Blueprint for holistic approach to carbon farming
Active Land Management & Agricultural Production (AL-MAP) Method

This document provides a blueprint for developing a more holistic approach to carbon farming across Australia. If implemented, the approach will help modernise carbon farming from the typical 'one property, one activity, one method' structure. The Blueprint provides an action plan to deliver a more sophisticated, fit-for-purpose carbon farming approach that incentivises a diverse range of carbon management activities to be implemented on a given farm or property, creating new opportunities for regional investment and maintenance and creation of jobs in sustainable agriculture production and environmental stewardship sectors. The approach will **enable more land managers and Traditional Custodians to participate in carbon farming or expand on their existing carbon farming activities**, helping to transition Australia's land and agriculture sectors to net zero or climate-positive. It will deliver environmental and natural capital stewardship, sustainable agricultural commodities, drought resilience, social, cultural and economic benefits across rural, regional and remote Australia.

This holistic agricultural production and land management method establishes a 'whole-of-landscape' framework combining vegetation and soil methods to allow land managers to receive carbon credits for multiple carbon farming activities on a single property. An increased abatement amount per property can enable increased participation of smaller land managers in the ERF, and in general significantly scale up carbon abatement and ACCU supply nationally.

The Blueprint has been developed as part of a collaboration between the carbon, agriculture, technology, resources and conservation sectors, with inputs from Traditional Owner groups, State and Federal Government and researchers. Cross-sector participants have come together to support a **harmonised land sector carbon method**, choosing to unite our resources as opposed to splitting our efforts across a patchwork of land sector methods which would entrench the outdated approach of 'one-property, one-method'. The Blueprint draws on years of practical experience in implementing carbon farming projects and methods, with contributors having provided carbon services for 500+ land-based ERF carbon projects. It applies lessons learned from pilots that test this more holistic approach to carbon farming and **aligns with contemporary accounting adopted by Australia as part of the Paris Agreement. It also delivers on recommendations put forward in the King review and recent ERAC reviews of relevant land sector methods**.

Phase 1 of the Blueprint is ready to be operationalised within a 12-month period and is not contingent upon further research and development. In relation to phase 1, we note that:

- The science is completed, meets the ERF integrity standards and is peer-reviewed and published (details of key references provided in Appendix 4.1)
- The National Greenhouse Gas Inventory (NGGI) includes or has recently been updated to include the relevant carbon pools (e.g. update for improved fire management and standing dead pool)
- Existing proponents utilising a range of land use methods (e.g., human-induced regeneration, avoided clearing, savanna fire management, environmental plantings and soil carbon) are interested in transitioning to the new method and take a more holistic approach to carbon farming on their farms or properties
- Expert analysis indicates that Phase 1 of the Blueprint could unlock 5,000+ new projects covering 65 million hectares, generating up to 2.5 billion carbon credits worth >$50 billion over a ten-year period.

Following implementation of Phase 1 of the Blueprint, subsequent phases have been identified, and these could be prioritised in 2023 and beyond. These include expanding the method to incorporate livestock supplements in grazing herds, energy & fuel efficiency activities and further updates to the way vegetation and soil is accounted for in FullCAM based on pilots and testing through alternative models with associated validation protocols. This would deliver an even more comprehensive "whole-of-property" approach within a 2-3 year period and unlock additional projects and abatement around Australia.

The AL-MAP method will enable significant emissions reductions across the economy through nature-based solutions, protecting agricultural production industries by maintaining access to international markets and positioning Australia as a global leader in sustainable, carbon neutral agricultural commodities. The AL-MAP method also helps to stimulate the regional economy, protect agricultural jobs, and create new job opportunities in regional Australia for land managers, ranger programs and through adoption of Australian technology. Companies, organisations and individuals ask that the Minister for Energy & Emissions Reduction, Hon. Angus Taylor, adopts this Blueprint and prioritises development of this combined vegetation and soil method (referred to as the Active Land Management & Agricultural Production Method, 'the AL-MAP method') in 2022.

The Blueprint also highlights scope for expansion of the method and continuous improvement of national systems (such as FullCAM) in subsequent years, as current research and development priorities become ready for implementation on the ground: Changes made through this method should be accompanied by investment in supporting technology through the **Technology Roadmap**, including transitioning Australia's national spatial mapping products to the **latest satellite technology and updating the user interface for a new release of Spatial FullCAM**.

Complementary reforms identified as part of finalising the accounting architecture of the AL-MAP method could also be used to **rectify drafting and administrative errors in existing methods**, such as the savanna and human-induced regeneration methods. The reduction of transaction costs compared with a stacking approach that requires registration of several projects under different methods will enable increasingly smaller property sizes to become commercially viable by implementing the AL-MAP method (addressing smallholder participation, also recommended as part of King Review).

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Real-world Case Studies: Active Land Management & Agricultural Production Method (AL-MAP) on the ground

Case Study 1: Savanna high rainfall zone


Photo: CSIRO (2020) Climate Change in the Northern Territory

Property Type	Native Title / Aboriginal land grant area
Project Owner / Proponent	PBC / Aboriginal Corporation / Ranger Group
Project activities	Savanna Fire Management, Environmental planting Feral animal management
Location	above 1,000 mm rainfall zone
Baseline activities	Poor fire management practices: 20%EDS/40%LDS
Example property size	180,000 ha
Example co-benefits	Improved access to country and employment for Traditional Owners, improved biodiversity, improved health outcomes due to reduced smoke
Mgmt. activities incl. in carbon project	Planned 10% ES/10% LDS improved fire management 350 ha of Environmental Plantings Management of feral animals across property
Eligible carbon pools based on management changes	Fire emissions Aboveground biomass (shrub & tree) Belowground biomass Debris
Example abatement (ACCUs over 25 yrs)	100,000 - Debris 500,000 - Methane & nitrous oxide flux 800,000 – AGB + BGB
Total ACCUs	1,400,000
How does AL-MAP method change project viability or outcomes?	180% increase in abatement from current method. Currently only possible to implement avoided emissions savanna project delivering around 500,000 ACCUs over 25 years, or sequestration project only accounting for limited pools (e.g. excl live biomass).

Case Study 2: Agricultural production in mid rainfall zone

Photo: Guy Webb (left) and Climate Friendly (right)

Property Type	Grazing enterprise – cattle
Project Owner / Proponent	Family run farm
Project activities	Establishing ~200 ha rows of leucaena plantings with conventional pastures in the inter-row. Increased liveweight gain due to improved year-round pasture quality.
Location	600 – 800mm rainfall zone
Baseline activities	Grazing of livestock on conventional pastures
Example property size	600 ha
Example co-benefits	Increased drought resilience by provision of green feed during drought, shelter of livestock, reduced soil erosion, increased soil fertility.
Mgmt. activities incl. in carbon project	Pasture renovation Establishment of Leucaena plantings
Eligible carbon pools based on management changes	Soil Aboveground biomass Belowground biomass Debris
Example abatement (ACCUs over 25 yrs)	25,000 – Soil pool 50,000 – AGB + BGB 5,000 - Debris
Total ACCUs	80,000
How does AL-MAP method change project viability or outcomes?	220% increase in abatement compared to current methods. Without the AL-MAP method, this property could only register a soil carbon project and deliver 25,000 ACCUS which would not be commercially viable to run.

Case Study 3: Rangelands agricultural production (low rainfall zone)

Photos: GreenCollar

Property Type	Grazing enterprise – sheep and cattle
Project Owner / Proponent	Family agribusiness
Project activities	Planned rotational cell block grazing, improved watering and fencing infrastructure, strategic goat eradication, multi-species pastures, decision to cease broad scale native forest and regrowth clearing except for targeted ecological thinning or for firebreaks
Location	~400mm annual rainfall
Baseline activities	Set stocking of livestock, opportunistic goat harvest, periodic native forest and regrowth clearing via PVP/Cat X
Example property size	20,000 ha
Example co-benefits	Increased livestock productivity, drought resilience and biodiversity. Reduced soil erosion.
Mgmt. activities incl. in carbon project	Rotational livestock grazing Feral grazing management Cease clearing native forest Multi species pasture
Eligible carbon pools based on management changes	Soil Aboveground biomass Belowground biomass Debris
Example abatement (ACCUs over 25 yrs)	40,000 – Soil 250,000 – AGB + BGB 20,000 – Debris
Total ACCUs	310,000
How does AL-MAP method change project viability or outcomes?	55% increase in abatement compared to current methods when including soil, as enabled by the AL-MAP method.

Case Study 4: Agricultural production in high rainfall zone

Photos: Climate Friendly (left); Australian Regional Development Conference (right)

Property Type	Grazing enterprise – sheep and cattle
Project Owner / Proponent	Family agribusiness
Project activities	Planned grazing, multi-species pastures, environmental planting of shelterbelts, farm forestry
Location	Victoria, 650mm rainfall zone
Baseline activities	Set stocking of livestock, scattered paddock trees across the property
Example property size	400 ha
Example co-benefits	Increased livestock productivity, drought resilience, biodiversity, supply of domestic wood.
Mgmt activities incl. in carbon project	Planned grazing, multi-species pastures, environmental planting of shelterbelts, farm forestry
Eligible carbon pools based on management changes	Soil Aboveground biomass Belowground biomass Debris
Example abatement (ACCUs over 25 yrs)	40,000 – Soil 50,000 – AGB + BGB 5,000 – Debris
Total ACCUs	95,000
How does AL-MAP method change project viability or outcomes?	110% increase in abatement compared to current methods. Without the AL-MAP method, this property could only register a soil carbon project and deliver 25,000 ACCUS which would not be commercially viable to run.

Alignment with Government Priorities

Technology Investment Roadmap - accelerating low emissions technologies

Emergent, high-resolution remote sensing technologies can be adopted to further improve the accuracy and precision of Australia's world-class carbon accounting infrastructure. Investment by the Australian Government as part of the next phase of the Technology Roadmap in the latest remote sensing technology at a national scale will help to drive down the costs of monitoring carbon sequestration in both vegetation and soil, enabling increasing precision in predictions of soil carbon from space. This will reduce costs of field measurements, enabling more targeted sampling on the ground, and it will also provide high-tech, real-time information to land managers on pasture and vegetation cover to inform their on-ground management. This investment supports the transition to Spatial FullCAM, enabling use of pixel-level spatial data across an entire property, leveraging big-data and emerging Australian technology systems and products. Adopting this approach with also increase method integrity and reduce uncertainty, delivering environmental and economic benefits.

Carbon farming participants can contribute project level data, such as management histories, livestock movements and LiDAR based drone surveys to support this technology transition. Contributing these valuable datasets to a national database (with appropriate privacy protections) enables a bottom-up calibration and continuous improvement process of Spatial FullCAM. This creates a positive feedback cycle where ongoing improvements to the national system will enable greater participation in carbon farming by reducing the transaction costs of monitoring and reporting project-scale emissions reduction activities. We recommend investment in this national data bank, through one or more databases, for vegetation and soil data as part of the 2022 implementation of the Technology Roadmap.

Phase 2 of the Blueprint enables incorporation of other emergent agricultural and energy technologies into the AL-MAP method. Continued investment in these technologies in parallel to Phase 1 implementation of AL-MAP is encouraged. Highly prospective technologies include livestock feed and forage supplements for grazing herds, electrification of farm utilities and vehicles using renewables, and modular energy-to-waste bioreactors to improve the circular economy of the agricultural sector.

King Review: Expert Panel examining additional sources of low-cost abatement

The AL-MAP method will deliver on multiple recommendations put forward in the 2020 King Review, which included a detailed examination of low-cost abatement opportunities in the agriculture sector. The core principles adopted by the Expert Panel indicated that transparent, technology neutral policies should be designed collaboratively and encourage administratively simple solutions that focus on economically productive activities, to reduce transaction costs and increase participation in the Emissions Reduction Fund.

First and foremost, the AL-MAP method builds upon recommendation 6.9 to allow land managers to conduct multiple eligible activities on the same property. Including multiple activities within a single project reduces barriers to participation by reducing administrative costs while increasing the potential carbon abatement opportunity across a single project. The proposed AL-MAP project accounting framework is an administratively simple to unite many eligible management activities that have well understood carbon abatement outcomes, as well as co-benefits related to the improved management of vegetation and soil. Combining multiple activities within one method will result in a significant step towards streamlining and minimising the administrative burden in relation to project audits which currently require one audit per activity. This change is particularly attractive for small-scale project where activities, such as shelterbelt plantings, can benefit from additional abatement opportunities with little additional overhead.

Secondly, the AL-MAP method addresses the essential elements of recommendations 6.3, 6.5 and 6.10 by introducing the concepts of a Land Management Strategy, spatial abatement modelling and alternative models with validation protocols. The Land Management Strategy draws on expert and traditional knowledge as an administrative mechanism to ensure that management activities are carried out with a duty of utmost good faith. Spatial abatement modelling brings 'big-data' to bear on the task of project activity verification and, when combined with the Land Management Strategy, means that the integrity of abatement outcomes due project management activities is assessed with high precision. This approach leverages the technological capabilities of the National Greenhouse Gas Inventory (NGGI) and the nationally available carbon modelling tool FullCAM. Wherever alternative models are better suited to local conditions, a cost-effective validation protocol is used to ensure these models are fit for purpose and can be used to reduce the costs of measuring carbon stocks directly. Validation datasets are shared to improve the national FullCAM model and help resolve scientific uncertainties.

Lastly, the proposed AL-MAP method was developed collaboratively following recommendations 6.1 and 6.13 and has been a welcome opportunity to accelerate method development. The method co-design process fosters innovation in the carbon farming sector and cross-sector participation from Traditional Owner groups, State and Federal Government and researchers ensures that new methods are robust and fit for purpose. The phased implementation of the AL-MAP method will allow for innovative new technologies and land management strategies to be incorporated as they develop. Co-design of the AL-MAP method can continue with contributions from diverse participants in their respective areas of expertise.

Agriculture Biodiversity Stewardship Package

The AL-MAP method is closely aligned with and provides an platform to accelerate the scale up of the various components of the Agricultural Biodiversity Stewardship Package. The Agriculture Stewardship Package will help farmers improve on-farm land management practices. It will develop arrangements to reward farmers for protecting biodiversity and identify other sustainability opportunities. Having a single carbon method covering vegetation and soil with increase the ability to stack applicable biodiversity outcomes, delivering dual goals of improved carbon storage coupled with a well-managed, biodiverse and drought resilient natural resource base. AL-MAP is compatible with each of the following programs:

- Carbon + Biodiversity Program
- Enhancing Remnant Vegetation Program
- Australian Farm Biodiversity Certification Scheme
- Biodiversity Trading Platform
- Sustainability framework for Australian agriculture

Wherever possible, options to streamline administration of the above programs to minimise transaction costs for participants delivering both carbon and biodiversity stewardship is encouraged.

Phase 1:

1.1 AL-MAP Architecture

Overview

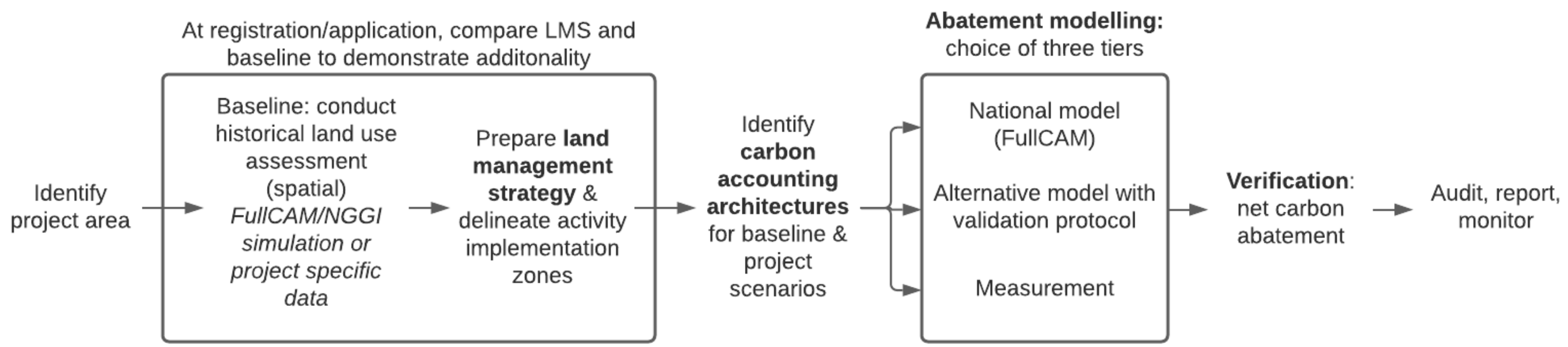


Figure 1. Provides an overview of the AL-MAP method project cycle, from project identification, the registration process (including project baselines, land management strategies and evidence of additionality) through to carbon account preparation and verification, and ongoing project implementation with auditing, reporting, and monitoring. Further details of each part pf the project cycle are provided throughout the Blueprint.

Categories of eligible activities:

Phase 1 of the AL-MAP method is proposed to include the following broad categories of management practice changes or carbon management activities. The method will include appropriate safeguard provisions to avoid adverse environmental and/or social outcomes, ensuring activities are conducted and outcomes delivered in an ecosystem-appropriate manner, and where possible encourage optimisation of other co-benefits.

Vegetation:

- Establishing and maintaining new vegetation by planting, seeding or natural regeneration on degraded non-forest and forest systems to increase the density and extent of woody vegetation as part of the natural vegetation structure, resulting in increased sequestration;
- Stimulating vegetation growth and removal of suppression agents to improve the structure and composition of existing vegetation & grasslands, resulting in increased sequestration;
- Changing the fire management of woody vegetation and grasslands to reduce emissions from fire (i.e. combustion), and to increase sequestration of carbon in vegetation through improved ecosystem health;
- Changing management, clearing, or harvesting practices of native and non-native woody vegetation and grasslands to reduce vegetation disturbance and/or improve ecosystem health, resulting in increased sequestration and/or avoided emissions;
- Changing the way livestock, non-domestic native and non-native feral animals are managed to facilitate increased growth of vegetation, resulting in increased sequestration and/or avoided emissions;
- Changing the harvest and removal practices of live vegetation, standing deadwood and coarse woody debris to increase the retention time of carbon within the project.

Soil:

- Mechanical, chemical or biological modification of the soil structure and/or composition to increase the root mass of plants and/or increase the amount of carbon entering and retained in the soil;
- Changing the way that livestock are managed to increase organic matter entering and retained in the soil;
- Changing the way that croplands are managed to increase organic matter entering and retained in the soil and/or increasing the proportion of ground cover to reduce the rate of organic matter decomposition;
- Changing the way that pasture is managed to increase the root mass of plants and/or increase the amount of carbon entering and retained in the soil;
- Changing the way that water is managed on the land to increase water infiltration rates to the soil, and/or reduce evapotranspiration, resulting in increased carbon entering and retained in the soil; and/or reduced erosion of soil carbon;
- Changing the way that woody vegetation is managed to increase organic matter entering the soil and/or reduce soil erosion.

A more detailed list of specific management changes that fall within these broad categories is included in Appendix 4.2.

The carbon accounting options section below specifies how changes to carbon stock in vegetation and soil, along with associated flux-based emissions, would be calculated for these activities, including how baselines and changes as a result of these management practices can be determined. Additionality requirements will be maintained, drawing on the array of existing land sector methods, and are covered in the land management strategy and additionality sections that follow.

Restricted activities

Some management activities may be expressly ruled out where there is potential for perverse outcomes. For example, management activities should ensure that the changes to the composition and structure of vegetative communities are appropriate to the local ecosystem context.

Existing methods have restricted activities that ensure management does not contravene other Government objectives or result in 'leakage' of emissions outside the project area. In specific cases, restricted activities might enforce limits on the extent to which a management activity can be carried out without adverse impacts.

Land management strategy

Key principles:

- Evidence, e.g. via expert, integrity-based, appropriately qualified advice or other records, and statement on the historical and forecast business as usual land management practices.
- Outlines scope of activity implementation across all eligible areas, accompanied by a map showing the activity implementation zones across the property.
- Provides an evidence basis for the choice of nominated accounting architectures (i.e., used for forecasting baseline and project scenarios).
- May be accompanied by socio-economic or biophysical modelling or other data to support predictions of baseline activities.
- Essential evidence of additionality.

It is proposed that all eligible activities are described in a land management strategy. This draws on experience in other methods which have a similar requirement, like a fire, agronomy or farm management plan.

<u>Expert advice</u>

An appropriately qualified expert will prepare or review a written land management strategy for the implementation of all eligible land management activities to be carried out as part of the project to demonstrate:

- how the planned land management meets the criteria of one or more categories of eligible activities; and
- how the planned land management changes are a demonstrable change from the historical or hypothetical ‘business as usual’ case; and
- at least one eligible management activity will be undertaken on all eligible areas to be included in the project.

In establishing the eligibility and extent of management activities, the land management strategy is an essential element of determining which accounting architectures and abatement models will be used, as described in the Project Accounting section. In other words, the management activities described in the Strategy will determine how the project and baseline scenarios are forecast.

The expert preparing the strategy is deemed to be appropriately qualified if they are a member of an appropriate professional body or have appropriate training and qualifications or appropriate traditional/customary knowledge to advise on the land management practices that form part of the project. The processes underlying preparation of the land management strategy, and the integrity of statements within it, are subject to audit. The land management strategy can be supported by socio-economic or biophysical modelling, or third-party documentation that verifies that the implemented project activities are new and additional to business-as-usual.

This documentation may include templated financial analysis, contracts, licences or permits to continue historic management practices, existing fire management plans, or agronomic limitations to productivity such as nutrient deficiencies. In some cases where the baseline scenario is based on a hypothetical forecast (rather than the observed current or historical situation), an integrity declaration by both the author of the strategy, and the proponent, will be required to certify the newness of the land management activities.

Lastly, the land management strategy should provide sufficient evidence that emissions reductions activities can be maintained until the end of the permanence obligation period for the project. Where necessary, additional monitoring and record keeping requirements may be recommended to verify the objectives of the land management strategy are being achieved.

The land management strategy can be updated periodically at appropriate junctures in the life of the project.

Activity implementation mapping

Following expert advice, the project area is stratified according to ‘activity implementation zones’ or areas where different activities are conducted.

Activity implementation zones can be delineated in either of two ways:

- a ‘default’ approach to setting the baseline using the NGGI land use history simulations, with a validated and approved land management map for project activities; or
- a project-specific approach, using alternative validated and approved historical spatial data for the baseline, and a validated and approved land management map for project activities.

Historical and planned/actual land use practices are used to determine which of the four universal carbon accounting architectures apply to the baseline and project scenarios, and to determine the initialisation of carbon stocks in project scenario abatement estimates. This will involve mapping or stratification of the project area into activity implementation zones on a pixel level basis. This is broadly equivalent to how the existing suite of land methods operate, but carbon estimation areas will be run as a point-based (pixel level) model across an entire project area.

Under the NGGI, analysis of land use is already performed annually, Australia-wide, based on imagery dating back to 1972. Making the historical NGGI land use simulations available via a user portal (or API) would simplify stratification and modelling and provide a 'default' approach to determination of eligible management zones. In the case of spatial carbon models, the NGGI simulations also provide a modelled initial carbon stock. If using the NGGI simulations as a baseline, the land management strategy must describe how management activities will be implemented within these land use classes.

In cases where the NGGI data is not appropriate for use at the project level, or where project-specific mapping products supplement the NGGI data, a project specific determination of activity implementation zones is applied. Any project specific materials (spatial and non-spatial) must be validated through audit to ensure they are accurate and fit for purpose. Where the best estimate of the desired attribute is represented as a range of values, as occurs in very long-term land use histories (e.g., cleared between 1900-1940), sensitivity analyses should be undertaken to assess the impact of choosing the mean or median value on the simulation outcome.

Examples of information that may be used to develop activity implementation zones include:

- Land use classification and land use history; or
- Estimated land-use age (also referred to as 'modelling commencement date'); or
- Standing or initial carbon stocks; or
- Disturbance history, such as:
  - areas of controlled or mosaic burning, and fuel load; or
  - areas of woody vegetation clearing; or
- Management events, such as:
  - crop and wood harvests and thinning; or
  - stocking rates and grazing pressure; or
  - irrigation, landform manipulation and soil amendments; or
- Management plans (where history is similar, but planned activities vary).

Carbon accounting options

Key principles:

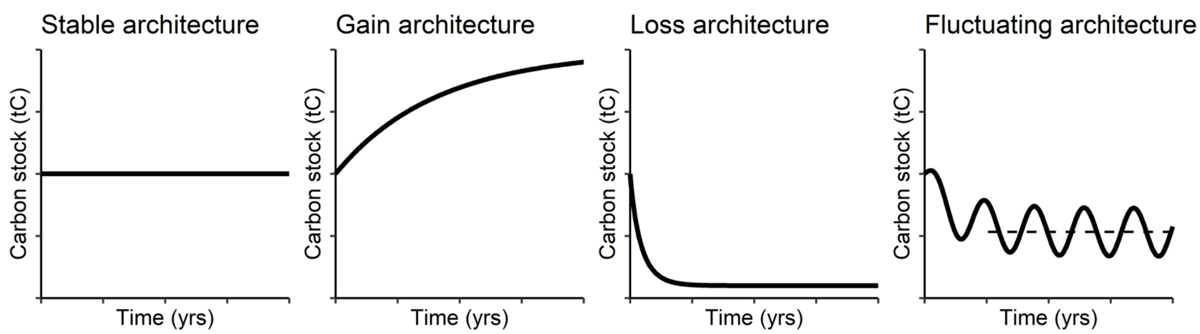
- Proponent identifies relevant carbon pools and management practice change.
- Accounting options to suit a range of project types and sizes
- Maintains environmental integrity through appropriate validation.

Carbon stock changes in the baseline and project scenarios can be estimated (retrospectively) or forecast using one of the four 'key carbon accounting architectures' that are universal across all land-sector carbon methods. These architectures already form the fundamental basis of carbon stock changes in the existing suite of ERF methods.

The four universal carbon accounting architectures are:

1. Stable (i.e., zero or maintenance of consistent non-zero carbon stocks); or
2. Gain (i.e., sequestration); or
3. Loss (i.e., transition to a lower carbon state); and
4. Fluctuating (i.e., sequestration followed by loss, fluctuating around a long-term average carbon stock).

The equations underlying each combination of project and baseline architectures could be included as modules or supplements to the method.



$C = C_{t0}$ $\quad$ $C = C_{t2} - C_{t1}$ $\quad$ $C = \frac{C_{t1} - C_{t2}}{t_2 - t_1}$ $\quad$ $C = \frac{\sum_{x=0}^{t} C_x}{t}$

Figure 2. An illustrative example of the four universal carbon accounting architectures: stable, gain, loss and fluctuating. Carbon stock equations are demonstrated for each architecture with scope to refine the period over which carbon stocks are calculated.

A framework such as the 'IPCC Key Categories Analysis' can be applied to determine which carbon pools should be estimated for each management activity.[1] This ensures that all material carbon pools are estimated and accounted for, and that carbon pools are only excluded where it

[1] The IPCC Key Categories analysis can be located at: https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/1_Volume1/V1_4_Ch4_MethodChoice.pdf

is conservative to do so. Alternatively, the set of pools to model for each architecture or activity category could be pre-determined within the method.

The four universal architectures apply to changes in carbon stocks only, not to flux-based emissions. Separate equations will be included in the Net Abatement Calculations, described later, to account for relevant fluxes such as combustion associated with fire, enteric fermentation, electricity and fuel usage. These equations are already well establishing within existing methods and the NGERS legislation.

Baselines

Key principles:

- Baselines that are linked to activities described in the land management strategy.
- Maintains robust evidence basis/burden of proof, including leveraging lessons learned from existing methods where appropriate and transferable.
- Long-term FullCAM averages for national model as a default option.
- Further evidence required for models with additional inputs.

A project's land management strategy and its associated supporting documentation can be used to develop a business-as-usual baseline, representing a counterfactual against which the abatement activities implemented as part of a project will be compared. Baselines can either be an assumed continuation of the historically observed land use patterns, or a modelled change from historical patterns based on clear evidence to back up that change.

Some illustrative examples of counterfactual baselines include:

- Permanent clearing of woody vegetation due to a planned land use conversion (schedule 4 in the current co-design draft of the Plantation Forestry method, provides a precedent of a model used to evidence this); or
- Typical harvest or clearing rotations of existing woody vegetation, including the use of 'risk of' datasets such as the risk of clearing map developed by Queensland Herbarium or other jurisdictions; or
- Evidence of suppression of regeneration of woody vegetation; or
- Long-term average emissions due to disturbances or management activity such as burning; or
- Long-term limitations of productivity in woody and non-woody vegetation; or
- Long-term trends in regional land use history and time since land use conversion.

Baselines are a focal area for method development co-design and will require a high burden of proof to ensure a robust evidence basis, as required under the scheme. A key outcome of the method development co-design process will be *guidelines and a process* to determine which of the four fundamental carbon accounting architectures should apply and how baselines for each architecture should be developed, including determining minimum evidentiary requirements.

In cases where historical observation of land use patterns is deemed an appropriate way to forecast the baseline, the National Greenhouse Gas Inventory (NGGI) historical land use simulations could be considered as a conservative 'default' baseline if the project proponent is satisfied that the NGGI simulations adequately represent local conditions.

Appropriate discounts may be applied to projects using highly uncertain baselines to ensure that any assumptions are conservative and avoid the over-estimation of project abatement estimates. On some projects, likely at small scales, it may be cost-effective to provide additional information or measurement data to develop the project-specific baselines and reduce the associated discounting. This can include calibrating alternative models, which are then subject to an ongoing validation protocol, as discussed in the next section.

Project reporting: measurement and modelling approaches

Key principles:

- The method has three options to estimate carbon stock changes:
    1. national model (i.e., FullCAM), with supplementary project data; or
    2. alternative models with validation protocols; or
    3. measurement only.
- The national model option provides a low-cost estimation approach where suitable calibrations are available and where the default NGGI spatial land use analysis can be used to determine initial carbon stocks.
- FullCAM can be supplemented with additional project specific data from the land management strategy, where the NGGI spatial land use data is not considered fit-for-purpose.
- Where alternative models and model calibrations are used, these are subject to validation protocols that compare estimates against measurement data to confirm the accuracy of modelled carbon sequestration and avoided emissions from vegetation or soils.
- Measurements follow standardised protocols for in-field measurement (as per existing methods).
- Estimation of flux-based emissions such as enteric fermentation, fuels and electricity is based on third party documentation and default emissions factors.

<u>National model (FullCAM)</u>

Biophysical modelling
The Full Carbon Accounting Model (FullCAM) is used by the NGGI to estimate land carbon stocks across Australia. The public availability of FullCAM enables a low-cost, user friendly project accounting tool that is aligned with the NGGI simulations and can be broadly applied to carbon farming projects across Australia, including small scale projects (< 500 ha) or very large, extensive projects (> 10,000 ha) where direct measurement of carbons stocks is cost prohibitive. FullCAM simulations track the change in carbon stocks associated with land use, land use change and disturbance histories.

The national model approach can be applied for any management activities where the Government is satisfied with the accuracy of the national FullCAM calibrations. At the time of writing, FullCAM is already in-use for modelling of forest regeneration, avoided re-clearing, environmental and mallee plantings, plantation forestry and farm forestry. FullCAM has also been used for modelling soil carbon stocks under the default soil carbon methodology. The development of a simple user portal similar to the current SavBat or FullCAM portals, preferably with an API connection will enable proponents to readily participate, as discussed in Section 1.2 Project Accounting Tools & Enabling Technology Work Program.

Activities where the Government is not satisfied with the accuracy of the national calibration could be targeted for future R&D investment. Such activities would be required to apply either an alternative model, or a measurement approach as described below. These measurements provide a valuable data source to help calibrate the national model, reducing uncertainties and driving down costs of participation over time.

Spatial FullCAM

The Government already runs FullCAM spatially to estimate carbon stock changes in the NGGI for each pixel across Australia.

A spatial model, in effect, treats each pixel as an individual CEA, with carbon pools that are independent of neighbouring pixels. In other words, it combines the biophysical modelling capability of FullCAM, with historical land use analysis performed under the NGGI simulation. Under this approach, the historical carbon stores for each pixel are estimated by running a time-series model of land use history, including disturbance and land use change. For example, a pixel classified as forest is assumed to increase following a growth curve. Carbon stocks increase or change in line with growth curve for every year the pixel remains forest class, unless impacted by disturbance which might cause carbon stocks to stabilise or decrease. In a savanna context, carbon stocks and emissions from fire are calculated for each pixel based on a history of fire scar data. Carbon stocks increase based on one or more vegetation growth curves, which vary (slows) in years where the pixel is burnt, and decreases proportionally to fuel load in years where the pixel is burnt.

As part of the FullCAM modernisation roadmap, the Government can extend this spatial capability to individual projects to allow for increased precision in project accounting. Pixel based modelling dramatically simplifies, and strengthens the integrity of, the modelling of multiple management activities and disturbance histories on a single project as each pixel can be treated independently. Importantly, this allows for conservative accounting of project abatement as individual pixels are assessed independently, rather than at a single point representing an entire CEA. This means that pixels that do not change under project management activities are not included in the Net Abatement estimate. This change not only improves accounting, but also enhance project transparency and integrity with all pixels in a project area being modelled individually.

Modelling vegetation

The initial carbon stock of a pixel project may be either zero or non-zero, depending on the carbon mass of existing woody vegetation. Initial carbon stocks are described as being material or not material based on whether the long-term average carbon mass of woody vegetation is more than 5 per cent of what the modelled carbon mass of woody vegetation would be after 100 years of undisturbed growth.

A zero initial carbon stock only needs calculating once in a project, and applies if:

- comprehensive suppression of woody vegetation growth (inc. clearing) has occurred, and
- the carbon mass of woody vegetation has not been material (as defined above) for the 10 years (or more if longer baseline appropriate) before the project began.

A stable → gain accounting architecture is used to calculate the difference between the initial carbon and the subsequent modelled growth in woody vegetation biomass. Where pixels have non-zero initial carbon stocks, a counterfactual baseline is calculated as the long-term average of carbon mass of vegetation of the pixel. Counterfactual baselines must be recalculated for each reporting period with updated climate data but a repeating cycle of land-use and disturbance history.

Long-term average baselines are required if:

- the woody vegetation has been managed for pastoral use, and
- the carbon mass of woody vegetation has reached a material level in the 10 years before the project began; or
- soil carbon stocks are included in the project accounts.

A fluctuating → stable or gain accounting architecture is used to calculate the difference between the most recently modelled counterfactual carbon stock and the subsequent modelled growth in woody vegetation biomass.

A loss → stable or loss → gain accounting architecture may be appropriate where vegetation is at risk of being cleared in the future. Under the model-based approach, the risk of a clearing event that would result in the loss of current or future forest cover on a unit of land can be ascertained based on a composite of a number of risk factors, not limited to the fact that it has been cleared before or has a pre-existing permit to clear. Key factors include rainfall, location, historical farming practices, forest type, representation of the vegetation within the wider ecosystem and a range of other factors specific to the region. This could be done either at a project scale, or more ideally using a jurisdictional model (such as the model developed by Queensland Herbarium) or a national model, similar to the ABARES modelling framework referenced Schedule 4 in the current draft Plantation Forestry method. Some architectures (particularly loss → other scenarios) are likely to be accompanied by an avoided emissions element where project management activities have also avoided a volume of GHG emissions that would have occurred under the business-as-usual activities e.g., burning after clearing or higher emission late dry season burns.

All relevant management activities and/or disturbances such as ecological thinning, prescribed burns, wildfires, other tree mortality or growth pauses etc could be modelled using well-accepted equations that are included in many vegetation methods.

Modelling soil
Similar to pixels with existing vegetation, soil carbon pools have non-zero initial carbon stocks and require a modelled counterfactual baseline. Due to the integrated nature of the FullCAM model is the same counterfactual baseline used to model vegetation. The productivity of pixels classified as grasslands or croplands are derived independently of the woody vegetation growth curve using the agricultural models within FullCAM.

The long-term average baseline can be recalculated for each reporting period using:

- the repeating cycle of land-use and disturbance history; and
- the most recent climate data; and
- modelled estimates of ground cover and organic matter inputs from vegetation.

A fluctuating → fluctuating accounting architecture is used to calculate the difference between the most recently modelled counterfactual baseline and the subsequent modelled long-term average carbon stock following the implementation of the land management strategy.

Any uncertainty in project estimates of soil carbon stocks due to the coarse resolution of FullCAM data layers may be subject to discounts to ensure consistency with the Offsets Integrity Standard of conservativeness. Projects targeting marginal improvements in soil carbon stocks that are not commercially viable after discounting may instead require investment in an alternative model with higher precision.

Alternative models with validation protocols

In cases where the Government or proponents are not satisfied with the accuracy of the national FullCAM calibration, proponents may choose to calibrate FullCAM to local conditions using field measurements and project specific management history. This approach is already applied under the Farm Forestry and Environmental Plantings methods, where proponents can collect field inventory data to calibrate FullCAM.

Proponents also have the option to apply their own models and/or model calibrations to capture local ecosystem dynamics that the national model does not adequately represent. Alternative models require upfront measurement of carbon stocks to initialise the model and are subject to ongoing validation protocols to maintain the models adequately capture on-ground changes. Precedents for this approach exist in Schedule 2 of the Draft *Estimation of Soil Organic Carbon Sequestration using Measurement and Models Methodology Determination 2021* where proponents can choose their own soil model and calibrate it with field data. Under Schedule 2, a subset of CEAs are sampled to test the model predictions and uncertainty discounts are applied to ensure that alternative models are accurate and conservative.

Alternative models can also be applied spatially, i.e., run for individual pixels, but in cases where proponents do not wish to invest in spatial capability, the simple stratified approach adopted in existing methods can be used.

Measurement approach

Proponents have the option to take field-based measurements in lieu of a national or alternative model. Examples include measured soil, and woody biomass inventory approach described in the Avoided Deforestation and Reforestation and Afforestation methods. Measurements should follow standard protocols to ensure consistency. These protocols are already available from the existing suite of methods and technical guidelines, but could potentially be further harmonised as part of a parallel work program.

When measurements cannot be assigned to a single pixel, as in the simple stratified approach, multiple measurements are conducted across homogenous strata and the average carbon stock for the strata is reported. Uncertainty discounts proportional to the measurement variability within the strata are used to ensure that abatement discounts are conservative. The decision to use measurement over an alternative accounting approach should be determined at project application/registration.

Net carbon abatement

Key principles:

- The net carbon stock change from all pixels (in the case of a spatial modelling approach) or from all CEAs (in the case of the simple stratified approach), across all management zones in the project area is summed to calculate the net carbon stock change.
- The total flux from all emissions sources is deducted from, or any net flux reduction added to, the net carbon stock change to calculate net carbon abatement.

Additionality

Key principles:

- Project activities must not have begun to be implemented before the submission of a offset project application, or formal notice of intent submitted to the Clean Energy Regulator.
- Project activities must not be required to be carried out by or under a Commonwealth, State or Territory law or be likely to be carried out under another Commonwealth, state or territory government program in the absence of registration under the Emissions Reduction Fund.
- Project activities must be an improvement on the land management activities conducted in the system during the baseline such that at least one of the activities is new or materially different from the equivalent activity conducted during the baseline. Comparison of planned activities to historical or 'risk-based' (forecast) land use simulations is a good way to demonstrate this.
- Land management strategies and associated records provide essential evidence to assess and ensure additionality.

Record keeping requirements

Key principles:

- As in existing methodologies, records are to be kept to evidence project implementation and compliance with the methodology and legislation.
- Must keep records of each land management strategy prepared for the project, including the initial and all subsequent revisions.
- Records that evidence the commencement land management activities that fall under one or more of the categories of eligible activities.
- If alternative models are adopted, the project proponent must make and keep records that describe the validation protocol, including all input data and how this was collected or derived.
- Records relating to the calculation of net abatement including information relating to disturbance events (such as type, date, area affected) and fuel use.

Monitoring requirements:

Key principles:

- Monitor for compliance with project operation, including the implementation of the land management strategy in the project area. If a land management strategy specifies additional steps to monitor a project, those requirements must be met.
- Monitor for any disturbance events.
- For the baseline and crediting period, the project proponent must determine, at least once a year, the number of livestock within each project area according to species, duration and livestock class. Where possible, numbers of non-domestic native and non-native feral animals are also reported.
- Undertake sufficient monitoring so as to be able to ascertain required inputs for any models. This monitoring is key to contributing to further development and refinement of the national model (see section 1.2 below).
- Data is to be collected in a consistent format and aligned with requirements for research and development.

1.2 Project Accounting Tools & Enabling Technology Work Program

Key principles

- Technology improvements are an ongoing, continuous process that should occur in parallel to method development.
- Changes to user interfaces should be prioritised under the Technology Investment Roadmap, including the development of a simplified ‘default’ model and a more comprehensive FullCAM public release, as well as a SavBAT-equivalent interface for carbon accounting for fire management.
- The development of standardised protocols for carbon stock measurement using new technologies will further reduce costs and improve project and national scale model calibrations.
- Measurement data and model inputs should be used to improve the national model, subject to a secure and privacy minded data sharing framework.

Much of the technical capability to implement the AL-MAP method exists today in FullCAM and the NGGI. Efforts to bring new functionality and improve access to existing features are encouraged and will increase the scope and extent to which FullCAM can be applied. Some existing capabilities that would markedly improve the implementation of the AL-MAP method include a public release of spatial FullCAM and a fire module that introduces a feedback loop between fire emissions and disturbance, vegetation growth and soil carbon processes. All other technologies are available today.

Making the existing capabilities of FullCAM more accessible is a priority work item to enable greater participation in carbon farming. The current SavBat portal provides a good example of how powerful technologies can be delivered in a way that bolsters the capabilities of land managers without requiring specialist expertise. In the first instance, creating tools that cater to a wide audience instance should focus on the default calibrations of the National Model, which can be applied at low cost to small scale (< 500 ha) and extensive (> 10,000 ha) projects. For proponents that prefer to develop specialist capability, or those that wish to invest in project specific calibrations, will require lower-level integrations with the FullCAM infrastructure such as an application programming interface (API) that expose the necessary data fields and parameter values to re-use the FullCAM infrastructure with alternative calibrations.

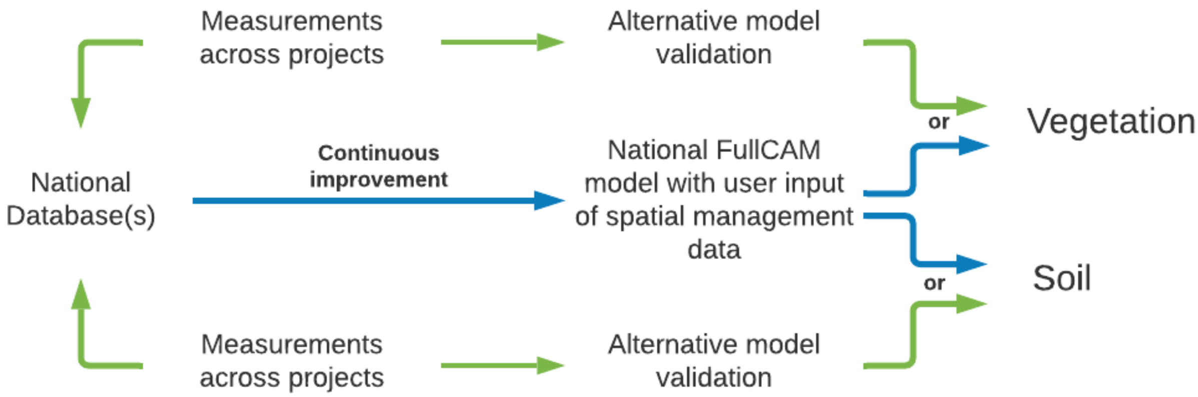


Figure 3. Proponents have the choice to use national FullCAM default model settings (blue), coupled with the required inputs regarding management and land use history, or to supply an alternative model (green) with supporting measurement data. In addition to validating the abatement estimates of the alternative model, the measurement data can be fed back into the national FullCAM model to continuously improve the default calibration.

Wherever alternative model calibrations are preferred, the measurements taken for calibration and validation should be conducted using standardised protocols that ensure consistency between projects. Because measurement technology improves rapidly, the development of standard measurement protocols is best undertaken outside the method development framework. Examples of standard sampling protocols include vegetation inventories (following the Avoided Clearing or CSIRO MaxBio sampling protocols), soil core sampling and analysis of carbon stocks using oxidative, chemical or spectroscopic techniques, and map accuracy assessment using photo points, drone surveys or aerial LiDAR acquisitions.

Measurement data collected to support alternative model calibrations is especially valuable to the ongoing calibration of NGGI layers, described in the Complimentary R&D section below. National databases will be required to facilitate a continuous improvement process where project data are able to be shared with research organisations, while maintaining the privacy of project proponents. Where raw measurements are synthesised into less sensitive, de-identified products these could be released under an appropriate creative common or commercial use licence to foster the advancement of model improvements by industry and academia.

Complementary reforms:

2.1 Phase 2: Expansion of Method Architecture

Key principles:

- Additional elements to whole-of-farm accounting can be brought online in subsequent phases of method improvement.
- Where future components of the method require further R&D this should be pursued in parallel

Five major emissions reduction activities that are not included in Phase 1 are a livestock supplements method for grass-fed/extensively managed livestock; a beef herd management method (for increased liveweight gain); reductions in enteric emissions from managing wild ruminant populations (e.g., camel, buffalo, wild cattle), improved management of farm waste streams and improved energy efficiency of on farm activities. Opportunity for further expansion to include additional management actions not currently included is encouraged.

At the time of writing, it is understood that DISER is soon to launch the LessGAS grant to better understand emission reductions associated with feed supplements for extensively managed livestock. It is reasonable to assume that the results of this grant program could be readily integrated into a module under the AL-MAP method. Recommendations from the Cooperative Research Centre for Developing Northern Australia suggest that increased investment in translating existing science of beef herd management can result in dramatic improvements in herd efficiency, increasing productivity and profitability while reducing emissions. The humane management of wild ruminant populations is also an effective means to curb emissions from enteric fermentation. It is assumed that such project types would readily overlap with soil and vegetation sequestration activities.

Alternative forms of emissions reduction include using waste-to-energy and waste-to-fertiliser bioreactors and energy efficiency improvements through the installation of such as the installation of solar power, or transition from diesel fuels. Including these additional management activities would provide an effective means for a ‘whole-of-farm’ account that positions the agricultural sector for a net-zero future.

2.2 Complementary R&D

As measurement data are fed back into the NGGI, improved calibrations may enable project proponents to use the national default model where previously alternative models were required. This process creates a positive feedback loop where proponents investing in carbon stock measurements, as part of the validation protocol of alternative models, receive a benefit in the form of reduced uncertainty discounts while also lowering the barrier to entry for small scale participation in carbon farming.

There are two major types of calibrations that are the active focus of ongoing research and development:

1. continental maps of existing and potential carbon stocks
2. activity specific rates of carbon change.

Improved calibration of existing NGGI layers

Historic and future measurements of vegetation biomass and soil carbon stocks will be incorporated into continental carbon maps that reflect the state of land management across Australia. These maps provide point-in-time snapshots across the country, using appropriate interpolation techniques, and will require periodic updates to maintain concordance with on-the-ground conditions. An annual update and review cycle enables project proponents to plan for any potential impacts that changes in the NGGI layers may have on carbon stock estimates of the National Model. Similarly, ongoing updates to NGGI climate data will enable proponents to accurately forecast potential abatement returns using the latest information available, rather than relying on long-term averages that may not reflect recent conditions.

Activity specific rates of carbon change

Adding new activities or improving existing FullCAM calibrations often require intensively focused measurements following standard protocols. At a minimum, calibrating activity specific rates of carbon change typically requires repeated measurements and additional management context, and adequate replication across a range of ecosystem types and environmental conditions. Examples include calibrating growth curves for environmental plantings, vegetation thinning interventions and the application of biostimulants on pasture productivity. Often, these calibrations benefit from a bespoke experimental design, and are undertaken infrequently, when there is a mature body of evidence to draw upon.

Appendices:

4.1 Literature review demonstrating support for emissions reduction activities

A summary of key scientific papers related to AL-MAP is below, with references attached.

Vegetation

The emissions reduction potential of establishing of new woody vegetation is well understood [1–3]. This can involve the cessation of activities that supress regeneration of new forests[4,5], as well as direct seeding[6,7] and the planting of tube-stocks or seedlings[8,9]. Equally important are maintaining and enhancing existing forests[10]. Ceasing clearing of vegetation cover allows woody vegetation to sequester additional carbon, as well as avoiding the loss of existing carbon stocks that would have occurred under a business-as-usual scenario[11,12].

Additional activities that improve the emissions reduction potential of existing and regenerating woody vegetation include the management and timing of grazing[13], management of feral animals[14], removal of weeds[15], protection from fire[16] and ecological thinning[17]. Livestock are known suppress regeneration until new vegetation is above browsing height (~1.3m for cattle). Reduced stocking levels during the early stages of regeneration enables vegetation growth and allows for greater recruitment of new vegetation[18]. Feral animals such as goats and deer[19,20], and competition from non-native plant species[21] are known to suppress the recruitment of new seedlings and can limit the growth of existing woody vegetation[22]. Changing fire regimes to low intensity or mosaic burns reduces emissions [23,24], and also results in increased survival and enhanced growth of woody vegetation[25,26] due to additional nutrient cycling[27,28] and reduced competition for limiting resources[29]. Similarly, ecological thinning of dense vegetation is an established practice to improve growth rates and enhance carbon sequestration by reducing competition between trees[30,31]. In a harvest context, optimising the timing and extent of tree removal can also reduce emissions and increase woody vegetation growth rates to enhance carbon sequestration[32].

Soil

Soil carbon stocks can be increased in two ways: by increasing the rate of carbon inputs from organic[33] and inorganic sources[34] and by preventing losses of existing carbon stocks in the form of atmospheric emissions[35] and erosion[36].

Agricultural sources of organic carbon include pasture, crops and manure[37]. In woody vegetation this can include leaf litter, coarse woody debris and deadfall[38]. Live vegetation in both contexts can release organic carbon into the soil as root exudates[39], often forming beneficial symbioses with mycorrhizal fungi and microbia to improve nutrient cycling and increasing productivity[40]. The subsequent proliferation of soil microbia and fungi in a healthy soil ecosystem can also increase soil carbon[41]. Increasing the productivity of vegetative biomass and reducing harvest offtake allows more organic matter to enter the soil carbon cycle[37,42,43]. Productivity can be increased by amending material soil deficiencies[44], sowing mixtures of species for improved pastures[45], pasture cropping[46], managing the timing and extent of grazing[47,48], and the modification of landforms for improved water infiltration[49]. Changing the timing and extent of grazing[43], retaining stubble[50] or converting to no tillage practices[50] can also allow organic matter that typically would've been lost from the system to enter into the soil carbon cycle.

There are two major classes of activities that prevent the loss of existing soil carbon stocks: retaining persistent vegetation cover[51,52] and improving soil water infiltration. Retaining vegetation cover slows down the decomposition of organic matter[35], extending the lifetime of carbon within the soil, as well as prevents erosion from wind and rain[36,53]. Similarly, improved water infiltration prevents soils from drying out and being lost from the property during large wind and rain events[54]. Mechanically redistributing soil through the profile can similarly move carbon rich soil out of reach of erosion events[55].

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4.2 Comprehensive list of management activities.

Eligible management activities under existing methods

implement a fire management plant to reduce fire frequency and intensity

undertaking planned burning to reduce emissions without decreasing sequestration

manage the structure and composition of the vegetative community to reduce fuel loads

permanently cease mechanical or chemical destruction, or suppression, of native regrowth

managing the timing and extent of grazing

managing feral animals in a humane manner

managing plants that are not native to the project area

establishing and maintaining woody vegetation on land that has been clear of forest for at least five years

addition of new vegetation species by direct seeding or tube stock

convert a short-rotation plantation to a long-rotation plantation

establish a new plantation forest on land that has had no plantation forest for seven years

establish and maintain a planting at a density sufficient for the trees to have the potential to achieve forest cover

planting of shelterbelts

manage the forest to maintain a structure and composition of the vegetative community of the IBRA bioregion

rescind a pre-existing vegetation clearing consent

maintain a native forest that is not cleared

applying nutrients to address a material deficiency

applying ameliorants to remediate acid soils

applying gypsum to remediate sodic or magnesic soils

undertaking new irrigation

improving pasture by seeding or pasture cropping;

establishing new pasture

using a cover crop to promote vegetation cover

retaining stubble after a crop is harvested

converting to reduced or no tillage practices;

modification of landforms for improved water infiltration

modifying landform to reduce erosion and soil compaction

mechanically redistribute soil through the soil profile

mechanically distributing biochar through the soil profile
using legume species
reduction of synthetic fertiliser use

Ancillary activities that might currently be ineligible under existing methods
ecological thinning of woody vegetation to reduce competition and improve growth rates
addition of new species by direct seeding or tube stock
infill planting using direct seeding &/or tubestock
be at risk of clearing
cessation of selective removal for timber or firewood
increased forest cover to increase input to dead wood pool
increased forest cover to reduce turnover of woody debris
using mycorrhizal fungi or biostimulants
applying non-nutrient soil amendments to improve water retention and nutrient absorption
optimising joining and weaning rates to increase reproduction
use of livestock feed supplements to reduce emissions intensity
planting improved pastures
improving herd genetics
modification of landforms to increase moisture retention