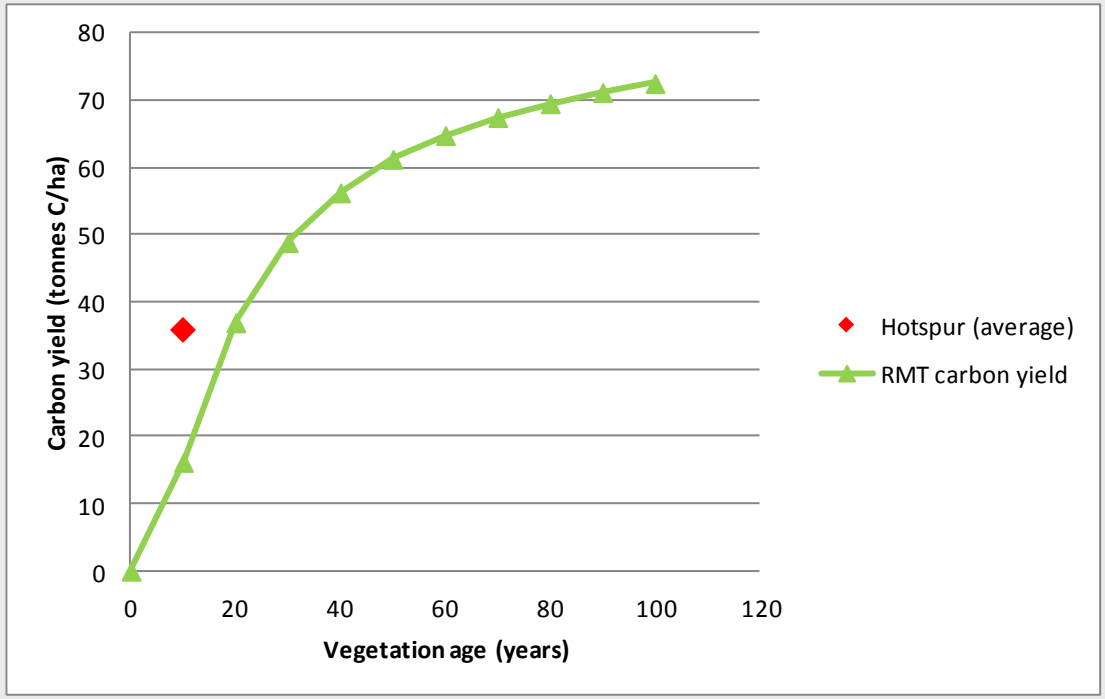
Green Triangle—Hotspur

The Hotspur revegetation site was established in 2003 adjacent to a blue-gum plantation. The site features eucalypts and wattles, with black wattles having been particularly successful. Direct measurement of trees on site indicates the total amount of carbon sequestered is approximately **35.8 tonne/ha**. Overall, the vegetation has an accumulation rate of greater than **3.5 tonnes of carbon per hectare per year**. By comparison, the RMT output indicates that a 10-year old direct-seeded, mixed species plantation at the equivalent location would sequester approximately 16 tonnes/ha, or 1.6 tonnes/ha/year.

To convert these numbers into carbon dioxide-equivalent units, we estimate the site has currently sequestered almost **130 tonnes of CO_2-equivalent greenhouse gases/ha**.

The graph below shows tree carbon sequestration per hectare as a function of age—the RMT estimate curve is a green line, and the actual measured carbon sequestration of these 10-year-old trees is a red point.

Hotspur carbon yield (tonnes/ha) versus age (years)



Greening Australia

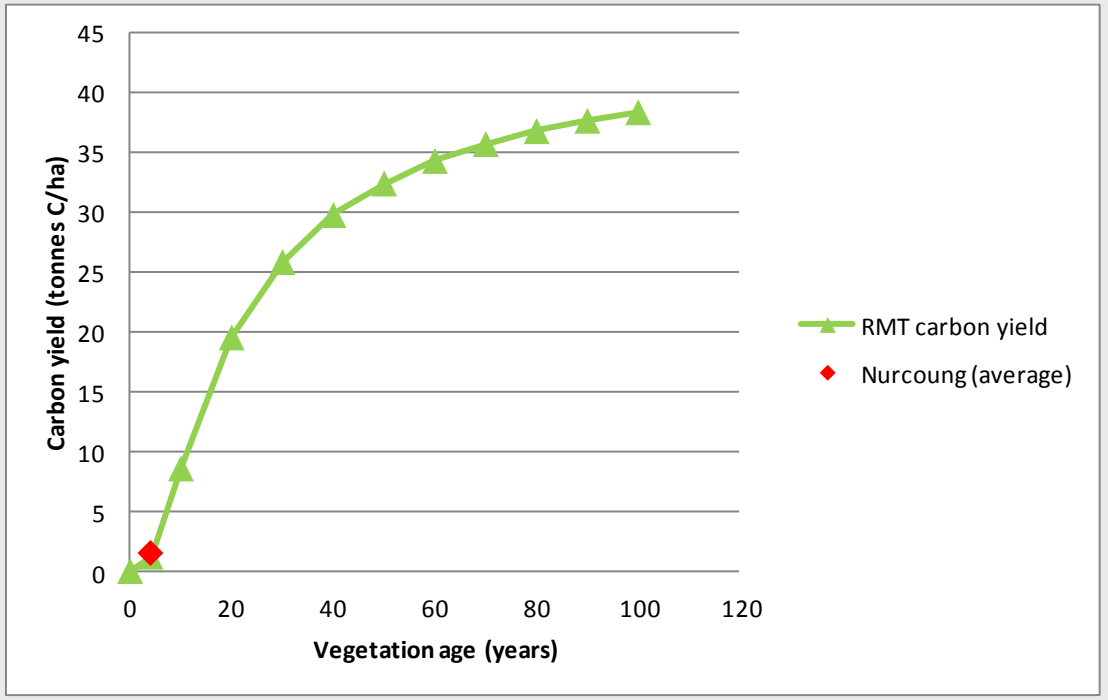
Wimmera — Nurcoung

The soils and climate of the Wimmera are typically ancient weathered soils; the climate is low rainfall (~450mm) and semi-arid. The Nurcoung carbon assessment indicates the total carbon sequestered by the trees on site is averaged at **1.5 tonne/ha**. The sandy ridge line of the site gives the greatest carbon yield per hectare, with more than 2 tonnes of carbon per hectare. Since establishment in 2009, this approximate **0.4 tonnes of carbon per hectare per year**. The RMT output indicates that an equivalent direct-seeded, mixed species plantation at this location would sequester around 1.2 tonnes/ha, or just over 0.3 tonne/ha/year.

To convert these numbers into carbon dioxide-equivalent units, we estimate the site has currently sequestered **5.5 tonnes of CO_2-equivalent greenhouse gases/ha**.

The graph below shows tree carbon sequestration per hectare as a function of age—the RMT estimate curve is a green line, and the actual measured carbon sequestration of these four-year-old trees is a red point.

Nurcoung carbon yield (tonnes/ha) versus age (years)



Greening Australia

Wimmera — Edenhope

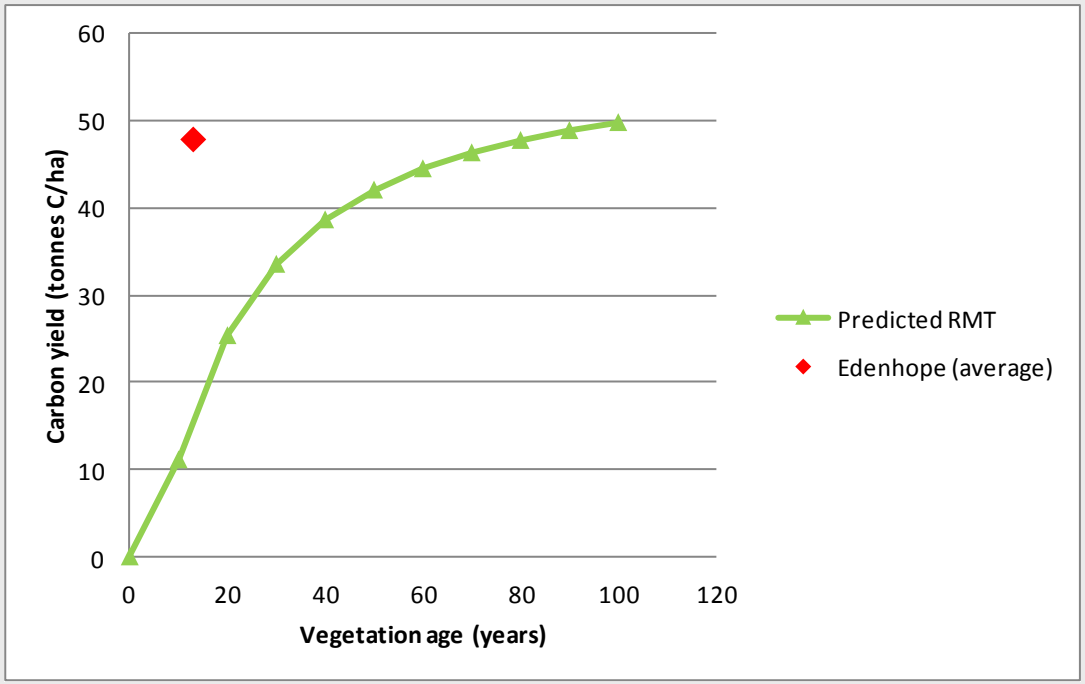
Land use around Edenhope comprises mainly dryland cropping, pasture production and sheep grazing. The soils are ancient dunes and swales of sands, silts and clays. Average annual rainfall is approximately 550mm, and the climate is semi-arid. Remnant vegetation includes Plains Woodlands, Heathy Woodlands and Damp Sands Herb-rich Woodlands.

The total carbon measured on site is approximately **48 tonne/ha**, which is more than **3.5 tonnes of carbon per hectare per year** since 2000. The RMT indicates a 13 year old direct-seeded, mixed species plantation would sequester approximately 16 tonnes/ha (1.2 tonne/ha/year).

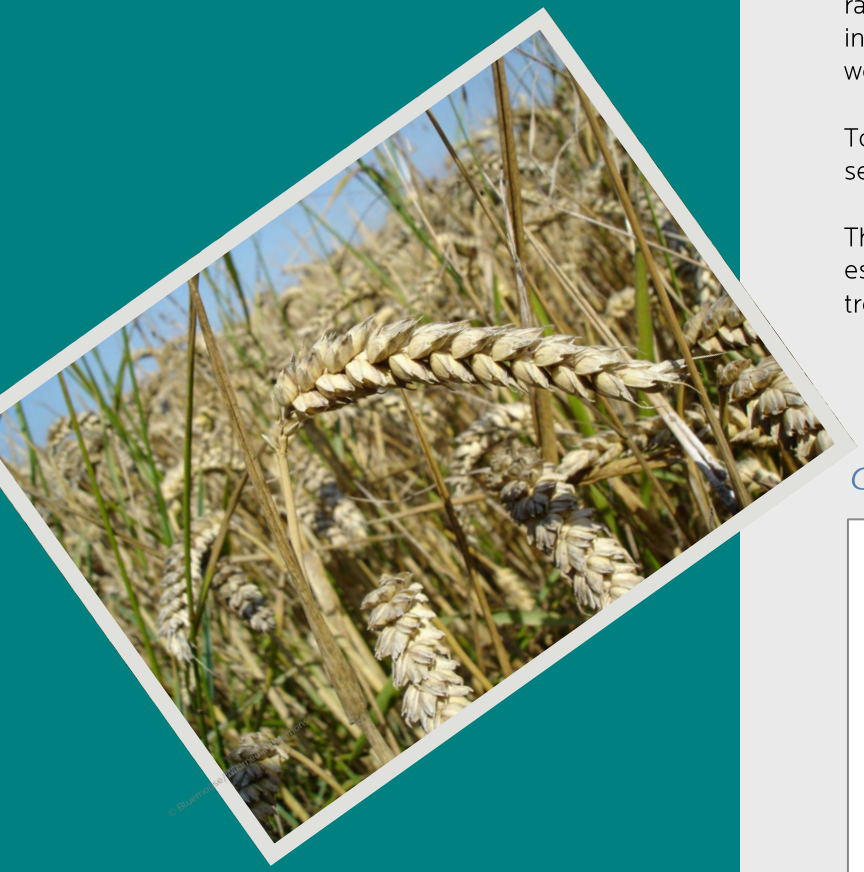
To convert these numbers into carbon dioxide-equivalent units, we estimate the site has currently sequestered almost **180 tonnes of CO_2-equivalent greenhouse gases/ha**.

The graph below shows tree carbon sequestration per hectare as a function of age—the RMT estimate curve is a green line, and the actual measured carbon sequestration of these 13-year-old trees is a red point.

Edenhope carbon yield (tonnes/ha) versus age (years)



Greening Australia



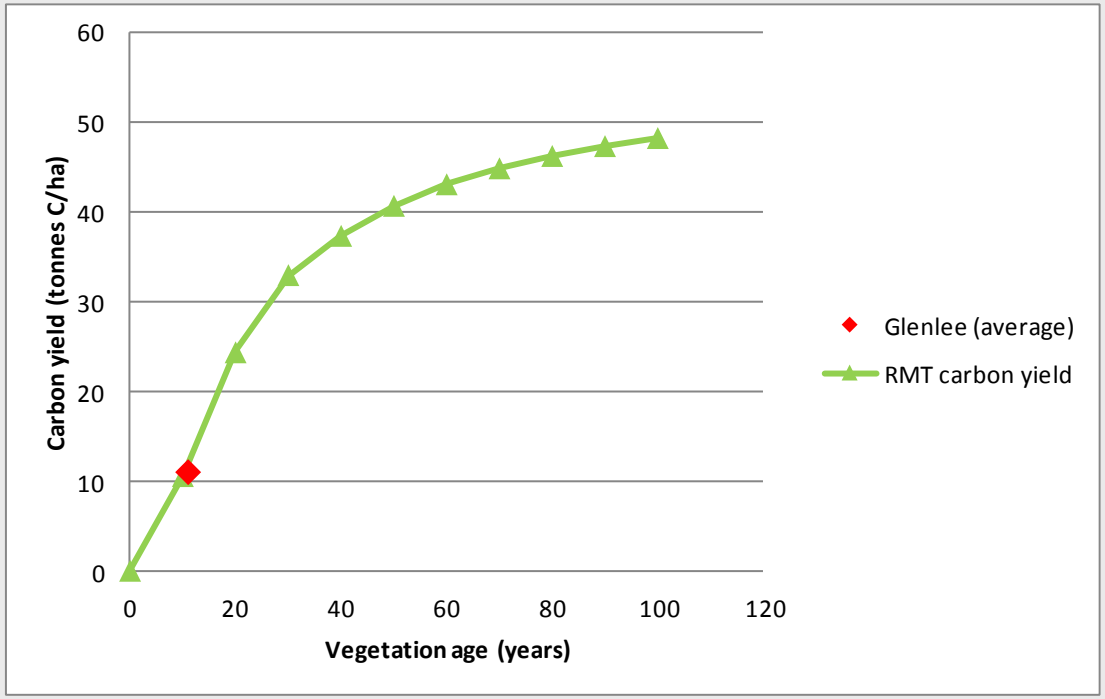
Mallee — Glenlee

The work done at Glenlee indicates that the total amount of carbon sequestered by the trees on site is approximately **11 tonne/ha**. The planting is eleven years old, which gives an accumulation rate of greater than **1 tonne of carbon per hectare per year**. By comparison, the RMT output indicates that a 11-year-old direct-seeded, mixed species plantation at the equivalent location would sequester approximately 12 tonnes/ha, or just over 1 tonne/ha/year.

To convert these numbers into carbon dioxide-equivalent units, we estimate the site has currently sequestered **40 tonnes of CO_2-equivalent greenhouse gases/ha**.

The graph below shows tree carbon sequestration per hectare as a function of age—the RMT estimate curve is a green line, and the actual measured carbon sequestration of these 11-year-old trees is a red point.

Glenlee carbon yield (tonnes/ha) versus age (years)



Greening Australia

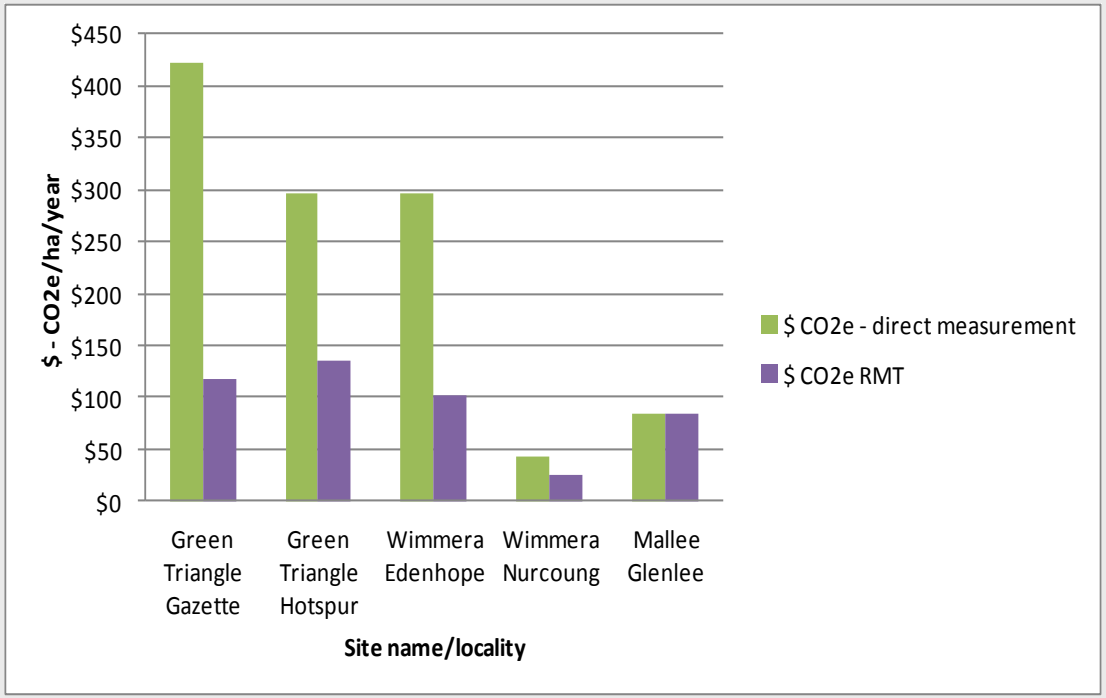
Carbon Sequestration & Carbon Credits

Where a nominal price of carbon ($23 per tonne of CO2-equivalent) is applied to the measured and modelled carbon yields, a range of potential returns can be evaluated for each site. The value of $23 per ACCU was set in 2012 by the Federal Government, indexed at 2.5% per year until 2014/15 (the 'fixed' price period) for compliant market activities. Depending on policy direction, after 2015 (the 'flexible' price period), the Government will auction a fixed number of ACCUs (market prices).

The appeal of establishing native plantings for carbon sequestration purposes is dependent upon the known amount of carbon stored at a site and the carbon price. This project illustrates the importance of refining methodologies and techniques to gain the most informative picture of how much carbon is being sequestered at a given site, so that most benefit can be gained from any future methodologies that are refined around direct-measurement techniques.

The graph below shows the comparison between potential returns using a direct-measurement calculation for carbon credits (green) versus the expected returns estimated carbon credits derived using the RMT (purple).

Carbon yields (tonnes C/ha/year) - comparison of direct measurement vs RMT



Disclaimer. Please note that the information presented relates to the potential income generated from ACCUs as a result of an environmental planting. It does not provide information regarding the cost, risk or potential financial returns from such a planting. Advice regarding the financial returns from a CFI project investment should be sought from a licensed source.

Greening Australia

Summary & Conclusions

This project's findings are important in building understanding of potential carbon yields in H141, and how direct-measurement techniques may inform methodologies to measure on–site carbon versus more conservative modelling approaches. Ultimately, this knowledge informs approaches to carbon farming, and earning carbon credits from establishing native vegetation on rural properties.

Participation in a carbon market via native plantings depends on many factors, such as existing land use and the income derived from those enterprises, versus the opportunity costs of establishing trees, plus their potential carbon yields and income. With the right information, landholders can compare expected gross margins for current land uses, versus expected returns from carbon, and make decisions on the most beneficial and profitable land-uses for their property. The returns from carbon yields of native plantings are additional to the multitude of ecosystem services that such plantings provide: shelter, shade, erosion control, evaporation reduction, salinity mitigation, habitat for birds, mammals, frogs and reptiles, beneficial insect predators, and aesthetic enhancement.

The benefits to productivity of shelterbelts is estimated to be at least $1.20 per DSE (SKM 2012), plus the 'ecosystem services' provided to the farm. Evidence from the Gunnedah region of New South Wales shows native vegetation cover of 34% in agricultural landscapes yields an optimum income from grazing enterprises (Walpole 1999 and Lockwood *et al.* 2000).

For a cropping situation, alley cropping, with tree belts alternating with crop rows, provides protection for emerging crops as well as predator control from native fauna, and enhanced nutrient levels in soil around trees and shrubs (Wilson 2002). For example, shade and shelter in the Northern Tablelands of NSW showed 30% increase in financial return due to increased sheep weight, wool yield and quality (Reid & Thompson 1999), and 3 – 14% increase in crop growth in eastern South Australian agricultural districts (Bennell & Verbyla 2008).

There is great scope to pursue further research opportunities with this work done to date. The plantings are less than 15 years of age; and native vegetation can be expected to have a high growth rate, and thus carbon sequestration rate, for approximately 30 years after establishment. Future analysis of these sites will be valuable to determine how carbon sequestration patterns change over time, and across different regions. There are avenues for further research with individual tree measurements and forestry techniques employed to make a meaningful contribution to knowledge of carbon sequestration in native biodiverse plantings.

Greening Australia

Greening Australia

References

Sinclair Knight Merz (2012). Bioenergy generation business case analysis. Report for Greening Australia. SKM: Wangaratta.

Bennell, M. R. and Verbyla, A. P. (2008). Quantifying the response of crops to shelter in the agricultural regions of South Australia. *Australian Journal of Agricultural Research* **59**: 950–957.

Lockwood, M., Walpole, S. C. and Miles, C. A. (2000). Economics of remnant native vegetation conservation on private property. LWRDC Occasional Paper, No 2/00, Land and Water Resources Research and Development Corporation, Canberra.

Reid, N. and Thompson, D. (1999). Economics of windbreaks and sheep production on the northern Tablelands. In *Sustainable and Practical Vegetation Management into the New Millennium – Economics and Environment* (Eds Norsearch Ltd). Proceedings of the Australian Association of Natural Resource Management, Coffs Harbour.

Walpole, S. C. (1999). Assessment of the economic and ecological impacts of remnant vegetation on pasture productivity. *Pacific Conservation Biology* **5**: 28–35.

Wilson, B. R. (2002). Influence of scattered paddock trees on surface soil properties: a study on the Northern Tablelands of NSW. *Ecological Management & Restoration* **3**: 211–219.

For more information about this research project please contact:

Dave Warne

Greening Australia

M: 0427 000 446

E: dwarne@gavic.org.au

Anna Carrucan

Greening Australia

M: 0427 047 413

E: acarrucan@gavic.org.au