

Review

Options for Forest Sector Participation in International Carbon Markets: Unlocking the Carbon Market Potential of Australia's Forest Sector

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Abstract: Carbon markets have emerged as a central component of international climate change policies. Within these markets, forest carbon offset projects have become a key nature-based solution due to their low cost, large scale, and co-benefits. However, despite Australia's vast forest estate, forest sector-specific offsets remain nascent in the Australian Carbon Market, the ACCU Scheme. Only 3.27% of Australian Carbon Credit Units have been issued to forest sector projects. This limited participation can be attributed to several constraints within the ACCU Scheme, principally the limited number of methods available for the forest sector to engage in. As a result, less than 1% of Australia's current forest estate, both plantation and native forests, is considered eligible to participate in the ACCU Scheme. This limited eligibility is further compounded by the complexity and cost of participation, which act as significant barriers for forest projects within the ACCU Scheme. This paper explores the potential to expand forest sector involvement in the Australian carbon market through a comprehensive literature review of forest sector involvement in international carbon markets. The review found extensive participation by the forest sector in international carbon markets, with various methods available across 20 markets, including the largest voluntary and compliance markets. These methods cover plantation forests, native forests, the bioeconomy, and the built environment. Key results indicate that revising existing methods, developing new ones through the ACCU Scheme's proponent-led method development process, and increasing participation in international voluntary methods could significantly expand the types of forest sector projects contributing to emissions reductions through carbon markets. Broader conclusions suggest that by embracing lessons from international practises and addressing current methodological constraints, Australia can realise this potential. Doing so would not only bolster the nation's climate change mitigation efforts, but also unlock the co-benefits of biodiversity, water quality, soil productivity, and ecosystem resilience, ultimately contributing to a sustainable and resilient bioeconomy.

Keywords: forest offsets; climate change; Australian Carbon Credit Units Scheme; carbon credits and forests



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1. Introduction

The Earth's climate has warmed by at least 1.25 °C since the Industrial Revolution [1], a trend that is expected to continue [2]. This warming is attributable to the increase in

atmospheric greenhouse gas (GHG) concentrations, especially carbon dioxide (CO₂), also referred to as carbon [3]. Furthermore, it is increasingly clear that reducing emissions alone will not be sufficient to limit warming to 1.5 °C. The International Panel on Climate Change (IPCC) emphasises that achieving this target requires both rapid reductions in global greenhouse gas emissions and the removal of carbon from the atmosphere [4]. Nature-based solutions offer a suite of well-developed approaches to enhance the capacity of natural biological systems to sequester carbon from the atmosphere [5]. Australia is endowed with a significant amount of nature-based carbon sequestration potential, such as existing forests and sites for afforestation [6]. Protecting existing forests and implementing afforestation efforts along with various forest management techniques can enhance these natural processes, contributing to the removal of GHGs from the atmosphere [5,7,8]. This was recognised by the Kyoto Protocol [9,10], and forests now play a central role in global carbon markets, exemplified by the “Chubb Review”, which found that photosynthesis is the only current technology that we have to remove CO₂ from the atmosphere [11].

Australia has a vast forest estate [12] that plays a critical role in mitigating climate change [13]. Managing a significant portion of this estate is the forest sector. The forest sector is defined as entities that are primarily engaged in the commercial management of native and plantation forests or their products, covering the full life cycle of forest management, and includes forest establishment and management, conservation, harvesting and haulage, the processing of timber resources, and the manufacturing of pulp, paper, and bioproducts [12,14,15]. As a result, the forest sector has been actively involved in Australia’s efforts to reduce emissions. This involvement has primarily taken the form of project-level participation in various carbon crediting mechanisms [16]. However, despite this early engagement, the number of forest sector projects under the ACCU Scheme (and its preceding carbon crediting mechanisms) is low [17]. Several recent reviews have identified that method constraints and, in particular, a lack of ACCU Scheme methods that the forest sector can participate in are the key barriers to realising the full climate change mitigation potential of Australia’s forest sector [11,18,19].

This research examines the Australian forest sector’s participation in the Australian carbon market relative to its global counterparts and explores the reasons for its relatively low participation rate. Firstly, in Sections 1.1.1 and 1.1.2, we describe the historical development of the nation’s climate policies within the context of global efforts. Secondly, in Section 1.1.3, we investigate the potential of forests to mitigate climate change, both globally and specifically for Australia. Building on that, in Sections 1.2.1 and 1.2.2, this study assesses the current contribution of the Australian forest sector to national climate action, including its participation in the national carbon market. Recognising the current limitations, the research then identifies and analyses the barriers to the sector’s broader involvement in this market in Section 1.2.3. In Section 3, this study then presents the results of the literature review on the forest sector’s participation in international carbon markets. Drawing on this review, in Section 4, this study proposes and discusses actionable opportunities for increasing Australia’s forest sector engagement in carbon markets, with a particular focus on expanding the number and type of ACCU scheme methods available to the sector. With this comprehensive approach, this research aims to contribute insights to the ongoing discussion on how to increase the use of forests for climate change mitigation in Australia.

1.1. Climate Policy and Forests

1.1.1. Global Policy Response to Climate Change

International Agreements

In response to the escalating challenges posed by climate change, a succession of international agreements has emerged [20,21]. The United Nations Forum on Climate Change (UNFCCC), launched in 1992, is the principal multilateral body in charge of cooperative action on climate change. The first instrument agreed in the UNFCCC was the Kyoto Protocol [22]. The UNFCCC provides the framework for the conference of parties (COP), which are annual international gatherings to discuss and negotiate actions to address climate change, including agreements on protocols and methodologies [22]. Parallel to these developments, the IPCC was founded in 1988, with the remit of delivering authoritative evaluations of climate science, thereby informing policy decisions and governmental actions [4].

The Kyoto Protocol, adopted in 1997 and effective from 2005, marked a significant milestone by committing signatories to binding emission reduction targets [23] and by establishing mechanisms for emissions trading, the Joint Implementation, and the Clean Development Mechanism [20]. These mechanisms allowed for countries to trade emission units or undertake emission reduction projects in other countries [24] and created the framework for the development of carbon markets [10]. Subsequently, the Paris Agreement was ratified by 196 countries at COP21 in Paris, 2015. This agreement, which superseded the Kyoto Protocol in 2020, introduced Nationally Determined Contributions (NDCs) in lieu of legally binding targets, reflecting a new phase in international climate policy [23]. In alignment with this, the Australian Government submitted an updated NDC in 2020, setting an ambitious target to reduce greenhouse gas emissions by 43% below 2005 levels by 2030 [25].

Policy Mechanisms to Address Climate Change

Attempts to combat climate change and make good the beforementioned agreements has led to governments around the world making commitments to reduce carbon emissions. Governments have responded in numerous ways to achieve this, such as taxes on fossil-based energy, subsidies for clean energy production [26], energy efficiency standards, mandated renewable energy targets, low-carbon fuel standards and targets [27], clean energy transitioning policies, environmental regulation, education and behavioural change programmes, support for research into low-emissions technologies, and subsidies to encourage the adoption of low-carbon emissions technologies [28]. However, the traditional economic approach to mitigating climate change has been the implementation of a Pigouvian fee, as conceptualised by Arthur Pigou [29]. This fee aims to internalise the external costs of carbon emissions which are not accounted for in market prices, thereby incentivising reductions in emissions. The creation of a carbon market through mechanisms such as cap-and-trade schemes or carbon taxes is a direct application of this principle [26,30–32].

Carbon Markets

Carbon markets facilitate the trading of carbon credits or “offsets” or “units”, which represent one tonne of carbon dioxide equivalent ($\text{tCO}_2\text{-e}$)¹ removed from the atmosphere and stored or emission-avoided [26,30–32]. Reference [3] detailed two types of carbon markets. Emissions Trading Schemes (ETS) regulate greenhouse gas emissions by requiring covered entities to obtain and surrender emission units to match their emissions within a compliance period, facilitating the trade of carbon credits to meet established emissions targets. There are two main forms of ETs—baseline and credit, and cap and trade—with 37 ETs worldwide, including Australia’s Safeguard Mechanism [33]. The second type,

crediting mechanisms, convert emission reductions from projects or activities into credits, which are then allocated to the project initiators. Globally, there are 36 crediting mechanisms, such as the Australian ACCU Scheme [3]. Carbon markets can be compliance-based, where participants have an obligation to participate, or voluntary-based markets, where participants choose to be involved [32,34].

Nested within carbon markets are carbon registries, which establish offset protocols that define project eligibility criteria and methods for monitoring and calculating the carbon impacts of each participating project. The protocols or methods set the standard for the quality of the carbon credits [19,35]. Credits are issued to projects ex-post (after the project has been implemented and emissions reduced) or ex-ante (before the emissions reduction occurs based on modelled abatement) [31,35].

1.1.2. Australia's Policy Response to Climate Change

To meet its emissions reduction commitments, Australia has implemented a succession of market-based policy mechanisms, all of which have included forest-based projects. From 2012 to 2014, the Australian Carbon Tax, a cap-and-trade system, established emission limits for specific sectors and entities, mandating that emitters hold permits proportional to their allowed emissions. The number of available permits was set to decrease over time, starting with a carbon price of AUD 23 per tonne, which was expected to rise by AUD 5 annually, as caps were reduced until transitioning to a flexible trading scheme in 2015 [36]. Concurrently, the Carbon Farming Initiative (CFI) from 2011 to 2014, a voluntary scheme, enabled land managers to create and sell emissions units by sequestering carbon or reducing greenhouse gas emissions, complementing the carbon pricing mechanism by providing offset credits [37]. With the change in government in 2013, these arrangements were replaced by the Emissions Reduction Fund (ERF), operational from 2014 to 2022, as one of the few examples globally of government-led voluntary offset programmes [18,38], allowing for participants to generate Australian Carbon Credit Units (ACCUs) through approved projects, which could be sold directly or via government reverse auctions. The ERF operated in conjunction with the Safeguard Mechanism, setting emission limits for large industrial entities, obligating them to maintain emissions within these limits or purchase ACCUs to do so [33,39]. Limits were allowed to increase over time, and few entities needed to purchase ACCUs to meet their requirements. The ACCU Scheme, active from 2022 onwards, operates in conjunction with the Safeguard Mechanism and emerged with the change in government concurrent with the findings of the Independent Review of Australian Carbon Credit Units led by Professor Ian Chubb, AC. The Chubb Review, which addressed concerns about the validity of most ACCUs [40], ultimately affirmed the integrity of the ACCU system. The review also led to creating a process to enhance current methods and a proponent-led new method development process [11,39], which involves allowing for proponents to propose changes to existing methods and the introduction of new ones.

1.1.3. Forests and Climate Change

To meet current climate goals, all sectors require GHG emissions reductions and mitigation actions [4]. The forest sector provides a cost-effective pathway to both sequester and store a substantial amount of carbon [41]. Forest sector activities are prominent in national and international commitments to mitigate climate change, and it is suggested that they have the potential to achieve one-quarter to one-third of the mitigation required to meet climate stabilisation targets [42]. Reference [13] noted that, in Australia, "the land sector, which accounts for changes in the amount of carbon stored in trees, vegetation, soils and harvested wood products contributed net negative emissions of 64 Mt CO₂-e in 2023".

Forests, Their Management, and the Carbon Cycle

Through the process of photosynthesis, forests remove carbon from the atmosphere, and 50% of the biomass in trees consists of carbon, and carbon stored in wood products continues to store this carbon for life, both in service and in landfill [7,15,43]. Forests are the largest carbon sink in the terrestrial biosphere [44], storing approximately 45% of the total Earth's carbon [45]. In Australia, forests are estimated to contain approximately 10.5 Gt of above-ground carbon. When this carbon is converted to GHG emissions, it amounted to 77 times Australia's greenhouse gas emissions in 2021 [15,43]. However, forests also release carbon back into the atmosphere through processes like vegetation respiration, the decomposition of organic matter, and combustion [20]. Annually, 125 Gt of carbon is exchanged between terrestrial ecosystems and the atmosphere [46]. Therefore, it is essential to recognise that forests are dynamic systems, and the carbon stored in them is not permanently locked away. This is represented in Figure 1.

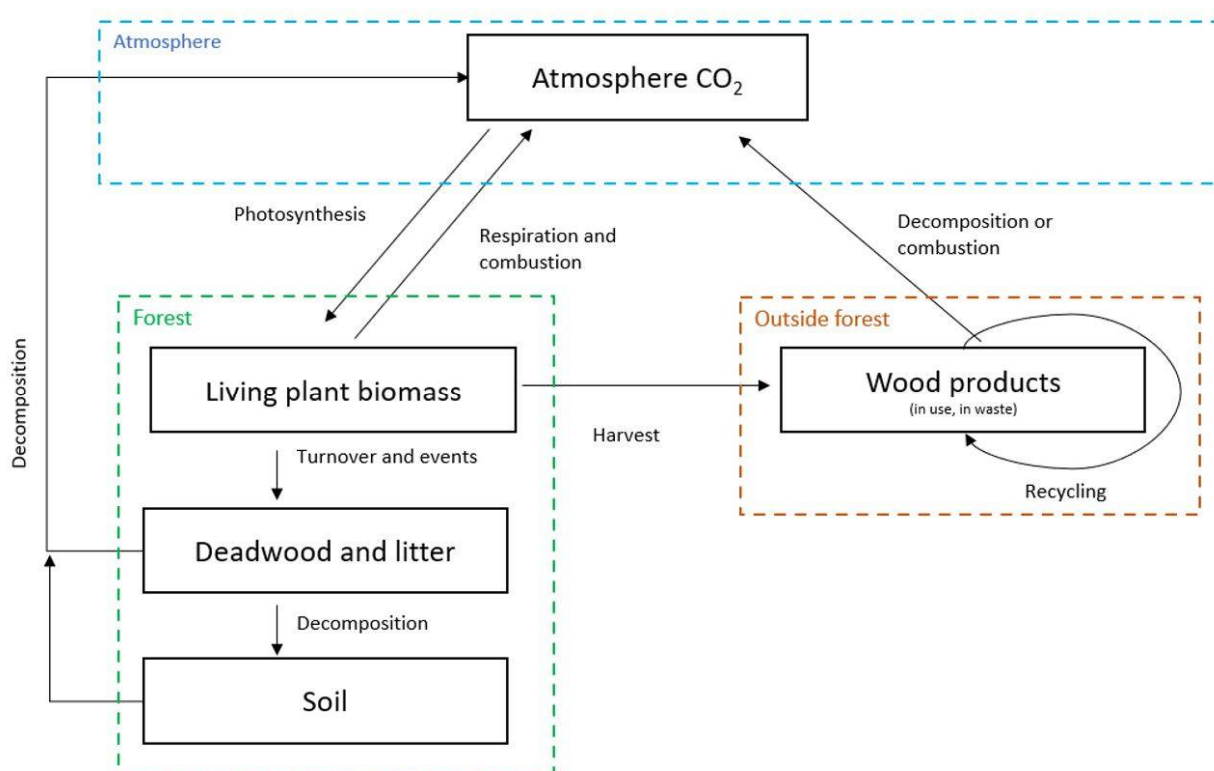


Figure 1. Simplified example showing the movement of carbon in a working forest from the atmosphere into four terrestrial carbon pools adapted from [47].

With the potential of forests in mind, many countries are planning to rely on them to help meet their GHG emissions reduction targets [48]. For example, the United States has the fourth largest forested area in the world, and its forests offset approximately 11% of the country's emissions in 2019; the US plans to meet its target partly by enhancing its forest carbon sink and reducing emissions from forests through protection, restoration, and management [5]. The restoration and planting of new trees is seen as one of the most effective strategies for climate change mitigation [49]. Reference [50] noted that "planting new forests has received scientific and political attention as a measure to mitigate climate change". However, the sustainable management of existing forests, which are available for wood production, has received less attention. Better management of existing forests would improve forest growth and help mitigate climate change by increasing forest carbon, increasing forest resilience by storing carbon in forest products, and by

generating wood-based materials by substituting fossil carbon-based materials or other carbon emission-intensive materials [50].

The net carbon consequences of forest management and timber harvesting for wood products have been debated extensively [51]. Some have determined that the carbon released in harvesting operations substantially exceeds the additional carbon sequestered by reforestation [52], while others argue that forest management and harvesting increases carbon sequestration by storing carbon in long-term products and sequestering large amounts of carbon in reforestation [53].

Supporting the latter conclusion, it has been commonly found that forests managed sustainably to produce wood products can provide greater mitigation than in no-harvest scenarios [50,51,54–64]. In addition to this research, there are many instances where important international institutions have released statements that support the principle that the sustainable management of forests for production is a valid, and indeed desirable, activity that assists with climate change mitigation outcomes. For example, [22] stated that “Forests and forest products have a key role to play in mitigation and adaptation, not only because of their double role as sink and source of emissions, but also through the potential for wider use of wood products to displace more fossil fuel intense products.”, and the IPCC assessment reports [4,65,66] have each made similar statements.

However, not all of the literature shares the view of the positive impacts of forest management, including timber harvesting, on climate change. Reference [67] concluded that “Emissions to the atmosphere can be avoided by ceasing logging. Removals of carbon dioxide from the atmosphere can be increased by allowing forests to continue growing”. Ref. [68] quantified this, noting that “forest harvests between 2010 and 2050 will probably have annualised carbon costs of 3.5–4.2 Gt CO_{2-e} yr”.

In summary, forest management for wood production can have either positive or negative impacts on climate change, and may be valid in certain circumstances. The consequences depend on many factors: the area harvested, the intensity of harvest, the timeframe of the analysis, the efficiency of utilisation, and the longevity of storage of wood products [22]. Therefore, there is no one-size fits-all approach to forest management for meeting carbon-related goals. The preferred approach for any forest will vary on a case-by-case basis and be determined by climate implications, site-specific considerations, including risks from natural disturbances, and forest owner values.

Australia’s Forest Sector and Its Climate Change Mitigation Options

Forests are managed for a range of purposes, including conservation, recreation, carbon sequestration, and timber harvesting [15]. The forest sector covers the full life cycle of forest management and includes forest establishment and management, harvesting and haulage, and the processing of timber resources and manufacturing of pulp, paper, and bioproducts. Australia’s forest sector directly employs 80,000 people in Australia and indirectly employs another 100,000 [14]. In the 2015–16 financial year, the value of production of wood product industries was AUD 23.7 billion [12]. Australia has 133.6 million hectares of forest, covering 17% of the nation’s total land area, including 1.72 million ha of plantations [68]. This includes 22 million ha of protected areas (national parks), 11 million ha of state forests (managed for multiple uses including wood production), 48 million ha of leasehold forest, 43 million ha of private native forest, and 10 million ha of forest on other Crown land [69]. Australia has the seventh largest area of forest in the world by country, approximately 3% of the world’s forest area [70], and approximately 5 ha of forest for every Australian [71]. Considering this, few other nations have comparable potential for forest management to offset its carbon emissions. The options for forest management

to mitigate climate change are detailed in Table 1, providing a key reference for potential carbon market methods.

Table 1. Forest sector climate change mitigation options and their carbon benefits.

Activity	Mitigation Action	Carbon Benefits
Afforestation or reforestation	Reforestation is growing forests where they recently existed [24], while afforestation is growing forests where they did not. This includes planting forests for timber production or conservation [72].	Growing trees increases forest carbon and carbon in wood products from managed forests [73].
Extended rotation	Extending the time between harvests for commercial forests, plantations, and native forests [74].	Extending tree growth sequesters more carbon and increases availability for longer-lived wood products [75].
Reduced or avoided deforestation and degradation	Tropical deforestation accounts for about 20% of global GHG emissions [52]. Reducing deforestation and degradation could contribute 1.2% to 18% of the emissions cuts needed for the 1.5 °C goal [9].	Maintaining forests avoids GHG emissions, preserves carbon removal, and reduces future timber demand pressures [41].
Avoided harvesting	Stopping harvesting in commercial forests impacts old growth forests most, where long-lived wood products are fewer due to decay [76]. However, it can cause GHG emissions to increase elsewhere [77]. So, a case-by-case approach is best.	Un-harvested trees store carbon, but there is a risk of carbon leakage to other areas [41].
Increased forest health, pest, weed and disease management.	Forest-health-focused management through various silviculture activities allows for the maximisation of growth and adaptive capacity and avoidance of losses from pest, disease, and other stressors [22].	Maximises carbon removal and storage through keeping forests alive and growing [22].
Fire management	Forest management often involves removing fuels or suppressing fires to protect the production of forest assets [78].	Carbon losses are diminished from fire [78].
Soil management	Forest carbon sequestration capacity can be significantly enhanced by careful mechanical soil preparation prior to afforestation [73].	Increases sequestered carbon, then is stored in the soil pool [73].
Genetics	Tree breeding and genetic improvements can increase the growth rates of plantation species [79].	Selecting fast-growing genotypes for plantation forests can boost carbon sequestration by 10–20% per generation [73].
Increasing wood utilisation	Increased wood use in the bioeconomy, with opportunities to change wood product composition, such as diverting non-sawlog-grade logs to longer-term carbon storage products [79].	Increases off-site carbon storage by using harvested wood products and avoiding emissions from concrete, metal, bricks, and plastic [22,46].
Thinning	Thinning selectively removes trees to improve forest health and achieve production, ecological, or cultural outcomes [80–82].	Thinning reduces forest carbon stock initially, but stimulates compensatory growth, increasing tree height and diameter. Benefits are enhanced if thinned biomass is used for wood products [82].
Use of wood for bioenergy, and bioenergy carbon capture and storage	Using sustainably produced wood for energy [22] displaces high-emitting products [83]. Bioenergy carbon capture and storage (BECCS) goes further by storing GHGs underground, making it a negative emissions technology [83].	Avoids GHG emissions by substituting fossil fuels and preventing biomass decomposition and post-harvest burns [22].

Table 1. *Cont.*

Activity	Mitigation Action	Carbon Benefits
Improved forest management	Improved forest management (IFM) includes actions like avoiding harvesting ecologically important forests, thinning for stand improvement, promoting uneven-aged management, facilitating regeneration, and changing the wood product mix [74,84,85]. IFM also makes forests less susceptible to carbon reversals from wildfire, drought, and pests [35].	IFM incentivises the optimisation of carbon within a forest estate and a supply chain [35].

1.2. Australian Carbon Markets and Forests

The forest sector has been actively participating in Australia’s carbon markets since the introduction of the CFI. Over time, this participation has grown as more projects or “methods” have become available and barriers have been reduced. Despite this progress, the sector’s involvement still falls short of its full potential.

1.2.1. ACCUs Issued to Australian Forest Sector Methods

The ACCU Scheme Project Register shows that, as of 7 January 2024, there had been 140,364,685 ACCUs issued; of these, 4,582,994 or 3.27% are from forestry sector methods [17], detailed in Table 2.

Table 2. ACCUs issued by current and past forest sector methods.

Method	Current or Historic Method	Number of Projects	Total ACCUs Issued	Portion of Total ACCUs (%)
Designated Verified Carbon Standard Projects Methodology Determination 2015	Historic	3	867,861	0.62
Plantation Forestry Methodology Determination 2017	Historic	35	279,768	0.20
Plantation Forestry Methodology Determination 2022	Current	60	4967	0.00
Reforestation and Afforestation 2.0 Methodology Determination 2015	Current	4	-	0.00
Measurement Based Methods for New Farm Forestry Plantations Methodology Determination 2014	Historic	3	409,017	0.29
Reforestation and Afforestation—1.2 Methodology Determination 2013	Historic	11	531,721	0.38
Reforestation and Afforestation Methodology Determination 2013	Historic	4	381,073	0.27
Reforestation by Environmental or Mallee Plantings (REMP)—FullCAM Methodology Determination 2014	Current	190	2,067,733	1.47
REMP-FullCAM Methodology Determination 2014 (Compilation No. 2)	Historic	7	-	0.00
Carbon Farming (Quantifying Carbon Sequestration by Permanent Environmental Plantings of Native Species using the CFI Reforestation Modelling Tool) Methodology Determination 2012	Historic	47	40,854	0.03
Total forest sector methods		374	4,582,994	3.27
Total all methods		2048	140,364,685	100

1.2.2. Current Opportunities for Forestry Organisations

Domestically, there are currently three ACCU Scheme methods available to the forest sector: the plantations method [75], reforestation by environmental or mallee plantings (REMP) method [16], and the afforestation and reforestation method [17]. There are several other ACCU Scheme methods that are categorised as “vegetation” methods; however, they are not methods that the forest sector engages in [16]. Australian carbon project developers can also participate in international methods such as the Verified Carbon Standard and the Gold Standard [86,87]. However, there appears to be relatively low uptake of international forest sector methods in Australia due to the low and variable prices and the high-cost environment for land, wages, and other inputs [62,88] (Peterson St-Laurent et al., 2017; Donofrio & Procton, 2023) such as relative high ACCU prices [89], the complexity of participation, and the lack of understanding on how to participate [90].

1.2.3. Barriers Prohibiting Forest Sector Participation

Ecosystem services are inherently difficult to commercialise, because they are intangible and do not physically travel along commodity chains [91]. This is expressly true of forest carbon credits [92]. Subsequently, there are a number of barriers restricting forest sector participation in Australia’s carbon market [11,18,19]. These have been identified as policy uncertainty, complexity [34,92], and cost of participation, but most notable are the lack of suitable methods for the forest sector to participate [23]. These restrictions exclude the majority of Australia’s current plantation estate, as the bulk of it has had a previous rotation over a certain age (21 years) and is not at risk of conversion, both of which preclude participation. In addition to this, there are no methods for existing native forests. This means that more than 99% of Australia’s forests are currently excluded from participation in the ACCU Scheme [69]. The forest sector also extends beyond the forests into the bioeconomy and built environment [14]. However, there are no opportunities within the ACCU Scheme for encouraging the uptake of forest products in the bioeconomy [43]. Furthermore, the eligibility criteria of the few methods that the forest sector can participate in are highly specific, meaning that a minor deviation from them renders a project ineligible, restricting wider forest sector involvement [75,93].

2. Method

This systematic literature review was guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses method (PRISMA) [94]. One database, Scopus, was systematically searched for keywords in February 2024. Scopus was selected due to its extensive coverage of the peer-reviewed literature and its relevance to the research topic. This choice was influenced by a previous similar study [95].

The first phase of the systematic review process consisted of searching the database using the following search string of terms for the abstract title: (“forest” OR “forestry” AND “carbon market” OR “offsets” OR “credits”). The search was restricted to English publications published between 2005 and January 2024, as the Kyoto protocol, the agreement that formally established the framework for carbon markets, did not come into force until 2005 [96]. Only articles, reports, books, and book chapters were included.

To capture all relevant publications, it was necessary to assemble a supplementary material list based on background research and searching references captured in the systematic literature review and including material already known to the authors and grey literature.

2.1. Screening Process

The search of Scopus yielded 374 publications, and 70 publications were identified externally. The screening and eligibility phases consisted of removing duplicates and

non-English documents, then checking titles and abstracts for qualitative information on forest carbon markets and methods. Only publications that presented information on forest carbon markets or forest carbon offset methods were fully analysed. Of the total search units, 242 were excluded in the screening and eligibility phases, removing duplicates ($n = 4$), non-compliant publications ($n = 87$), abstracts of irrelevance ($n = 143$), and not in English ($n = 8$). In total, 202 publications were included in the review. Figure 2, which was adapted from [94], depicts this process.

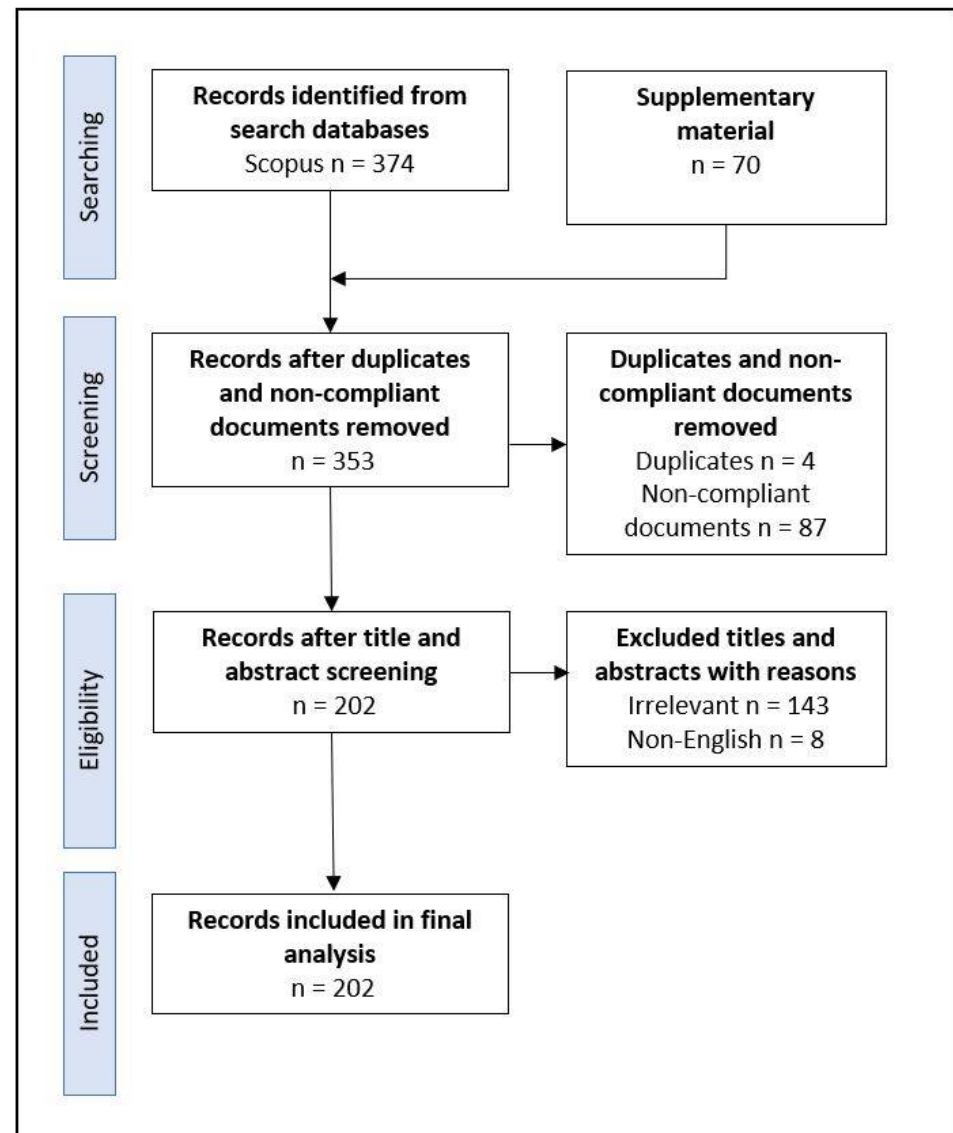


Figure 2. Illustration showing the steps of the literature search and elimination process used for the systematic review.

2.2. Synthesis of the Literature

The publications ranged from reviews of forest carbon markets, details on specific mechanisms, descriptions of forest carbon policies, case studies, legislation, explanatory documents, web pages, and programme guidelines. These publications were each reviewed, and qualitative information on specific forest carbon markets were synthesised and included in this review. The details from each were then used to inform the Discussion and Conclusions.

2.3. Categorising Forest Sector Methods

For the purposes of this study, forest sector methods were categorised as those that forest sector participants, as defined in Section “Australia’s Forest Sector and Its Climate Change Mitigation Options”, could engage in, noting that the forest sector also extends beyond forests into the bioeconomy and built environment [14]. The ACCU Scheme’s human-induced regeneration and the avoided native forest deforestation methods were not categorised as forest sector methods [16].

3. Results

3.1. International Carbon Markets and the Forest Sector

Since the creation of compliance carbon credit systems with the Kyoto Protocol in 1997, forest carbon offsets represented 17% of total offsets in global compliance markets as of 2017 [38], and they accounted for greater than 30% of the total offset credits issued by voluntary registries in 2023 [90]. Furthermore, [97] noted that forest sector projects, encompassing 21 types, accounted for 46% of the voluntary market share in 2021. More specifically, the South Korea Emissions Trading Scheme is said to have over 50% of its projects come from the forest sector [98], and, within the California Compliance Offset Program, forest offset credits account for 85% of all carbon credits issued in 2022 [99].

This study found that 19 carbon markets include various forest sector “methods”, “projects”, “project types”, “interventions”, or “protocols” as a mechanism to sequester carbon or avoid emissions to earn carbon credits, and a further one, the world’s second largest compliance market, the European Union (EU) ETS, has recently agreed to include forest sector methods. These 20 markets include the top five voluntary markets by credits issued, being the Verified Carbon Standard, Californian Compliance Offset Program, Gold Standard, American Carbon Registry, and Climate Action Reserve [3,90], with the top three compliance markets by size being Chinese ETS, EU ETS, and the South Korean ETS [3]. Specific options for participation are detailed in this section.

3.1.1. American Carbon Registry

Established: 1996	Footprint: Global	Type: Voluntary, Crediting Mechanism	Crediting: Ex-Post
Description: The American Carbon Registry (ACR) was founded by the Environmental Defense Fund and is now overseen by Winrock International. ACR is an approved offset project registry for the California cap and trade system. ACR does not confine its projects to the US and works globally. There is an emphasis on projects that increase economic opportunities, sustain natural resources, and address differences in opportunities for disadvantaged communities [38].		Opportunities for forest sector participation - Afforestation and reforestation. - Active conservation and forest management: conservation combined with activities, such as reduced impact logging or ecological thinning, improved fire management, thinning and selective harvesting, and pest and disease management. - Improved forest management (Canadian forestlands and US Federal forest lands) [100].	

3.1.2. Plan Vivo

Established: 1997	Footprint: Global	Type: Voluntary, Crediting Mechanism	Crediting: Ex-Ante
Description: The Plan Vivo (PV) standard was established to promote carbon projects with various co-benefits beyond carbon emission reductions: social benefits for rural and deprived communities in developing countries, promotion of ecological services, and conservation of biodiversity [87]. Projects selling PV credits are required to aim to deliver at least 60% of the proceeds of sales to communities [38].		Opportunities for forest sector participation • <i>Agroforestry</i>: Intercropping trees with agricultural. • <i>Reforestation and afforestation</i>. • <i>Forest Protection</i>. • <i>Improved forest management</i> [101].	

3.1.3. Climate Action Reserve

Established: 2001	Footprint: Global	Type: Crediting Mechanism	Crediting: Ex-Post and Ex-Ante
Description: The Climate Action Reserve (CAR) was founded under the California State Legislature as the carbon offset registry of the California Climate Action Registry. It operates in the voluntary market, but its protocols have also been verified by Californian Air Resources Board. Therefore, projects registered with CAR can trade their offset credits on California's cap-and-trade market. Although CAR crediting is primarily ex-post, it also offers an ex-ante programme called Climate Forward [102,103].		Opportunities for forest sector participation • <i>Reforestation</i>. • <i>Avoided conversion</i>: includes subsequent timber harvesting. • <i>Improved forest management</i>. • <i>US and Canada Biochar—under development</i>: conversion of forest biomass into biochar [104].	

3.1.4. Gold Standard

Established: 2003	Footprint: Global	Type: Voluntary, Crediting Mechanism	Crediting: Ex-Post
Description: The Gold Standard, administered by the Gold Standard Foundation, Geneva, Switzerland, was developed by the World Wildlife Fund [3] to overcome the shortcomings of the Clean Development Mechanism, which focused exclusively on carbon-emission reduction, as defined in the Kyoto Protocol. Projects must make positive contributions to at least three sustainable development goals [88].		Opportunities for forest sector participation • <i>Soil organic carbon from pulp and paper mill sludges</i>: use of pulp and paper mill waste to improve soil organic carbon [105]. • <i>Agroforestry</i>. • <i>Afforestation and reforestation</i> [106]. <i>Improved forest management</i> is an eligible project scope; therefore, proponents can seek to develop an improved forest management method [105].	

3.1.5. Verified Carbon Standard

Established: 2005	Footprint: Global	Type: Voluntary, Crediting Mechanism	Crediting: Ex-Post
Description: The Verified Carbon Standard (VCS) was established in Switzerland by The Climate Group, the International Emissions Trading Association, the World Business Council for Sustainable Development, and the World Economic Forum [33] to consolidate the voluntary carbon market. In addition to its own carbon methodologies, VCS is open to projects employing methodologies developed under the Clean Development Mechanism or Climate Action Reserve [87]. The VCS celebrated the issuance of its 1 billionth VCS credit in 2022 [33]. The VCS is the largest making up 70% of the voluntary carbon market [38].		Opportunities for forest sector participation • <i>Forest protection:</i> preventing deforestation or degradation. • <i>Improved forest management,</i> such as improved harvesting practises, extension of rotation age, selective harvesting, and harvested wood product type and destination. • <i>Afforestation and reforestation.</i> • <i>Biochar utilisation:</i> conversion of waste biomass into biochar. • <i>Conversion of low-productive forest to high-productive forest:</i> implementing silvicultural techniques to increase forest density, such as liberation thinning or enrichment planting. • <i>Avoided unplanned deforestation:</i> keeping areas under forest that are at risk of conversion to non-forest. Timber harvesting can occur. • <i>Avoided forest degradation through fire management:</i> undertaking fire management mitigation activities that prevent fire in the East Miombo ecoregion of Africa [107].	

3.1.6. UK Woodland Carbon Code

Established: 2011	Footprint: United Kingdom	Type: Voluntary, Crediting Mechanism	Crediting: Ex-Ante
Description: The Woodland Carbon Code is the quality assurance standard for woodland creation projects in the United Kingdom and generates high-integrity independently verified carbon units [108].		Opportunities for forest sector participation • <i>Woodland creation:</i> human-induced conversion to woodland of land that has not been under tree cover for at least 25 years [108].	

3.1.7. Quebec Offset Crediting Mechanism

Established: 2013	Footprint: Quebec, Canada	Type: Voluntary, Crediting Mechanism	Crediting: Ex-Ante
Description: The government of Quebec established a crediting programme that issues Quebec offset credits for both the Quebec cap-and-trade ETS and the voluntary market [109].		Opportunities for forest sector participation • <i>Afforestation and reforestation.</i>	

3.1.8. California Compliance Offset Program

Established: 2013	Footprint: United States	Type: Crediting Mechanism	Crediting: Ex-Ante
Description: The California Compliance Offset Program is the mechanism that supplies carbon offset credits within California's cap-and-trade programme, which are both implemented and overseen by the California Air Resources Board [99].		Opportunities for forest sector participation • <i>Afforestation and reforestation.</i> • <i>Improved forest management.</i> • <i>Urban forestry:</i> thinning of diseased and suppressed trees; avoided tree removal; planting additional trees; avoiding premature mortality [85].	

3.1.9. J-Credit Scheme

Established: 2013	Footprint: Japan	Type: Voluntary, Crediting Mechanism	Crediting: Ex-Post
Description: The J-Credit Scheme (JCS) was created in 2013 by merging the "Japanese" Domestic Credit Scheme and the Offset Credit (J-VER) Scheme. The Japanese Government scheme is designed to certify the amount of greenhouse gas emissions reduced and removed and issue J-Credits [110]. Credits from forestry projects under the JCS can also be used for compliance under the Saitama ETS [3].		Opportunities for forest sector participation • <i>Afforestation and reforestation.</i> • <i>Biochar addition to soil.</i> • <i>Improved forest management</i> [110].	

3.1.10. Thailand Voluntary Emissions Reduction Program

Established: 2014	Footprint: Thailand	Type: Voluntary, Crediting Mechanism	Crediting: Ex-Ante and Ex-Post
Description: The Thailand Greenhouse Gas Management Organisation has developed a voluntary domestic GHG crediting mechanism called Thailand Voluntary Emission Reduction Program (T-VER). T-VER aims to encourage the public and private sector to reduce GHG emissions while enhancing sustainable development [3].		Opportunities for forest sector participation Permissible activities to earn carbon credits include the following: • <i>Afforestation and reforestation.</i> • <i>Forest restoration and conservation.</i> • <i>Fast growing plantations</i> [3].	

3.1.11. City Forest Credits

Established: 2015	Footprint: United States	Type: Voluntary, Crediting Mechanism	Crediting: Ex-Post and Ex-Ante
Description: City forest credits are a nonprofit carbon registry that issues third-party verified City Forest Carbon+ Credits from tree planting and preservation projects in cities in the United States [111].		Opportunities for forest sector participation • <i>Preservation:</i> preservation and management of existing urban forests. • <i>Afforestation and reforestation</i> of urban forests [111].	

3.1.12. British Columbia Offset Protocol

Established: 2016	Footprint: British Columbia	Type: Voluntary, Crediting Mechanism	Crediting: Ex-Ante
Description: The British Columbia Offset Program, or the British Columbia Greenhouse Gas Emission Offset System, was created and is administered by the Government of British Columbia. Through this programme, the government Climate Action Secretariat purchases offsets to meet government-mandated carbon neutrality [112].		Opportunities for forest sector participation • <i>Afforestation or reforestation.</i> • <i>Improved forest management.</i> • <i>Conservation/avoided deforestation:</i> areas of avoided deforestation can have timber harvesting [113].	

3.1.13. Puro Earth

Established: 2019	Footprint: Global	Type: Voluntary, Crediting Mechanism	Crediting: Ex-Post
Description: Puro Earth, through its Puro Standard, issues science-based certificates that represent carbon sequestered. The Puro Standard is the first carbon removal standard for engineered carbon removal methods in the voluntary carbon market. Puro Earth's carbon credit is called the CO ₂ Removal Certificate or CORC [114].		Opportunities for forest sector participation • <i>Biochar.</i> • <i>Terrestrial storage of biomass:</i> burying woody biomass under conditions that inhibit biomass decomposition and can maintain those conditions for containment of the stored carbon for at least 100 years. • <i>Geological carbon storage:</i> allows for bioenergy carbon capture and storage, amongst other mechanisms. • <i>Bio-based construction materials:</i> use of sustainably grown wood in construction [114].	

3.1.14. Canada's Greenhouse Gas Offset Credit System

Established: 2022	Footprint: Canada	Type: Voluntary, Crediting Mechanism	Crediting: Ex-Post and Ex-Ante
Description: Canada's Greenhouse Gas Offset Credit System builds on the Pan-Canadian GHG Offsets Framework agreed between federal, provincial, and territorial governments in 2018. It exists alongside several other Canadian provincial offset mechanisms [23]. The main purpose of the system is to generate offset credits for use in the federal Output-Based Pricing System, BPS, thereby increasing the supply of compliance units for the system [3].		Opportunities for forest sector participation As it is less than two years old, the system currently only has two methods, but has many more under development, including the following: • <i>Draft—'Federal Offset Protocol: Improved Forest Management on Private Land' [115].</i>	

3.1.15. New Zealand Emissions Trading Scheme

Established: 2008	Footprint: New Zealand	Type: Compliance, ETS	Crediting: Ex-Post
Description: The New Zealand Emissions Trading Scheme (NZ ETS) was established to address the country's commitments under the Kyoto Protocol. The NZ ETS is the only ETS in the world designed to cover all sectors of the economy. The ETS places a price on emissions by requiring certain sectors to account for their greenhouse gas emissions and acquire/surrender New Zealand Units (NZUs) or other eligible emission units [48].		Opportunities for forest sector participation The NZ ETS covers forestry at a sectoral scale, in contrast to other systems that recognise forestry projects as offsetting activities. It applies mandatory liabilities for deforestation of pre-1990 forests (defined below) and the option to earn units for post-1989 afforestation [48]. The government provided pre-1990 forest landowners with an option to apply for a one-off allocation of New Zealand Units (NZUs) between 2010 and 2013. Pre-1990 forest landowners can harvest and replant their forest without any liability. But if the land is deforested, the landowner must notify the government of deforestation and pay for any emissions created through deforesting the land. Post-1989 forest landowners can apply to register as voluntary ETS participants at any time to earn NZUs for carbon sequestered by the forest. However, they must surrender NZUs when the trees are harvested or if the land is deregistered from the New Zealand ETS [19]. It is the only system in the world with symmetrical incentives that reward forest owners who afforest and make liable those who deforest [48].	

3.1.16. Saitama Target Setting Emissions Trading System

Established: 2011	Footprint: Saitama Province, Japan	Type: Compliance, ETS	Crediting: Ex-Post and Ex-Ante
Description: The Saitama Target Setting Emissions Trading System was instituted as part of the Saitama Prefecture Global Warming Strategy Promotion Ordinance. Saitama's ETS is linked to Tokyo's cap-and-trade programme, with credits mutually exchangeable between the two jurisdictions. Nested within the Saitama Target Setting Emissions Trading System is the Saitama Forest Absorption Certification System [116].		Opportunities for forest sector participation The Saitama Forest Absorption Certification System allows for the development, certification, trading, and offsetting of Forest Absorption Credits [117], where credits from forests inside Saitama Prefecture are counted at 1.5 times the value of regular credits [116]. However, there is little information available in English on the methods through which these credits can be created.	

3.1.17. South Korea Emissions Trading Scheme

Established: 2015	Footprint: South Korea	Type: Compliance, ETS	Crediting: Ex-Post and Ex-Ante
Description: The South Korea ETS is the world's third-largest compliance trading scheme behind China and the EU and was the first mandatory scheme to be launched in East Asia [118].		Opportunities for forest sector participation • Afforestation and reforestation. • Extension of the rotation age. • Vegetation restoration. • Use of wood products. • Utilisation of forest biomass energy. • Reforestation with new species. • Reforestation in areas affected by fires and pests [98].	

3.1.18. Chinese Emissions Trading Scheme

Established: 2021	Footprint: China	Type: Compliance, ETS	Crediting: Ex-Ante
Description: From 2011, China's National Development and Reform Commission approved the establishment of eight pilot carbon markets in Shenzhen (2013), Beijing (2013), Shanghai (2013), Tianjin (2013), Guangdong (2013), Hubei (2014), Chongqing (2014), and Fujian (2016) [119]. Learning from these, the national ETS was developed and implemented in 2021 and is the largest ETS in the world. It trades Chinese Certified Emissions Reductions [118].		Opportunities for forest sector participation As the Chinese ETS is relatively new, forest sector methods are still under review [120]. The forest sector methods that were available in the pilot schemes include the following: • Afforestation and reforestation. • (Improved) Forest management. • Small scale forest establishment [33].	

3.1.19. Indonesian Carbon Exchange

Established: 2023	Footprint: Indonesia	Type: Compliance, ETS	Crediting: Ex-Ante and Ex-Post
Description: Indonesia's Ministry of Environment and Forests adopted a ministerial regulation on domestic carbon trading in 2022. The ministerial regulation states that carbon credit generation and trading would be eligible in the energy, waste, industrial processes, agriculture, and forestry sectors. The Indonesian Carbon Exchange was developed to implement these [33].		Opportunities for forest sector participation • Reduction in the rate of deforestation of mineral lands: timber harvesting can occur. • Development of plantation forests. • Sustainable forest management (improved forest management). • Afforestation in ex-mining areas: timber harvesting can occur. • Rehabilitation of plants under 5 years old. • Social forestry. • Mentoring in customary forests. • Development of green open spaces. • Supervision and law enforcement to support the protection and security of forest areas (Kawasan Hutan) [33].	

3.1.20. European Emissions Trading System

Established: 2005	Footprint: European Union	Type: Compliance, ETS	Crediting: Ex-Ante and Ex-Post
Description: The European Union Emissions Trading System (EU ETS) is a cap-and-trade system that covers all of the EU countries as well as Iceland, Liechtenstein, and Norway. The UK launched its own ETS after it dropped out of the EU at the beginning of 2021 [118].		Opportunities for forest sector participation There are currently no mechanisms for the forest sector to participate in the EU ETS [55,121] (Nabuurs et al., 2015; World Bank, 2023). However, in February 2024, the European Commission agreed to regulation to establish the first EU-level certification framework for permanent carbon removals in forests, carbon farming, and carbon storage in forest products [122].	

Other mechanisms that the [3] identified as having forestry and land use sector involvement include the following: the Sakhalin Oblast Pilot crediting mechanism, Sri Lanka Carbon Crediting Mechanism, Switzerland CO₂ Attestations Crediting Mechanism, and the Colombia Crediting Mechanism. However, no further information on the types of forest sector specific opportunities could be found.

4. Discussion

Internationally, countries have recognised the importance of, and their moral responsibility to, manage their forests and meet domestic demand for forest products [15]. This is seen as part of the solution to climate change through establishing bio-economies based on sustainable biomass [55,123]. Forest management as a climate change solution is now being recognised by carbon markets, which are globally preferencing nature-based carbon removal credits over avoided-emissions credits [124]. This is because forest carbon projects actively enhance forest sinks to provide a range of co-benefits beyond carbon sequestration, such as for biodiversity, water quality, soil productivity, ecosystem resilience to climate change impacts, and human wellbeing [48]. These preferences are also now being exhibited in the Australian carbon market through the higher purchase price of nature-based carbon removal credits, including those from the Plantations and REMP methods [89].

Australia, the seventh most forested nation [69], has a substantial forest sector managing and expanding these forests [12]. Successive Australian governments have aimed to expand the forest estate through ambitious policies like “A Billion Trees for Jobs and Growth” [125]. With global timber demand projected to triple from 2.2 billion m³ in 2020 to 5.8 billion m³ by 2050 [126], there is significant potential for the forest sector to contribute to Australia’s greenhouse gas reduction targets.

However, the potential role of the forest sector in mitigating climate change, although substantial, has been largely overlooked in Australian climate change policy. Only 3.27% of all ACCUs issued to date have been to forest sector projects, and less than 1% of Australia’s native and plantation forests can currently participate in the ACCU Scheme [17]. This is because there are a range of barriers limiting forest sector participation [11,18,19]. Some of these barriers, such as the ACCU Scheme’s complexity, cost of participation, and low carbon price, are being overcome as the scheme and the market matures. However, the key barriers—a lack of methods available to the forest sector, and those that are available being subject to internal constraints—remain.

This low level of forest sector participation in carbon markets is not mirrored in the major international carbon markets. This study identified that forest sector opportunities are prevalent in the top five international voluntary markets, being the Verified Carbon

Standard, Californian Compliance Offset Program, Gold Standard, American Carbon Registry, and Climate Action Reserve [3,90], along with the top four compliance markets by size, including the Chinese ETS, EU ETS, California Compliance Offset Program, and the South Korean ETS [3]. Forest sector projects, encompassing 21 types, accounted for 46% of the voluntary market share in 2021 [23]. Specifically, forest projects make up over 50% of the South Korean ETS [98]. For the Californian Compliance Offset Program, forest offset credits account for 85% of all carbon credits issued under that scheme until 2022, with the majority of these coming from improved forest management methods [99].

The two most recent external reviews of Australia's carbon market, the King Review [18] and the Chubb Review [11], both found that there is a need for new methods to increase participation and provide the carbon abatement that is predicted to be required for Australia to meet its GHG reduction commitments. Furthermore, the Chubb review found that, to achieve this, a new proponent-led method development approach was required. The Australian Government has responded to the Chubb Review [39] and is developing this proponent-led method development process. This will provide the opportunity to many of current barriers to forest sector participation to be overcome.

Learning from forest sector participation in international carbon markets, there are many options to increase forest sector participation in Australia, ranging from addressing the constraints within the current methods and the development of new methods based on those that exist in other carbon markets to increasing participation in international voluntary markets.

4.1. Method and Model Improvements

Current ACCU Scheme methods available to the forest sector have a number of constraints which, if resolved, would increase opportunities and sector participation in the scheme. Key barriers that are not already on a pathway to resolution, for which variations could be proposed, include changes to modelling, method prescriptions, and project crediting.

Carbon abatement for forest sector projects is calculated using FullCAM, Australia's land sector carbon accounting model, which is guided by the FullCAM guidelines [93]. However, FullCAM is a continent-wide model, and point-in-time input parameters fail to capture certain nuanced, geographically specific dynamics, such as the misrepresentation of Tasmanian long-rotation plantation hardwood sawlogs as export pulp logs [127]. This could be rectified by allowing proponents to seek changes to the FullCAM guidelines. Separately, carbon stored in harvested wood products placed in landfill is not currently accounted for in FullCAM's eligible abatement for forest sector projects, while it is included in Australia's GHG accounts [128]. Addressing this by including, in the method, an "end of life storage" pool could lead to an increase in project abatement by up to 15% for current forest sector projects [43].

There are a range of highly specific eligibility criteria or prescriptions within the forest sector methods that could be removed or adjusted. These include the following: removing the need to have project within 50 km of a national plantation inventory region; allowing for the inclusion of alternative plantation species, such as very short rotation woody crops; and providing options for existing plantations greater than their arbitrary short rotation maximum age, for example, 21 years [75]. Finally, as detailed in the King review [18], allowing for all forest sector methods to award ACCUs on a compressed timeframe would align incentives with when projects incur their major costs would reduce the barriers faced by projects with high upfront capital costs.

4.2. New Methods

The analysis of international schemes revealed a range of potential new forest sector methods that could be adopted in the ACCU Scheme.

4.2.1. Small-Scale Plantings

King et al. [18] recommended that the then-ERF create a small-scale method for small plantations of shelterbelts. These small-scale methods could have streamlined measurement, reporting, and verification requirements, reducing transaction costs and driving participation from farm-scale forest projects. The model for this method could be based on the NZ ETS, whereby, for forest areas, less than 100 ha participants can use look-up tables that give pre-calculated values for a forest's carbon stock based on its age, region, and forest type, thus avoiding the need for costly carbon service providers. In addition to this, independent third-party verification is required in emission reports, but the government could conduct a sample of audits each year. This would avoid the costs of engaging project auditors, therefore making small-scale planting project more economically viable [48].

4.2.2. Utilisation of Forest Residues

Forest residues are created from the harvest of trees and conversion of logs into finished wood products, and the amount varies with forest type, tree species, silviculture, and local markets. Harvest residues range from 22% to 53% of the tree biomass for native forests and 15% to 25% for plantations [43]. It is a resource that is often underutilised, and it is suitable for a number of applications that could also store carbon or reduce GHG emissions through substituting fossil fuels. Therefore, a method(s) could be created for emissions avoided and, in some cases, both emissions avoided and sequestration projects. Examples include using residues for applications such as bioenergy, bioenergy carbon capture and storage, biochar, or simply by burial.

Bioenergy generation can be considered as carbon-neutral because the released CO₂ when converting sustainably derived biomass to energy is part of the natural short-term cycle of plant growth [51]. Forest residue bioenergy methods are explicitly available in international schemes such as the South Korean ETS [98] and several others through the improved forest management methods. This can be taken one step further with bioenergy carbon capture and storage (BECCS), which is a carbon removal technology that involves converting biomass (organic material) into energy and capturing carbon emissions released from the conversion process and storing them into geological formations. BECCs both substitutes fossil fuel emissions and puts the once-biogenic carbon into long-term storage. It is, therefore, considered a negative-emissions technology [129]. BECCs is an available method under Puro Earth [114].

Biochar can be created by burning forest residues in low-oxygen environments, where it is turned into a stable long-term carbon store that can be used to for a range of purposes such as soil amendment, water filtration, and road-making [114]. The creation and utilisation of biochar is available in many international methods, including the world's largest voluntary scheme the Verified Carbon Standard [107].

Puro Earth has also recently released a method called “wood vault” or “terrestrial storage of biomass” for projects which bury wood in the soil, under conditions which inhibit decomposition. It was based on research finding that, after 100 years, 95% of the carbon remains in woody biomass buried below the sub-soil [114].

4.2.3. Native Forest Restoration

Currently, low or declining carbon stocks in native forests may be due to multiple fires, grazing, or past harvesting practises. This can result in areas that are unstocked

or, alternatively, highly stocked dense stands of small trees or forest canopies that may be susceptible to dieback and decline due to pests and diseases. Activities to increase carbon stocks include re-seeding, ecological thinning, thinning of invasive native scrub, extending harvest cycles or rotation lengths, enrichment planting, improving natural regeneration by excluding or modifying grazing and removing feral animals, or halting other agents of decline or dieback [19]. There are areas of Australia that have experienced multiple wildfires in short intervals and have passed their tolerable fire intervals, and, therefore, have not returned as forest or an altered forest with a much lower carbon carrying capacity [130]. These areas would be candidates for such a project. A native forest restoration method or methods that would allow for restoration projects are available in most of the 20 international schemes identified in this study.

4.2.4. Timber Construction

The forest sector and its climate benefits extend beyond forests into the bioeconomy and built environment. However, there are no opportunities within the ACCU Scheme for encouraging uptake of forests products that provide a demonstrable climate benefit. An increase in the market share of timber in buildings has the climate benefit both from the carbon storage in the products and displacement of greenhouse-intensive alternatives, as well as the additional carbon sequestration in new forests required to meet the increased demand for wood products [22]. Projects that use wood in construction are permissible in the South Korean ETS [98], Indonesian Carbon Exchange [33], and Puro Earth [114], and implicitly through many of those markets that have improved forest management methods.

4.2.5. Fire Management

Fuel load management practises such as indigenous fire management, fuel reduction burning, and mechanical removal of biomass can help mitigate the risk of destructive wildfires and maintain forest carbon stocks [131,132]. The VCS currently has a methodology for avoiding forest degradation through fire management methods that is currently being updated [107].

4.2.6. Forest Thinning

There are a range of forests in Australia that may be degraded or overstocked, which may benefit from thinning activities. Thinning activities involve the removal of individual trees to achieve certain management outcomes. Those can be production-driven to increase the quality of larger merchantable products or driven by ecological and or cultural outcomes [80]. Although thinning initially reduces forest carbon stock, it can stimulate compensatory growth and have a medium- to long-term positive carbon outcome, depending on the use of thinned wood [82]; for example, if the biomass derived from thinning were utilised as forest products or to substitute emissions-intensive energy sources [43]. Thinning of native forest is occurring at scale within Australia, with the climate benefits of management activity being the key driver. For example, the Western Australian Government is aiming to thin up to 9000 ha of native forest a year to increase forest carbon stocks and make forests more resilient to climate change. The key assumption is that trees in thin forests grow and mature faster and are, therefore, more resilient to climate change and disturbance, thus avoiding the release of carbon through combustion or mortality [133]. Thinning is an acceptable management option in all of those markets that use integrated forest management methods.

4.2.7. Improved Forest Management

Improved forest management (IFM) methods allow for a range of forest management activities to take place within forests. Individual or multiple activities can occur in a single

project. These activities range from those already identified in this section in addition to conservation, forest health management [107], social forestry [33], extended rotation cycles, and changing mix of logs to longer-lived products [98]. These could all be standalone methods, but it is likely to be administratively less burdensome for both the regulator and the project proponent if a forest manager could undertake a range in activities on their estate through the one method. An integrated approach which maximises inclusion (in terms of project size, tenure type, jurisdiction, and activity types) would allow for the optimisation of carbon within a forest estate. Forests are not homogeneous, and neither are the management approaches that are optimal for carbon management. For example, on one forest estate, a project proponent could conserve an area of high carbon and conservation value from harvesting, treat an area of overstocked or unhealthy forest, and divert forest products into longer-lived products, all in one project.

Improved forest management methods are available in the main voluntary markets, the VCS [107], Plan Vivo [101], Climate Action Reserve [104], and American Carbon Reserve [100], and within the Gold Standard, it is an eligible project scope; therefore, proponents can seek to develop an improved forest management method [105]. IFM methods are also available in many of the compliance markets, such as Canada's Greenhouse Gas Offset Protocol Credit System [115], British Columbia Offset Protocol [113], Chinese Emissions Trading Scheme [33], J-Credit Scheme [110], and the California Compliance Offset Program [85]. In the international voluntary carbon markets, there are 293 IFM offset projects that have produced 11% of the total voluntary offset credits to date [90]. There are likely to be more, but project-level details are not publicly available for compliance markets.

4.3. Participation in International Markets

Australian forest sector carbon project proponents are eligible to participate in many of the international voluntary carbon markets; however, participation to date has been low. This is likely attributable to the low and variable prices of international credits [88], relatively high ACCU prices, the complexity of participation, and a lack of understanding on how to participate [90]. Eight examples of Australian afforestation/reforestation and improved forest management projects now exist within international markets. Seven are registered in the VCS [90]. The largest project, the Yarra Yarra Biodiversity Corridor, a 21,000 hectare aggregated environmental planting initiative, is registered under the Gold Standard [134].

Similar to the trend observed in Australia, differentiation in the price of carbon is starting to occur in international voluntary markets, with forest sector credits achieving a premium [88]. For instance, in 2022, an all-time high average price of USD 7.37 per tonne of CO₂-e was observed for international voluntary market credits [88], whereas the Yarra Yarra Biodiversity Corridor project seeks close to AUD 40 per tonne of carbon for its offsets [134]. Therefore, if more carbon project opportunities cannot be realised by the forestry sector within the ACCU Scheme, increasing awareness of the opportunities in international markets and rising international forest carbon prices could see an increase in participation from Australian proponents in international carbon markets.

5. Conclusions

This study highlights the extensive involvement of the forest sector in international carbon markets and the diverse methods employed across 20 markets, offering a blueprint for Australia to enhance its forest sector's engagement in carbon markets.

To capitalise on these opportunities, several actionable strategies are suggested. These include revising existing methods, developing new methods through the ACCU Scheme's proponent-led method development process, and increasing participation in international

voluntary methods. Such initiatives could significantly expand the types of forest sector projects contributing to emissions reductions through carbon markets. By embracing lessons from international practises and addressing current methodological constraints, Australia can realise this potential. This would bolster the nation's climate change mitigation efforts and unlock co-benefits such as biodiversity, water quality, soil productivity, and ecosystem resilience, ultimately contributing to a sustainable and resilient bioeconomy.

6. Limitations

This paper identifies several limitations and recommendations for further work. It notes that, while the number of forest methods available in international markets was presented, further research is needed to determine the extent of participation in these methods. Additionally, some markets, such as the Chinese Emissions Trading Scheme, Thailand Voluntary Emissions Reduction Program, and the J-Credit Scheme, had limited information available in English, suggesting a need for translation efforts. The rapidly evolving nature of carbon markets means that policy or market changes during the timeframe of the study could impact the findings. Moreover, the methodology used in this study did not search every research database, which limits the comprehensiveness of the review. Despite the best efforts of the authors, there may still be references that were inadvertently missed. The vast and ever-growing body of literature makes it challenging to capture every pertinent study. Lastly, the was a desktop literature review, and engaging a wider range of stakeholders, including policymakers, industry representatives, and local communities, could lead to more holistic and effective forest carbon market strategies.

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Note

- ¹ Carbon dioxide equivalent CO₂-e means the number of metric tons of CO₂ emissions with the same global warming potential as one metric ton of another greenhouse gas.

References

1. Cattiaux, J.; Ribes, A.; Cariou, E. How Extreme Were Daily Global Temperatures in 2023 and Early 2024? *Geophys. Res. Lett.* **2024**, *51*, e2024GL110531. [CrossRef]
2. Damon Matthews, H.; Wynes, S. Current global efforts are insufficient to limit warming to 1.5 °C. *Science* **2022**, *376*, 1404–1409. [CrossRef] [PubMed]
3. World Bank. Carbon Pricing Dashboard 2024. Available online: <https://carbonpricingdashboard.worldbank.org> (accessed on 24 January 2024).
4. IPCC. *Sixth Assessment Report*; IPCC: Cambridge, UK, 2021.
5. Giebank, C.L.; Domke, G.M.; Fisher, R.A.; Heilman, K.A.; Moore, D.J.P.; DeRose, R.J.; Evans, M.E.K. The policy and ecology of forest-based climate mitigation: Challenges, needs, and opportunities. *Plant Soil.* **2022**, *479*, 25–52. [CrossRef]
6. Climate Change Authority. *Reduce, Remove and Store—The Role of Carbon Sequestration in Accelerating Australia's Decarbonisation*; Climate Change Authority: Canberra, Australia, 2023.

7. Sullivan, P.; Lewis, S.L.; Affum-Baffoe, K.; Castilho, C.; Costa, F.; Cuni Sanchez, A.; Ewango, C.E.N.; Hubau, W.; Marimon, B.; Monteagudo-Mendoza, A.; et al. Long-term thermal sensitivity of Earth's tropical forests. *Science* **2020**, *368*, 869–874. [[CrossRef](#)] [[PubMed](#)]
8. UNFCCC. *Adoption of the Paris Agreement Report No. United Nations Framework Convention on Climate Change*; UNFCCC: Bonn, Germany, 2015.
9. UN. *Paris Agreement*; UN: New York, NY, USA, 2015.
10. UN. *Kyoto Protocol to the United Nations Framework Convention on Climate Change*; UN: New York, NY, USA, 1998.
11. Chubb, I.; Bennett, A.; Gorrington, A.; Hstfield-Dodds, S. *Independent Review of Australia Carbon Credit Units*; Department of Climate Change, Energy, the Environment and Water (Australia): Canberra, Australia, 2022.
12. ABARES. *Australia State of the Forests Report 2018*; ABARES: Canberra, Australia, 2018.
13. Climate Change Authority. *2023 Annual Progress Report*; Climate Change Authority: Canberra, Australia, 2023.
14. AFPA. *Australia Forest Products Association—Annual Report 2022–2023*; AFPA: Canberra, Australia, 2023.
15. Raison, R.J. A review of the impacts of sustainable harvesting, non-harvest management and wildfire on net carbon emissions from Australia native forests. *Aust. For.* **2024**, *87*, 167–194. [[CrossRef](#)]
16. CER Vegetation Methods. ACCU Scheme Vegetation Methods 2024. Available online: <https://cer.gov.au/schemes/australian-carbon-credit-unit-scheme/accu-scheme-methods#vegetation-methods> (accessed on 1 February 2024).
17. CER. Emissions Reduction Fund Project Register 2024. Available online: <https://www.cleanenergyregulator.gov.au/ERF/project-and-contracts-registers/project-register> (accessed on 27 January 2024).
18. King, G.; Smith, S.; Parker, D.; Macintosh, A. Report of the Expert Panel Examining Additional Sources of Low Cost Abatement. 2020. Available online: <https://www.dccew.gov.au/climate-change/publications/examining-additional-sources-of-low-cost-abatement-expert-panel-report> (accessed on 2 January 2024).
19. Keenan, R.; Ryan, Z.; Stewart, H. *Climate Change and Carbon Policy Assessment Report*; Prepared for the North-North West Tasmania Regional Forestry Hub; University of Melbourne: Melbourne, Australia, 2020.
20. Moroni, M. *The Role of Forest Management in Greenhouse-Gas Mitigation: A Contextual Framework for AUSTRALIA*; Forest & Wood Products Australia: Melbourne, Australia, 2011. [[CrossRef](#)]
21. Ximenes, F.; George, B.H.; Cowie, A.; Williams, J.; Kelly, G. Greenhouse gas balance of native forests in New South Wales. *Forests* **2012**, *3*, 653–683. [[CrossRef](#)]
22. FAO. *Forestry for a Low-Carbon Future: Integrating Forests and Wood Products in Climate Change Strategies*; FAO: Rome, Italy, 2016.
23. Pan, C.; Li, C.; An, A.; Deng, G.; Lin, J.; He, J.; Li, J.F.; Zhu, X.; Zhou, G.; Shrestha, A.K.; et al. Canada's Green Gold: Unveiling Challenges, Opportunities, and Pathways for Sustainable Forestry Offsets. *Forests* **2023**, *14*, 2206. [[CrossRef](#)]
24. Gorte, W.; Ramseur, J. *Forest Carbon Market Potential and Drawbacks*; DIANE Publishing: Collingdale, PA, USA, 2008.
25. DFAT. International Cooperation on Climate Change 2023. Available online: <https://www.dfat.gov.au/international-relations/themes/climate-change/international-cooperation-on-climate-change> (accessed on 9 January 2024).
26. Argent, D.; Arndt, C.; Miller, M.; Tarp, F.; Zinerman, O. *The Political Economy of Clean Energy Transitions*; Oxford University Press: Oxford, UK, 2017.
27. Lucatello, S. *Springer Climate Towards an Emissions Trading System in Mexico*; Springer: Berlin/Heidelberg, Germany, 2020.
28. Böhm, S.; Dabhi, S. *Upsetting the Offset: The Political Economy of Carbon Markets Accounting for the Sustainable Livelihoods of Smallholder Farmers View Project*; MayFlyBooks: London, UK, 2009.
29. Pigou, A. *The Economics of Welfare*, 4th ed.; MacMillan: London, UK, 1932.
30. Grubb, M.; Hourcade, J.; Neuhoof, K. The Three Domains structure of energy-climate transitions. *Technol. Forecast. Soc. Change* **2015**, *98*, 290–302. [[CrossRef](#)]
31. Gulbrandsen, L.H.; Wettstad, J.; Victor, D.G.; Underdal, A. The political roots of divergence in carbon market design: Implications for linking. *Clim. Policy* **2019**, *19*, 427–438. [[CrossRef](#)]
32. Döbbling-Hildebrandt, N.; Miersch, K.; Khanna, T.M.; Bachelet, M.; Bruns, S.B.; Callaghan, M.; Edenhofer, O.; Flachsland, C.; Forster, P.M.; Kalkuhl, M.; et al. Systematic review and meta-analysis of ex-post evaluations on the effectiveness of carbon pricing. *Nat. Commun.* **2024**, *15*, 4147. [[CrossRef](#)]
33. World Bank. *State and Trends of Carbon Pricing 2023*; World Bank: Washington, DC, USA, 2023.
34. Graeme, M.; Knaggs, C. *Tasmanian Carbon Markets*; Point Advisory: Melbourne, Australia, 2021.
35. Haya, B.K.; Evans, S.; Brown, L.; Bukoski, J.; Butsic, V.; Cabiyo, B.; Jacobson, R.; Kerr, A.; Potts, M.; Sanchez, D.L. Comprehensive review of carbon quantification by improved forest management offset protocols. *Front. For. Glob. Change* **2023**, *9*, 958879. [[CrossRef](#)]
36. Kumarasiri, J.; Lodhia, S. The Australia carbon tax: Corporate perceptions, responses and motivations. *Meditari Account. Res.* **2020**, *28*, 515–542. [[CrossRef](#)]

37. Ximenes, F.; Smith, H. *Production Forest Methodologies for the Emissions Reduction Fund*; Forest & Wood Products Australia: Melbourne, Australia, 2019; Available online: <https://fwpa.com.au/report/production-forest-methodologies-for-the-emissions-reduction-fund/> (accessed on 14 January 2024).
38. Vass, M. Renewable energies cannot compete with forest carbon sequestration to cost-efficiently meet the EU carbon target for 2050. *Renew. Energy* **2017**, *107*, 164–180. [CrossRef]
39. CER. About the ACCU Scheme 2023. Available online: <https://www.cleanenergyregulator.gov.au/ERF/About-the-Emissions-Reduction-Fund> (accessed on 13 January 2024).
40. Macintosh, A.; Butler, D.; Ansell, D.; Waschka, M. *The Emissions Reduction Fund (ERF): Problems and Solutions*; The Australia National University: Canberra, Australia, 2023.
41. Papa, C.C.; DeLyser, K.; Clay, K.; Gadoth-Goodman, D.; Cooper, L.; Kurz, W.A.; Magnan, M.; Ontl, T. Modeling climate-smart forest management and wood use for climate mitigation potential in Maryland and Pennsylvania. *Front. For. Glob. Change* **2023**, *6*, 1259010. [CrossRef]
42. Zhao, M.; Yang, J.; Zhao, N.; Wilson, J. Estimation of the relative contributions of forest areal expansion and growth to China's forest stand biomass carbon sequestration from 1977 to 2018. *J. Environ. Manag.* **2021**, *300*, 113757. [CrossRef]
43. Ximenes, F. *Forests Plantations Wood Products and Australia's Carbon Balance*; Forest & Wood Products Australia: Melbourne, Australia, 2023.
44. Pan, Y.; Birdsey, R.A.; Fang, J.; Houghton, R.; Kauppi, P.E.; Kurz, W.A.; Phillips, O.L.; Shvidenko, A.; Lewis, S.L.; Canadell, J.G.; et al. A large and persistent carbon sink in the world's forests. *Science* **2011**, *333*, 988–993. [CrossRef]
45. Bonan, G. Forests and Climate Change: Forcings, Feedbacks, and the Climate Benefits of Forests. *Science* **2008**, *320*, 1444–1449. [CrossRef]
46. Van Kooten, G.C.; Johnston, C.M.T. The economics of forest carbon offsets. *Annu. Rev. Resour. Econ.* **2016**, *8*, 227–246. [CrossRef]
47. IPCC. *Guidelines for National Greenhouse Gas Inventories*; Agriculture Forestry and Other Land Use; IPCC: Cambridge, UK, 2006; Volume 4.
48. Carver, T.; Dawson, P.; O'Brien, S.; Kotula, H.; Kerr, S.; Leining, C. Including forestry in an emissions trading scheme: Lessons from New Zealand. *Front. For. Glob. Change* **2022**, *5*, 956196. [CrossRef]
49. Bastin, J.-F.; Finegold, Y.; Garcia, C.; Mollicone, D.; Rezende, M.; Routh, D.; Sacande, M.; Sparrow, B.; Zohner, C.M.; Crowther, T.W. The global tree restoration potential. *Science* **2019**, *365*, 76–79. [CrossRef]
50. Kauppi, P.E.; Stål, G.; Arneson-Ceder, L.; Hallberg Sramek, I.; Hoen, H.F.; Svensson, A.; Wernick, I.K.; Höglberg, P.; Lundmark, T.; Nordin, A. Managing existing forests can mitigate climate change. *For. Ecol. Manag.* **2022**, *513*, 120186. [CrossRef]
51. Favero, A.; Daigneault, A.; Sohngen, B. Forests: Carbon Sequestration, Biomass Energy, or Both? *Sci. Adv.* **2020**, *6*, eaay6792. [CrossRef] [PubMed]
52. Harmon, M.; Ferrell, W.; Franklin, J. Effects on carbon storage of conversion of old-growth forests to young forests. *Science* **1990**, *247*, 699–702. [CrossRef] [PubMed]
53. Lippke, B.; Oneil, E.; Harrison, R.; Skog, K.; Gustavsson, L.; Sathre, R. Life cycle impacts of forest management and wood utilization on carbon mitigation: Knowns and unknowns. *Carbon Manag.* **2011**, *2*, 303–333. [CrossRef]
54. Oliver, C.D.; Nassar, N.T.; Lippke, B.R.; McCarter, J.B. International wood trade and forest change: A global analysis. *J. Sustain. For.* **2014**, *33*, 947–956. [CrossRef]
55. Nabuurs, G.-J.; Delacote, P.; Ellison, D.; Hanewinkel, M.; Lindner, M.; Nesbit, M.; Ollikainen, M.; Savaresi, A. *A New Role for Forests and the Forest Sector in the EU Post-2020 Climate Targets*; European Forest Institute: Joensuu, Finland, 2015; pp. 1–36. [CrossRef]
56. Cintas, O.; Berndes, G.; Cowie, A.L.; Egnell, G.; Holmström, H.; Ågren, G.I. The climate effect of increased forest bioenergy use in Sweden: Evaluation at different spatial and temporal scales. *Wiley Interdiscip. Rev. Energy Environ.* **2016**, *5*, 351–369. [CrossRef]
57. Daigneault, A.; Baker, J.S.; Guo, J.; Lauri, P.; Favero, A.; Forsell, N.; Johnston, C.; Ohrel, S.B.; Sohngen, B. How the future of the global forest sink depends on timber demand, forest management, and carbon policies. *Glob. Environ. Change* **2022**, *76*, 102582. [CrossRef]
58. Forster, E.J.; Healey, J.R.; Dymond, C.; Styles, D. Commercial afforestation can deliver effective climate change mitigation under multiple decarbonisation pathways. *Nat. Commun.* **2021**, *12*, 3831. [CrossRef]
59. Gustavsson, L.; Haus, S.; Lundblad, M.; Lundström, A.; Ortiz, C.A. Climate change effects of forestry and substitution of carbon-intensive materials and fossil fuels. *Renew. Sustain. Energy Rev.* **2017**, *67*, 612–624. [CrossRef]
60. Wernick, I.K.; Kauppi, P.E. Storing carbon and growing forests. *Land Use Policy* **2022**, *121*, 106319. [CrossRef]
61. Kim, S.J.; Baker, J.S.; Sohngen, B.L.; Shell, M. Cumulative global forest carbon implications of regional bioenergy expansion policies. *Resour. Energy Econ.* **2018**, *53*, 198–219. [CrossRef]
62. Peterson St-Laurent, G.; Hagerman, S.; Hoberg, G. Barriers to the development of forest carbon offsetting: Insights from British Columbia, Canada. *J. Environ. Manag.* **2017**, *203*, 208–217. [CrossRef] [PubMed]

63. Petersson, H.; Ellison, D.; Appiah Mensah, A.; Berndes, G.; Egnell, G.; Lundblad, M.; Lundmark, T.; Lundström, A.; Stendahl, J.; Wikberg, P. On the role of forests and the forest sector for climate change mitigation in Sweden. *GCB Bioenergy* **2022**, *14*, 793–813. [CrossRef]
64. Smyth, C.E.; Xu, Z.; Lemprière, T.C.; Kurz, W.A. Climate change mitigation in British Columbia's forest sector: GHG reductions, costs, and environmental impacts. *Carbon Balance Manag.* **2020**, *15*, 21. [CrossRef]
65. IPCC. *Fourth Assessment Report: Climate Change*; IPCC: Cambridge, UK, 2007.
66. IPCC. Summary for Policymakers. In *Climate Change and Land: An IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse Gas Fluxes in Terrestrial Ecosystems*; IPCC: Cambridge, UK, 2019.
67. Keith, H.; Lindenmayer, D.; MacKey, B.; Blair, D.; Carter, L.; McBurney, L.; Okada, S.; Konishi-Nagano, T. Managing temperate forests for carbon storage: Impacts of logging versus forest protection on carbon stocks. *Ecosphere* **2014**, *5*, 1–34. [CrossRef]
68. Peng, L.; Searchinger, T.D.; Zions, J.; Waite, R. The carbon costs of global wood harvests. *Nature* **2023**, *620*, 110–115. [CrossRef]
69. ABARES. *Australia State of the Forests Report—Indicator 1.1a.i*; ABARES: Canberra, Australia, 2023.
70. Ritchie, H. Forest Area. Our World in Data 2021. Available online: <https://ourworldindata.org/forest-area> (accessed on 20 February 2024).
71. ABS. Population 2024. Available online: <https://www.abs.gov.au/statistics/people/population> (accessed on 15 January 2024).
72. Paul, K.I.; Roxburgh, S.H.; England, J.R. Sequestration of carbon in commercial plantations and farm forestry. *Trees For. People* **2022**, *9*, 100284. [CrossRef]
73. Ameray, A.; Bergeron, Y.; Valeria, O.; Girona, M.M.; Cavard, X. Forest Carbon Management a Review of Silvicultural Practices. *Curr. For. Rep.* **2021**, *7*, 245–266. [CrossRef]
74. Kaarakka, L.; Cornett, M.; Domke, G.; Ontl, T.; Dee, L.E. Improved forest management as a natural climate solution: A review. *Ecol. Solut. Evid.* **2021**, *2*, e12090. [CrossRef]
75. CER. *Understanding your Plantation Forestry Project*; CER: Canberra, Australia, 2022.
76. Fargione, J.E.; Bassett, S.; Boucher, T.; Bridgham, S.D.; Conant, R.T.; Cook-Patton, S.C.; Ellis, P.W.; Falcucci, A.; Fourqurean, J.W.; Gopalakrishna, T.; et al. Natural climate solutions for the United States. *Sci. Adv.* **2018**, *4*, eaat1869. [CrossRef]
77. Gan, J.; McCarl, B.A. Measuring transnational leakage of forest conservation. *Ecol. Econ.* **2007**, *64*, 423–432. [CrossRef]
78. Hurteau, M.D.; North, M. Carbon recovery rates following different wildfire risk mitigation treatments. *For. Ecol. Manag.* **2010**, *260*, 930–937. [CrossRef]
79. Davis, D.; Lopez Peralta, M.; Eckard, R.; Brear, R. *Downscaling—The Role of Forestry in Enhancing the Australia Land CO₂ Sink*; Net Zero Australia: Melbourne, Australia, 2023.
80. Houghton, R.A. Potential and economic efficiency of carbon sequestration in forest biomass through silvicultural management. *Glob. Chang. Biol.* **1994**, *40*, 429–451.
81. Huynh, T.; Lee, D.J.; Lewis, T.; Applegate, G. Effects of site characteristics and stand management on biomass and carbon sequestration in spotted gum (*Corymbia citriodora* subsp. *variegata*) plantations. *For. Ecol. Manag.* **2023**, *529*, 120725. [CrossRef]
82. Zhang, H.; Liu, S.; Yu, J.; Li, J.; Shanguan, Z.; Deng, L. Thinning increases forest ecosystem carbon stocks. *For. Ecol. Manag.* **2024**, *555*, 121702. [CrossRef]
83. Cowie, A.L.; Berndes, G.; Bentsen, N.S.; Brandão, M.; Cherubini, F.; Egnell, G.; George, B.; Gustavsson, L.; Hanewinkel, M.; Harris, Z.M.; et al. Applying a science-based systems perspective to dispel misconceptions about climate effects of forest bioenergy. *GCB Bioenergy* **2021**, *13*, 1210–1231. [CrossRef]
84. Miller, K.; Snyder, S.; Kilgore, M.; Davenport, M. Family forest landowners interest in forest carbon offset programs. USA. *Environ. Manag.* **2014**, *54*, 1399–1411. [CrossRef]
85. CARB. *California Air Resources Board*; CARB: Los Angeles, CA, USA, 2024.
86. Foster, B.C.; Wang, D.; Auld, G.; Cuesta, R.M.R. Assessing audit impact and thoroughness of VCS forest carbon offset projects. *Environ. Sci. Policy* **2017**, *78*, 121–141. [CrossRef]
87. Lee, D.; Kim, D.; Kim, S. Characteristics of forest carbon credit transactions in the voluntary carbon market. *Clim. Policy* **2018**, *18*, 235–245. [CrossRef]
88. Donofrio, S.; Procton, A. *State of the Voluntary Carbon Markets 2023*; Ecosystem Marketplace: Washington, DC, USA, 2023.
89. Clima. ACCU Bull Market Beckons; Clima: 2024. Available online: <https://www.clima.com.au/blog/2024/01/26/accu-bull-market-beckons> (accessed on 2 February 2024).
90. So, S.; Haya, B.K.; Elias, M. Voluntary Registry Offsets Database Version 9. 2023. Available online: <https://gspp.berkeley.edu/research-and-impact/centers/cepp/projects/berkeley-carbon-trading-project/offsets-database> (accessed on 3 March 2024).
91. Grover, I.; Sutor, S.; O'Reilly-Wapstra, J.; Tocock, M.; Volker, P.; Hatton MacDonald, D. The adoption of natural capital accounting: Lessons from the Tasmanian forest management system. *For. Policy Econ.* **2025**, *172*, 103441. [CrossRef]
92. Kelly, E.C.; Schmitz, M.B. Forest offsets and the California compliance market: Bringing an abstract ecosystem good to market. *Geoforum* **2016**, *75*, 99–109. [CrossRef]

93. CER. *FullCAM Guidelines*; CER: Canberra, Australia, 2022.
94. Moher, D.; Liberati, A.; Tetzlaff, J.; Altman, D.G. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *PLoS Med.* **2009**, *6*, 1000097. [CrossRef] [PubMed]
95. Grover, I.; O'Reilly-Wapstra, J.; Sutor, S.; Hatton MacDonald, D. Not seeing the accounts for the forest: A systematic literature review of ecosystem accounting for forest resource management purposes. *Ecol. Econ.* **2023**, *212*, 107922. [CrossRef]
96. IPCC. What is the Kyoto Protocol? 2023. Available online: https://unfccc.int/kyoto_protocol (accessed on 9 January 2024).
97. Pan, C.; Shrestha, A.; Innes, J.L.; Zhou, G.; Li, N.; Li, J.; He, Y.; Sheng, C.; Niles, J.-O.; Wang, G. Key challenges and approaches to addressing barriers in forest carbon offset projects. *J. For. Res.* **2022**, *33*, 1109–1122. [CrossRef]
98. Woo, H.; Acuna, M.; Choi, B.; Kim, J. Net revenue of forest carbon offset projects: Application of the Korean emission trading system in the forestry sector. *Forests* **2021**, *12*, 742. [CrossRef]
99. Stapp, J.; Nolte, C.; Potts, M.; Baumann, M.; Haya, B.K.; Butsic, V. Little evidence of management change in California's forest offset program. *Commun. Earth Environ.* **2023**, *4*, 331. [CrossRef]
100. ACR. ACR Website 2024. Available online: <https://acrcarbon.org/methodology/active-conservation-us/> (accessed on 25 February 2024).
101. Berry, N. Agriculture and Forestry Carbon Benefit Assessment Methodology. 2023. Available online: <https://www.planvivo.org/pm001> (accessed on 12 February 2025).
102. Parajuli, R.; Megalos, M.; Ruseva, T.; Chizmar, S.; Fisher, M. An Introduction to Forest Carbon Offset Markets. 2019. Available online: <https://content.ces.ncsu.edu/an-introduction-to-forest-carbon-offset-markets> (accessed on 14 February 2024).
103. Jo, J.H.; Roh, T.; Hwang, J.; Lee, K.H.; Lee, C. Factors and paths affecting payment for forest ecosystem service: Evidence from voluntary forest carbon market in South Korea. *Sustainability* **2020**, *12*, 7009. [CrossRef]
104. CAR. Climate Action Reserve—Protocols. *Climate Action Reserve Website* 2024. Available online: <https://www.climateactionreserve.org/how/protocols/#ncs> (accessed on 25 February 2024).
105. Gold Standard. *Gold Standard*; Gold Standard: Geneva, Switzerland, 2024; Available online: <https://www.goldstandard.org> (accessed on 12 February 2024).
106. Gold Standard. *Land Use and Forest Activity Requirements*; Gold Standard: Geneva, Switzerland, 2020; Available online: <https://globalgoals.goldstandard.org/203-ar-luf-activity-requirements/> (accessed on 12 February 2024).
107. Verra. Verified Carbon Standard. *Verified Carbon Standard Website* 2024. Available online: <https://verra.org/programs/verified-carbon-standard/> (accessed on 23 February 2024).
108. UK Woodland Carbon Code. UK Woodland Carbon Code. 2024. Available online: <https://woodlandcarboncode.org.uk/> (accessed on 25 February 2024).
109. Ministère de l'Environnement. The Carbon Market, a Green Economy Growth Tool 2024. Available online: https://www.environnement.gouv.qc.ca/changementsclimatiques/marche-carbone_en.asp (accessed on 27 February 2024).
110. Japanese Government. J-Credit Scheme 2024. Available online: <https://japancredit.go.jp/english/> (accessed on 29 February 2024).
111. City Forest Credits. City Forest Credits 2024. Available online: <https://www.cityforestcredits.org/> (accessed on 25 February 2024).
112. Isaac, D.; Horne, M.; Harcourt, M.; Bleeker, S.R.; Andersen, S.; Berkhourt, T. Carbon Markets in BC. 2021. Available online: https://vancouvereconomic.com/wp-content/uploads/2021/12/2021_Carbon_Offset_Report_WEB.pdf (accessed on 24 December 2023).
113. British Colombia Government. *Protocol for the Creation of Forest Carbon Offsets in British Columbia*; British Colombia Government: Victoria, BC, Canada, 2023.
114. Puro Earth. Puro Earth 2024. Available online: <https://puro.earth/> (accessed on 25 February 2024).
115. Environment and Climate Change Canada. *Improved Forest Management on Private Land—Federal Offset Protocol Public Consultation Draft*; Environment and Climate Change Canada: Gatineau, QC, Canada, 2023.
116. International Carbon Action Partnership. *Japan—Saitama Target Setting Emissions Trading System*; International Carbon Action Partnership: Berlin, Germany, 2022.
117. Lokuge, N.; Anders, S. Carbon-credit systems in agriculture: A review of the literature. *Sch. Public Policy Publ.* **2022**, *15*. [CrossRef]
118. ANZ. *Carbon Markets 101: Pricing Climate Change Solutions*; ANZ: Melbourne, Australia, 2021.
119. Liao, Z.; Yao, Q. Flexibility is needed in China's national carbon market. *Nat. Clim. Change* **2022**, *12*, 106–107. [CrossRef]
120. Li, X.; Ning, Z.; Yang, H. A review of the relationship between China's key forestry ecology projects and carbon market under carbon neutrality. *Trees For. People* **2022**, *9*, 100311. [CrossRef]
121. World Bank. *The Global Health Cost of PM2.5 Air Pollution: A Case for Action Beyond 2021*; World Bank: Washington, DC, USA, 2022.
122. European Commission. Climate Action: Council and Parliament Agree to Establish an EU Carbon Removals Certification Framework 2024. Available online: <https://www.consilium.europa.eu/en/> (accessed on 21 February 2024).

123. Winkle, G. Towards A Sustainable European Forest-Based Bioeconomy. European Forest Institute 2017. Available online: <https://efi.int/publications-bank/towards-sustainable-european-forest-based-bioeconomy-assessment-and-way-forward> (accessed on 18 February 2024).
124. Mannion, P.; Parry, E.; Patel, M.; Ringvold, E.; Scott, J. *Carbon Removals: How to Scale a New Gigaton Industry*; McKinsey Sustainability: New York, NY, USA, 2023.
125. Australia Government. *A Billion Trees for Jobs and Growth*; Australia Government: Canberra, Australia, 2018.
126. Gresham House. *Global Timber Outlook 2020*; Gresham House: London, UK, 2020.
127. STT. Sustainable Timber Tasmania Annual Reports. 2024. Available online: <https://sttas.com.au/about-us/annual-reports> (accessed on 11 March 2024).
128. DCCEEW. *Volume 1: National Inventory Report 2021*; DCCEEW: Canberra, Australia, 2023.
129. Fitch, P.; Battaglia, M.; Lenton, A.; Feron, P.; Gao, L.; Mei, Y. Australia's Carbon Sequestration Potential A Stocktake and Analysis of Sequestration Technologies 2022. Available online: <https://research.csiro.au/tnz/australias-carbon-sequestration-potential/> (accessed on 24 December 2023).
130. Fairman, T.A.; Bennett, L.T.; Nitschke, C.R. Short-interval wildfires increase likelihood of resprouting failure in fire-tolerant trees. *J. Environ. Manag.* **2019**, *231*, 59–65. [CrossRef]
131. Collins, L.; Trouvé, R.; Baker, P.J.; Cirulus, B.; Nitschke, C.R.; Nolan, R.H.; Smith, L.; Penman, T. Fuel reduction burning reduces wildfire severity during extreme fire events in south-eastern Australia. *J. Environ. Manag.* **2023**, *343*, 118171. [CrossRef]
132. McCormick, B.; May, D. *Bushfire and Fuel Reduction Burning*; Canberra, Australia. 2021. Available online: https://parlinfo.aph.gov.au/parlInfo/download/library/prspub/8248193/upload_binary/8248193.pdf (accessed on 23 March 2024).
133. Conservation and Parks Commission. *Forest Management Plan 2024–2033*; Conservation and Parks Commission: Perth, Australia, 2023.
134. Carbon Neutral. Our projects—Yarra Yarra Biodiversity Corridor 2024. Available online: <https://carbonneutral.com.au/about-us/our-projects/> (accessed on 16 March 2024).

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