



Carbon Abatement Report

Hills and Fleurieu Landscape Board

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Method and Results

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Executive Summary

The Hills and Fleurieu Landscape Board oversees approximately 670,000 hectares (ha) of land across South Australia, from the Adelaide Hills to Fleurieu Peninsula. FLINTpro (formally The Mullion Group) was engaged by Hills and Fleurieu Landscape Board to model forest carbon abatement potential through time across the current non-forest land using the FLINTpro system. Only areas identified as non-forest, with no forest cover present for the 7 years prior to commencement in 2024, were modelled for eligibility. Regeneration was calculated in these areas, using the Environmental Plantings (EP) scenario guidelines, for an abatement assessment over 25 years from 2024-2048.

The results of the simulation indicate that forest carbon stocks in aboveground biomass (AGB), belowground biomass (BGB), and dead organic matter (DOM), accumulate carbon at a steady rate. Spatial results for forest carbon stocks were calculated in tonnes of Carbon per hectare and had a maximum of 132.94 tC/ha after 25 years (Figure 1).

Carbon abatement potential is presented in Carbon Dioxide equivalents per hectare ($\text{tCO}_2\cdot\text{ha}^{-1}$). Abatement potential after 5 years in 2027 is approximately $35.63 \text{ tCO}_2\cdot\text{ha}^{-1}$, after 10 years in 2034 is approximately $101.99 \text{ tCO}_2\cdot\text{ha}^{-1}$, and after 25 years in 2048 is approximately $207.78 \text{ tCO}_2\cdot\text{ha}^{-1}$. The total abatement potential after 25 years is approximately 68,013,587 tCO_2 for the total simulated area of 327,339 ha. These totals are presented purely for information purposes and are not considered to represent a real abatement scenario.

This report outlines the methods, data and parameters used in the simulation and presents high level results.

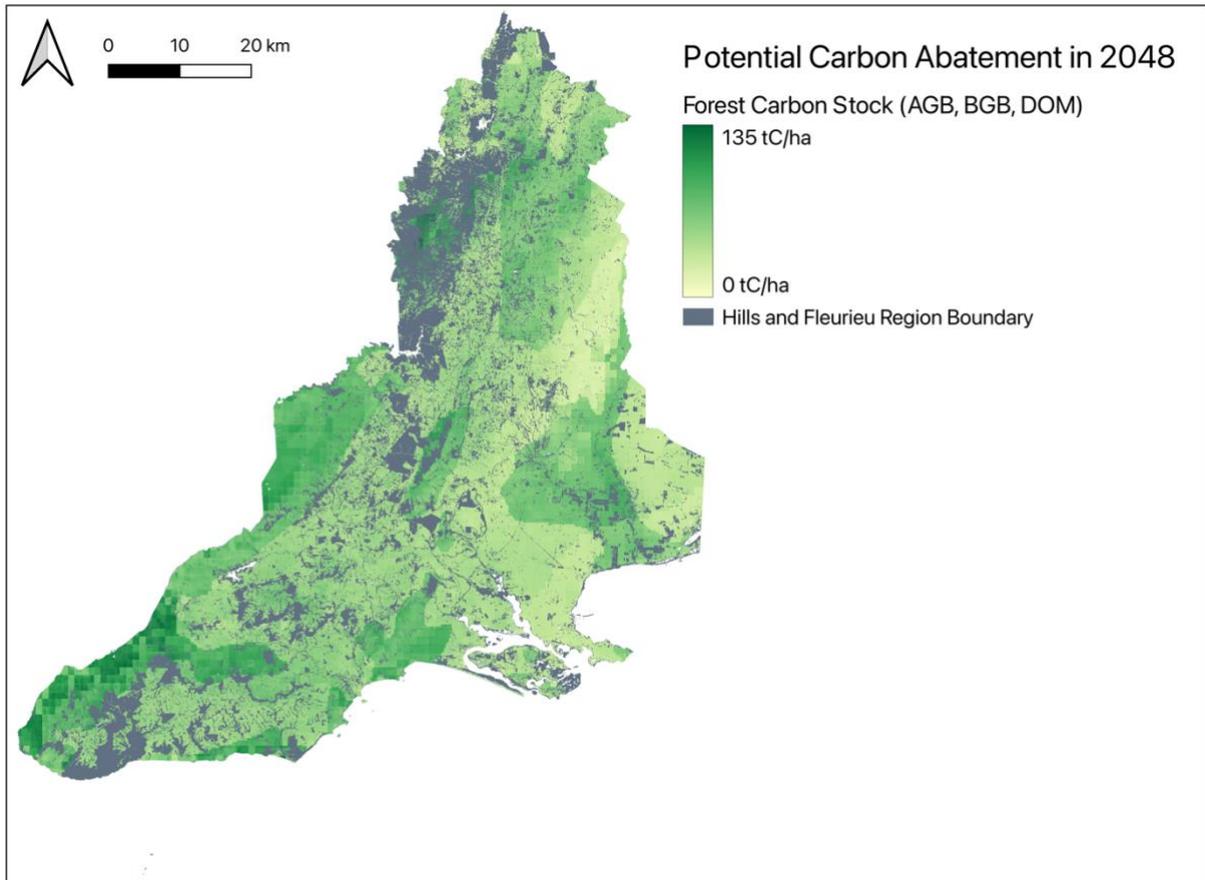


Figure 1 - Map of the Hills and Fleurieu region showing potential carbon abatement in tonnes of carbon per hectare (tC.ha⁻¹) after 25 years from hypothetical regeneration commencement in 2024.

1. Introduction

This report presents the methodology and results of a Tier 3 carbon abatement assessment undertaken using the FLINTpro software for the Hills and Fleurieu Region in South Australia. The purpose of the report is to provide a rapid assessment of carbon stock potential in relation to forests in the region using readily available data. The results presented here are provided in good faith for the purpose of providing an indicative carbon balance and are limited by the following:

- The carbon estimates rely on high level and publicly available vegetation mapping. This has not been verified for the specified region and may include errors inherent to the vegetation mapping data used.
- The methods while based on National Inventory Methods are not consistent with the ACCU Scheme method requirements (spatially explicit, rather than point based)
- The carbon estimates do not include changes in carbon across areas smaller than 0.2ha and with less than 20% tree cover (for example, it may not pick up recent regrowth, isolated paddock trees, tree rows along fence lines or Leucaena).

The results provide an indication of the future potential forest carbon stock based on FLINTpro that replicates the Australian Governments FullCAM model and using Australian Government data. While indicative, it is recommended that local data be used to derive more accurate estimates.

1.1. Abatement Assessment

The objective of the Abatement Potential Assessment is to assess the possible carbon outcomes of reforestation through Mixed Species Environmental Plantings within the region boundary. That is, if a Mixed Species Environmental Planting was established, what would be the carbon outcome of this for carbon stocks as the combination of Aboveground Biomass (AGB), Belowground Biomass (BGB), and Dead Organic Matter (DOM).

The Abatement Potential Assessment uses Environmental Plantings (EP) as the regeneration type. The Emissions Reduction Fund (ERF) outlines eligible land for EP regeneration as having no forest cover present for the 7 years prior to commencement, as an establishment of non-forest landcover. Within FLINTpro, the historical forest cover for the region can be assessed for areas that are potentially eligible by this requirement based on the National Forest and Sparse Woody dataset. In line with the modelling used for tree biomass under the ERF for EP projects, a hypothetical project can be established on all potentially eligible land to measure potential abatement under this scenario. This can then be used to calculate an average per/ha abatement potential for the region, with the range being analysed at 5, 10, and 25 years post-establishment of the Environmental Plantings scenario.

FLINTpro can be used to estimate abatement, by operating FLINTpro modelling using FullCAM calibrations. This allows for a spatially explicit implementation of FullCAM to provide the variation in biomass potential across the region.

2. Methods

The results presented in this report were developed using the FLINTpro software (<https://flintpro.com/>). FLINTpro provides an enterprise solution for monitoring greenhouse gas emissions (GHG) and removals from the land sector. FLINTpro is built around the Full Lands Integration Tool, or FLINT. The FLINT is an open-source C++ platform that provides tools to integrate multiple data types (including remote sensing) with FLINT-compatible modules to produce spatially explicit calculations of GHG emissions and other variables.

In practical terms, FLINTpro uses temporally explicit spatial data to identify activities and events (e.g., forest loss, forest gain, fire, harvest) that impact forest carbon. The activity data is complemented with information describing the impact of the activity on the forest carbon (e.g., thinning intensities, harvest intensities, fire intensities, or forest growth rates). Carbon fluxes are quantified by applying the activity data to the respective pixel (~25x25 m) and its current carbon/biomass value. This process is undertaken for every pixel in the simulation. As FLINTpro tracks areas of land through time, carbon fluxes vary by forest type, land use and disturbance history, with younger forests having a lower carbon stock than older forests (Figure 2).

A mixed-species Environmental Plantings (EP) scenario consists of a planting that is a mixture of tree and shrub species that are native to the local area and are appropriate for the area. The specific

requirements that need to be satisfied for this planting type are outlined in the Carbon Credit Methodology by the Australian Government.

To estimate abatement for Environmental Plantings, FLINTpro applies the FullCAM calibrations for mixed species environmental block plantings. The methodology for EP projects under the Emissions Reduction Fund (ERF), requires that projects be conducted on land that has had no forest cover present for the 7 years prior to commencement. An indicative assessment of this requirement is included by assessing the National Greenhouse Gas Inventory forest cover time series to include areas that are potentially eligible under this requirement. For the area identified as potentially eligible, FLINTpro simulates the growth of forest over the next 25 years. Our results include annual CO₂ removals, as well as annual carbon stocks and stock changes. The results are also provided as per hectare results, are made available as time series of spatially explicit maps and in an aggregated tabular form for the simulation area. Annual GHG emissions can be generated directly from biomass-to-atmosphere fluxes or indirectly by calculating the difference in forest carbon stock from one year to another.

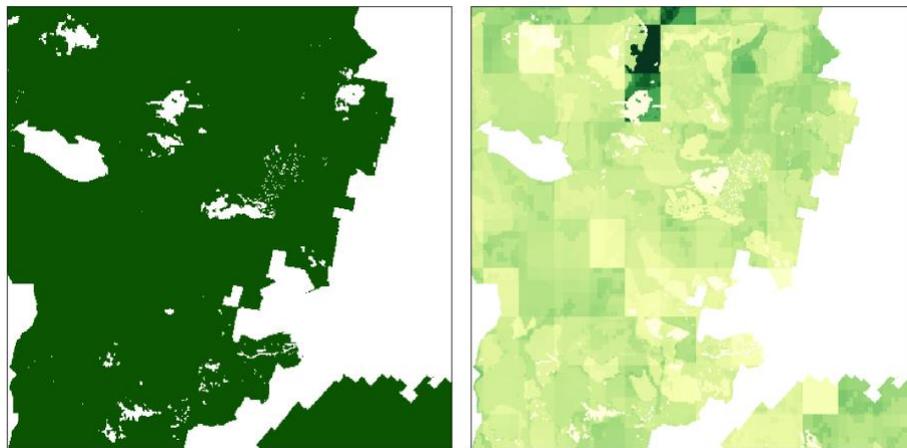


Figure 2 - In FLINTpro, the land cover products delineating forest extent (left) are integrated with forest growth models to produce estimates of carbon stock (right) and stock changes over time.

2.1. Spatial input data

The simulation area was provided by Hills and Fleurieu Landscape Board as a vector layer. For the area of interest defined by the simulation area boundary, FLINTpro accesses a number spatial data including:

- Potentially Eligible Land Area map (FLINTpro analysis of DISER, 2022a)
- Maximum Above Ground Biomass (AGB) map (DISER, 2020b; Roxburgh et al. 2019)
- Forest productivity map (DISER, 2020b)

The simulation area was clipped (i.e., layer differences removed) using a watercourses vector layer developed from a combination of the national boundary of Australia and the Digital Earth Australia (DEA) Waterbodies data product (both publicly available datasets) (Figure 3). This clipping eliminated the accidental regeneration of areas identified as waterways (i.e., lakes, rivers, dams etc.) that may be picked up as non-forest in the simulation.

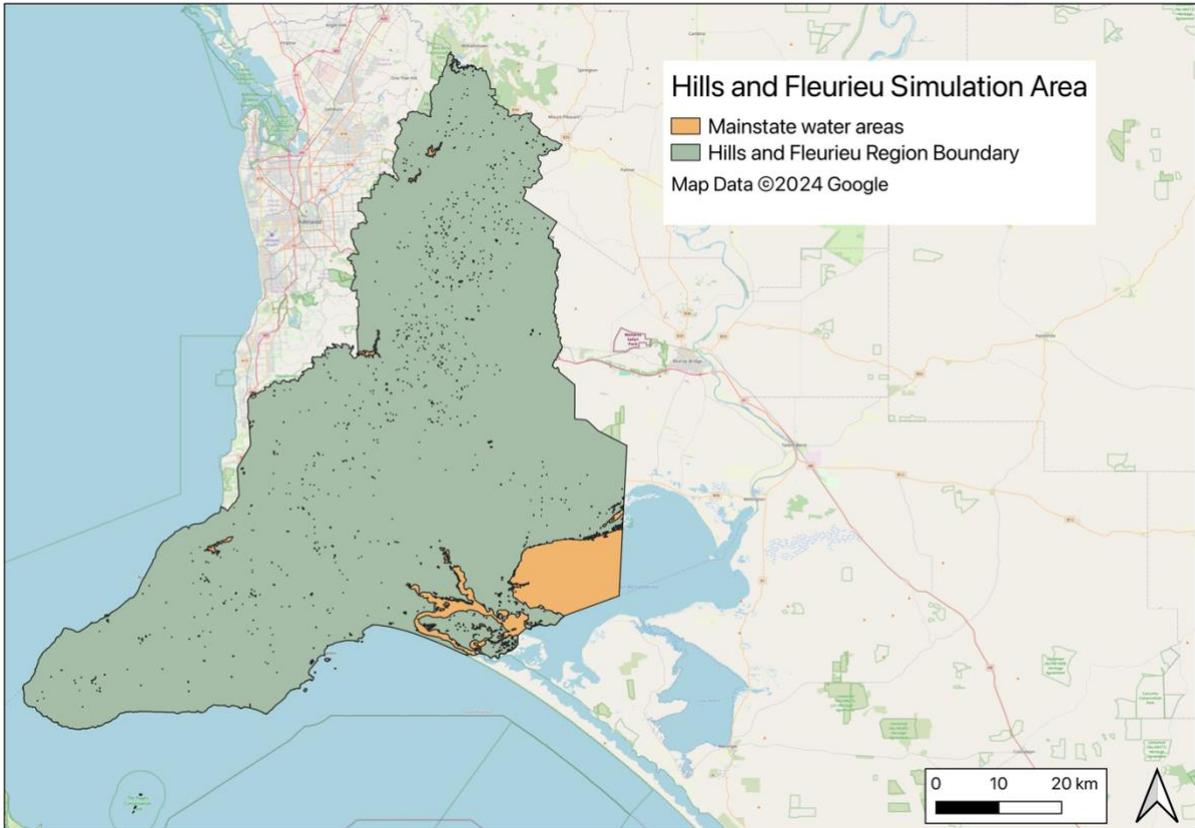


Figure 3 - Simulation area located around Adelaide, South Australia. Provided by Hills and Fleurieu Landscape Board as a vector boundary layer (green) overlaid with the regions clipped (yellow) for state watercourses (i.e. lakes, rivers).

2.2. Forest mapping and growth

All pixels within the simulation area that were classified as potentially eligible are assigned a forest of age of 0 years in 2024. Starting from 2024, the forests grow according to a location-specific growth curve. A growth function is initiated, starting the accumulation of carbon on that pixel. This results in fluxes of carbon from the atmosphere to the pixel's forest biomass pools over time. The growth of Belowground Biomass (BGB) is simulated as a fraction of above ground biomass, using vegetation type-specific parameters. Dead Organic Matter (DOM) accumulates from dying branches, leaves and roots which decompose over time.

3. Results

The results are displayed as (a) net removals of CO₂ equivalent and (b) forest carbon stock (combined AGB, BGB, and DOM) at 5, 10 and 25 years from commencement of regeneration. The results are also provided as per hectare results which are derived by dividing the results by the total forest abatement area. Only those pixels (25x25m) whose centroids fall within the simulation area are included in the simulation. Area calculations are determined using complete pixels. In instances where the simulation area is small or has an elongated shape, the area estimation may deviate from the actual project area.

The carbon abatement assessment was simulated across the Hills and Fleurieu region for a period of 25 years from 2024-2048. The Environmental Planting (EP) regeneration scenario was modelled over areas which had not had forest cover in the preceding 7 years to estimate the average abatement potential on a per hectare basis. A map of this potential is shown in Figure 5. Note that this is an indication of the potentially eligible area, however, for a precise assessment, a more detailed analysis would be required following the project requirements under the ACCU scheme method.

The assessment indicates that in 2048, at 25 years from simulation commencement, the total potentially eligible area of approximately 327,339 hectares had a total abatement potential of 68,013,587.22 tCO₂, and a mean abatement potential of 207.78 tCO₂.ha⁻¹ (Table 1). The potential abatement after 5 years in 2027 is approximately 35.63 tCO₂.ha⁻¹, and after 10 years in 2034 is approximately 101.99 tCO₂.ha⁻¹. Table 1 presents the results at a per ha scale, region scale, and the average over the entire assessment period, to provide a basis for assessing possible abatement. Three scenarios that assume 5%, 10% and 15% of the potentially eligible area is established as mixed species environmental plantings are also presented in Table 1. The estimated abatement after 25 years for these scenarios is 3,400,679 tCO₂, 6,801,359 tCO₂ and 10,202,038 tCO₂ respectively. The potential amount of area and where they might be located would be assessed by Hills and Fleurieu Landscape Board. The results are therefore indicative only.

The spatial distribution range of carbon abatement potential at 5, 10, and 25 years post-establishment, is shown in Figure 5. Carbon abatement potentials are highest (dark green) in the southwest regions, and in a smaller patchy region directly east of Adelaide (Figure 5). The approximate maximum carbon abatement at 5 years is 22.79 tC/ha, at 10 years is 65.26 tC/ha, and at 25 years is 132.94 tC/ha.

Comparing these results to a South Australian specific assessment of abatement potential¹, suggests that the estimated average abatement per year over 25 years (8.31 tCO₂-e) is generally significantly lower in this report using the National Greenhouse Gas Inventory calibrations compared to results for the Central Hills and Fleurieu Peninsula Cropping Region results² (16.54 tCO₂-e). In addition the spatial pattern of sequestration rates based on the National Greenhouse Gas Inventory calibrations (Figure 4), are quite different to the patterns in the South Australia assessment³. In particular the South Australia assessment shows higher sequestration rates over the central hills declining towards the coastline⁴ and to the Murray region, while the pattern is almost the opposite in Figure 4. It is likely that the South Australian assessment will provide a good estimate of the sequestration potential for environmental plantings, while the results in this report will tend to be more conservative and indicative of the sequestration rates that would be applicable under the current Reforestation by environmental or mallee plantings FullCAM method⁵ as well as the accounting for these planting types under the State and Territory Greenhouse Gas Inventories⁶.

¹ Hobbs TJ, Neumann CR, Tucker M, Ryan KT, 2013, *Carbon sequestration from revegetation: South Australian Agricultural Regions*, DEWNR Technical Report 2013/14, Government of South Australia, through Department of Environment, Water and Natural Resources, Adelaide & Future Farm Industries Cooperative Research Centre.

² See Table 25 of report in footnote 1

³ Hobbs TJ, Neumann CR, Tucker M, Ryan KT, 2013, *Carbon sequestration from revegetation: South Australian Agricultural Regions*, DEWNR Technical Report 2013/14, Government of South Australia, through Department of Environment, Water and Natural Resources, Adelaide & Future Farm Industries Cooperative Research Centre.

⁴ See figure 22 of the report in footnote 3.

⁵ <https://cer.gov.au/schemes/australian-carbon-credit-unit-scheme/accu-scheme-methods/reforestation-environmental-or-mallee-plantings-fullcam-method-2014>

⁶ <https://www.dcceew.gov.au/climate-change/publications/state-and-territory-greenhouse-gas-inventories>

Table 1 – Results of the abatement potential simulation under the Environmental Plantings. Abatement potential after 5, 10 and 25 years is presented in average tonnes of CO₂ per hectare, average abatement per hectare, abatement for the total area (potentially eligible), and abatement assuming 5%, 10% and 15% of the potentially eligible area.

Region	Area (ha)	Abatement after 5 years (tCO ₂)	Abatement after 10 years (tCO ₂)	Abatement after 25 years (tCO ₂)	Average annual abatement over 25 years (tCO ₂ .yr ⁻¹)
Per hectare average	1	35.63	101.99	207.78	8.31
Total Area	327,339	11,661,879	33,385,319	68,013,587	2,720,543
5% of total	16,367	583,094	1,669,266	3,400,679	136,027
10% of total	32,734	1,166,188	3,338,532	6,801,359	272,054
15% of total	49,101	1,749,282	5,007,798	10,202,038	408,082

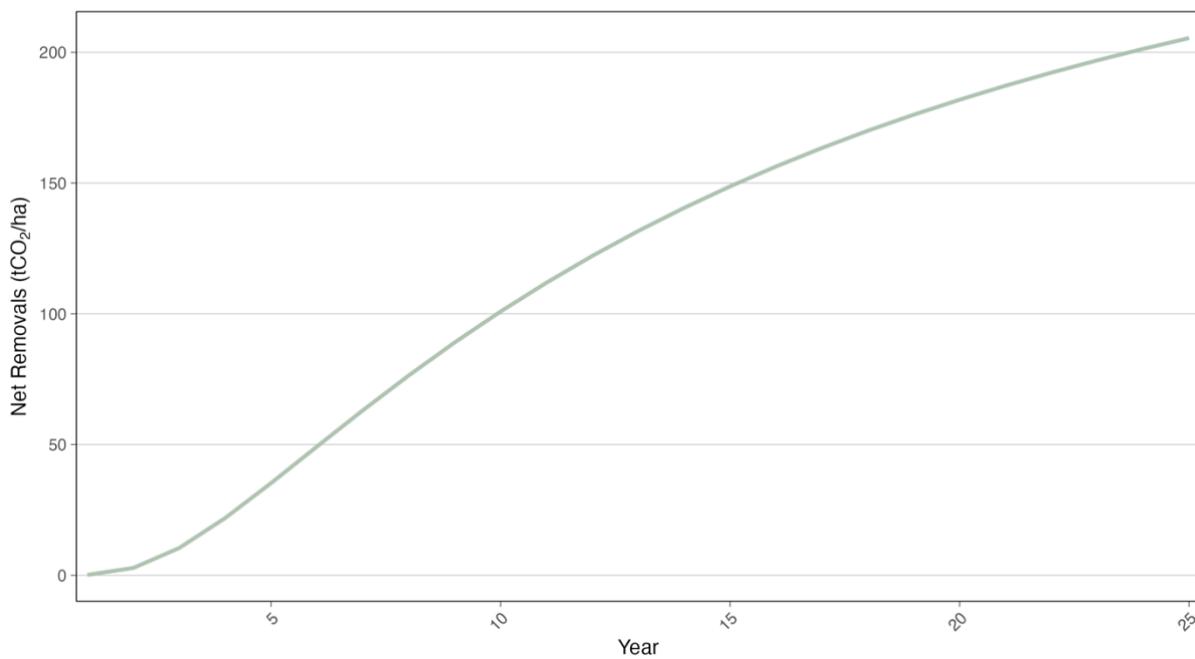
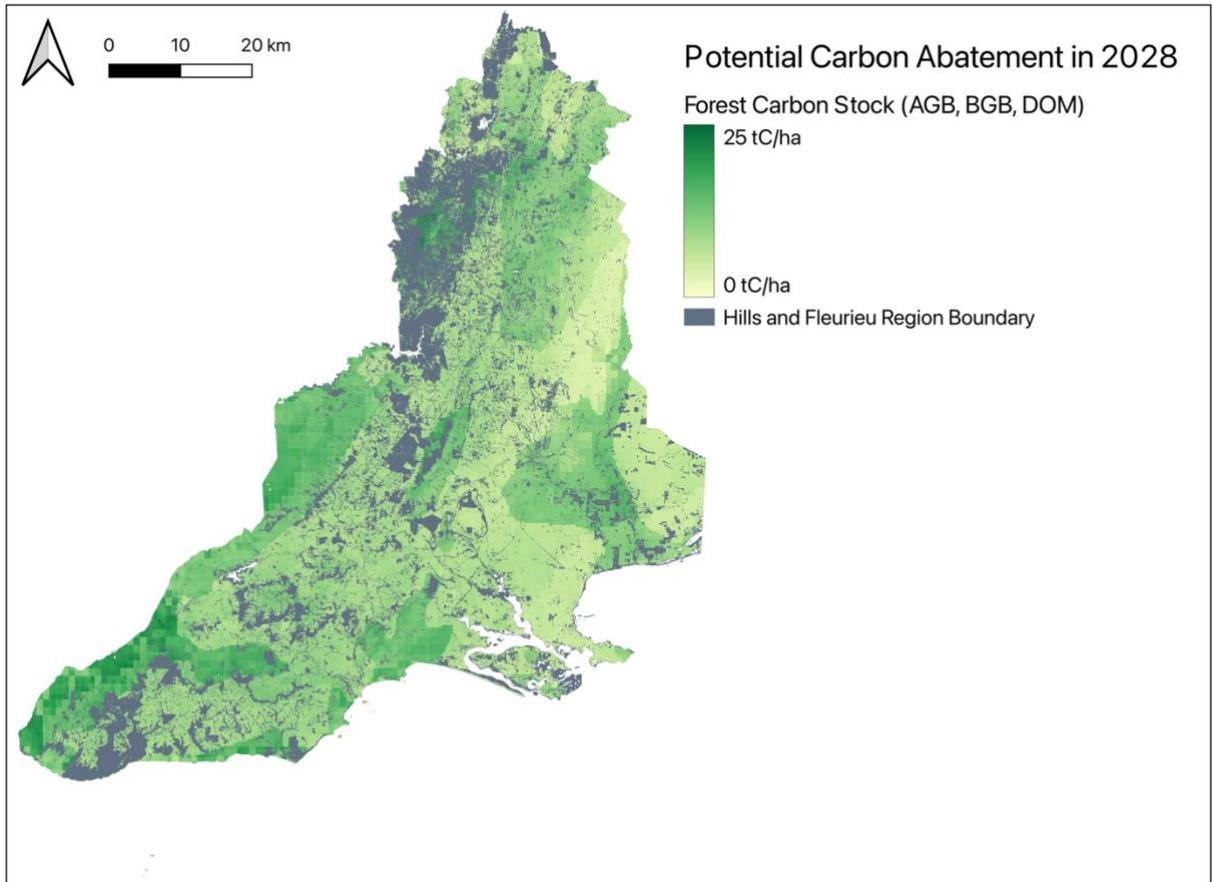


Figure 4 - Average accumulation of forest carbon across the property projected under the EP method, presented in tonnes of CO₂ per hectare (tCO₂.ha⁻¹).



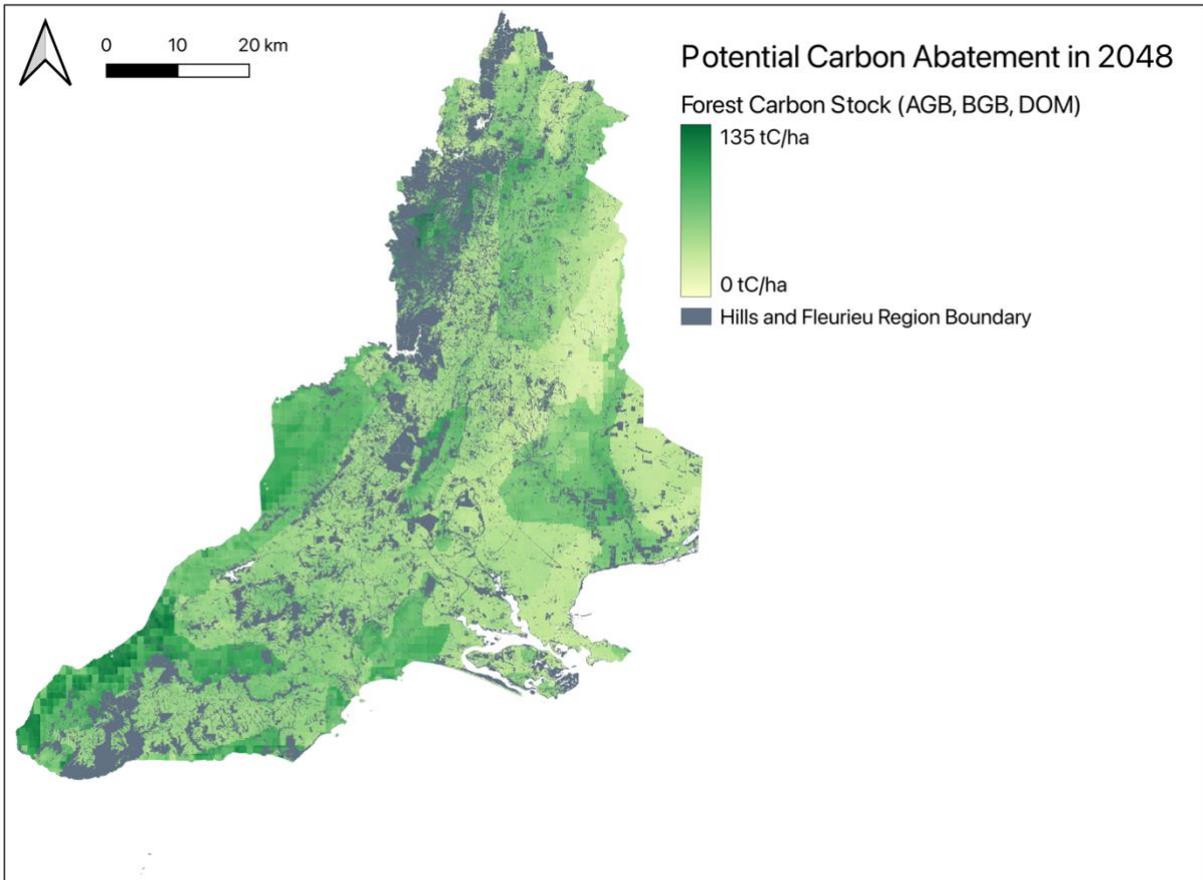
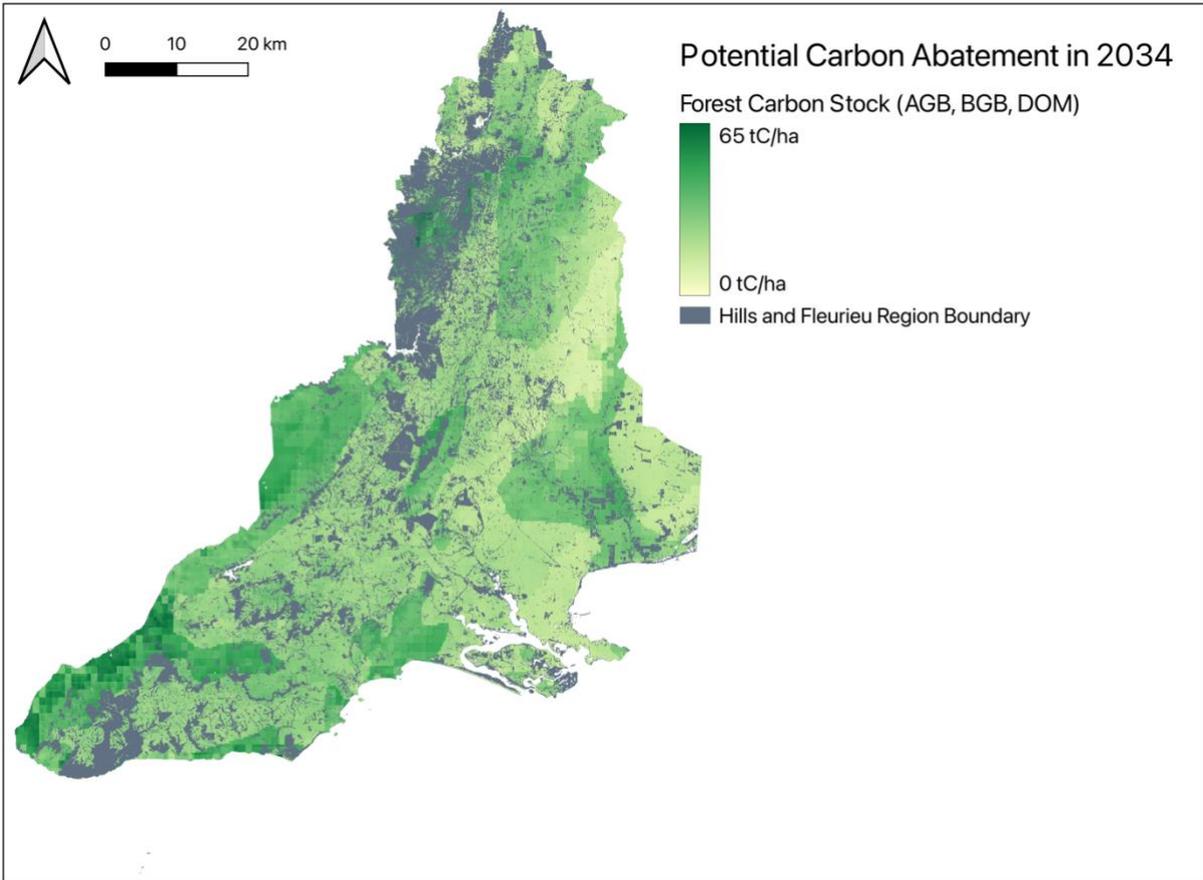


Figure 5 - Map of the Hills and Fleurieu region showing potential carbon abatement in tonnes of carbon per hectare ($\text{tC}\cdot\text{ha}^{-1}$) after 5 (top), 10 (middle), and 25 (bottom) years from 2024. Note the scale difference between spatial results.

4. Common Questions

What is a carbon sink and source?

An area of land will be a carbon sink when there is more carbon being sequestered (absorbed) within the land than emissions from it. Inversely, the land will be a source when there is more carbon being emitted than is being sequestered.

How is the forest carbon stock estimated?

FLINTpro uses a model approach that replicates the modelling approach used in Australia's National Greenhouse Gas Inventory for forest conversion. This approach uses a map of the potential maximum carbon stock that a natural forest could achieve based on a relationship between a forest productivity index (based on temperature, rainfall, frost days, vegetation greenness and soil properties) and measurements of the carbon in mature vegetation at a large number of sites across the continent. Each 250m grid square of Australia has its own estimated potential maximum forest carbon stock. This potential maximum is used in a common growth curve (the Chapman-Richards curve) to calculate the carbon that accumulates in the forest areas as they grow. Based on the National Inventory, forest that was present is assumed to be at its maximum carbon potential.

Can I use these results for getting carbon credits?

The results provide an indication of the potential trends in carbon stock and carbon emissions from changes in tree cover. The results are using national datasets as well as global data. Given the datatypes that are being used, the results are not currently suitable for the purpose of valuing or creating carbon credits under any scheme.

Why aren't areas of forest showing up on my map?

The forest cover maps used for this modelling process are based on a national forest cover product developed for the Department of Climate Change, Energy, the Environment, and Water. The product is a national product, there may be inconsistencies in certain regions, with small areas of forest not being correctly identified. It may also be that the vegetated areas fail one of the requirements of the forest definition for Australia, being vegetation that has a height of 2 metres, crown canopy of at least 20% and a minimum forest area of 0.2 hectares.

5. Data Assumptions and Limitations

The data has been developed to be accurate, on average, across the region. For an area of land to be recognised as a carbon sink, it must have a forest definition in accordance with the Australian definition of being vegetation that has a height of 2 metres, crown canopy of at least 20% and a minimum forest area of 0.2 hectares. Areas with trees that do not meet these criteria are not recognised as forest within the baseline assessment and are not considered in these results. All projections assume no decline in forest productivity. Where there are changes in productivity, or updates to FullCAM, the outputs of projections will be altered.

Data Required	Default Source	Description
Forest Cover Loss & Gain	Data.gov.au	"Landsat satellite imagery is used to derive woody vegetation extent products that discriminate between forest, sparse woody and non-woody

		land cover across a time series from 1988 to 2021. A forest is defined as woody vegetation with a minimum 20 per cent canopy cover, potentially reaching 2 metres high and a minimum area of 0.2 hectares. Sparse woody is defined as woody vegetation with a canopy cover between 5-19 per cent.”
Spatial differentiation of forests	Major Vegetation Groups - environment.gov.au	The Major Vegetation Groups provide a national level grouping of the likely vegetation types across Australia. This is based on data from each of the states and territories and provides an estimate of the pre-1788 vegetation type.
Forest Biomass	www.industry.gov.au/data-and-publications/national-greenhouse-gas-inventory-report-2018	A 250 m long-term average Forest Productivity Index is calculated using yearly average data from 1970–2017. This is used with a relationship (equation) based on ground based measurements of minimally disturbed forests that estimates the likely maximum forest biomass (potential carbon).

6. References

DCCEEW 2020. Full Carbon Accounting Model (FullCAM). Department of Climate Change, Energy, the Environment and Water (FullCAM, 2020 Public Release, Version 6.20.03.0827).

DISER. 2020b. Site Potential (M) and FPI Average Versions 2.0. Australian Government Department of Industry, Science, Energy and Resources.

DISER. 2022a. National Forest and Sparse Woody Vegetation Data. Version 6.0. Version 6.0. Commonwealth of Australia, Canberra: Department of Industry, Science, Energy and Resources.

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