Submission: Independent Review of Australian Carbon Credit Units
September 2022
About Climate Friendly

Founded in 2003 by a CSIRO scientist, Climate Friendly is a profit-for-purpose company with a vision for a productive, sustainable land sector that contributes to a zero net emission Australia by 2050. We achieved our first target to support 20 million tonnes of greenhouse gas reductions at the end of 2020, and our purpose is to scale up to 100 million tonnes by 2025. We are one of the longest operating and most experienced carbon extension service providers in Australia. Our growing team of 65+ expert staff has supported registration of over 150 carbon projects since 2014. We partner with agricultural producers, foresters, Traditional Owners, conservation organisations and governments to design and implement these projects across approximately 10 million hectares of land.

Part 2: Technical rigour and integrity of ERF methods & projects

Each carbon farming method has its own set of detailed technical rules and guidelines. In this part of our submission, we provide an assessment in relation to the Human-Induced Regeneration (HIR) method and the HIR projects that we service, as these projects form a significant portion of our project portfolio and an important component of the ACCU Review Terms of Reference. **The data presented in this submission demonstrates that the HIR method has high integrity, rigour and an independent scientific basis, and the ACCUs issued to HIR projects we support have been credited on a conservative basis.**

Firstly, we note that commercial viability of land management practice changes has been the key driver of ERF project locations to date. This is shown below by reviewing Figure 1 and 2. Figure 1 shows projects overlaid with average land values (Data source: Rural Bank, Australian Farmland Values 2022). This highlights that land-based ERF projects have to date predominately been located in regions with lower land values (i.e. below $1000/per hectare, noting values for WA are not all available but in our experience also fall into this category in the regions were ERF projects are located). Figure 2 shows the ACCU price since 2015 (ERF Fixed & Optional Auctions, plus ACCU spot trades), compared to the New Zealand and European carbon credit unit prices. This highlights that the emerging ACCU market has been conservatively priced to comparable international markets, and that it only started to modestly increase in the later part of 2021 to spot prices consistently above $27. Some commentary on the ERF has inferred that the fact that most ERF projects are located outside high rainfall and biodiversity regions is due to the low integrity methods. However, in our view, low ACCU prices are the driver of project locations. At lower prices, it is only commercially viable to make land management practice changes on lower productivity and lower value agricultural lands. The increase in ACCU prices in 2021 also coincided with an increase in registrations of projects in higher value land areas (refer Figure 1 and increase of registrations in higher value lands in eastern Australia). As such, we suggest that a well-functioning carbon market underpinned by strong emissions reductions targets and comparable international carbon prices is the key to incentivising greater uptake of ERF methods in higher value land and higher biodiversity regions.

Figure 1: ERF project registrations pre and post July 2021 compared to median property values per hectare

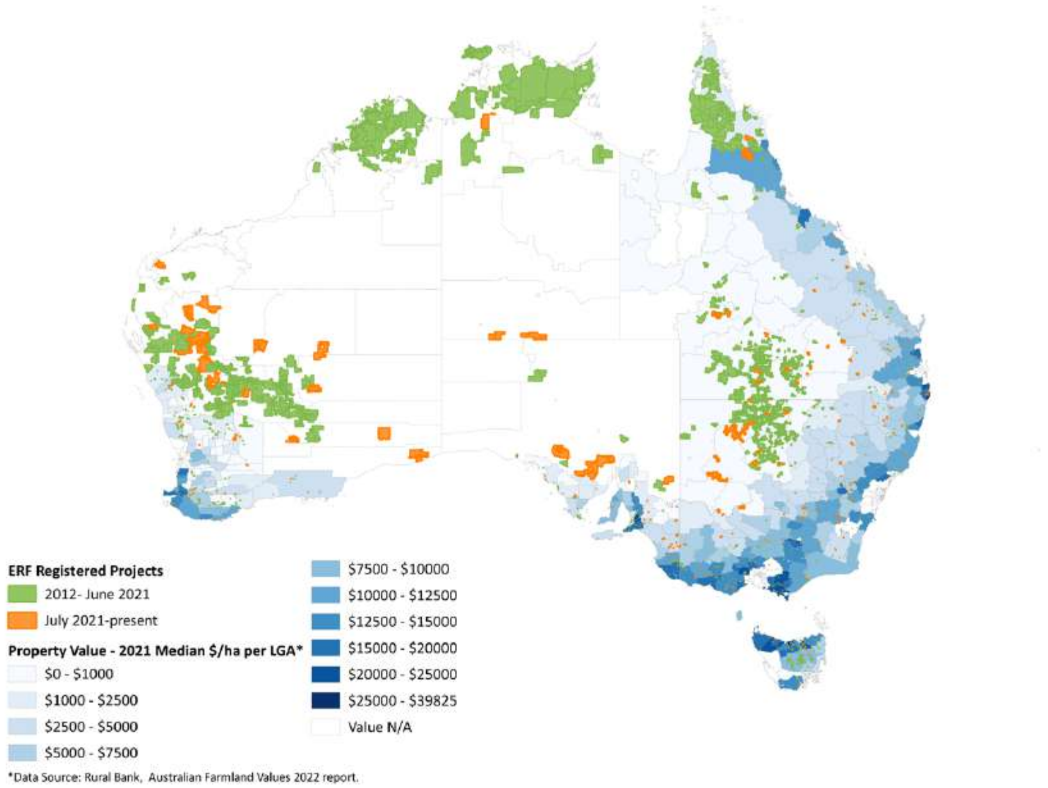
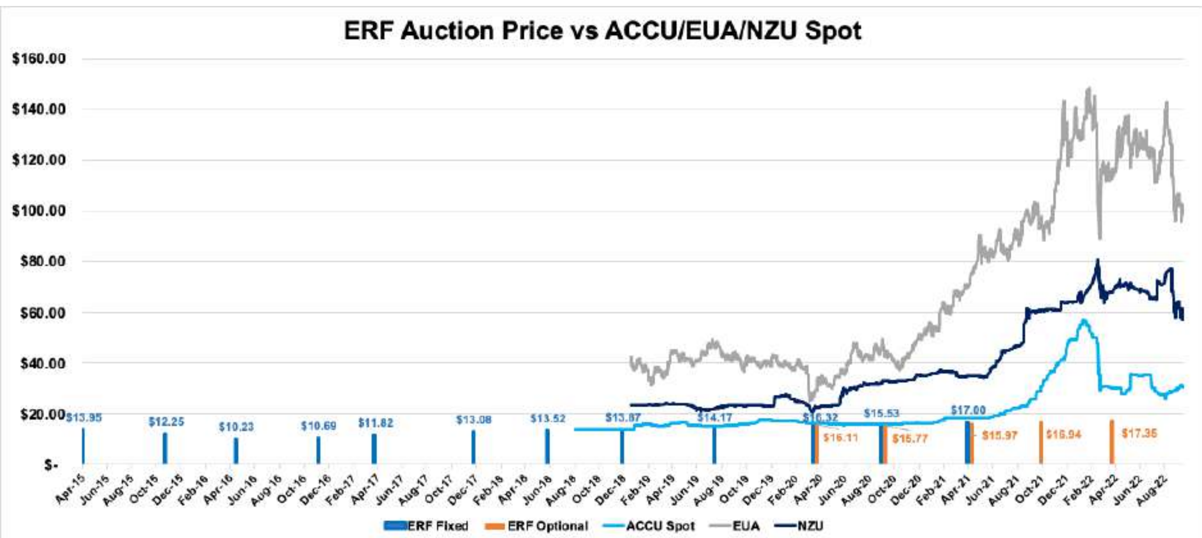


Figure 2: ACCU and international carbon price comparisons since 2015



Detailed analysis on Human-Induced Regeneration (HIR) Method

This section provides detailed analysis related to:

1. Recent claims raised about the HIR method; and
2. An assessment of the HIR method in relation to the offsets integrity standards.

Climate Friendly summarises the key concerns raised and our responses to these concerns through an analysis of the below questions:

1. Does grazing management suppress vegetation (woody biomass) in the rangelands?
2. Can vegetation in the rangelands achieve forest cover or are the rangelands regions unable to support forest cover?
3. Do HIR projects provide adequate evidence of suppression pre-project and evidence of the removal of suppression following project commencement?
4. Is removal of suppression leading to increase in forest cover in HIR project areas?
5. Are HIR projects over credited or conservatively credited when compared to actual abatement? Specifically, are pre-existing trees being credited, or does their presence in the project estimation areas create a risk of over-crediting, or are their sufficient controls to ensure pre-existing trees are accounted for and crediting is conservative?

Our analysis and the information provided in this submission demonstrates the following:

1. **Grazing causes degeneration and suppression of palatable vegetation**.
   - Livestock (e.g. sheep & cattle) and goats eat palatable woody vegetation.
   - This is supported by an extensive body of peer-reviewed science, as well as auditable project-specific data, and results in suppression of woody biomass.
   - 89% of projects involve multiple management changes to remove multiple forms of suppression which collectively have prevented forest regeneration in the past.
2. **The Australian Rangelands can form and sustain acacia forests and acacia open woodland forests which have greater than 20% tree canopy and store carbon**
3. **HIR carbon projects provide extensive evidence of project level suppression and regeneration following the removal of suppression to independent auditors and the Regulator.**
4. **There is a clear detectable trend of increasing forest cover in project areas that is correlated with management change to remove suppression factors (over-grazing, clearing and uncontrolled feral animals).**
   - Carbon projects should be viewed as *facilitating* the ongoing growth and survival of trees that has in fact been *triggered* by rainfall and other environmental conditions. They involve removing suppression agents which were stopping forests from regenerating (i.e. rain makes trees grow, land management changes remove inhibitors to growth).
   - There is no discernible difference in the rate forest regeneration between projects with avoided clearing compared to grazing management as the key practice change. This suggests that both are equally valid ways to sequester carbon.
5. **HIR projects are being issued ACCUs conservatively, and pre-existing trees are appropriately accounted for in abatement calculations.**
   - The quantum of issued ACCUs to projects we support is less than ground measurements of actual carbon stored carbon in the regenerating forest conducted by CSIRO.
   - FullCAM was calibrated with pre-existing trees in the calibration sites and the HIR method has several controls that restrict the possibility of any risk of over-crediting

Recommendations:

1. *Note the evidence of grazing, feral animal, clearing and other suppression of vegetation in the rangelands region where human-induced regeneration projects commonly occur*
2. *Note the evidence of land management practice changes and the consequent regeneration of the project implementation areas that has occurred in human-induced regeneration projects. Confirm that there is no evidence of fraudulent conduct, and that ACCUs issued from human-induced regeneration projects are based on credible science, have rigorous technical safeguards, and passed independent audits.*
3. *Note the conservative crediting of carbon abatement compared with actual carbon stored in HIR projects as verified through ground measurements*
4. *Note the substantial risk of plantation forests being cleared and not replanted, releasing carbon (refer Appendix 5, further information available on request)*
5. *Note the potential of the Integrated Farm Management method to scale up land-based carbon sequestration using the latest science and technology, informed by lessons from implementation of land-based carbon projects to date, and support finalisation of this method as a priority.*

1. Does grazing management suppress vegetation in the rangelands?

Summary:

- Livestock (e.g. sheep & cattle) and goats eat palatable woody vegetation.
- This is supported by an extensive body of peer-reviewed science, as well as auditable project-specific data, and results in suppression of woody biomass.
- 89% of the projects we support were subject to multiple forms of suppression in the project baseline and implement two or more management changes as part of the project to facilitate regeneration.

Rangelands properties in Australia are primarily used for grazing, with the main land tenure type in the region for NSW, QLD, WA, SA and NT being pastoral leases**.** Sheep and cattle are the predominant form of grazing, although more recently, there has been increasing presence of feral and domestic goats in southern QLD, NSW, SA and WA**.** There are a broad range of palatable tree species in the rangelands, as outlined in Appendix 1 and 2. When examining the feasibility for a HIR project, Climate Friendly's expert team assesses these palatable species for signs of suppression from grazing and feral animals.

Mulga, *Acacia aneura*, is one of the primary palatable native trees present in the semi-arid "mulgalands" which compose part of the Australian rangelands. Appendix 1 and 2 outline that the palatability of mulga to cattle is rated as "A" (Department of Agriculture and Fisheries, Queensland, 2022), and "High" for goats (Meat and Livestock Australia, May 2007). As the region is semi-arid, there is not consistent pasture or herbage during dry periods. Mulga has been known as the "standing haystack", as it is eaten by stock when the intermittent pasture diminishes or when there is insufficient pasture compared to total grazing pressure.

Continuous and/or heavy grazing of palatable species that are within reach causes a "hedging" or even a "bonsai" effect and can supress and even kill the plant. When the availability of palatable species runs out during drought periods, fodder harvesting, mechanical pushing, pulling, felling or lopping of higher trees commonly occurs to provide drought tolerant feed for cattle, particularly in QLD and NSW.

Peer reviewed science on grazing suppression:

There is an extensive body of peer reviewed scientific literature studying the degradation and suppression of native vegetation in the rangelands from grazing (refer to Appendix 3). A unique 90+ year case study of Koonamore Station in South Australia provides an extensive body of peer reviewed literature on both a) the ability of grazing to suppress vegetation growth and b) how changing practice to remove grazing suppression can deliver forest restoration. Below is a remote sensed image of the impacts of removal of suppression from Koonamore Station, where the profound change to vegetation is clear compared to the surrounding landscape which has continued to be grazed.

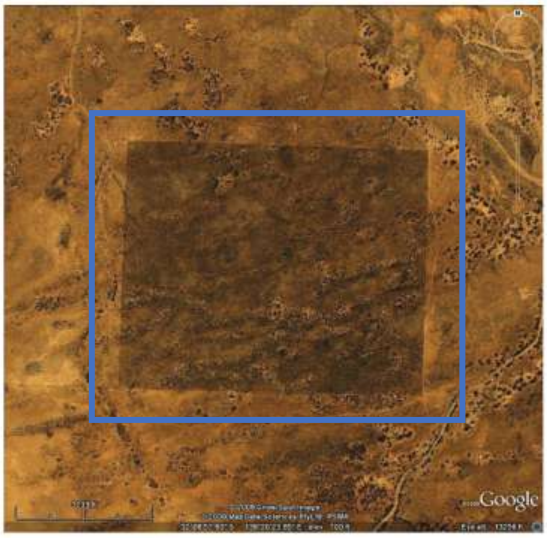


Fig. 1. Aerial view of the reserve, 2009.

Figure 3: Satellite imagery showing the long-term (90yr) effects of grazing management on the vegetation of the TGB Osborne Vegetation Reserve, Koonamore; SA. Materially more vegetation can be observed within the fenced area than in neighbouring properties. Sinclair R. and Facelli, J.M. (2019) Ninety years of change on the TGB Osborn Vegetation Reserve, Koonamore: a unique research opportunity. The Rangeland Journal 41(3): 185-187.

The practice changes implemented on Koonamore are akin to changes being undertaken as part of many HIR carbon projects, and this shows the potential long-term ability of these projects to regenerate the landscape.

Climate Friendly's approach to assessing grazing suppression:

At a project scale, Climate Friendly assesses the effect of grazing on the vegetation by integrating several data sets to compile and assess vegetation growth patterns compared to management practices and climatic drivers of regeneration (e.g. rainfall). Prior to assessing whether specific tree species are being suppressed, staff assess a range of key evidence to assess whether there has been consistent high grazing pressure that is likely to have resulted in suppression and degradation of forest cover. Our approach includes:

1. **High level satellite data:** Analysis of NCAS & SLATS datasets as well as aerial imagery to provide a broad indicator of forest cover change and/or suppression, to guide field data collection.
2. **Stock, trapping and sales records**: Project proponents provide third-party auditable evidence of historical numbers of stock and feral animals/pests through sales and stock rate records. These records are compared to safe grazing calculations to determine how frequently the stock rates have exceeded pasture availability.
3. **Safe-grazing calculator**: Climate Friendly has developed a 'Safe Grazing Calculator' to evaluate and monitor the likelihood of suppression occurring due to sheep and cattle grazing based on records of stock numbers compared to pasture availability. Pasture availability varies overtime according to rainfall and other factors. This indicates periods where livestock are likely to have supressed palatable vegetation. See discussion on question 3, provision of auditable evidence, for more information on our safe grazing calculator approach.
4. **Lack of ground cover**: High grazing pressure can be visible from satellite imagery of ground cover on properties in periods of low rainfall where the pasture body and herbage cover appears heavily grazed or largely absent.

5. **Browse lines**: Browse-lines manifest as uniformly top-heavy vegetation, where the absence of lower branches or foliage indicate that the specimen is being eaten but has reached a height that is out of browsing reach.
6. **Lack of young palatable species**: Properties with clear browse lines also often have a general lack of young age palatable species. This is an indicator of ongoing suppression.
7. **Sightings and density of ferals**: Site visits record the numbers of ferals (goats) sighted on properties, as well we evidence in scat densities or goat harvest and sales receipts.
8. **Heavy use of feed supplements:** Graziers often use feed supplements to promote digestion of less palatable species by livestock. A heavy reliance on feed supplements can therefore be a good indicator of suppression by livestock.
9. **Tree species:** the palatability of the tree species present in a region and on a property is considered to ensure the species have the potential to be suppressed and to form forest cover (refer to next section for further information on forest potential)

Cumulatively, these data and analyses provide important information needed to assess project eligibility and whether or not there has been historical grazing pressure that may have resulted in degradation and suppression. Where high grazing pressure is deemed likely, Climate Friendly then supplements this data and analyses with auditable property specific evidence of grazing impact on regeneration. This commonly includes photographic evidence of grazing suppression on the property. A collection of examples of photographic evidence of grazing-based suppression is presented below. This is a small set of photos from our portfolio to help visualise how grazing suppression looks on the ground. This includes evidence of:

1. **Hedging**: Hedge mulga (and less commonly other tree species) is formed by close and repeated grazing on the young mulga. This results in the trees being clipped into a consistent height, or hedge, from cattle or goats. The hallmarks are a very even height of the young shrub-formed mulga.
2. **Snapped or trampled stems**: Tall stems are often snapped where goats or cattle have reached up on their hind legs and brought down the stem to access the feed at the top. Or smaller trees are commonly trampled for easier access to the palatable vegetation. This is not just suppression on young regeneration, but also active degradation of trees that can contribute to forest cover.
3. **Other stunted growth formations**: the type of suppression commonly varies according to livestock type. Signs in thickened stems and ‘bonsai’ like growth of suppressed palatable vegetation are more commonly associated with sheep and goats. These formations show stunted growth forms with thick base stems, indicating browsing is suppressing regeneration.
4. **Grazing of bark**: Some species have palatable bark, such as Cypress. Eating of the bark can result in suppression or death of the tree. Signs of ringbarking of these species is an indication of degeneration and suppression of forest cover.
5. **Pushing and fodder harvesting:** In periods of drought, mature trees are often used by graziers as a feed stock. This is more prevalent on properties with high grazing pressure and suppresses forest cover.
6. **Fence line comparisons:** photographic evidence of suppression can also include comparisons of the condition between two different paddocks or properties which are separated by a fence. In this instance, the effects grazing management on one side of the fence leading to ongoing suppression is evident compared to an adjacent area of land that has different grazing and/or clearing patterns.

Photos 1 & 2: examples of "hedging" are identified in blue boxes. Palatable woody biomass in a paddock is kept at a consistent height. Shrubs are suppressed from regenerating to become trees due to constant grazing, typically by cattle and goats

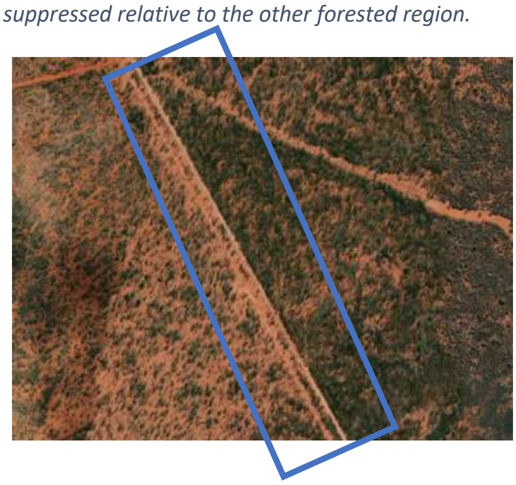
Photos 3 & 4: examples of snapped stems are identified in blue circles. These are typically caused by goats and cattle breaking higher stems to access growing tips, or through physical trampling.

Photos 5 & 6: examples of "Bonsai and thickened stems" are identified within the blue circles. This growth form is caused by continual grazing of individual trees, typically by sheep, keeping them in a 'bonsai' form with highly thickened stems

Photo 7: example of "Ring barking" identified in the below blue circle. This is generally caused when goats eat the bark off palatable trees.

Photo 8 & 9: example of "pushing trees and fodder harvesting" are identified in the below blue boxes. Mulga is often pushed to provide feed for livestock in drought periods, or to increase pasture.

Photos 10 & 11: examples of fence line comparisons in rangelands properties where HIR projects occur are identified in the below blue boxes. They highlight the impact of – different management regimes in regions that otherwise have the same ecosystem and climate conditions. One side of the fence is suppressed relative to the other forested region.



Projects typically involve multiple management changes to remove suppression:

Recent criticisms of the HIR method have focused on whether or not grazing is a valid suppression agent. However, in most HIR projects there are multiple suppression factors prior to project commencement. 89% of the projects we support involve two or more management changes, and over 70% of the projects also including changes to clearing practices. Typically, it is a combination of several interconnected historical factors and a package of management changes that combined lead to positive regeneration outcomes.

Table 1. Management change activities for 124 of Climate Friendly's projects.

Activity	No. Projects	Proportion of CF projects
exclusion of livestock	3	2%
manage feral animals	79	64%
manage timing and extent of grazing	114	92%
cease mechanical or chemical suppression	88	71%

Note that 89% of projects are undertaking two or more management activities.

2. Can vegetation in the rangelands achieve forest cover or are the rangelands regions unable to support forest cover?

Summary:

- The Australian Rangelands can form and sustain acacia forests and acacia open woodland forests which have greater than 20% tree canopy and store carbon

The definition of forest has been considered at length (*IPCC Special Report on Land Use, Land-Use Change and Forestry 2000*). The current use of a cover-based characterisation provides an objective and consistent definition of 'forest' that can be applied globally. The use of crown projective cover (CPC) above 20% was chosen to include both dense forests (closed canopy), in which virtually the entire land surface is covered by tree canopies, and woodlands (open canopy), in which the crowns of scattered trees or groups of trees may cover only some of the land surface. The inclusion of open woodlands is particularly important in the Australian rangelands context.

Acacia forests and Acacia open woodland forests, commonly found in the arid and semi-arid rangelands of Australia, have "forest potential", being composed of a number of species that attain height in excess of 2 m tall and canopy cover greater than 20%. Dominant species include lancewood (*Acacia shirleyi*), bendee (*A. catenulata*), mulga (*A. aneura*), gidgee (*A. cambagei*), brigalow (*A. harpophylla*), western myall (*A. papyrocarpa*) and blackwood (*A. melanoxylon*). Canopy species also include members of the box group of eucalypts (*Eucalyptus* section *Adnataria*) that exceed the 2 m height criteria. Many of these species are long lived and sequester substantial quantities of carbon, even as open canopy forest woodland[1].

There are many checks and balances to ensure that land which does not attain forest cover does not get credited. Coinciding with the 2019 HIR Method review conducted by ERAC, the Federal Government legislated an additional key regulatory change in 2019 required each project to attain forest cover by a specified date. If a project does not meet this requirement

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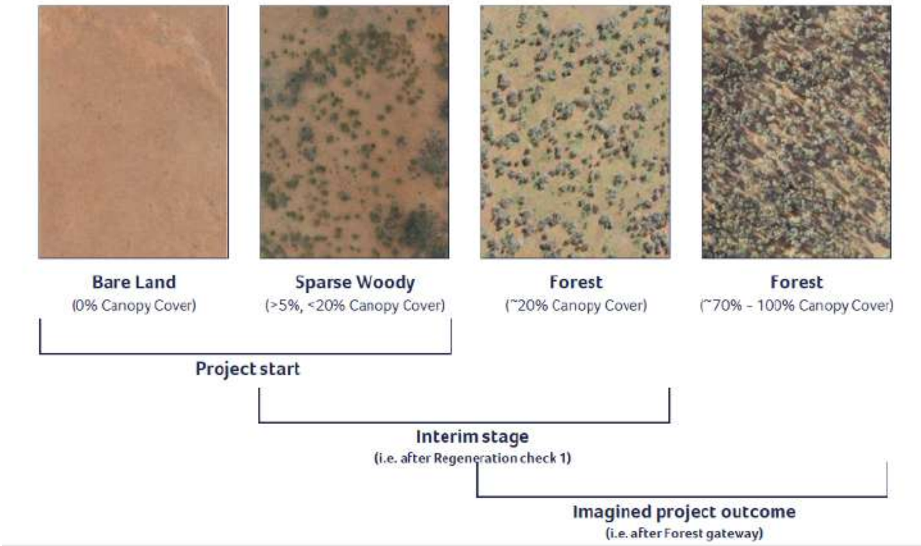
[1] Roxburgh, S. H., Karunaratne, S. B., Paul, K. I., Lucas, R. M., Armston, J. D., & Sun, J. (2019). A revised above-ground maximum biomass layer for the Australian continent. *Forest Ecology and Management*, *432*, 264-275.

no further credits will be issued on the portion that has not performed, and it will have to be removed from the project. In parallel, the Clean Energy Regulator introduced new technical guidelines on stratification, evidence and records for HIR projects. This included the introduction of gateway checks to ensure that projects were transitioning towards attainment of forest cover, in line with the intents and purposes of the HIR method. The threshold for the first regeneration check is ≥7.5% crown canopy cover (or crown canopy cover increases 5% over 5 years). Figure 4 below provides an illustrative example of forest cover transition in the rangelands towards "forest cover".

Figure 4: canopy cover stages and comparison to HIR carbon project gateways



Source: CMI Working Paper: Response to Research on HIR Method, HIR Method Review Sub-Committee, April 2022.

3. Do HIR projects provide adequate evidence of suppression pre-project and evidence of the removal of suppression following project commencement?

Summary:

- HIR carbon projects provide auditable evidence of project level suppression and regeneration following the removal of suppression to independent auditors and the Regulator.

Every HIR carbon project is audited by a *National Greenhouse and Energy Reporting Scheme (NGERs)* auditor. These auditors are approved by the Clean Energy Regulator and underpin the integrity of not just carbon project compliance, but also corporate emissions under the *National Greenhouse and Energy Reporting Scheme*. The auditors are themselves audited at regulator intervals by the Clean Energy Regulatory to ensure they are auditing correctly. The Clean Energy Regulator audit framework is also audited by the ANAO from time to time.

Every rangelands HIR project is audited at least three times over its life by these independent auditors to assess compliance with the legislation, with the first audit occurring prior to the first issuance of ACCUs. This includes assessing that there is evidence of suppression, including Climate Friendly's safe grazing calculator, field verification data and associated stocking records (see Box 1), and that there are enough juvenile and/or suppressed trees to grow to attain forest cover. This includes assessment of spatial mapping which must meet stringent map accuracy assessment requirements, field data, site visits and/or equivalent high-resolution data to validate the status and extent suppression and regeneration of specific areas delineated within projects. It also includes technical reviews of abatement calculations and an assessment of legal documentation, consents and management plans.

Box 1: Climate Friendly's Safe Grazing Calculator

Climate Friendly developed a 'safe' grazing calculator to monitor the impacts of grazing in both the 10-year baseline period and throughout project implementation. This calculator is used to assess stocking rates relative to pasture availability. The calculator uses inputs from stocking numbers and simulated pasture biomass, which is based on site-specific environment and climate data and calibrated to remotely sensed data. Stock data is obtained from quarterly monitoring reports provided by the land manager, and evidenced through auditable datasets, such as receipts. Stock classes are converted to a 'dry sheep equivalent' (DSE) figure based on standard conversion factors.

Safe grazing levels refer to the stocking of the property that will ensure sustainable pasture production, given the climatic and other conditions. Periods above "safe grazing pressure" indicate potential for suppression of vegetation, as livestock and goats will utilise the palatable vegetation in periods of limited pasture availability. By monitoring the likely availability of pasture, this enables us to advise land managers to alter stocking rates to prevent grazing from having a suppressing impact during the project period. This calculator, with accompanying third-party evidence and records related to stock, is used as to provide one part of the evidence base to demonstrate that vegetation was impacted in the baseline period and that management changes which comply with the HIR method have been implemented since project commencement.

While the safe grazing calculator uses environmental data specific to the project area, the calculator should still be considered an indicative model. Supplementary actions, such as purchase of feed, are not considered. The grazing calculator is just one input and source of integrated information used to both assess project eligibility and monitor ongoing impact.

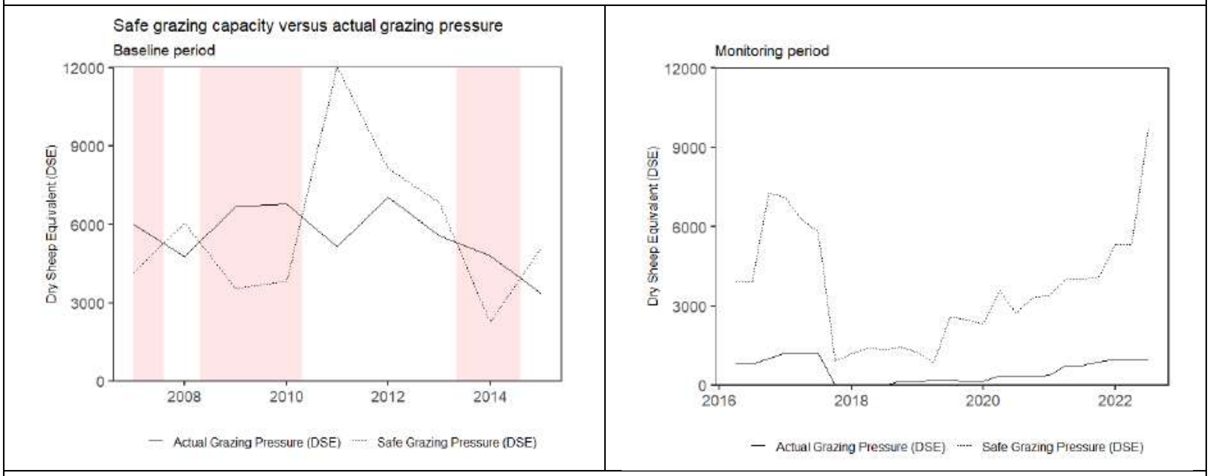


Figure 5. An example of a safe grazing timeseries for a project. In the baseline period, actual grazing pressure (dry sheep equivalent) exceeds safe grazing capacity, indicated by the red shading. This results in the depletion of pasture and grazing suppression of regenerating trees. In the project period, actual grazing pressure remains below safe grazing capacity and pasture levels are not depleted, ensuring that livestock do not graze regenerating trees.

The grazing calculator was initially derived from the following source: Johnston PW, Tannock PR, Beale IF (1996) Objective `Safe' Grazing Capacities for South-West Queensland Australia: Model Application and Evaluation. The Rangeland Journal 18, 259–269. It has been subsequently updated based on emerging datasets and research.

4. Is removal of suppression leading to increase in forest cover in HIR project areas?

Summary:

- There is a clear detectable trend of increasing forest cover in project areas that is correlated with management change to remove suppression factors (over-grazing, clearing and uncontrolled feral animals).
- HIR projects *facilitate* the ongoing growth and survival of trees that has in fact been *triggered* by rainfall and other environmental conditions. They involve removing suppression agents which were stopping forests from regenerating (i.e. rain makes trees grow, management changes remove inhibitors to growth).
- There is no discernible difference in the rate forest regeneration between projects with avoided clearing compared to grazing management as the key practice change. This suggests that both management changes are an equally valid way to sequester carbon.

Analysis of carbon estimation areas (CEAs) in similar properties with different project commencement times

Carbon projects should be viewed as *facilitating* the ongoing growth and survival of trees that has in fact been *triggered* by rainfall and other environmental conditions. The interplay between management changes and variable climate conditions can make it challenging to demonstrate the impact of project implementation.

Climate Friendly has attempted to account for these climatic conditions by assessing the performance of HIR projects over three La Niña periods with heavy rainfall. Our analysis includes a comparison of changes in sparse woody vegetation and forest cover within early and later projects in response to high rainfall periods (La Niña) and changes in management practice. The early projects implemented practice changes in the period of 2010-2013, following announcements from the Australian Government of their intention to create land-based carbon farming methods and to include provisions to recognise early action. Evidence of suppression and management changes, as previously described, are collected on both early and late projects, supporting that that suppression has been removed in early projects and continued in later projects. This evidence information has been subject to third party independent audits as part of project implementation. The early projects are in the same regions and rainfall bands as later projects that commenced carbon farming between 2017 and 2021.

This analysis based on NCAS forest and sparse woody classifications is detailed in Appendix 4. The figure below provides an overview of the results. The chosen time scale covers the three main La Niña periods from 1996 (see Appendix 4, Figure 6).

Figure 6: A comparison of forest regeneration in CEAs for 'early' and 'later' HIR projects supported by Climate Friendly shows a clear trend of increasing forest cover corresponding to the change in management for the early projects, and long term suppression during both multiple high rainfall La Niña periods and drought periods for later projects.

Note that NCAS "forest pixels" do not equate to "forest area" but are isolated forest pixels that can contain some larger pre-existing paddock trees. Pixels are classified as forest against a threshold of at least 20% crown canopy cover in the pixel. There must be at least three contiguous pixels for an area to constitute a "forest area" in line with internationally approved definitions of forest in Australia. All forest areas are removed from carbon estimation areas. We also note that Climate Friendly currently utilises Sentinel-2 satellite data which are higher resolution (10x10m pixels) for our human-induced regeneration project mapping, but these datasets are only available back to 2015. For the purposes of time series analysis, we have utilised two different versions of NCAS datasets (25x25m pixels) which are the only long run change datasets available. Further, the above analysis shows that carbon estimation areas contain less than 10% forest pixels at project start. We are not credited for these pre-existing paddock trees. All existing carbon stocks are removed from crediting and the presence of scattered trees is accounted for in the FullCAM model calibration.

The project CEAs of early projects display a clear increase in the growth of forest and in conversion from bare land to sparse woody vegetation, that aligns with the change to management practices. The rate of forest conversion seen here (to around 20% CEA on average) is aligned regeneration check guidelines (which require ~5% increase in canopy over 5 years or supplementary field evidence of regeneration and forest potential) and estimated forest attainment for this cohort of early projects, with some variation between individual projects expected depending on the initial conditions and degree of degradation.

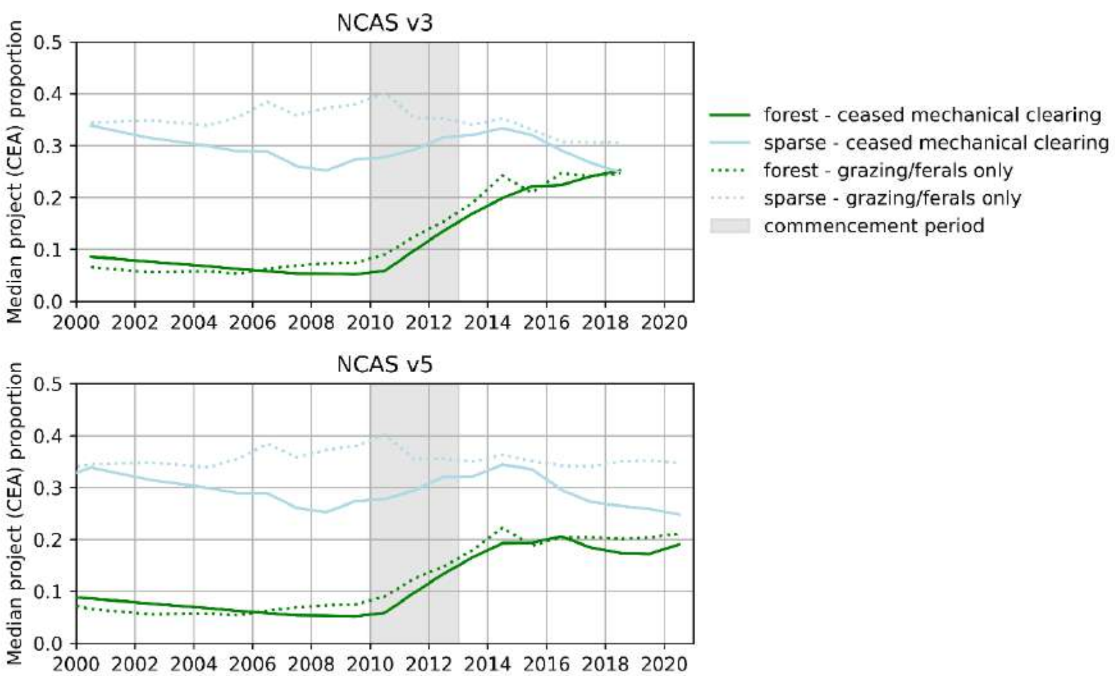
The areas of later projects which are now CEAs show a lack of regeneration over the same period, despite these areas being deemed as having 'forest potential', and despite there being sufficient rainfall through successive La Niña periods for these areas to transition to sparse woody or forest area in the earlier decades. This analysis indicates that CEA mapping is correctly targeting vegetation which has long-run suppression.

We acknowledge that current restrictions on data access mean that this analysis is not easily undertaken by external third parties. Refer to Part 1 of our submission which details our proposal to establish a National Integrated Land Database to help facilitate better analysis in the future, while providing appropriate privacy protections for individual land managers.

Comparison of different management changes: cessation of clearing vs changes to grazing management

Recent commentary on HIR projects has suggested that projects which involve changes in clearing practices are valid, while projects that involve changes in grazing management are problematic. Climate Friendly has completed a comparison of forest growth in carbon estimation areas that included cessation of mechanical or chemical clearing, and projects that only included changes to grazing management. The analysis concludes that there are very similar positive trends in forest regeneration rates in both projects with cessation of clearing and projects that include changes to grazing. The change in forest growth aligns with beginning of management change. This analysis suggests that the impact of grazing practices on suppression and restoration are in fact comparable to restoration due to ceasing land clearing. Further details on this analysis and the selection of projects can be found in Appendix 4.

Figure 7: The rate of forest restoration is consistent between HIR projects which involve changes to grazing management alone, when compared to projects that include a cessation of clearing.



Changes in land clearing practice, alongside changes in grazing management

Rangelands land managers commonly use a combination of grazing and land clearing to suppress the growth of woody vegetation. Land clearing can take many forms including broad scale conversion of forest to pasture, selective clearing within forest areas, repeated clearing of shrubs that have re-grown from past forest clearing and fodder harvesting. Some of these forms of clearing are readily detected with remote sensing, such as the conversion of forest to non-forest, while others are more cryptic and harder to detect remotely.

Land clearing as a suppression agent is relatively common in the rangelands of QLD and NSW, and less common in SA, NT and WA

Figure 8: Example of extensive land clearing in the rangelands (QLD)

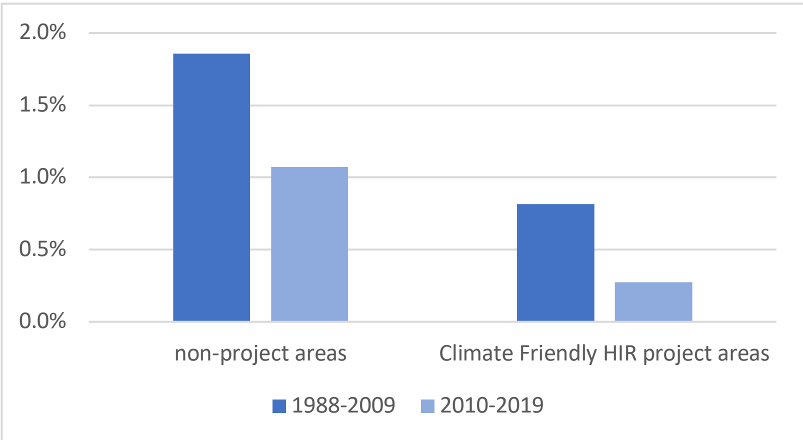
Recent commentary on the HIR method has also suggested that prevalence of clearing in the rangelands regions was low. Our analysis shows that prior to project commencement, there was a material volume of land clearing. It also shows that following project implementation, land clearing within project implementation areas (CEA) has ceased, in contrast to broader regional trends associated with clearing. Further, there is no evidence of within project leakage of clearing, instead rates have reduced across properties with carbon projects even in areas outside the implementation area. Carbon projects are required to commit to store sequestered carbon for a period of 25 or 100 years. This permanence obligation is in contrast to grazed properties not covered by carbon projects and eliminates risks of land clearing in future years.

Climate Friendly completed this analysis of the loss of woody canopy cover within our QLD projects. We used the Statewide Landcover and Trees Study (SLATS) mapping data which detects the location and extent of woody vegetation loss each year. While SLATS mapping data exist for NSW, the detection of disturbance to woody vegetation in NSW appears to be sensitive to changes in the technology and data over time (i.e. it is difficult to conduct time series analysis comparing changes across years in NSW). This means that a consistent comparison of disturbance patterns over long timespans is more difficult to achieve in the rangelands in NSW, hence the focus on QLD.

Registered HIR projects include carbon estimation areas (CEAs) and exclusion areas. Exclusion areas include baseline forest and non-implementation areas that either don't have forest potential or that were excluded from the management change at project start. Assessing clearing rates within project boundaries tests for "leakage" to ensure that any clearing on exclusion areas does not offset changes made in the project. It is important to note that some clearing and thinning is allowed to continue in excluded areas within HIR projects area provided that the levels are not greater in those areas than had generally occurred during the baseline period. Such clearing is often undertaken to maintain fire breaks and road access infrastructure.

When assessing change in clearing rates, we compare two broad time periods: 1988-2009 prior to the implementation of carbon farming projects, and 2010-2019, during which project activities progressively occurred (noting projects had different start dates, which means some clearing in project areas is attributable to the fact that projects had not yet begun to be implemented). We compare the relative change in clearing rates of project and non-project areas over time. The maximum annual clearing rate of all non-project areas declined by 42% between the periods of 1989-2009 and 2010-2019 (Figure 9). A larger reduction of 66% was observed in HIR project areas. Further, the maximum observed clearing rate in non-project areas remains higher (1.1% p.a.) than in HIR project areas (0.3% p.a.).

Figure 9. Comparison of the maximum annual rate of clearing before and after HIR projects commenced.



We note that while a regional clearing level in non-project areas of 1.1% or a pre-project clearing level of 0.8% may sound small, this constitutes a material volume of clearing potential over a 25-year project period. If conducted on an annual basis, this could result in up to 25% of a property being cleared over the life of a project. We note that maximum clearing rates tend not to occur on an annual basis, but are more cyclical based on periods of drought. As such, a range of 5-15% is more likely to represent the historical clearing risk in the rangelands region. While reductions in clearing provide a clear benefit maintaining mature forest and stored carbon in the landscape, these avoided emissions from cessation of clearing undertaken as part of HIR project management changes are not credited.

5. **Are HIR projects over credited or conservatively credited when compared to actual abatement? Specifically, are pre-existing trees being credited, or does their presence in the project estimation areas create a risk of over-crediting, or are their sufficient controls to ensure pre-existing trees are taken into account and crediting is conservative?**

Summary:

- FullCAM was calibrated with pre-existing trees in the calibration sites and the HIR method has several controls that restrict the possibility of any risk of over-crediting
- Modelled carbon stocks reported for HIR projects focus on a narrow set of eligible carbon pools and are discounted before crediting, following the Offsets Integrity Standard of Conservativeness.
- HIR projects are being issued ACCUs conservatively, and pre-existing trees are appropriately accounted for in abatement calculations.
- The quantum of issued ACCUs to projects we support is less than ground measurements of actual carbon stored carbon in the regenerating forest conducted by CSIRO.

Concerns have been raised that pre-existing trees are resulting in an over-estimate of abatement due to how FullCAM and the method is applied.

Carbon projects CEAs do include pre-existing mature trees. In fact, without these trees, the CEAs would generally not have the viable seed bank required for regeneration to occur. This was well known when the method was written. If all areas with any existing trees were ineligible, human-induced regeneration would not be ecologically possible. Equally, the method requires that there is evidence of forest potential in the form of regenerating trees that are suppressed from growing towards maturity for land to be eligible to generate carbon credits.

The calibration process of FullCAM is well documented[2],[3]. Sites used to calibrate the sequestration rate of natural regeneration included pre-existing trees (median carbon stocks of 6.3 tC/ha). Therefore, the application of FullCAM on sites with pre-existing trees that do not meet the definition of forest is valid.

The key question is whether the impact of pre-existing mature trees on estimates of abatement are accounted for within method deductions and modelling equations. Our analysis shows that there are multiple restrictions in the method and FullCAM application mitigate any concerns that the presence of mature trees might lead to over-crediting.

[2] Paul & Roxburgh (2021) Verification of FullCAM's Tree Yield Formula for Regenerating Systems. *CSIRO*.
[3] Paul & Roxburgh (2020). Predicting carbon sequestration of woody biomass following land restoration. *Forest Ecology and Management*, *460*, 117838.

Are models of abatement conservative?

FullCAM is the key modelling tool used to estimate abatement for HIR projects. The method only credits abatement from a narrow range of carbon pools on these projects that are known to store carbon. The method also includes a range of discounts from calculated abatement, to ensure conservatism. Climate Friendly believe the narrow range of eligible carbon pools, coupled with discounting prior to crediting, results in substantial under crediting when compared to the actual volume of carbon sequestered or emissions avoided on these projects that result from the management change.

When considering the claims of over-crediting, we feel it is important to note the range of abatement sources on the ground that are presently not eligible to generate carbon credits.

Present sources of on the ground abatement that are not eligible for carbon credits under the HIR method include:

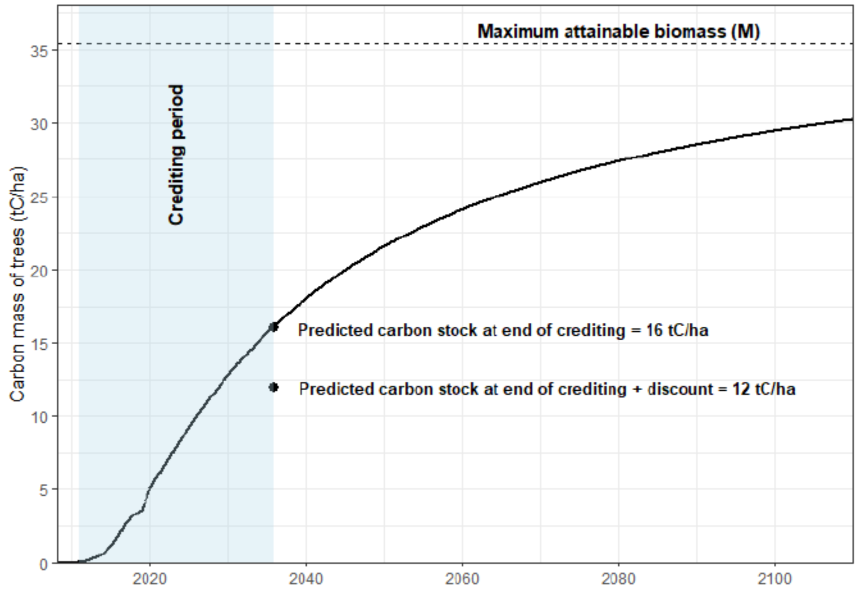
1. Regeneration of suppressed trees in the project areas that have over 20% tree cover at project commencement,
2. Regeneration of shrublands that are unable to attain forest cover.
3. Standing deadwood is not currently included in modelled abatement.
4. Decay rates of dead wood are assumed to be 7-11 years, when field research suggests they are in fact many decades. This reduces eligible abatement.
5. Soil carbon stored in projects is ineligible.
6. Reduced methane emissions from lower stock densities is ineligible for most properties.
7. Avoided emissions from changes in clearing practices, as covered in the section above.

The reason these additional forms of abatement were ineligible in the HIR method is in large part due to when the rules where developed. The HIR method was developed during the Kyoto Protocol period which had a detailed set of accounting rules based on specific activities. This led to the development of discrete methods covering a sub-set of carbon pools and specific activities. These rules have been updated the Paris Accord, which takes a more holistic approach to carbon accounting across a landscape.

Carbon projects also are also generally deducted another 25% of modelled abatement due to a 5% risk of reversal buffer and a 20% permanence discount for projects with a 25-year permanence period (Figure 10).

Combined, the HIR method leads to highly conservative crediting of abatement compared to on ground management changes and impacts. While consistent with the Offsets Integrity Standards, it is likely that the current crediting approach is overly conservative and in our view in fact leads to under-crediting of changes implemented by land managers.

Figure 10. Example of the Tree Yield formula underpinning FullCAM models of natural regeneration. Maximum attainable biomass (M) is converted from tonnes of aboveground biomass to tonnes of total carbon stored in trees. The eligible abatement of HIR projects is calculated at the end of the 25 year crediting period. Eligible abatement is calculated as the predicted 25 year carbon stock, less any initial carbon stocks, risk of reversal buffers or permanence discounts. In this example, the eligible abatement is 34% of M. Growth toward M is shown to asymptote (i.e. slow down) over the long-term.



Does FullCAM and its application under- or over-credit abatement on the ground?

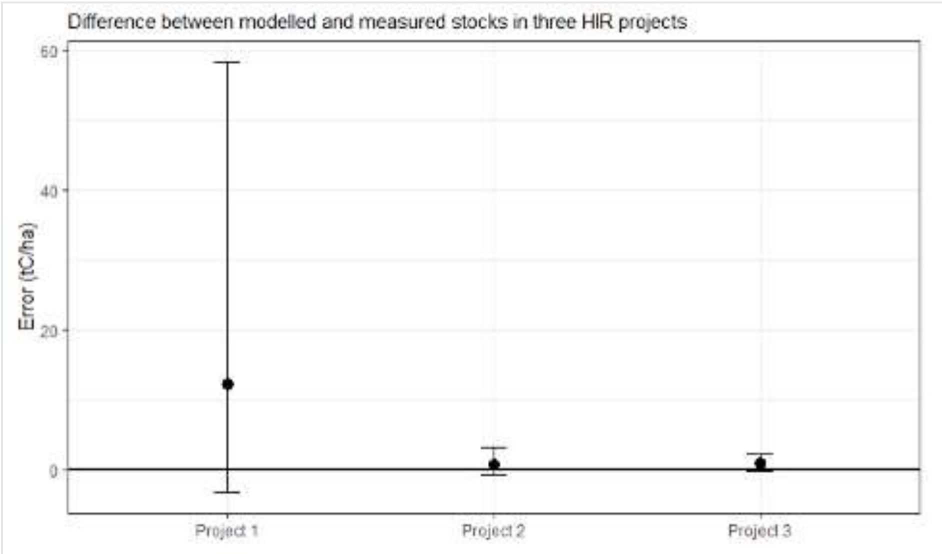
Climate Friendly notes the proposed inclusion of an option for validation measurement in the Integrated Farm Management method which is currently under development. We support the inclusion of this option, which will enable land managers to receive credits in line with actual impacts of their management changes, which we believe are currently in excess of the abatement modelled by FullCAM.

Our analysis in Figure 11 below demonstrates this conservatism using measurements taken by CSIRO on a sub-set of our projects and comparing the measurement to carbon abatement modelled on the same projects using FullCAM.

CSIRO collected 81 validation transects in 2021 located within carbon estimation areas on three HIR projects in Climate Friendly's project portfolio. Plots were chosen by CSIRO to reflect a range of suppression, clearing and regeneration histories. Following the calibration protocol of the Tree Yield Formula, remnant or pre-existing trees are excluded to obtain a measurement of carbon stocks associated with regeneration following project management change. The upper size limit for regeneration is described in Paul et al (2021)[4].

[4] Paul & Roxburgh (2021) Verification of FullCAM's Tree Yield Formula for Regenerating Systems. *CSIRO*.

Figure 11. Comparing measured and modelled carbon stocks associated with regeneration demonstrates that modelled carbon stocks are conservative, even before discounting is applied. Error is calculated as the measurement minus the modelled carbon stock for each of 81 transects across three projects. The point is the mean error and the lines show the range of errors within each project. Values above zero show that measured stocks are above modelled stocks.



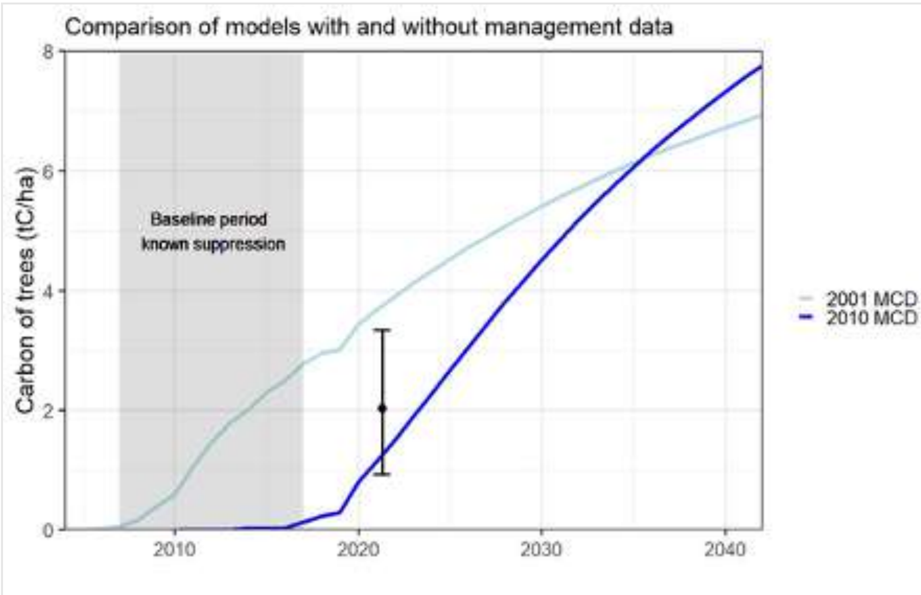
FullCAM models were created by Climate Friendly following the HIR FullCAM Guidelines to calculate the eligible project abatement. These models reflect the project stratification, management history and the ecosystem dynamics of rainfall driven episodic recruitment. Climate Friendly's abatement modelling has been reviewed by an external auditor. We consistently observe measured biomass is greater than the modelled biomass used to calculate eligible carbon credits under HIR.

Pre-existing or remnant trees are not included in transect observed biomass. Therefore, this comparison demonstrates that FullCAM is conservative when used to estimate carbon stocks associated with regeneration. Presence of remnant vegetation within CEA areas does not appear to result in over-crediting.

Are management changes being modelled correctly?

In the analysis of Paul et al (2021) a second set of FullCAM models were generated that assuming regeneration occurred without suppression. The purpose of this model was to locally validate the Natural Regeneration calibration of FullCAM, but it is illustrative to demonstrate the importance of including auditable, time series management data in modelled estimates of abatement.

Figure 12. Comparing two different approaches to modelling – one with (dark blue) and one without (light blue) detailed management information on a single property. The last known clearing event was in 2001. The model without management information assumes that trees grew unsuppressed following clearing, using a model commencement date (MCD) of 2001. The model with management information assumes an MCD of 2010, following the first major rainfall event following clearing. The black point and lines show measured carbon stocks taken in CSIRO transects. The model with management information is a good and conservative fit compared to measured carbon.



This analysis demonstrates how detailed, site specific local management information is key to appropriately modelling eligible abatement. Detailed management data is submitted as part of every project offset reports but is unavailable to external researchers and analysts. See Part 1 of our submission for further information on how this might be rectified through a National Integrated Land Database with appropriate land manager privacy protections.

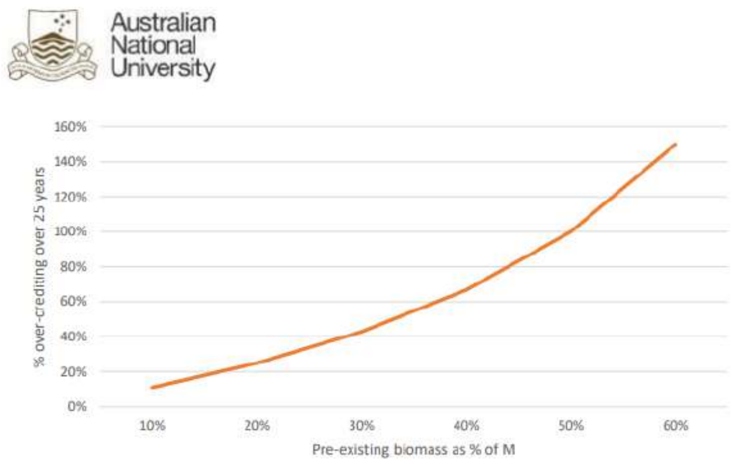
In Figure 12, the model with management information is an example of how Climate Friendly models carbon abatement using FullCAM and detailed timeseries management and rainfall data across our HIR portfolio. Because the CEA was heavily stocked during the baseline period (until 2017) the growth of regenerating trees was suppressed. Growth pauses are applied in the model to reflect this. The land manager decided to commence a carbon project in 2017 and made management changes to remove the suppression of regenerating trees, allowing the vegetation to then grow unsuppressed.

The measurements of regenerating biomass, taken by CSIRO in 2021 correspond with our modelling approach showing that the modelled abatement is conservative compared to the actual regenerating carbon stocks. The model assuming unsuppressed regrowth since last clearing event is inconsistent with observed regenerating carbon stocks.

Are pre-existing trees adequately accounted for in calculations of eligible abatement?

MacIntosh et al. (2022) Integrity and the ERF's Human-Induced Regeneration Method: The Measurement Problem Explained; *Australian National University* use the following graph to communicate their concern regarding potential risk of over crediting projects due to existing woody vegetation at the commencement of projects.

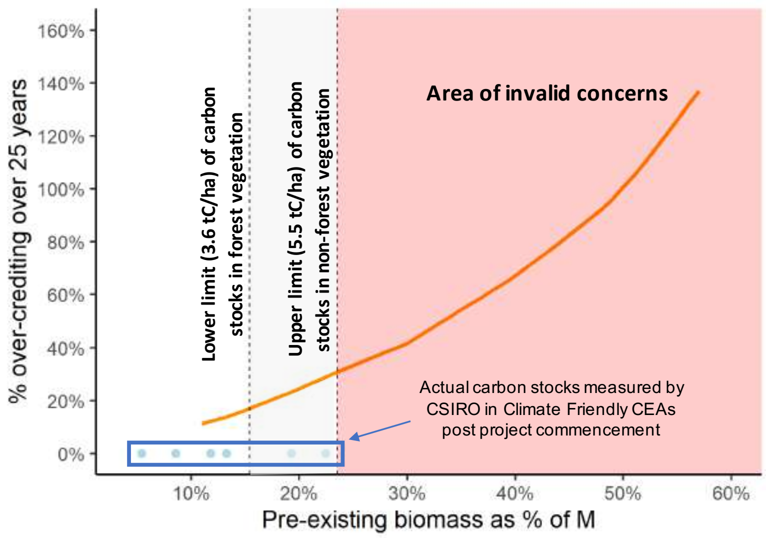
Figure 13. Reproduced from MacIntosh et al.



Lamour et al. (2018)[5] cite the theoretical maximum biomass corresponding to forests with over 20% cover. Stands are found to have carbon stocks between 3.6 and 5.5 tC / ha at forest attainment.

The HIR method requires that areas of baseline forest are excluded. This means that HIR carbon estimation areas must have less than 20% cover. By logical extension, CEAs must have less than 5.5 tC / ha. Figure 14 overlays these constraints on Figure 13 to highlight the overstatements around any potential over-crediting risk.

Figure 14. Key data points overlaid, with reference to measured carbon stocks in Climate Friendly Carbon Estimation Areas. Concerns raised regarding over crediting due to pre-existing trees do not appropriately factor in existing scheme controls.



[5] Larmour, J., Davies, M., Paul, K., England, J., Roxburgh, S. (2018) Relating canopy cover and average height to the biomass of the stand. Report prepared for the Department of the Environment and Energy. CSIRO Land and Water, Canberra.

The first key point missed by MacIntosh et al. is that all areas with greater than 20% canopy cover at commencement are ineligible and must be removed from the CEA. This is ensured via stringent technical guidelines outlining required accuracy of mapping forest areas. Analysis of maximum biomass (M) in the regions where Climate Friendly supports HIR projects show that areas below the forest cover threshold must be below 24% of M. This is the line represented as the Upper Limit (5.5 tC / ha) of carbon stocks in non-forest vegetation in Figure 14. We stress that this is the absolute theoretical maximum potential for over-claims and would require every project CEA to have 19.99% canopy cover and have the most carbon dense relationship between canopy area and total carbon stocks possible. In our experience, a project with this level of canopy cover would not pass independent audit. A less dense canopy area-to-carbon stock relationships, which would be common in the rangelands, would mean that areas just below the forest cover threshold would be at most 15% of M. Again, this is a theoretical maximum and this is represented as the Lower Limit (3.6 tC / ha) of carbon stocks in forest vegetation in Figure 14.

In fact, actual regenerating carbon stocks measured and reported on Climate Friendly CEAs are significantly lower. The dots overlaid on the graph show actual CSIRO measurements of regenerating biomass, estimated using tree size inventory and allometry. These observations were made after project commencement, with some of the sites measured already having several years of project implementation. All measured stocks were still below 5.5tC threshold at this point in project implementation and, as per analysis in the above section, there has been no over-crediting of biomass compared to actual carbon stored.

Future method development

Summary:

- Note the potential of the Integrated Farm Management method to scale up land-based carbon sequestration using the latest science and technology, informed by lessons from implementation of land-based carbon projects to date, and support finalisation of this method as a priority.

Tackling climate change will require significant scale up of carbon storage in the land sector, as identified by the IPCC in its latest report. New methods should build on experience and successful implementation of land-based carbon method, such as the HIR method, to date. They should also address barriers to participation.

Climate Friendly believes the continued development of the Integrated Farm Management method, which is currently in early stages of co-design, should be prioritised to achieve this goal. This holistic agricultural production and land management method establishes can establish a Paris-aligned 'whole-of-landscape' accounting framework combining vegetation and soil methods to allow land managers to implement multiple carbon farming activities on a single property. This would enable increased participation of smaller land managers in the ERF, scale up participation in higher rainfall regions which typically have smaller farm sizes and mixed-farming enterprises, and in general significantly scale up carbon abatement and ACCU supply nationally.

This method should be informed by the Blueprint which was developed with input from carbon, agriculture, technology, resources and conservation sectors, with inputs from Traditional Owner groups, State and Federal Government and researchers and is available here: https://carbonmarketinstitute.org/app/uploads/2021/08/AL-MAP-Method-Blueprint_final.pdf.

Appendix 1: Palatability of rangelands species to cattle

Excerpt from (Department of Agriculture and Fisheries, Queensland, 2022), showing the palatability of various native vegetation to cattle.

Common name	Palatability	Nutritive Value	Comments
Currant bush	C	B	Not readily eaten
Desert gum or cabbage gum	B	B	Eaten fairly readily
Doolan	B	B	May be toxic to hungry stock
Gidyea	C	B	Not much in the area. Best to feed by fire to lift acceptance. Good results if eaten
Green wattle	X	X	Not touched by cattle
Ironbark	B	C	Eaten fairly readily when supplemented with urea/molasses
Kurrajong	A+	A	Has laxative effect. Very palatable and one of the best to feed
Leopardwood	A	A	Well eaten - short supply
Limebush	C	B	Young plants are unpalatable
Mimosa bush	B	A	Grazed by sheep
Mulga	A	B	Well eaten and a plentiful supply in south-west Queensland. Dense stands make easy pushing and cutting
Myall	A	B	Well eaten
Myrtle tree	B	B	Readily eaten by sheep and cattle
Old man saltbush	A+	A+	Self harvested
Plumwood or true sandalwood	A+	A+	Short supply
Popla box	C	C	Eaten if nothing else

Appendix 2 Palatability of rangelands vegetation species to goats

Palatability of an excerpt of "weeds" to goats (Meat and Livestock Australia, May 2007).

The palatability of weeds (not necessarily endemic to Australia) to goats when weeds are grown in Australia.

Botanical name	Common name	*	Botanical name	Common name	*
Acacia aneura	*mulga*	H	*Asclepias curassavica*	*redhead cotton bush*	N
Acacia escelsa	*ironwood*	M	*Asphodelus fistulosus*	*onion weed*	N
Acacia farnesiana	*mimosa bush*	M	*Atalaya hemiglauca*	*whitewood*	H
Acacia glaucescens	*coastal myall*	T	*Atriplex spp*	*saltbush*	M
Acacia karoo	*karoo thorn*	L	*Atropa belladonna*	*deadly nightshade*	T
Acacia mearnsii	*black wattle*	H F	*Avena spp*	*wild oats*	H
Acacia nilotica	*prickly acacia*	M	*Baccharis halimifolia*	*groundsel bush*	H
Acacia homalophylla	*yarran*	M	*Bambusa spp*	*bamboo*	H R
Acacia paradoxa	*kangaroo thorn*	M	*Bidens pilosa*	*cobblers peg*	H
Acaena ovina	*sheeps burr*	M	*Brachychiton populneum*	*kurrajong*	H
Acetosa sagittata	*turkey rhubarb*	H	*Brassica tournefortii*	*wild turnip*	H
Aconitum napellus	*monkshood*	T	*Bromus diandrus*	*great brome*	H R
Acroptilon repens	*hard head thistle*	M	*Brugmansia candida*	*angels trumpet*	T
Aesculus	*horse chestnut*	M	*Bursaria spinosa*	*jimmy burn*	H
Agapanthus spp	*agapanthus*	L	*Buxus spp*	*box hedge*	M
Agave spp	*century plant*	L	*Caesalpina spp*	*bird of paradise*	N
Ageratina adenophora	*crofton weed*	M	*Calicotome spinosa*	*spiny broom*	M
Ageratum houstonianum	*blue billygoat weed*	M	*Callitris columellaris*	*cyprus pine*	H
Ageratum riparia	*mistflower*	M	*Callitris endlicheri*	*black cyprus pine*	H
Ailanthus altissima	*tree of heaven*	L	*Calotropis procera*	*rubber bush*	N
Alhagi pseudalhagi	*camel thorn*	M	*Cannabis sativa*	*indian hemp*	H
Allium triquetrum	*three corner garlic*	L	*Capparis mitchellii*	*white orange*	H
Allium vineale	*wild garlic*	L	*Capsella bursa-pastoris*	*shepherds purse*	M
Alternanthera pungens	*khaki weed*	L	*Cardiospermum spp*	*balloon vine*	N
Amaranthus spp	*amaranth*	M	*Carduus nutans*	*nodding thistle*	M F
Ambrosia artemisifolia	*annual ragweed*	M	*Carduus pycnocephalus*	*slender thistle*	M F
Ambrosia confertiflora	*burr ragweed*	M	*Carex spp*	*sedge*	M F
Ambrosia psilostachya	*perennial ragweed*	M	*Carthamus lanatus*	*saffron thistle*	M F
Ambrosia tenuifolia	*lacy ragweed*	M	*Carthamus leucocaulos*	*glaucous star thistle*	M F
Ammi majus	*bishops weed*	M	*Cassia artemisioides*	*silver cassia*	L
Amsinckia spp	*amsinckia*	N	*Cassia eremophila*	*punty bush*	N
Andropogon virginicus	*whisky grass*	M R	*Cassia floribunda*	*smooth cassia*	M
Angophora spp	*angophora*	M H	*Cassinia arcuata*	*sifton bush*	L
Anredera cordifolia	*madeira vine*	L	*Casuarina cristata*	*belah*	H
Apophyllum anomalum	*warrior bush*	H	*Cenchrus echinatus*	*Mossman river grass*	M R
Araujia hortorum	*mothplant*	M	*Cenchrus spp*	*spiny burrgrass*	M R
Arctotheca calendula	*capeweed*	H	*Centaurea melitensis*	*cockspur*	L
Argemone mexicana	*Mexican poppy*	N	*Centaurea nigra*	*black knapweed*	M
Aristida spp	*wire grass*	M	*Centaurea solstitialis*	*st Barnaby thistle*	M F
Asclepias spp	*cotton bush*	N	*Cestrum parqui*	*green cestrum*	T

Appendix 3: Key references related to grazing suppression in the rangelands

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Appendix 4 – Detailed analysis on how management changes to remove suppression agents have impacted forest regeneration in carbon estimation areas

Purpose: to assess the impact of removal of suppression agents on forest regeneration in early HIR projects supported by Climate Friendly.

Summary:

- Regeneration of woody vegetation in CEAs is related to management change, not rainfall alone.
- Indicative evidence of regeneration and suppression is broadly consistent with estimates of safe grazing exceedance.
- Suppression and regeneration of woody vegetation in CEAs was not notably different for rangeland areas with higher and lower productivity.
- Suppression and regeneration of woody vegetation in CEAs was not notably different for projects that ceased mechanical or chemical suppression compared with those that only altered the management of stock or feral animals.

Introduction:

Overview

The CFI has been operating for nearly a decade and there is an increasing body of data and information available to evaluate the on-ground impact of Human-induced Regeneration (HIR) projects. For an early cohort of projects whose commencement was backdated[6], there have now been ten or more years since management changes were implemented. While this is still early to observe trends in rangelands forests systems given their slow growing nature, this time period is likely to be sufficient time for signals of change changes in woody vegetation to be detectable in long-running remote sensing datasets (e.g., products derived from Landsat satellite imagery which is the only long running time series dataset available).

Using the Landsat-based National Forest and Sparse Woody Vegetation dataset, formerly produced under the National Carbon Accounting System[7] (hereafter: 'NCAS'), along with supplementary environmental and management data, the aim of this analysis was to evaluate changes to forest area and sparse woody vegetation in project Carbon Estimation Areas (CEAs) since project start. The study described below was designed to control, where possible, for the influence of climate and land management on tree growth, among other factors.

[6] These projects implemented management changes following announcements from the Australian Government of their intention to create land-based carbon farming methods and to include provisions to recognise early action. These management changes are evidenced by auditable data.

[7] Furby, S. (2002). Land Cover Change: Specification for Remote Sensing Analysis, National Carbon Accounting System, Technical Report No. 9.

The key questions addressed were:

- Is there evidence that management changes in early HIR projects have facilitated regeneration?
- Are there indications that CEAs in both early and later projects have been subject to long-run suppression?
- What is the relative impact of suppression from grazing pressure alone when compared to projects that include clearing suppression (cessation of mechanical and chemical suppression)?

Hypotheses

It is important to consider what temporal patterns should realistically be expected in relation to project start dates and the influence of climate on tree growth. Three important assumptions are laid out below:

1. HIR CEAs must have forest potential. In accordance with the Government *Guidelines on Stratification, Evidence and Records for HIR Projects*, this means that they must have sufficient regenerating stems per hectare and/or > 5% canopy cover. They must also not be forest at project commencement, so must have < 20% canopy cover provided by trees >= 2 m in height. This means that individual Landsat pixels within CEAs are expected to contain a variety of initial tree densities (see response to question 5 above for an explanation of why a small number of existing mature trees does not overestimate carbon abatement).
2. Management changes implemented as part of HIR projects do not *cause* growth, they remove *inhibitors* that were suppressing growth. That is: in the absence of the carbon project and associated practice changes, continuation of baseline land management practices reduces tree survival, reduce recruitment of new trees, and/or prevents woody biomass from growing (suppression). Management changes associated with the carbon project lead to the removal of these inhibitors or suppression agents, and therefore allow woody biomass to grow larger and/or live longer (removal of suppression). So, regeneration can be ‘induced’ by the carbon project, but this should not be taken to mean the projects are *driving* tree growth or recruitment. Rather, the trees grow due to rainfall and other environmental factors, enabled by management changes. This is an important nuance.
3. When HIR CEAs are initially defined or stratified, suppression is evidenced by multiple integrated and complementary data sources as outlined earlier in this submission.

Integrating these discussions of forest attainment, management & climate interactions and CEA stratification yields the following four hypotheses:

1. Increases in pixels meeting the criteria for ‘forest’ should be moderate in the early years of a project.
2. Detectable regeneration should be traceable (initially) to suitable rainfall events combined with or followed by changes to remove suppression agents.
3. Removal of suppression should increase the likelihood of regenerating vegetation being preserved and possibly continuing to grow through dry periods when pasture is scarce.
4. Project CEAs should have consistently low numbers of forest pixels over multiple high rainfall (La Niña) events prior to management changes indicative of long run suppression.

Hypothesis 1 highlights the importance of a) targeting analyses within CEA boundaries (which are not publicly available) where incremental amounts of forest gain would be detectable; and b) simultaneously analysing patterns in the sparse woody and non-woody classifications along with forest to obtain a more complete picture of changes within CEAs.

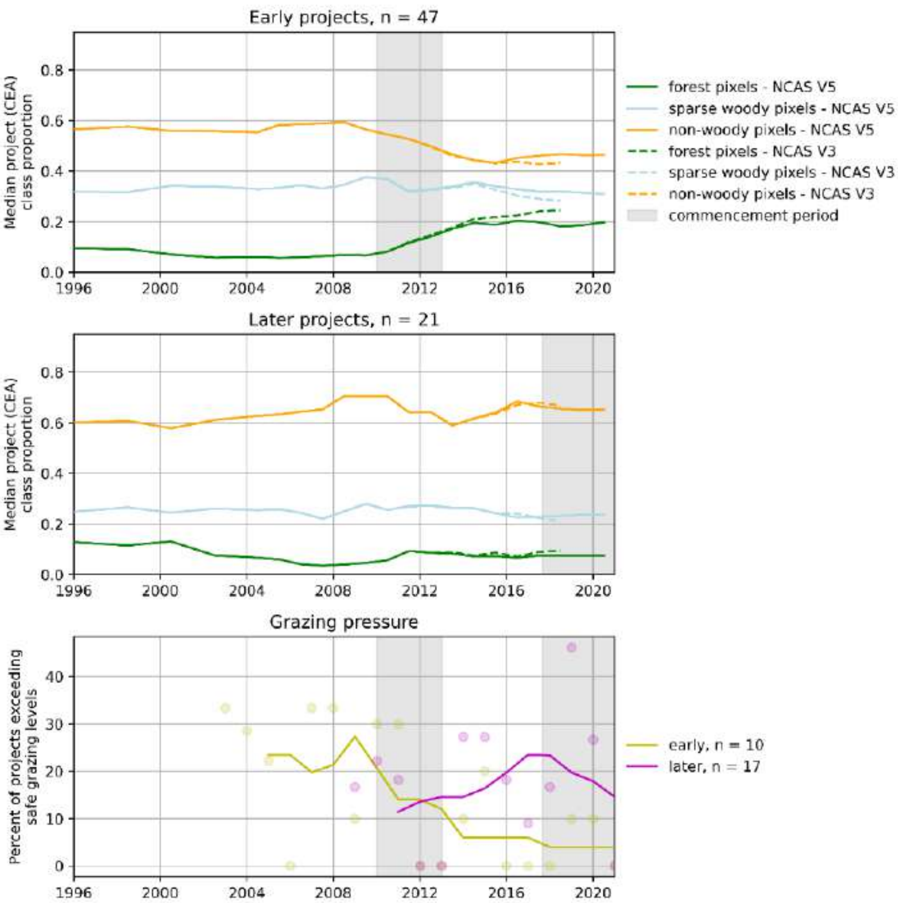
Detailed methods are described at the end of this Appendix.

Results and discussion:

NCAS and safe grazing – overview for early and later HIR projects in NSW and QLD

The cohort of early projects displayed an initial upward trend in forest pixels following implementation of the management change, reaching between ~12-15% above 2009 levels by 2014 (Figure 1). NCAS v5 data suggests that forest area stabilised during the dry periods that occurred after 2013, while NCAS v3 shows a slight continuation of forest expansion (to ~18% above 2009 levels on average by 2018), despite the dry conditions (Figure 1). Rainfall during the 2016/2017 La Niña event apparently did not trigger sufficient growth for many pixels to transition between categories, and the latest NCAS outputs (2018-2020) could not show the impact of very recent rainfall events (mid-2020 onwards). The observed forest attainment in the early project cohort (up to 18% of CEA within a typical project by 2018), is broadly consistent with the expected of rates of forest formation discussed in the introduction.

Figure 1. Top: The annual median proportion of project CEAs in each NCAS category for early projects whose management change occurred from 2010-2013 (indicated by the grey shading). Middle: As for the top plot but instead showing results for later projects whose management change was implemented after September 2017. Bottom: summary of grazing data from a selection of the early and later cohorts, shown as the percentage of each sample that exceeded safe grazing levels within a given year (points) with a five-year moving average shown (lines) to capture the overall trend in grazing pressure.



Note that NCAS "forest pixels" do not equate to "forest area" but are isolated forest pixels that can contain some larger pre-existing paddock trees. Pixels are classified as forest against a threshold of at least 20% crown canopy cover in the pixel. There must be at least three contiguous pixels for an area to constitute a "forest area" in line with internationally approved definitions of forest in Australia. All forest areas are removed from carbon estimation areas. We also note that Climate Friendly currently utilises Sentinel-2 satellite data which are higher resolution (10x10m pixels) for our human-induced regeneration project mapping, but these datasets are only available back to 2015. For the purposes of time series analysis, we have utilised two different versions of NCAS datasets (25x25m pixels) which are the only long run change datasets available. Further, the above analysis shows that carbon estimation areas contain less than 10% forest pixels at project start. We are not credited for these pre-existing paddock trees. All existing carbon stocks are removed from crediting and the presence of scattered trees is accounted for in the FullCAM model calibration.

The trend of pixels transitioning to forest was broadly mirrored in a decrease in the proportion of bare/non-woody land. The median proportion of sparse woody vegetation remained relatively stable (Figure 1). The decline in the median non-woody proportion appeared to begin around 2008 (corresponding with a slight uptick in sparse woody) (Figure 1), likely in response to recruitment events in some locations being triggered by healthy rainfall in 2008. The overall trend through the project period indicates that until 2016 bare or non-woody land was converting to sparse woody, while other sparse woody areas were converting to forest, keeping the sparse category balanced. The non-woody category stabilised in the dry period following 2016. There is insufficient data to assess the changes expected to result from rainfall post-2020.

The pre-baseline and baseline period of later projects displayed a small decline in forest pixels during the millennium drought following the 1998-2001 La-Niña event, plus a comparatively smaller increase in forest pixel area around the 2010-2012 La-Niña period (with a corresponding drop in bare pixels). This trend plateaued around 2012 (at ~ 5% above 2009 levels on average), sooner than the plateau seen in the early project cohort. Non-woody pixels showed a slight increase during the ensuing dry periods (while the same category was stable in the median of earlier projects). This is consistent with the expectation that the protection of woody vegetation under management would be visible during drought periods when woody vegetation would most likely be suppressed.

Considering only forest pixels, the striking contrast between the trends of early (increasing) and later (stagnant) CEAs alone cannot be used to infer that forest conversion was more substantial than it would have been in the absence of a carbon project. This is because, by definition, any areas that might have become forested (including meeting the minimum area of 0.2 ha) through this period would be excluded from the CEAs of the later projects. However, the data is nevertheless *consistent* with this picture. Furthermore, the same selection bias does not apply to pixels that transitioned from non-woody to sparse woody. Thus, the larger net conversion from non-woody to sparse seen in early CEAs compared to later CEAs (Figure 1) supports the interpretation that management changes were impactful.

Stocking records from a subset of the early project cohort (n = 10) showed that grazing pressure ran above safe levels intermittently during the baseline periods (pre-2010/2011/2012). This occurred less often during the project periods (post-2012) with typical stocking rates being more comfortably within safe levels after project commencement (Figure 1). Simultaneously, grazing data from the baseline periods of 17 later projects suggested many properties were running above safe grazing limits during the same period, particularly from 2014-2016 (Figure 1).

Thus, collectively this data:

a) Is consistent with and supports the interpretation that management change facilitated enhanced regeneration in early projects following sufficient rainfall in 2010-2012;
b) Highlights the preservation of sparse woody vegetation during dry periods when suppression might otherwise be expected;
c) Suggests that CEA mapping is adequately identifying areas with the potential to reach forest criteria; and
d) Supports the interpretation that suppression by grazing impeded the regeneration of later projects' CEAs through their baseline period, despite there clearly being sufficient rainfall for regeneration across the region, and despite these areas being identified as having forest potential.

Although the findings presented above suggest that management changes implemented as part of HIR projects have a meaningful impact on the progression of rangeland areas toward forest cover that cannot be explained by rainfall events alone, this has only been a high-level summary of project performance from a sample of Climate Friendly's portfolio. Each project exists with a unique set of circumstances. As such, project specific analysis which is provided to auditors and the Regulator presents a better perspective of the impact of a specific project.

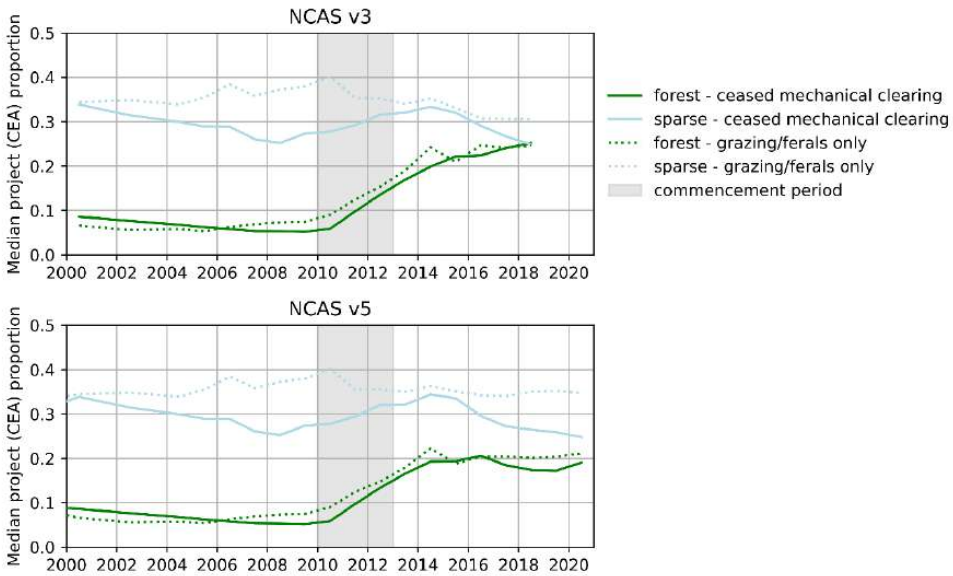
Accounting for other variables

Considering only the early project cohort, three further analyses were completed by stratifying projects according to:

(a) Whether the HIR management change was managing grazing pressure (from livestock and/or feral animals) alone, or whether the changes included a combination of grazing management plus the cessation of mechanical and chemical suppression;
(b) State boundaries – since regional clusters of projects with similar management change exist (e.g., a high number of projects in NSW are managing feral animals); and
(c) Areas of higher and lower productivity (indicated by simulated pasture growth from 2000 to 2022)

Neither version of NCAS shows a notable difference in forest cover proportions for the early cohort when properties were split according to whether implementation included the cessation of clearing (chemical or mechanical) (Figure 2). The typical mapped proportion of sparse woody vegetation was higher and more stable in projects managing stock and feral animals only (Figure 2).

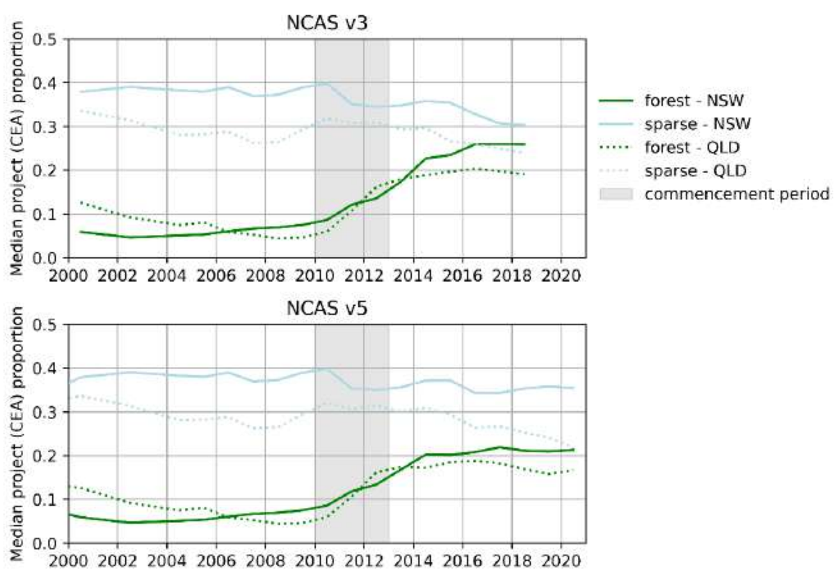
Figure 2. Trends in sparse woody and forest pixels in the CEAs of early projects, split according to whether management changes included the cessation of mechanical clearing or else only the management of stock and feral animals. Category proportions were first aggregated within CEAs of specific projects, then summarised across projects with the median value for each year.



Note that management changes and suppression types/figures are reported for entire CEAs and we have summarised changes in land cover at a comparable scale, while noting that changes within CEAs can vary spatially. Furthermore, unlike the grazing data presented, only the presence/absence of suppression from feral animals or clearing was accounted for here, not the extent or degree.

Stratification by state boundaries yielded qualitatively comparable results to stratification by management type, with trends in forest area being broadly comparable between QLD and NSW (Figure 3). That said, projects in NSW displayed marginally higher forest attainment and higher coverage of sparse woody vegetation. Overall, the results indicated that the recovery of sparse woody vegetation can be induced by management change regardless of the major form of suppression.

Figure 3. Trends in sparse woody and forest pixels in the CEAs of early projects, split according to state boundaries (NSW and QLD only). Category proportions were first aggregated within CEAs of specific projects, then summarised across projects with the median value for each year.



For each project, estimated pasture growth was averaged between 2000 and 2022. Projects were partitioned into 'higher' or 'lower' productivity groups (Figure 4). This was to test whether differences in woody biomass regeneration could be caused by differences in productivity (rather than the management change) by re-analysing early projects in lower and higher productivity sub-groups.

Trends in forest, sparse woody and bare/non-woody were broadly consistent between the higher and lower productivity groups (Figure 5). This analysis suggests that differences in average productivity do not explain the trends in the broader analysis above.

Figure 4. Histogram of average simulated pasture growth for the period of January 2000 to July 2022, shown for the early project cohort (see methods). The dashed line is placed halfway between the maximum and minimum values and was used to split projects into lower and higher productivity groups.

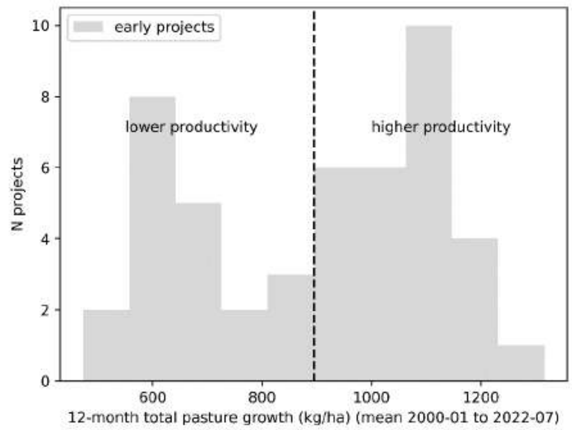
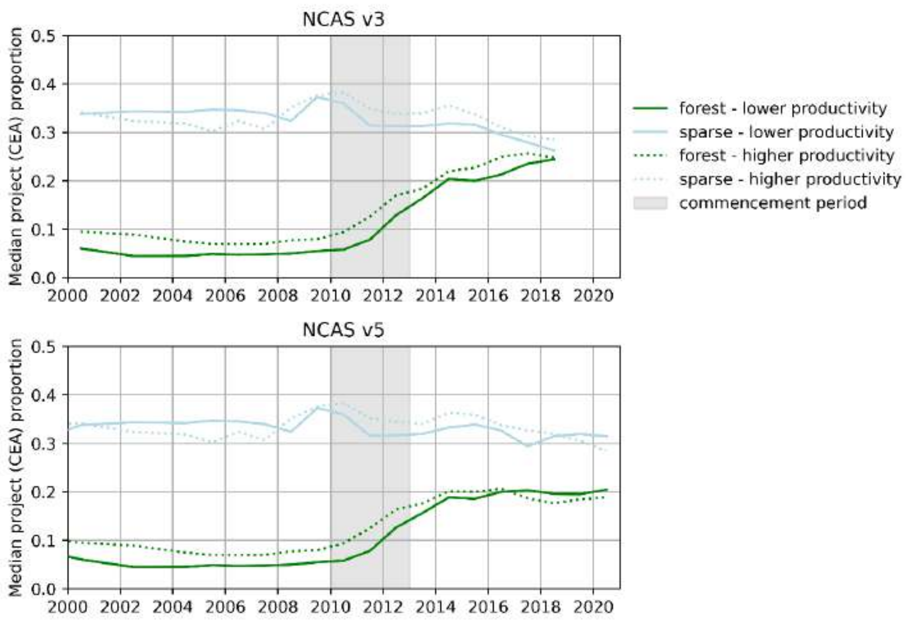


Figure 5. Trends in sparse woody and forest pixels in the CEAs of early projects, divided into lower and higher productivity groups, determined by simulated pasture growth, averaged from 2000 to 2022 (see Figure 4). Category proportions were first aggregated within CEAs of specific projects, then summarised across projects with the median value for each year.



Methods:

Study sites:

This analysis focused on the subset of HIR projects that Climate Friendly supports in NSW and QLD (n = 90). Analyses of remote sensing data focused solely on the CEAs of these projects, which are the areas within projects that are subject to abatement calculations.

Projects were repeatedly subsampled to undertake several analyses that control for factors such as project start time, climatic conditions and productivity, and suppression type. This subsampling is described further below.

Datasets:

NCAS

We use the National Forest and Sparse Woody Vegetation dataset., To assess the change in vegetation over long time periods (>20yrs). The technical approaches used in each version of NCAS are described in detail[8,9]. Although specific classes are detected with different accuracy, it is unlikely that these differences would affect this comparative analysis of early and late projects

Both NCAS versions 3 (up to 2018) and 5 (up to 2020) were analysed. These products are three-class classifications of Landsat pixels into either forest (>=20% crown cover), sparse woody vegetation (5-19%), or non-woody (0-4%) pixels. (Note: non-woody referred to in the figures as 'bare'). NCAS products are subject to post-processing after the initial allocation of cover classes. This is done in hindsight, with the most recent classifications being used to test the plausibility of previous outputs. This implies that the last 1-2 years of data shown could be subject to revision in future releases. NCAS v5 involved a change in the classification algorithm applied to the 2019 and 2020 imagery, which has implications for outputs in the preceding years due to time series post-processing[10]. It is important to note that when the category 'forest' is applied to a single Landsat pixel, this differs from the definition of forest area used elsewhere in the HIR method and in this submission, which includes a minimum area of 0.2 ha (or approx. 3.2 NCAS pixels). Unless stated otherwise, references to forest area or forest pixels in this appendix should be taken to refer to the NCAS pixel category, irrespective of the minimum area.

The proportion of CEA covered by each NCAS class was aggregated for individual projects. CEA parts, stored as polygon features, were buffered inwards by 20 m and overlapping NCAS pixels were extracted. Inward buffering ensures that only the NCAS pixels falling completely within the CEA were sampled. Given that woody vegetation thickening is more likely to occur near the boundary of existing forest (where seeds are more abundant and conditions are more favourable for recruitment, etc.), this inward buffering process provides a conservative estimate of the change in CEA forest area.

We summarised the change of each group of projects by their median project values for each year. Thus, projects were effectively treated as individual data points, and the results

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8 Department of Industry, Science, Energy and Resources (2018). National forest and sparse woody vegetation data. Version 3. Commonwealth of Australia, Canberra.
9 Department of Industry, Science, Energy and Resources (2021). National forest and sparse woody vegetation data. Version 5. Commonwealth of Australia, Canberra.
10 Department of Industry, Science, Energy and Resources (2021) National Inventory Report Volume 2. Commonwealth of Australia, Canberra.

were not weighted by the size of each project's CEAs. The annual values presented should be interpreted as what were 'typical' aggregated CEA proportions for each NCAS class.

AussieGRASS

Spatial and temporal variability in productivity (and, implicitly, climatic conditions) was evaluated using the simulated pasture growth (kg/ha) provided by the AussieGRASS environmental calculator[11]. This is an estimate of growth (driven by photosynthesis) and not 'total biomass', which would require accounting for rates of consumption by grazing[12]. Temporal variability in simulated pasture growth typically follows rainfall patterns, but the absolute values are also influenced by soil attributes, estimated ground cover and tree basal area. This product gives a holistic picture of the climate variation relevant to agricultural productivity and can be used to infer when regenerating trees are likely to be targeted as feed (whereby low levels of simulated pasture growth may increase pressure on trees as fodder sources). AussieGRASS data is provided on a coarse grid (5 x 5 km pixels) and was summarised at the property scale.

Grazing pressure

Where available, project-specific data on grazing pressure in relation to an estimated 'safe grazing' level (informed by the pasture growth estimates described above) was used to indicate the likelihood of suppression by stock grazing (or lack-thereof). Further detail on the calculation of safe grazing levels can be found in discussion on Question 3, Box 1 earlier in this submission. The collation of Climate Friendly's historical project grazing and management data into a common format across all projects that can be used for portfolio level analyses is ongoing and while the sample was substantial, it was not a complete sample of projects due to this ongoing process.

Study design:

Comparing 'early' and 'late' groups of projects

The interplay between management changes and variable climate conditions makes it challenging to test the impact of project implementation at scale.

A cohort of projects whose implementation was backdated to between July 2010 and January 2013 provided a useful test case to explore the impact of management changes through multiple wet and dry periods. A total of 47 'early' projects were included. These projects had the following attributes:

- Growth stimulated by good rainfall in the 2010-2012 La Niña event(s) (in some cases as early as the 2007-2009 La Niña event(s)) (see Figure 6).
- Successive droughts (2013-2015 and 2018-2020) through which the effect of removing suppression was expected to have been visible (see Figure 6).
- Sufficient time since project start for regeneration to have been visible in medium-resolution remote sensing data.

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[11] https://longpaddock.qld.gov.au/aussiegrass/
[12] State of Queensland, Department of Science, Information Technology and Innovation (2015). AussieGRASS Environmental Calculator – Product Descriptions v1.5

Another perspective was provided by a second cohort of 21 'later' projects, commencing from September 2017 onwards. These projects shared the following attributes:

- Baseline periods where the woody biomass was subject to known suppression, that temporally overlapped the implementation periods of the early cohort.
- The same period of known suppression also covered a period of time where regeneration might have been otherwise expected following the 2010-2012 La Niña event(s)
- Project-facilitated regeneration is not yet expected to have been visible in NCAS data given some projects commenced as recently as 2021. These data sets would not have captured a response to the most recent high rainfall events which is the first period we would anticipate observing regeneration post removal of suppression.

Figure 6. Top: AussieGRASS simulated pasture growth summarised with a mean +/- standard deviation of values from relevant local government areas (Paroo, Bourke, Quilpie, Bulloo, Murweh). Bottom: bar chart showing the number of projects starting in each year with the shaded regions corresponding to the early and later projects used for the analyses presented here.

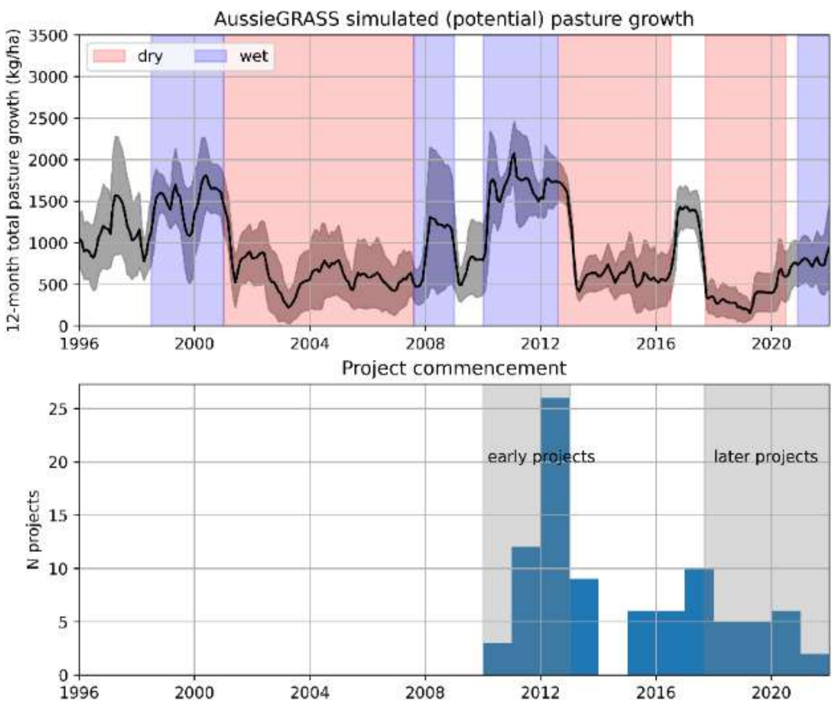
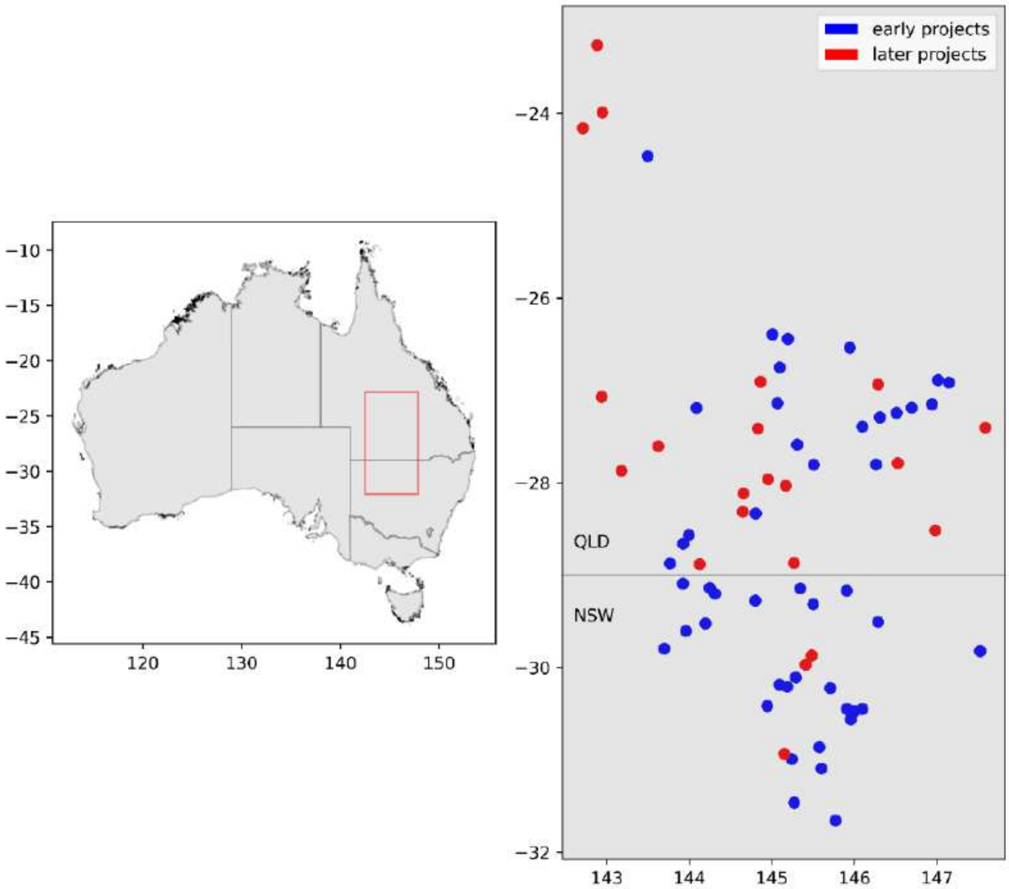


Figure 7. Distribution of projects within the early and later groups.



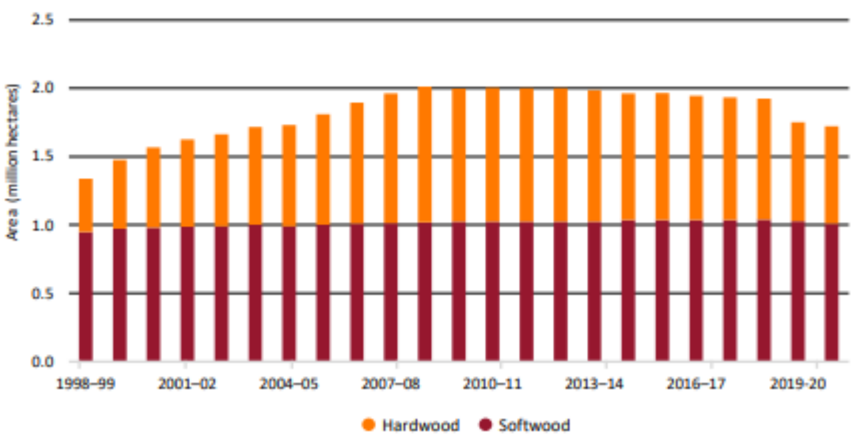
Appendix 5 – Risk of plantation forests being cleared and not replanted

The 2022 plantation forestry method has expanded the range of activities that are eligible for abatement. We understand that concerns have been raised about the 2022 Plantation Forestry Method, particularly Schedules 3 and 4 (which involve re-planting of plantations deemed at risk of conversion to non-forest; and conversion of an existing plantation to a not-for-harvest plantation, respectively).

At the time of writing, there are seven projects registered under the 2022 Plantation Forestry method. According to the ERF project register, it appears that all of these are new plantings (i.e. they are not Schedule 3 or 4 projects).[13] As such, there is insufficient data to provide a direct assessment of the integrity of this project type based on project uptake or implementation to date under Schedules 3 and 4 of the 2022 Plantation Forestry method.

However, Climate Friendly believes that the assumptions underlying Schedules 3 and 4 of the plantation forestry method are sound. That is, plantations on private land appear to be genuinely at risk of conversion to non-forest, with ABARES data[14] showing that more than 10% of Australia's plantation extent has been lost since 2010/11 (Figure 22). This has been particularly evident for hardwood plantations, with some States losing more than 50% of their plantation estate since 2010/11.

Figure 1 The total area of plantations in Australia has been steadily declining since 2010/11



Source: ABARES Plantation Statistics Update, 2022

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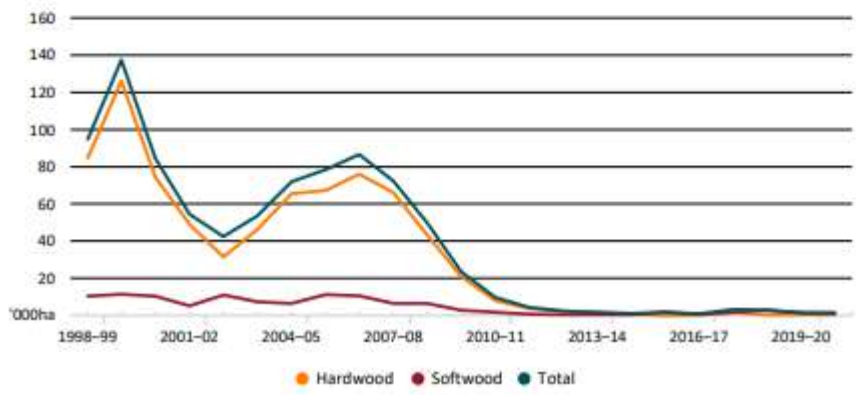
[13] Source: ERF Project Register. Accessed 26 September 2022. https://www.cleanenergyregulator.gov.au/ERF/project-and-contracts-registers/project-register The type of plantation for all seven projects registered under the 2022 plantation forestry method was described as "establishing and maintaining a new plantation forest for commercial harvesting of wood products."

[14] Source: ABARES (2022). Australian plantation statistics update. Available at: https://www.agriculture.gov.au/abares/research-topics/forests/forest-economics/plantations-update#collapsible_inner_link_plantationstatisticsinfographics

Conversely, the rate of new plantation establishment has dwindled to around 1,500 hectares in 2020/21 (Figure 23).

Figure 2 The total area of plantations in Australia has been steadily declining since 2010/11



Source: ABARES Plantation Statistics Update, 2022

This trend results in loss of carbon from Australia's plantation estate at a time when there are critical timber shortages, and when the forestry sector is ready and able to play a significant role in delivering on the nation's climate change targets. Against this backdrop, we believe that the 2022 Plantation Forestry method plays an important role in helping incentivise the establishment of new plantations, and reducing the loss of existing plantations.