Report 23/43

Feasibility of environmental market-based mechanisms as an income source for farmers in the Mossman district

Nathan Waltham, Katie Motson, James C. R. Smart, Syezlin Hasan, Diane Jarvis, Ben Jarihani, Mahmood Sadat-Noori, Allyson Genson

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Centre for Tropical Water & Aquatic Ecosystem Research (TropWATER) James Cook University

Townsville, Australia

TropWATER@jcu.edu.au

Web: www.jcu.edu.au/tropwater/

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Contacts

For more information contact: Nathan Waltham, nathan.waltham@jcu.edu.au

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- Landholders for their participation in interviews.
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- DAF regional economists and John Rolfe for providing feedback and reviewing report drafts.

KEY MESSAGES

Project description

- This project evaluates the suitability of relevant environmental market schemes in the Mossman District as an option for potentially providing additional income by changing land use on a land block within a farm business whilst standard agricultural production continues elsewhere on the farm proprety. Landholders' participation in the scheme(s) either as a sole project proponent or in partnership with a project developer is assessed from the perspective of a project as a whole, with returns to landholders and/or the project developer further articulated for each environmental credit scheme included in this study. Key considerations, cost and revenue streams, and requisite processes for each scheme are detailed for three blue carbon case study sites and 21 potential green carbon sites.

Environmental Markets: Background

- Environmental markets are an economic mechanism for incentivising environmental improvements through trading in specific ecosystem services or environmental outcomes attributable to the project. Environmental improvement activities include promoting best management practices (e.g., reduced fertiliser application) and ecosystem rehabilitation and restoration to improve the extent and condition of ecosystem assets and delivery of ecosystem services such as carbon sequestration, carbon storage and nutrient cycling. These activities can help to improve water quality in the Great Barrier Reef, address the impacts of climatic change, and repair and prevent future environmental degradation.
- Environmental improvement projects provide income by generating environmental credits or certificates that can be sold at auction or traded in an environmental market. The number of credits generated corresponds to a quantifiable unit of an environmental outcome such as the increased delivery of an important ecosystem service (e.g., tonnes of carbon sequestered) or improved state of nature (e.g., hectares of improved rainforest condition, new cassowary habitat, newly restored saltmarsh). Quantification of environmental credits and all the requirements pertaining to the projects that generate the relevant credits must follow an approved methodology of the relevant credit scheme.
- Environmental credit schemes typically involve land use change, restoration, and/or management actions undertaken in accordance with government- (e.g., ACCU scheme methods) or non-government-regulated but scientifically accredited methods (e.g., Reef Credit methods). These actions yield *additional* flows of environmental or ecosystem services from improved ecosystem condition and/or extent, novel land uses, restored ecosystems, or changes in management practice relative to the baseline situation. The resulting flows of environmental services are independently verified in accordance with the scheme-specific prescribed methods to produce *verified environmental credits or certificates* for sale in environmental markets.
- The demand for environmental credits is driven by mandatory regulation (in compliance markets), government purchases using public funds, and voluntary participation. In voluntary environmental markets, the investment proposition is still developing. Some businesses have invested in environmental credit schemes linked to corporate climate- and nature-related sustainability targets. The Task Force on Climate-related Financial Disclosure (TCFD) and subsequently, the Taskforce on Nature Related Financial Disclosures (TNFD), have developed risk management and disclosure frameworks for businesses to identify, assess, manage and disclose climate- and nature-related impacts, dependencies, risks and opportunities (TCFD, 2017; TNFD, 2023). These disclosure frameworks are designed to enable businesses and financial institutions to integrate climate- and nature-related information into decision-making. The Australian Government recently mandated

large business entities to disclose information on climate-related risks and opportunities over a four-year period beginning from mid-2024 (The Treasury, 2024) and TCFD recommendations represent a significant part of this disclosure (ISSB IFRS, 2023). In January 2024, 320 organisations from over 46 countries committed to start making nature-related disclosures based on the TNFD recommendations (TNFD, 2024). These disclosures and private sector responses to address nature-related risks and opportunities may drive increased demand for environmental credits.

- For many environmental improvement projects in environmental credit markets, both established and emerging, there is a shortage of publicly available project-scale information regarding the different components of upfront and ongoing costs, timeframes to clarify when these costs are incurred, timeframes for project approval, and the financial risks to the parties involved.

Landholder sentiments

- Interviews with local landholders revealed a clear lack of knowledge regarding the various environmental markets that could be available to them; this lack of knowledge translated into little current interest in participation in the markets.
- The landholders interviewed perceived a range of barriers that need to be addressed if their attitudes towards market participation are to change. The key barriers identified were as follows:
    - Belief that farming sugarcane would generate a higher financial return/lack of belief in economic viability of environmental markets.
    - Lack of capital to invest in the transition.
    - Perception that participation in environmental markets would require onerous and costly administrative requirements, including both record keeping and reporting compliance.
    - Expectation that the biophysical monitoring and reporting compliance processes would also be costly and onerous, particularly for small site blue carbon projects.
    - Uncertainty over impact on operating costs of the property such as rates and insurance.
    - Concerns relating to contractual obligations incurred through participation in markets, and the time period over which these obligations remained in place. These concerns included potential impact on the ability to sell the property at a later date.
    - Fears of impact on property values, including both value if the farmer sought to sell the property but also the value of the property as security for credit.

The current lack of knowledge of environmental market opportunities by farmers, and their consequent lack of interest in participating in such markets, poses risks to policy makers, market proponents and project developers who are considering investing in and promoting these markets. Farmers need to be appropriately informed and supported to enable them to make informed choices around whether to participate.

Environmental Market Schemes & their applicability to the Mossman District

- The number of relevant market-based mechanisms for ecosystem service provision is rapidly expanding. Moreover, novel methods are continually being released under the various schemes (e.g., the Integrated Land Farm Management method currently under development within the ACCU scheme). For example, the Nature Repair Market, a government-regulated emerging credit scheme, will be applicable to the Mossman district once established; so too will the following non-government-regulated environmental schemes: Cassowary Credits, Coastal Resilience Credits and NaturePlus™ Credits.
- Under the scenario of non-ongoing sugarcane production in the Mossman district, the Australian Carbon Credit Units (ACCUs) Scheme (formerly the Emissions Reduction Fund) is a relevant and established government-regulated scheme (i.e., government agencies and regulators ensure compliance with legislative requirements). The Land Restoration Fund (LRF), a Queensland

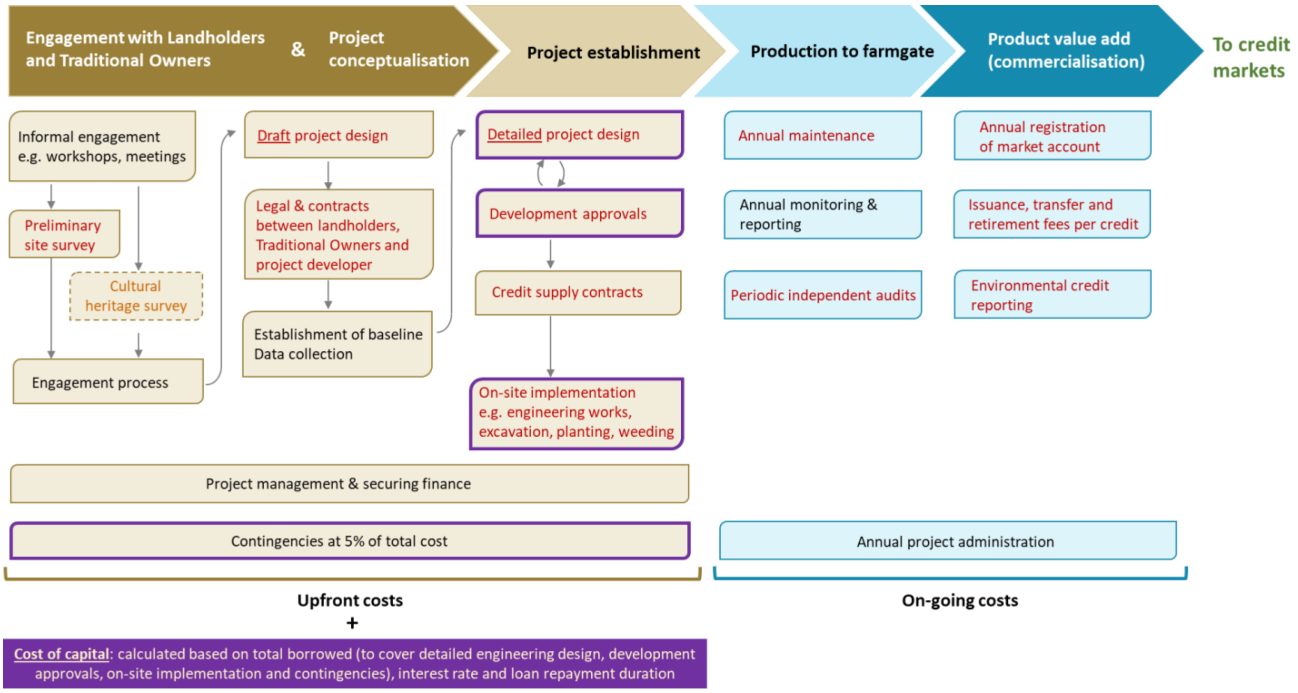
Government program that leverages the carbon market and provides additional payments for co-benefits, is also relevant to the Mossman district.

- Under the scenario of non-ongoing sugarcane production in the Mossman district, land that has been used to produce sugarcane can be converted to produce ACCUs via, for example, the Reforestation by Environmental or Mallee Plantings under the FullCAM method ('green carbon ACCUs'), or the Tidal Restoration of Blue Carbon Ecosystems under the BlueCAM method ('blue carbon ACCUs').
- Reef Credits (via the Method for Accounting Reduction in Nutrient Run-off through Managed Fertiliser Application) is a scheme that is complementary to continuing sugarcane production on a given block of land. Reduced fertiliser application to sugarcane fields is an activity eligible for DIN Reef Credits. However, given the uncertainties surrounding the future financial viability of Mossman Mill, both scenarios (i.e., ongoing and non-ongoing sugarcane production) are possible. If the Mosmman Mill remains closed, sugarcane farms in the district will no longer be eligible to earn DIN Reef Credits by improving fertiliser management practice whilst continuing sugarcane production, *unless* an alternative use, means or location for processing Mossman sugarcane is found (e.g., for use as a biofuel, or transporting to another district for crushing).
- This report does *not* evaluate the financial viability of DIN Reef Credits as an environmental credit scheme operating in conjunction with continuing sugarcane production on the same land block. In such a setting, economic outcomes from practice changes which reduce DIN losses and generate DIN Reef Credits would have to be evaluated fully within the framing of continuing sugarcane production. A recently released DAF Report provides detailed estimates of the capital expenditure requirement, change in farm gross margin, net present value, annualised equivalent benefit, reductions in DIN loss at the cane field (all changes expressed on a per hectare basis), and internal rate of return for sequential improvements in practice management for representative small-, medium-, and large-sized farms in selected districts in every sugar-producing region along the Reef coastline (Department of Agriculture and Fisheries, 2024). This DAF report provides an appropriate basis from which the economic feasibility of DIN Reef Credits in conjunction with continuing sugarcane production could be evaluated for representative sugarcane farms along the Reef coastline.
- On 23 April 2024 discussion with Eco-Markets Australia clarified that Eco-Markets Australia has an understanding with CANEGROWERS and the Australian Sugar Milling Council that Reef Credit projects which could promote a change in land use that impacts on the viability of the sugar industry require evidence from the project proponent that indicates that these considerations have been addressed e.g. through reference to Natural Resource Management plans, other documentation or stakeholder engagement. Consequently, cessation of fertiliser application on land transitioning from sugarcane to production of green or blue ACCUs may *not* eligible for DIN Reef Credits. However, in this report, the financial viability of green and blue carbon projects under relevant ACCUs schemes is evaluated with and without additional revenue from DIN Reef Credits. Inclusion of DIN Reef Credits in this way is solely intended to illustrate how credit stacking with an environmental co-benefit can improve the financial viability of a green or blue carbon project on a land block. Emerging schemes such as Cassowary Credits, NaturePlus™, the Nature Repair Market (described later in this report) and the Constructed Wetland method (see https://eco-markets.org.au/methodologies/), currently under review as part of the Reef Credits scheme, could potentially fulfil this role for relevant locations and contexts.
- Project sites are highly context-specific, depending upon the size of the property, the type of environmental market scheme selected, biophysical characteristics of the land, and site-specific development and regulatory approvals and permits required. As such, projects vary greatly in size, development time, and level of capital investment required, from simple projects that a landholder might conduct themselves, to larger projects requiring partnership with a project developer.The site- and context-specific nature of environmental credit projects mean that project lead times are difficult to quantify. Reasons for this include: the number of actors involved, differing requirements for permits and regulatory and development approvals, differing levels of stakeholder

engagement, and the complexity of on-ground works, planning and design required. Lead times for environmental improvement projects can thus vary considerably, ranging from six months to five years, and potentially longer (The Carbon Farming Foundation, 2022).

Economic Analysis: Methods

- In this report, economic evaluations via discounted cashflow analysis (DCFA) are conducted only on the land block that is converted for environmental credit generation. Any potential returns delivered by this portion of converted land are meant to provide additional income to a farm business alongside on-going agricultural production on the remainder of the farm's land. Consequently, the DCFAs in this report only consider economic costs and benefits arising from switching a block of land within the farm to environmental market use(s), rather than whole-of-farm replacement of agricultural production. Costs and benefits that might arise if the whole-of-farm business switches from agricultural production to generation of environmental credits and/or certificates for sale on environmental markets are not included in the our analysis (e.g., revenues arising from sale of equipment such as tractors, sprayers, or fertiliser spreaders used for prior agricultural production.).
- DCFA outcomes are reported for the project as a whole, and – separately – for the landholder(s) and project developer as key actors.
- Based on discussions with project developers, we model an environmental market project as comprising four phases of activity, see conceptual diagram below:
    - *Engagement and conceptualisation*: when the environmental market opportunity is first socialised with landholders, willing landholders are recruited and legal heads of agreement for the project partnership are signed.
    - *Establishment*: when a detailed project design is developed, necessary approvals are obtained and on-site works are implemented to establish the green or blue carbon ecosystem that will produce environmental credits.
    - *Production*: when environmental credits are generated over a contractually defined crediting period.
    - *Commercialisation*: (runs in parallel with *Production*) when environmental credits are brought to the environmental market and sold.



Conceptual diagram of environmental improvement project activity phases (see Figure 9 for full figure caption).

- The financial viability of an environmental improvement project as a whole depends on the quantity of credits generated, the price at which those credits are sold, and the costs incurred by the project developer and landolder(s) during all four phases of project activity.
- The developer and landholder(s) incur different types of costs. Based on discussions with relevant stakeholders and interviews with Mossman farmers, we assume that the landholder(s) incurs an opportunity cost from foregone agricultural gross margin and a reduction in the value of land that is committed to the project. This reduction in land value is assumed to arise as a conseqeuence of the loss of flexibility and contractual liability for any maintenance costs that would follow from signing land up to an environmental market project, together with uncertainty surrounding the revenue stream that could accrue from environmental market outputs. All other costs (e.g., for legal and contracts, cost of capital, on-site works, monitoring and reporting, independent auditing, credit commercialisation) are assumed to be paid by the project developer. Total project costs are the sum of costs incurred by the project developer and the landholder(s).
- Project revenues, net of total project costs, are assumed to be split between the developer and landholder(s) in proportion to each actor's share of total project cost.
- The project as a whole is financially viable if the sum of present value net revenues is positive. From a landholder's perspective a project is attractive if their share of project present value net revenue exceeds the present value of their costs. Similarly, a project will be attractive to the developer if their share of project present value net revenue provides a sufficient return on the costs they incur.
- DCFAs are implemented on 21 potential green ACCU sites under the Reforestation by Environmental or Mallee Plantings FullCAM Method, aiming for native rainforest restoration to potentially obtain additional revenue streams from the sale of biodiversity certificates, Cassowary credits or NaturePlus™ credits.
- DCFAs are also implemented on three case study blue ACCUs sites under the Tidal Restoration of Blue Carbon Ecosystems BlueCAM method.
- Given the on-going uncertainty regarding the form of agricultural production that may eventuate in Mossman district, our DCFAs include the following three scenarions for the costs incurred by landholders:

  Scenario 1: A property value reduction of $5018/ha and forgone gross margin of $430/ha/year, as ***upper-bound estimates*** for these costs. These are derived using averages for sugarcane production in far north Queensland from the ABARES farm survey (see main text for a full explantation).

  Scenario 2: A property value reduction and forgone gross margin at 50% of the values in Scenario 1 to provide a ***mid-point estimates*** for these costs.

  Scenario 3: A property value reduction at 50% of Scenario 1 and $0/ha/year for forgone gross margin to provide ***lower-bound estimates*** for these costs. Landholder cost Scenario 3 is motivated by a situation in which a blue ACCUs project is proposed on land where agricultural production has already ceased, but the value of the land is still above the unimproved land value.

Economic Analysis:Results

Green ACCUs Results

Key results from DCFAs under landholder cost Scenario 1 and landholder cost Scenario 2, with and without credit stacking, for our 21 green carbon sites are:

- None of the green ACCUs rainforest restoration sites delivered positive whole-of-project NPVs from green carbon credits alone (without stacking) for landholder cost Scenario 1 or landholder cost Scenario 2 under the range of ACCU pricing explored (between $30 and $100 per ACCU).
- When FullCAM green ACCUs were hypothetically stacked with DIN Reef Credits (as a proxy for other potentially stackable environmental market credits or certificates) whole-of-project NPVs remained negative for all 21 green ACCUs rainforest restoration sits under landholder cost

Scenarios 1 and 2 (Table 22). Whole-of-project NPVs with stacking were however less negative than those without stacking.

- The shortfall in preset value revenues relative to present value costs for green ACCUs rainforest restoration projects could potentially be addressed if the necessary additional net revenue flows could be generated from other credit schemes (e.g., potentially via NaturePlus™, Cassowary Credits or the Nature Repair Market). However, the levels of environmental credit pricing required to do this would far exceed any pricing for environmental market credits or certificates that has been seen in Australia, currently or historically.
- For green carbon projects that aim to **restore native rainforest**, whole-of-project costs are dominated by the very high upfront cost the developer incurs in preparing the site, purchasing tree seedlings, planting tree seedlings and weeding for three years following planting. These costs were estimated to be around $55,000/ha. We have high confidence in this cost estimate as it was obtained through interviews with project developers who are highly experienced in woodland regeneration plantings. At our green carbon sites, developers typically incurred around 86% (under landholder cost Scenario 1) and 93% (under landholder cost Scenario 2) of total project costs.
- Given that the majority of costs for green ACCUs rainforest restoration projects accrue to the developer, extremely high additional environmental credit payments would still be required (alongside green ACCUs) even if the costs landholders incured from reduction in land value and opportunity cost of foregone agricultural net revenues were substantially lower than those assumed in our analysis.

Blue ACCUs Results

Key results from the DCFAs for the three blue carbon case study sites under landholder cost scenarios 1, 2 and 3 are:

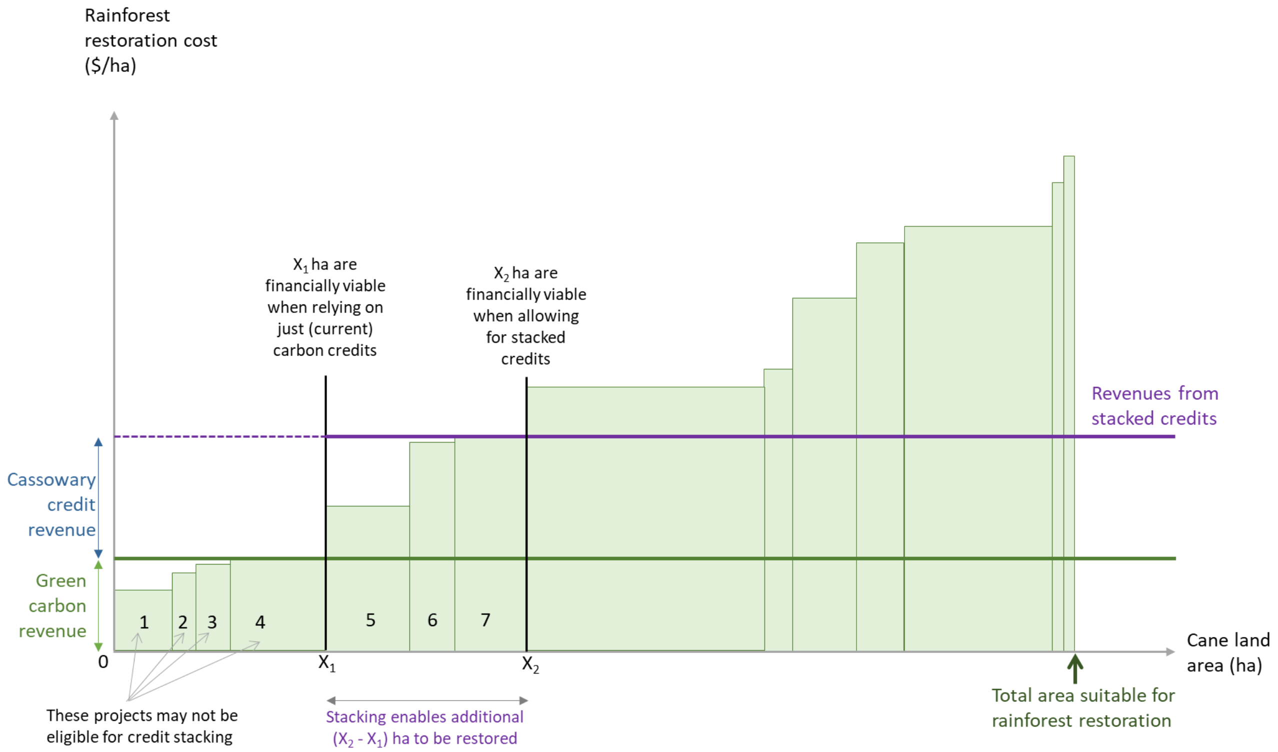
- Tidal re-introduction will typically only regenerate blue carbon ecosystems over part of the project site. However, areas that remain dry will likely be heavily fragmented, preventing their use for agricultural production. Blue carbon revenues and (and potentially other environmental credits) are only likely to be produced by the regenerating blue carbon ecosystems which will typically comprise only a portion of the site. However, (depending on which landholder cost scenario is applied) landholder(s) incur opportunity cost and reduction in land value across the full project area. This has two important implications. Firstly, at blue ACCUs sites, costs to the landholder account for a much higher proportion of total project cost than was the case at green ACCUs rainforest regeneration sites. Landholder's costs comprised between 75% and 84% of total costs at our case study blue ACCUs sites at the upper bound estimates of opportunity cost ($430/ha/year) and reduction in land value ($5018/ha) (Scenario 1). At the mid-point estimates of opportunity cost ($215/ha/year) and reduction in land value ($2509/ha) (Scenario 2), the proportions of project costs borne by landholders were between 60% and 68%, and at the lower bound estimates (Scenario 3), total project cost share for the landholder(s) ranged between 43% and 57%. Secondly, sites at which simple, low-cost interventions to re-instate tidal flows yield large areas of environmental credit-generating blue carbon ecosystems will likely be the most cost-effective, particularly if only a small number of landholders are involved.
- DCFA results identified Site 1 as potentially the best performing blue carbon case study site. Whilst it is not the largest site, 50% of total site area reverts to blue carbon ecosystems when tidal flows are re-introduced (through a relatively simple intervention). Site 3 is the worst performing site, mainly because only 15% of that site reverts to blue carbon ecosystems for a similar intervention cost.
- None of the blue carbon case study sites delivered positive whole-of-project NPVs from blue carbon credits alone under all three landholder cost scenarios across the range of ACCU pricing explored (between $30 and $100 per ACCU).
- When blue ACCUs are hypothetically stacked with DIN Reef Credits (as a proxy for potential stacking with other forms of marketable environmental credits or certificates), positive whole-of-

project NPVs can be obtained for all three case study sites at approximately current levels of environmental credit pricing under landholder cost Scenario 3 (lower-bound estimates) with the estimated levels of implementation cost. Higher ACCU prices and stacked credit pricing could potentially produce positive NPVs under higher landholder cost scenarios (Scenarios 1 and 2). Environmental credit net revenue flows that would deliver positive whole-of-project NPVs under landholder cost scenarios 1 and 2 could potentially be obtained from schemes such as NaturePlus™, the Nature Repair Market, or Coastal Resilience Credits. However, the required net revenue flows from these sources are very high, far exceeding any pricing that has been seen currently or historically for environmental market credits in Australia

- This illustrative analysis shows that the stacked environmental credit revenue required to achieve positive whole-of-project NPV outcomes at our blue carbon case study sites is sensitive to a landholder's perception of the level of costs they are likely to incur when they sign up to a blue carbon and/or other environmental credit market project. Further investigation into the driving factors behind landholders' perceptions of costs could be a useful endeavour for further research.
- There are currently no measured costs for land conversion to blue carbon ecosystems in Mossman district. Cost estimates and project timelines in our analyses were estimated based on the best information from publicly available sources and detailed interviews with Terrain NRM, the Clean Energy Regulator, GreenCollar, the Land Restoration Fund, Douglas Shire Council, Greening Australia, and Eco-Markets Australia. However, these costs should still be regarded as somewhat uncertain until the costs of converting land to blue carbon wetland have been determined by implementing blue carbon wetlands at several sites along the Reef coastline. (In comparison, the uncertainty surrounding cost estimates for rainforest restoration is likely to be substantially lower.)
- Economic outcomes from blue carbon projects are likely to be sensitive to the costs incurred in project engagement, conceptualisation, establishment, production and commercialisation. Many of these costs are likely to be highly site and context-specific.This suggests that cross calibrating cost estimates for implementing and operating blue carbon projects in Mossman with the costs incurred in implementing on-going blue carbon projects elsewhere around Australia's coastline – as actual implementation costs at other sites begin to emerge – would be a useful endeavour for future research. So too would investigation into the factors that influence different elements of these costs.
- Finally, risks should be considered in future studies because they will influence participation, revenue sharing and benchmark rates of returns. We have not considered risks in this study to keep our discounted cash flow analysis tractable.

Scaling up restoration

- A conceptual framework is suggested to inform planning around opportunities for scaling up restoration across Mossman district (see Figures 52-57). This framework could be used to guide thinking around possible aggregations of land blocks to improve the cost-effectiveness of restoration and highlight the importance of credit stacking for the financial viability of environmental credits projects.



Conceptual framework for scaling up restoration across Mossman district. Rainforest restoration costs on former sugarcane production land, arranged cumulatively by area from lowest cost per hectare ($/ha) to highest cost per hectare ($/ha), two revenue streams (green carbon revenue from reforestation by environmental plantings and a biodiversity credit scheme e.g., Cassowary Credits). A higher proportion of suitable sugarcane land can be restored (and more projects become financially viable) the higher the carbon revenue, and vice versa. Credit stacking opens up opportunities for larger-scale restoration projects (X_2 ha restored instead of X_1 ha). The area in each rectangular block represents the total cost of rainforest restoration under a particular project.

Knowledge gaps

- Data gaps in our analysis include:
    - The location and specifications of constructed tidal restriction mechanisms in the Mossman district. This information is essential for hydrological modelling of the inundation area and to understand eligibility for the Tidal Restoration of Blue Carbon Ecosystems method under the ACCU scheme, specifically that the structure is constructed, legal and has been in place for at least 7 years.
    - Land tenure – i.e., the proportion of sugarcane farmers that own or lease their farmland. This is important as only the landholder can benefit from environmental markets, therefore sugarcane growers that lease their land will not be eligible to participate in environmental market schemes.
    - Property boundaries to identify where tidal re-instatement could impact neighbouring landholder’s properties, potentially necessitating additional project costs through engineering works and legal agreements.

Recommendations for landholder participation in environmental markets

- Our recommendations to promote and facilitate participation of sugarcane farmers/landholders in environmental markets, and to address the perceived barriers to participation include: (i) provision of clear and tailored information to critically important questions regarding obligations, time commitments, and impacts on property values; (ii) provision of relevant local examples that demonstrate that markets are a viable alternate to cane farming; and (iii) provision of support (financial and in terms of advice), knowledge and skills building, to assist the transition. The farmer interviews confirmed the advice provided by the Douglas Shire Council staff, that farmers would need clear information and support, before they would be willing to participate in environmental markets.

Table 1: Summary of the key findings from Stage 1 and Stage 2, illustrating the viable environmental market schemes suitable for sugarcane land within the Mossman district.

ACCU Scheme	Opportunities	Constraints	Economic feasibility
Tidal Restoration of Blue Carbon Ecosystems method *No cane production*	• Potential opportunity for stacking with future emerging markets, particularly biodiversity and coastal protection schemes • Potential for site aggregations among landholders	• High project complexity • Likely long project lead times • Carbon sequestration is slow initially whilst coastal wetlands become established. • There are no projects currently registered under this method and therefore no examples of project implementation or timelines, increasing the perceived risk of projects under this method • Requires expertise from hydrological modellers and engineers. • Potentially high engineering costs • Potential displacement of freshwater species • Potential impacts on adjoining landholders • Requirement that tidal restriction mechanisms are constructed and were built legally	• Very dependent on site context and topography. • Sites where low-cost interventions to re-instate tidal flows yield large areas of blue carbon ecosystems will be the most cost-effective, particularly if only a small number of landholders are involved. • Landholders carry most of the project cost (assuming land continues to be financially viable for agriculture if Mossman Mill closes).
Tidal Restoration of Blue Carbon Ecosystems method *Ongoing cane production*	• Blue carbon opportunities on marginal land with low productivity/yield and/or impacted by saline intrusion. • Elligible for DIN Reef Credits within the credit stack	• *(As above)*	• Ability to earn additional income from low cost marginal land with low productivity/yield
Environmental Plantings *No cane production*	• Low project complexity • Potential for site aggregations among landholders • High initial carbon accumulation (typically during the first 8 years after planting), when seedlings undergo highest growth rate • Project maintenance reduces after ~3 years once seedlings have grown and become established. • Potential opportunity for stacking with future emerging markets, particularly biodiversity schemes	• High stem densities required for tropical reforestation/planting projects. • High initial project maintenance to control weeds (~0-3 years).	• High planting costs at requisite stem densities reduces financial viability • Project developer carries most of the project cost.
Environmental Plantings *Ongoing cane production*	• Green carbon opportunities on low quality agricultural land/riparian areas • Elligible for DIN Reef Credits within the credit stack	• *(As above)*	• Ability to earn additional income from low quality agricultural land/riparian areas

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ACRONYMS

ABS…………. Australian Bureau of Statistics
ACCU………. Australian Carbon Credit Unit
AHD………... Australian Height Datum
ASL…………. Above Sea Level
CEA………… Carbon Estimation Area
DAF………… Department of Agriculture and Fisheries
DCFA………. Discounted cash flow analysis
DEM………... Digital Elevation Model
DESI…………. Department of Environment, Science and Innovation
DIN…………. Dissolved Inorganic Nitrogen
ERF………… Emissions Reduction Fund
HAT………… Highest Astronomical Tide
LRF………… Land Restoration Fund
NPV ….......... Net Present Value
RCP ….......... Representative Concentration Pathway
RNTBH…….. Registered Native Title Body Holder
SLR…………. Sea Level Rise
TCFD……….. Task Force on Climate-related Financial Disclosure
TNFD……….. Taskforce on Nature-related Financial Disclosures

GLOSSARY OF TERMS

Additionality: 'whether a project or activity creates 'additional' emissions reductions that would not have occurred in the absence of the incentive.' (The Climate Change Authority, 2014).

APSIM: The Agricultural Production Systems sIMulator is a 'platform for modelling and simulation of agricultural systems. It contains a suite of modules that enable the simulation of systems for a diverse range of plant, animal, soil, climate, and management interactions.' (The APSIM Initiative, 2023).

BlueCAM: The Blue Carbon Accounting Model is a tool to calculate net abatement under the blue carbon method (Clean Energy Regulator, 2021).

Blue carbon ACCUs (or 'blue ACCUs'): ACCUs generated under the Tidal Restoration of Blue Carbon Ecosystems method (Clean Energy Regulator, 2024d).

CAMBA: China-Australia Migratory Bird Agreement.

Carbon abatement contract: 'A carbon abatement contract is a contractual arrangement to sell Australian carbon credit units (ACCUs) to the Commonwealth. A contract can be secured by participating in an ACCU purchasing process such as an auction.' (Emissions Reduction Fund, 2023b).

Carbon increment: carbon increment, in tonnes per hectare per year for a given site in a given year, reports the increase in the total mass of carbon in trees and forest debris at that site in that year, as predicted by the FullCAM Full Carbon Accounting Model (2020 Public Release) Version 6.20.03.0827 (DCCEEW 2023a).

Compliance market: 'The compliance market is used by companies and governments that by law have to account for their GHG emissions.' (Seeberg-Elverfeldt, 2010).

Crediting period: 'A crediting period is the period of time a project is able to apply to claim ACCUs. Crediting periods vary depending on the type of project.' (Clean Energy Regulator, 2023).

Crediting scheme: A scheme enabling credits to be purchased in exchange for an environmental good or service, e.g., the ACCU scheme and Emissions Reduction Fund are carbon crediting schemes, and Cassowary Credits is a biodiversity crediting scheme.

DIN Reef Credits: In this report, DIN Reef Credits refer to Reef Credits generated through the DIN reduction method.

Discounting: The standard approach used by economists and financial analysts to assess investments spanning several years into the future. Discounting converts future streams of costs and benefits (i.e. cash flows) into equivalent values at a fixed point in time, typically the time when a decision is made whether to proceed with the investment or not. Where the fixed point in time is the present, values discounted to that point in time are preferred to as present value.

Discount rate: The percentage rate per time period (e.g. day, month or year) at which future streams of costs and benefits are *reduced* to bring them in line with the values in the present day. The discount rate reflects the social time preference whereby individuals prefer to receive benefits now rather than later even after accounting for the inflation rate (i.e., after ensuring there is no change in purchasing power between the two time periods).

Environmental additionality: A project lacks environmental additionality if the benefits achieved (e.g., carbon sequestration) would have occurred without the project taking place.

Environmental Improvement Project: A project designed to provide additional income through the generation of credits or certificates that can be sold at auction or traded in an environmental market.

Financial additionality: Also known as investment additionality, financial additionality directly assesses whether a particular project would go ahead without the financial incentive from the scheme (The Climate Change Authority, 2014).

Financial viability: A project is regarded as financially viable if the sum of revenue flows from the sale of environmental credits exceeds *all costs* incurred by the project to produce those credits for sale in environmental markets, and if the net revenues generated are sufficient to provide all relevant parties with an acceptable return for the resources they invest in the project and the risks associated with those investments.

FullCAM: The Full Carbon Accounting Model is a calculation tool for modelling Australia's greenhouse gas emissions from the land sector (DCCEEW, 2020). In this project, the FullCAM model is used to predict the quantity of ACCUs that would be generated per hectare of land planted with mixed species environmental plantings (tropical) under the Reforestation by Environmental or Mallee Plantings FullCAM Method 2014 (Clean Energy Regulator, 2024c).

Green carbon ACCUs (or '**green ACCUs**'): ACCUs generated via the Reforestation by Environmental or Mallee Plantings FullCAM method (Clean Energy Regulator, 2024c).

Impacted land: 'In relation to a tidal restoration project, means land that experiences tidal introduction relating to the eligible project activities implemented for the project' (Carbon Credits (Carbon Farming Initiative): Tidal Restoration of Blue Carbon Ecosystems - Methodology Determination, 2022).

JAMBA: Japan-Australia Migratory Bird Agreement.

Opportunity Cost: The net revenue that could be earned by farmers if they were to use the land to produce sugarcane or other commercial crops. When the farmland is converted to non-agricultural land uses, the net revenue i.e. gross margins from agricultural production would be forgone. This forgone gross margin is regarded as an opportunity cost to the landholder.

P2R Projector: The Paddock to Reef (P2R) Projector is a tool used to estimate the water quality improvements from farm-scale agricultural practice change projects (Truii, 2023).

Permanence period: For carbon sequestration projects conducted under methods defined by the Clean Energy Regulator, proponents may nominate 'either a 25-year or a 100-year permanence period for their sequestration project'. The permanence period starts on the date ACCUs are first issued to a project. A project must be maintained for the period of time nominated, even though the project's crediting, reporting and delivery periods may have ended (Clean Energy Regulator, 2016). Projects under other land use change or environmental restoration schemes generally use equivalent terminology.

Reporting period: For carbon sequestration projects conducted under methods defined by the Clean Energy Regulator, the reporting period is a period of time, within the crediting period, for which a project report is prepared for submission (Clean Energy Regulator, 2023). Projects operating under other credit schemes generally use equivalent terminology.

ROKAMBA: Republic of Korea-Australia Migratory Bird Agreement.

Verra: An organisation that focuses on the development of standards for environmental and sustainable development programs, including carbon and ecosystem services markets (https://verra.org/).

Voluntary market: In the voluntary market, the trade of credits (e.g., carbon credits) is on a voluntary basis, i.e., purchasers do not have a mandatory requirement to offset emissions in excess of capped baselines by using purchased credits as offsets.

1. INTRODUCTION

1.1 BACKGROUND

Sugarcane is an important industry in Queensland. Around 30.1 million tonnes of sugarcane were crushed in the 2021 season in Australia, from 342,900 hectares. Approximately 95% of the sugarcane crushed in Australia in 2021 was produced in Queensland. Several different sugarcane regions are recognised within Queensland, each relating to a specific mill catchment. The Mossman district, and the Mossman Sugar Mill, crushed 733,290 tonnes of sugarcane in the 2021 season, harvested from 9,108 hectares, representing just under 3% of Australia's total production (by tonnes and hectares; Canegrowers, 2022).

As the most northern mill in Australia, the Mossman Mill was built in 1894 and, until November 2023, has operated continuously (Douglas Shire Council, 2023). Until November 2023, the mill was operated by Far Northern Milling Pty Ltd, which acquired the mill in 2019 from Mackay Sugar, the second largest sugar producer in Queensland, and supplies to both Australian and overseas markets. Historically, the mill employs approximately 150 employees in the crushing season, around 80 employees in the offseason, and supports approximately 100 sugarcane farmers—making it the second largest employer within Douglas Shire (Douglas Shire Council, 2023; Far Northern Milling, 2022).

Across Queensland, there has been a steady decline in the number of mills operating, with closures driven by the need to reduce costs and to reach sufficient scale for operations to be economically sustainable. Saline intrusion, reduced sugarcane yields, and concern over the future of sugar mills and the sugarcane industry in Australia more broadly, have caused some landholders to move away from sugarcane production, reducing the tonnage of sugarcane crushed by the local mills.

Inevitably, smaller mills, such as that in Mossman, have come under increasing pressure to remain profitable, which places pressure on local communities that have employment affiliated with the mill. Sugarcane is a bulk commodity; growers are therefore dependent on the local mill which purchases all their production, at a price that is determined by world prices. Consequently, if a mill closes, this has a dramatic impact on the local sugarcane growers and businesses affiliated with the industry. For example, in Maryborough, the Sugar Mill closed at the end of the 2020 crushing season; whilst some growers have continued to grow sugarcane, it now must be transported further to the closest mill, incurring additional costs. As a result, approximately 2,500 hectares of growing land are in the process of being converted into macadamia fields (Sugar Research Australia, 2022).

In Mossman, the mill has received Australian and Queensland government support to explore diversification options, such as a bio-refinery, to secure the long-term viability of the industry (Australian Manufacturing, 2018). These diversification options are not yet operating at the scale required to support long-term mill viability and as such, the mill announced in November 2023 that it was entering voluntary administration, with an announcement made on 21st March that the mill is being transitioned into liquidation (Byrne et al., 2024). Whilst the mill is no longer operational, sugarcane was planted in 2023 under previous advice from the mill that crushing would take place in 2024. As a result, approximately 75% of the required fertiliser has already been applied to the crop (*pers. comm.*).

As the mill has gone into liquidation, sugarcane farmers in the region face the difficult choice of converting to alternative farming products, or to consider exiting farming entirely. Environmental markets may therefore provide an avenue for landholders in the Mossman district to earn additional income.

Environmental markets, such as the carbon market, provide a financial incentive to promote alternative land management and uses that benefit the environment, such as the restoration of rainforest, mangroves, saltmarsh, and supra-tidal swamp forest. The demand for environmental credits is driven by mandatory regulation (in compliance markets), government purchases using public funds, and voluntary participation. These markets form a financial instrument that uses market trading to incentivise change and *'…make it easier for businesses, organisations, governments and individuals to invest in projects to protect, manage and restore nature.'* (DCCEEW, 2023b). Environmental improvement projects provide income by generating environmental credits or certificates that can be sold at auction or traded in an environmental market. The number of credits generated corresponds to a quantifiable unit of an environmental outcome such as the increased delivery of an important ecosystem service (e.g., tonnes of carbon sequestered) or improved state of nature (e.g., hectares of improved rainforest condition, new cassowary habitat, newly restored saltmarsh). Quantification of environmental credits and all the requirements pertaining to the projects that generate the relevant credits must follow an approved methodology of the relevant credit scheme.

For a situation that could potentially arise in the Mossman district, where sugarcane farmers could be looking for alternative uses for some of their less productive land, environmental markets can provide an additional income stream.

It is important to note that whilst the intent of this project is to understand the potential for environmental market-based mechanisms to provide additional income for sugarcane growers in the Mossman district, participants in environmental market schemes are likely to be the landholders in partnership with project developer(s). Of the 5,120 ha of sugarcane planted in the Mossman district in 2023, 4,294 ha are on freehold land and the remaining 826 ha are on leasehold land. Of the freehold land, we understand that for some of the properties, the landholders are also the farmers of the land. However, what we understand to be a small proportion of land in the Mossman district, is leased by the landholder to external sugarcane growers to farm. This information however is confidential and therefore unavailable publicly. From discussions with several landholders and stakeholders in the district, some landholders within the Mossman district lease their land to external farmers once they themselves have retired from sugarcane farming, or due to the history and increasing uncertainty of sugarcane farming in the area, among other reasons. Due to the unknown proportion of landholders in the Mossman district that farm vs. lease their land to external farmers, for the purposes of this report, it is assumed that landholders are farming sugarcane on their own properties. As such, the terms 'farmer' and 'landholder' are used interchangeably in this report.

In this report, we focus on the potential land use change opportunities presented by environmental markets to landholders (i.e., sugarcane farmers that own their farmland) in the Mossman district and assess the key considerations, cost-benefits, and processes of implementing environmental improvement projects at three blue carbon case study sites, and 21 indicative green carbon sites more broadly.

1.2 PROJECT DESCRIPTION

A feasibility assessment has been requested by the Queensland Department of Agriculture and Fisheries (DAF) to outline the potential for environmental market-based mechanisms to provide additional income for sugarcane growers in the Mossman district of Far North Queensland. This project seeks to identify and understand environmental markets relevant to the Mossman district. We initially reviewed the Australian and International literature to identify the environmental markets and opportunities available. Market-based mechanisms that have recently been released or are under development were explored in Stage 1 of this report to determine applicability to the Mossman district. From Stage 1, it was determined that environmental planting and tidal restoration methods for green and blue carbon sequestration under the Clean Energy Regulator's ACCU schemes and DIN Reef Credits had sufficient data for inclusion in the current feasibility assessment.

This assessment aims to understand if environmental market-based mechanisms could potentially provide an additional source of income for landholders in the Mossman district. This report outlines the relative applicability of these schemes, identifies cost components, revenue pathways, contractual terms and risks for landholders, administrative processes, and limitations (biophysical, economic, and social) and applies these to three hypothetical case study sites within the Mossman district. The environmental benefits (e.g., water quality improvement, biodiversity enhancement, habitat restoration, carbon sequestration etc.) and potential for credit stacking of co-benefits to increase the financial viability of a project are also discussed.

This report presents the findings from Stage 1—detailing the applicable environmental market schemes to the Mossman district, and Stage 2—providing detailed hydrological and economic assessments for three case study sites within the district. This report also summarises the sentiments and interests of several sugarcane farmers within the district regarding their knowledge of and attitude towards participating in environmental markets. This report furthers our understanding of the potential opportunities and challenges associated with environmental market-based mechanisms in the Mossman district.

2. STUDY AREA

2.1 LOCATION

The Mossman district lies within Douglas Shire Council in Far North Queensland. The Douglas Shire Council region stretches from the tourist town of Port Douglas in the south to the Daintree National Park in the north, with the town of Mossman and the surrounding district, comprised mainly of agriculture, situated between the two. The region is part of two distinct World Heritage Areas, The Great Barrier Reef, and the Wet Tropics World Heritage Area, and is thus often described as where “the rainforest meets the Reef”.

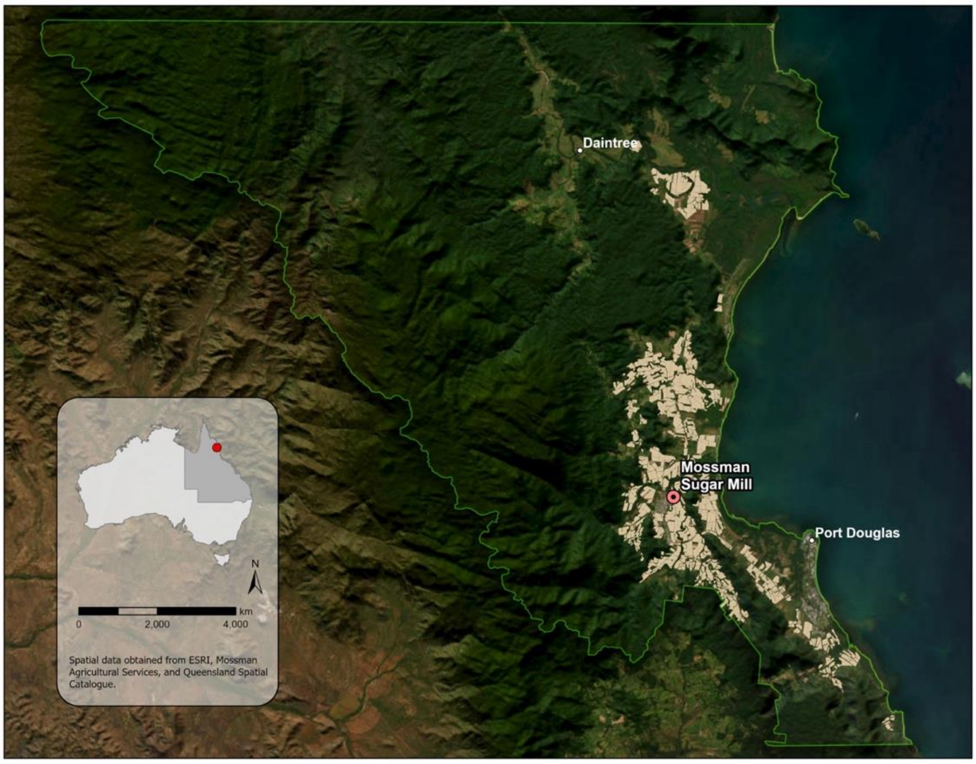


Figure 1: Map of the Mossman project boundary and current sugarcane properties supplying the Mossman Mill in 2023. Inset: Location of the Mossman District, Queensland.

Beyond the important ecological values of the region, there are important cultural, social, and economic values (Figure 2). The region is the traditional Country of the Eastern Kuku Yalanji Aboriginal people. Their Native Title rights are protected and managed by the Jabalbina Yalanji Aboriginal Corporation Registered Native Title Body Holder (RNTBC), who care for their traditional land and sea Country, managing a Ranger program and an Indigenous Protected Area (Jabalbina, 2021). Additionally, they manage a tourism operation which includes the Indigenous-ecotourism development at Mossman Gorge (State of Queensland, 2023c). As the RNTBC, Jabalbina are responsible for managing the process of determining who has cultural authority to speak for any area of Country where an environmental market project could be proposed, and – under relevant land ownership, governance, and legal settings – for working with the project proponent to ensure cultural heritage is appropriately surveyed, recorded, and managed. The area of traditionally owned land within the project area equates to 87,706 ha, of which approximately 7 ha overlap with sugarcane land planted in 2023.

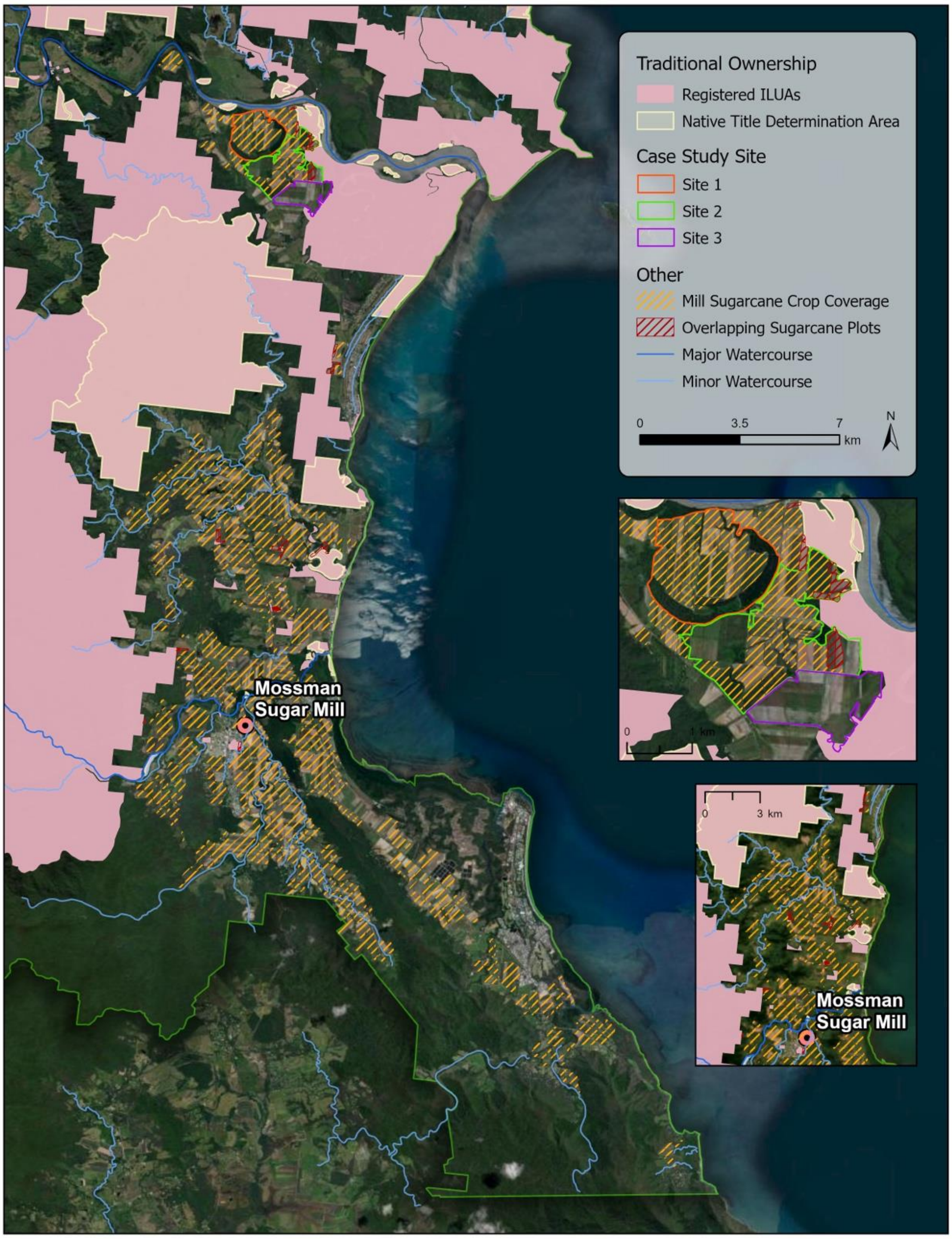


Figure 2: The Native Title and Indigenous Land Use Agreements (ILUA) of the local Kuku Yalanji Traditional Owners and partners. Current sugarcane properties supplying the Mossman Mill in 2023 (Mossman Agricultural Services, 2023). Parcels and/or sugarcane plots that overlap with Traditionally Owned lands are highlighted in red. Native Title and ILUA areas were provided by the National Native Title Tribunal. Location of case study sites 1-3 are also outlined.

2.2 SOCIO-ECONOMIC CONTEXT

Based upon the Australian Bureau of Statistics (ABS) statistical geographical regions, data for Mossman and the surrounding district is combined with the Daintree National Park region (ABS region: Daintree 306041164), with data for the Mossman district alone being unavailable. The Daintree region covers 223,120 ha of land, with 144,036 ha (~ 65%) of this classified as protected land (Australian Bureau of Statistics, 2022), which includes both National Park and Indigenous Protected lands, and 5,120 ha (~ 2%) were used to produce sugarcane in 2023. This large region is sparsely populated, being home to less than 7,000 people based on Census 2021 data. The people of this region are generally older, lower paid, more likely to be male, and more likely to be Indigenous, than is the case when compared to the wider Council region, and to the State and the National average (Table 2).

Table 2: 2021 Census data for the Daintree Region, including Mossman, with comparators at a larger geographical scale (Australian Bureau of Statistics, 2021b).

	Daintree (ABS SA2 region)[1]	**Douglas Shire Council[2]**	**Queensland[3]**	**Australia[4]**
Total population	6,674	12,337	5,156,138	25,422,788
Male population, as % of total	51.1%	50.8%	49.3%	49.3%
Median age	47 years	46 years	38 years	38 years
Indigenous population, as % of total	12.9%	8.4%	4.6%	3.2%
Unemployment rate	4.4%	4.2%	5.4%	5.1%
Median weekly household income (AUD)	$1,201	$1,310	$1,675	$1,746
Education - % complete year 12 or higher	56.6%	60.2%	65.7%	66.7%

There are also notable differences in the key employment sectors within the region, compared to the larger, geographic-scale comparators. Particularly, the region is far more dependent on tourism-related segments (accommodation, food services, retail) and less dependent on the public sector, compared to State and National data. The two largest employment sectors within the region are 'combined public sectors' (24.1%) and 'accommodation and food services' (14%; Table 3). Agriculture is also an important segment, providing more than double the proportion of jobs compared to State and National data.

Table 3: 2021 Census data showing main sectors for employment within the Daintree Region, with comparators at a larger geographic scale (Australian Bureau of Statistics, 2021a).

	Daintree (ABS SA2 region)	**Douglas Shire Council**	**Queensland**	**Australia**
Public sectors combined*	24.1%	19.4%	30.4%	30.0%
Accommodation and Food Services	14.0%	23.3%	7.2%	6.5%
Retail trade	10.3%	9.4%	9.3%	9.1%
Construction	8.3%	7.4%	9.1%	8.9%
Agriculture, forestry & fishing	5.4%	3.5%	2.6%	2.3%

* Based on a total of three employment sectors combined: health care and social assistance, education and training, and public administration and safety.

In 2023, the Douglas Shire Council contracted consultants, AEC Group Ltd, to explore agricultural opportunities across the region, specifically to understand the agricultural diversification options and opportunities in the Mossman district. As part of that work, a workshop was held in April 2023 with local industry participants, and an action plan was developed seeking to resolve the barriers identified at the workshop. The AEC's work identified the importance of agriculture and related industries to employment within the region; specifically, the importance of sugarcane farming as the largest agricultural employer in the area (Figure 3).

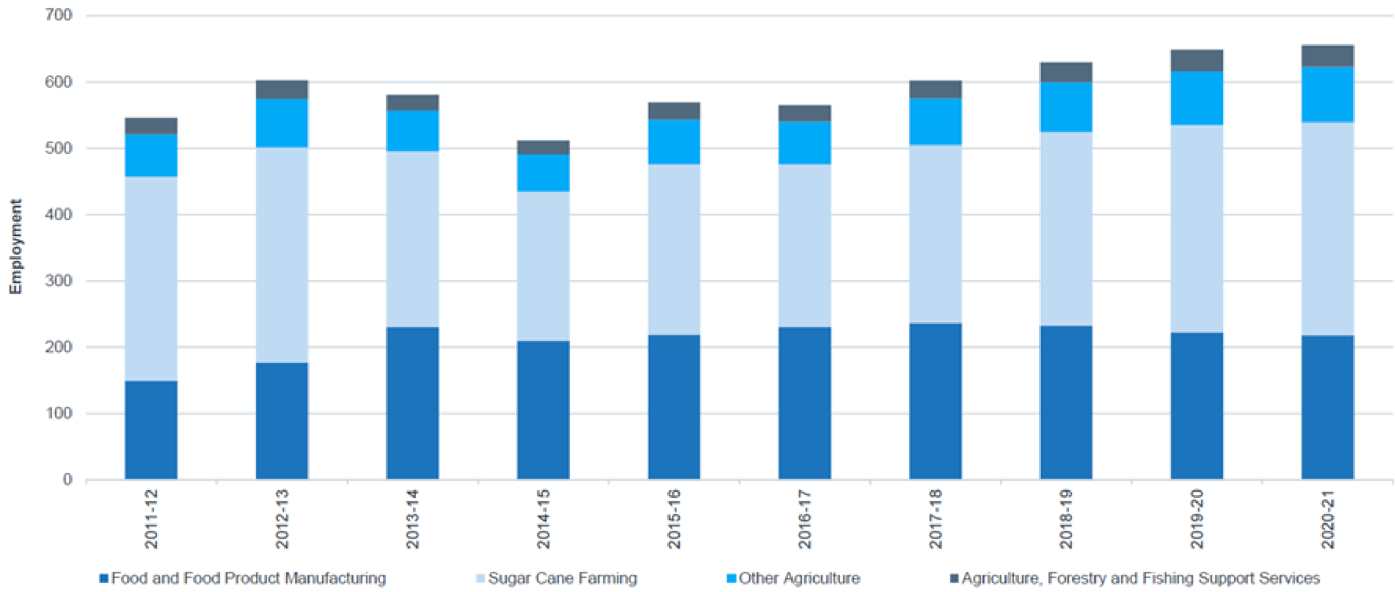


Figure 3: FTE employment in agriculture and food manufacturing within the Douglas Shire Council Region, based on research by AEC Group Ltd (AEC, 2023).

AEC focused on farmers diversifying towards a range of potential alternative crops, the financial returns that could result from investing in alternative cropping opportunities, and the likely customers and supply chains. Whilst specific crops were not listed within the workshop outcomes, alternative crops that have been tested in the district are soybeans, sorghum, cacao, peanuts and macadamias (*pers. comm.*). This previous work did not explore environmental market opportunities but did identify a need to explore financial returns from different activities (compared to the status quo) and different markets and supply chains (AEC, 2023). Although this project has different objectives it complements the work undertaken by AEC.

2.3 CLIMATE

Rainfall has been recorded daily at the Mossman Central Mill (031044) station since 1910 (Bureau of Meteorology, 2023b)(Bureau of Meteorology, 2023b)(Bureau of Meteorology, 2023b). The highest accumulative wet season (November to March) rainfall occurred in 1978/79 (4060 mm), while the lowest was recorded in 1922/23 (676mm; see Appendix 1). The most recent wet season rainfall total (2022/23; 1772.9 mm) was slightly below the long-term mean of 1912.6 mm (Table 4; Bureau of Meteorology, 2023a)Bureau of Meteorology, 2023a)Bureau of Meteorology, 2023a). The Mossman district has a tropical climate, with an average annual temperature of 22.2 °C. The period of May to November is widely regarded as the peak season for visitation.

Table 4: Summary statistics of wet season (Nov-March) rainfall recorded at Mossman Central Mill Station (Bureau of Meteorology, 2023a).

Statistic	**Wet season rainfall (Year)**
Minimum	676 mm (1922/23)
Maximum	4060 mm (1978/79)
Overall mean	1912.6 mm
95th percentile	3046.3 mm
5th percentile	852.4 mm

2022/23 wet season total	1772.9 mm

2.4 BIODIVERSITY

The Mossman district lies within the Wet Tropics World Heritage Area, accredited due to its tropical rainforest that supports a rich and unique diversity of plants, marsupials, birds, and many rare, endemic, and endangered species (UNESCO World Heritage Centre, 2023; Table 5). The Wet Tropics World Heritage Area is ranked sixth globally for its irreplaceable endemic and threatened species, making the Mossman district and its habitats part of a globally significant biodiversity hub (Wet Tropics Management Authority, n.d.-b).

Table 5: The number of endemic species, the total number of species, and proportion of Australian species found within the Wet Tropics World Heritage Area (UNESCO World Heritage Centre, 2023b; Wet Tropics Management Authority, n.d.-a, n.d.-b).

	Number of endemic species	Total number of species	% of Australian species
Vascular plants	576	3,000	18%
Mammals	11	107	(30% of marsupials) (60% of bat species) (25% of rodents)
Birds	11	368	40%
Reptiles	24	113	20%
Amphibians	22	51	(30% of frog species)
Insects	?	65,417	(60% of butterfly species)
Total	**644**	**69,056**	-

According to the Queensland WildNet database (2000-2023), there are 1,040 recorded species, including 109 species of birds, 17 mammal species, 23 species of reptiles, 25 amphibian species, 24 species of fish, 11 insect species, and 831 species of terrestrial plants (class: Equisetopsida) within the Mossman district (State of Queensland, 2023d). Moreover, three endemic plant species are known only to occur in the Mossman district: *Zieria alata, Garcinia russellii* and *Cynometra roseiflora* (Cooper, 2013, 2015; Duretto & Forster, 2007).

Of the 1,040 species recorded, four species are classified as 'critically endangered', 13 species 'endangered', and 20 species as 'vulnerable' under the Queensland Nature Conservation Act, 1992 (Figure 4; Table 6). As several of these rare and endangered species, namely birds and mammals, are threatened by habitat loss, modification, and fragmentation (Table 6), the conservation of these species may benefit from reforestation and habitat restoration projects in the area, funded by environmental market schemes.

Two migratory bird species, *Numenius phaeopus*, the Whimbrel, and *Symposiachrus trivirgatus*, the Spectacled monarch, are also found within the Mossman district. Both bird species are found in forest and shrubland habitats, with the Whimbrel, *N. phaeopus*, found also in inland wetlands and coastal habitats outside of the breeding season (BirdLife International, 2016, 2017). Whilst categorised as 'least concern' under the Queensland Nature Conservation Act, 1992, both bird species are listed under the Convention on the Conservation of Migratory Species of Wild Animals (aka, the Bonn Convention), a treaty aimed at conserving migratory species across their home range (DCCEEW, 2023d). Due to its extensive range, found globally along temperate and tropical coastlines, the whimbrel, *N. phaeopus,* is also listed in several bi-lateral treaties aimed at protecting migratory birds (CAMBA, JAMBA and ROKAMBA) and is classified as endangered in the state of Victoria, Australia (DCCEEW, 2023c). Blue carbon projects that restore coastal wetland habitats and green carbon reforestation projects may therefore contribute to the conservation of these nationally and internationally important species.

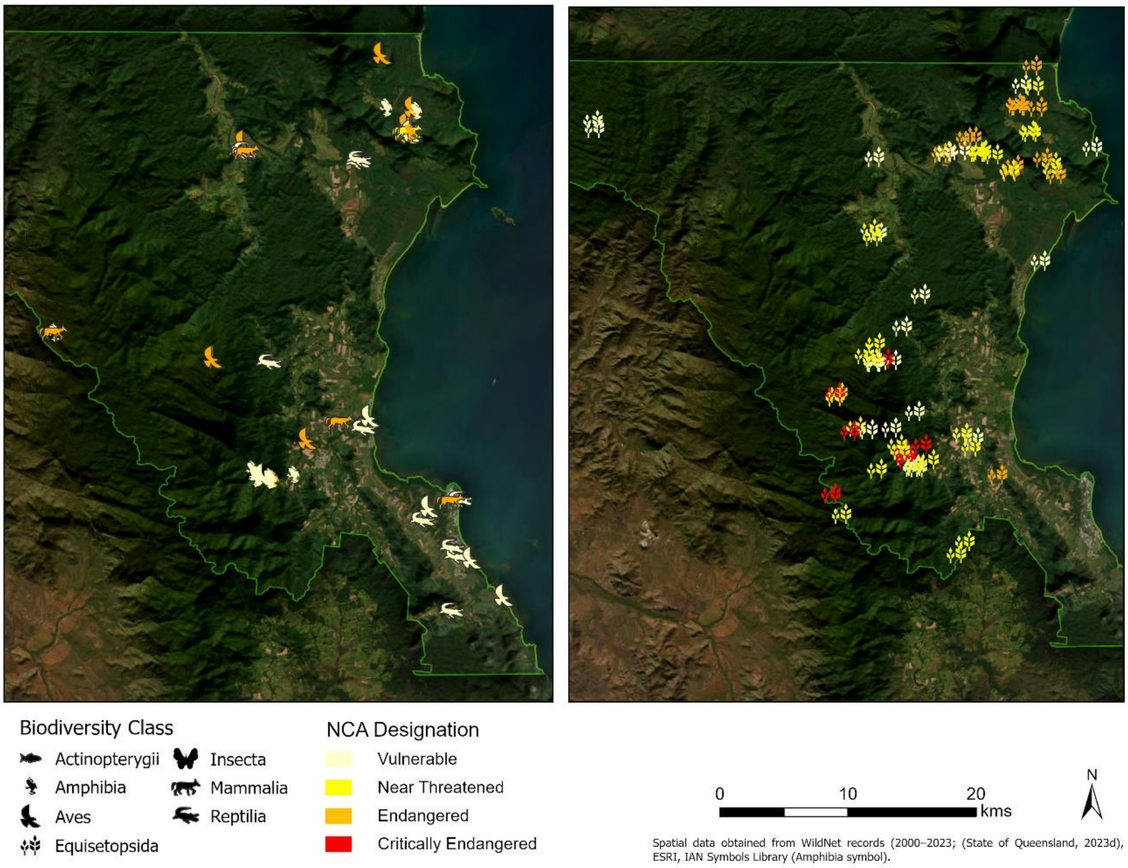


Figure 4: Map of biodiversity within the Mossman district according to conservation status under the Queensland Nature Conservation Act 1992 using WildNet records (2000–2023; State of Queensland, 2023d).

Table 6: Critically endangered and Endangered species recorded within the Mossman district between 2000-2023 (Department of Environment and Resource Management, 2010, 2011; Department of Environment, 2016; State of Queensland, 2023d; Threatened Species Scientific Committee, 2008, 2017).

Class	Species name	Common name	NCA status	Threats
Amphibians (Amphibia)	*Litoria rheocola*	Common mist frog	Endangered	Disease; Invasive species *No national recovery plan exists for this species.*
Birds (Aves)	*Casuarius casuarius johnsonii* *(Southern population)*	Southern cassowary	Endangered	Loss and fragmentation of 80% of pre-European lowland and upland cassowary habitat; Vehicle strike; Dog attack;
Mammals (Mammalia)	*Dasyurus maculatus gracilis*	Spotted-tailed quoll (Northern subspecies)	Endangered	Forest (habitat) reduction, loss, and fragmentation; Competition and predation from introduced predators; Deliberate killing;

Class	Species name	Common name	NCA status	Threats
				Road mortality; Bushfires and prescriptive burning; Cane toad poisoning;
	Petaurus australis brevirostrum	Yellow-bellied Glider (Northern subspecies)	Endangered	Forest (habitat) alteration and fragmentation; *No national recovery plan exists for this sub-species.*
	Pteropus conspicillatus	Spectacled flying-fox	Endangered	Habitat loss; Illegal killing, incidental mortality, human harassment, entanglement, vehicle collisions Cyclones; Tick paralysis;
Plants (Equisetopsida)	*Boea kinnearii*	Rock violet	Endangered	-
	Cheilocostus potierae	n/a	Endangered	-
	Endiandra cooperana	n/a	Endangered	-
	Hedyotis novoguineensis	n/a	Endangered	-
	Isachne sharpii	n/a	Endangered	-
	Rhodomyrtus effusa	n/a	Endangered	-
	Rhodomyrtus pervagata	n/a	Endangered	-
	Toechima pterocarpum	Orange tamarind	Endangered	Land clearing for agriculture and urbanisation
	Garcinia russellii	Rupert’s mangosteen	Critically endangered	-
	Zieria alata	Mount Lewis stink bush	Critically endangered	-
	Hollandaea porphyrocarpa	n/a	Critically endangered	-
	Cynometra roseiflora	n/a	Critically endangered	-

2.5 TOPOGRAPHY AND STORM TIDE INUNDATION RISK

The low-lying areas in the Mossman district are highly susceptible to a range of flood and inundation hazards (Figure 5). River floods pose a significant risk to local properties and infrastructure, as the proximity of these areas to water bodies makes them vulnerable to rising water levels during heavy rainfall events. Furthermore, the region is exposed to the potential threat of storm surges generated by cyclones. These surges can lead to rapid and extensive inundation of coastal and low-lying areas, exacerbating flood risks and causing severe damage to communities and infrastructure.

In addition to river floods and cyclonic storm surges, the Mossman district faces the potential threat of tsunamis, which can result from undersea seismic activity. The coastal location of the region places it at risk of tsunami waves, which can inundate low-lying areas swiftly and with little warning, necessitating robust disaster preparedness and early warning systems. Whilst the threat of tsunamis is very low, particularly due to the presence of the Great Barrier Reef, the effects of global tsunamis have been recorded in Queensland six times between 1960-2010 (Bureau of Meteorology, 2024). Climate change and the associated sea-level rise further amplify the susceptibility of these low-lying regions to inundation risks, with local predicted median sea level rise of 0.8 metres by 2100 under high emissions scenario RCP 8.5 (IPCC, 2021). This value is relatively consistent across Australia, with Perth (Western Australia) and Sydney (New South Wales) projected to experience approximately +0.70 m and + 0.78 m sea level rise under RCP 8.5 respectively (CoastAdapt, 2017). As sea levels continue to rise, the cumulative impact on flood-prone areas is set to become more pronounced, demanding proactive strategies for adaptation and resilience building to safeguard both communities and ecosystems.

Additionally, wetlands closer to the coast in the Mossman district are susceptible to tidal inundation on a more regular basis. These wetlands, which serve as vital ecological buffers, face recurrent challenges as tides rise and fall, affecting the delicate balance of these ecosystems. Whilst, these systems will likely migrate inland, as sea levels rise in the area (pending no obstruction by urban infrastructure), sea level rise may occur, and waterlines may shift, faster than wetland migration can take place (Parkinson, 2024). This ongoing tidal inundation underscores the need for holistic wetland management and conservation efforts that consider both natural and human-induced stressors to maintain their ecological integrity, resilience and provision of ecosystem services in the face of multiple inundation threats.

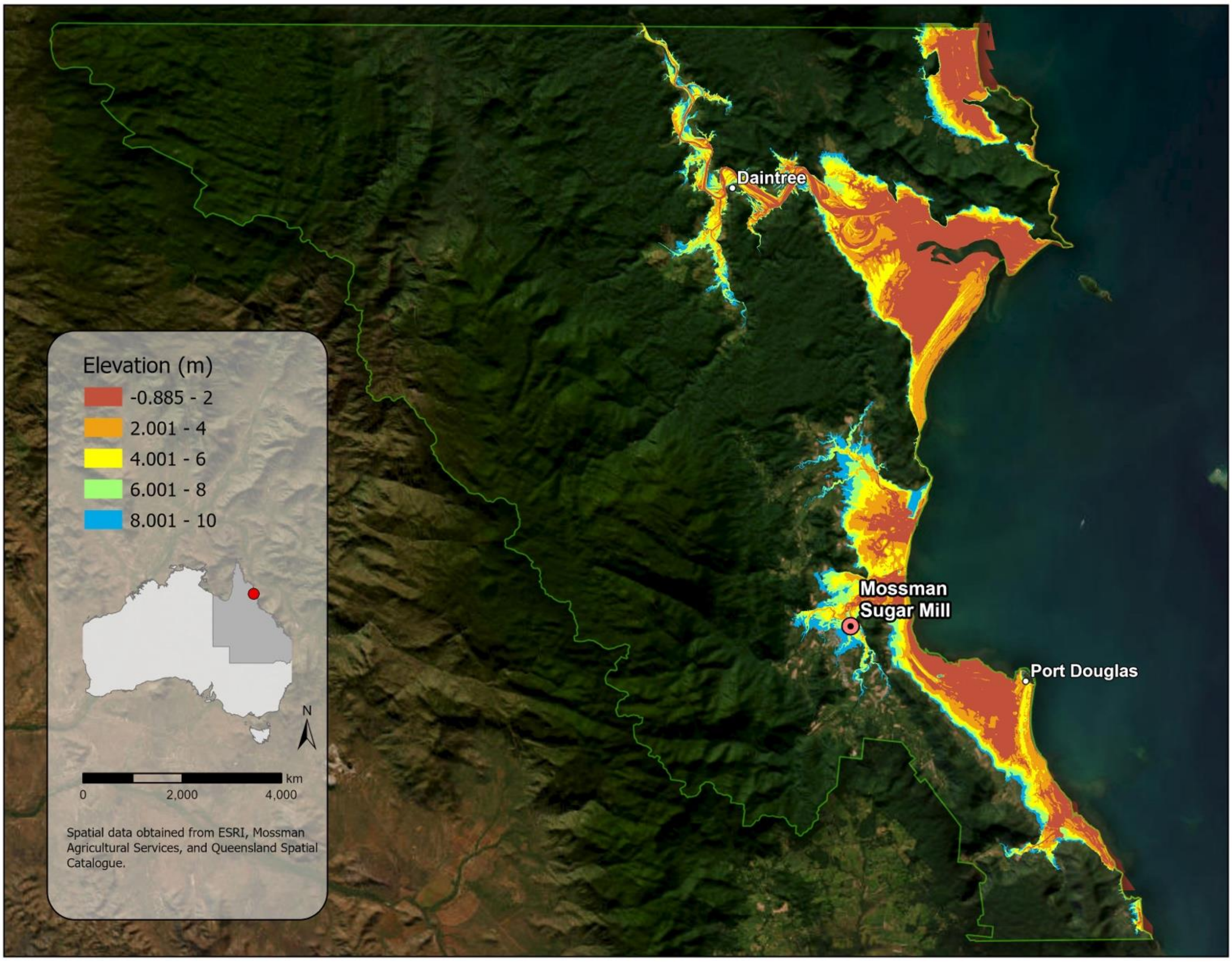


Figure 5: Topographic map of the Mossman Project area, derived from the Queensland Government's 5 m LiDAR data. Coloured areas indicate regions with elevations below 10 m relative to present-day sea level that are susceptible to inundation from storm surges.

In the Mossman project area, there are 2,162 ha that are susceptible to inundation during 'medium hazard' storm tides (i.e., the area inundated by water less than 1.0 m in depth), with 8,763 ha of low-lying lands susceptible to inundation during 'high hazard' storm tides (i.e., inundated by water greater than 1.0 m in depth). These estimates include predicted inundation as a result of sea level rise by 2100 (in accordance with IPCC projections; IPCC, 2021), with sea levels increasing by an average of 0.1 m each decade, reaching +0.8 m by 2100. Of these areas, approximately 523 ha and 489 ha are considered to be current sugarcane cropland susceptible to 'high' and 'medium' hazard storm tides, respectively. These areas are located in flat coastal areas and low-lying areas along the Daintree River and its floodplain (Figure 6).

To generate these estimates, the Regional Australian Height Datum (AHD) Digital Elevation Model (DEM) was subtracted against the 2010 tide tables to create the Highest Astronomical Tide (HAT). A reclassification on the HAT DEM (e.g., IPCC sea level rise: 0.8 m above current HAT) was performed and then converted to polygons representing high and medium tide hazard areas.

It is important to note that, based on the product metadata, "the AHD DEM models were not hydrologically corrected as, in the opinion of project staff, there were not any drainage data sets with high enough resolution that would be able to perform an accurate determination of hydrological flow. Also, given the size of the DEMs and the time limits, the process to hydrologically correct the regional AHD DEM models would not be viable" (State of Queensland Department of Resources, 2022).

As the Daintree is wetter, low-lying, and further from the Mossman Mill—experiencing elevated transport costs, opportunities for environmental markets may be more abundant in this particular area of the Mossman district.

Figure 6: Storm tide hazard maps of the Mossman District, based on Queensland Government 'Storm Tide High Hazard Queensland' and 'Storm Tide Medium Hazard Queensland' products, including projected sea level rise (+0.8 m) as a result of climate change by 2100. The medium and high hazard areas refer to areas inundated by less than and greater than 1 metre of water, respectively. This map is created from Version 4 of the Storm Tide Inundation Area products of The State of Queensland Department of Environment and Science (State of Queensland Department of Resources, 2022).

3. ENVIRONMENTAL MARKETS IN THE MOSSMAN DISTRICT

3.1 LITERATURE REVIEW METHODS

Grey and peer-reviewed literature were reviewed to establish which environmental markets are relevant to the Mossman district (see Appendix 2 for a summary of environmental markets relevant to the Mossman district and Appendix 3 for the literature reviewed). For peer-reviewed literature, article abstracts, titles, and keywords were searched in the Scopus database using the strings listed in Table 7. Searches were restricted to journal articles written in English, that are publicly available, and published between 2010-2023. Articles concerning theoretical and hypothetical markets were also excluded from the review. Grey literature searches were conducted informally, using the authors' knowledge of established and emerging environmental markets and the regulating bodies.

Table 7: Search strings used for the Scopus database search.

Search strings
"ecosystem service market*" OR "environmental market*" OR "nature repair" OR "nature positive" OR "people positive" OR "water quality trading" AND income* OR livelihood* OR agri* OR farm*
("environmental market*" OR "nature repair market*") AND ("carbon credit*" OR "blue carbon credit*" OR "biodiversity credit*" OR "nitrogen trad*" OR "nitrogen market*" OR "reef credit*" OR "cassowary credit*" OR cap* OR permit* OR certificate*)

3.2 STAKEHOLDER AND LANDHOLDER INTERVIEW PROCESS

3.2.1 STAKEHOLDER INTERVIEW PROCESS

As part of Stage 1 of this work, semi-structured interviews were conducted with key stakeholders of environmental market schemes and of the Mossman district (Table 8). These interviews sought additional information regarding the details of how different markets and mechanisms operate (see Appendix 4 for the list of potential interview questions). This information has informed the economic analysis and the detailed notes on the various markets available and their timelines (see Appendices 2 and 5). Stakeholder interviews also sought to gain insights into how Mossman landholders' involvement with environmental markets could develop in future and the perceived barriers and challenges impacting this involvement.

Interviews were conducted under the approval of human ethics secured through James Cook University (JCU Human Research Ethics Committee approval: H9180). All interviews were conducted online and were recorded with the consent of the interviewees. The information obtained from these interviews is summarised below.

Table 8: Key stakeholders involved in semi-structured interviews during stage 1.

Organisation	Date	Role
Terrain	16 October 2023	Cassowary Credits market proponent; NRM group
Clean Energy Regulator	17 October 2023	Regulator
GreenCollar	17 October 2023	Reef Credits; project developer
Douglas Shire Council	17 October 2023	Local government
DESI, Queensland Government	18 October 2023	State government; Land Restoration Fund market proponent
Eco-Markets Australia	18 October 2023	Project developer

3.2.2 Landholder Interview Process

Semi-structured interviews were conducted with several sugarcane farmers (n = 4) from across the Mossman district. The interviews were conducted between Monday 12th and Friday 23rd February 2024 (see Appendix 6 for a list of interview questions). Thus, all interviews took place during the period after the Mill had entered Administration and prior to the meeting to determine whether the Mill would be Liquidated. Four farmers consented to participate in the interviews.

The interview process has been designed to explore the core drivers of behaviour, and behavioural change, based upon the expanded theory of planned behaviour (Ajzen, 1991). See Figure 7 for a diagram illustrating this theory, and how the theory relates to the planned topics of discussion for the semi-structured interviews.

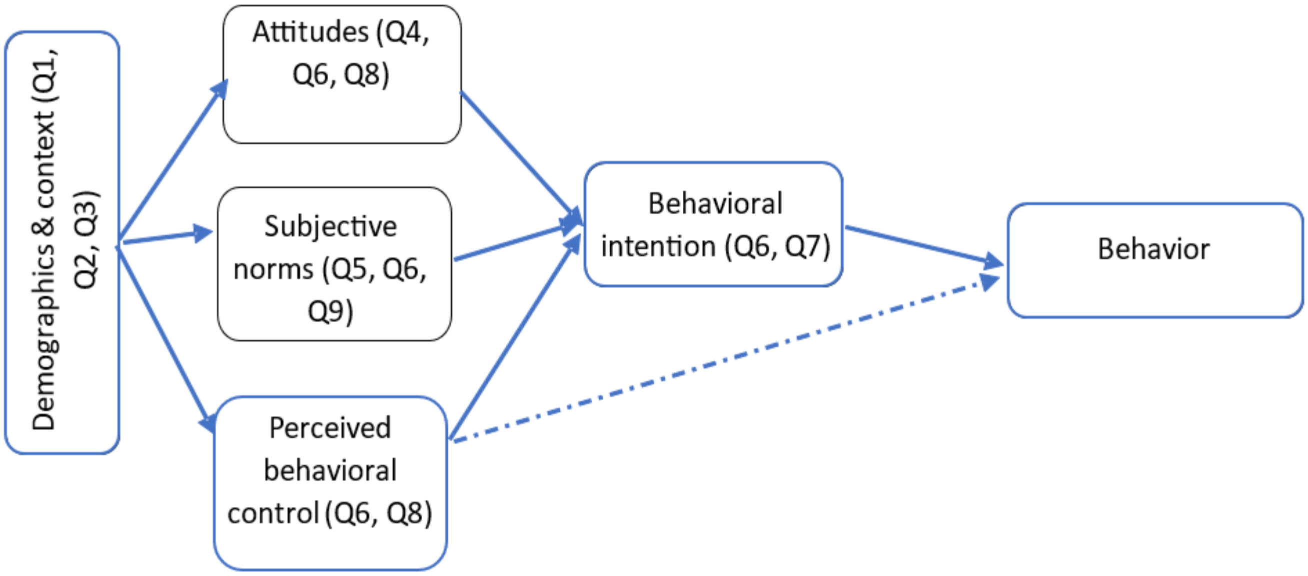


Figure 7: Expanded theory of planned behaviour (Ajzen, 1991) underpinning the semi-structured landholder interview process.

The first two questions sought to understand the landholders' history of farming and provide background context, whilst the third question sought to understand the landholder's existing knowledge of the opportunities presented by environmental markets. Questions four and five sought to understand the landholders' attitudes, and those of their peers, towards participating in environmental markets, including perceived benefits and barriers to involvement. Questions six to eight delved deeper into the landholders' actual and potential involvement in these markets, whilst the final questions sought to focus on social norms. Interviews were conducted under the approval of human ethics secured through James Cook University (JCU Human Research Ethics Committee approval: H9180). As part of the ethics approval, farmers who consented to be interviewed were guaranteed anonymity; thus, no identifying details are provided. All interviews were conducted face to face, on or adjacent to the farmers property, and were recorded with the consent of the interviewees. The interviews were conducted in a conversational style, rather than adopting a formal question and response approach; this allowed the farmers to feel at ease and provided space for them to elaborate on their thoughts and perceptions as they deemed appropriate.

3.3 LITERATURE REVIEW & INTERVIEW RESULTS

From the literature searches and interviews with key stakeholders and landholders, the following established and emerging markets were identified as applicable to sugarcane land use in the Mossman district. The advantages and constraints of each scheme are detailed below.

3.3.1 Established Markets

Australian Carbon Credit Unit (ACCU) Scheme

The ACCU Scheme (formerly known as the Emissions Reduction Fund) offers landholders, communities, and businesses the opportunity to run projects in Australia that avoid the release of greenhouse gas emissions or remove and sequester carbon from the atmosphere. In operation since 2012, participants can generate ACCUs from a range of activities, with one ACCU representing one tonne of carbon dioxide equivalent emissions stored or avoided by the project. The scheme is administered by the Clean Energy Regulator, whose role includes registering projects, running auctions, managing carbon abatement contracts, and issuing ACCUs on achievement of emissions reductions.

Scheme participants, having been issued ACCUs, can choose to: (1) hold some or all of their ACCUs for future sale or retain them for their own use; (2) sell some or all the ACCUs to the Clean Energy Regulator where the price is determined by willing participants offering to supply ACCUs into an auction process; and/or (3) sell some or all of their ACCUs in a secondary market (not regulated or controlled by government) under a private commercial agreement.

There is a wide range of product supply methods that can be adopted by projects seeking to earn ACCUs. Those likely to be of relevance within the Mossman district are: (1) Measurement-based methods for new farm forestry plantations method; (2) Plantation forestry method; (3) Estimation of soil organic carbon sequestration using measurement and models method; (4) Estimating sequestration of carbon in soil using default values method (model-based soil carbon); (5) Reforestation and afforestation; (6) Reforestation by environmental or mallee plantings FullCAM method; (7) Environmental plantings; and (8) Tidal Restoration of Blue Carbon Ecosystems method (referred to forthwith as the 'Tidal Restoration Method') (Clean Energy Regulator, 2024a). Project permanence periods are either 25 or 100 years, depending on the methodology adopted.

To date, more than 133 million ACCUs have been supplied in Australia, across 1,620 projects. A green carbon project is currently operating within the Douglas Shire local government area and was registered in 2022—the Saltwater Creek Carbon Project (see LRF section below for details). Although not widely adopted (yet) across the Mossman district, there seems no reason why further projects could not be developed under the scheme; indeed, the registration of the first scheme in the region in 2022 could be a catalyst for other landholders to follow if they see that the project is successful and generates good returns.

Across the ACCU 15 auctions held so far with the Clean Energy Regulator as the buyer (first held in April 2015, latest in March 2023) the average price paid per ACCU at each auction has fluctuated between a minimum of $10.23 per tonne of abatement April 2016) and a maximum of $18.94 per tonne of abatement (October 2021). At the latest auction, the average price was $17.12 per tonne of abatement, with a total of 7.9 million tonnes contracted across 24 projects (Emissions Reduction Fund, 2023a). Spot prices for generic ACCUs are higher than those achieved at ERF auctions, varying between a high of around $38/ACCU and a spike low of around $24/ACCU over the past 12 months, with generic spot ACCUs trading in excess of $31/ACCU for much of this time (Jarden Australia on https://accus.com.au; Core Markets on https://coremarkets.co/resources/market-prices).

Two methods under the ACCU scheme may be applicable to the Mossman district in particular: Reforestation by Environmental or Mallee Plantings FullCAM method and the Tidal Restoration method. The Reforestation by Environmental or Mallee Plantings FullCAM method requires '*establishing and maintaining vegetation such as trees or shrubs on land that has been clear of forest for at least five years'* (Clean Energy Regulator, 2024d). A mix of native trees, shrubs and understory species, or species of mallee eucalypts, can be planted under this method. This method is suited to the Mossman district, as there are large areas of land that have been cleared for agriculture for more than 5 years. The Tidal Restoration Method involves the removal of a constructed and legal tidal restriction mechanism, such as a tidal gate or bund wall, to allow saltwater reintroduction and the establishment of coastal wetland habitats, such as mangrove and saltmarsh (Clean Energy Regulator, 2024e). This method is particularly well-suited to the Mossman district due to its coastal location, the presence of coastal wetlands in the area that would allow for natural re-seeding and establishment of coastal wetland habitats following tidal reinstatement, and the use of tidal restriction mechanisms in the area that prevent saltwater intrusion into agricultural lands.

A third ACCU scheme method, the Integrated Land Farm Management Method, is currently under development, but may be applicable to the Mossman district in future. This method seeks to combine several soil and vegetation sequestration activities, including regeneration of native tree species indigenous to the project's local area, into one (DCCEEW, 2024). The method, once approved, will allow landholders to use multiple carbon sequestration methods on the same property, with the administrative requirements of a single method.

For sugarcane farmers in the Mossman district, the ACCU scheme has a substantial amount of information available surrounding the various methods, eligibility requirements, additionality, and crediting and permanence periods etc. Despite having access to readily available information, the process of establishing a project under the ACCU scheme proves to be challenging, with multiple complex steps and technicalities. There are multiple resources available online to assist landholders which are helpful, however landholders expressed a preference for information to be shared face to face, and ideally, one on one, to ensure the materials can be understood in relation to the landholders particular circumstances. Without suitable support, landholders are unlikely to choose to participate in environmental markets. One good opportunity for such information sharing could be as part of the initial engagement during the process whereby project developers work with landholders under a partnership arrangement.

A particular advantage of the ACCU scheme is that, for green carbon projects specifically, there are multiple case studies and active projects earning carbon credits that landholders can learn from, with 216 'vegetation' projects underway in Queensland (https://www.cleanenergyregulator.gov.au/maps/Pages/erf-projects/index.html). For blue carbon projects however, as of the writing of this report, there are currently no projects registered under the ACCU scheme, with the first project estimated to be registered by the end of 2024. Due to the potential time lag between the establishment of blue carbon ecosystems under the current blue carbon method, as well as the logistics and timeframes of reporting periods and requirements, the first blue carbon credits may not be issued for another 2-5 years. However, with several blue carbon projects at an early stage of development across Australia (DCCEEW, 2022b), and with Australia voluntarily reporting on its net emissions from the extraction and regeneration of mangrove forest, conversion of tidal marsh, and dredging of seagrass (DCCEEW, 2022a), development in this space will hopefully grow and become more streamlined, providing several national case studies for landholders to learn from. Lastly, as the ACCU scheme is an Australian government initiative, regulated by the Clean Energy Regulator—an Australian government body, the relative risk to landholders of undertaking a carbon project under the ACCU scheme is reduced.

Land Restoration Fund (LRF)

The Land Restoration Fund (LRF) was established by the Queensland Government in 2017 and is administered by the Department of Environment, Science and Innovation. Whilst not an environmental market as such, the fund is designed to expand carbon farming in Queensland and to support land management projects that provide additional benefits beyond sequestering or avoiding carbon emissions, delivering positive impacts or 'co-benefits' for the environment and for communities across Queensland. Specific opportunities for FNQ include investing in projects that improve the environment through supporting: threatened wildlife (animals and plants), threatened ecosystems, native vegetation, soil health, the health of the Great Barrier Reef, wetlands and coastal ecosystems and/or providing socio-economic benefits including improving employment and skills, community resilience, environmental connection, diversity, and human rights, and providing opportunities for First Nations groups within the region (Department of Environment and Science, 2023b).

The LRF supports projects that deliver co-benefits over and above carbon benefits by paying the landholders for these as part of the overall sum offered. Accordingly, the LRF may pay more when it purchases ACCUs from such projects than would be paid via CER reverse auctions under the Australian Government's ACCU Scheme as those auctions are required to purchase the lowest cost abatement of carbon alone.

LRF projects are required to register with the ACCU Scheme and generate ACCUs by following a method specified under that scheme. However, rather than the ACCUs being sold to the Australian Government at the lowest cost via reverse auction, the LRF offers dedicated investment rounds where projects are contracted to supply premium carbon credits based on the ACCUs plus co-benefits.

As an ACCU + co-benefits scheme, the land eligibility requirements and product supply methods for the LRF are the same as for the ACCU Scheme, resulting in similar categories of upfront and ongoing costs being incurred (see 'Economic Framing'). However, co-benefits must also be reported and verified, resulting in additional reporting and auditing. The contract period for LRF projects is 5 to 15 years, during this period a landholder may sell up to 80% of the project ACCUs generated to the LRF. As carbon sequestration projects under the ACCU Scheme have a crediting period of 25 years, this enables landholders to generate and sell additional ACCUs on the voluntary market once the LRF project contract is complete. The LRF has now been established for several years and has completed two investment rounds. The first, in 2020, with median payments for ACCU + co-benefits amounting to $52.50 for 1,033,790 ACCUs, whilst the second in 2021 paid a median price of $81.08 for 169,626 ACCUs (State of Queensland, 2023a). Stage 2 final applications for Round 3 closed on the 13th of October 2023. LRF submission rounds are assessed via reverse auction for offers to supply bundles of carbon sequestration plus co-benefits.

Within the Douglas Shire local government area, is the Saltwater Creek Carbon Project, registered with the LRF in 2022. The scheme uses the ACCU scheme's Reforestation by Environmental or Mallee Plantings FullCAM method and will establish permanent plantings of a mix of tree species native to the local area, on land that was predominantly used for agricultural purposes for at least five years prior to project commencement. In terms of co-benefits, the project aims to improve local biodiversity, water quality, and connectivity between remnant native vegetation, and generate socio-economic benefits through local employment (State of Queensland, 2023b).

For landholders that seek environmental, financial and/or legal advice regarding an application to the LRF, rebates are available to help cover the costs of carbon farming advice received from an LRF Approved Adviser (Department of Environment and Science, 2023a).

Reef Credits

The Reef Credit Scheme was developed through a Queensland Government funded major integrated project with Terrain NRM, NQ Dry Tropics and GreenCollar. The Reef Credit Scheme is independently administered by Eco-Markets Australia, a not-for-profit company established in 2020. The Reef Credit registry and market are administered independently by Eco-Markets Australia, having been established in 2020. The scheme is designed to offer a market-based incentive to landholders to improve the quality of water entering the Great Barrier Reef through changes in land management practices and changes in land use. A Reef Credit is a tradable unit of pollutant reduction, representing a quantifiable volume of dissolved inorganic nitrogen (DIN) or fine sediment (specifically 1 kg of DIN or 538 kg of fine sediment) prevented from entering the Great Barrier Reef lagoon. Currently, pesticides are not included in the Reef Credit Scheme. There are currently three approved methodologies under the Reef Credit Scheme, the DIN Method, the Gully Method and the Wastewater Method, (see website: https://eco-markets.org.au/methodologies/) and two more methodologies are currently being reviewed. The Reef Credit market is still fairly new, and continues to develop and explore new methodologies. However, as with all developing markets, providing the opportunity to earn Reef Credits does not guarantee demand will exist from market participants wishing to purchase the credits offered.

To be eligible to earn Reef Credits, a Reef Credit project must be undertaken on land situated within Great Barrier Reef (GBR) Natural Resource Management (NRM) regions and be able to apply one of the three approved Reef Credit Methodologies: (i) DIN method – this method requires land to have been under cultivation and treated with nitrogen-based fertiliser during a 7-year baseline period); (ii) Gully Method (i.e., Reduction in Sediment Run-Off through Gully Rehabilitation; GreenCollar, 2021); iii) Wastewater Method, whereby municipal wastewater is treated using algal bioremediation, reducing the concentration of DIN discharged to the GBR. The crediting period for Reef Credits is up to 10 years for the DIN method and up to 25 years for the Gully Rehabilitation Method (Eco-Markets Australia, 2021). According to the Queensland Globe database, gully erosion is not present in the Mossman district, so this method would not be applicable in the region.

To date, twelve projects have been registered under the Reef Credit scheme, with 46,622 Reef Credits issued (as of July 2024). No information has been made publicly available regarding the average price paid for credits over time. However, the September 2023 Eco-Markets Australia Quarterly Market Snapshot report (https://eco-markets.org.au/2023/09/20/ema-quarterly-market-snapshot-sept-23/) revealed that in the last quarter, Reef Credits issued under the DIN method have been sold for $100 per credit (i.e. $100 per kg DIN reduction at end-of-catchment); and also revealed that forward contracts indicate the price is expected to increase in the next quarter. The lack of detailed information on Reef Credit pricing means that the potential revenue flows are difficult to assess.

Due to the range of methods available under the Reef Credit scheme, ranging from simple fertiliser reduction to more complex and capital-intensive land use change, pre-project timelines (i.e. project lead times) are difficult to quantify.

A discussion with Eco-Markets Australia on 23 April 2024 clarified two important points. Firstly, if sugarcane production ceases in the Mossman district, reductions in end-of-catchment DIN load following cessation of fertiliser application to former sugarcane land would not be considered *additional* and therefore would not be eligible for DIN Reef Credits. However, if shipping sugarcane grown in Mossman district to another mill for crushing were to be financially viable, or if sugarcane was still grown for other uses, then fertiliser reductions on land producing sugarcane would still be eligible for DIN Reef Credits, with caveats. In this context, revenue from DIN Reef Credits could potentially offset some of the increased cost of transporting sugarcane to an alternative mill. Secondly, Eco-Markets Australia has an understanding with CANEGROWERS and the Australian Sugar Milling Council that Reef Credit projects which could promote a change in land use that impacts the viability of the sugar industry, require evidence from the project proponent that indicates that these considerations have been addressed e.g., through reference to Natural Resource Management plans, other documentation, or stakeholder engagement. As the Mossman district may still be eligible for DIN Reef Credits, if sugarcane continues to be grown in the area, the project team have included DIN Reef Credits i) should sugarcane continue to be grown in the Mossman district, 2) as a hypothetical example of a stacked revenue payment from a co-benefit alongside the production of green or blue ACCUs. This example also shows how credit stacking from co-benefits can improve the financial viability of an environmental market project. Emerging schemes such as Cassowary Credits, NaturePlus™ and Nature Repair Market (described in sections that follow) could potentially fulfil this role for relevant locations and contexts.

This report does *not* evaluate the financial viability of DIN Reef Credits as an environmental credit scheme operating in conjunction with continuing sugarcane production on the same land block. In such a setting, economic outcomes from practice changes which reduce DIN losses and generate DIN Reef Credits would have to be evaluated fully within the framing of continuing sugarcane production. To do so requires estimates of the changes in the sugarcane yield and commercial sugar content of the sugarcane produced on a given land block under different location-specific fertiliser application rates (and representative fallow practices, soil management and mill mud management), together with estimates of changes in capital and operating cost required to, for example, purchase a GIS-linked fertiliser box to allow fertiliser application rate to be varied at least at cane block scale (or at finer scale; Department of Environment and Science, 2022). A forthcoming DAF Report provides detailed estimates of the capital expenditure requirement, change in farm gross margin, net present value, annualised equivalent benefit, reductions in DIN loss at the cane field (all changes expressed on a per hectare basis), and internal rate of return for sequential improvements in practice management for representative small-, medium-, and large-sized farms in selected districts in every sugar-producing region along the Reef coastline (Thompson et al. 2024). The forthcoming DAF report, titled 'Economic evaluation of sugarcane management practices that improve water quality' will provide an appropriate basis from which the economic feasibility of DIN Reef Credits in conjunction with continuing sugarcane production could be evaluated for representative sugarcane farms along the Reef coastline (Thompson et al. 2024).

If the Reef Credits constructed wetland methodology is finalised and approved, this may also be an applicable method for sugarcane land within the Mossman district and could be adopted instead of sugarcane production, but likely only on appropriately situated small blocks of land.

3.3.2 EMERGING MARKETS

NaturePlus™ Credits

NaturePlus™ is an international biodiversity credit scheme developed by GreenCollar to generate credits from restoration and conservation projects in high conservation value landscapes. Under this scheme, land managers undertake land management practices to restore environmental conditions for ecosystems, habitats, and threatened species (https://greencollar.com.au/our-services/natureplus/). The goal is to achieve nature-positive outcomes viewed in terms of improvements in environmental condition attributable to the project. Nature-positive outcomes are third-party audited, verified, and then certified using the Accounting for Nature's environmental accounting framework. Each NaturePlus^{TM} credit represents a one-hectare area of measured and verified restoration or conservation of an environmental asset (i.e., habitat or species). In particular, the scheme '*recognises different levels of conservation value by identifying where projects overlap with Key Biodiversity Areas and threatened ecosystems or species populations. Credits generated across a land or seascape are categorised into tiers according to whether they overlap areas of state, national or international significance*' (NaturePlus, n.d.-b). Projects must meet a minimum level of environmental condition to be eligible and demonstrate progressive measured restoration to be awarded credits. Once environmental condition has reached a sustainable level, projects switch from restoration to conservation and must remain above that level to continue with the crediting.

Different in concept to many other credit schemes, NaturePlus^{TM} only awards credits to projects that have delivered restoration and environmental outcomes, rather than rewarding actions taken to restore biodiversity (e.g., see Cassowary Credits below). Focusing on the achieved environmental outcomes instead of on restoration actions is meant to reassure credit purchasers of the legitimacy of the credit product and to eliminate accusations of greenwashing. However, it is unclear whether such focus delays revenue flow into the project such that revenues cannot be used to support the costs of project development and delivery in the initial stages. Hence, this delay in revenue could reduce the attractiveness of the scheme at least from the landholders' perspective.

Projects registered under the NaturePlus^{TM} scheme have an undisclosed duration and permanence period. Instead, the scheme aims to incentivise the permanence of project outcomes '*through a continuous crediting period with no limit to the crediting opportunity so long as restoration and/or conservation outcomes can continue to be demonstrated.*' To manage the risk of a project's beneficial outcomes being reversed, similar to the risk of reversal buffer applied to ACCU scheme projects, a portion of credits are withheld from the proponent as a buffer. The number of credits withheld is calculated using a Non-permanence Deduction Factor, which calculates the risk of a project's beneficial outcomes being reversed.

The scheme is currently in a pilot commercialisation phase, allowing the standard to be tested, validated, and refined. As such, there are 20 pilot projects currently registered under the NaturePlus^{TM} scheme, of which two projects have been issued 60,435 credits (NaturePlus, n.d.-a). NaturePlus^{TM}, once fully operational, is likely to be an applicable scheme for landholders within the Mossman district. The scheme has not been included in the present analysis however, due to a lack of publicly available information as to the upfront and ongoing costs of undertaking a project under the NaturePlus^{TM} scheme, and credit pricing data.

Cassowary Credits

The Cassowary Credit Scheme has been developed by Terrain NRM supported by the Queensland Government's Land Restoration Fund and will be administered by Eco-Markets Australia (https://terrain.org.au/what-we-do/biodiversity/cassowary-credit-scheme/). The scheme is designed to increase investment in habitat restoration within the Wet Tropics region, and targets land that is unsuitable for agriculture specifically targeting less productive land (based on soil type, slope and/or closeness to watercourses) to avoid competing with other land uses. The scheme cannot be used for offsets because the goal is to achieve a positive gain in biodiversity through large-scale restoration across the region to build connectivity between habitats.

The scheme is designed to reward cumulative progress from a baseline condition, rather than withholding payment until a functional rainforest has been produced; this approach specifically enables a flow of income to be generated in the earlier years of a restoration project, aligning with the high initial project inputs required (site preparation, planting, maintenance etc.), with income flow reducing over time as the ongoing maintenance and monitoring costs also reduce. Cassowary Credit projects are required to protect the improvement in vegetation condition (permanence period) for 25 years. The scheme is not prescriptive with regards to activities undertaken, rather it is prescriptive of the outcomes required. Whilst Cassowary Credits are ultimately intended to be a high-integrity, standalone, bundled product decoupled from carbon markets, stacking of credits may be allowed in the first few years following the launch of the scheme to encourage investor participation. This should be done in accordance with strict guidelines set out in the methodology to ensure that additionality requirements are satisfied.

Following an initial feasibility study, a scheme methodology has been designed to account for the change in condition generated by Cassowary Credit project activities. Two methods are available: (i) reforestation of cleared land - e.g., planting of seedlings or direct seeding; and (ii) actions that reduce/remove factors that impact the condition of rainforest - e.g., controlling invasive weed species. However, the market has not yet been fully launched, although field testing at several revegetation sites has now begun (https://terrain.org.au/cassowary-credits-field-testing/). As the market is still in its development phase, no evidence yet exists of the potential financial benefits that could arise to landholders from this credit market in the future.

Nature Repair Market

Currently under development by the Federal Government, the Nature Repair Market will provide opportunities for businesses, organisations, governments, and individuals to invest in projects to protect, manage, and restore nature. Demand for the Nature Repair Market product is anticipated to arise from mandatory regulation (numerous sources mandatory regulation (in compliance markets), government purchases using public funds, and voluntary participation, by businesses, individuals and civil society groups. This include including participants compliance markets), government purchases using public funds, and voluntary participation by businesses, individuals and civil society groups. This includephilanthropic and corporate Environmental, Social and Governance (ESG) motivated investment, driven by reporting and disclosure initiatives such as the Task Force on Climate-related Financial Disclosure (TCFD) (https://www.fsb-tcfd.org/) and the Taskforce on Nature--related Financial Disclosures (TNFD) (https://tnfd.global). TCFD and TNFD have developed risk management and disclosure framework for businesses to identify, assess, manage and disclose climate- and nature-related impacts, dependencies, risks and opportunities (TCFD, 2017; TNFD, 2023).). These disclosure frameworks are designed to enable businesses and financial institutions to integrate climate- and nature-related information into decision- making. The Australian Government recently mandated large business entities to disclose information on climate-related risks and opportunities over a four-year period beginning from mid-2024 (The Treasury, 2024) and TCFD recommendations represent a significant part of this disclosure (ISSB IFRS, 2023). In January 2024, 320 organisations from over 46 countries committed to start making nature-related disclosures based on the TNFD recommendations (TNFD, 2024). These disclosures and private sector responses to address nature-related risks and opportunities could drive increased demand for environmental credits. The government Bill for Nature Repair Market was introduced in Parliament in March 2023, with the intention that the market will be open for trading in the second half of 2024.

The government-regulated Nature Repair Market is designed to enable Australian landholders to be issued with tradeable biodiversity certificates for projects that protect, manage, and restore nature, in accordance with methodologies approved by the Clean Energy Regulator. Examples of projects likely to generate biodiversity certificates include those likely to improve or restore existing native vegetation, through fencing or weeding, those involving planting a mix of local species, and those providing protection for rare grasslands that provide habitat for endangered species. The proposed permanence period is either 25 or 100 years. The biodiversity certificates will be tracked through a public register containing standardised information enabling investors to compare and value projects, and the certificates will be available for purchase by businesses, organisations, governments, and individuals.

The market is designed to operate in parallel with carbon markets, so landholders can get certificates from carbon projects that create biodiversity. Notably, unlike carbon credits, only one tradeable certificate is issued per project (Nature Repair Market Bill 2023 and Nature Repair Market (Consequential Amendments) Bill 2023 [Provisions], 2023). The Clean Energy Regulator will regulate the market to help align carbon and biodiversity markets. However, it is yet unclear whether Nature Repair certificates will be stackable with other environmental market schemes.

The Agriculture Biodiversity Stewardship Package was established to trial biodiversity market arrangements that encourage private investment and enable landholders to be paid for biodiversity outcomes, and so inform the development of the Nature Repair Market (Jacob et al., 2023). Current trials are being run in 6 regions with assistance provided by the Australian National University to develop rules for participation and processes for measuring, reporting, and verifying environmental outcomes in landholder's biodiversity projects. The pilot projects are either carbon plus biodiversity pilots, or enhancing remnant vegetation pilots, and are underway in several regions, including within the Burnett-Mary and in the Fitzroy basin within Qld. No application rounds are currently open to enable new projects to participate in the pilot phase.

Coastal Resilience Credits

The Coastal Resilience Credit is an emerging method developed by The Nature Conservancy that will be managed and regulated by Verra (https://verra.org/). The scheme is currently undergoing review and validation under Verra's Sustainable Development Verified Impact Standard, a program that certifies the sustainable development benefits of social and environmental projects. The scheme aims to tackle climate change impacts and enable coastal communities to be resilient and build adaptive capacity in the face of climate-related hazards and natural disasters (Beck et al., 2021). The methodology seeks to provide coastal resilience benefits through restoring and protecting tidal wetlands and quantifying the annual reduction in flood risk experienced by local communities (Unit: (in persons), '*the reduced number of people at risk of coastal flooding each year*'; (Beck et al., 2021). The method currently applies to mangrove and saltmarsh restoration but may be extended in future to incorporate oyster and coral reefs. Due to the historical and current presence of saltmarsh and mangrove habitats within the Mossman district, once established, this method is likely to be highly applicable in the area.

3.3.3 PEER-REVIEWED LITERATURE

From the search strings, 26 journal articles, spanning more than seven countries (Australia, Canada, Denmark, England, India, Iran, and the USA) were eligible for inclusion within the peer-reviewed literature review, with more than 50% (n = 14) of the eligible papers reviewed based within the United States. The literature focused mainly on biodiversity, co-benefits, and water quality-related environmental market schemes, as well as Payment for Ecosystem Services schemes more broadly, and credit stacking. These studies identified a range of challenges in the implementation of environmental markets, including risk allocation, social sustainability, a lack of trust compromising market success, and market complexity etc. A suite of recommendations to tackle these challenges was also identified, including transparency, rigorous monitoring and reporting, the need for government support and increased inter-agency coordination (Appendix 3, Table S3).

3.4 STAKEHOLDER SEMI-STRUCTURED INTERVIEWS

One key interview was conducted with representatives of the Douglas Shire Council. During the interview, it was explained that the Council is committed, via their economic development strategy, to explore avenues and opportunities for diversification within the key industries of the region: tourism and agriculture. Due to the known issues of the vulnerability of the mill and concerns around the long-term viability of sugarcane in this area, in 2023 the Council, working alongside external advisers (Mossman Agricultural Services, AEC Group), held a workshop to explore the attitudes of the district's sugarcane farmers towards diversification, and their perceived barriers. From this workshop, there was an apparent appetite among local sugarcane farmers to look at other crops and opportunities for their land. However, it was also clear that farmers are heavily geared towards sugarcane production and that sugarcane farming is all they know. Additionally, (prior to the mill entering voluntary administration) the market for sugarcane producers is secured through their relationship with the mill, therefore they do not need to concern themselves with seeking out market opportunities or understanding the full supply chain. Further, many of the farms are run by older-generation farmers, often operating alone. Combined, these factors mean that there is limited willingness and openness to try novel opportunities, despite the farmers knowing that their livelihoods are at stake. Consequently, novel recommendations must be approached carefully and be supported by sufficient evidence that the proposal can work on their farm and enable them to earn additional income—only with this confidence will landholders be willing to try something new.

Interview participants explained that the Council are aware of some progressive and innovative work being undertaken in the Daintree rainforest, including (i) work by not-for-profit organisations around carbon sequestration and carbon credits; (ii) projects run by Jabalbina Aboriginal Corporation working closely with the Eastern Kuku Yalanji Traditional Owners to care for their traditional estate; and (iii) a potential rainforest regeneration tourism project. If projects such as these were able to prove the concept and the financial and economic credibility, demonstrating tangible results, then the sugarcane farmers may be more willing to look at these innovative ideas.

The interview participants explained that, in their view, to encourage the farmers to be willing to participate in something new it would be key to set out what would be required in clear steps, with details on the costs and benefits of each step. To be acceptable, the changes would likely have to be simple farming practice changes, set out in basic steps. These changes must also be sensitive to the uncertain future that the farmers have been required to cope with over the last few years, and the insecurities this has caused, particularly in recent months since the mill entered voluntary administration.

For some farmers, particularly those with relatively unproductive land, it was thought that generating income through the credit markets may be appealing if presented simply and appropriately. For example, if it were set out in simple terms that the farmer could convert some of their low-yielding sugarcane land back to mangroves, and earn money from that via credits instead, then this could be an attractive proposition. However, as many farmers are already financially strained, they may be unwilling to do anything different that they perceive as being financially risky.

During the interview, the participants discussed if one or two big players in the region adopt a change, whether other members of the farming community would be likely to follow—exploring whether the farmers tended to follow emerging social norms or tended to act independently. The interviewees responded that the key factor would be whether the change undertaken by the early adopters was clearly a success or not. It was felt that the landholders would need absolute confidence that the change would be successful and allow them to make money before they were likely to follow. This has been demonstrated in the region where some landholders have trialled alternative crops which have not been successful, and this has served to further reinforce the general attitude of being geared to grow sugarcane and not wanting to change. The interviewees did note that a shift has started from sugarcane back to grazing land, particularly in the Daintree and around the Daintree ferry section of the region.

There was discussion around examples of different farming methods or products being successfully adopted elsewhere, and whether sharing those examples and lessons learned within the Mossman farming community may be likely to influence attitudes towards change. Past attempts at this have not been successful, as Mossman farmers and/or the Cane Growers Association have dismissed examples from the south as irrelevant to farming within the tropics, with high rainfall levels, and examples from irrigated farms not being relevant to non-irrigated farms.

Overall, the key advice from the Council interviewees in encouraging sugarcane farmers to consider participation in an environmental market was to keep the explanations clear and simple, ensuring that the farmers are spoken to using their language (rather than jargon, legal or policy speak), and to have successful context-relevant examples (rather than from other farming communities or other climate zones). The importance of successful trials within the region for influencing others should not be underestimated.

The other interviews with key stakeholders elicited a range of insights relating to opportunities and barriers facing environmental markets generally, in addition to insights specifically relating to the Mossman district context.

Biodiversity-based schemes were seen by the stakeholders to offer a great opportunity to landholders in the region. This view is evidenced by the growing number of schemes under development, including the Nature Repair Market and non-government regulated schemes (such as NaturePlus™ and Cassowary Credits). However, it is important to note that the views of the sugarcane farmers revealed in separate interviews (see below) did not strongly align; the farmers had little knowledge of, or current appetite for, the opportunities provided by these markets. Beyond the existing carbon and growing biodiversity schemes, the interviews also revealed an appetite to pay for societal co-benefits, such as employment opportunities, and opportunities for Traditional Owner Rangers on Country. The need to ensure that such schemes are evidence-based and verified was emphasised, and to ensure the credits taken to market are clearly high quality, greenwash-resistant products.

The opportunities for bundling benefits or stacking market instruments were described by several interviewees, and clearly offer a great opportunity for co-generating environmental and societal benefits whilst offering appropriate financial returns to the landholder. However, careful planning is required when seeking to stack credits: it is vital to ensure that participation in environmental credit schemes is undertaken in the appropriate order. For example, ACCU schemes with strong additionality clauses will typically require implementation prior to other schemes to ensure that commitments to another product(s) do not breach the additionality requirements. Careful planning should enable landholders to maximise their returns across several different schemes, and by following the approved methodologies for the various schemes together be able to generate multiple income streams. Whilst legislation for the Nature Repair Market is still to be finalised, this was identified by interviewees as a market that is being designed to be complimentary to ACCU schemes and is likely to allow landholders to leverage their carbon activities to generate co-benefits that can be rewarded through the new market.

Issues of scale emerged regularly through the interviews. Schemes generally favour larger-scale restoration projects where economies of scale can be realised across a range of different cost categories (project management, registration, auditing etc.). Opportunities for aggregating several project sites into one larger project can open environmental markets to smaller-scale landholders. Aggregating could involve a third party purchasing several parcels of land for this purpose, or alternatively could involve a project developer working with a group of landholders to submit a single project to the environmental market on behalf of the collaborating group. Further, from the developer's viewpoint, managing a portfolio of projects rather than one or two can realise both economies of scale and risk reduction. Thus, aggregation is likely to be more cost-effective, as this need for scale may make participation in environmental markets less tenable for individual farmers.

Greenwashing (as mentioned above) was raised as a potential risk to the success of environmental markets. Scheme processes and project outcomes need to be appropriately and reliably regulated, audited, and verified to ensure sustained demand for credits from international and national, government, and private sector purchasers. There is an important trade-off here – reducing risks of perceived greenwashing may incur costs but could increase the prices that purchasers are willing to pay (recognising the high quality of credits) and can open opportunities to be part of international biodiversity markets, hence increasing the number of potential buyers.

A key barrier to engagement in environmental markets was the cost (time, money, risk) of development approvals. Project sites where EPBC issues were likely to exist are unlikely to attract the interest of developers due to the cost and complexity of the approval process. In locations under appropriate legal and property right settings where there is no pre-existing relationship with the Traditional Owner group(s), or where the traditional ownership is contested, the engagement process may be slow and costly; however, where – in such settings – the developer and local Traditional Owners group have an existing and trust-based relationship, then the engagement, any necessary cultural heritage survey, and approval processes may operate far more smoothly. Beyond these factors, development approvals for projects can be fraught for numerous other reasons too. The process can be complex with many and changing requirements (bush fire plans, mosquito management plans, water licenses etc.) and can take from a few months to two years depending on project specifics. Development approval delays also can induce further delays if the project misses key activity windows (for plantings, earthworks etc.) which can be particularly tight in the Wet Tropics region. Local context can also add further delays and/or costs, for example, a project site may be unsuitable for more widely used techniques and machinery due to its terrain; this is widely recognised as a particular problem in the Wet Tropics climate zone.

Within the context of the Mossman district, there was clear consensus from several interviewees that communication with the landholders was key. It was important to work with the landholders, exploring what they value and what their business goals are, to ensure they could then understand how environmental markets can fit within that framework. It was noted that the success or failure of an environmental market-based strategy in Mossman will be down to whether the Community is treated respectfully, in terms of defining the opportunities for themselves.

There was also discussion about the need to take a wider landscape scale view, exploring options that provided benefits at the societal level and landholder level over a longer time scale. It was noted that there may need to be a role for government in facilitating alternative land management within the region. The opportunities could be considered across a spectrum, from individual to community decisions, where actions such as changing land management practices were at the individualistic end of the spectrum whilst actions such as restoring wetlands for blue carbon and other co-benefits were at the collective end of the spectrum requiring cross landscape coordination.

3.5 LANDHOLDER INTERVIEWS: ACCEPTANCE AND WILLINGNESS TO PARTICIPATE IN ENVIRONMENTAL MARKETS

The farmers interviewed all had a long history of sugarcane farming in the region, for decades, and in some cases, for generations. All were solely invested in sugarcane farming rather than having diversified into other forms of agriculture. The interviewees' circumstances ranged from those seeking to sell their property and exit the industry, to those hoping to pass the farm on to the next generation. Half of the farmers interviewed had planted, fertilised, weed sprayed etc as usual for the 2024 crushing season in the hope that the Mill would remain in operation for at least that season; others had either partially or totally reduced their investment in the farm for the 2024 crushing due to the uncertainty. Farm sizes varied, from small to large. Thus, the farmers' individual circumstances represented a range of different contexts. However, strong and consistent themes emerged from the interviews with the farmers. Some of the key themes emerging from the interviews are illustrated in the word cloud (Figure 8), particularly highlighting that the farmers and their families have been growing sugar cane on these lands for a long time period, with 'years' being the most frequently used word.

Figure 8: Word cloud capturing the most frequent words used by interviewees (analysis assisted by use of NVIVO release 1.7.1).

3.5.1 ATTITUDES, NORMS AND PERCEIVED BARRIERS TO SUGARCANE FARMING AND ALTERNATIVE AGRICULTURAL OPTIONS

All farmers interviewed had a strongly positive attitude towards sugarcane farming in the Mossman district, believing this crop to be most suited to the soils, climate, and conditions of the region. All farmers noted that sugarcane was one of the few crops that could cope with regular inundation during the wet season, resulting in an economically viable crop being produced in most years. It was also observed that the industry complemented the tourism industry in the region, as tourists liked to see the well-kept manicured sugarcane farms. Farmers were aware to varying degrees of the different options being explored by the Mill, including the production of biodiesel, sustainable aviation fuels, fertilisers, sauces etc. The farmers generally appeared positive towards the possibility of changing the sugarcane varieties grown if the focus of the Mill were to change from sugar to biomass. One farmer summed up his view as (please note, some quotes haves been altered for clarity):

> *"… don't care what they make … there's a little boom would happen here ... And then you get certainty back onto the farms … people start buying tractors and gear again".*

This view seemed fairly representative of all the farmers interviewed. All farmers agreed that there were no viable alternative to supplying sugarcane if the Mossman Mill closed; the Tablelands Mill was understood to be already at capacity, and it would be unviable to truck sugarcane there from Mossman; similarly, whilst Mulgrave Mill was understood to have capacity, trucking sugarcane to Smithfield then transferring to rail for the journey on to Gordonvale was not seen as financially viable.

Other alternative products that interviewees had considered growing, or were aware of others having tried, included tea tree oil, agarwood, soya beans, peanuts, sorghum, vanilla, bananas, paw paws, and other fruit trees. However, the interviewees were unaware of anyone having better outcomes from alternative crops, as sugarcane is considered best suited to the land. As explained by one farmer "It's good agricultural, well I think it's good, it's good sugarcane land. ... like I say, if it was good agricultural land we'd be able to grow anything". Another farmer explained how if the farmer tried to change to another crop, "… machinery would be a big expense or a big problem to change." It was also noted that if growing some other crops, then there may be a need for irrigation licenses, which the landholders don't currently have or need for growing sugarcane.

Cattle was considered a less suitable option for several reasons including lack of knowledge regarding cattle farming, the need for capital investment into infrastructure (water, fencing etc.) to facilitate cattle, the size of the farms being too small to enable sufficient head of cattle, and the risk in a substantial flooding event that the cattle would be washed out to sea; the attitude to cattle can be summarised by "there's no money in cattle" as expressed by several interviewees. When asked about aquaculture options, such as prawn farming and barramundi, similarly negative views were expressed: again, such a transition would require knowledge and capital, and this industry also carries a high risk that a flood event will wash the stocks out to sea, as was seen in the 2019 flood event and again recently following the flooding post cyclone Jasper (December 2023).

Despite the positive attitudes towards growing sugarcane, barriers to continuing within the industry were noted, both related to and separate from the uncertainty over the mill's future. Key barriers to continuing in sugarcane farming were as follows:

- The Mossman Mill's future has been uncertain for around 20 years. The cumulative impact of this ongoing uncertainty has affected investment in farms, tractors and other equipment and has prevented effective succession planning.
- Difficulties in securing funding from banks to invest in purchasing sugarcane farms, as farming in Mossman is considered too risky to provide security. This restricts new farmers from entering the industry but also restricts those who would like to exit the industry (for retirement or other reasons) from being able to sell.
- Uncertainty over the Mill and the future of the sugarcane industry has impacted the supporting industries within the region, resulting in services such as tractor maintenance, mechanics etc now needing to be brought in from elsewhere rather than being available locally, generally incurring delays and higher costs.
- Sugarcane farmers in the Mossman district are generally older than elsewhere, and the ageing of the sugarcane farmers was seen as a critical issue. Young people are not incentivised to enter the industry, due to uncertainty and higher incomes available from mining and other industries outside of the region, whilst older farmers struggle to retire when they cannot sell the land or pass it on to the next generation.

- Increasing need for economies of scale to enable the business to be financially viable, due to technological advancement and increasing costs of capital equipment. Small farms struggle to be economically viable.
- Sugar prices (it was noted these are currently high) would encourage farmers to plant more sugarcane if not for the uncertainty around the Mill.
- Fertiliser prices have increased substantially, increasing costs and/or impacting production if less fertiliser is used in response to the higher costs.
- Increasing environmental restrictions, relating to nitrogen, and sediment.
- Adoption of BMP accreditation, and related reduced fertiliser use, impacting the production levels generated from the land.
- Weather events, particularly rain and flooding. Record flooding events have been experienced in 2014 and 2019 in addition to 2023.
- Pests, particularly pigs and rats.

Despite these obstacles, sugarcane remains the preferred option for these farmers rather than transitioning to other forms of agriculture.

All farmers interviewed were aware of the carbon credits available for tree planting, and similarly, all were aware to a greater or lesser extent of the Reef Credits market. The farmers were not aware of the opportunities for blue carbon, and none had heard of the Cassowary Credits market.

3.5.2 Attitudes and Subjective Norms Towards Markets in General

The farmers were asked whether they had any fundamental disagreement with the philosophy underpinning environmental markets, i.e., did they agree that farmers should be able to generate an income stream from changing land management practices towards those that delivered positive outcomes for the environment (such as sequestering carbon, improving water quality, and/or improving habitat to support biodiversity).

Key concerns and potential barriers towards environmental markets in general were as follows:

- Concerns regarding food security.
- Concerns regarding market viability.
- A lack of information about, and successful examples of, environmental market projects — perceived as ‘experimental’.
- Landholder costs.
- Uncertainty as to how environmental markets benefit the local economy and employment relative to other alternative land uses (e.g., growing sugarcane for biofuel).
- The advancing age of farmers in the area—i.e., many would find it easier to retire or sell the land instead of starting an environmental market-based project.
- Perceptions of onerous and costly monitoring, record keeping and reporting requirements to demonstrate compliance.
- Concerns regarding the legitimacy of new schemes and a lack of trust.
- Concerns regarding the contractual obligations and their duration.
- The unknown impact on property value.

One farmer advised that he was against environmental markets as “… we're only farming so we can eat something … in 50 years’ time, they're going to be pretty hungry around the place”.

However, the three other farmers were more receptive to the concept of environmental markets in principle. Two farmers explicitly expressed the view that if the community wanted farmers to deliver such outcomes, then it was appropriate for the community to provide the funding required to achieve these outcomes. One farmer explained ‘… if that's what the community wants, well the community … has to pay to some extent”, whilst another stated, “I think if the community expects you to do different things than farm, they should be paying for it”.

The farmers described how, whilst not necessarily against environmental markets, they would require convincing that such schemes were viable before they would be interested in participating. One farmer commented "… only if it's viable and if the science has been done to prove that it actually works … otherwise, it's a waste of time" whilst another commented "… not going to do it unless it's sort of viable … I'm not suggesting any of these particular projects, because I don't know enough about them, but … some of these things […] they just seem unviable … these things are nice, but they have to stack up or there has to be an incentive". A third farmer's comments reinforced this view, stating "it's hard to be green if you're in the red. … So, playing with experimental stuff. … I've been burnt playing with these things trying to do the right thing for a while. Now basically, if I can't see the green [the money] at the end, I'm not going to do the red [incur expenses on trialling or transitioning to other options]."

The farmers discussed the delivery of benefits to the environment and referred to various changes they had made to their land management over the years to improve environmental conditions, noting "We're not here to stuff the place up". One farmer described how the Mill switching towards products such as biofuels etc. would likely produce more benefits than if sugarcane farmers participated in environmental markets rather than sugarcane farming, as this would provide alternative non-carbon-based sources of fuel and would also deliver economic benefits for the region. This farmer stated "the bio systems that have been proposed are probably better than the carbon sequestration and things like that. Because it'll be an active process rather than passive one where you're growing trees, you'll be employing people, … you'll be creating biodiesel, … you'll be generating income for … the local economy." Another farmer also noted their view that investing money in the Mill to facilitate biodiesel production and use would have a better impact on carbon reduction than investing in carbon sequestration projects.

The farmers referred to the <u>advancing age of many of the farmers</u> as a likely barrier preventing many farmers in the region from considering participation in environmental markets. One noted "… some of them will just say, oh this is all too hard, I'll just get out and retire, and they'll just lease their place out if there's someone to take it, for some other person to do whatever". Another landholder expressed the view that many farmers in the region would likely be interested in selling their land to others who would then be able to undertake and manage the environmental market projects and benefit from the credits. Another farmer noted that the price of land in the region has been falling, thus several farmers who would like to sell (to retire or for other reasons) have been unable to because they are unable to get a good enough price for their land. One farmer thought that if the mill closed and land couldn't be sold, it would likely be better financially for the farmer to abandon the land and do nothing with it, rather than trying to transition to participate in environmental markets because of the ongoing maintenance and monitoring costs. He explained, "What do you do? Or you abandon it? … Because it could be more expensive to … maintain it … do the testing … it would be completely uneconomical."

Another barrier raised by the farmers was the <u>access to capital to fund the transition</u> from sugarcane to environmental markets, comments including "I don't have the money to invest". One farmer expanded on this theme, in the context of the Mill closing "We'll be broke. I can't see us being able to do anything else. We won't have the capital, we won't have anything to do." When asked whether some underwriting of costs would be required to help the transition and encourage uptake: "I think 5 years would be too short. It'd have to be at least 10, I'd reckon."

A key barrier related to <u>perceptions of onerous and costly monitoring, record keeping and reporting requirements to demonstrate compliance</u>. Both administrative and biophysical compliance requirements were raised by the farmers as being of concern to them. The farmers' overall concerns regarding onerous compliance requirements in general, and their expectation of onerous record-keeping requirements in particular, are captured by these quotes:

"I think people are worn down from interference … there's someone always looking over your shoulder, …, telling you what you've got to do".

"Farmers are always concerned about restrictions, … any sort of extra red tape".

"You might find one or two pretty adamant record keepers in farmers, but that'd be one out of a hundred. I reckon the other 99 are pretty anti-records. Not that we're illiterate, but … the

more time you spend in the office is the less, ... boots on the ground is what grows stuff, not bloody office work".

There were also expectations that the costs of monitoring and reporting biophysical conditions on their lands could be onerous. This also led to recommendations that support could be required "if the government had … a program where they, if they did the measurements and paid for the measurements, then it might become viable".

Concerns were raised about costs and the potential <u>impact on the operating costs</u> of the property, as summarised in the comment: "How does that affect my well the dollars in terms of rates, insurance…?"

These concerns raised regarding capital costs, administration, monitoring, and operating costs, all link back to the farmer's fundamental need to see that environmental market schemes are viable before they would be willing to change their operations. The farmers interviewed saw themselves and many of the farmers they know as being more likely to be willing to participate in markets after they have seen others demonstrate that they can be viable. Comments included:

"... rather than lead, they probably follow others if ... they need examples of people to follow, you certainly need examples ... they need to see another opportunity before they'll go down that road. They're not prepared to do it themselves."

"... farmers will follow the money trail. I mean ... if they ... could see you doing that, and then you're getting very positive results, ... if they can see ... a future, and it is viable, and they see you're making a success, well they'd certainly, they'd have no choice but to do it."

"But until you can show that these systems are working and they're economical, nobody's gonna risk it."

The farmers' scepticism was not only focused on environmental markets themselves. Two farmers expressed concern about the legitimacy of any potential alternatives to growing sugarcane and/or alternatives to the mill crushing for sugar; furthermore, concerns were expressed about the trustworthiness of those promoting such alternatives. These concerns were based on long experience of other schemes that have been proposed for the mill and the region over the last few years. One farmer explained "There's big money in it apparently, which, which is a bit scary because all the shysters come out too, all the … snake oil salesmen and, and Mossman has been a magnate for snake oil salesmen here … we are very, very sceptical around Mossman these days", noting "… you've got to sort out … the shysters from the genuines, and that's the hard bit." A second farmer echoed these views, explaining "there's been schemes … going back over the last couple of decades … there's been some … there's been certain big failures … so … people that haven't been involved I think have that image of, is this another one of these too good to be true schemes" and noting "you get the snake oil salesman type people where people are just, well … there's always a few of those sort of people".

These concerns extended to the <u>legitimacy of environmental markets, and those involved in the markets</u>. One farmer noted, "I'm very sceptical that there's a lot of corruption going on there". Another farmer explained he had been reading about the role of developers within carbon markets, probably in Cane Grower Magazine, and had been concerned: "… I read an article on that bit last week, and they said most of those blokes get more money than [farmers]".

A further important concern related to the <u>contractual obligations incurred</u> through participation in markets and the, potentially lengthy, <u>time period of these obligations</u>. One farmer clearly stated, "the barriers are really the commitment and, and the time period … because some of these may be long term commitments and from a contractual sort of point of view." The farmers were particularly concerned about the consequences should a farmer enter into an environmental market and then subsequently wish to withdraw. Questions related to restrictions on their ability to use/see the property as they chose, and potential penalties for future actions. Illustrative quotes from the farmers are as follows:

"What are the financial penalties if you go down this road, and then through circumstances outside their control, it might be their health or whatever, they've got to get out".

"...being concerned that they'd be looking ahead too, well how's that going to affect the property? ... in the future ... do they lose flexibility? Can I sell the, what happens if I want to sell the place or family for family reasons ... ill health or whatever, you know what I mean? Or, or you know, it's going down another generation, but none of that generation want anything to do with it and want to sell it."

"...any other sort of potential restrictions as a result of going down this path, you know, in terms of what you can and can't do with your property ... maybe there's no issues with any of them but, But they need to be answered, or foreshadowed."

"You need to know the term, the dollars, what the actual commitment really means in terms of restrictions with your property?"

The final, and very important area of concern with regards to participation in environmental markets related to the potential impact this may have on property values. This includes both value if the farmer sought to sell the property "what it does to you, the value of your property", but also the value of the property as security for credit:

"... for instance, that the farmer may be using the property to as you know for further banking ... for credit for other things to invest into something else. ... Security, yeah, bank security. How would they see that?"

"Does it do anything to your security of your property in terms of financial institutions or if you're trying to ... say you're going to sell it? Does it put up all sorts of red flags?"

3.5.3 Attitudes and Subjective Norms Specific to Particular Environmental Markets

The farmers' attitudes towards specific markets were also explored. As noted above, the farmers all had some awareness of the opportunities offered by tree planting/green carbon schemes; however, none had particularly positive views of these opportunities.

Key concerns and potential barriers towards tree planting/green carbon schemes were as follows:

- Loss of good agricultural land to tree plantations, a belief that the land could be better employed.
- Project duration – the land is 'locked up' for a long time.
- Concerns that tree planting schemes may promote single species plantations and the associated risks/problems that arise.
- The viability of green carbon schemes.

Comments included "It's good agricultural land, to turn around and put it back under trees and have it locked up for, you know, I just think that would be an absolute waste. I'm sure we can do something better and better production than that on this land", and "Trees aren't very high on the priority". Another farmer expressed concern that such schemes may encourage the planting of single varieties "…too many trees of the same type together, … in the past, … people were planting a lot of red cedar, but too many red cedars together, you had all sorts of other, other issues … You've got to have a mixture of different varieties of trees". As with markets in general, key concerns were regarding the viability of green carbon schemes, as summarised by the following quote: "I have spoken to some other private people to do with trees … but nothing from what I could see really, really stacked up".

With regards to blue carbon markets, key concerns and potential barriers towards blue carbon schemes were as follows:

- Lack of awareness of the blue carbon market and potential methods.
- Concern regarding introducing saltwater to marginal lands and its impact on neighbouring, productive agricultural land.
- Skepticism regarding project/method success.
- Monitoring and reporting costs to the farmer.

One farmer was vaguely aware of the blue carbon market whilst the others were completely unaware. Accordingly, an overview of the blue carbon market was provided and then discussed. Two of the farmers could identify parts of their land that may be suitable for a blue carbon scheme, for the other two it became apparent that this market offered no opportunities for them. As with green carbon schemes, the farmers were not particularly receptive to the idea, identifying a number of possible risks. One farmer was concerned that if currently marginal lands were converted to saltwater wetlands then there was a risk that adjacent currently productive farmland could become marginal as saltwater intrusion moved further inland. Another farmer was sceptical that restoration of wetlands would achieve the desired restoration aim, noting that allowing salt water back "… doesn't mean … there's going to be a good sequestration of carbon in there. … The science hasn't been done". One farmer also expressed an expectation that the costs of monitoring and reporting could be particularly onerous for a small-scale blue carbon project, noting:

"I'm assuming that ... you would have to pay for somebody to come and measure the carbon content. ... I suspect that ... doing the, the carbon measurements in such small areas that we've got, not worth it ... It'd be way too, yeah, too costly."

With regards to Reef Credits, all farmers were aware of the market, but only one had explored the scheme in any detail.

Key concerns and potential barriers towards Reef Credits were as follows:

- Administrative requirements.
- The impact upon the farmer's ability to farm effectively.
- Disadvantaging those farmers already doing the right thing without financial incentive, whilst advantaging those that haven't.

This farmer had concerns around both the administrative requirements of the scheme, but also on the impact the scheme could have on his ability to farm effectively:

"The fleeting look I had at them now, they just didn't work."

"... every fleeting look I had, the record keeping, the oversights ... what they wanted from me was more than I was getting from them ... and always. It was more trouble than what it was worth. And, and it generally interfered with what I was trying, and I'm trying to grow a cane, and it generally interfered with what I was trying to do."

The farmers all described how their land management practices already cared for the environment, as they, and other farmers across the region, had been planting riparian vegetation, trash blanketing, reducing fertiliser use and adopting best management practices (BMP) for a number of years. The farmers described how they had adopted these practices without accessing any markets or receiving financial support, and expressed some dissatisfaction that those who had managed their lands well for many years received no benefits whilst laggards who only recently adopted BMP were able to access funding. Comments included:

"The reef credit… I think it's one of those ... things that ... we're probably already doing and we're not getting any money for it."

None of the farmers were aware of the existence of the Cassowary Credits scheme. As this scheme is not yet fully operational it was not further discussed.

3.5.4 Summary of Perceived Behavioural Control, and Perceived Barriers to Participating in Markets

As described above, none of the farmers interviewed expressed a current intention to participate in environmental markets in the future. A number of reasons for this were discussed, with some clear themes emerging from the discussions. The actual or perceived barriers to participation in environmental markets, discussed in more detail above are summarised below.

- Belief that farming sugarcane would generate a higher financial return/lack of belief in economic viability of environmental markets.

- Lack of capital to invest in the transition.
- Perception that participation in environmental markets would require onerous and costly administrative requirements, including both record keeping and reporting compliance.
- Expectation that the biophysical monitoring and reporting compliance processes would also be costly and onerous, particularly for small site blue carbon projects.
- Uncertainty over impact on operating costs of the property such as rates and insurance.
- Concerns relating to contractual obligations incurred through participation in markets, and the time period over which these obligations remained in place. These concerns included potential impact on the ability to sell the property at a later date.
- Fears of impact on property values, including both value if the farmer sought to sell the property but also the value of the property as security for credit.

4. ECONOMIC FRAMING

This section outlines the framing we adopt in this Report for a generic environmental market project. This framing draws on information from scheme and market operators' websites, information and insights obtained through key stakeholder interviews, and the authors' prior experience. The generic project framing described here and illustrated in Figure 9 was reviewed and iterated with project developers until they agreed that it was representative of the activities involved in the initial engagement, conceptualisation, establishment, production and commercialisation phases of an environmental market project (Figure 9). The specific components included in individual projects may differ, however, depending on the legal and property right context, local requirements for development approvals, and an individual landholder's situation and preferences.

A wide range of policy approaches have been implemented over recent decades with the aim of improving Reef water quality through practice change in the agriculture sector in catchments along the Reef coast, particularly in sugarcane production, banana horticulture and cattle grazing. As the focus of this Report is to assess the potential for environmental market opportunities to generate additional income for sugarcane growers in the Mossman district, we refer the reader to Rolfe & Windle (2016) and Star et al. (2018) who summarise the broader policy landscape and reflect on the performance and cost-effectiveness of various policy approaches across different agricultural sectors and spatial settings.

The financial viability of environmental market projects for indicative case study locations in the Mossman district is assessed via Discounted Cashflow Analysis (DCFA). The DCFA is conducted initially at a *whole-of-project* level and draws on the economic framing described here and illustrated in Figure 9.

The framing identifies project actors, their roles and contributions, and the costs each actor incurs. Economic outcomes are quantified initially at a whole-of-project level, and then for each actor (or group of actors, e.g., for a group of landholders when multiple landholders are involved) separately. It is important to recognise that a project will have to be financially viable for *every* actor if it is to go ahead. The actors who participate in an environmental market project contribute different resource inputs (e.g., financial capital, entrepreneurship, land, Traditional Knowledge) and undertake different activities at different points in time over the project lifespan. The magnitude and timing of the costs and risks incurred in contributing factor inputs and undertaking activities differ depending on the scale and nature of the resources contributed. Differences between actors in terms of costs incurred and exposure to risk will influence how net revenues from the sale of environmental credits or certificates might be shared between the different actors.

The section begins with a description of key project actors, and their roles and contributions within the life cycle of an illustrative project. The categories of costs incurred through that life cycle and the revenues which flow back to the different actors are then described. The framing described in this section provides the basis for subsequent DCFAs and project outcomes reported in Stage 2 of this report.

Several Project Actors are typically involved in a project that seeks to generate revenue by selling credits or certificates on an environmental market. Outcomes for all actors therefore need to be assessed when the viability of the project as a whole is being considered. The combination of actors will differ depending on project size, scale, and complexity. A starting point for a general framing is to identify the key resources and expertise required to implement a project – and then consider which actor(s) contribute those resources and expertise in a particular project setting.

Land on which to conduct project activities is the first key resource. This resource is contributed by the *landholder(s)*, a key actor in the project[1]. In committing land to the project, landholders will incur costs. These costs to the landholder are explained further in the Economic Methods section and Table 12 and Table 13. For projects that involve land restoration or a change in land use on land under relevant forms of land title or land use agreement, Traditional Owners or Traditional Custodians could be another relevant actor (see Appendix 7 for information regarding cultural heritage surveys and engaging Traditional Owners). Traditional Owners or Traditional Custodians can contribute Traditional Knowledge to inform restoration and their involvement as a project partner may add value to carbon credits generated from changes in land use or land management (Barker, 2024). We consider it unlikely that Traditional Owners would be involved in projects which are carried out solely on private freehold land, unless the project involves restoration of a large area of original habitat (such as coastal wetland or tropical rainforest) and the landholder and developers choose to engage with Traditional Owners.

Most land use change projects, require significant upfront capital for design, approval, and implementation of necessary on-ground works before any environmental credits can be produced. Depending on the type of project involved, access to this capital may have to be secured several years before revenues begin to flow from environmental market products. The actor who secures access to this upfront capital and subsequently carries the cost and risk of repaying the capital loan – with interest – is thus a key actor in the project. The upfront capital loan could be sourced and secured by the landholder themselves; however, for land use change projects with substantial upfront capital requirements, it is more likely that an external actor will fulfil this role. In such contexts that actor will also typically manage overall project implementation and administration. Here we call this actor the *project developer*, but note that, particularly for smaller projects, the landholder may choose to fulfil the project developer role.

Once the project begins to generate ‘product’ in the form of environmental credits or certificates, that product will have to be commercialised through sale of credits or certificates on an environmental market(s)[2]. Commercialisation can benefit from expertise in and familiarity with the relevant market(s). In many contexts, market expertise can be purchased from a broker for an agreed fee. In these situations, we regard the broker as an *external service provider* rather than a key actor within the project. In other contexts, the project developer typically utilises their own expertise for efficient commercialisation, or the landholder may choose to undertake this role themselves. The roles of the different project actors are illustrated in Figure 10.

4.1 PROJECT PHASES, ACTIVITIES AND COST COMPONENTS

Whilst no two environmental market opportunities are the same, iterative interview-based discussions with project developers indicated that environmental market projects typically comprise four main phases of activity over their life cycle: *engagement and conceptualisation, establishment, production,* and *commercialisation* (Figure 9 – block arrows at the top of the diagram). The engagement, conceptualisation and project establishment phases at a given site can take several years for larger, more complex projects (see timelines in Appendix 5). We term this the *lead-in time*. The production and commercialisation phases run concurrently as product is produced, taken to market and sold.

A project’s *crediting period* is the duration for which the project can claim production of environmental credits (Clean Energy Regulator, 2016). The crediting period for projects that produce ACCUs for the Clean Energy Regulator is 25 years (Clean Energy Regulator, 2016). The crediting period for DIN Reef Credits is 10 years

[1] Private landholders in Mossman district who produce sugarcane on their freehold land are the focus of this report. We recognise that some Mossman growers will lease the land on which they produce sugarcane. However, where the environmental market opportunity entails a change in land use and a commitment to maintain that land use for a contracted permanence period, the landholder – rather than the tenant – will be the party engaged in the project. Noting that the majority of sugarcane production in Mossman district is from freehold land, for simplicity, we assume in our analyses that the sugarcane grower is also the landholder. Hereafter, the term ‘landholder’ is used as shortform to denote ‘landholder who is also a sugarcane grower’. In other contexts, environmental market projects could be conducted on land held by governments, public agencies (e.g., the Department of Defence) or corporations (e.g., water supply companies).

[2] Or, in the case of Queensland’s Land Restoration Fund or some ACCU schemes operated by the Clean Energy Regulator, through submission of an ‘offer to supply’ to a reverse auction.

(Schulz & Sinclair, 2020). The crediting period spans the entire production and commercialisation phases in Figure 6. For projects that produce ACCUs for the Clean Energy Regulator, project proponents can nominate a *permanence period* of either 25 years or 100 years for their project. Carbon stores (e.g. in vegetation or soil) at the project site must be maintained in adequate condition for the full duration of the nominated permanence period to ensure that the site continues to store the quantity of carbon for which ACCUs were issued during the crediting period (Clean Energy Regulator, 2016). The permanence period commences on the date the first ACCUs are issued to the project (Clean Energy Regulator, 2016). This will typically be a one year and a few months (e.g. 5 months) into the production phase to accommodate the time required for paperwork preparation, independent audit (if required by the environmental credit scheme) and approval for the first tranche of environmental credits by the credit scheme administrator (see top part of Figure 9). A project's crediting period will thus finish before the end of the permanence period. If the project proponent nominates a 25-year permanence period the time offset between the crediting period and permanence period is given by the duration of the first reporting period, report preparation time and the time it takes the credit scheme administrator to assess, and approval of the project report. If a 100-year permanence period is nominated, the permanence period extends for more than 75 years beyond the end of the crediting period. This may explain why project developers report that – in their experience – landholders always elect for a 25-year permanence period rather than a 100-year permanence period.

Different categories of activity, and thus cost, are incurred in the different phases (Figure 9 – coloured tiles below the relevant block arrows). Figure 9 shows a generic set of costs incurred in a relatively complex project. Costs are classified as upfront or on-going. *Upfront costs* are those that are incurred only once during a project's permanence period and take place in the early phases of the project prior to completion of on-ground works. Once on-ground works have been completed, additional periodic costs continue to be incurred during production and commercialisation phases until the end of the permanence period. These annual and periodic costs are referred in this study as *on-going costs*.

Some activities are typically undertaken directly by actors in the project (usually the actor(s) in the *landholder* and *project developer* roles). These activities and costs are shown in black lettering in the coloured tiles in Figure 9.

In the economic analysis, landholders[3] are assumed to:

- Incur an annual opportunity cost from foregone net revenue from the land committed to the project for the full project duration.
- Suffer a reduction in land value once land is signed up to environmental market projects that require a change of land use.

In the economic analysis, project developers are assumed to:

- Incur up-front costs through engaging with landholders, conducting preliminary site surveys, producing an initial draft project design, setting up legal agreements with landholders, and establishing a credit baseline for the project.
- Secure finance to meet the costs of producing a detailed project design, securing development and regulatory approvals, and implementing all necessary on-site works (specific on-site activities will differ depending on the scheme and site concerned). The developer is also assumed to carry the risk surrounding repayment of the finance loan, with interest –over a 10-year repayment period.
- Incur on-going costs for annual monitoring and reporting of credit production, periodic independent audits of credit production (if these are required for the particular environmental credit generation method concerned), interfacing with credit markets and credit buyers, and on-going management of the project.

[3] Beside the opportunity cost and reduction in land value, landholders may still likely bear some other costs e.g. costs in developing and setting up projects. However, in our analysis, we assume that these costs are incurred by project developers.

Other activities are typically implemented by *external service providers*, who submit payment invoices to the project developer. In the economic analysis, we assume these invoices are paid by the project developer. These activities and costs are shown in red lettering in the coloured tiles in Figure 9 and are assumed to comprise:

- Costs of producing a detailed project design, securing development and regulatory approvals, and implementing all necessary on-site works
- Annual and periodic on-ground operating expenditures during the production phase
- Annual and periodic fees and costs associated with independent auditing, verification and commercialisation of credits or certificates during the commercialisation phase.

The various cost components that are assumed to be incurred during engagement and conceptualisation, establishment, production, and commercialisation phases, are further described in Box 1.

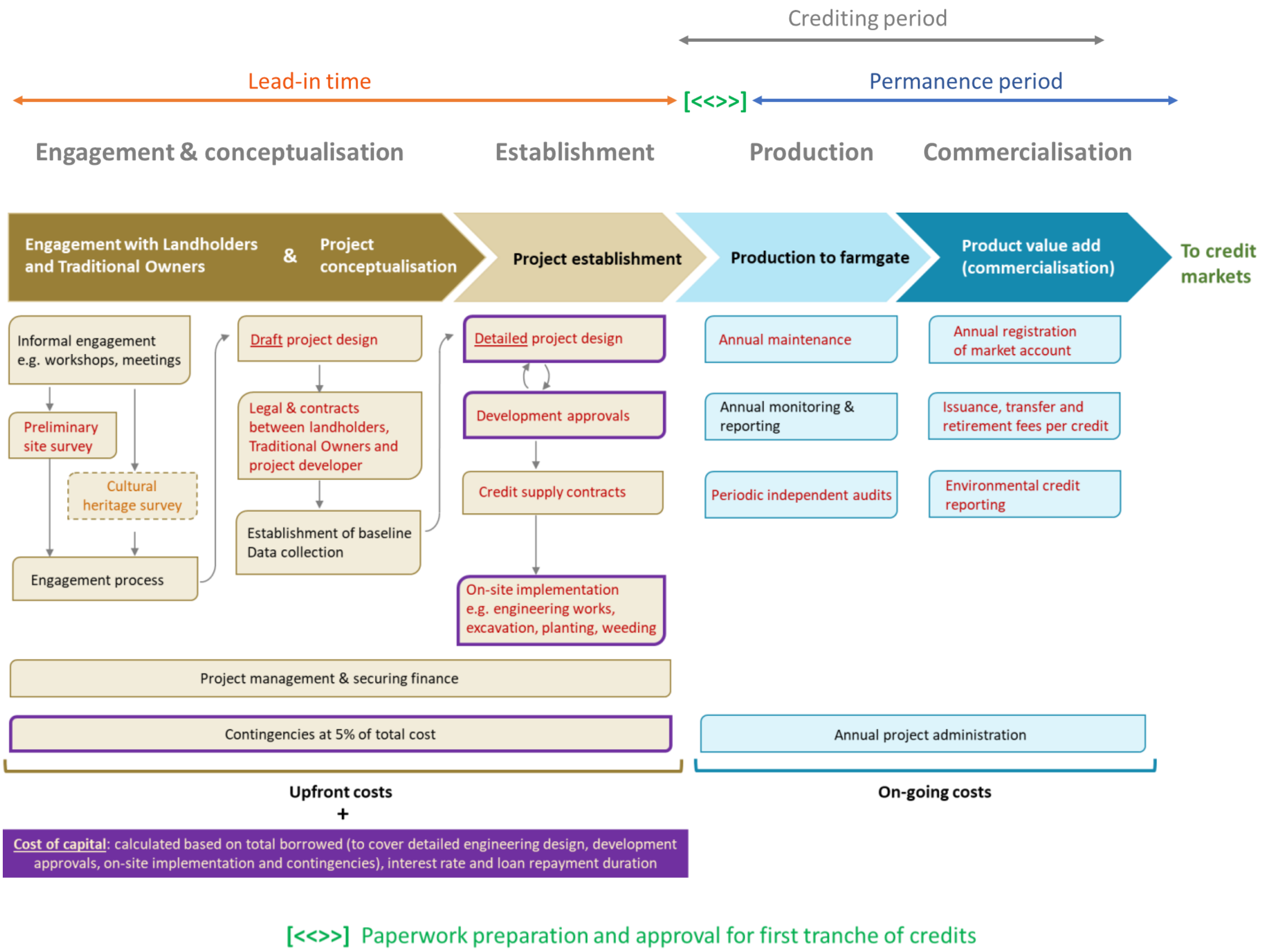


Figure 9: Activity phases (in block arrows) and illustrative cost components (in rectangular tiles) for a generic environmental market project of moderate scale and complexity – as determined through iterative interview-based discussions with project developers. Project lead-in time comprises the engagement and conceptualisation phase and the establishment phase. The project's crediting period starts earlier and therefore finishes earlier than the project's permanence period. The project's crediting period begins at the start of production phase and runs through to commercialisation. The project's permanence period begins from the date of approval for the first tranche of environmental credits by the credit scheme administrator and continues through commercialisation. Cost components in black text are incurred directly by project actors (usually the landholder and the project developer). Red text denotes activities undertaken by external service providers who invoice the project developer for payment. Rectangular boxes with a purple outline (detailed project design, development and regulatory approvals, on-site works and implementation, and contingencies) together constitute the major proportion of the upfront capital requirement. We assume that these costs are financed via a loan secured by the project developer.

The durations of the production and commercialisation phases vary depending on the scheme concerned. For example, production and commercialisation runs for 10 years for Reef Credits generated under the fertiliser reduction method (GreenCollar, 2023), and 25 years for ACCUs generated under the reforestation by environmental or mallee plantings method (Emissions Reduction Fund, 2023c).

Figure 10 illustrates how actors in the landholder(s), and project developer roles incur costs across the project life cycle by implementing activities directly (shown in black text) and paying invoices submitted for activities undertaken by external service providers (shown in red text).

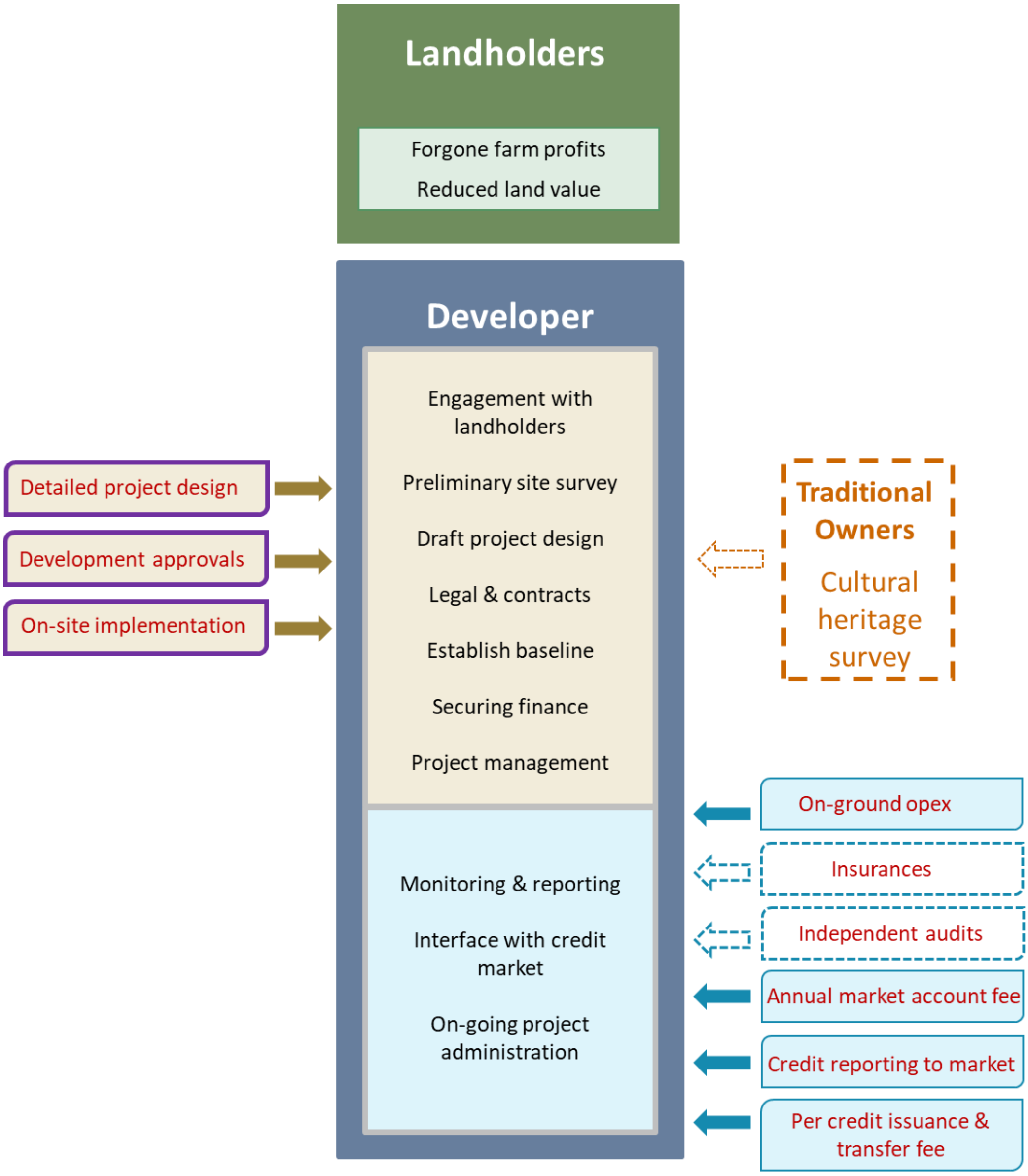


Figure 10: Activities and costs incurred by project actors directly (in black) and activities undertaken by external service providers (in red) during the different stages of the project life cycle. Costs incurred during engagement, conceptualisation and establishment are shown on a buff background. Costs incurred during production and commercialisation are shown on a blue background. Cost components which typically require access to significant upfront capital are outlined in purple.

Box 1: Description of cost categories incurred during the engagement and conceptualisation, establishment, production, and commercialisation phases, as shown in Figure 9 and Figure 10. The description here draws on information from scheme and market operators' websites, information and insights obtained through key stakeholder interviews, and the authors' prior experience. The cost categories incurred in the different phases of the project (as illustrated in Figure 7) were reviewed and iterated with project developers until they agreed that these were representative of the costs incurred through the initial engagement, conceptualisation, establishment, production, and commercialisation phases of an environmental market project. The specific components included in individual projects may differ, however, depending on the legal and property right context, local requirements for development approvals, and an individual landholder's situation and preferences.

Engagement and conceptualisation

The engagement and conceptualisation phase begins when an environmental market opportunity is first socialised with local landholders, typically via shed meetings and informal discussions. If there appears to be sufficient interest, a more formal engagement process will follow during which the nature and scale of the project will be conceptualised. This will typically require a draft project design as a starting point for discussion. Preliminary site surveys[i] and cultural heritage surveys may also be commissioned as necessary and appropriate. Once landholder interest in participation becomes more concrete, a 'Heads of Agreement' between project participants will typically be drawn up and signed. Thereafter data will be collated and processed to establish pre-project baselines[ii] (e.g., for carbon storage in existing land cover on land use change projects). Activities will typically be initiated to secure access to the capital required for the subsequent establishment phase during the engagement and conceptualisation phase [iii].

Establishment

The project establishment phase will require a detailed project design. The project design will typically require iteration as it proceeds through development[iv] and regulatory approval. Once relevant approvals have been obtained the project can proceed to on-site implementation (e.g., engineering works, excavation, planting – with activities depending on the environmental market opportunity being pursued). As noted in Appendix 5, an ACCUs project must be registered with the Clean Energy Regulator *before* any on-site implementation works commence, to satisfy the additionality requirements of these schemes (Emissions Reduction Fund, 2021). The establishment phase requires full mobilisation of the upfront capital for detailed project design, development and regulatory approval, and on-site implementation[v]. These three components typically comprise the major proportion of the upfront capital requirement for land use change projects. This is indicated by the purple outline around these activity tiles in Figure 9. The upfront capital requirement for some land use change projects can be very substantial. Contingency is usually included in the upfront capital requirement[vi] (again indicated by a purple outline around the 'contingencies' tile in Figure 9).

Production

After establishment, the project enters its production phase and begins to produce product in the form of environmental credits or certificates. Annual and periodic (i.e., on-going) operating costs are incurred during the production phase. Costs will typically be incurred for annual and periodic maintenance and repair on the project site. The number of years for which annual site maintenance will be required will differ between projects. Weed control on green ACCUs projects where environmental plantings are established at high densities to restore native rainforest in the Wet Tropics will typically only be required for three or four years after planting until the forest canopy closes (interviews with Greening Australia and Terrain NRM; van Oosterzee et al., 2020). However, in the event of tropical cyclones opening up forest canopy, active weed management may be required until re-closure of canopy. In contrast, blue ACCUs projects rely on saltwater ingress to suppress growth of freshwater weeds in regenerating mangrove and saltmarsh areas after tidal re-introduction. Active weed suppression may be required for longer durations at blue ACCUs sites if freshwater flows onto the site are higher than expected for example, due to high end-of-catchment flows following tropical cyclones. In addition to weeding, costs will also typically be incurred for annual monitoring and reporting on habitat change, condition improvement, or tree growth (from which carbon sequestration can be calculated). Depending on the scheme, independent audits of site condition may be required at specified intervals to provide independent verification that on-site conditions remain appropriate to support continuing credit delivery. Costs will also be incurred annually for management of on-ground activities and credit reporting throughout the production phase. If a 100-year permanence period is nominated, annual and periodic costs for maintaining and repairing the site, and a permanence obligation regarding the carbon stored on the site, will persist for more than 75 years after the end of the production phase. This likely explains why project developers report that – in their experience – landholders always elect for a 25-year permanence period rather than a 100-year permanence period on ACCUs projects.

Commercialisation

Costs will also be incurred when environmental credits and certificates are brought to the market and sold. Depending on the environmental market concerned, credits and certificates could be sold via a broker for an agreed commission. Alternatively, the project developer may be required to pay to register a market transaction account to receive payments from product sales. Charges may also be incurred for credit registration, credit issuance or credit transfer. Costs will also be incurred annually for project administration throughout commercialisation.

[i] Depending on the location, condition, land use agreements and land title at the site, preliminary site surveys could include, for example, an ecological survey (e.g. Environmental Protection and Biodiversity Conservation (EPBC) Act), a cultural heritage survey, a mosquito risk survey and an acid sulphate soils risk survey.

[ii] Complexity and cost in verifying baseline condition could be heavily site dependent and will also be influenced by the number of types of environmental credit the project aims to generate.

[iii] For an entirely new environmental credit opportunity it may be necessary to develop and register a new method for project implementation, monitoring, and assessment.

[iv] Depending on the location of the project site, regulatory approvals could include, for example, approval to work in waterways, approval for alteration of fish passage, and approval of an acid sulphate soil management plan and a mosquito management plan.

[v] On-site implementation cost is anticipated to be the largest component of upfront cost when considering restoration of blue carbon ecosystems via reinstatement of tidal flows, environmental plantings for carbon sequestration and rainforest restoration, and nitrogen reduction via wetland construction. Implementation cost can vary considerably with the type(s) of activity undertaken (e.g. tidal restoration vs. tree planting vs. wetland construction) and with specific characteristics of individual sites.

[vi] Contingency might typically be estimated as a 5% addition to the total upfront cost.

4.2 REVENUES

Net revenues from the sale of environmental credits or certificates will be shared between the different actors in agreed proportions. Net revenue shares would be expected to reflect the level of capital provided and costs incurred by the different actors, as well as their differing levels of exposure to risk.

Figure 11 shows revenues from the sale of credits or certificates in the environmental market flowing to the project developer initially (large grey arrow at the bottom of the diagram). The developer would use some of this revenue to make loan repayments and to pay invoices received from external service providers (shown in red text in Figure 11). The project developer would also use some net revenue to cover the costs they themselves incur in delivering and managing the project (shown in black text in Figure 11).

Once all these costs have been covered, the remaining *net revenue* can then be split between the landholder(s) and project developer as per the project agreement. For land use change projects which require a large loan to finance upfront costs, a considerable share of net revenue would typically go to the project developer, in recognition of the share of capital they contributed and their risk exposure. The net revenue share to the landholder would be expected to reflect the proportion of cost they incur via foregone sugarcane gross margin and reduction in land value on land committed to the project. Ultimately, sharing of net revenue would be determined through mutual agreement between participating actors.

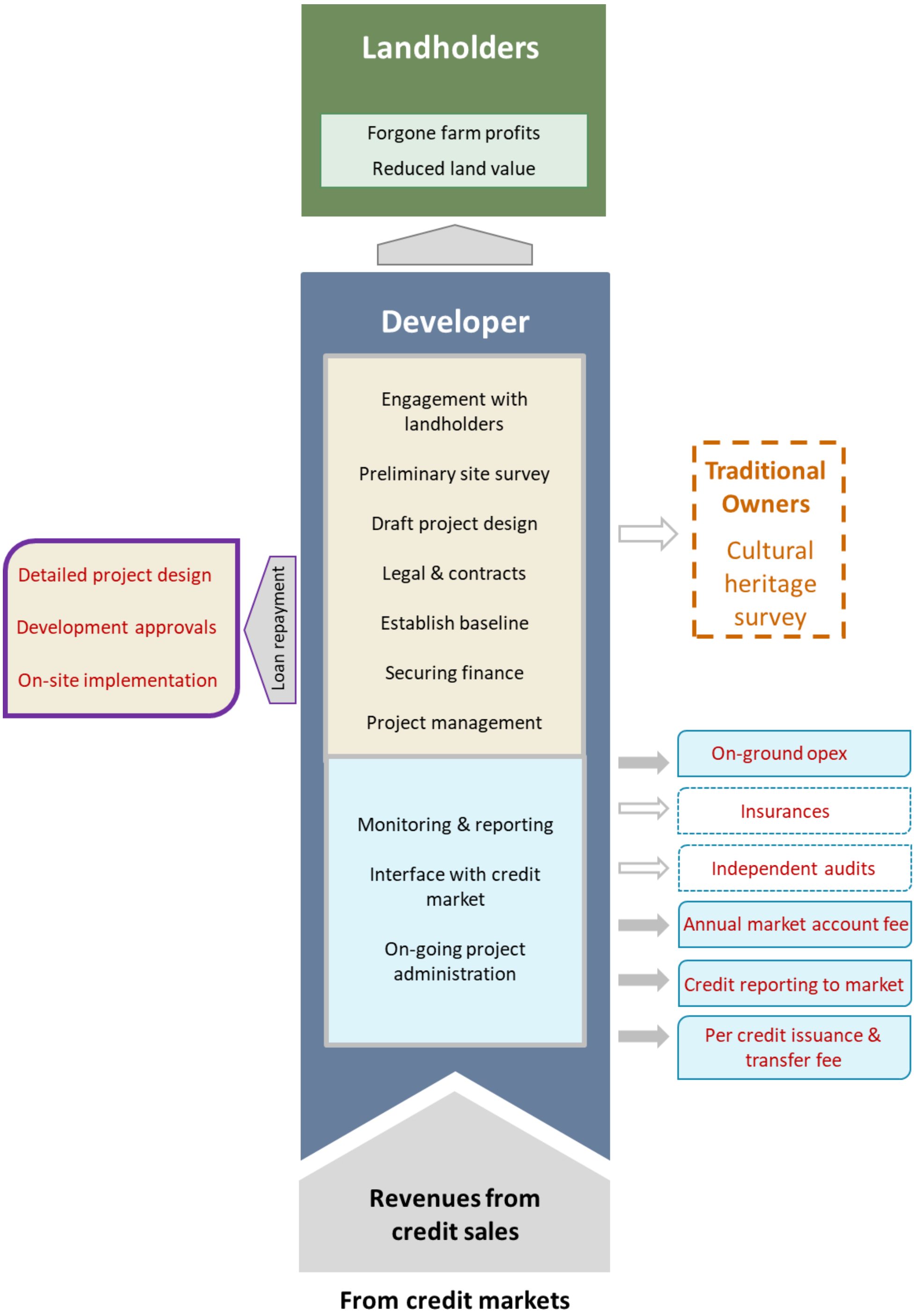


Figure 11: Revenue flows over the lifetime of a project, generated through the sale of credits or certificates on an environmental market(s). Some of the revenue from credit sales is used to pay the costs incurred by project actors (shown in black text), some is used for loan repayment (boxes with purple outline) and some is used to pay external service providers for services provided (shown in red text). Net revenue remaining after costs have been paid is returned to project actors (here the developer and landholder(s)).

5. CASE STUDY SITES & ASSESSMENT: METHODS

5.1 MAPPING

Tidal inundation data, expected sea level rise by 2107 under RCP 8.5 (+0.8 m), and 2023 sugarcane crop cover were used to identify sugarcane sites in Mossman that would not be inundated with sea level rise or tidal inundation by 2100. These dry sites would therefore be suitable areas for green carbon, biodiversity, and/or rainforest restoration projects. Reciprocally, inundated areas could potentially be eligible for blue carbon projects (Figure 12). Within the Mossman district, the total approximate area available for green carbon, biodiversity, and/or rainforest restoration projects equates to 3,996 ha, with 1,244 ha potentially suitable for blue carbon projects (including case study sites).

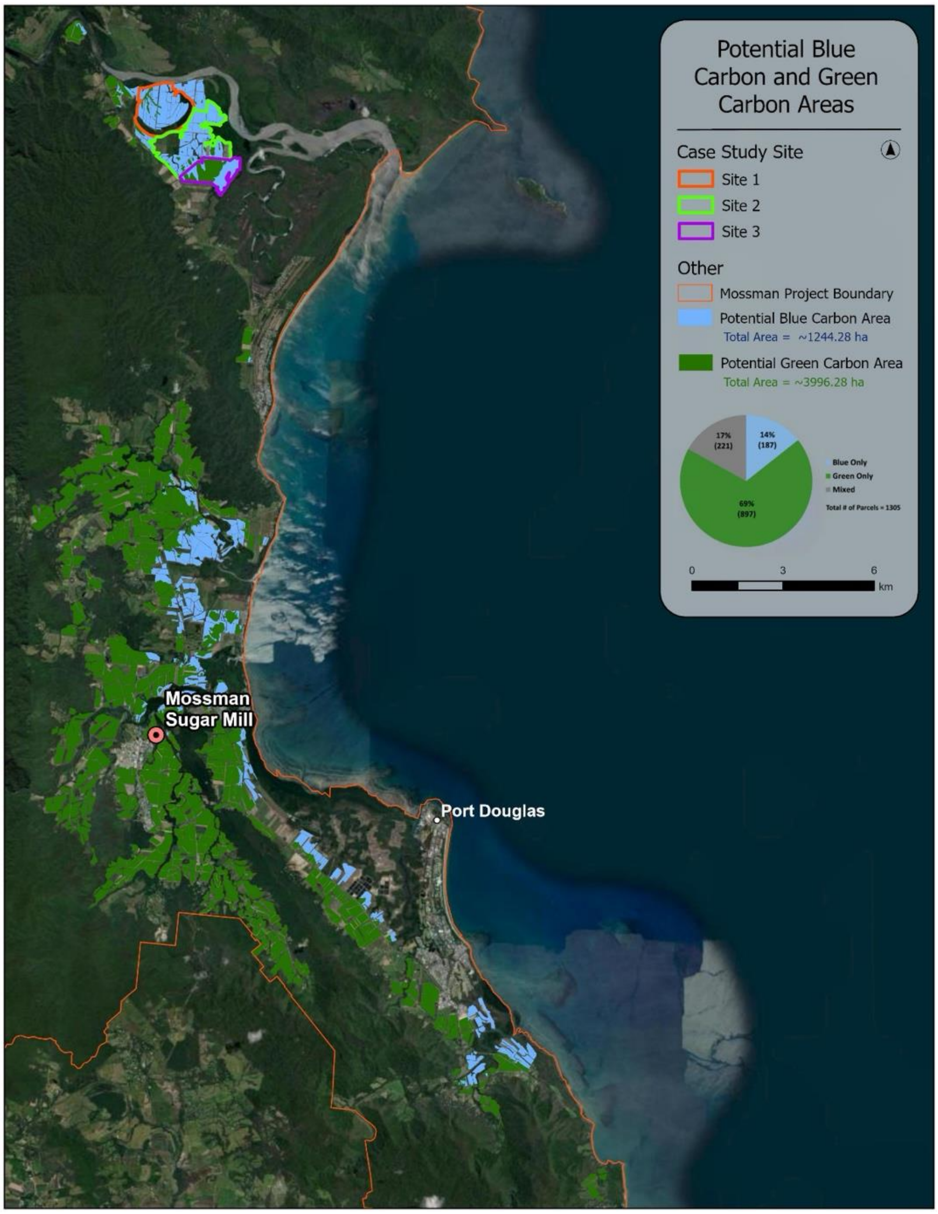


Figure 12: Location of case study sites 1-3. Sugarcane land parcels suitable for green carbon, biodiversity, and/or rainforest restoration projects are highlighted in green. Sugarcane land parcels suitable for blue carbon projects (i.e., will be inundated by SLR 2107) are highlighted in blue. Note: some land parcels may be eligible for both blue and green carbon projects.

5.2 SITE VISITS

On 24 August 2023, the team met with staff from DAF to visit potential project sites to be examined in more detail to improve our understanding of potential opportunities and challenges surrounding the different environmental market opportunities in the Mossman district. From this assessment, five project sites were identified as possible candidates for further investigation and to test the proposition of environmental markets as part of alternative land use management.

These sites were selected as they are on marginal land which was left fallow, experiencing low sugarcane yields and quality, or saline intrusion is occurring (i.e., for the blue carbon tidal reintroduction method), as environmental market projects will be most effective in these areas. These sites also happened to be in close proximity, rendering analyses of potential site aggregations possible. Case study sites included areas of marginal sugarcane production and unproductive land, where yields are reduced, or saline intrusion is occurring (i.e., for the blue carbon tidal reintroduction method), as environmental market projects will be most effective in these areas. On the 12th of February, the team re-visited the sites to collect site-specific data regarding the project site boundaries, and to identify areas susceptible to inundation and tidal restriction mechanisms and specifications at each site.

5.3 HYDROLOGICAL ANALYSIS

The hydrological assessment was conducted following recommendations by the Clean Energy Regulator's Emission Reduction Fund Supplement to the Carbon Credits (Clean Energy Regulator, 2022). The hydrological analysis was designed to advance our comprehension of complex water flow patterns, dynamics, inundation depth and area, and the overarching hydrological processes at each case study site. In this project, we selected a two-dimensional (2D) hydrodynamic modelling approach for hydrological assessment. The open–source HEC-RAS hydrodynamic modelling package was used for this purpose. HEC-RAS is a strong model that provides one- and two-dimensional solutions to the free-surface flow equations to simulate flood and tidal wave propagation. HEC-RAS has the ability to establish flow and inundation patterns in floodplains, drains and coastal waters where the flow behaviour is essentially 2D in nature. As such, HEC-RAS is well suited for this assessment.

A large reach of the Daintree River channel and its floodplain is selected for 2D model set up to accurately account for and simulate tidal and river flow interaction and movement. The model boundary was extended from the mouth of the Daintree River (i.e., the downstream boundary was the ocean) to approximately 12 km upstream of the river in Daintree Village. LiDAR-derived 1m resolution Digital Elevation Model acquired from the Geoscience Australia site, ELVIS (https://elevation.fsdf.org.au/), was used to extract the topography and develop the hydrodynamic model grid. Model flow area covered 2.66 million grids of 5x5 m. For tidal boundary conditions, tidal data from Port Douglas, the closest tide gauge, was acquired from the Queensland Government (Department of Environment, Science and Innovation) and used for model set up. The tidal time series was converted to Australian Height Datum (AHD) by a 1.7 m adjustment equivalent to the mean sea level at Port Douglas.

Based on this model set up, water level frequency and inundation analysis were then conducted to determine the inundation height and duration for various scenarios within each site. The developed models simulated the water depth and associated inundation area for three scenarios: 1) HAT (1.7 m above sea level; asl), 2) HAT plus sea level rise in next 25 years (1.7+0.37 = 2.07 m asl, and 3) HAT plus sea level rise by 2100 years (1.7+0.8 = 2.5 m asl).

Currently in selected study sites, there are tidal restrictions in place to avoid tidal inundations. These include flood gates and bund walls. Based on the site visits and elevation extraction from the LiDAR data, the current restrictions are designed (~1.8 m asl) to stop tidal movement from the ocean side into sugarcane areas. Therefore, in the model set up, we tested two inundation scenarios with and without these barriers and restrictions. For the scenario, without barriers, we virtually removed these barriers from the model by lowering the elevation of these locations (dykes) from current elevation down to the elevation of the nearest stream or surrounding area.

5.4 FULLCAM, BLUECAM AND P2R MODELLING

5.4.1 SIMULATING ACCU PRODUCTION VIA FULLCAM

The FullCAM Full Carbon Accounting Model (2020 Public Release) Version 6.20.03.0827 was used to model carbon accumulation in trees and woody debris over a 100-year period when mixed environmental plantings of tropical species were planted on indicative sites on former sugarcane land in the Mossman catchment (DCCEEW, 2023a). FullCAM simulations were configured appropriately for predicting carbon sequestration and storage that could potentially be achieved by implementing the Reforestation by Environmental or Mallee Plantings FullCAM Method at these sites. Reforestation was assumed to be aiming to restore tropical rainforest by planting at least 20 native species at high density across the restoration site. This would potentially enable additional revenue to be produced from the sale of biodiversity certificates, Cassowary Credits or NaturePlus™ credits.

FullCAM simulations were run at the locations shown in Figure 13, comprising 21 sites across five soil types as listed in Table 9. Simulations were run over a 100-year period commencing 1st January 2024. Carbon accumulation was reported at monthly intervals. Site-specific biophysical data for FullCAM modelling (soil type, average air temperature, open-pan evaporation, rainfall, maximum above-ground forest biomass, long-term average forest productivity index, and tree species (mixed species environmental plantings tropical)) were downloaded from the FullCAM server using the latitude and longitude of the geographical centroid of each of the 21 sites (Figure 13). Modelling assumed that there was no existing forest biomass on the site prior to planting. The mixed species environmental plantings were simulated as seedlings planted on 1st January 2024. Informed by interview discussions with Greening Australia and Terrain NRM, weed control was then applied on 1st January for three subsequent years (2025, 2026 and 2027) until (assumed) canopy closure.

FullCAM modelled accumulation of per hectare carbon mass in trees and woody debris over the 100-year simulation. Annual increment to carbon accumulation (tonnes of carbon per hectare) at the site was calculated for each year using FullCAM predictions of the carbon mass in trees and the carbon mass in forest debris at the site (Carbon Credits (Carbon Farming Initiative): Reforestation by Environmental or Mallee Plantings—FullCAM - Methodology Determination 2014, 2018). Carbon increments were then converted to tonnes of carbon dioxide equivalent (tonnes CO_2-e per hectare) by multiplying by the ratio of the molecular weight of carbon dioxide to carbon (44/12). The quantity of ACCUs generated annually was set equal to FullCAM estimates of the annual increments to tonnes of carbon dioxide stored, less any emissions from fuel burnt during planting and site maintenance in each year. Example plots of FullCAM output are shown in Figure 14.

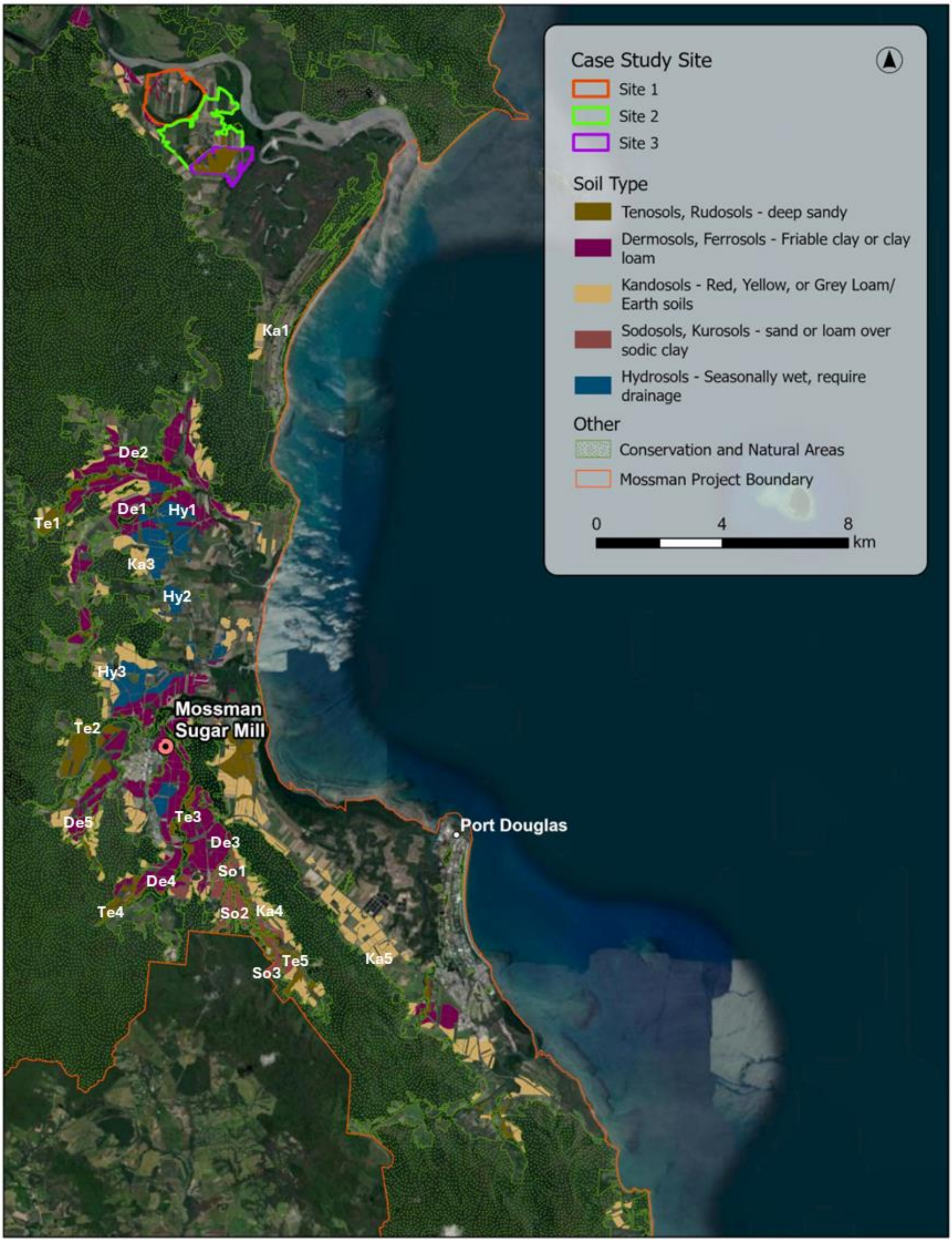
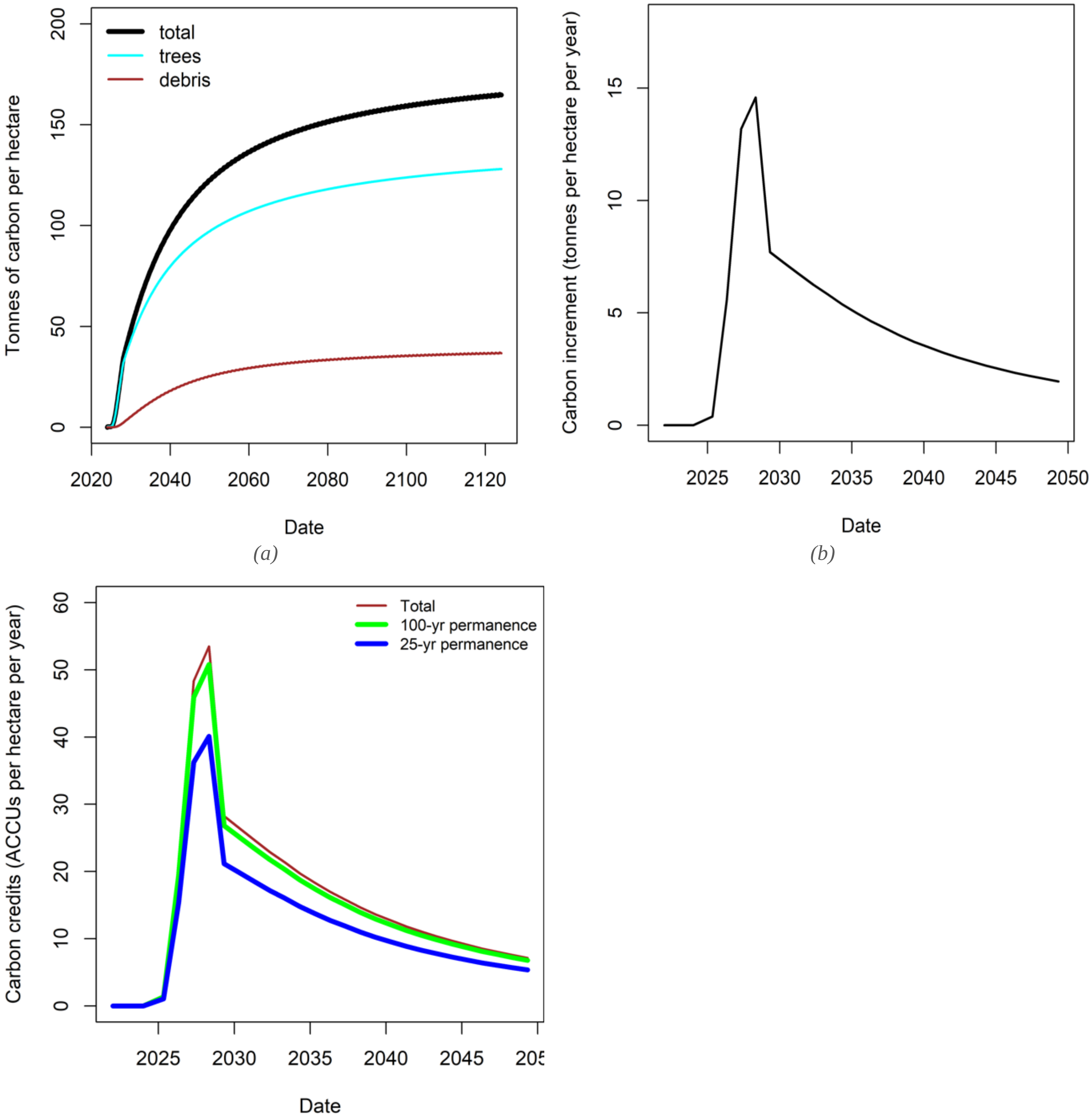


Figure 13: Locations of the 21 indicative sites for FullCAM simulation of carbon sequestration and ACCU generation under the Reforestation by Environmental or Mallee Plantings FullCAM Method. All sites modelled are currently sugarcane land within 15m of existing forested area. Site areas and soil types are listed in Table 9.

Table 9: Characteristics of the 21 indicative sites used for FullCAM simulation of carbon sequestration and ACCU generation under the Reforestation by Environmental or Mallee Plantings FullCAM Method.

Name	Area (ha)	Soil Type	Description	Map colour
Ka1	35.61	Kandosols	Red, yellow, or grey loam earth soils	Cream
Ka2	35.94	Kandosols	Red, yellow, or grey loam earth soils	Cream
Ka3	38.34	Kandosols	Red, yellow, or grey loam earth soils	Cream
Ka4	40.04	Kandosols	Red, yellow, or grey loam earth soils	Cream
Ka5	19.76	Kandosols	Red, yellow, or grey loam earth soils	Cream
De1	41.06	Dermosols & Ferrosols	Friable clay or clay loam	Magenta
De2	64.04	Dermosols & Ferrosols	Friable clay or clay loam	Magenta
De3	47.18	Dermosols & Ferrosols	Friable clay or clay loam	Magenta
De4	85.86	Dermosols & Ferrosols	Friable clay or clay loam	Magenta
De5	49.94	Dermosols & Ferrosols	Friable clay or clay loam	Magenta
Te1	38.77	Tenosols & Rudosols	Deep sandy	Coffee
Te2	53.31	Tenosols & Rudosols	Deep sandy	Coffee
Te3	29.5	Tenosols & Rudosols	Deep sandy	Coffee
Te4	27.88	Tenosols & Rudosols	Deep sandy	Coffee
Te5	6.66	Tenosols & Rudosols	Deep sandy	Coffee
Hy1	21.37	Hydrosols	Seasonally wet - require drainage	Blue
Hy2	18.38	Hydrosols	Seasonally wet - require drainage	Blue
Hy3	10.73	Hydrosols	Seasonally wet - require drainage	Blue
So1	28.43	Sodosols & Kurosols	Sand or loam over sodic clay	Red ocre
So2	53.89	Sodosols & Kurosols	Sand or loam over sodic clay	Red ocre
So3	36.47	Sodosols & Kurosols	Sand or loam over sodic clay	Red ocre



(a) (b)

(c) (d)

Figure 14: Example plots of FullCAM outputs for (a) carbon storage through time, (b) annual carbon increment, and (c) annual ACCU generation (when opting for 25-year and 100-year permanence periods for the project at the site) from an indicative Reforestation by Environmental or Mallee Plantings site on a dermosol/ferrosol soil in the Mossman catchment. The discontinuities in the early years of annual carbon increments in (b) and ACCUs per hectare per year in (c) arise because FullCAM simulates the effect of weeding by advancing carbon accumulation by one additional year for each weeding event. The results shown here incorporate the impact of weeding on 1st January 2025, 2026 and 2027.

5.4.2 SIMULATING ACCU PRODUCTION VIA BLUECAM

Blue carbon estimation areas were defined across each case study site based on on-site inspections with staff from DAF, in addition to landholders, following the BlueCAM Supplement (Clean Energy Regulator, 2022). For each Carbon Estimation Area (CEA), both the elevation and project area were calculated using DEM and hydrodynamic modelling. Given that Mossman is in the wet tropics, for the BlueCAM assessment 'Tropical Humid' conditions were applied here. The existing vegetation is assumed to be old given the land use has been generally the same for several decades (corroborated by Google Earth assessment). The projected land type for the end of the reporting period was determined based on examination of local marine vegetation communities, which is mostly mangroves with some saltmarsh species. No saltpan habitat was assumed here. The tidal range at project sites was modelled on 2.7 meters. BlueCAM calculations were modelled on the reporting period 22/7/2024 to 22/7/2049 (25-year crediting period), with a 100-year permanence period, meaning that no project area discount was applied. Fuel use during the reporting period was estimated at 1kL (diesel post-2004 vehicle) for any works (though this estimate would need further revision in a more detailed feasibility assessment for this site). The land type for each CEA based on the last reporting period, for each case study, was assumed to be sugarcane land.

Any land inundated due to sea level rise over the 25-year crediting period was included within the carbon estimation area, as per the Tidal Restoration method. Any land inundated due to sea-level rise after the crediting period (i.e., after the first 25 years) was not eligible for inclusion in the carbon estimation area.

5.4.3 ESTIMATING DIN REEF CREDITS VIA APSIM AND PADDOCK TO REEF MODELLING

As noted in the section 'Established Markets – Reef Credits', discussion with Eco-Markets Australia on 23 April 2024 clarified two key points as follows:

(i) If sugarcane production is no longer viable in Mossman district following the closure of the Mill, reductions in end-of-catchment DIN load following cessation of fertiliser application to former sugarcane land would not be considered *additional* and therefore would not be eligible for DIN Reef Credits.

(ii) Eco-Markets Australia has an understanding with CANEGROWERS and the Australian Sugar Milling Council that Reef Credit projects which could promote a change in land use that impacts on the viability of the sugar industry, require evidence from the project proponent that indicates that these considerations have been addressed e.g. through reference to Natural Resource Management plans, other documentation or stakeholder engagement. Consequently, cessation of fertiliser application on land transitioning from sugarcane to production of green or blue ACCUs may *not* eligible for DIN Reef Credits.

Hence, it currently appears that reductions in end-of-catchment DIN loads that follow from cessation of fertiliser application on former sugarcane land in Mossman district which transitions to production of green or blue ACCUs will ***not*** be eligible for DIN Reef Credits. However, if sugarcane production continues in the Mossman district, then fertiliser reductions on land producing sugarcane may be eligible for DIN Reef Credits, under the caveats and conditions raised in point ii. above.

The project team have, however, decided to retain DIN Reef Credits as a potential 'stacked' value contribution in their analysis of green and blue ACCUs projects as an example of stacked revenue payment from a co-benefit alongside green or blue ACCUs production. This illustrates how credit stacking from co-benefits can improve the financial viability of an ACCUs-based environmental market project. Emerging schemes such as Cassowary Credits, NaturePlus™ and the Nature Repair Market could potentially fulfil this role for relevant locations and contexts.

The potential number of DIN Reef Credits that could be generated via the Managed Fertiliser Application Method when all fertiliser applications cease following land use change from sugarcane production at green carbon and blue carbon sites was estimated using predictions of DIN losses from the Paddock to Reef framework for sugarcane land in the Mossman and Daintree districts under representative prior fertiliser applications. These data were provided to a previous research project (Smart et al., 2020) by Dr Melanie Shaw in the (then) Queensland Government's Department of Natural Resources and Mines following implementation of APSIM sugarcane modelling in the P2R framework for the 2016 Reef Report Card. Dr Shaw provided APSIM-derived simulations of average at-the-field DIN losses to surface runoff and drainage from sugarcane production under six levels of fertiliser management practice across the Wet Tropics. These average DIN loss estimates were produced by running APSIM P2R on daily weather data for each year from 1987 – 2013. Average at-the-field DIN losses were provided for sugarcane land in unique combinations (termed 'management units') of six soil types, three soil permeabilities (low, medium and high) and 101 SILO climate zones (Queensland Government 2020). A total of 36 unique management units covered sugarcane production land in the Mossman and Daintree catchments.

Average estimates of DIN loss (kg DIN per hectare at the field) to surface runoff and drainage were provided for each Mossman and Daintree management unit under different levels of fertiliser application. For this investigation, DIN losses under what were termed Bp level fertiliser management practice when Dr Shaw provided the DIN loss data are considered representative of fertiliser application rates that would be consistent with Farm-level Nitrogen Management Plans under the 2019 Revisions to the Reef Regulations and the Prescribed Methodology for Sugarcane Production in Great Barrier Reef Catchments (Queensland Government, 2022). The basis for assumed fertiliser application rates under fertiliser management practice Bp are reported in Table 10.

Table 10: Definition of fertiliser management practice Bp used to produce DIN loss estimates.

Practice	Description	Fertiliser application rates to plant and ratoon cane
Bp	Six Easy Steps derived from District Yield Potential with adjustment for soil organic carbon, plus further adjustment to plant sugarcane rate to account for application of mill mud and/or legume fallow	Follow Six Easy Steps: Fertiliser application to ratoon crops derived using a nitrogen utilisation index after Keating et al. (1997) (1.4 kgN/ha per tonne/ha maximum annual sugarcane yield up to 100 tonnes/ha, plus 1 kgN/ha per tonne/ha maximum sugarcane yield thereafter), adjusting for soil organic carbon, mill mud and legume fallow. Minimum of 30 kgN/ha applied to plant sugarcane. Maximum annual sugarcane yield determined from ***District Yield Potential***.

Predicted at-the-field DIN losses to surface water and drainage under fertiliser practice Bp were converted to end-of-catchment DIN losses by:

(i) Applying a surface delivery ratio (SDR) to DIN surface runoff to account for runoff trapping processes between the field and the nearest river channel
(ii) Applying a sub-surface delivery ratio (SSDR) to DIN losses to drainage to account for drainage and transformation losses in the sub-surface pathway from the field to the nearest river channel, and
(iii) Applying a riverine system delivery ratio (RSDR) to account for in-stream DIN losses between the river channel and end-of-catchment.

The data from Dr Shaw provided separate RSDRs for each of the 36 management units across the Daintree and Mossman catchments. Following Truii (2023) (https://p2rprojector.net.au/how-it-works/delivery-ratios/), SDRs were set to 1.0 and SSDRs were set to 0.3 for all management units across the Daintree and Mossman catchments. Applying these SDRs, SSDRs and RSDRs to Dr Shaw's predicted at-the-field DIN losses to surface runoff and drainage produced the average end-of-catchment DIN loss (kg end-of-catchment DIN/ha of sugarcane land) shown in Table 11 for fertiliser application practice Bp across 14 sugarcane management units in the Daintree catchment and 22 sugarcane management units in the Mossman catchment.

Table 11: Average DIN losses reaching end-of-catchment from fertiliser management practice Bp (see Table 10) on sugarcane land in the Daintree and Mossman catchments. DIN losses at-the-field modelled via APSIM in the Paddock to Reef framework. DIN losses at end-of-catchment are derived by applying appropriate surface delivery ratios, sub-surface delivery ratios and management unit-specific riverine system delivery ratios to at-the-field loss estimates.

Catchment	Average end-of-catchment DIN loss (kg DIN/ha) under fertiliser management practice *Bp*
Daintree	8.05
Mossman	8.30

We assume that fertiliser applications – and therefore DIN losses estimated under the APSIM / Paddock to Reef Projector method[4] – will cease completely if former sugarcane land is converted to produce ACCUs via the Reforestation by Environmental or Mallee Plantings FullCAM Method ('green ACCUs') or the Tidal Restoration Method ('blue ACCUs'). The average end-of-catchment DIN reductions in these circumstances are asumed to be equal to the average DIN losses quoted in Table 11 in the relevant catchment. For the purposed explained above, these reductions in end-of-catchment DIN losses provide indicative estimates of the quantity of DIN Reef Credits that could hypothetically generate stacked co-benefit revenue at green ACCU or blue ACCU sites.

5.5 ECONOMIC METHODS

5.5.1 CONTEXT FOR THE DISCOUNTED CASH FLOW ANALYSIS

The analyses in this Report investigate environmental market opportunities as a mechanism for potentially providing additional income by changing land use on a land block within a farm business whilst standard agricultural production continues elsewhere on the farm. The DCFAs in the report envisage that only a portion of the farmland area switches from agricultural production to production of environmental credits and/or certificates for sale on environmental markets. The remainder of the farm is assumed to continue with some form of agricultural production under 'business as usual'.

Consequently, **the DCFAs in the Report only consider economic costs and benefits arising from switching an area of land within the farm to environmental market uses, rather than whole-of-farm replacement of agricultural production.** Costs or benefits that might arise if the whole farm business switches from agricultural production to production of environmental credits and/or certificates for sale on environmental markets are not included. Thus, for example, costs arising from the sale of assets from prior agricultural production (e.g. tractors, fertiliser spreaders, sprayers, cane harvesters), sale of stocks of fertiliser and agro-chemicals, ability to service on-going borrowings or debt in the farm business, are not included in our DCFAs.

In the initial stages of the project the 'on-going agricultural production' was implicitly considered to be sugarcane. Latterley it became clear that some other - as yet unknown - form of agricultural production would have to fulfil this role. In the final version of the Report, we address this uncertainty regarding on-going agricultural production by including three scenarios for the costs the landholder incurs in switching a land block from agricultural production to environmental market usage. These scenarios include different levels of costs arising from a reduction in property value and foregone agricultural gross margin that accrue to the landholder.

- ***Scenario 1***: A property value reduction of $5018/ha and forgone gross margin of $430/ha/year, as ***upper-bound estimates*** for costs to the landholder. These are derived using averages for sugarcane production in far north Queensland from the ABARES farm survey (see later subsection for a full explantation).
- ***Scenario 2***: A property value reduction and forgone gross margin at 50% of the values in Scenario 1 to provide a ***mid-point estimate*** for costs to the landholder.
- ***Scenario 3***: A property value reduction at 50% of Scenario 1 and $0/ha/year for forgone gross margin to provide ***lower-bound estimates*** for costs to the landholder. These lower-bound estimates are motivated by a situation in which a blue ACCUs project is proposed on land where agricultural production has already ceased, but the value of the land on the block is still somewhat above the unimproved land value.

The DCFAs could be repeated in the future once new forms of agricultural production emerge in the Mossman area and the levels of landholder cost incurred through property value reduction and foregone gross margin have been clearly established.

Our justification for including a reduction in property value ($/ha) and a foregone gross margin ($/ha/year) as costs that accrue to the landholder when a portion of the land area of the farm is switched from prior agricultural usage to production of credits and/or certificates for environmental markets is as follows.

[4] Truii's Natural Capital Credit software suite (https://naturalcapitalsuite.au/credit/) is current replacing the Paddock to Reef Projector as the designated tool for calculating DIN credit generation following change in fertiliser management practice.

When a landholder signs up to an environmental market project they are contractually required to continue the environmental market land use for a defined period – typically at least 25 years. This removes all flexibility regarding land use on the contracted area. Any potential purchaser of the land would have to accept these contractual constraints on land use. A potential purchaser would also have to incur any costs required to maintain relevant assets (e.g., restored rainforest or mangrove wetland) in good condition over that period. Furthermore, there are currently no available data on the profitability of green ACCUs from rainforest restoration or blue ACCUs from mangrove wetland restoration in Mossman district. Thus, the current Mossman context,this loss of flexibility, uncertainty surrounding the potential revenue stream and contractual liability for any maintenance costs – in combination – are likely to dampen demand relative to supply of land offered for sale and consequently the value of land signed up to environmental market uses will likely fall below that of land under an established agricultural use (for which there would be considerable flexibility regarding future options, and for which the profit potential would be relatively well known). This suggests that landholders would be concerned abouta potential reduction in land value when considering whether to switch a block of land from agricultural to environmental market usage.

If a landholder chose to continue with an established agricultural use on a block of land rather than signing it up to an environmental market usage they would receive an ongoing stream of annual gross margin from agricultural production. **The opportunity to generate this income stream would be lost if a landholder signed the land up for environmental credit generation for sale in environmental markets. The landholder would consider this foregone stream of agricultural gross margin as an opportunity cost of signing the land up to environmental market usage** – and would account for this cost when considering whether to switch the land to environmental market usage. This forgone stream of agricultural gross margin is **in addition** to the potential reduction in property value. **The reduction in property value reflects the loss in the flexibility of using the land and the binding contractual obligations, including the required maintenance cost, for the remainder of the crediting period.**

As described in earlier sections, interviews with Mossman farmers suggest that landholders have concerns regarding reduction in property value and foregone agricultural gross margin when considering whether to switch usage of a block of land from agricultural production to production of credits and/or certificates for sale on environmental markets:

5.5.2 LANDHOLDERS' CONCERNS REGARDING IMPACTS ON PROPERTY VALUE

Interviews with Mossman farmers clearly established that landholders were concerned about the unknown (but implicitly adverse) impact that switching some of their land from sugarcane production to an environmental market usage would have on property value. One farmer who was interviewed expressed concern that the price of land in the region was already falling and this restricted options for farmers (many of whom are elderly) looking to retire, as well as reducing the amount of capital that could be borrowed against land collateral for potential new ventures. A related concern was voiced regarding the contractual obligations incurred for a lengthy time period once a landholder signed up to an environmental market project:

"…being concerned that they'd be looking ahead too, well how's that going to affect the property? … in the future … do they lose flexibility? Can I sell the, what happens if I want to sell the place or family for family reasons … ill health or whatever, you know what I mean? Or, or you know, it's going down another generation, but none of that generation want anything to do with it and want to sell it."

An adverse impact on property value is therefore included in our DCFAs as a cost to the landholder.

5.5.3 LANDHOLDERS' CONCERNS REGARDING IMPACTS ON PROFITABILITY

Concerns regarding impacts on profitability were also clearly voiced during farmer interviews:

"… not going to do it unless it's sort of viable … I'm not suggesting any of these particular projects, because I don't know enough about them, but … some of these things […] they just seem unviable … these things are nice, but they have to stack up or there has to be an incentive"

"it's hard to be green if you're in the red. ... So, playing with experimental stuff. ... I've been burnt playing with these things trying to do the right thing for a while. Now basically, if I can't see the green [the money] at the end, I'm not going to do the red [incur expenses on trialling or transitioning to other options]."

Whilst none of the interviewed farmers used the term 'opportunity cost' directly, concerns voiced regarding profitability suggest that the 'viability' of environmental market opportunities will be gauged against other land use options. The opportunity cost of foregone net revenues from alternative uses to which a scarce resource could be committed is a commonly used approach for representing a 'viability' comparison in discounted cashflow analysis (Boardman et al. 2001). This suggests that it is appropriate to include the opportunity cost of foregone gross margins from (some form of) agricultural production in our DCFAs.

A substantial literature explores factors affecting landholders' willingness to commit to voluntary private land conservation programs that seek to improve native biodiversity on private landholdings through mechanisms such as grant payments, land management agreements and covenants (e.g., Simmons et al. 2020). From a landholder's perspective, signing up to private land conservation programs shares many characteristics with signing up to an environmental market scheme. These include a long-term commitment to forego existing land uses or land management practices on designated blocks of land, concerns regarding loss of flexibility and autonomy, concerns regarding the stability of funding in the longer term, and concerns regarding the cost, time requirement, and potentially invasive oversight surrounding monitoring and verification.

5.5.4 PROJECT-LEVEL DISCOUNTED CASH FLOW ANALYSIS

The potential financial viability of environmental market opportunities for case study sites in the Mossman and Daintree districts is assessed initially using discounted cash flow analysis (DCFA) at **whole-of-project scale** on the converted land block, under different scenarios for the costs incurred by the landholder, and with sensitivity analyses on environmental credit pricing. In combination, this affects net returns to the project as a whole and returns to individual project actors (Boardman et al., 2001). The following environmental market schemes were evaluated for relevant sites:

(1) ACCUs produced from **rainforest restoration** via the Reforestation by Environmental or Mallee Plantings FullCAM method ('green ACCUs')

(2) ACCUs produced via the Tidal Restoration method ('blue ACCUs')

(3) Green ACCUs hypothetically stacked with DIN Reef Credits

(4) Blue ACCUs hypothetically stacked with DIN Reef Credits

The DCFA initially calculates the net present value (NPV) generated **by the project as a whole**, by subtracting the total present value of costs incurred from the total present value of revenues generated over the full duration of the project, as shown in Equation 1 (Boardman et al., 2001).

$$NPV = \sum_{t=1}^{T} \frac{R_t}{(1+r)^t} - \sum_{t=1}^{T} \frac{C_t^D}{(1+r)^t} - \sum_{t=1}^{T} \frac{C_t^L}{(1+r)^t}$$

Equation 1

Where:

NPV = net present value of the project

T = Final year of project duration = end of project permanence period

t = successive years of project operation from the start of the establishment phase

r = real discount rate (% per annum) [Converted to the equivalent daily discount rate for the green ACCUs DCFA to incorporate the 5-month time delay between compiling a carbon credit report and approval of that report triggering release of ACCUs for sale on the market.]

R_t = revenue accruing to the project in year t

C_t^D = costs accruing to project developer in year t

C_t^L = costs accruing to landholder in year t

For DCFA analysis, the full duration of the project runs from the start of the engagement and conceptualisation phase to the end of the permanence period. As noted earlier, when a 25-year permanence period is nominated for a project, the permanence period will extend approximately 18 months beyond the end of the production and commercialisation phases (see Figure 9). Consultations with project developers indicated that, in their experience, landholders invariably select a 25-year permanence period under green ACCUs schemes, consequently **we use a 25-year permanence period in all DCFAs.**

The suite of costs and revenues included in the DCFA will differ depending on the environmental market opportunity targeted by the project. The costs incurred and revenues generated, estimated timescales for the various phases, and overall project duration, will be scheme-specific, although the general sequence is expected to follow that shown in Figure 9.

For an individual project, the DCFA proceeds as follows (refer to Figure 15 for a diagrammatic representation):

1. Drawing on a combination of literature and site-specific context, informed by consultations in key informant interviews, a $ cost is estimated for each cost component (see Table 12, Table 13 and Table 14), a scenario for landholder costs is selected and relevant ranges are assumed for credit prices for ACCUs and DIN Reef Credits (as a proxy for other potentially stackable environmental market credits or certificates).
2. The upfront capital requirement for the project is determined as the combination of costs incurred in detailed project design, development approvals and on-site implementation works, plus a 5% contingency. It is assumed that upfront capital for the project is obtained via a loan.
3. The costs incurred in repaying the upfront capital loan in equal instalments is calculated over a 10-year term at 8% cost of capital [1]. Annual loan repayments are expressed in present value using a real discount rate of 7% per annum. Due to differences in lead-in time and the activities funded via the capital loan for blue carbon sites loan repayment starts in the second year and finishes in the eleventh year of the project, whereas loan repayment for green carbon sites starts in the third year and finishes in the twelfth year of project. Costs incurred during the engagement and conceptualisation phases which are not funded via the capital loan are positioned appropriately in time and expressed in present value using a real discount rate of 7% per annum. These (considerably lower) costs are assumed to be paid ‘out of pocket’ by the developer.
4. The landholder is assumed to incur a reduction in land value when they sign up to the project agreement (at the level specified in the selected landholder cost scenario). The cost arising to the landholder from reduction in land value is positioned appropriately in time and expressed in present value using a real discount rate of 7% per annum.
5. Periodic or recurrent annual costs incurred by the project developer during the production and commercialisation phases, through to the end of the permanence period, are positioned appropriately in time and expressed in present value using a real discount rate of 7% per annum.
6. The annual opportunity cost the landholder incurs through foregone net revenue from the land block is set at the level specified in the selected landholder cost scenario. The landholder is assumed to incur annual opportunity costs from the start of the establishment phase through to the end of the permanence

period. These opportunity costs to the landholder are positioned appropriately in time and expressed in present value using a real discount rate of 7% per annum.

7. All costs, including the cost of repaying the capital loan at 8% weighted average cost of capital over a 10-year duration, are summed to calculate the total present value cost of the project.
8. The quantity of environmental credits generated year by year through the production phase of the project is estimated (in biophysical terms) knowing specific conditions for blue ACCUs and hypothetical DIN Reef Credits at case study sites 1, 2 and 3, or representative conditions for green ACCUs and hypothetical DIN Reef Credits at indicative sites on different soil types across the catchment (Figure 13). Appropriate modelling tools and literature sources are used to do this (FullCAM for green ACCUs, BlueCAM for blue ACCUs, APSIM and P2R delivery ratios for hypothetical DIN Reef Credits).
9. Credit revenues (net of any commercialisation costs) returning to the project are calculated knowing the biophysical quantity of credit(s) produced (from step 8) and assumed ranges for sale prices for the environmental credit(s). Credit revenues (net of commercialisation costs) are positioned appropriately in time and expressed in present value using a real discount rate of 7%. Present value revenues are then summed to calculate the total present value of project revenue.
10. The net present value of the project is calculated by subtracting the total present value costs incurred by the developer and by the landholder from total present value revenue (Equation 1). **This is the NPV generated by the project as a whole**. *It is this value which will be shared between the landholder(s) and the project developer*.

The following results are reported **for the project as a whole**:

1. Net present value (NPV) of the project ($) (calculated via Equation 1, from the start of the engagement phase to the end of the permanence period).
2. Annualised equivalent of project NPV, expressed per hectare of land committed to the project ($/ha/year). This is calculated from project NPV using Equation 2 (Boardman et al., 2001), a real discount rate of 7%, and knowing project duration and total project land area.

$$AnnEqNPVperha = ProjectNPV\left(\frac{r}{(1-(1+r)^{-T})}\right)/SiteArea$$

Equation 2

Where:

$AnnEqNPVperha =$ Annualised equivalent of project net present value, per hectare project area

$ProjectNPV =$ Project net present value (calculated via Equation 1)

$r =$ real discount rate (% per annum)

$T =$ Final year of project duration = end of project permanence period

$SiteArea =$ Project site area in hectares

3. If, under the selected landholder cost scenario and relevant parameter combinations, a project returns a positive NPV, the internal rate of return (IRR %) will also be reported. IRR is the discount rate under which the project NPV becomes equal to $0 (Boardman et al. 2001). IRR provides a metric for comparing financial performance across projects.

The following results are reported **for the landholder**:

1. Net present value (NPV) ($) to the landholder, calculated via a landholder-specific version of Equation 1, using the landholder's percentage share of project net revenue less the costs the landholder incurs under the selected landholder cost scenario. **The landholder's percentage share of project net revenue is assumed to be in proportion to the landholder's share of total project present value cost**.
2. Year-by-year net cashflow to the landholder in present value ($/year), calculated from the landholder's percentage share of year-by-year net revenue and the year-by-year costs the landholder incurs through reduction in land value and foregone gross margin.
3. Annualised equivalent of landholder's NPV, expressed per hectare of land committed to the project ($/ha/year). This is calculated from landholder's NPV using the Equation 2, a real discount rate of 7%, and knowing project duration and total project land area.

The following results are reported **for the project developer**:

1. Net present value (NPV) ($) to the developer, calculated as the developer's percentage share of the project's present value net revenue less the present value costs incurred by the developer. **The developer's percentage share of net revenue is assumed to be in proportion to the developer's share of total project present value cost.**
2. Year-by-year net cashflow to the project developer in present value ($/year) over the full project duration.
3. If, under relevant parameter combinations, a project returns a positive NPV to the developer, a rate of return (%) to the developer will also be reported. The rate of return to the developer is calculated as the net present value to the developer divided by the total present value of developer's costs.

[1] The repayment term and cost of capital suggested here were derived using the authors' expertise, verified through key stakeholder interviews.

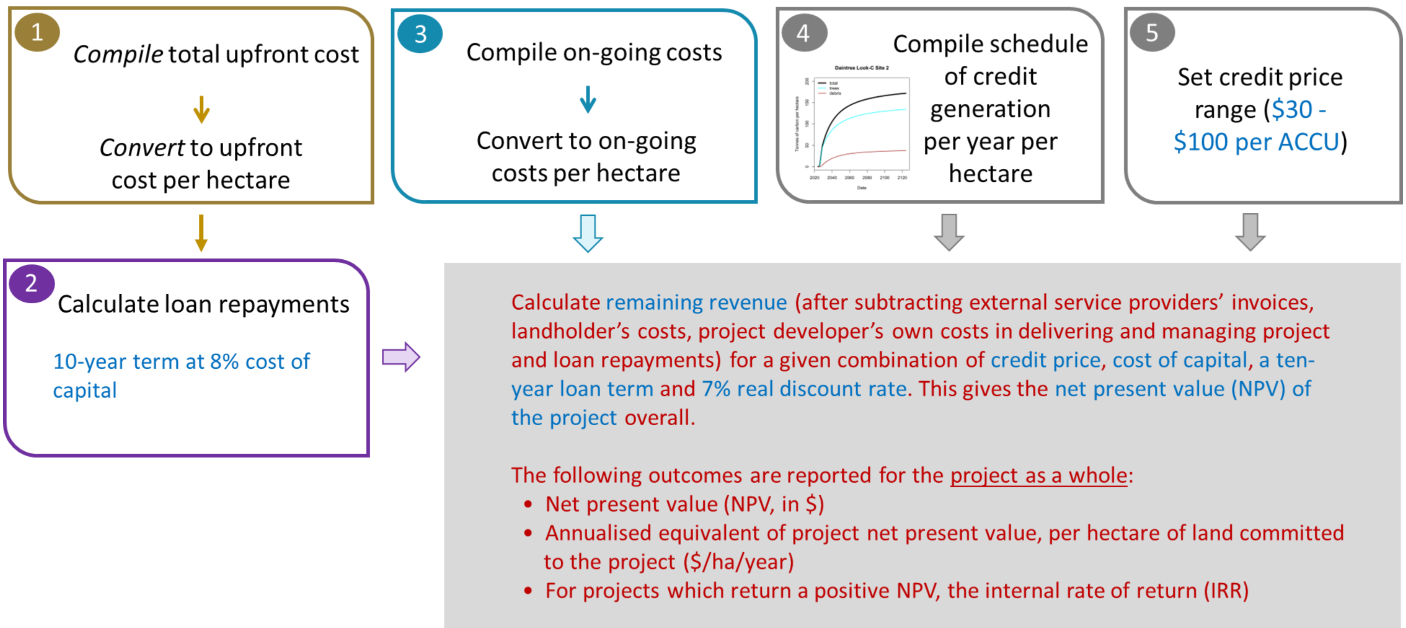


Figure 15: Discounted cash flow analysis for the project as a whole.

Results are first reported for:

1. Standalone green ACCUs projects at 21 indicative sites.
2. Standalone blue ACCUs projects at three case study sites.

As described previously, a discussion with Eco-Markets Australia on 23 April 2024 indicated that green or blue ACCUs projects on former sugarcane land may not be eligible for DIN Reef Credits if sugarcane production ceases in Mossman. However, the hypothetical stacking of DIN Reef Credits with green or blue ACCUs is analysed here to demonstrate how a stacked revenue payment from a co-benefit could potentially improve the financial viability of an environmental market project. Results are reported for the following hypothetical stacked credits:

3. Green ACCUs are hypothetically *stacked* with DIN Reef Credits at indicative sites.
4. Blue ACCUs are hypothetically *stacked* with DIN Reef Credits at case study sites.

In the simulations with stacked credits, (after differing lead-in times and after incurring different upfront costs), green or blue ACCUs generate revenues over a 25-year crediting period. DIN Reef Credit revenues are then hypothetically stacked on top of ACCU revenues over the first 10 years of the 25-year ACCU crediting period (because DIN Reef Credits have a 10-year crediting period). The additional costs of setting up and commercialising DIN Reef Credits are included in the DCFA.

Sensitivity Analysis

DCFA outcomes for a particular project are calculated across ranges for market prices for environmental credits as shown below across each of the landholder cost scenarios that are relevant for the environmental market opportunity being evaluated. The ranges used for environmental market credit prices draw on historical market pricing, key stakeholder interviews, and expertise of the project team:

1. For ACCU prices: $30/ACCU to $100/ACCU in $5 increments – with results reported in results tables for $40/ACCU, $70/ACCU and $100/ACCU.
2. For DIN Reef Credit prices: $100/DIN credit, $150/DIN credit and $200/DIN credit.

A real discount rate of 7%, a capital loan repayment term of 10 years, a weighted average cost of capital of 8%, and a 25-year permanence period are applied throughout.

Additional Revenue Streams from Emerging Environmental Credit Markets

Additional stackable revenue streams for these projects may become available in the future via, for example, LRF contracts, Cassowary Credits, NaturePlus™ credits, or through biodiversity certificates sold on the Nature Repair Market. These stackable revenue streams could potentially replace DIN Reef Credits in our hypothetical stacking examples.

For illustration purposes, we report the scale of per hectare environmental credit payments that would be required to achieve the same NPV and annualised net present value per hectare outcomes (for the project as a whole, for the developer and for the landholder) as those obtained from stacking DIN Reef Credits (at DIN Reef Credit prices of $100/DIN credit, $150/DIN credit and $200/DIN credit) with green or blue ACCUs at the site (at ACCU prices of $40/ACCU, $70/ACCU and $100/ACCU). We report the illustrative per hectare environmental credit payments that would be required to achieve these same outcomes over the following crediting periods:

1. A 10-year crediting period, with start and finish dates matching those of DIN Reef Credits
2. A 25-year crediting period, with start and finish dates matching those of green or blue ACCUs (as relevant to the site concerned.

5.6 COSTS

Cost information for the discounted cash flow analyses were sourced from a combination of publicly available reports and peer-reviewed publications, stakeholder interviews, direct consultation with industry experts and price movements reported on environmental market websites. Despite extensive consultation efforts by the project team, it was not possible to obtain data on all cost components. In these instances, costs were estimated based on the project team's expertise and prior experience. The cost components shown in Figure 9 were used as the basis for identifying scheme-specific costs in consultation with industry experts and stakeholders. These costs are outlined in the following sub-sections.

5.6.1 COSTS FOR REFORESTATION BY ENVIRONMENTAL OR MALLEE PLANTINGS – FULLCAM METHOD *('GREEN ACCUS')*

Information on input costs and timelines for restoration of tropical rainforest by environmental plantings under the ACCUs scheme are summarised in Table 12. ACCU production via reforestation of tropical rainforest is evaluated in this study because it provides potential opportunities for stacking green ACCUs revenues with revenues from Cassowary Credits, NaturePlus™ credits, or through biodiversity certificates sold on the Nature Repair Market. These stacking opportunities would probably not be available for lower density carbon-only focused tree planting schemes.

The FullCAM Method does not specify a planting density for 'mixed-species environmental plantings – tropical with block planting geometry' (Carbon Credits (Carbon Farming Initiative): Reforestation by Environmental or Mallee Plantings—FullCAM - Methodology Determination 2014, 2018); however, discussions with project developers and NRM groups – and published literature – indicated that planting densities for mixed species environmental plantings that target rainforest regeneration are typically between 3,500 to 5,000 stems per ha. This is consistent with the planting densities of between 3,000 and 6,000 stems per ha reported in the literature for 11 ecological restoration projects in the Wet Tropics covering areas of between 5 ha and 20 ha (Catterall & Harrison, 2006)[5]. **Our stakeholders also emphasised that, due to its tropical climate and rainforest, high planting densities with at least 20 different local species are recommended for the Mossman district to achieve rapid canopy closure.**

Project developers and NRM groups indicated that due to high-density planting, it is reasonable to expect that minimal or no weeding and maintenance would be required beyond the first three years after planting. This was confirmed via interviews with Greening Australia and Terrain NRM. In the Thiaki rainforest restoration project in the southern Atherton Tablelands, (van Oosterzee et al., 2020) maintenance costs were included for only four years from the date of planting because the restored forest was regarded to be self-maintaining thereafter.

A developer stated that the cost of site preparation, seedling purchase, planting, and site maintenance for three years was between $12 and $15 per stem. Applying these per stem costs to sites planted at 3,500 to 5,000 stems per ha produces cost of between $42,000 and $75,000 per hectare (for site preparation, seedling purchase, planting and site maintenance to canopy closure). Another interviewee indicated that the same set of operations could cost between $30,000 and $80,000 per ha.

In our DCFA we use a cost of $55,000 per hectare for site preparation, seedling purchase, planting and site maintenance as this is close to the mid-range of the per hectare costs from our two key informants.

[5] A subset of data was extracted from the scatterplot in Catterall & Harrison (2006, Figure 3.3c, p30) using web-based software:https://apps.automeris.io/wpd/ , date accessed: 15 August 2023.

*Table 12: Cost estimates used in the discounted cash flow analysis for the Reforestation by Environmental Plantings (Tropical mixed species, block planting) ACCU scheme ('green ACCUs'). Costs incurred by the project developer are shaded green. Costs incurred by the landholder are shaded cream. Costs in white cells were not included in our DCFAs but are reported here because they may be useful for analysis at other case study sites. Planting density is 5,000 stems per ha. Planting cost is $15/stem (in present value) and this cost **includes** site preparation prior to planting, purchase of seedlings, planting of seedlings, and maintenance for the first three years.*

** Indicates costs that are included in the upfront loan i.e., the loan amount requested is the sum of tree planting cost, planting design cost, development approval cost and 5% contingency.*

*** Commerford et al. (2015) reported the cost of 'planning/accreditation' at $10,000 per project (in 2010 AUD$). A key informant interview indicated that it typically took between 10 and 20 days of a professional's time to assist a landholder from initial engagement through to signature of a legal contract. Costing professional time at $200/hour, we use a cost of $15,000 for the following cost components in combination (refer back to* Figure 9*): initial engagement, preliminary site survey, engagement process, draft project design, legal contracts, and establishment of a carbon baseline for the site.*

Green ACCUs: Engagement and conceptualisation phase				
Cost component	**Cost amount (AU$ in 2024)**	**When incurred**	**Data source**	**Explanation**
Informal (initial) engagement**	$15,000 ** including other ** items below	First six months of project	Project team, informed by Greening Australia and Commerford et al (2015)	See ** in table caption.
Preliminary site survey**	**	First six months of project	Project team, informed by Greening Australia and Commerford et al (2015)	See ** in table caption.
Cultural heritage survey (Only likely to be undertaken at sites under relevant property rights and governance contexts). **Not included in the project's DCFA for green ACCU sites.**	**(Included here for information only)** Range between $3,000 for a small, simple case with no complications over two months to $30,000 for a large, complex case over 7 months. A typical survey would cost around $10,000 and take place over a 4-month period.	First six months of second year	Consultation with Jabalbina approved cultural heritage surveyor	**Not included** because the indicative green ACCUs sites (Table 9Table 9) are assumed to be implemented on privately owned land which is not under an Indigenous Land Use Agreement.
Engagement process**	**	Second six months	Project team, informed by Greening Australia and	See ** in table caption.

			Commerford et al (2015)	
Draft project design**	**	First six months of project	Project team, informed by Greening Australia and Commerford et al (2015)	See ** in table caption.
Secure finance**	**	Second six months	Project team, informed by Greening Australia and Commerford et al (2015)	See ** in table caption.
Legal & contracts between landholder and project developer**	**	Second six months	Project team, informed by Greening Australia and Commerford et al (2015)	See ** in table caption.
Baseline establishment**	**	Second six months	Project team, informed by Greening Australia and Commerford et al (2015)	See ** in table caption.
Green ACCUs: Project establishment phase				
Cost component	**Cost amount (AU$ in 2024)**	**When incurred**	**Data source**	**Explanation**
*Detailed project design (planting design)	*	n.a. (covered by the loan)	Project team, informed by Greening Australia and Commerford et al. (2015)	
*Development approvals	$10,000	n.a. (covered by the loan)	Project team, informed by discussion with GreenCollar and Greening Australia about development approvals surrounding change in land use for environmental	The time taken can be between 4 months to 2 years. However, the cost incurred by the developer will be site-specific and would include direct costs and indirect costs, including cost of delays. The figure here is indicative only, assumed by the project team i.e. not provided by GreenCollar.

			credit projects generally.	
*On-site implementation (tree planting)	$55,000 per ha	n.a. (covered by the loan)	Greening Australia & Terrain NRM	Approximately the midpoint of the ranges of cost quoted by two key informants for the full suite of onsite works.
* 3-years on-site maintenance until canopy closure	*	n.a. (covered by the loan)	Greening Australia & Terrain NRM	
Loan contingency	5% of loan request for items labelled *	n.a. (covered by the loan)	Project team	
Project management through engagement, conceptualisation and establishment phases	0.5% of total loan request	Second six months of second year	Project team	
Reduction in land value	$5018/ha under landholder cost Scenario 1 $2508/ha under landholder cost Scenario 2	Start of establishment phase	ABARES survey of sugarcane farms 2021 (Topp et al., 2021)	Reduction in land value under landholder cost Scenario 1 calculated as follows: Scenario 1 provides an upper-bound estimate for the reduction in land value, using an initial land value derived from sugarcane production. Assume the addition to unimproved land value per ha of sugarcane farm is derived from the infinite sum of the farm business profit per ha for the average sugarcane farm business in Far North Qld. This is obtained from the ABARES survey of sugarcane farms conducted in mid-2021 and reported in https://www.agriculture.gov.au/abares/research-topics/surveys/sugar Reported farm business profit per ha for the average sugarcane farm business in Far North Qld = $314.22/ha/year (in AUD$ FY20/21) Topp et al. (2021). Converts to $351.25/ha/year (in AUD$ FY22/23 using RBA inflation calculator). Infinite discounted sum of these annual profits (at 7% real annual discount rate) = $5018/ha ((in AUD$ FY22/23) Assume the land value reverts to the unimproved land value once the landholder signs up to the project agreement with the developer (i.e., the land value reduces by $5018/ha). For green ACCUs projects, assume the reduction in land value occurs one year before the start of the project's crediting period. This value of $5018/ha provides an upper bound estimates for this cost component.

				Landholder cost Scenario 2 uses a reduction in land value of $2509/ha. This is 50% of the reduction assumed in Scenario 1. The forms of agricultural production that will emerge in Mossman district in future years are not currently known. We use a land value reduction at 50% of the Scenario 1 level to provide an indicative estimate of the land value reduction that might arise if land is switched from future agriculutural production to environmental market usage.
Green ACCUs: Production phase				
Cost component	**Cost amount (AU$ in 2024)**	**When incurred**	**Data source**	**Explanation**
Annual on-ground maintenance (opex)	Already included in the on-site reforestation works for three years. Assumed no maintenance thereafter because of canopy closure.	Annually in the first three years after planting	Greening Australia & Terrain NRM	**Not included as a separate item** because this cost has already been costed in as part of the planting and establishment cost, following discussions with Greening Australia.
Annual monitoring and reporting (**by the project developer: i.e. not an independent audit**)	$56/ha	Annually starting in the first year	Commerford et al (2015)	'Monitoring/auditing' cost reported in Commerford et al (2015) was $40/ha (AUD at 2010).
Insurance against failure to supply	**Excluded from analysis**	Discussions with stakeholders indicated that it is difficult to obtain insurance for carbon projects particularly since the El-Nino was declared due to heightened fire risk.		
Independent audits	**Excluded from analysis**	Once in Year 1 and then every five years thereafter until the end of the permanence period for large green ACCUs projects under relevant Methods.	Greening Australia	**Not included** because independent audits were not required for project sites of < 200 ha operating under the (former) Environmental Plantings Pilot Method (Clean Energy Regulator, 2024c). We assume that a similar 'light touch' option will be instituted under the forthcoming Integrated Farm and Land Management Method or under a revised version of the Reforestation by Environmental or Mallee Plantings 2014 method (DCCEEW, 2024)

Foregone net revenue from agricultural production on land committed to the green ACCUs project	$430/ha/year under landholder cost Scenario 1 $215/ha/year under landholder cost Scenario 2	Annually from the start of the production phase until the end of the permanence period.	ABARES survey of sugarcane farms 2021 (Topp et al., 2021)	Opportunity cost of foregone agricultural net revenue under landholder cost Scenario 1 calculated as follows. Scenario 1 provides an upper-bound estimate for the opportunity cost of foregone agricultural net revenue, using the annual gross margin derived from sugarcane production calculated as follows: Assume annual opportunity cost of foregone sugarcane gross margin per ha is given by the average sugarcane cash margin per ha reported for sugarcane farms in Far North Qld. Data in the ABARES survey of sugarcane farms conducted in mid-2021 and reported in https://www.agriculture.gov.au/abares/research-topics/surveys/sugar Reported average sugarcane cash margin reported for sugarcane farms in Far North Qld = $385/ha/year (in AUD$ FY20/21). Converts to $430/ha/year (in AUD$ FY22/23 using RBA inflation calculator). Topp et al. (2021). This value of $430/ha/year provides an upper bound estimate for this cost component. Landholder cost Scenario 2 uses an opportunity cost of $215/ha/year. This is 50% of the opportunity cost assumed in Scenario 1. The forms of agricultural production that will emerge in Mossman district in future years are not currently known. We use an opportunity cost at 50% of the Scenario 1 level to provide an indicative estimate of the opportunity cost that might arise if land is switched from future agriculutural production to environmental market usage.
Green ACCUs: Commercialisation				
Cost component	**Cost amount (AU$ in 2024)**	**When incurred**	**Data source**	**Explanation**
Carbon credit broker's fee – for small projects (<= 5 ha)	5% of credit sales at the low end Between 10% - 20% of credit sales depending on broker's expertise, type of projects and other factors.	**Not included here**. However, if included would be incurred annually, soon after the annual report is completed and crediting approval obtained from CER	Carbon Credits .com	A 10% for broker's fee could be used in a DCFA for small green ACCUs projects: assume this arrangement only applies for projects < 5ha in area. Hence **not included** for any of the indicative green (or blue) ACCU project sites evaluated in Mossman district.

		Annually from the first year		
Commercialisation assumed to be via an ‘over the counter’ bilateral contract between project developer and credit buyer – for projects	$0 Assume costs covered by selling in bulk to volume buyers	**Not included** as a cost in green ACCUs projects	Greening Australia	Greening Australia advised that a well-connected project developer would probably disregard commercialisation costs for setting up ‘over the counter’ bilateral contracts with major credit buyers because the (modest) costs incurred would probably be more than recouped via the pricing achieved.

5.6.2 Costs for Tidal Restoration of Blue Carbon Ecosystem BlueCAM method

Input cost data and timelines for restoration of tidal flows in case study sites under the ACCU scheme Tidal Restoration method are summarised in Table 13.

Table 13: Cost estimates used in the discounted cash flow analysis for the Tidal Restoration for Blue Carbon Ecosystem ACCU scheme. Assume Lead-in Time is 3 years. Site 1 will involve three landholders. Site 2 and Site 3 are assumed to each involve one landholder. Costs incurred by the project developer are shaded green. Costs incurred by the landholder are shaded cream. Costs in white cells were not included in our DCFAs but are reported here because they may be useful for equivalent analysis at other case study sites.

Blue ACCUs: Engagement and conceptualisation phase				
Cost component	**Cost amount (AU$ in 2024)**	**When incurred**	**Data source**	**Explanation**
Informal (initial) engagement	$1,000 per landholder	First year of project	Project team	Some sites likely to involve multiple landowners.
Preliminary site survey	$5,000 per site	First year of project	Project team	
Engagement process	$2,500 per landholder	First year of project	Project team	
Initial hydrological assessment	$12,000 per site	First year of project	Project team (based on JCU hourly commercial rates)	This is a pre-registration hydrological assessment and includes collation of the necessary datasets to run a detailed hydrological model in the next phase.
Cultural heritage survey (only likely to be undertaken at sites under relevant property rights and governance contexts). **Not included in the project's DCFA for blue ACCU sites.**	**(Included here for information only)** Range between $3,000 for a small, simple case with no complications over two months to $30,000 for a large, complex case over 7 months. A typical survey would cost around $10,000 and take place over a 4-month period.	Second year of project	Consultation with Jabalbina approved cultural heritage surveyor	**Not included** because blue carbon sites are assumed to be privately owned land which is not under an Indigenous Land Use Agreement.
Legal & contracts between landholders, and project developer	$10,000 per actor	Second year of project	Project team	
Baseline establishment	$5,000 per project site	Third year of project	Project team	For project additionality assessment.
Reduction in land value	$5018/ha under landholder cost Scenario 1 $2509/ha under landholder cost Scenario 2	Start of establishment phase (second year of project).	ABARES survey of sugarcane farms 2021 (Topp et al., 2021)	Reduction in land value under landholder cost Scenario 1 calculated as follows: Scenario 1 provides an upper-bound estimate for the reduction in land value, using an initial

	$2509/ha under landholder cost Scenario 3			land value derived from sugarcane production. Assume the addition to unimproved land value per ha of sugarcane farm is derived from the infinite sum of the farm business profit per ha for the average sugarcane farm business in Far North Qld. This is obtained from the ABARES survey of sugarcane farms conducted in mid-2021 and reported in https://www.agriculture.gov.au/abares/research-topics/surveys/sugar Reported farm business profit per ha for the average sugarcane farm business in Far North Qld = $314.22/ha/year (in AUD$ FY20/21) Topp et al. (2021).. Converts to $351.25/ha/year (in AUD$ FY22/23 using RBA inflation calculator). Infinite discounted sum of these annual profits (at 7% real annual discount rate) = $5018/ha ((in AUD$ FY22/23) Assume the land value reverts to the unimproved land value once the landholder signs up to the project agreement with the developer (i.e., the land value reduces by $5018/ha). For blue ACCUs projects, assume the reduction in land value occurs two years before the start of the project's crediting period. Landholder cost Scenario 2 uses a reduction in land value of $2509/ha. This is 50% of the reduction assumed in Scenario 1. The forms of agricultural production that will emerge in Mossman

				district in future years are not currently known. We use a land value reduction at 50% of the Scenario 1 level to provide an indicative estimate of the land value reduction that might arise in land is switched from future agriculutural production to environmental market usage. Landholder cost Scenario 3 uses the same reduction in land value as Scenario 2.
Blue ACCUs: Project establishment phase				
Cost component	**Cost amount (AU$ in 2024)**	**When incurred**	**Data source**	**Explanation**
Detailed project design (including detailed hydrological assessment)	$32,000 per site	Third year of project	Project team (based on JCU hourly commercial rates)	Hydrological assessment including site visits, data collection, model development and calibration. Cost also includes the cost for a qualified engineer to review the hydrological assessment and proposed project operations. Proposed project operations comprise designs for the planned engineering works to allow tidal ingress and the proposed plan for on-going maintenance of the blue carbon ecosystems during the permanence period.
Development approvals	$50,000	Third year of project	Project team, informed by discussion with GreenCollar about development approvals surrounding change in land use for environmental credit projects generally.	The time taken can be between 4 months to 2 years; however, the actual duration will be site-specific and would cover direct costs and indirect costs, including cost of delays. The duration here is assumed by the project team. Development approval cost for tidal restoration is expected to be much higher than the development approval for reforestation for green carbon. For example,

				approval for a water licence may be required when undertaking tidal restoration but may not be relevant for a reforestation project.
On-site works (barrier removal for tidal restoration)	Costs are site-specific. <u>Site 1</u> Excavation cost is $3,840 for partial removal of a bund [130m (length) x 5m (width) x 1.5m (height)]. Three flood gates to be removed. <u>Site 2:</u> Excavation cost is $4,357 to remove a bund [150m (length) x 5m (width) x 1.5m (height)]. One flood gate to remove. <u>Site 3:</u> Excavation cost is $1,646 to remove a bund [60m (length) x 6m (width) x 1m (height)]. No flood gate removal required at Site 3. <u>Sites 1, 2 and 3:</u> Assume rock reinforcement is required when removing a bund, it will add another $125,000 to the cost for each of the three sites.	Third year of project	Cost of soil excavated was calculated using the cost function in Canning et al. (2023). The volumes of soil to remove were estimated by JCU team. Costs of removing floodgates and bunds with construction of accompanying rock ramp reinforcement to prevent increased erosion around bends in river channels and where flood gates were formerly situated were sourced from Catchment Solutions (2022) report commissioned by Reef Catchments NRM.	$60,000 to $80,000 (in AUD 2021) for removal of floodgates including rock reinforcement. $100,000 to $150,000 (in AUD 2021) for removal of bund including rock reinforcement around new location of tidal ingress.
Project management through engagement,	20% of total expenditure on	Assumed to be split equally	Project team	

conceptualisation, and establishment phases	development approvals, detailed project design and on-site works.	between years 1, 2 and 3 of the project.		

Blue ACCUs: Production phase				
Cost component	**Cost amount (AU$ in 2024)**	**When incurred**	**Data source**	**Explanation**
Annual on-ground maintenance (opex)	$925 per ha of inundation per year	Annually starting in the fourth year of project. Continues until tidal wetland is fully established (assume this occurs in year 8 of the project).	Waltham et al. (2021)	Weed removal, repair of rock reinforcement (if necessary). The annual maintenance cost $750/ha/year for restored wetland from Waltham et al 2021 was in AUD2016. This amount is escalated to 2023 AUD using the Consumer Price Index published by the Australian Bureau of Statistics.
Monitoring and reporting	$2,500	Occurs in years when ACCUs are claimed: assumed to be in years 4,9,14,19,24 and 29 of project,	Project team	Monitoring reports must be submitted every time ACCUs are claimed. Based on typical large green ACCUs projects, the first monitoring report is submitted to cover the first year of carbon sequestration (in consultation with Greening Australia). We assume monitoring reports are submitted and blue ACCUs claimed every five years thereafter until the end of 25-year crediting period.
Insurance against failure to supply	Excluded from analysis	Discussions with stakeholders indicate that it is difficult to obtain insurance quotes because the blue carbon scheme is new		
Independent audits	$20,000 per audit	Years 9 and 19 of project.	Greening Australia	The cost of an independent audit for BlueCAM Method is unknown. Assume at this stage that the independent audit cost will be the same as the cost incurred under the reforestation FullCAM ACCU scheme, typically $20,000 per audit (in consultation with Greening Australia). An initial independent audit must be submitted with the project's first monitoring report (Clean Energy Regulator, 2024b). For projects with annual average abatement below 50,000 tonnes of CO_2e, two subsequent independent audits will be required during the crediting period (https://www.legislation.gov.au/F2015L00284/latest/text, item 5, p1). We assume these subsequent audits are undertaken 5 and 15 years after the initial audit.

Opportunity cost to the landholder of foregone net revenue from agricultural production on land committed to the blue ACCUs project	$430/ha/year under landholder cost Scenario 1 $215/ha/year under landholder cost Scenario 2 $0/ha/year under landholder cost Scenario 3	Annually from the start of the production phase until the end of the permanence period (Year 3 onwards).	ABARES survey of sugarcane farms 2021 (Topp et al., 2021)	Opportunity cost of foregone agricultural net revenue under landholder cost Scenario 1 calculated as follows. Scenario 1 provides an upper-bound estimate for the opportunity cost of foregone agricultural net revenue, using the annual gross margin derived from sugarcane production calculated as follows: Assume annual opportunity cost of foregone sugarcane gross margin per ha is given by the average sugarcane cash margin per ha reported for sugarcane farms in Far North Qld. Data in the ABARES survey of sugarcane farms conducted in mid-2021 and reported in https://www.agriculture.gov.au/abares/research-topics/surveys/sugar Reported average sugarcane cash margin reported for sugarcane farms in Far North Qld = $385/ha/year (in AUD$ FY20/21). Converts to $430/ha/year (in AUD$ FY22/23 using RBA inflation calculator). Topp et al. (2021). This value of $430/ha/year under landholder cost Scenario 1 provides an upper bound estimates for this cost component. Landholder cost Scenario 2 uses an opportunity cost of $215/ha/year. This is 50% of the opportunity cost assumed in Scenario 1. The forms of agricultural production that will emerge in Mossman district in future years are not currently known. In landholder cost Scenario 2 we use an opportunity cost at 50% of the Scenario 1 level to provide an indicative estimate of the opportunity cost that might arise in land is switched from future agricultural production to environmental market usage.

				Landholder cost Scenario 3 uses an opportunity cost of $0/ha/year. This scenario is included to represent the situation in which the blue carbon project will be implemented on abandoned agricultural land.
Blue ACCUs: Commercialisation				
Cost component	**Cost amount (AU$ in 2024)**	**When incurred**	**Data source**	**Explanation**
Commercialisation via over the counter bilateral contract between project developer and credit buyer.	Costs recouped by selling in bulk to volume buyers	Not included	Greening Australia	

5.6.3 COSTS FOR REEF CREDITS VIA THE MANAGED FERTILISER APPLICATION METHOD (FOR HYPOTHETICAL CREDIT STACKING WITH GREEN ACCUS AND BLUE ACCUS PROJECTS)

Input cost data and timelines for Reef Credits scheme via the Managed Fertiliser Application Method are summarised in Table 14. Costs and price data were obtained through consultation with industry stakeholders and internet research of figures published on the website of Eco-Markets Australia.

Table 14: Cost estimates used in the discounted cash flow analysis for the Reef Credits scheme via the Managed Fertiliser Application Method, when implemented as a hypothetical example of a stacked credit with a primary green or blue ACCUs project. Cost estimated are based on discussions with our stakeholders. Costs incurred by the project developer are shaded green. Costs incurred by the landholder are shaded cream. Costs in white cells were not included in our DCFAs but are reported here because they may be useful for equivalent analysis at other case study sites. Costs to the landholder arising from reduction in land value and the opportunity cost of foregone sugarcane revenues have already been included in the ACCUs component of the stacked project.

DIN Reef Credits stacked with ACCUs: Engagement and conceptualisation phase				
Cost component	**Cost amount (AU$ in 2024)**	**When incurred**	**Data source**	**Explanation**
Informal (initial) engagement	$0 per landholder	First year of project	Project team	Already engaged with landholders via the primary ACCUs project.
Engagement process	$0 per landholder	First year of project	Project team	as above.
Legal & contracts between landholder and project developer	$0 per actor	First year of project	Project team	Assume a single contract covers all schemes in the stack
Baseline establishment & data collection (7 years of farm data on fertiliser purchase and application)	$5,000 per project site	First year of project	Project team, informed by discussion with GreenCollar.	This is baseline data collection specifically for the stacked Reef Credits.
DIN Reef Credits stacked with ACCUs: Project establishment phase				
Cost component	**Cost amount (AU$ in 2024)**	**When incurred**	**Data source**	**Explanation**
Development approvals	Not included	n.a.	GreenCollar	Assume that no specific development approvals are required for cessation of fertiliser applications
Project management through all phases of the DIN Reef Credit component of the stacked project	$10,000	First year of project	Project team	Greening Australia advised that a well-connected project developer would expect to recoup the (modest) costs incurred via the pricing achieved.

DIN Reef Credits stacked with ACCUs: Production phase				
Cost component	**Cost amount (AU$ in 2024)**	**When incurred**	**Data source**	**Explanation**
Annual monitoring and reporting	$2,500	Annually starting in the first year	Project team	
Independent audits	$7,000 to $11,000 per audit. $7000 cost is used in DCFA for Sites 1, 2 and 3.	Annually	Consultation with GreenCollar	Range depends on complexity. Audit cost could be lower if project sites can be aggregated.
DIN Reef Credits stacked with ACCUs: Commercialisation				
Cost component	**Cost amount (AU$ in 2024)**	**When incurred**	**Data source**	**Explanation**
Open registry account	$1,500	Once per project during the first year	Eco Markets Reef Credit Fee Schedule v2.0 14 October 2021	Registry Account Opening Fee
Project registration & lodgement	$750		Eco Markets: Project Crediting Procedures v2.0 14 October 2021	Project Registration Fee
Application for credit certification & issuance	$750			Certification Review Fee
Reef Credits issued to registry account	$0.50 per credit	Annually over crediting period of 10 years		Reef Credit Issuance Fee
Transfer of Reef Credits to buyer	$0.25 per credit	Annually over crediting period of 10 years		Reef Credit Transfer Fee
Methodology compensation payment	$0.25 per credit	Annually over crediting period of 10 years		Method Compensation Rebate
Truii Natural Capital Suite software	$2 per credit claimed	Annually over crediting period of 10 years	https://naturalcapitalsuite.au/credit/	This fee is to support software development and maintenance.

6. CASE STUDY SITES & ASSESSMENT: RESULTS

6.1 GREEN CARBON SITES

6.1.1 SITE DESCRIPTION – INDICATIVE GREEN ACCUS SITES

As described previously, FullCAM was used to estimate production of 'Green ACCUs' from rainforest restoration planting at 21 indicative sites (Figure 13 and Table 9) across six soil types and multiple SILO climate zones in Mossman catchment.

6.1.2 PROJECT WORKS & REQUIREMENTS

Activities required to implement rainforest restoration Green ACCUs projects were assumed to follow the activity phases and timing shown in Figure 9. It was assumed that *a project developer and a single landholder* were the key actors involved in all Green ACCUs projects.

Costings for the various project activities were informed through interviews with key informants from Terrain, Greening Australia and GreenCollar (Table 12). These interviews established that site preparation and planting costs are the dominant costs in Green ACCUs projects in the Wet Tropics which aim to restore native rainforest through planting a diverse mix of tropical tree species native to the local area. This requires planting densities of 5,000 stems per hectare and incurs a cost outlay in the region of $55,000 per hectare to cover site preparation, purchase of tree seedlings, planting and maintenance for three years after planting. Maintenance requirements will be much less intensive for the remainder of the project duration as weed growth is assumed to be light-restricted following canopy closure. The indicative Green ACCUs sites selected for this modelling exercise (Figure 13 and Table 9) have a mean area of 37ha. The planting cost for a site of this size is approximately $2 million. Estimated planting costs exceed $1 million for 19 of the 21 Green ACCUs sites modelled. Estimated planting cost for the largest site (De4) exceeds $4.7 million. Given the levels of expenditure required, it was assumed that the project developer would take out a loan to cover the cost of obtaining development approvals, site preparation, purchase of tree seedlings, planting and maintenance for three years after planting. It was assumed that this loan will be repaid in equal instalments over a 10-year period, at a weighted average cost of capital of 8%.

The landholder incurs costs through a reduction in land value (on signing up to the Green ACCUs project) and the opportunity cost of foregone sugarcane (or other agricultural) revenues through to the end of the project's 25-year permanence period (assuming continuation of cane farming in the district). For Green ACCUs sites DCFAs are conducted under landholder cost Scenario 1 and landholder cost Scenario 2. (Landholder cost Scenario 3 is not used for Green ACCUs sites because we assume that these sites are still likely to remain in some form of agricultural usage in the future, even if sugar production ceases.)

6.1.3 FULLCAM OUTPUTS

Example FullCAM results for carbon storage, carbon increment, ACCUs credited over a 25-year permanence period, and cumulative present value revenue ($) generated are shown in Figure 16, Figure 17 and Figure 18 for the sites that deliver the highest (De2), median (So3) and lowest (Hy3) modelled NPV outcomes per hectare from a stand-alone green ACCUs project at an ACCU price of $40/ACCU. The DCFA results for all 21 indicative sites are reported in the next section.

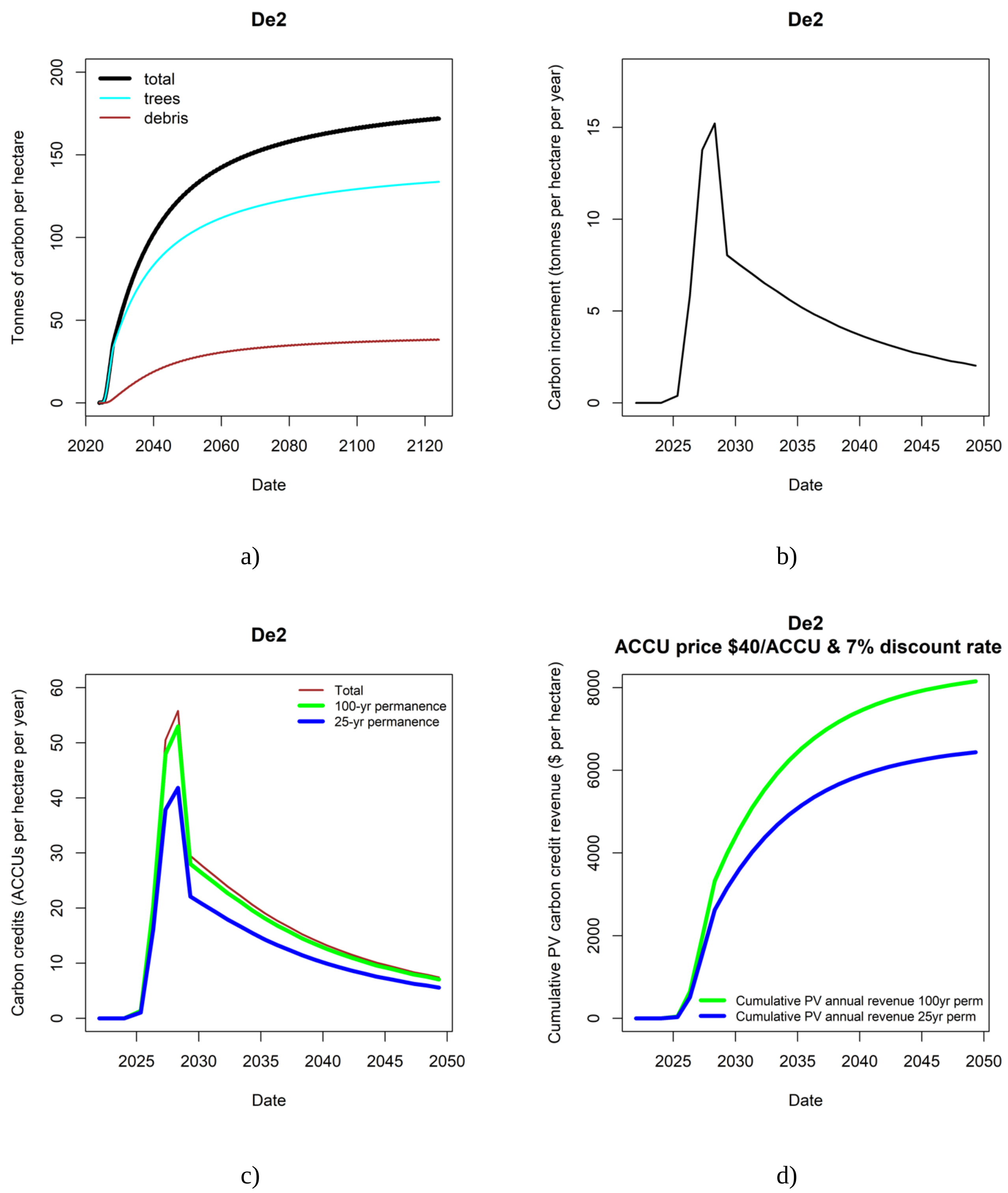


*Figure 16: FullCAM results for per ha (a) carbon storage, (b) carbon increment, (c) ACCUs credited over a 25-year permanence period, and (d) cumulative present value of ACCU revenue at **site De2** (which delivers the **highest** NPV per ha outcome from a standalone green ACCUs project when evaluated at an ACCU price of $40/ACCU and a real discount rate of 7% over the full project duration).*

The changes of slope seen in the early years in Figure 16 panels b), c) and d) arise because FullCAM represents the effect of weeding at a site by advancing tree age by 12 months each time weeding occurs.

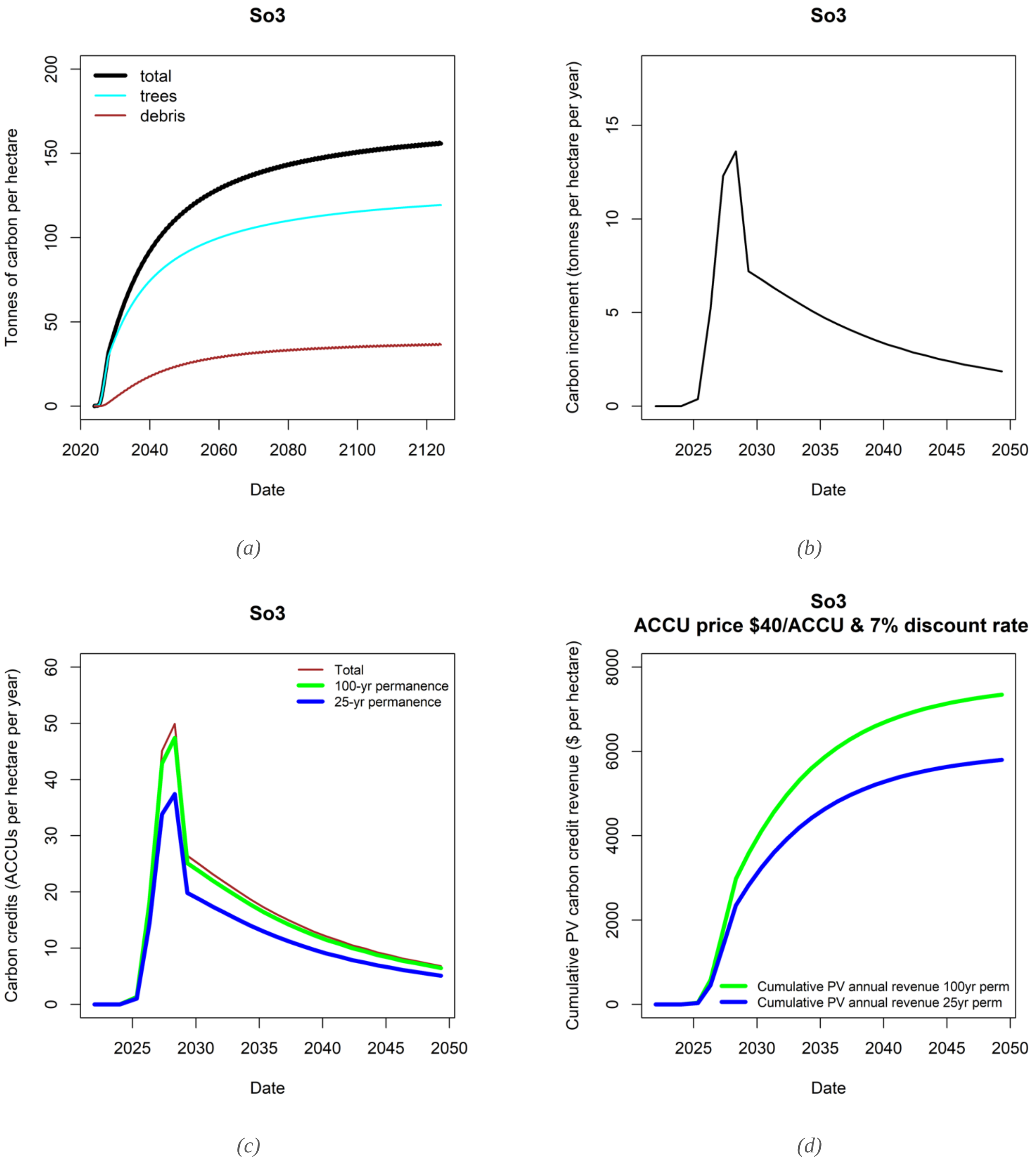
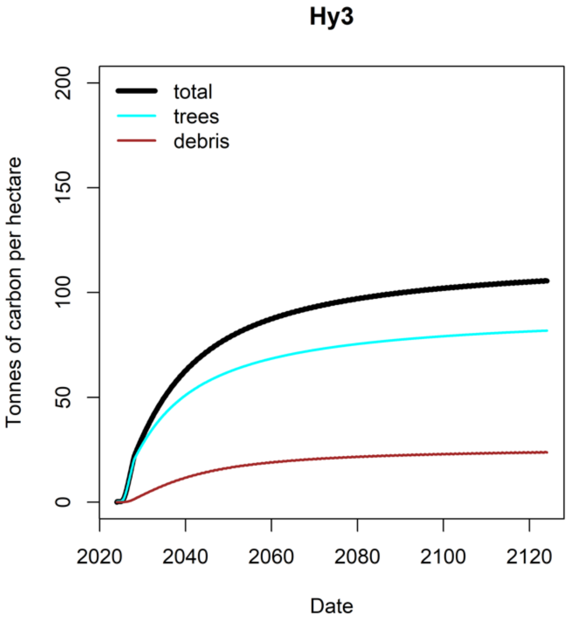
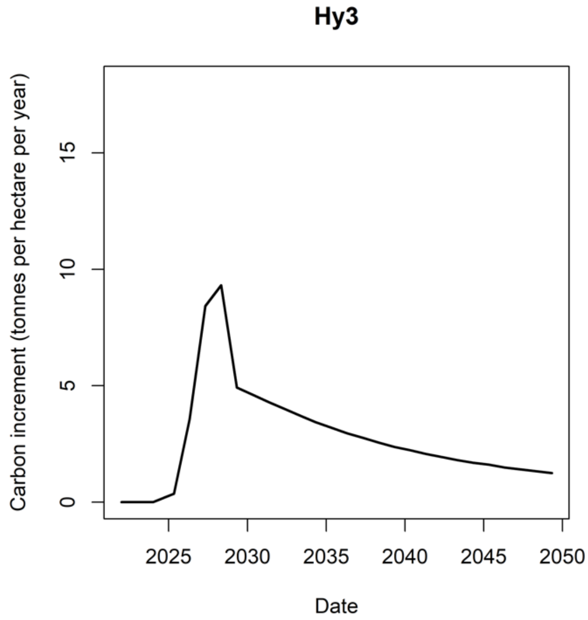


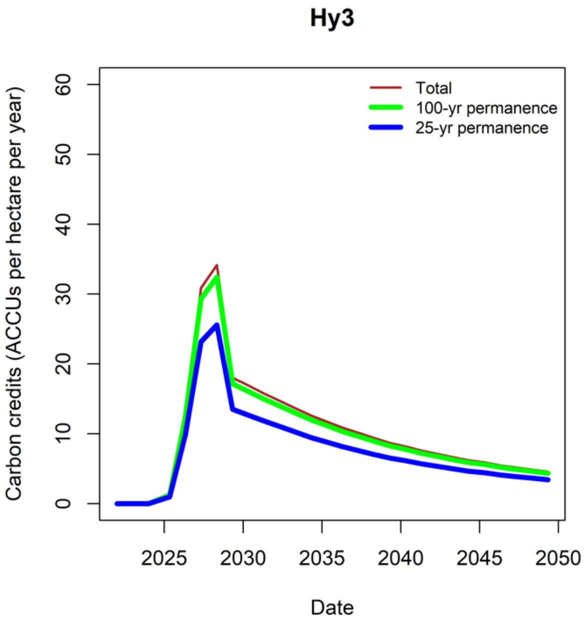
Figure 17: FullCAM results for per ha (a) carbon storage, (b) carbon increment, (c) ACCUs credited over a 25-year permanence period, and (d) cumulative present value of ACCU revenue at ***site So3*** *(which delivers the* ***median*** *NPV per ha outcome from a standalone green ACCUs project when evaluated at an ACCU price of $40/ACCU and a real discount rate of 7% over the full project duration).*



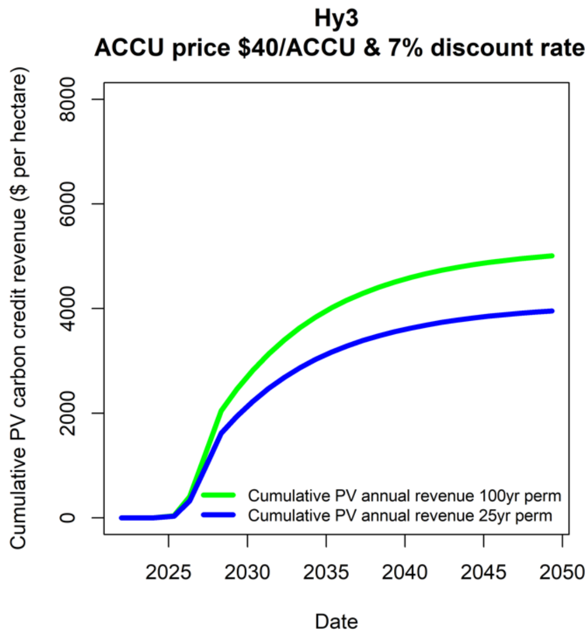
(a)



(b)



(c)



(d)

Figure 18: FullCAM results for per ha (a) carbon storage, (b) carbon increment, (c) ACCUs credited over a 25-year permanence period, and (d) cumulative present value of ACCU revenue at ***site Hy3*** *(which delivers the* ***lowest*** *NPV per ha outcome from a standalone green ACCUs project when evaluated at an ACCU price of $40/ACCU and a real discount rate of 7% over the full project duration).*

6.1.4 GREEN ACCUS DISCOUNTED CASH FLOW ANALYSIS: RESULTS

Discounted cash flow analyses were conducted for the following environmental market opportunities under landholder cost scenarios 1 and 2 at 21 indicative green ACCUs sites in Mossman district (see Table 9 and Figure 13):

- FullCAM 'Green ACCUs' alone
- FullCAM 'Green ACCUs' hypothetically stacked with DIN Reef Credits.

The DCFAs reported for green ACCUs sites were undertaken with the key parameter settings and ranges shown in Table 15.

Table 15: Parameter settings for discounted cash flow analyses of standalone Green ACCUs projects at the 21 green ACCUs sites listed in Table 9.

Parameter	Setting
Real discount rate	7% per annum
Cost of capital	8% per annum
Loan duration	10 years
ACCU pricing	Between $30 and $100 $/ACCU in steps of $5
DIN Reef Credit pricing (when stacking)	$100/credit, $150/credit and $200/credit
Project permanence period	25 years
Project crediting periods	25 years for green carbon ACCUs 10 years for DIN Reef Credits
Lead-in Time	2 years for green carbon ACCUs 2 years for green carbon ACCUs and DIN Reef Credits stacked
Total project duration	28 years for green carbon ACCUs 28 years for green carbon ACCUs and DIN Reef Credits stacked

6.2 GREEN CARBON SITES: DISCOUNTED CASH FLOW ANALYSIS: RESULTS

Key results from DCFAs under landholder cost Scenario 1 and landholder cost Scenario 2 with and without stacking for our 21 green carbon sites under Scenario 1 are summarised as follows:

- None of the green ACCUs sites delivered positive whole-of-project NPVs from green carbon credits alone (without stacking) for landholder cost Scenario 1 or landholder cost Scenario 2 under the range of ACCU pricing explored (between $30 and $100 per ACCU).
- Under the scenario where the FullCAM 'Green ACCUs' are hypothetically stacked with DIN Reef Credits, the whole-of-project NPVs are also negative under landholder cost Scenarios 1 and 2 for all 21 sites (Table 22), although whole-of-project NPVs are less negative than those under the no stacking scenario.
- The shortfall in preset value revenues relative to present value costs could potentially be addressed if the necessary additional net revenue flows could be generated from other credit schemes (e.g., potentially via NaturePlus™, Cassowary Credits or the Nature Repair Market). However, the levels of environmental credit pricing required to do this would far exceed any pricing that has been seen currently or historically.

For green carbon projects that aim to restore native rainforest, whole-of-project costs are dominated by the very high upfront cost the developer incurs in preparing the site, purchasing tree seedlings, planting tree seedlings and weeding for three years following planting. These costs were estimated to be around $55,000/ha. We have high confidence in this cost estimate as it was obtained through interviews with project developers who are highly experienced in woodland regeneration plantings. At our green carbon sites, developers typically incurred around 86% (under landholder cost Scenario 1) and 93% (under landholder cost Scenario 2) of total project costs.

Given that the majority of green ACCU project costs accrue to the developer, extremely high additional environmental credit payments would still be required (alongside green ACCUs) even if the costs landholders incured through reduction in land value and opportunity cost of foregone agricultural net revenues were substantially lower than those assumed in our analysis.

FULLCAM GREEN ACCUS STANDALONE DCFA RESULTS

Whole-of-project DCFA outcomes from all 21 indicative green ACCUs sites under landholder cost Scenarios 1 and 2 are reported in Table 16a (Scenario 1) and Table 16b (Scenario 2). DCFA outcomes for the landholder are reported in Table 17a (Scenario 1) and Table 17b (Scenario 2). DCFA outcomes for the developer are reported in Table 18a (scenario 1) and Table 18b (Scenario 2). Summary results for best, median and worst performing standalone green ACCUs sites are reported Tables 19a, 20a, 21a (Scenario 1) and Tables 19b, 20b and 21b (Scenario 2), respectively. The corresponding DCFA results for best (site De2), median (site So3) and worst (site Hy3) performing green ACCU sites are shown in Figures 17a, 18a and 19a (Scenario 1), and Figures 17b, 18b and 19b (Scenario 2), respectively. [#]A worked example for site De2 whole-of-project NPV outcome under landholder cost Scenario 1 is provided in Appendix 8. (N.B. As described in the Economic Methods section, the green ACCUs DCFA applies daily discounting, whereas the DCFA spreadsheet in Appendix 8 applies annual discounting, hence the results in the spreadsheet in Appendix 8 are similar, but not identical, to those reported in the results table here).

Table 16a (Landholder cost scenario 1): Summary ***whole-of-project*** *results from DCFA for standalone Green ACCUs projects at 21 indicative green ACCUs sites in Mossman district. NPV denotes net present value. Annualised equivalent NPV is calculated from NPV via Equation 2. NPV and annualised equivalent NPV to the landholder are reported for the project site and per hectare. NPV is calculated at 7% real discount rate, an 8% annual cost of capital, and a loan duration of 10 years. NPV is calculated over the full project duration of 28 years. Scenario 1: reduction in land value is assumed to be $5018/ha and opportunity cost is assumed to be $430/ha/year.*

Green ACCUs only: **Whole-of-project**												
Site	Site area (ha)	Loan ($M)	Loan per ha ($k/ha)	Developer cost share (%)	Landholder cost share (%)	Metric	Project site			Per hectare		
							ACCU price ($/ACCU)					
							40	70	100	40	70	100
De1	41.1	2.38	58	85.9	14.1	NPV ($k)	-2489	-2299	-2109	-60.6	-56	-51.4
						Annualised NPV ($k/year)	-207	-191	-175	-5	-4.7	-4.3
De2	64	3.71	57.9	85.8	14.2	NPV (k$)	-3846[#]	-3537	-3228	-60.1	-55.2	-50.4
						Annualised NPV ($k/year)	-319[#]	-294	-268	-5	-4.6	-4.2
De3	47.2	2.74	58	85.9	14.1	NPV ($k)	-2856	-2639	-2422	-60.5	-55.9	-51.3
						Annualised NPV ($k/year)	-237	-219	-201	-5	-4.6	-4.3
De4	85.9	4.97	57.9	85.8	14.2	NPV ($k)	-5211	-4847	-4482	-60.7	-56.5	-52.2
						Annualised NPV ($k/year)	-433	-403	-372	-5	-4.7	-4.3
De5	49.9	2.89	58	85.8	14.2	NPV ($k)	-3026	-2799	-2572	-60.6	-56	-51.5
						Annualised NPV ($k/year)	-251	-233	-214	-5	-4.7	-4.3
Hy1	21.4	1.24	58.2	86	14	NPV ($k)	-1305	-1202	-1098	-61.1	-56.2	-51.4
						Annualised NPV ($k/year)	-108	-100	-91	-5.1	-4.7	-4.3
Hy2	18.4	1.07	58.3	86.1	13.9	NPV ($)	-1173	-1118	-1063	-63.8	-60.8	-57.8
						Annualised NPV ($k/year)	-97	-93	-88	-5.3	-5.1	-4.8
Hy3	10.7	0.63	58.7	86.4	13.6	NPV ($k)	-699	-667	-635	-65.2	-62.2	-59.2
						Annualised NPV ($k/year)	-58	-55	-53	-5.4	-5.2	-4.9

Table 16a contd.

Green ACCUs only: Whole-of-project												
Site	Site area (ha)	Loan ($M)	Loan per ha ($k/ha)	Developer cost share (%)	Landholder cost share (%)	Metric	Project site			Per hectare		
							ACCU price ($/ACCU)					
							40	70	100	40	70	100
Ka1	35.6	2.07	58	85.9	14.1	NPV ($k)	-2222	-2102	-1981	-62.4	-59	-55.6
						Annualised NPV ($k/year)	-185	-175	-165	-5.2	-4.9	-4.6
Ka2	35.9	2.09	58	85.9	14.1	NPV ($k)	-2165	-1985	-1806	-60.2	-55.2	-50.2
						Annualised NPV ($k/year)	-180	-165	-150	-5	-4.6	-4.2
Ka3	38.3	2.22	58	85.9	14.1	NPV ($k)	-2408	-2291	-2175	-62.8	-59.8	-56.7
						Annualised NPV ($k/year)	-200	-190	-181	-5.2	-5	-4.7
Ka4	40	2.32	58	85.9	14.1	NPV ($k)	-2432	-2249	-2067	-60.7	-56.2	-51.6
						Annualised NPV ($k/year)	-202	-187	-172	-5	-4.7	-4.3
Ka5	19.8	1.15	58.3	86.1	13.9	NPV ($k)	-1219	-1131	-1043	-61.7	-57.2	-52.8
						Annualised NPV ($k/year)	-101	-94	-87	-5.1	-4.8	-4.4
So1	28.4	1.65	58.1	86	14	NPV ($k)	-1742	-1616	-1491	-61.3	-56.9	-52.4
						Annualised NPV ($k/year)	-145	-134	-124	-5.1	-4.7	-4.4
So2	53.9	3.12	57.9	85.8	14.2	NPV ($k)	-3260	-3014	-2768	-60.5	-55.9	-51.4
						Annualised NPV ($k/year)	-271	-250	-230	-5	-4.6	-4.3
So3	36.5	2.12	58	85.9	14.1	NPV ($k)	-2228	-2069	-1911	-61.1	-56.7	-52.4
						Annualised NPV ($k/year)	-185	-172	-159	-5.1	-4.7	-4.4

Table 16a contd.

Green ACCUs only: Whole-of-project												
							Project site			Per hectare		
							ACCU price ($/ACCU)					
Site	Site area (ha)	Loan ($M)	Loan per ha ($k/ha)	Developer cost share (%)	Landholder cost share (%)	Metric	40	70	100	40	70	100
Te1	38.8	2.25	58	85.9	14.1	NPV ($k)	-2341	-2153	-1965	-60.4	-55.5	-50.7
						Annualised NPV ($k/year)	-194	-179	-163	-5	-4.6	-4.2
Te2	53.3	3.09	57.9	85.8	14.2	NPV ($k)	-3233	-2995	-2756	-60.6	-56.2	-51.7
						Annualised NPV ($k/year)	-269	-249	-229	-5	-4.7	-4.3
Te3	29.5	1.71	58.1	85.9	14.1	NPV ($k)	-1811	-1685	-1559	-61.4	-57.1	-52.8
						Annualised NPV ($k/year)	-150	-140	-129	-5.1	-4.7	-4.4
Te4	27.9	1.62	58.1	86	14	NPV ($k)	-1708	-1584	-1461	-61.3	-56.8	-52.4
						Annualised NPV ($k/year)	-142	-132	-121	-5.1	-4.7	-4.4
Te5	6.7	0.4	59.3	86.7	13.3	NPV ($k)	-432	-402	-371	-64.9	-60.3	-55.7
						Annualised NPV ($k/year)	-36	-33	-31	-5.4	-5	-4.6

Table 16b (Landholder cost scenario 2): Summary whole-of-project results from DCFA for standalone Green ACCUs projects at 21 indicative green ACCUs sites in Mossman district. NPV denotes net present value. Annualised equivalent NPV is calculated from NPV via Equation 2. NPV and annualised equivalent NPV to the landholder are reported for the project site and per hectare. NPV is calculated at 7% real discount rate, an 8% annual cost of capital, and a loan duration of 10 years. NPV is calculated over the full project duration of 28 years. Scenario 2: reduction in land value is assumed to be $2509/ha and opportunity cost is assumed to be $215/ha/year.

Green ACCUs only: **Whole-of-project**												
Site	Site area (ha)	Loan ($M)	Loan per ha ($k/ha)	Developer cost share (%)	Landholder cost share (%)	Metric	Project site			Per hectare		
							ACCU price ($/ACCU)					
							40	70	100	40	70	100
De1	41.1	2.38	58	92.4	7.6	NPV ($k)	-2295	-2105	-1915	-55.9	-51.3	-46.6
						Annualised NPV ($k/year)	-191	-175	-159	-4.6	-4.3	-3.9
De2	64	3.71	57.9	92.4	7.6	NPV (k$)	-3544#	-3235	-2926	-55.3	-50.5	-45.7
						Annualised NPV ($k/year)	-294#	-269	-243	-4.6	-4.2	-3.8
De3	47.2	2.74	58	92.4	7.6	NPV ($k)	-2634	-2417	-2200	-55.8	-51.2	-46.6
						Annualised NPV ($k/year)	-219	-201	-183	-4.6	-4.3	-3.9
De4	85.9	4.97	57.9	92.3	7.7	NPV ($k)	-4806	-4442	-4077	-56	-51.7	-47.5
						Annualised NPV ($k/year)	-399	-369	-339	-4.7	-4.3	-3.9
De5	49.9	2.89	58	92.4	7.6	NPV ($k)	-2790	-2563	-2336	-55.9	-51.3	-46.8
						Annualised NPV ($k/year)	-232	-213	-194	-4.6	-4.3	-3.9
Hy1	21.4	1.24	58.2	92.5	7.5	NPV ($k)	-1205	-1101	-998	-56.4	-51.5	-46.7
						Annualised NPV ($k/year)	-100	-91	-83	-4.7	-4.3	-3.9
Hy2	18.4	1.07	58.3	92.5	7.5	NPV ($)	-1086	-1031	-976	-59.1	-56.1	-53.1
						Annualised NPV ($k/year)	-90	-86	-81	-4.9	-4.7	-4.4
Hy3	10.7	0.63	58.7	92.7	7.3	NPV ($k)	-648	-617	-585	-60.4	-57.5	-54.5
						Annualised NPV ($k/year)	-54	-51	-49	-5	-4.8	-4.5

Table 16b contd.

Green ACCUs only: Whole-of-project												
Site	Site area (ha)	Loan ($M)	Loan per ha ($k/ha)	Developer cost share (%)	Landholder cost share (%)	Metric	Project site			Per hectare		
							ACCU price ($/ACCU)					
							40	70	100	40	70	100
Ka1	35.6	2.07	58	92.4	7.6	NPV ($k)	-2054	-1934	-1814	-57.7	-54.3	-50.9
						Annualised NPV ($k/year)	-171	-161	-151	-4.8	-4.5	-4.2
Ka2	35.9	2.09	58	92.4	7.6	NPV ($k)	-1995	-1816	-1636	-55.5	-50.5	-45.5
						Annualised NPV ($k/year)	-166	-151	-136	-4.6	-4.2	-3.8
Ka3	38.3	2.22	58	92.4	7.6	NPV ($k)	-2227	-2110	-1994	-58.1	-55	-52
						Annualised NPV ($k/year)	-185	-175	-166	-4.8	-4.6	-4.3
Ka4	40	2.32	58	92.4	7.6	NPV ($k)	-2243	-2061	-1878	-56	-51.5	-46.9
						Annualised NPV ($k/year)	-186	-171	-156	-4.7	-4.3	-3.9
Ka5	19.8	1.15	58.3	92.5	7.5	NPV ($k)	-1126	-1038	-950	-57	-52.5	-48.1
						Annualised NPV ($k/year)	-94	-86	-79	-4.7	-4.4	-4
So1	28.4	1.65	58.1	92.4	7.6	NPV ($k)	-1608	-1482	-1357	-56.5	-52.1	-47.7
						Annualised NPV ($k/year)	-134	-123	-113	-4.7	-4.3	-4
So2	53.9	3.12	57.9	92.4	7.6	NPV ($k)	-3006	-2760	-2514	-55.8	-51.2	-46.7
						Annualised NPV ($k/year)	-250	-229	-209	-4.6	-4.3	-3.9
So3	36.5	2.12	58	92.4	7.6	NPV ($k)	-2056	-1897	-1739	-56.4	-52	-47.7
						Annualised NPV ($k/year)	-171	-158	-144	-4.7	-4.3	-4

Table 16b contd.

Green ACCUs only: Whole-of-project												
							Project site			Per hectare		
							ACCU price ($/ACCU)					
Site	Site area (ha)	Loan ($M)	Loan per ha ($k/ha)	Developer cost share (%)	Landholder cost share (%)	Metric	40	70	100	40	70	100
Te1	38.8	2.25	58	92.4	7.6	NPV ($k)	-2158	-1970	-1782	-55.7	-50.8	-46
						Annualised NPV ($k/year)	-179	-164	-148	-4.6	-4.2	-3.8
Te2	53.3	3.09	57.9	92.4	7.6	NPV ($k)	-2981	-2743	-2505	-55.9	-51.5	-47
						Annualised NPV ($k/year)	-248	-228	-208	-4.6	-4.3	-3.9
Te3	29.5	1.71	58.1	92.4	7.6	NPV ($k)	-1672	-1546	-1419	-56.7	-52.4	-48.1
						Annualised NPV ($k/year)	-139	-128	-118	-4.7	-4.4	-4
Te4	27.9	1.62	58.1	92.4	7.6	NPV ($k)	-1576	-1453	-1329	-56.5	-52.1	-47.7
						Annualised NPV ($k/year)	-131	-121	-110	-4.7	-4.3	-4
Te5	6.7	0.4	59.3	92.9	7.1	NPV ($k)	-401	-370	-340	-60.2	-55.6	-51
						Annualised NPV ($k/year)	-33	-31	-28	-5	-4.6	-4.2

Table 17a (Landholder cost scenario 1): Landholder outcomes from DCFAs for standalone Green ACCUs projects at 21 indicative green ACCUs sites in Mossman district. At each project site the NPV accruing to the landholder is reported as NPV over the full project duration and as annualised equivalent NPV (calculated from NPV via Equation 2). NPV and annualised equivalent NPV to the landholder are reported for the project site and per hectare. NPV denotes net present value. NPV is calculated at 7% real discount rate, an 8% annual cost of capital, and a loan duration of 10 years evaluated over the full project duration of 28 years. Scenario 1: reduction in land value is $5018/ha and opportunity cost is $430/ha/year.

Green ACCUs only: Landholder outcomes							
		Project site			Per hectare		
		ACCU price ($/ACCU)					
Site	Metric	40	70	100	40	70	100
De1	NPV ($k)	-352	-325	-298	-8.6	-7.9	-7.3
	Annualised NPV ($k/year)	-29	-27	-25	-0.71	-0.66	-0.6
De2	NPV ($k)	-546	-502	-458	-8.5	-7.8	-7.1
	Annualised NPV ($k/year)	-45	-42	-38	-0.71	-0.65	-0.59
De3	NPV ($k)	-404	-373	-343	-8.6	-7.9	-7.3
	Annualised NPV ($k/year)	-34	-31	-28	-0.71	-0.66	-0.6
De4	NPV ($k)	-741	-689	-637	-8.6	-8	-7.4
	Annualised NPV ($k/year)	-62	-57	-53	-0.72	-0.67	-0.62
De5	NPV ($k)	-428	-396	-364	-8.6	-7.9	-7.3
	Annualised NPV ($k/year)	-36	-33	-30	-0.71	-0.66	-0.61
Hy1	NPV ($k)	-182	-168	-153	-8.5	-7.9	-7.2
	Annualised NPV ($k/year)	-15	-14	-13	-0.71	-0.65	-0.6
Hy2	NPV ($k)	-163	-156	-148	-8.9	-8.5	-8
	Annualised NPV ($k/year)	-14	-13	-12	-0.74	-0.7	-0.67
Hy3	NPV ($k)	-95	-91	-87	-8.9	-8.5	-8.1
	Annualised NPV ($k/year)	-8	-8	-7	-0.74	-0.71	-0.67
Ka1	NPV ($k)	-313	-296	-279	-8.8	-8.3	-7.8
	Annualised NPV ($k/year)	-26	-25	-23	-0.73	-0.69	-0.65
Ka2	NPV ($k)	-305	-280	-255	-8.5	-7.8	-7.1
	Annualised NPV ($k/year)	-25	-23	-21	-0.71	-0.65	-0.59
Ka3	NPV ($k)	-340	-323	-307	-8.9	-8.4	-8
	Annualised NPV ($k/year)	-28	-27	-25	-0.74	-0.7	-0.66
Ka4	NPV ($k)	-343	-318	-292	-8.6	-7.9	-7.3
	Annualised NPV ($k/year)	-29	-26	-24	-0.71	-0.66	-0.61
Ka5	NPV ($k)	-170	-158	-145	-8.6	-8	-7.4
	Annualised NPV ($k/year)	-352	-325	-298	-8.6	-7.9	-7.3

Table 17a contd.

Green ACCUs only: Landholder outcomes							
		Project site			Per hectare		
		ACCU price ($/ACCU)					
Site	Metric	40	70	100	40	70	100
So1	NPV ($k)	-245	-227	-209	-8.6	-8	-7.4
	Annualised NPV ($k/year)	-20	-19	-17	-0.71	-0.66	-0.61
So2	NPV ($k)	-462	-427	-392	-8.6	-7.9	-7.3
	Annualised NPV ($k/year)	-38	-35	-33	-0.71	-0.66	-0.6
So3	NPV ($k)	-314	-292	-269	-8.6	-8	-7.4
	Annualised NPV ($k/year)	-26	-24	-22	-0.72	-0.66	-0.61
Te1	NPV ($k)	-330	-304	-277	-8.5	-7.8	-7.2
	Annualised NPV ($k/year)	-27	-25	-23	-0.71	-0.65	-0.59
Te2	NPV ($k)	-458	-424	-390	-8.6	-8	-7.3
	Annualised NPV ($k/year)	-38	-35	-32	-0.71	-0.66	-0.61
Te3	NPV ($k)	-255	-237	-219	-8.6	-8	-7.4
	Annualised NPV ($k/year)	-21	-20	-18	-0.72	-0.67	-0.62
Te4	NPV ($k)	-240	-222	-205	-8.6	-8	-7.4
	Annualised NPV ($k/year)	-20	-18	-17	-0.71	-0.66	-0.61
Te5	NPV ($k)	-57	-53	-49	-8.6	-8	-7.4
	Annualised NPV ($k/year)	-5	-4	-4	-0.72	-0.67	-0.61

Table 17b (Landholder cost scenario 2): Landholder outcomes from DCFAs for standalone Green ACCUs projects at 21 indicative green ACCUs sites in Mossman district. At each project site the NPV accruing to the landholder is reported as NPV over the full project duration and as annualised equivalent NPV (calculated from NPV via Equation 2). NPV and annualised equivalent NPV to the landholder are reported for the project site and per hectare. NPV denotes net present value. NPV is calculated at 7% real discount rate, an 8% annual cost of capital, and a loan duration of 10 years evaluated over the full project duration of 28 years. Scenario 2: reduction in land value is $2509/ha and opportunity cost is $215/ha/year.

Green ACCUs only: Landholder outcomes							
		Project site			Per hectare		
		ACCU price ($/ACCU)					
Site	Metric	40	70	100	40	70	100
De1	NPV ($k)	-174	-160	-146	-4.2	-3.9	-3.5
	Annualised NPV ($k/year)	-14	-13	-12	-0.35	-0.32	-0.29
De2	NPV ($k)	-271	-247	-223	-4.2	-3.9	-3.5
	Annualised NPV ($k/year)	-22	-21	-19	-0.35	-0.32	-0.29
De3	NPV ($k)	-200	-184	-167	-4.2	-3.9	-3.5
	Annualised NPV ($k/year)	-17	-15	-14	-0.35	-0.32	-0.29
De4	NPV ($k)	-368	-340	-312	-4.3	-4	-3.6
	Annualised NPV ($k/year)	-31	-28	-26	-0.36	-0.33	-0.30
De5	NPV ($k)	-212	-195	-178	-4.3	-3.9	-3.6
	Annualised NPV ($k/year)	-18	-16	-15	-0.35	-0.32	-0.30
Hy1	NPV ($k)	-90	-83	-75	-4.2	-3.9	-3.5
	Annualised NPV ($k/year)	-8	-7	-6	-0.35	-0.32	-0.29
Hy2	NPV ($k)	-81	-77	-73	-4.4	-4.2	-4
	Annualised NPV ($k/year)	-7	-6	-6	-0.37	-0.35	-0.33
Hy3	NPV ($k)	-47	-45	-43	-4.4	-4.2	-4
	Annualised NPV ($k/year)	-4	-4	-4	-0.37	-0.35	-0.33
Ka1	NPV ($k)	-156	-147	-138	-4.4	-4.1	-3.9
	Annualised NPV ($k/year)	-13	-12	-11	-0.36	-0.34	-0.32
Ka2	NPV ($k)	-151	-138	-124	-4.2	-3.8	-3.5
	Annualised NPV ($k/year)	-13	-11	-10	-0.35	-0.32	-0.29
Ka3	NPV ($k)	-169	-160	-151	-4.4	-4.2	-3.9
	Annualised NPV ($k/year)	-14	-13	-13	-0.37	-0.35	-0.33
Ka4	NPV ($k)	-170	-157	-143	-4.3	-3.9	-3.6
	Annualised NPV ($k/year)	-14	-13	-12	-0.35	-0.32	-0.30
Ka5	NPV ($k)	-84	-78	-71	-4.3	-3.9	-3.6
	Annualised NPV ($k/year)	-7	-6	-6	-0.35	-0.33	-0.30

Table 17b contd.

Green ACCUs only: Landholder outcomes							
		Project site			Per hectare		
		ACCU price ($/ACCU)					
Site	Metric	40	70	100	40	70	100
So1	NPV ($k)	-121	-112	-102	-4.3	-3.9	-3.6
	Annualised NPV ($k/year)	-10	-9	-9	-0.35	-0.33	-0.30
So2	NPV ($k)	-229	-210	-192	-4.3	-3.9	-3.6
	Annualised NPV ($k/year)	-19	-17	-16	-0.35	-0.32	-0.30
So3	NPV ($k)	-156	-144	-132	-4.3	-3.9	-3.6
	Annualised NPV ($k/year)	-13	-12	-11	-0.36	-0.33	-0.30
Te1	NPV ($k)	-164	-150	-135	-4.2	-3.9	-3.5
	Annualised NPV ($k/year)	-14	-12	-11	-0.35	-0.32	-0.29
Te2	NPV ($k)	-227	-209	-191	-4.3	-3.9	-3.6
	Annualised NPV ($k/year)	-19	-17	-16	-0.35	-0.33	-0.30
Te3	NPV ($k)	-126	-117	-107	-4.3	-4	-3.6
	Annualised NPV ($k/year)	-10	-10	-9	-0.36	-0.33	-0.30
Te4	NPV ($k)	-119	-110	-100	-4.3	-3.9	-3.6
	Annualised NPV ($k/year)	-10	-9	-8	-0.35	-0.33	-0.3
Te5	NPV ($k)	-29	-26	-24	-4.3	-4	-3.6
	Annualised NPV ($k/year)	-2	-2	-2	-0.36	-0.33	-0.30

Table 18a (Landholder cost scenario 1): Developer outcomes from DCFAs for standalone Green ACCUs projects at 21 indicative green ACCUs sites in Mossman district. Outcomes for the developer at each project site are reported for the project site and per hectare. NPV denotes net present value. Rate of return is calculated by dividing the developer's NPV by the total PV of developer's costs. PV and NPV are calculated at 7% real discount rate, an 8% annual cost of cap, and a loan duration of 10 years. NPV is calculated over the full project duration of 28 years. Scenario 1: reduction in land value is $5018/ha and opportunity cost id $430/ha/year.

Green ACCUs only: Developer outcomes							
		Project site			Per hectare		
		ACCU price ($/ACCU)					
Site	Metric	40	70	100	40	70	100
De1	NPV ($k)	-2137	-1974	-1811	-52.1	-48.1	-44.1
	Rate of Return (%)	-	-	-	-	-	-
De2	NPV ($k)	-3300	-3035	-2770	-51.5	-47.4	-43.2
	Rate of Return (%)	-	-	-	-	-	-
De3	NPV ($k)	-2452	-2266	-2079	-52	-48	-44.1
	Rate of Return (%)	-	-	-	-	-	-
De4	NPV ($k)	-4471	-4158	-3845	-52.1	-48.4	-44.8
	Rate of Return (%)	-	-	-	-	-	-
De5	NPV ($k)	-2597	-2403	-2208	-52	-48.1	-44.2
	Rate of Return (%)	-	-	-	-	-	-
Hy1	NPV ($k)	-1123	-1034	-945	-52.6	-48.4	-44.2
	Rate of Return (%)	-	-	-	-	-	-
Hy2	NPV ($k)	-1010	-962	-915	-54.9	-52.4	-49.8
	Rate of Return (%)	-	-	-	-	-	-
Hy3	NPV ($k)	-604	-576	-549	-56.3	-53.7	-51.1
	Rate of Return (%)	-	-	-	-	-	-
Ka1	NPV ($k)	-1909	-1806	-1702	-53.6	-50.7	-47.8
	Rate of Return (%)	-	-	-	-	-	-
Ka2	NPV ($k)	-1860	-1705	-1551	-51.7	-47.5	-43.2
	Rate of Return (%)	-	-	-	-	-	-
Ka3	NPV ($k)	-2068	-1968	-1868	-53.9	-51.3	-48.7
	Rate of Return (%)	-	-	-	-	-	-
Ka4	NPV ($k)	-2088	-1932	-1775	-52.2	-48.2	-44.3
	Rate of Return (%)	-	-	-	-	-	-
Ka5	NPV ($k)	-1049	-973	-897	-53.1	-49.3	-45.4
	Rate of Return (%)	-	-	-	-	-	-

Table 18a contd.

Green ACCUs only: Developer outcomes							
		Project site			Per hectare		
		ACCU price ($/ACCU)					
Site	Metric	40	70	100	40	70	100
So1	NPV ($k)	-1497	-1389	-1281	-52.7	-48.9	-45.1
	Rate of Return (%)	-	-	-	-	-	-
So2	NPV ($k)	-2799	-2587	-2376	-51.9	-48	-44.1
	Rate of Return (%)	-	-	-	-	-	-
So3	NPV ($k)	-1914	-1778	-1641	-52.5	-48.7	-45
	Rate of Return (%)	-	-	-	-	-	-
Te1	NPV ($k)	-2010	-1849	-1688	-51.9	-47.7	-43.5
	Rate of Return (%)	-	-	-	-	-	-
Te2	NPV ($k)	-2775	-2570	-2366	-52.1	-48.2	-44.4
	Rate of Return (%)	-	-	-	-	-	-
Te3	NPV ($k)	-1557	-1448	-1339	-52.8	-49.1	-45.4
	Rate of Return (%)	-	-	-	-	-	-
Te4	NPV ($k)	-1468	-1362	-1255	-52.7	-48.8	-45
	Rate of Return (%)	-	-	-	-	-	-
Te5	NPV ($k)	-375	-348	-322	-56.3	-52.3	-48.3
	Rate of Return (%)	-	-	-	-	-	-

Table 18b (Landholder cost scenario 2): Developer outcomes from DCFAs for standalone Green ACCUs projects at 21 indicative green ACCUs sites in Mossman district. Outcomes for the developer at each project site are reported for the project site and per hectare. NPV denotes net present value. Rate of return is calculated by dividing the developer's NPV by the total PV of developer's costs. PV and NPV are calculated at 7% real discount rate, an 8% annual cost of cap, and a loan duration of 10 years. NPV is calculated over the full project duration of 28 years. Scenario 2: reduction in land value is $2509/ha and opportunity cost id $215/ha/year.

Green ACCUs only: Developer outcomes							
		Project site			Per hectare		
		ACCU price ($/ACCU)					
Site	Metric	40	70	100	40	70	100
De1	NPV ($k)	-2121	-1945	-1770	-51.7	-47.4	-43.1
	Rate of Return (%)	-	-	-	-	-	-
De2	NPV ($k)	-3273	-2988	-2702	-51.1	-46.7	-42.2
	Rate of Return (%)	-	-	-	-	-	-
De3	NPV ($k)	-2433	-2233	-2032	-51.6	-47.3	-43.1
	Rate of Return (%)	-	-	-	-	-	-
De4	NPV ($k)	-4439	-4102	-3765	-51.7	-47.8	-43.9
	Rate of Return (%)	-	-	-	-	-	-
De5	NPV ($k)	-2578	-2368	-2158	-51.6	-47.4	-43.2
	Rate of Return (%)	-	-	-	-	-	-
Hy1	NPV ($k)	-1114	-1019	-923	-52.1	-47.7	-43.2
	Rate of Return (%)	-	-	-	-	-	-
Hy2	NPV ($k)	-1005	-954	-903	-54.7	-51.9	-49.2
	Rate of Return (%)	-	-	-	-	-	-
Hy3	NPV ($k)	-601	-572	-542	-56	-53.3	-50.5
	Rate of Return (%)	-	-	-	-	-	-
Ka1	NPV ($k)	-1899	-1787	-1676	-53.3	-50.2	-47.1
	Rate of Return (%)	-	-	-	-	-	-
Ka2	NPV ($k)	-1844	-1678	-1512	-51.3	-46.7	-42.1
	Rate of Return (%)	-	-	-	-	-	-
Ka3	NPV ($k)	-2058	-1950	-1843	-53.7	-50.9	-48.1
	Rate of Return (%)	-	-	-	-	-	-
Ka4	NPV ($k)	-2073	-1904	-1736	-51.8	-47.6	-43.3
	Rate of Return (%)	-	-	-	-	-	-
Ka5	NPV ($k)	-1042	-960	-878	-52.7	-48.6	-44.5
	Rate of Return (%)	-	-	-	-	-	-

Table 18b contd.

Green ACCUs only: Developer outcomes							
		Project site			Per hectare		
		ACCU price ($/ACCU)					
Site	Metric	40	70	100	40	70	100
So1	NPV ($k)	-1486	-1370	-1254	-52.3	-48.2	-44.1
	Rate of Return (%)	-	-	-	-	-	-
So2	NPV ($k)	-2777	-2550	-2323	-51.5	-47.3	-43.1
	Rate of Return (%)	-	-	-	-	-	-
So3	NPV ($k)	-1900	-1753	-1607	-52.1	-48.1	-44.1
	Rate of Return (%)	-	-	-	-	-	-
Te1	NPV ($k)	-1994	-1820	-1647	-51.4	-47	-42.5
	Rate of Return (%)	-	-	-	-	-	-
Te2	NPV ($k)	-2754	-2534	-2314	-51.7	-47.5	-43.4
	Rate of Return (%)	-	-	-	-	-	-
Te3	NPV ($k)	-1546	-1429	-1312	-52.4	-48.4	-44.5
	Rate of Return (%)	-	-	-	-	-	-
Te4	NPV ($k)	-1457	-1343	-1229	-52.3	-48.2	-44.1
	Rate of Return (%)	-	-	-	-	-	-
Te5	NPV ($k)	-372	-344	-315	-55.9	-51.6	-47.4
	Rate of Return (%)	-	-	-	-	-	-

*Table 19a (Landholder cost scenario 1): Summary results from DCFA for **best** performing green ACCUs site **De2** (see Table 9) under a 25-year permanence period. Reported for the project as a whole, for the landholder and for the developer. DCFA outcomes are reported for the project area and per hectare. PV denotes present value. NPV denotes net present value. PV and NPV are calculated at 7% real discount rate, an 8% annual cost of cap, and a loan duration of 10 years. NPV is calculated over the full project duration of 28 years. Scenario 1: reduction in land value is $5018/ha and opportunity cost is $430/ha/year.*

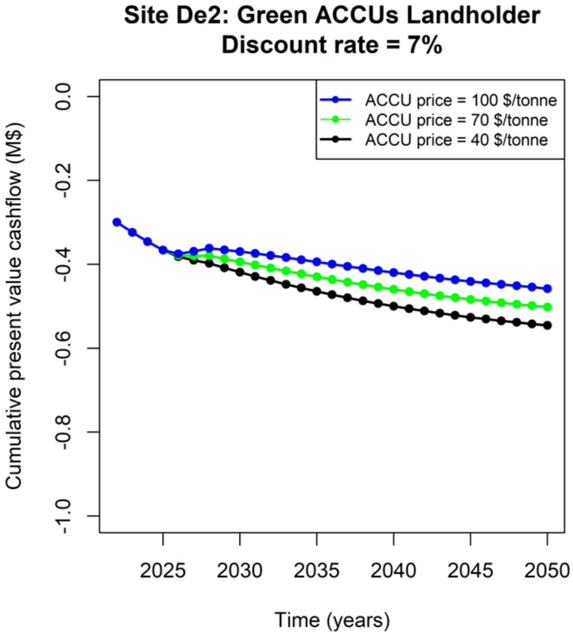
** Upfront loan covers the following costs incurred by the developer: site preparation for planting, detailed planting design, sourcing planting stock, tree planting, development approval, annual weeding at the site for three years following tree planting, and 5% contingency. The loan is repaid, with interest (assuming the cost of capital is 8% per annum), via equal annual instalments over a 10-year term.*

Green ACCUs only, best performing site De2						
Metric	**Site area (64ha)**			**Per hectare**		
Upfront loan*	3.71 $ million			57.9 $k		
Developer's share of PV project cost	85.8			-		
Landholder's share of PV project cost	14.2			-		
Results for whole-of-project						
ACCU price ($/ACCU)	*40*	*70*	*100*	*40*	*70*	*100*
NPV ($k)	-3846	-3537	-3228	-60.1	-55.2	-50.4
Annualised equivalent NPV ($k/year)	-319	-294	-268	-5	-4.6	-4.2
Internal rate of return (%)	-	-	-	-	-	-
Results for landholder						
ACCU price ($/ACCU)	*40*	*70*	*100*	*40*	*70*	*100*
NPV ($k)	-546	-502	-458	-8.5	-7.8	-7.1
Annualised equivalent NPV ($k/year)	-45	-42	-38	-0.71	-0.65	-0.59
Cumulative PV cash flow ($k)	See Figure 19a(a)			See Figure 19a(b)		
Results for developer						
ACCU price ($/ACCU)	*40*	*70*	*100*	*40*	*70*	*100*
NPV ($k)	-3300	-3035	-2770	-51.5	-47.4	-43.2
Rate of return (%)	-	-	-	-	-	-
Cumulative PV cash flow ($k)	See Figure 19a(c)			See Figure 19a(d)		

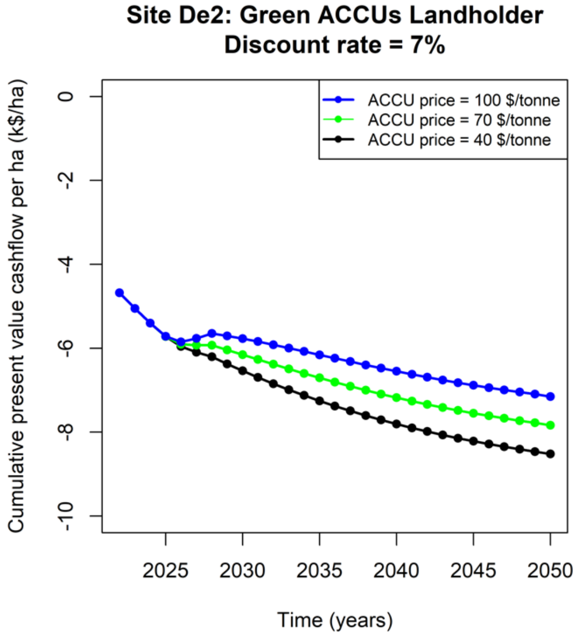
Table 19b (Landholder cost scenario 2): Summary results from DCFA for best performing green ACCUs site De2 (see Table 9) under a 25-year permanence period. Reported for the project as a whole, for the landholder and for the developer. DCFA outcomes are reported for the project area and per hectare. PV denotes present value. NPV denotes net present value. PV and NPV are calculated at 7% real discount rate, an 8% annual cost of cap, and a loan duration of 10 years. NPV is calculated over the full project duration of 28 years. Scenario 2: reduction in land value is $2509/ha and opportunity cost is $215/ha/year.

** Upfront loan covers the following costs incurred by the developer: site preparation for planting, detailed planting design, sourcing planting stock, tree planting, development approval, annual weeding at the site for three years following tree planting, and 5% contingency. The loan is repaid, with interest (assuming the cost of capital is 8% per annum), via equal annual instalments over a 10-year term.*

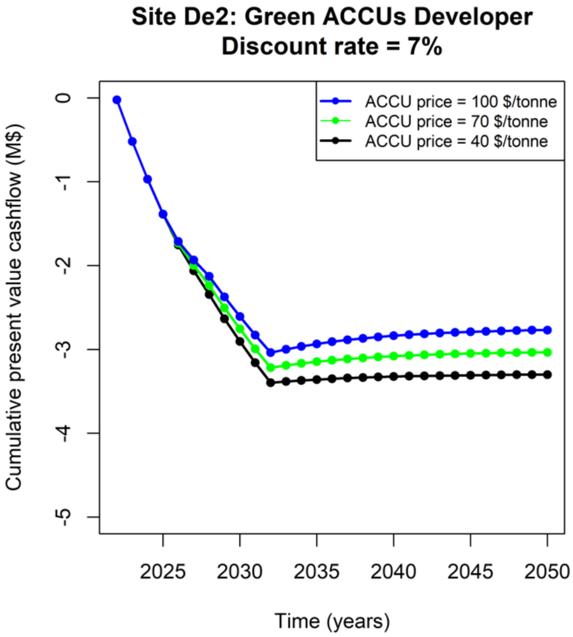
Green ACCUs only, best performing site De2						
Metric	**Site area (64ha)**			**Per hectare**		
Upfront loan*	3.71 $ million			57.9 $k		
Developer's share of PV project cost	94.4			-		
Landholder's share of PV project cost	7.6			-		
Results for whole-of-project						
ACCU price ($/ACCU)	*40*	*70*	*100*	*40*	*70*	*100*
NPV ($k)	-3544	-3235	-2926	-55.3	-50.5	-45.7
Annualised equivalent NPV ($k/year)	-294	-269	-243	-4.6	-4.2	-3.8
Internal rate of return (%)	-	-	-	-	-	-
Results for landholder						
ACCU price ($/ACCU)	*40*	*70*	*100*	*40*	*70*	*100*
NPV ($k)	-271	-247	-223	-4.2	-3.9	-3.5
Annualised equivalent NPV ($k/year)	-22	-21	-19	-0.35	-0.32	-0.29
Cumulative PV cash flow ($k)	See Figure 19b(a)			See Figure 19b(b)		
Results for developer						
ACCU price ($/ACCU)	*40*	*70*	*100*	*40*	*70*	*100*
NPV ($k)	-3273	-2988	-2702	-51.1	-46.7	-42.2
Rate of return (%)	-	-	-	-	-	-
Cumulative PV cash flow ($k)	See Figure 19b(c)			See Figure 19b(d)		



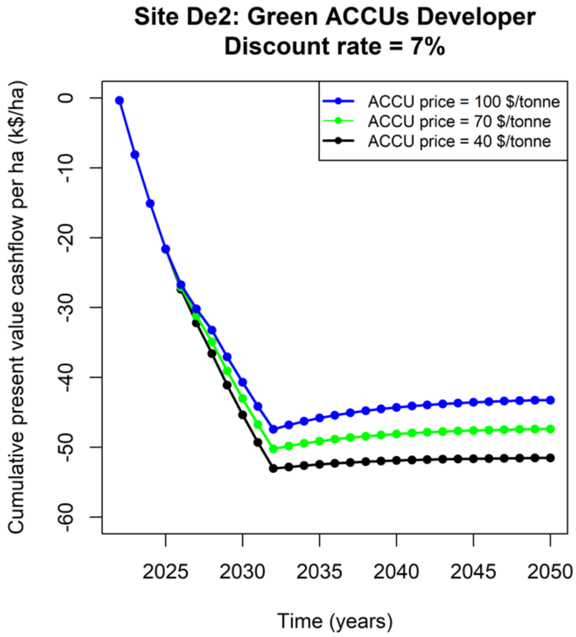
(a)



(b)



(c)



(d)

Figure 19a (Landholder cost scenario 1): DCFA results for best performing stand-alone green ACCUs site ***De2*** *showing (a) cumulative present value cashflow for the landholder (for the site as a whole) (b), cumulative present value cashflow for the landholder (per site hectare) (c), cumulative present value cashflow for the developer (for the site as a whole), and (d) cumulative present value cashflow for the developer (per site hectare). All results reported for a 25-year permanence period, a 7% real discount rate, an 8% annual cost of capital, and a 10-year loan term. Scenario 1: reduction in land value is $5018/ha and opportunity cost is $430/ha/year.*

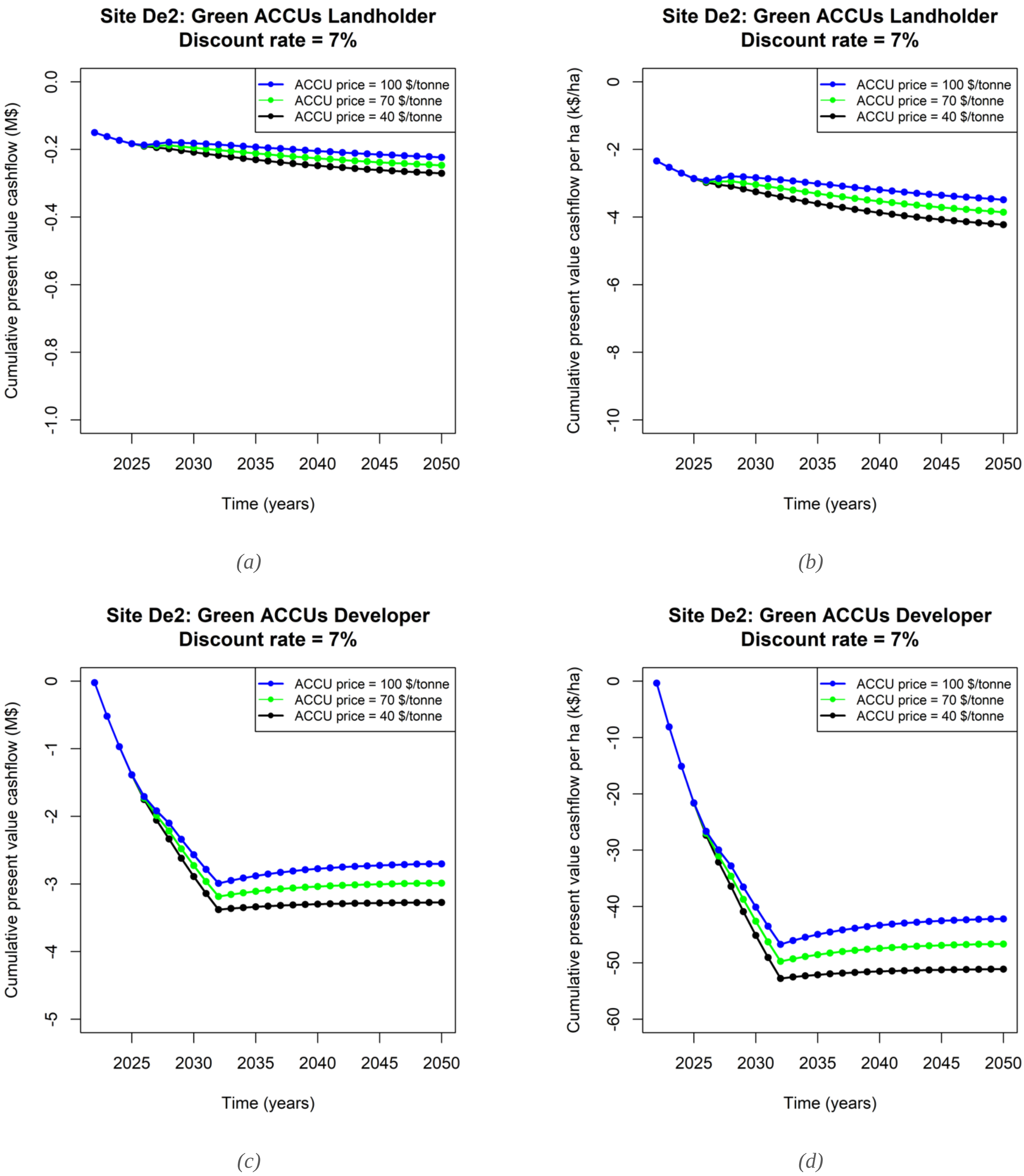


Figure 19b (Landholder cost scenario 2): DCFA results for best performing stand-alone green ACCUs site ***De2*** *showing (a) cumulative present value cashflow for the landholder (for the site as a whole) (b), cumulative present value cashflow for the landholder (per site hectare) (c), cumulative present value cashflow for the developer (for the site as a whole), and (d) cumulative present value cashflow for the developer (per site hectare). All results reported for a 25-year permanence period, a 7% real discount rate, an 8% annual cost of capital, and a 10-year loan term. Scenario 2: reduction in land value is $2509/ha and opportunity cost is $215/ha/year.*

*Table 20a (Landholder cost scenario 1): Summary results from DCFA for **median** performing green ACCUs site **So3** (see Table 9) under a 25-year permanence period. Reported for the project as a whole, for the landholder and for the developer. DCFA outcomes are reported for the full site area and per hectare. PV denotes present value. NPV denotes net present value. PV and NPV are calculated at 7% real discount rate, an 8% annual cost of cap, and a loan duration of 10 years. NPV is calculated over the full project duration of 28 years. Scenario 1: reduction in land value is $5018/ha and opportunity cost is $430/ha/year.*

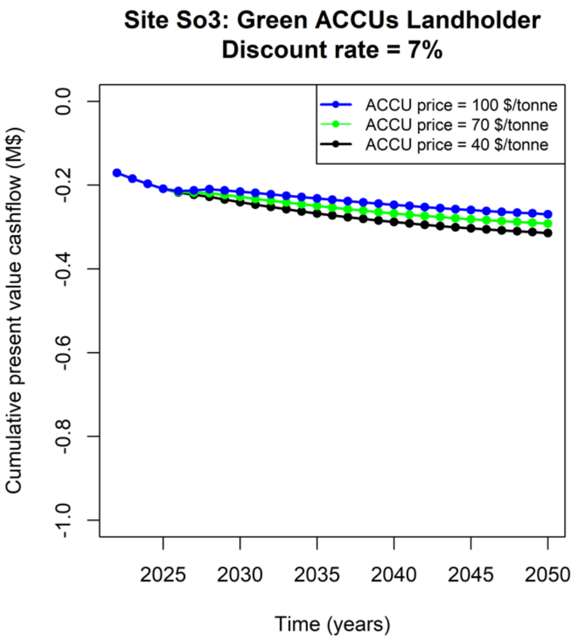
** Upfront loan covers the following costs incurred by the developer: site preparation for planting, detailed planting design, sourcing planting stock, tree planting, development approval, annual weeding at the site for three years following tree planting, and 5% contingency. The loan is repaid, with interest (assuming the cost of capital is 8% per annum), via equal annual instalments over a 10-year term.*

Green ACCUs only, median performing site So3						
Metric	**Site area (36.5ha)**			**Per hectare**		
Upfront loan*	2.12 $ million			58 $k		
Developer's share of PV project cost	85.9			-		
Landholder's share of PV project cost	14.1			-		
Results for whole-of-project						
ACCU price ($/ACCU)	*40*	*70*	*100*	*40*	*70*	*100*
NPV ($k)	-2228	-2069	-1911	-61.1	-56.7	-52.4
Annualised equivalent NPV ($k/year)	-185	-172	-159	-5.1	-4.7	-4.4
Internal rate of return (%)	-	-	-	-	-	-
Results for landholder						
ACCU price ($/ACCU)	*40*	*70*	*100*	*40*	*70*	*100*
NPV ($k)	-314	-292	-269	-8.6	-8	-7.4
Annualised equivalent NPV ($k/year)	-26	-24	-22	-0.72	-0.66	-0.61
Cumulative PV cash flow ($k)	See Figure 20a(a)			See Figure 20a(b)		
Results for developer						
ACCU price ($/ACCU)	*40*	*70*	*100*	*40*	*70*	*100*
NPV ($k)	-1914	-1778	-1641	-52.5	-48.7	-45
Rate of return (%)	-	-	-	-	-	-
Cumulative PV cash flow ($k)	See Figure 20a(c)			See Figure 20a(d)		

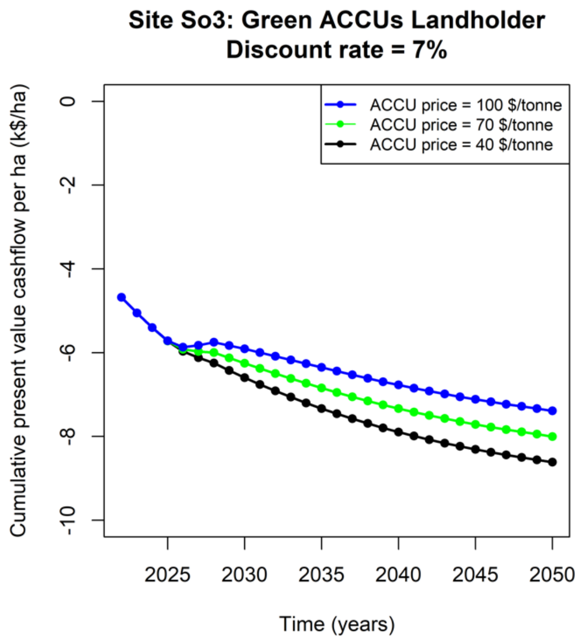
*Table 20b (Landholder cost scenario 2): Summary results from DCFA for **median** performing green ACCUs site site **So3** (see Table 9) under a 25-year permanence period. Reported for the project as a whole, for the landholder and for the developer. DCFA outcomes are reported for the full site area and per hectare. PV denotes present value. NPV denotes net present value. PV and NPV are calculated at 7% real discount rate, an 8% annual cost of cap, and a loan duration of 10 years. NPV is calculated over the full project duration of 28 years. Scenario 2: reduction in land value is $2509/ha and opportunity cost is $215/ha/year.*

** Upfront loan covers the following costs incurred by the developer: site preparation for planting, detailed planting design, sourcing planting stock, tree planting, development approval, annual weeding at the site for three years following tree planting, and 5% contingency. The loan is repaid, with interest (assuming the cost of capital is 8% per annum), via equal annual instalments over a 10-year term.*

Green ACCUs only, median performing site So3						
Metric	**Site area (36.5ha)**			**Per hectare**		
Upfront loan*	2.12 $ million			58 $k		
Developer's share of PV project cost	92.4			-		
Landholder's share of PV project cost	7.6			-		
Results for whole-of-project						
ACCU price ($/ACCU)	*40*	*70*	*100*	*40*	*70*	*100*
NPV ($k)	-2056	-1897	-1739	-56.4	-52	-47.7
Annualised equivalent NPV ($k/year)	-171	-158	-144	-4.7	-4.3	-4
Internal rate of return (%)	-	-	-	-	-	-
Results for landholder						
ACCU price ($/ACCU)	*40*	*70*	*100*	*40*	*70*	*100*
NPV ($k)	-156	-144	-132	-4.3	-3.9	-3.6
Annualised equivalent NPV ($k/year)	-13	-12	-11	-0.36	-0.33	-0.30
Cumulative PV cash flow ($k)	See Figure 20b(a)			See Figure 20b(b)		
Results for developer						
ACCU price ($/ACCU)	*40*	*70*	*100*	*40*	*70*	*100*
NPV ($k)	-1900	-1753	-1607	-52.1	-48.1	-44.1
Rate of return (%)	-	-	-	-	-	-
Cumulative PV cash flow ($k)	See Figure 20b(c)			See Figure 20b(d)		



(a)



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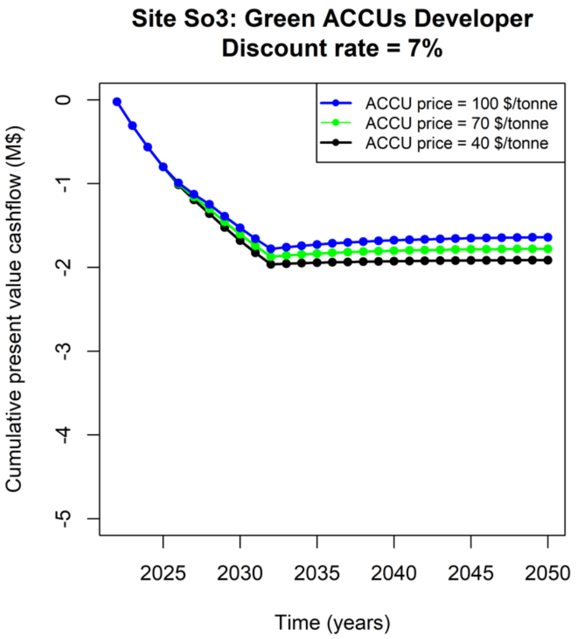

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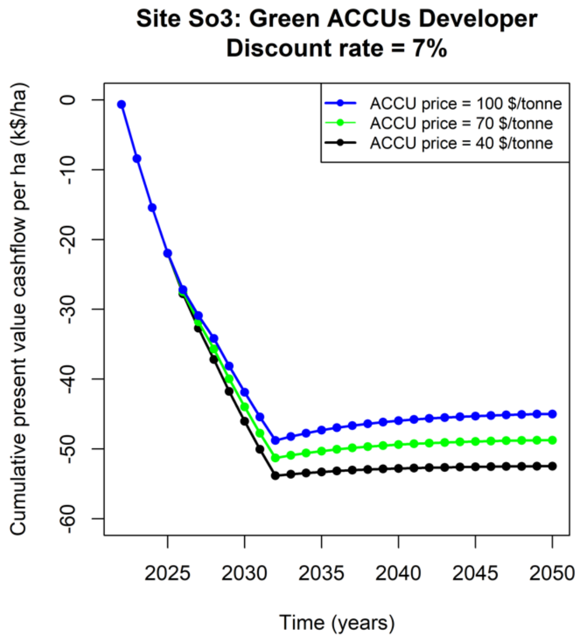
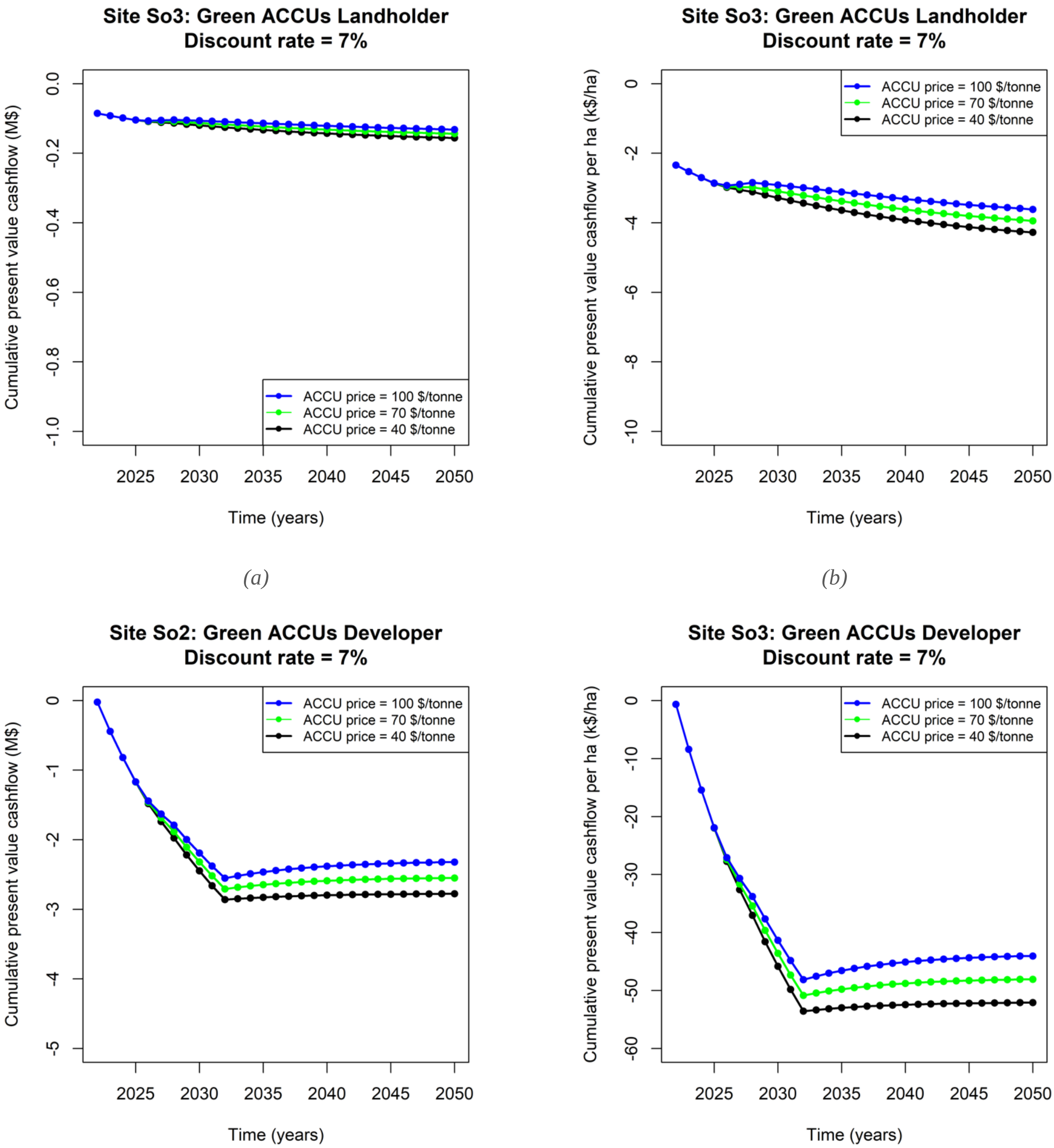


(d)

Figure 20a (Landholder scanerio 1): DCFA results for ***median*** *performing green ACCUs site* ***So3*** *showing (a) cumulative present value cashflow for the landholder (for the site as a whole) (b), cumulative present value cashflow for the landholder (per site hectare) (c) cumulative present value cashflow for the developer (for the site as a whole), and (d) cumulative present value cashflow for the developer (per site hectare). All results reported for a 25-year permanence period, a 7% real discount rate, an 8% annual cost of capital, and a 10-year loan term. Scenario 1: reduction in land value is $5018/ha and opportunity cost is $430/ha/year.*



(c) (d)

*Figure 20b (Landholder scanerio 2): DCFA results for **median** performing green ACCUs site **So3** showing (a) cumulative present value cashflow for the landholder (for the site as a whole) (b), cumulative present value cashflow for the landholder (per site hectare) (c) cumulative present value cashflow for the developer (for the site as a whole), and (d) cumulative present value cashflow for the developer (per site hectare). All results reported for a 25-year permanence period, a 7% real discount rate, an 8% annual cost of capital, and a 10-year loan term. Scenario 1: reduction in land value is $2509/ha and opportunity cost is $215/ha/year.*

Table 21a (Landholder cost scenario 1): Summary results from DCFA for ***worst*** *performing green ACCUs site* ***Hy3*** *(see Table 9) under a 25-year permanence period. DCFA outcomes are reported for the full site area and per hectare. PV denotes present value. NPV denotes net present value. PV and NPV are calculated at 7% real discount rate, an 8% annual cost of cap, and a loan duration of 10 years. NPV is calculated over the full project duration of 28 years. Annualised NPV is calculated from NPV via Equation 2. PV upfront cost indicates total cost in present value incurred during the lead-in time. Scenario 1: reduction in land value is $5018/ha and opportunity cost is $430/ha/year.*

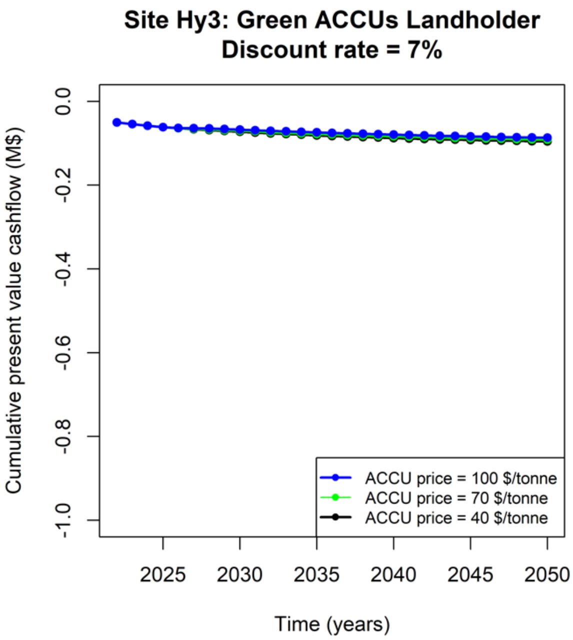
** Upfront loan covers the following costs incurred by the developer: site preparation for planting, detailed planting design, sourcing planting stock, tree planting, development approval, annual weeding at the site for three years following tree planting, and 5% contingency. The loan is repaid, with interest (assuming the cost of capital is 8% per annum), via equal annual instalments over a 10-year term.*

Green ACCUs only, worst performing site Hy3						
Metric	**Site area (10.7ha)**			**Per hectare**		
Upfront loan*	0.63 $ million			58.9 $k		
Developer's share of PV project cost	86.4			-		
Landholder's share of PV project cost	13.6			-		
Results for whole-of-project						
ACCU price ($/ACCU)	*40*	*70*	*100*	*40*	*70*	*100*
NPV ($k)	-699	-667	-635	-65.2	-62.2	-59.2
Annualised equivalent NPV ($k/year)	-58	-55	-53	-5.4	-5.2	-4.9
Internal rate of return (%)	-	-	-	-	-	-
Results for landholder						
ACCU price ($/ACCU)	*40*	*70*	*100*	*40*	*70*	*100*
NPV ($k)	-95	-91	-87	-8.9	-8.5	-8.1
Annualised equivalent NPV ($k/year)	-8	-8	-7	-0.74	-0.71	-0.67
Cumulative PV cash flow ($k)	See Figure 21a(a)			See Figure 21a(b)		
Results for developer						
ACCU price ($/ACCU)	*40*	*70*	*100*	*40*	*70*	*100*
NPV ($k)	-604	-576	-549	-56.3	-53.7	-51.1
Rate of return (%)	-	-	-	-	-	-
Cumulative PV cash flow ($k)	See Figure 21a(c)			See Figure 21a(d)		

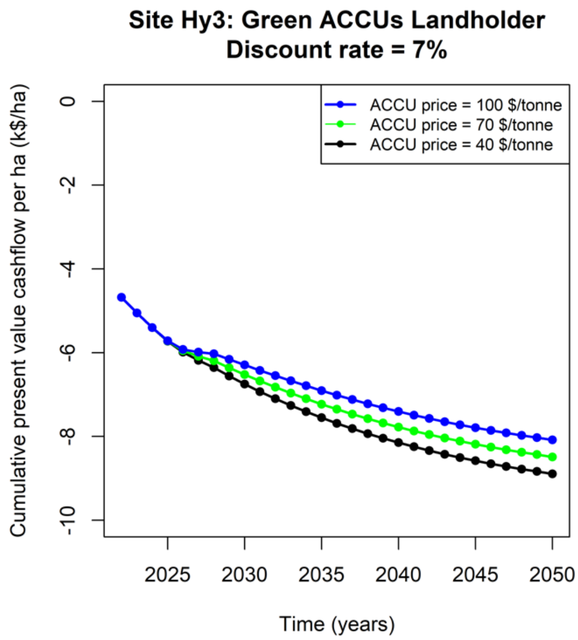
*Table 21b (Landholder cost scenario 2): Summary results from DCFA for worst performing green ACCUs site **Hy3** (see Table 9) under a 25-year permanence period. DCFA outcomes are reported for the full site area and per hectare. PV denotes present value. NPV denotes net present value. PV and NPV are calculated at 7% real discount rate, an 8% annual cost of cap, and a loan duration of 10 years. NPV is calculated over the full project duration of 28 years. Annualised NPV is calculated from NPV via Equation 2. PV upfront cost indicates total cost in present value incurred during the lead-in time. Scenario 2: reduction in land value is $2509/ha and opportunity cost is $215/ha/year.*

** Upfront loan covers the following costs incurred by the developer: site preparation for planting, detailed planting design, sourcing planting stock, tree planting, development approval, annual weeding at the site for three years following tree planting, and 5% contingency. The loan is repaid, with interest (assuming the cost of capital is 8% per annum), via equal annual instalments over a 10-year term.*

Green ACCUs only, worst performing site Hy3						
Metric	**Site area (10.7ha)**			**Per hectare**		
Upfront loan*	0.63 $ million			58.9 $k		
Developer's share of PV project cost	92.7			-		
Landholder's share of PV project cost	7.3			-		
Results for whole-of-project						
ACCU price ($/ACCU)	*40*	*70*	*100*	*40*	*70*	*100*
NPV ($k)	-648	-617	-585	-60.4	-57.5	-54.5
Annualised equivalent NPV ($k/year)	-54	-51	-49	-5	-4.8	-4.5
Internal rate of return (%)	-	-	-	-	-	-
Results for landholder						
ACCU price ($/ACCU)	*40*	*70*	*100*	*40*	*70*	*100*
NPV ($k)	-47	-45	-43	-4.4	-4.2	-4
Annualised equivalent NPV ($k/year)	-4	-4	-4	-0.37	-0.35	-0.33
Cumulative PV cash flow ($k)	See Figure 21b(a)			See Figure 21b(b)		
Results for developer						
ACCU price ($/ACCU)	*40*	*70*	*100*	*40*	*70*	*100*
NPV ($k)	-601	-572	-542	-56	-53.3	-50.5
Rate of return (%)	-	-	-	-	-	-
Cumulative PV cash flow ($k)	See Figure 21b(c)			See Figure 21b(d)		



(a)



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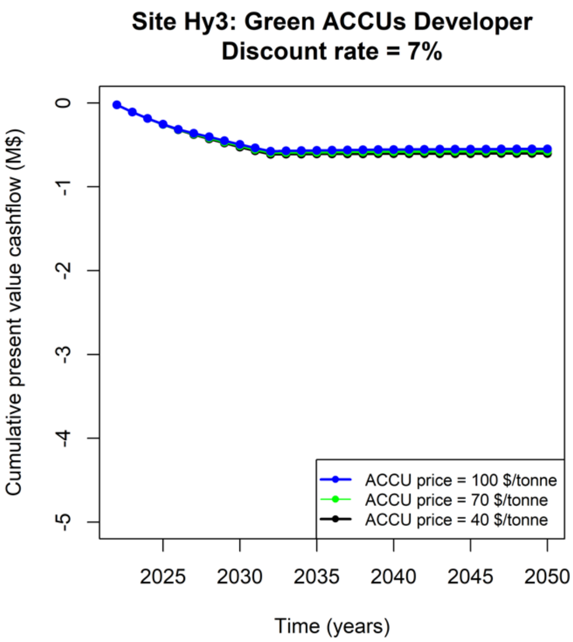

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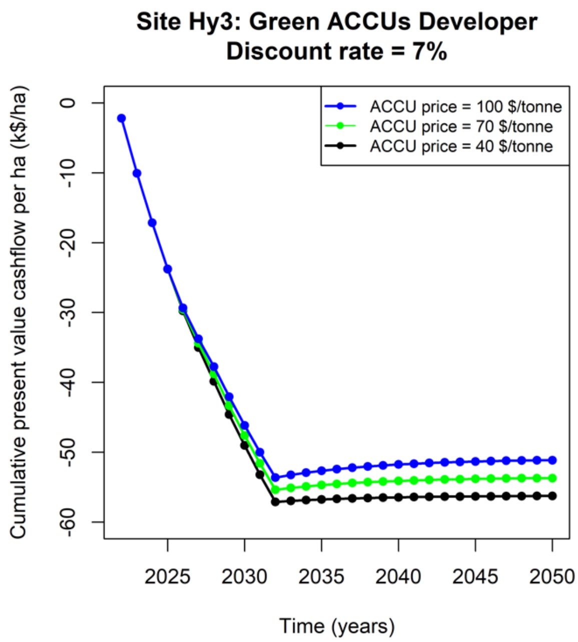


(d)

Figure 21a (Landholder cost scenario 1): DCFA results for the ***worst*** *performing standalone green ACCUs site* ***Hy3*** *showing (a) cumulative present value cashflow for the landholder (for the site as a whole) (b), cumulative present value cashflow for the landholder (per site hectare) (c), cumulative present value cashflow for the developer (for the site as a whole), and (d) cumulative present value cashflow for the developer (per site hectare). All results reported for a 25-year permanence period, a 7% real discount rate, an 8% annual cost of capital, and a 10-year loan term. Scenario 1: reduction in land value is $5018/ha and opportunity cost is $430/ha/year.*

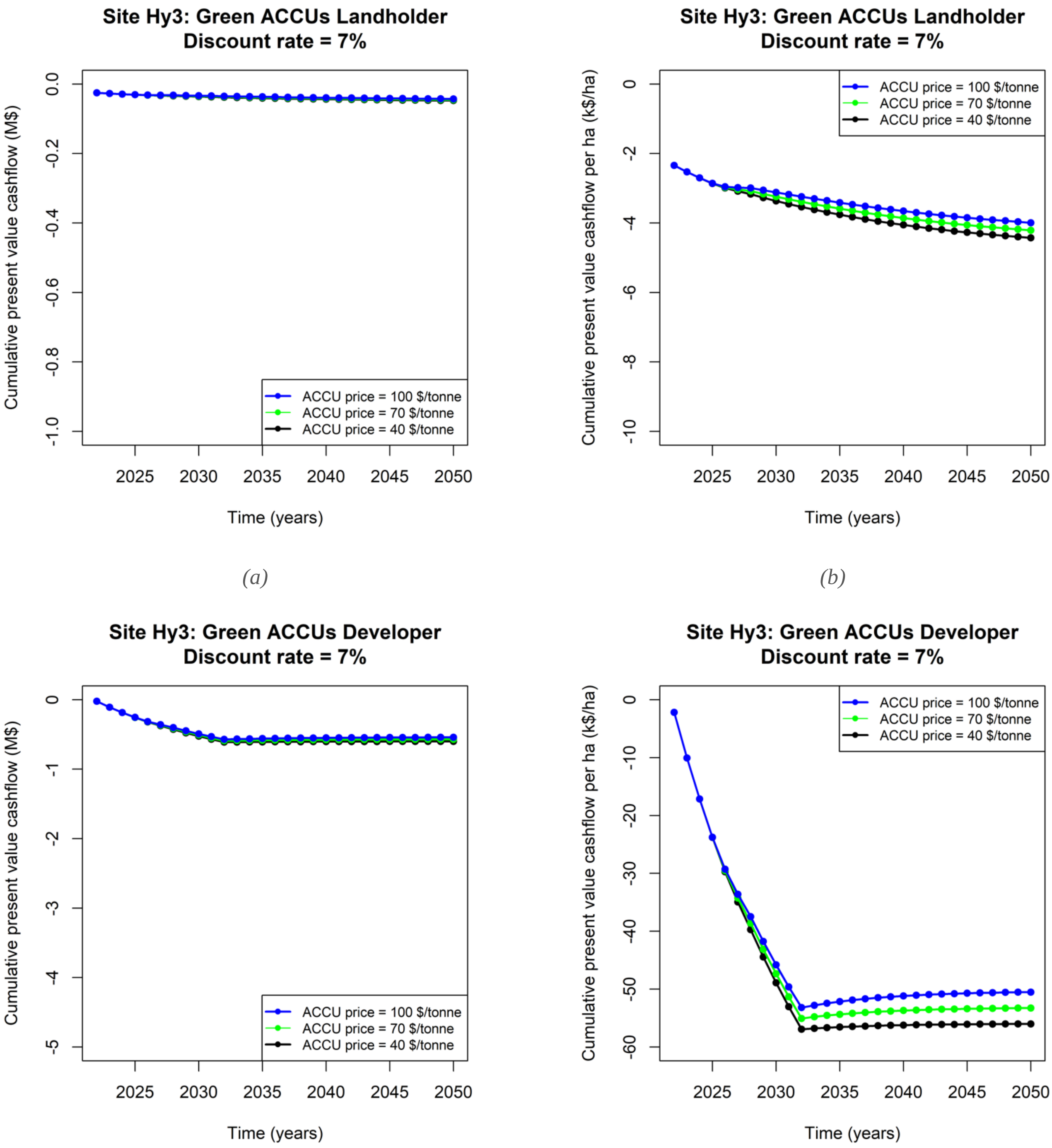


Figure 21b (Landholder scanerio 2): DCFA results for the worst performing standalone green ACCUs site ***Hy3*** *showing (a) cumulative present value cashflow for the landholder (for the site as a whole) (b), cumulative present value cashflow for the landholder (per site hectare) (c), cumulative present value cashflow for the developer (for the site as a whole), and (d) cumulative present value cashflow for the developer (per site hectare). All results reported for a 25-year permanence period, a 7% real discount rate, an 8% annual cost of capital, and a 10-year loan term. Scenario 2: reduction in land value is $2509/ha and opportunity cost is $215/ha/year.*

FULLCAM GREEN ACCUS STACKED WITH DIN REEF CREDITS: DCFA RESULTS

Whole-of-project DCFA outcomes from Green ACCUs stacked with DIN Reef Credits for all 21 indicative green ACCUs sites are reported in Table 22. DCFA outcomes for the landholder are reported in Table 25. DCFA outcomes for the developer are reported in Table 26.

*Table 22a (Landholder cost scenario 1) Summary **whole of project** results from DCFAs for Green ACCUs stacked with DIN Reef Credits at 21 indicative Green ACCUs sites in Mossman district. NPV denotes net present value. Annualised equivalent NPV is calculated from NPV via Equation 2. NPV and annualised equivalent NPV to the landholder are reported for the project site and per hectare. NPV is calculated at 7% real discount rate, an 8% annual cost of capital, and a loan duration of 10 years. NPV is calculated over the full project duration of 28 years. Scenario 1: reduction in land value is $5018/ha and opportunity cost is $430/ha/year.*

Green ACCUs stacked with DIN Reef Credits: Whole-of-project														
								Project site			Per hectare		
Site	Site area (ha)	Loan ($M)	Loan per ha ($k/ha)	Developer cost share (%)	Landholder cost share (%)		ACCU price ($/ACCU)	40	70	100	40	70	100
						and	DIN Reef Credits ($/kgDIN)	100	150	200	100	150	200
						or	10-year env. credit ($/ha/year)	830	1245	1660	830	1245	1660
						or	25-year env. credit ($/ha/year)	538	803	1071	538	803	1071
De1	41.1	2.38	58	86.3	13.7		NPV ($k)	-2344	-2041	-1738	-57.1	-49.7	-42.3
							Annualised NPV ($k/year)	-195	-170	-144	-4.7	-4.1	-3.5
De2	64	3.71	57.9	86.1	13.9		NPV ($k)	-3571	-3085	-2598	-55.8	-48.2	-40.6
							Annualised NPV ($k/year)	-297	-256	-216	-4.6	-4	-3.4
De3	47.2	2.74	58	86.2	13.8		NPV ($k)	-2677	-2330	-1983	-56.7	-49.4	-42
							Annualised NPV ($k/year)	-222	-194	-165	-4.7	-4.1	-3.5
De4	85.9	4.97	57.9	86	14		NPV ($k)	-4814	-4211	-3607	-56.1	-49	-42
							Annualised NPV ($k/year)	-400	-350	-300	-4.7	-4.1	-3.5
De5	49.9	2.89	58	86.2	13.8		NPV ($k)	-2830	-2466	-2101	-56.7	-49.4	-42.1
							Annualised NPV ($k/year)	-235	-205	-175	-4.7	-4.1	-3.5
Hy1	21.4	1.24	58.2	86.8	13.2		NPV ($k)	-1271	-1110	-950	-59.5	-52	-44.4
							Annualised NPV ($k/year)	-106	-92	-79	-4.9	-4.3	-3.7
Hy2	18.4	1.07	58.3	87	13		NPV ($k)	-1156	-1052	-948	-62.9	-57.2	-51.6
							Annualised NPV ($k/year)	-96	-87	-79	-5.2	-4.8	-4.3
Hy3	10.7	0.63	58.7	87.8	12.2		NPV ($k)	-725	-666	-606	-67.6	-62	-56.5
							Annualised NPV ($k/year)	-60	-55	-50	-5.6	-5.2	-4.7

Table 22a contd.

Green ACCUs stacked with DIN Reef Credits: Whole-of-project													
Site	Site area (ha)	Loan ($M)	Loan per ha ($k/ha)	Developer cost share (%)	Landholder cost share (%)			Project site			Per hectare		
							ACCU price ($/ACCU)	40	70	100	40	70	100
						and	DIN Reef Credits ($/kgDIN)	100	150	200	100	150	200
						or	10-year env. credit ($/ha/year)	830	1245	1660	830	1245	1660
						or	25-year env. credit ($/ha/year)	538	803	1071	538	803	1071
Ka1	35.6	2.07	58	86.4	13.6		NPV ($k)	-2108	-1890	-1672	-59.2	-53.1	-47
							Annualised NPV ($k/year)	-175	-157	-139	-4.9	-4.4	-3.9
Ka2	35.9	2.09	58	86.4	13.6		NPV ($k)	-2049	-1771	-1493	-57	-49.3	-41.5
							Annualised NPV ($k/year)	-170	-147	-124	-4.7	-4.1	-3.5
Ka3	38.3	2.22	58	86.4	13.6		NPV ($k)	-2278	-2056	-1835	-59.4	-53.6	-47.9
							Annualised NPV ($k/year)	-189	-171	-152	-4.9	-4.5	-4
Ka4	40	2.32	58	86.3	13.7		NPV ($k)	-2292	-2000	-1708	-57.3	-50	-42.7
							Annualised NPV ($k/year)	-190	-166	-142	-4.8	-4.1	-3.5
Ka5	19.8	1.15	58.3	86.9	13.1		NPV ($k)	-1194	-1053	-912	-60.4	-53.3	-46.2
							Annualised NPV ($k/year)	-99	-87	-76	-5	-4.4	-3.8
So1	28.4	1.65	58.1	86.6	13.4		NPV ($k)	-1668	-1465	-1262	-58.7	-51.5	-44.4
							Annualised NPV ($k/year)	-139	-122	-105	-4.9	-4.3	-3.7
So2	53.9	3.12	57.9	86.2	13.8		NPV ($k)	-3043	-2648	-2253	-56.5	-49.1	-41.8
							Annualised NPV ($k/year)	-253	-220	-187	-4.7	-4.1	-3.5
So3	36.5	2.12	58	86.4	13.6		NPV ($k)	-2109	-1850	-1592	-57.8	-50.7	-43.6
							Annualised NPV ($k/year)	-175	-154	-132	-4.8	-4.2	-3.6

Table 22a contd.

Green ACCUs stacked with DIN Reef Credits: Whole-of-project													
Site	Site area (ha)	Loan ($M)	Loan per ha ($k/ha)	Developer cost share (%)	Landholder cost share (%)			Project site			Per hectare		
							ACCU price($/ACCU)	40	70	100	40	70	100
						and	DIN Reef Credits ($/kgDIN)	100	150	200	100	150	200
						or	10-year env. credit ($/ha/year)	830	1245	1660	830	1245	1660
						or	25-year env. credit ($/ha/year)	538	803	1071	538	803	1071
Te1	38.8	2.25	58	86.4	13.6		NPV ($k)	-2208	-1914	-1620	-57	-49.4	-41.8
							Annualised NPV ($k/year)	-183	-159	-135	-4.7	-4.1	-3.5
Te2	53.3	3.09	57.9	86.2	13.8		NPV ($k)	-3019	-2633	-2248	-56.6	-49.4	-42.2
							Annualised NPV ($k/year)	-251	-219	-187	-4.7	-4.1	-3.5
Te3	29.5	1.71	58.1	86.5	13.5		NPV ($k)	-1731	-1525	-1318	-58.7	-51.7	-44.7
							Annualised NPV ($k/year)	-144	-127	-109	-4.9	-4.3	-3.7
Te4	27.9	1.62	58.1	86.6	13.4		NPV ($k)	-1637	-1438	-1238	-58.7	-51.6	-44.4
							Annualised NPV ($k/year)	-136	-119	-103	-4.9	-4.3	-3.7
Te5	6.7	0.4	59.3	88.8	11.2		NPV ($k)	-481	-434	-388	-72.2	-65.2	-58.2
							Annualised NPV ($k/year)	-40	-36	-32	-6	-5.4	-4.8

*Table 22b (Landholder cost scenario 2) Summary **whole of project** results from DCFAs for Green ACCUs stacked with DIN Reef Credits at 21 indicative Green ACCUs sites in Mossman district. NPV denotes net present value. Annualised equivalent NPV is calculated from NPV via Equation 2. NPV and annualised equivalent NPV to the landholder are reported for the project site and per hectare. NPV is calculated at 7% real discount rate, an 8% annual cost of capital, and a loan duration of 10 years. NPV is calculated over the full project duration of 28 years. Scenario 1: reduction in land value is $2509/ha and opportunity cost is $215/ha/year.*

Green ACCUs stacked with DIN Reef Credits: Whole-of-project														
								Project site			Per hectare		
Site	Site area (ha)	Loan ($M)	Loan per ha ($k/ha)	Developer cost share (%)	Landholder cost share (%)		ACCU price ($/ACCU)	40	70	100	40	70	100
						and	DIN Reef Credits ($/kgDIN)	100	150	200	100	150	200
						or	10-year env. credit ($/ha/year)	830	1245	1660	830	1245	1660
						or	25-year env. credit ($/ha/year)	538	803	1071	538	803	1071
De1	41.1	2.38	58	92.7	7.3		NPV ($k)	-2150	-1847	-1545	-52.4	-45	-37.6
							Annualised NPV ($k/year)	-179	-153	-128	-4.4	-3.7	-3.1
De2	64.0	3.71	57.9	92.5	7.5		NPV ($k)	-3269	-2783	-2296	-51.1	-43.5	-35.9
							Annualised NPV ($k/year)	-272	-231	-191	-4.2	-3.6	-3
De3	47.2	2.74	58	92.6	7.4		NPV ($k)	-2454	-2107	-1760	-52	-44.7	-37.3
							Annualised NPV ($k/year)	-204	-175	-146	-4.3	-3.7	-3.1
De4	85.9	4.97	57.9	92.5	7.5		NPV ($k)	-4409	-3806	-3202	-51.4	-44.3	-37.3
							Annualised NPV ($k/year)	-366	-316	-266	-4.3	-3.7	-3.1
De5	49.9	2.89	58	92.6	7.4		NPV ($k)	-2595	-2230	-1866	-52	-44.7	-37.4
							Annualised NPV ($k/year)	-216	-185	-155	-4.3	-3.7	-3.1
Hy1	21.4	1.24	58.2	93	7.0		NPV ($k)	-1170	-1010	-849	-54.8	-47.2	-39.7
							Annualised NPV ($k/year)	-97	-84	-71	-4.6	-3.9	-3.3
Hy2	18.4	1.07	58.3	93.1	6.9		NPV ($k)	-1069	-965	-861	-58.2	-52.5	-46.9
							Annualised NPV ($k/year)	-89	-80	-72	-4.8	-4.4	-3.9
Hy3	10.7	0.63	58.7	93.5	6.5		NPV ($k)	-674	-615	-556	-62.8	-57.3	-51.8
							Annualised NPV ($k/year)	-56	-51	-46	-5.2	-4.8	-4.3

Table 22b contd.

Green ACCUs stacked with DIN Reef Credits: Whole-of-project													
Site	Site area (ha)	Loan ($M)	Loan per ha ($k/ha)	Developer cost share (%)	Landholder cost share (%)			Project site			Per hectare		
							ACCU price ($/ACCU)	40	70	100	40	70	100
						and	DIN Reef Credits ($/kgDIN)	100	150	200	100	150	200
						or	10-year env. credit ($/ha/year)	830	1245	1660	830	1245	1660
						or	25-year env. credit ($/ha/year)	538	803	1071	538	803	1071
Ka1	35.6	2.07	58.0	92.7	7.3		NPV ($k)	-1940	-1722	-1504	-54.5	-48.4	-42.2
							Annualised NPV ($k/year)	-161	-143	-125	-4.5	-4	-3.5
Ka2	35.9	2.09	58.0	92.7	7.3		NPV ($k)	-1879	-1601	-1323	-52.3	-44.6	-36.8
							Annualised NPV ($k/year)	-156	-133	-110	-4.3	-3.7	-3.1
Ka3	38.3	2.22	58.0	92.7	7.3		NPV ($k)	-2097	-1876	-1654	-54.7	-48.9	-43.1
							Annualised NPV ($k/year)	-174	-156	-137	-4.5	-4.1	-3.6
Ka4	40.0	2.32	58.0	92.7	7.3		NPV ($k)	-2104	-1811	-1519	-52.5	-45.2	-37.9
							Annualised NPV ($k/year)	-175	-150	-126	-4.4	-3.8	-3.2
Ka5	19.8	1.15	58.3	93.0	7.0		NPV ($k)	-1101	-960	-819	-55.7	-48.6	-41.4
							Annualised NPV ($k/year)	-91	-80	-68	-4.6	-4	-3.4
So1	28.4	1.65	58.1	92.8	7.2		NPV ($k)	-1534	-1331	-1128	-53.9	-46.8	-39.7
							Annualised NPV ($k/year)	-127	-111	-94	-4.5	-3.9	-3.3
So2	53.9	3.12	57.9	92.6	7.4		NPV ($k)	-2789	-2394	-1999	-51.8	-44.4	-37.1
							Annualised NPV ($k/year)	-232	-199	-166	-4.3	-3.7	-3.1
So3	36.5	2.12	58.0	92.7	7.3		NPV ($k)	-1937	-1678	-1420	-53.1	-46	-38.9
							Annualised NPV ($k/year)	-161	-139	-118	-4.4	-3.8	-3.2

Table 22b contd.

Green ACCUs stacked with DIN Reef Credits: Whole-of-project														
								Project site			Per hectare		
Site	Site area (ha)	Loan ($M)	Loan per ha ($k/ha)	Developer cost share (%)	Landholder cost share (%)		ACCU price($/ACCU)	40	70	100	40	70	100
						and	DIN Reef Credits ($/kgDIN)	100	150	200	100	150	200
						or	10-year env. credit ($/ha/year)	830	1245	1660	830	1245	1660
						or	25-year env. credit ($/ha/year)	538	803	1071	538	803	1071
Te1	38.8	2.25	58	92.7	7.3		NPV ($k)	-2026	-1731	-1437	-52.2	-44.7	-37.1
							Annualised NPV ($k/year)	-168	-144	-119	-4.3	-3.7	-3.1
Te2	53.3	3.09	57.9	92.6	7.4		NPV ($k)	-2767	-2382	-1996	-51.9	-44.7	-37.4
							Annualised NPV ($k/year)	-230	-198	-166	-4.3	-3.7	-3.1
Te3	29.5	1.71	58.1	92.8	7.2		NPV ($k)	-1592	-1386	-1179	-54	-47	-40
							Annualised NPV ($k/year)	-132	-115	-98	-4.5	-3.9	-3.3
Te4	27.9	1.62	58.1	92.8	7.2		NPV ($k)	-1506	-1306	-1107	-54	-46.9	-39.7
							Annualised NPV ($k/year)	-125	-109	-92	-4.5	-3.9	-3.3
Te5	6.7	0.4	59.3	94.1	5.9		NPV ($k)	-449	-403	-356	-67.5	-60.5	-53.5
							Annualised NPV ($k/year)	-37	-33	-30	-5.6	-5	-4.4

Table 23a (Landholder cost scenario 1): Landholder outcomes from DCFAs for Green ACCUs stacked with DIN Reef Credits at 21 indicative green ACCUs sites in Mossman district. At each project site the NPV accruing to the landholder is reported as NPV over the full project duration and as annualised equivalent NPV (calculated from NPV via Equation 2). NPV and annualised equivalent NPV to the landholder are reported for the project site and per hectare. NPV denotes net present value. NPV is calculated at 7% real discount rate, an 8% annual cost of capital, and a loan duration of 10 years evaluated over the full project duration of 28 years. Scenario 1: reduction in land value is $5018/ha and opportunity cost is $430/ha/year.

Green ACCUs stacked with DIN Reef Credits: Landholder outcomes								
Site			Project site			Per hectare		
		ACCU price ($/ACCU)	40	70	100	40	70	100
	and	DIN Reef Credits ($/kgDIN)	100	150	200	100	150	200
	or	10-year env. credit ($/ha/year)	830	1245	1660	830	1245	1660
	or	25-year env. credit ($/ha/year)	538	803	1071	538	803	1071
De1	NPV ($k)		-321	-279	-238	-7.8	-6.8	-5.8
	Annualised NPV ($k/year)		-27	-23	-20	-0.65	-0.56	-0.48
De2	NPV ($k)		-497	-429	-361	-7.8	-6.7	-5.6
	Annualised NPV ($k/year)		-41	-36	-30	-0.64	-0.56	-0.47
De3	NPV ($k)		-369	-320	-272	-7.8	-6.8	-5.8
	Annualised NPV ($k/year)		-31	-27	-23	-0.65	-0.56	-0.48
De4	NPV ($k)		-674	-589	-505	-7.9	-6.9	-5.9
	Annualised NPV ($k/year)		-56	-49	-42	-0.65	-0.57	-0.49
De5	NPV ($k)		-391	-340	-289	-7.8	-6.8	-5.8
	Annualised NPV ($k/year)		-32	-28	-24	-0.65	-0.57	-0.48
Hy1	NPV ($k)		-168	-146	-125	-7.8	-6.8	-5.8
	Annualised NPV ($k/year)		-14	-12	-10	-0.65	-0.57	-0.48
Hy2	NPV ($k)		-150	-137	-123	-8.2	-7.4	-6.7
	Annualised NPV ($k/year)		-12	-11	-10	-0.68	-0.62	-0.56
Hy3	NPV ($k)		-89	-81	-74	-8.3	-7.6	-6.9
	Annualised NPV ($k/year)		-7	-7	-6	-0.69	-0.63	-0.57
Ka1	NPV ($k)		-287	-257	-227	-8.1	-7.2	-6.4
	Annualised NPV ($k/year)		-24	-21	-19	-0.67	-0.6	-0.53
Ka2	NPV ($k)		-279	-241	-203	-7.8	-6.7	-5.6
	Annualised NPV ($k/year)		-23	-20	-17	-0.64	-0.56	-0.47
Ka3	NPV ($k)		-311	-280	-250	-8.1	-7.3	-6.5
	Annualised NPV ($k/year)		-26	-23	-21	-0.67	-0.61	-0.54
Ka4	NPV ($k)		-314	-273	-233	-7.8	-6.8	-5.8
	Annualised NPV ($k/year)		-26	-23	-19	-0.65	-0.57	-0.48
Ka5	NPV ($k)		-156	-138	-119	-7.9	-7	-6
	Annualised NPV ($k/year)		-13	-11	-10	-0.66	-0.58	-0.5

Table 23a contd.

Green ACCUs stacked with DIN Reef Credits: Landholder outcomes							
Site		Project site			Per hectare		
	ACCU price ($/ACCU)	40	70	100	40	70	100
	and DIN Reef Credits ($/kgDIN)	100	150	200	100	150	200
	or 10-year env. credit ($/ha/year)	830	1245	1660	830	1245	1660
	or 25-year env. credit ($/ha/year)	538	803	1071	538	803	1071
So1	NPV ($k)	-224	-197	-169	-7.9	-6.9	-6
	Annualised NPV ($k/year)	-19	-16	-14	-0.65	-0.57	-0.49
So2	NPV ($k)	-421	-366	-311	-7.8	-6.8	-5.8
	Annualised NPV ($k/year)	-35	-30	-26	-0.65	-0.56	-0.48
So3	NPV ($k)	-287	-252	-216	-7.9	-6.9	-5.9
	Annualised NPV ($k/year)	-24	-21	-18	-0.65	-0.57	-0.49
Te1	NPV ($k)	-302	-261	-221	-7.8	-6.7	-5.7
	Annualised NPV ($k/year)	-25	-22	-18	-0.65	-0.56	-0.47
Te2	NPV ($k)	-417	-364	-310	-7.8	-6.8	-5.8
	Annualised NPV ($k/year)	-35	-30	-26	-0.65	-0.57	-0.48
Te3	NPV ($k)	-233	-205	-177	-7.9	-7	-6
	Annualised NPV ($k/year)	-19	-17	-15	-0.66	-0.58	-0.5
Te4	NPV ($k)	-220	-193	-166	-7.9	-6.9	-5.9
	Annualised NPV ($k/year)	-18	-16	-14	-0.65	-0.57	-0.49
Te5	NPV ($k)	-54	-49	-43	-8.1	-7.3	-6.5
	Annualised NPV ($k/year)	-4	-4	-4	-0.67	-0.61	-0.54

Table 23b (Landholder cost scenario 2): Landholder outcomes from DCFAs for Green ACCUs stacked with DIN Reef Credits at 21 indicative green ACCUs sites in Mossman district. At each project site the NPV accruing to the landholder is reported as NPV over the full project duration and as annualised equivalent NPV (calculated from NPV via Equation 2). NPV and annualised equivalent NPV to the landholder are reported for the project site and per hectare. NPV denotes net present value. NPV is calculated at 7% real discount rate, an 8% annual cost of capital, and a loan duration of 10 years evaluated over the full project duration of 28 years. Scenario 2: reduction in land value is $2509/ha and opportunity cost is $215/ha/year.

Green ACCUs stacked with DIN Reef Credits: Landholder outcomes								
			Project site			Per hectare		
		ACCU price ($/ACCU)	40	70	100	40	70	100
Site	and	DIN Reef Credits ($/kgDIN)	100	150	200	100	150	200
	or	10-year env. credit ($/ha/year)	830	1245	1660	830	1245	1660
	or	25-year env. credit ($/ha/year)	538	803	1071	538	803	1071
De1	NPV ($k)		-158	-136	-113	-3.8	-3.3	-2.8
	Annualised NPV ($k/year)		-13	-11	-9	-0.32	-0.27	-0.23
De2	NPV ($k)		-244	-208	-171	-3.8	-3.2	-2.7
	Annualised NPV ($k/year)		-20	-17	-14	-0.32	-0.27	-0.22
De3	NPV ($k)		-181	-156	-130	-3.8	-3.3	-2.8
	Annualised NPV ($k/year)		-15	-13	-11	-0.32	-0.27	-0.23
De4	NPV ($k)		-332	-286	-241	-3.9	-3.3	-2.8
	Annualised NPV ($k/year)		-28	-24	-20	-0.32	-0.28	-0.23
De5	NPV ($k)		-192	-165	-138	-3.8	-3.3	-2.8
	Annualised NPV ($k/year)		-16	-14	-11	-0.32	-0.27	-0.23
Hy1	NPV ($k)		-83	-71	-60	-3.9	-3.3	-2.8
	Annualised NPV ($k/year)		-7	-6	-5	-0.32	-0.28	-0.23
Hy2	NPV ($k)		-74	-67	-60	-4	-3.6	-3.2
	Annualised NPV ($k/year)		-6	-6	-5	-0.34	-0.3	-0.27
Hy3	NPV ($k)		-44	-40	-36	-4.1	-3.7	-3.3
	Annualised NPV ($k/year)		-4	-3	-3	-0.34	-0.31	-0.28
Ka1	NPV ($k)		-142	-126	-110	-4	-3.5	-3.1
	Annualised NPV ($k/year)		-12	-10	-9	-0.33	-0.29	-0.26
Ka2	NPV ($k)		-137	-117	-96	-3.8	-3.2	-2.7
	Annualised NPV ($k/year)		-11	-10	-8	-0.32	-0.27	-0.22
Ka3	NPV ($k)		-154	-137	-121	-4	-3.6	-3.2
	Annualised NPV ($k/year)		-13	-11	-10	-0.33	-0.3	-0.26
Ka4	NPV ($k)		-154	-133	-111	-3.9	-3.3	-2.8
	Annualised NPV ($k/year)		-13	-11	-9	-0.32	-0.28	-0.23
Ka5	NPV ($k)		-77	-67	-57	-3.9	-3.4	-2.9
	Annualised NPV ($k/year)		-6	-6	-5	-0.32	-0.28	-0.24

Table 23b contd.

Green ACCUs stacked with DIN Reef Credits: Landholder outcomes								
Site			Project site			Per hectare		
		ACCU price ($/ACCU)	40	70	100	40	70	100
	and	DIN Reef Credits ($/kgDIN)	100	150	200	100	150	200
	or	10-year env. credit ($/ha/year)	830	1245	1660	830	1245	1660
	or	25-year env. credit ($/ha/year)	538	803	1071	538	803	1071
So1	NPV ($k)		-110	-96	-81	-3.9	-3.4	-2.9
	Annualised NPV ($k/year)		-9	-8	-7	-0.32	-0.28	-0.24
So2	NPV ($k)		-207	-178	-148	-3.8	-3.3	-2.8
	Annualised NPV ($k/year)		-17	-15	-12	-0.32	-0.27	-0.23
So3	NPV ($k)		-142	-122	-104	-3.9	-3.4	-2.8
	Annualised NPV ($k/year)		-12	-10	-9	-0.32	-0.28	-0.24
Te1	NPV ($k)		-148	-127	-105	-3.8	-3.3	-2.7
	Annualised NPV ($k/year)		-12	-11	-9	-0.32	-0.27	-0.23
Te2	NPV ($k)		-206	-177	-148	-3.9	-3.3	-2.8
	Annualised NPV ($k/year)		-17	-15	-12	-0.32	-0.28	-0.23
Te3	NPV ($k)		-115	-100	-85	-3.9	-3.4	-2.9
	Annualised NPV ($k/year)		-10	-8	-7	-0.32	-0.28	-0.24
Te4	NPV ($k)		-108	-94	-79	-3.9	-3.4	-2.8
	Annualised NPV ($k/year)		-9	-8	-7	-0.32	-0.28	-0.24
Te5	NPV ($k)		-27	-24	-21	-4	-3.6	-3.2
	Annualised NPV ($k/year)		-2	-2	-2	-0.33	-0.3	-0.26

Table 24a (Landholder cost scenario 1): Developer outcomes from DCFAs for Green ACCUs stacked with DIN Reef Credits at 21 indicative green ACCUs sites in Mossman district.Outcomes for the developer at each project site are reported for the project site and per hectare. NPV denotes net present value. Rate of return is calculated by dividing the developer's NPV by the total PV of developer's costs. PV and NPV are calculated at 7% real discount rate, an 8% annual cost of cap, and a loan duration of 10 years. NPV is calculated over the full project duration of 28 years. Scenario 1: reduction in land value is $5018/ha and opportunity cost is $430/ha/year.

Green ACCUs stacked with DIN Reef Credits: Developer outcomes								
			Project site			Per hectare		
Site		ACCU price ($/ACCU)	40	70	100	40	70	100
	and	DIN Reef Credits ($/kgDIN)	100	150	200	100	150	200
	or	10-year env. credit ($/ha/year)	830	1245	1660	830	1245	1660
	or	25-year env. credit ($/ha/year)	538	803	1071	538	803	1071
De1	NPV ($k)		-2023	-1762	-1501	-49.3	-42.9	-36.6
	Rate of Return (%)		-	-	-	-	-	-
De2	NPV ($k)		-3075	-2656	-2237	-48	-41.5	-34.9
	Rate of Return (%)		-	-	-	-	-	-
De3	NPV ($k)		-2308	-2009	-1710	-48.9	-42.6	-36.2
	Rate of Return (%)		-	-	-	-	-	-
De4	NPV ($k)		-4140	-3621	-3102	-48.2	-42.2	-36.1
	Rate of Return (%)		-	-	-	-	-	-
De5	NPV ($k)		-2440	-2126	-1812	-48.9	-42.6	-36.3
	Rate of Return (%)		-	-	-	-	-	-
Hy1	NPV ($k)		-1104	-964	-825	-51.6	-45.1	-38.6
	Rate of Return (%)		-	-	-	-	-	-
Hy2	NPV ($k)		-1005	-915	-825	-54.7	-49.8	-44.9
	Rate of Return (%)		-	-	-	-	-	-
Hy3	NPV ($k)		-636	-585	-533	-59.3	-54.5	-49.7
	Rate of Return (%)		-	-	-	-	-	-
Ka1	NPV ($k)		-1821	-1633	-1445	-51.1	-45.9	-40.6
	Rate of Return (%)		-	-	-	-	-	-
Ka2	NPV ($k)		-1770	-1530	-1290	-49.2	-42.6	-35.9
	Rate of Return (%)		-	-	-	-	-	-
Ka3	NPV ($k)		-1967	-1776	-1585	-51.3	-46.3	-41.3
	Rate of Return (%)		-	-	-	-	-	-
Ka4	NPV ($k)		-1979	-1727	-1475	-49.4	-43.1	-36.8
	Rate of Return (%)		-	-	-	-	-	-
Ka5	NPV ($k)		-1038	-915	-793	-52.5	-46.3	-40.1
	Rate of Return (%)		-	-	-	-	-	-

Table 24a contd.

Green ACCUs stacked with DIN Reef Credits: Developer outcomes								
Site			Project site			Per hectare		
		ACCU price ($/ACCU)	40	70	100	40	70	100
	and	DIN Reef Credits ($/kgDIN)	100	150	200	100	150	200
	or	10-year env. credit ($/ha/year)	830	1245	1660	830	1245	1660
	or	25-year env. credit ($/ha/year)	538	803	1071	538	803	1071
So1	NPV ($k)		-1444	-1268	-1093	-50.8	-44.6	-38.5
	Rate of Return (%)		-	-	-	-	-	-
So2	NPV ($k)		-2622	-2282	-1942	-48.7	-42.3	-36.0
	Rate of Return (%)		-	-	-	-	-	-
So3	NPV ($k)		-1822	-1599	-1375	-49.9	-43.8	-37.7
	Rate of Return (%)		-	-	-	-	-	-
Te1	NPV ($k)		-1907	-1653	-1399	-49.2	-42.6	-36.1
	Rate of Return (%)		-	-	-	-	-	-
Te2	NPV ($k)		-2601	-2269	-1937	-48.8	-42.6	-36.3
	Rate of Return (%)		-	-	-	-	-	-
Te3	NPV ($k)		-1498	-1320	-1141	-50.8	-44.7	-38.7
	Rate of Return (%)		-	-	-	-	-	-
Te4	NPV ($k)		-1417	-1245	-1073	-50.8	-44.7	-38.5
	Rate of Return (%)		-	-	-	-	-	-
Te5	NPV ($k)		-427	-386	-345	-64.1	-57.9	-51.7
	Rate of Return (%)		-	-	-	-	-	-

Table 24b (Landholder cost scenario 2): Developer outcomes from DCFAs for Green ACCUs stacked with DIN Reef Credits at 21 indicative green ACCUs sites in Mossman district.Outcomes for the developer at each project site are reported for the project site and per hectare. NPV denotes net present value. Rate of return is calculated by dividing the developer's NPV by the total PV of developer's costs. PV and NPV are calculated at 7% real discount rate, an 8% annual cost of cap, and a loan duration of 10 years. NPV is calculated over the full project duration of 28 years. Scenario 2: reduction in land value is $2509/ha and opportunity cost is $215/ha/year.

Green ACCUs stacked with DIN Reef Credits: Developer outcomes								
			Project site			Per hectare		
		ACCU price ($/ACCU)	40	70	100	40	70	100
Site	and	DIN Reef Credits ($/kgDIN)	100	150	200	100	150	200
	or	10-year env. credit ($/ha/year)	830	1245	1660	830	1245	1660
	or	25-year env. credit ($/ha/year)	538	803	1071	538	803	1071
De1	NPV ($k)		-1992	-1712	-1431	-48.5	-41.7	-34.9
	Rate of Return (%)		-	-	-	-	-	-
De2	NPV ($k)		-3025	-2575	-2125	-47.2	-40.2	-33.2
	Rate of Return (%)		-	-	-	-	-	-
De3	NPV ($k)		-2273	-1952	-1630	-48.2	-41.4	-34.6
	Rate of Return (%)		-	-	-	-	-	-
De4	NPV ($k)		-4077	-3519	-2961	-47.5	-41	-34.5
	Rate of Return (%)		-	-	-	-	-	-
De5	NPV ($k)		-2403	-2065	-1728	-48.1	-41.4	-34.6
	Rate of Return (%)		-	-	-	-	-	-
Hy1	NPV ($k)		-1088	-939	-789	-50.9	-43.9	-36.9
	Rate of Return (%)		-	-	-	-	-	-
Hy2	NPV ($k)		-995	-898	-802	-54.1	-48.9	-43.6
	Rate of Return (%)		-	-	-	-	-	-
Hy3	NPV ($k)		-630	-575	-520	-58.7	-53.6	-48.5
	Rate of Return (%)		-	-	-	-	-	-
Ka1	NPV ($k)		-1798	-1597	-1395	-50.5	-44.8	-39.2
	Rate of Return (%)		-	-	-	-	-	-
Ka2	NPV ($k)		-1742	-1485	-1227	-48.5	-41.3	-34.1
	Rate of Return (%)		-	-	-	-	-	-
Ka3	NPV ($k)		-1943	-1738	-1533	-50.7	-45.3	-40.0
	Rate of Return (%)		-	-	-	-	-	-
Ka4	NPV ($k)		-1949	-1678	-1408	-48.7	-41.9	-35.2
	Rate of Return (%)		-	-	-	-	-	-
Ka5	NPV ($k)		-1024	-893	-762	-51.8	-45.2	-38.5
	Rate of Return (%)		-	-	-	-	-	-

Table 24b contd.

Green ACCUs stacked with DIN Reef Credits: Developer outcomes									
Site			Project site			Per hectare			
		ACCU price ($/ACCU)	40	70	100	40	70	100
	and	DIN Reef Credits ($/kgDIN)	100	150	200	100	150	200
	or	10-year env. credit ($/ha/year)	830	1245	1660	830	1245	1660
	or	25-year env. credit ($/ha/year)	538	803	1071	538	803	1071
So1	NPV ($k)		-1423	-1235	-1047	-50.1	-43.5	-36.8
	Rate of Return (%)		-	-	-	-	-	-
So2	NPV ($k)		-2582	-2216	-1851	-47.9	-41.1	-34.3
	Rate of Return (%)		-	-	-	-	-	-
So3	NPV ($k)		-1795	-1556	-1316	-49.2	-42.7	-36.1
	Rate of Return (%)		-	-	-	-	-	-
Te1	NPV ($k)		-1877	-1605	-1332	-48.4	-41.4	-34.4
	Rate of Return (%)		-	-	-	-	-	-
Te2	NPV ($k)		-2562	-2205	-1848	-48.1	-41.4	-34.7
	Rate of Return (%)		-	-	-	-	-	-
Te3	NPV ($k)		-1477	-1286	-1094	-50.1	-43.6	-37.1
	Rate of Return (%)		-	-	-	-	-	-
Te4	NPV ($k)		-1397	-1212	-1027	-50.1	-43.5	-36.9
	Rate of Return (%)		-	-	-	-	-	-
Te5	NPV ($k)		-423	-379	-335	-63.5	-56.9	-50.4
	Rate of Return (%)		-	-	-	-	-	-

Table 25a (Landholder cost scenario 1): Summary results from DCFA for green ACCUs stacked with DIN Reef Credits on ***best*** *performing site* ***De2*** *under a 25-year permanence period. Reported for the project as a whole and per hectare. PV denotes present value. NPV denotes net present value. PV and NPV are calculated at 7% real discount rate, an 8% annual cost of capital, and a loan duration of 10 years. NPV is calculated over the full project duration of 28 years. PV cost reports the sum of all present value costs incurred during the 28-year project, including the cost of repaying the upfront loan (with interest). Scenario 1: reduction in land value is $5018/ha and opportunity cost is $430/ha/year.*

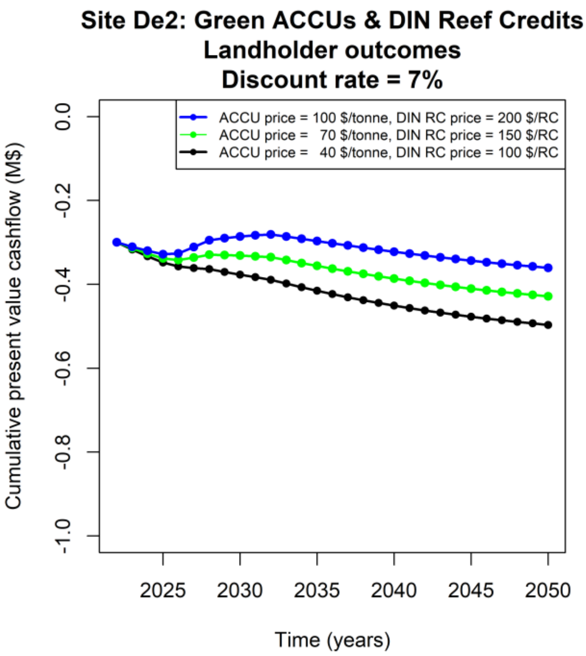
Green ACCUs and Reef Credits, best performing site De2						
Metric	**Site area (64ha)**			**Per hectare**		
Upfront loan*	3.71 $ million			57.9 $k		
Developer's share of PV project cost	86.1			-		
Landholder's share of PV project cost	13.9			-		
Results for whole-of-project						
ACCU price ($/ACCU)	*40*	*70*	*100*	*40*	*70*	*100*
and DIN Reef Credits ($/kgDIN)	100	150	200	100	150	200
or 10-year env. credit ($/ha/year)	830	1245	1660	830	1245	1660
or 25-year env. credit ($/ha/year)	538	803	1071	538	803	1071
NPV ($k)	-3571	-3085	-2598	-55.8	-48.2	-40.6
Annualised equivalent NPV ($k/year)	-297	-256	-216	-4.6	-4	-3.4
Internal rate of return (%)	-	-	-	-	-	-
Results for landholder						
ACCU price ($/ACCU)	*40*	*70*	*100*	*40*	*70*	*100*
and DIN Reef Credits ($/kgDIN)	100	150	200	100	150	200
or 10-year env. credit ($/ha/year)	830	1245	1660	830	1245	1660
or 25-year env. credit ($/ha/year)	538	803	1071	538	803	1071
NPV ($k)	-497	-429	-361	-7.8	-6.7	-5.6
Annualised equivalent NPV ($k/year)	-41	-36	-30	-0.64	-0.56	-0.47
Cumulative PV cash flow ($k)	See Figure 22a (a)			See Figure 22a (b)		
Results for developer						
ACCU price ($/ACCU)	*40*	*70*	*100*	*40*	*70*	*100*
and DIN Reef Credits ($/kgDIN)	100	150	200	100	150	200
or 10-year env. credit ($/ha/year)	830	1245	1660	830	1245	1660
or 25-year env. credit ($/ha/year)	538	803	1071	538	803	1071
NPV ($k)	-3075	-2656	-2237	-48	-41.5	-34.9
Rate of return (%)	-	-	-	-	-	-
Cumulative PV cash flow ($k)	See Figure 22a (c)			See Figure 22a (d)		

* Upfront loan covers the following costs incurred by the developer: site preparation for planting, detailed planting design, sourcing planting stock, tree planting, development approval, annual weeding at the site for three years following tree planting, and 5% contingency. The loan is repaid, with interest (assuming the cost of capital is 8% per annum), via equal annual instalments over a 10-year term.

*Table 25b (Landholder cost scenario 2): Summary results from DCFA for green ACCUs stacked with DIN Reef Credits on **best** performing site **De2** under a 25-year permanence period. Reported for the project as a whole and per hectare. PV denotes present value. NPV denotes net present value. PV and NPV are calculated at 7% real discount rate, an 8% annual cost of capital, and a loan duration of 10 years. NPV is calculated over the full project duration of 28 years. PV cost reports the sum of all present value costs incurred during the 28-year project, including the cost of repaying the upfront loan (with interest). Scenario 1: reduction in land value is $2509/ha and opportunity cost is $215/ha/year.*

Green ACCUs and Reef Credits, best performing site De2							
Metric		**Site area (64ha)**			**Per hectare**		
Upfront loan*		3.71 $ million			57.9 $k		
Developer's share of PV project cost		92.5%			-		
Landholder's share of PV project cost		7.5%			-		
Results for whole-of-project							
	ACCU price ($/ACCU)	*40*	*70*	*100*	*40*	*70*	*100*
and	DIN Reef Credits ($/kgDIN)	100	150	200	100	150	200
or	10-year env. credit ($/ha/year)	830	1245	1660	830	1245	1660
or	25-year env. credit ($/ha/year)	538	803	1071	538	803	1071
NPV ($k)		-3269	-2783	-2296	-51.1	-43.5	-35.9
Annualised equivalent NPV ($k/year)		-272	-231	-191	-4.2	-3.6	-3.0
Internal rate of return (%)		-	-	-	-	-	-
Results for landholder							
	ACCU price ($/ACCU)	*40*	*70*	*100*	*40*	*70*	*100*
and	DIN Reef Credits ($/kgDIN)	100	150	200	100	150	200
or	10-year env. credit ($/ha/year)	830	1245	1660	830	1245	1660
or	25-year env. credit ($/ha/year)	538	803	1071	538	803	1071
NPV ($k)		-244	-208	-171	-3.8	-3.2	-2.7
Annualised equivalent NPV ($k/year)		-20	-17	-14	-0.32	-0.27	-0.22
Cumulative PV cash flow ($k)		See Figure 22b (a)			See Figure 22b (b)		
Results for developer							
	ACCU price ($/ACCU)	*40*	*70*	*100*	*40*	*70*	*100*
and	DIN Reef Credits ($/kgDIN)	100	150	200	100	150	200
or	10-year env. credit ($/ha/year)	830	1245	1660	830	1245	1660
or	25-year env. credit ($/ha/year)	538	803	1071	538	803	1071
NPV ($k)		-3025	-2575	-2125	-47.2	-40.2	-33.2
Rate of return (%)		-	-	-	-	-	-
Cumulative PV cash flow ($k)		See Figure 22b (c)			See Figure 22b (d)		

* Upfront loan covers the following costs incurred by the developer: site preparation for planting, detailed planting design, sourcing planting stock, tree planting, development approval, annual weeding at the site for three years following tree planting, and 5% contingency. The loan is repaid, with interest (assuming the cost of capital is 8% per annum), via equal annual instalments over a 10-year term.



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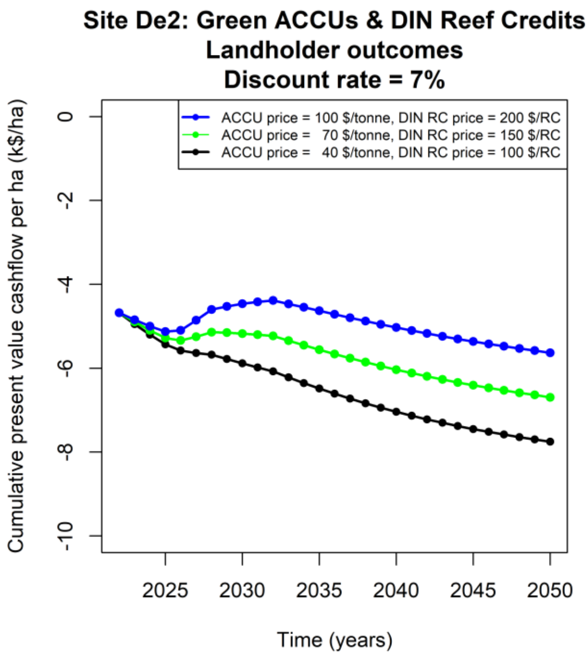

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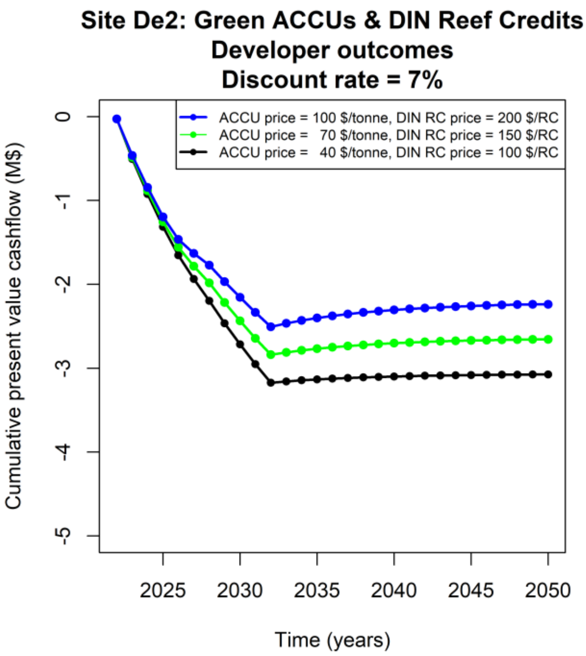

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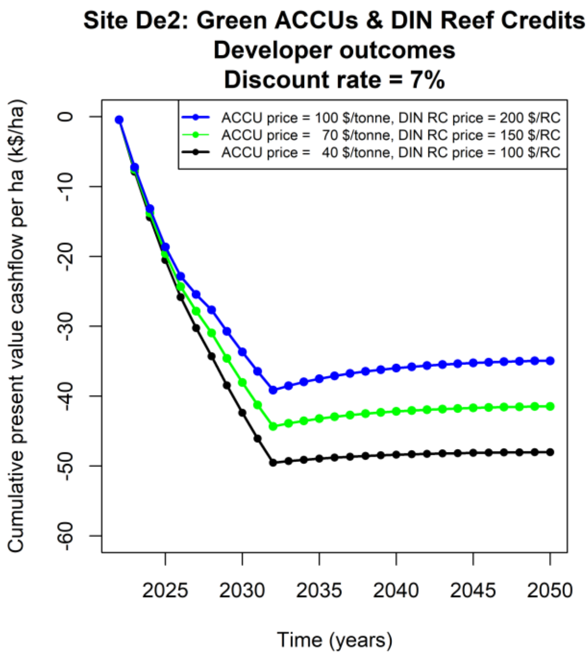
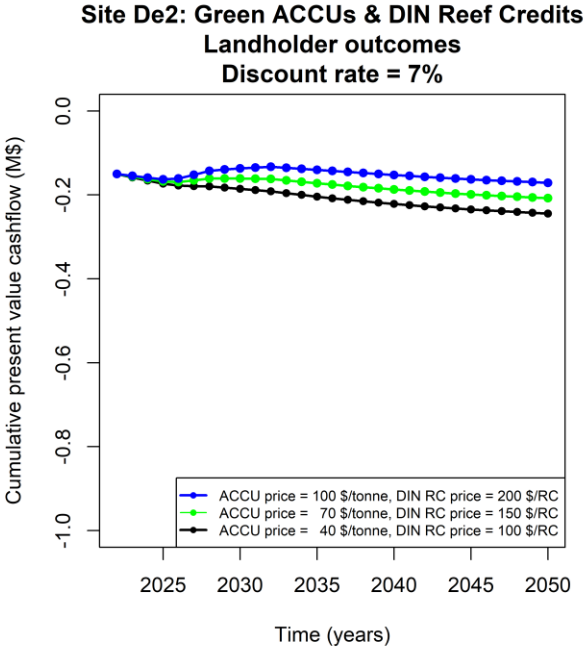


(d)

*Figure 22a (Landholder scanerio 1): DCFA results for best performing stacked green ACCUs site **De2** showing cumulative present value cashflow for the landholder (for the site as a whole) (a), for the landholder (per site hectare) (b), for the developer (for the site as a whole) (c) and for the developer (per site hectare) (d). All results reported a 25-year permanence period, a 7% real discount rate, an 8% annual cost of capital, and a 10-year loan term. Scenario 1: reduction in land value is $5018/ha and opportunity cost is $430/ha/year.*



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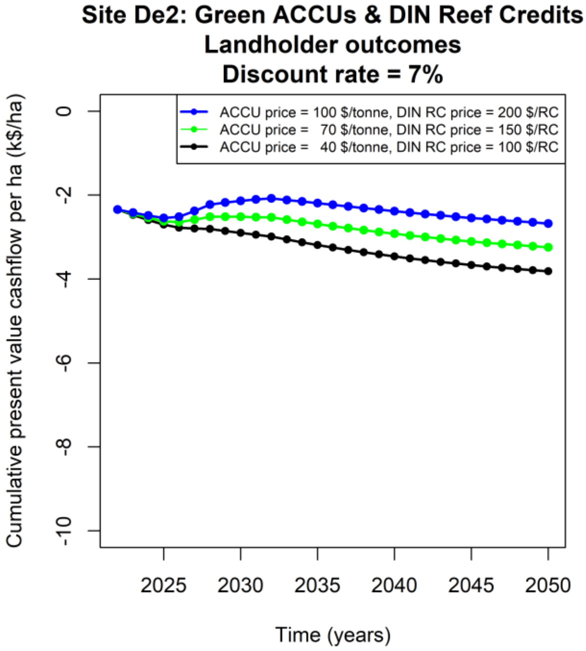

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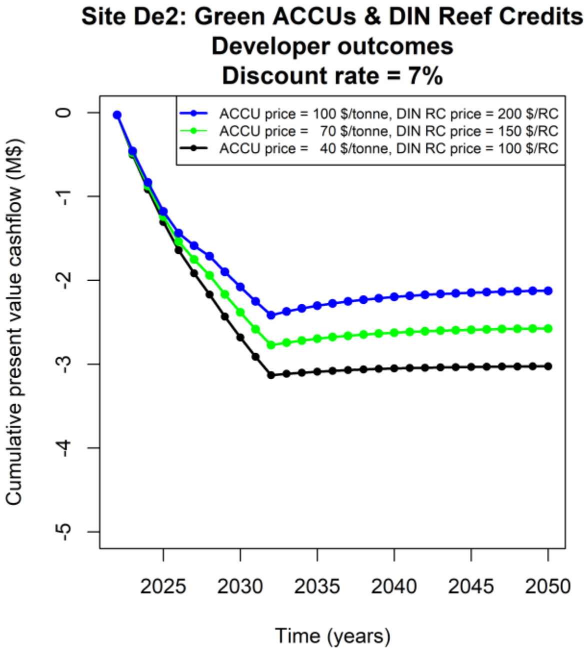

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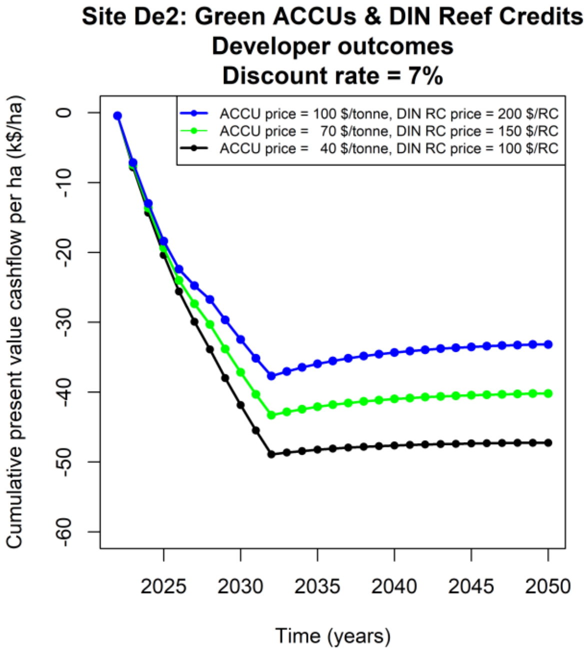


(d)

Figure 22b (Landholder scanerio 1): DCFA results for best performing stacked green ACCUs site ***De2*** *showing cumulative present value cashflow for the landholder (for the site as a whole) (a), for the landholder (per site hectare) (b), for the developer (for the site as a whole) (c) and for the developer (per site hectare) (d). All results reported a 25-year permanence period, a 7% real discount rate, an 8% annual cost of capital, and a 10-year loan term. Scenario 2: reduction in land value is $2509/ha and opportunity cost is $215/ha/year*

Table 26a (Landholder cost scenario 1): Summary results from DCFA for green ACCUs stacked with DIN Reef Credits on ***median*** *performing site* ***So3*** *under a 25-year permanence period. Reported for the project as a whole and per hectare. PV denotes present value. NPV denotes net present value. PV and NPV are calculated at 7% real discount rate, an 8% annual cost of capital, and a loan duration of 10 years. NPV is calculated over the full project duration of 28 years. PV cost reports the sum of all present value costs incurred during the 28-year project, including the cost of repaying the upfront loan (with interest). Scenario 1: reduction in land value is $5018/ha and opportunity cost is $430/ha/year.*

Green ACCUs and Reef Credits, median performing site So3						
Metric	**Site area (36.5ha)**			**Per hectare**		
Upfront loan	2.12 $ million			58 $k		
Developer's share of PV project cost	86.4			-		
Landholder's share of PV project cost	13.6			-		
Results for whole-of-project						
ACCU price ($/ACCU)	*40*	*70*	*100*	*40*	*70*	*100*
and DIN Reef Credits ($/kgDIN)	100	150	200	100	150	200
or 10-year env. credit ($/ha/year)	830	1245	1660	830	1245	1660
or 25-year env. credit ($/ha/year)	538	803	1071	538	803	1071
NPV ($k)	-2109	-1850	-1592	-57.8	-50.7	-43.6
Annualised equivalent NPV ($k/year)	-175	-154	-132	-4.8	-4.2	-3.6
Internal rate of return (%)	-	-	-	-	-	-
Results for landholder						
ACCU price ($/ACCU)	*40*	*70*	*100*	*40*	*70*	*100*
and DIN Reef Credits ($/kgDIN)	100	150	200	100	150	200
or 10-year env. credit ($/ha/year)	830	1245	1660	830	1245	1660
or 25-year env. credit ($/ha/year)	538	803	1071	538	803	1071
NPV ($k)	-287	-252	-216	-7.9	-6.9	-5.9
Annualised equivalent NPV ($k/year)	-24	-21	-18	-0.65	-0.57	-0.49
Cumulative PV cash flow ($k)	See Figure 23a (a)			See Figure 23a (b)		
Results for developer						
ACCU price ($/ACCU)	*40*	*70*	*100*	*40*	*70*	*100*
and DIN Reef Credits ($/kgDIN)	100	150	200	100	150	200
or 10-year env. credit ($/ha/year)	830	1245	1660	830	1245	1660
or 25-year env. credit ($/ha/year)	538	803	1071	538	803	1071
NPV ($k)	-1822	-1599	-1375	-49.9	-43.8	-37.7
Rate of return (%)	-	-	-	-	-	-
Cumulative PV cash flow ($k)	See Figure 23a (c)			See Figure 23a (d)		

* Upfront loan covers the following costs incurred by the developer: site preparation for planting, detailed planting design, sourcing planting stock, tree planting, development approval, annual weeding at the site for three years following tree planting, and 5% contingency. The loan is repaid, with interest (assuming the cost of capital is 8% per annum), via equal annual instalments over a 10-year term.

Table 26b (Landholder cost scenario 2): Summary results from DCFA for green ACCUs stacked with DIN Reef Credits on ***median*** *performing site* ***So3*** *under a 25-year permanence period. Reported for the project as a whole and per hectare. PV denotes present value. NPV denotes net present value. PV and NPV are calculated at 7% real discount rate, an 8% annual cost of capital, and a loan duration of 10 years. NPV is calculated over the full project duration of 28 years. PV cost reports the sum of all present value costs incurred during the 28-year project, including the cost of repaying the upfront loan (with interest). Scenario 2: reduction in land value is $2509/ha and opportunity cost is $215/ha/year.*

Green ACCUs and Reef Credits, median performing site So3							
Metric		**Site area (36.5ha)**			**Per hectare**		
Upfront loan		2.12 $ million			58 $k		
Developer's share of PV project cost		92.7%			-		
Landholder's share of PV project cost		7.3%			-		
Results for whole-of-project							
	ACCU price ($/ACCU)	*40*	*70*	*100*	*40*	*70*	*100*
and	DIN Reef Credits ($/kgDIN)	100	150	200	100	150	200
or	10-year env. credit ($/ha/year)	830	1245	1660	830	1245	1660
or	25-year env. credit ($/ha/year)	538	803	1071	538	803	1071
NPV ($k)		-1937	-1678	-1420	-53.1	-46	-38.9
Annualised equivalent NPV ($k/year)		-161	-139	-118	-4.4	-3.8	-3.2
Internal rate of return (%)		-	-	-	-	-	-
Results for landholder							
	ACCU price ($/ACCU)	*40*	*70*	*100*	*40*	*70*	*100*
and	DIN Reef Credits ($/kgDIN)	100	150	200	100	150	200
or	10-year env. credit ($/ha/year)	830	1245	1660	830	1245	1660
or	25-year env. credit ($/ha/year)	538	803	1071	538	803	1071
NPV ($k)		-142	-122	-104	-3.9	-3.4	-2.8
Annualised equivalent NPV ($k/year)		-12	-10	-9	-0.32	-0.28	-0.24
Cumulative PV cash flow ($k)		See Figure 23b (a)			See Figure 23b (b)		
Results for developer							
	ACCU price ($/ACCU)	*40*	*70*	*100*	*40*	*70*	*100*
and	DIN Reef Credits ($/kgDIN)	100	150	200	100	150	200
or	10-year env. credit ($/ha/year)	830	1245	1660	830	1245	1660
or	25-year env. credit ($/ha/year)	538	803	1071	538	803	1071
NPV ($k)		-1795	-1556	-1316	-49.2	-42.7	-36.1
Rate of return (%)		-	-	-	-	-	-
Cumulative PV cash flow ($k)		See Figure 23b (c)			See Figure 23b (d)		

* Upfront loan covers the following costs incurred by the developer: site preparation for planting, detailed planting design, sourcing planting stock, tree planting, development approval, annual weeding at the site for three years following tree planting, and 5% contingency. The loan is repaid, with interest (assuming the cost of capital is 8% per annum), via equal annual instalments over a 10-year term.

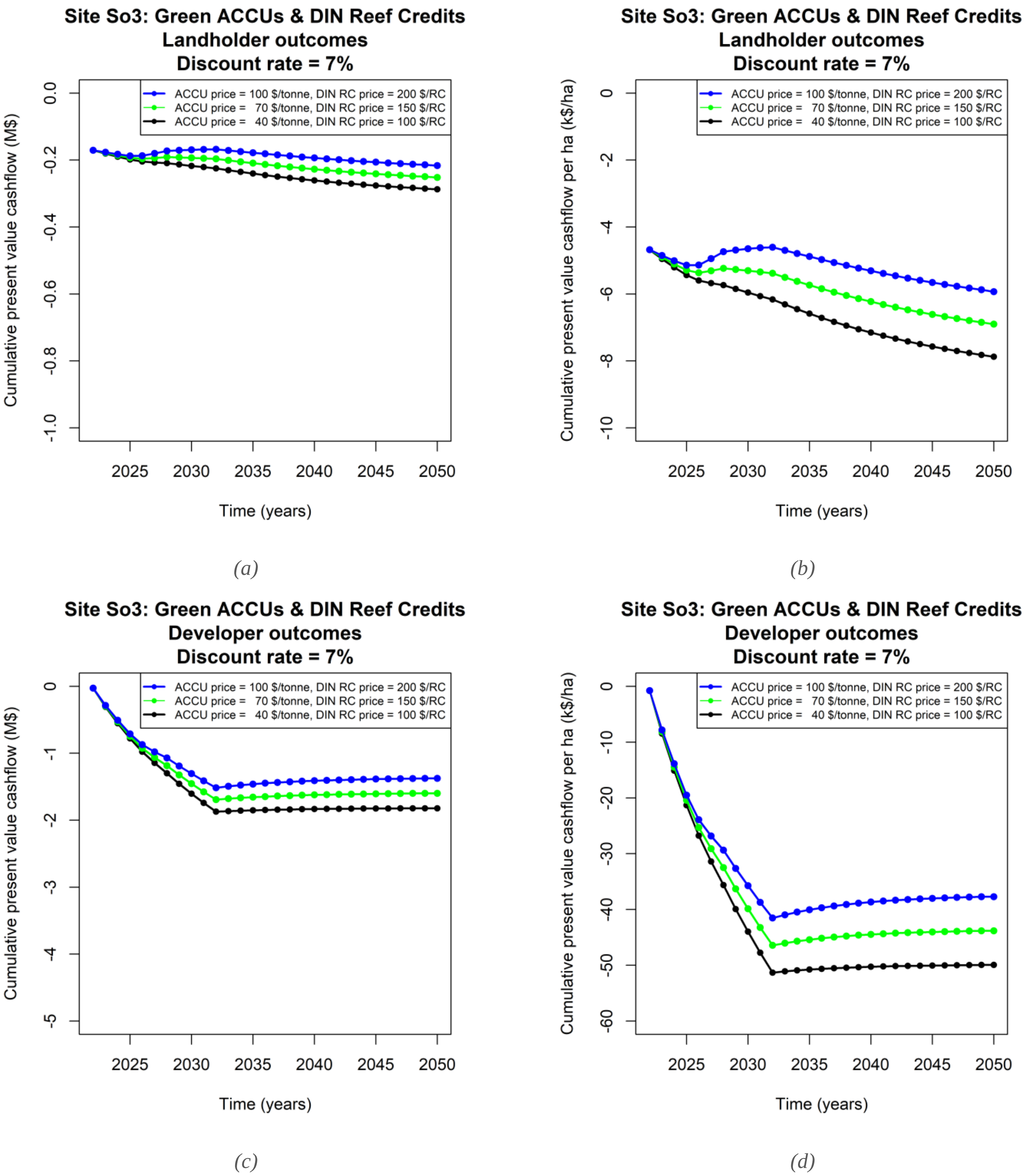
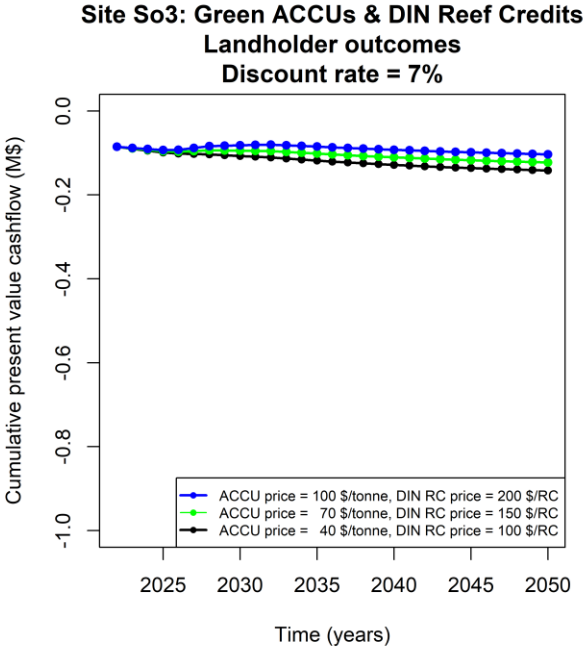


Figure 23a (Landholder cost scenario 1): DCFA results for ***median*** *performing stacked green ACCUs site* ***So3*** *showing cumulative present value cashflow for the landholder (for the site as a whole) (a), for the landholder (per site hectare) (b), for the developer (for the site as a whole) (c) and for the developer (per site hectare) (d). All results reported a 25-year permanence period, a 7% real discount rate, an 8% annual cost of capital, and a 10-year loan term. Scenario 1: reduction in land value is $5018/ha and opportunity cost is $430/ha/year.*



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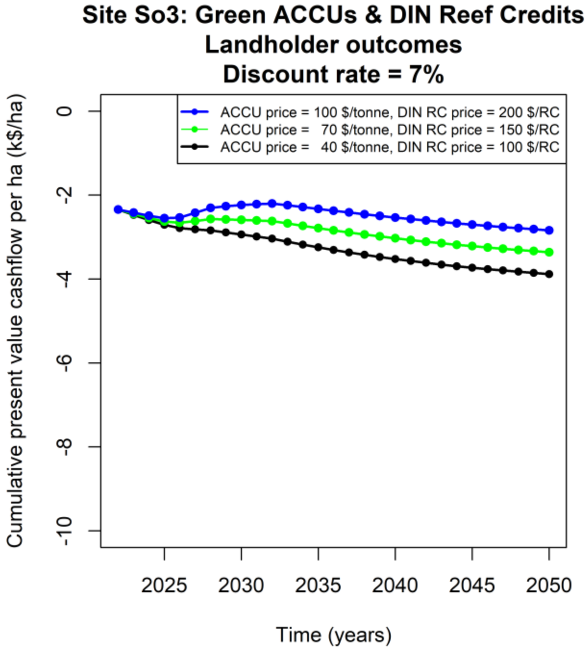

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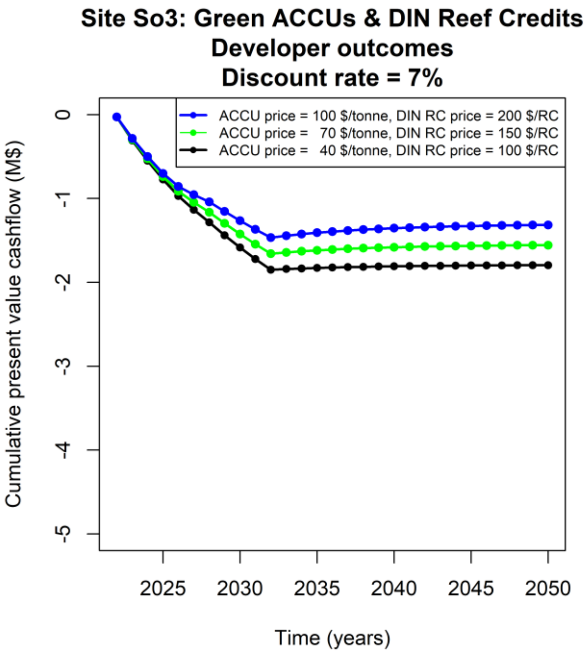

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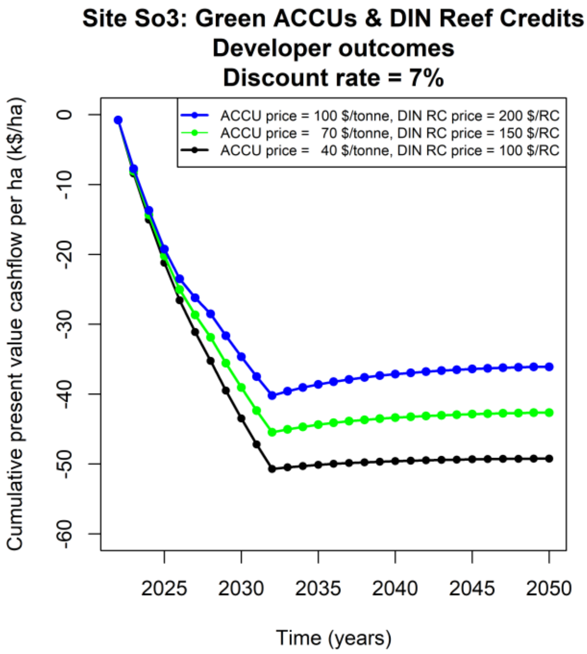


(d)

Figure 23b (Landholder cost scenario 1): DCFA results for ***median*** *performing stacked green ACCUs site* ***So3*** *showing cumulative present value cashflow for the landholder (for the site as a whole) (a), for the landholder (per site hectare) (b), for the developer (for the site as a whole) (c) and for the developer (per site hectare) (d). All results reported a 25-year permanence period, a 7% real discount rate, an 8% annual cost of capital, and a 10-year loan term. Scenario 2: reduction in land value is $2509/ha and opportunity cost is $215/ha/year.*

*Table 27a (Landholder cost scenario 1): Summary results from DCFA for green ACCUs stacked with DIN Reef Credits on **worst** performing site **Te5** under a 25-year permanence period. Reported for the project as a whole and per hectare. PV denotes present value. NPV denotes net present value. PV and NPV are calculated at 7% real discount rate, an 8% annual cost of capital, and a loan duration of 10 years. NPV is calculated over the full project duration of 28 years. PV cost reports the sum of all present value costs incurred during the 28-year project, including the cost of repaying the upfront loan (with interest). Scenario 1: reduction in land value is $5018/ha and opportunity cost is $430/ha/year.*

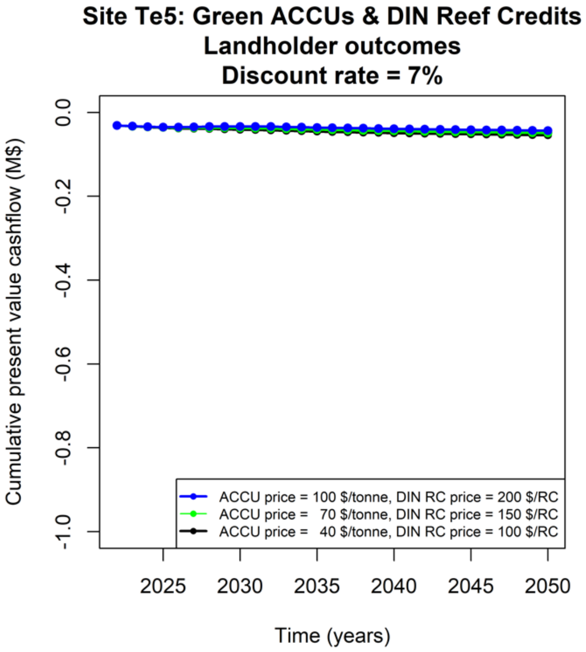
Green ACCUs and Reef Credits, worst performing site Te5						
Metric	**Site area (6.7ha)**			**Per hectare**		
Upfront loan	0.4 $ million			59.3 $k		
Developer's share of PV project cost	88.8			-		
Landholder's share of PV project cost	11.2			-		
Results for whole-of-project						
ACCU price ($/ACCU)	*40*	*70*	*100*	*40*	*70*	*100*
and DIN Reef Credits ($/kgDIN)	100	150	200	100	150	200
or 10-year env. credit ($/ha/year)	830	1245	1660	830	1245	1660
or 25-year env. credit ($/ha/year)	538	803	1071	538	803	1071
NPV ($k)	-481	-434	-388	-72.2	-65.2	-58.2
Annualised equivalent NPV ($k/year)	-40	-36	-32	-6	-5.4	-4.8
Internal rate of return (%)	-	-	-	-	-	-
Results for landholder						
ACCU price ($/ACCU)	*40*	*70*	*100*	*40*	*70*	*100*
and DIN Reef Credits ($/kgDIN)	100	150	200	100	150	200
or 10-year env. credit ($/ha/year)	830	1245	1660	830	1245	1660
or 25-year env. credit ($/ha/year)	538	803	1071	538	803	1071
NPV ($k)	-54	-49	-43	-8.1	-7.3	-6.5
Annualised equivalent NPV ($k/year)	-4	-4	-4	-0.67	-0.61	-0.54
Cumulative PV cash flow ($k)	See Figure 24a (a)			See Figure 24a (b)		
Results for developer						
ACCU price ($/ACCU)	*40*	*70*	*100*	*40*	*70*	*100*
and DIN Reef Credits ($/kgDIN)	100	150	200	100	150	200
or 10-year env. credit ($/ha/year)	830	1245	1660	830	1245	1660
or 25-year env. credit ($/ha/year)	538	803	1071	538	803	1071
NPV ($k)	-427	-386	-345	-64.1	-57.9	-51.7
Rate of return (%)	-	-	-	-	-	-
Cumulative PV cash flow ($k)	See Figure 24a (c)			See Figure 24a (d)		

* Upfront loan covers the following costs incurred by the developer: site preparation for planting, detailed planting design, sourcing planting stock, tree planting, development approval, annual weeding at the site for three years following tree planting, and 5% contingency. The loan is repaid, with interest (assuming the cost of capital is 8% per annum), via equal annual instalments over a 10-year term.

*Table 27b (Landholder cost scenario 2): Summary results from DCFA for green ACCUs stacked with DIN Reef Credits on **worst** performing site **Te5** under a 25-year permanence period. Reported for the project as a whole and per hectare. PV denotes present value. NPV denotes net present value. PV and NPV are calculated at 7% real discount rate, an 8% annual cost of capital, and a loan duration of 10 years. NPV is calculated over the full project duration of 28 years. PV cost reports the sum of all present value costs incurred during the 28-year project, including the cost of repaying the upfront loan (with interest). Scenario 2: reduction in land value is $2509/ha and opportunity cost is $215/ha/year.*

Green ACCUs and Reef Credits, worst performing site Te5						
Metric	**Site area (6.7ha)**			**Per hectare**		
Upfront loan	0.4 $ million			59.3 $k		
Developer's share of PV project cost	94.1%			-		
Landholder's share of PV project cost	5.9%			-		
Results for whole-of-project						
ACCU price ($/ACCU)	*40*	*70*	*100*	*40*	*70*	*100*
and DIN Reef Credits ($/kgDIN)	100	150	200	100	150	200
or 10-year env. credit ($/ha/year)	830	1245	1660	830	1245	1660
or 25-year env. credit ($/ha/year)	538	803	1071	538	803	1071
NPV ($k)	-449	-403	-356	-67.5	-60.5	-53.5
Annualised equivalent NPV ($k/year)	-37	-33	-30	-5.6	-5	-4.4
Internal rate of return (%)	-	-	-	-	-	-
Results for landholder						
ACCU price ($/ACCU)	*40*	*70*	*100*	*40*	*70*	*100*
and DIN Reef Credits ($/kgDIN)	100	150	200	100	150	200
or 10-year env. credit ($/ha/year)	830	1245	1660	830	1245	1660
or 25-year env. credit ($/ha/year)	538	803	1071	538	803	1071
NPV ($k)	-27	-24	-21	-4	-3.6	-3.2
Annualised equivalent NPV ($k/year)	-2	-2	-2	-0.33	-0.3	-0.26
Cumulative PV cash flow ($k)	See Figure 24b (a)			See Figure 24b (b)		
Results for developer						
ACCU price ($/ACCU)	*40*	*70*	*100*	*40*	*70*	*100*
and DIN Reef Credits ($/kgDIN)	100	150	200	100	150	200
or 10-year env. credit ($/ha/year)	830	1245	1660	830	1245	1660
or 25-year env. credit ($/ha/year)	538	803	1071	538	803	1071
NPV ($k)	-423	-379	-335	-63.5	-56.9	-50.4
Rate of return (%)	-	-	-	-	-	-
Cumulative PV cash flow ($k)	See Figure 24b (c)			See Figure 24b (d)		

* Upfront loan covers the following costs incurred by the developer: site preparation for planting, detailed planting design, sourcing planting stock, tree planting, development approval, annual weeding at the site for three years following tree planting, and 5% contingency. The loan is repaid, with interest (assuming the cost of capital is 8% per annum), via equal annual instalments over a 10-year term.



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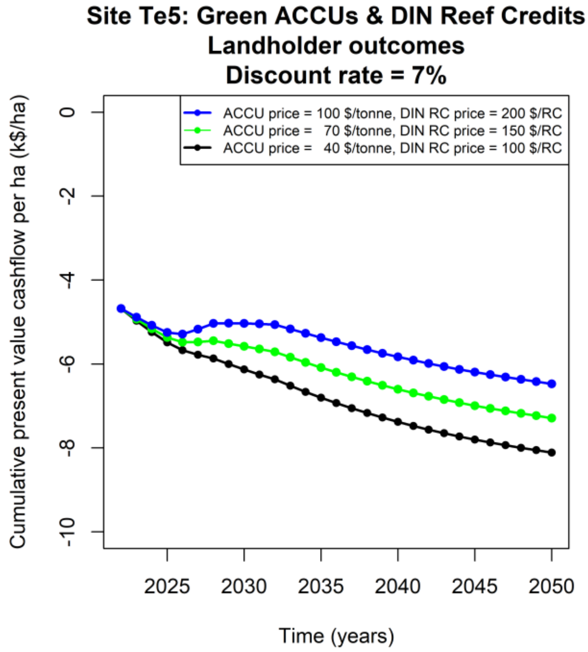

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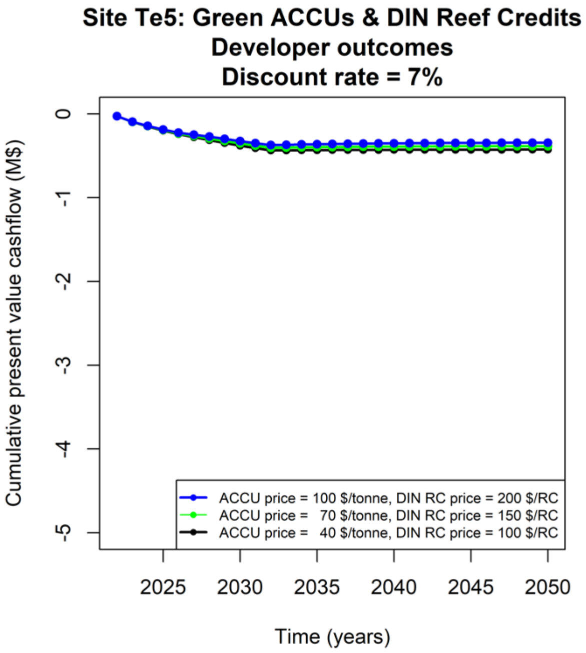

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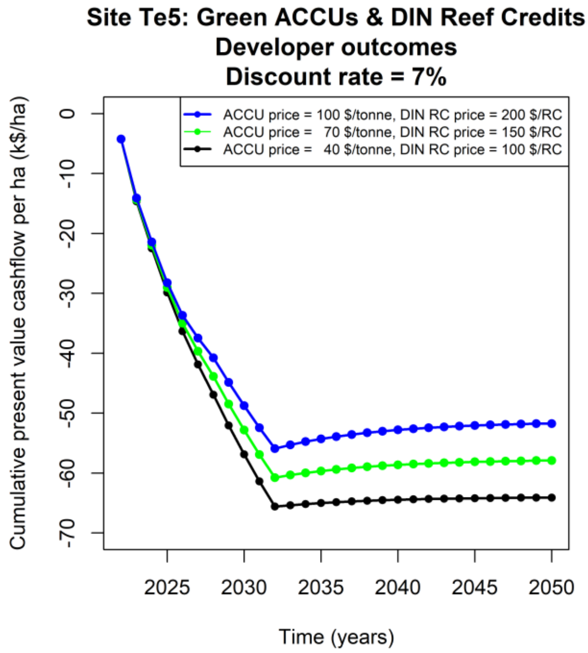
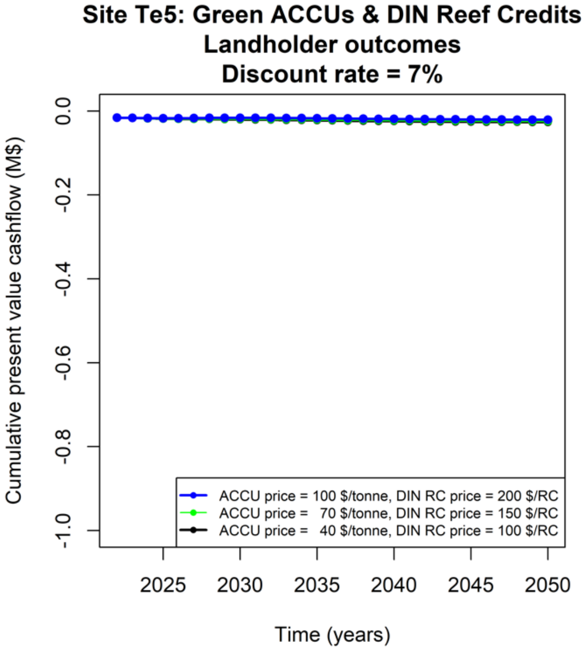


(d)

Figure 24a (Landholder cost scenario 1) DCFA results for ***worst*** *performing stacked green ACCUs site* ***Te5*** *showing cumulative present value cashflow for the landholder (for the site as a whole) (a), for the landholder (per site hectare) (b), for the developer (for the site as a whole) (c) and for the developer (per site hectare) (d). All results reported a 25-year permanence period, a 7% real discount rate, an 8% annual cost of capital, and a 10-year loan term. Scenario 1: reduction in land value is $5018/ha and opportunity cost is $430/ha/year.*



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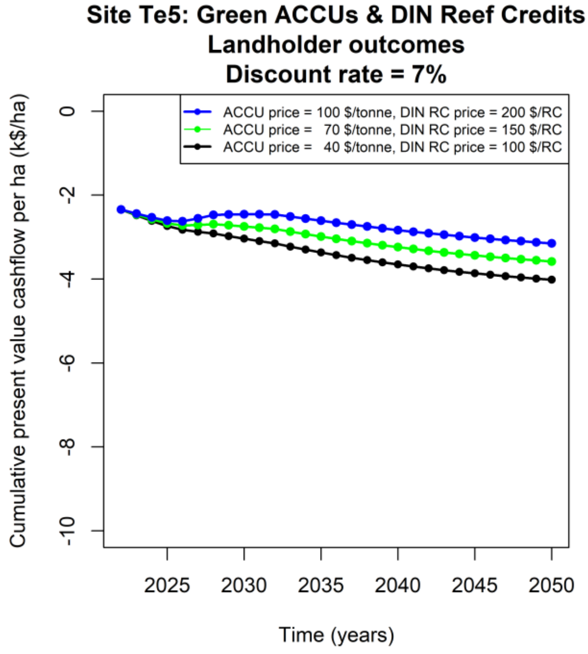

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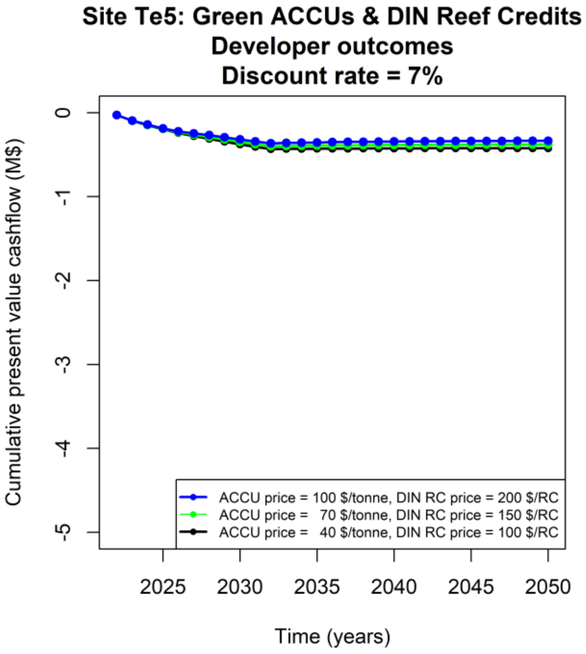

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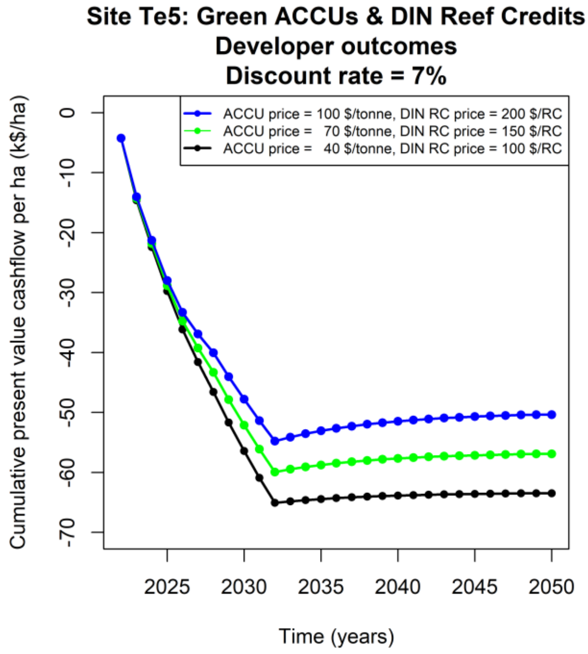

(d)

*Figure 24b (Landholder cost scenario 2) DCFA results for **worst** performing stacked green ACCUs site **Te5** showing cumulative present value cashflow for the landholder (for the site as a whole) (a), for the landholder (per site hectare) (b), for the developer (for the site as a whole) (c) and for the developer (per site hectare) (d). All results reported a 25-year permanence period, a 7% real discount rate, an 8% annual cost of capital, and a 10-year loan term. Scenario 2: reduction in land value is $2509/ha and opportunity cost is $215/ha/year.*

6.2.1 Costs & Co-benefits of Green Carbon Projects

Carbon sequestration & Environmental Benefits

The carbon sequestered in woody biomass over the 25-year permanence period would help reduce carbon dioxide concentrations in the atmosphere, contributing to global greenhouse gas mitigation efforts. Forest cover also reduces local temperatures by providing shade and can regulate local weather systems, influencing rainfall patterns via evapotranspiration.

Through their extensive root systems, forests stabilise the soil, preventing erosion and sedimentation of water bodies, helping to maintain local water quality. Through impeding and slowing water flows, forests can also increase soil infiltration and groundwater recharge, facilitating water availability (Brandon, 2014).

Biodiversity & Conservation

The Wet Tropics World Heritage Area provides a diversity of habitats and niches for 3,639 vertebrate and plant species, more than 65,000 insect species and is ranked sixth in the world for its threatened and endemic species (UNESCO World Heritage Centre, 2023b; Wet Tropics Management Authority, n.d.-b). Reforestation projects in the Mossman district therefore have the potential to become important biodiversity and conservation hubs. With species in the district threatened by habitat loss, alteration, and fragmentation, reforestation projects have the potential to increase the area of available habitat, increase habitat connectivity and provide critical habitat for numerous species, particularly those that are threatened and/or endemic to the region, such as the Southern cassowary, Spotted-tailed quoll (Northern sub-species), Rupert’s Mangosteen and the Mount Lewis Stink Bush (Department of Environment, 2016).

Cultural heritage, recreation and education

Forests and Tropical Rainforests provide a wide range of cultural, recreational, and educational benefits, serving as valuable natural assets for communities and visitors alike. Traditional owners and local communities may have deep cultural connections to forest ecosystems and Country, serving as sites for cultural practices and traditions (Pert et al., 2015). Forests also have a high aesthetic appeal and offer diverse recreational opportunities for people to enjoy nature and engage in outdoor activities. Activities such as birdwatching, hiking, and wildlife photography are popular recreational pursuits in forest areas, attracting visitors and promoting ecotourism. Forests also serve as valuable educational resources for formal and informal learning, providing hands-on opportunities for environmental education, allowing students, educators, and the general public to learn about forest and rainforest ecology, biodiversity, conservation, and the importance of their ecosystem services.

Costs and Risks

The carbon storage potential of forests is negatively affected by climate change and associated events such as drought, bushfires, and disease (Anderegg et al., 2020). Therefore, whilst green carbon projects may help mitigate atmospheric greenhouse gas concentrations and the impacts of climate change, unless broader and more substantial action is taken globally to reduce global greenhouse gas emissions, green carbon projects require risk management plans and activities to ensure that their carbon stores are not reversed in future.

6.3 BLUE CARBON SITES

Discounted cash flow analyses were conducted for the following projects at the three case study sites:

- BlueCAM 'Blue ACCUs' alone
- BlueCAM 'Blue ACCUs' *hypothetically stacked* with DIN Reef Credits

A project to potentially combine BlueCAM Blue ACCUs, FullCAM Green ACCUs (on the remaining un-inundated areas of the site) and DIN Reef Credits was not evaluated via discounted cash flow analysis (DCFA) because DCFAs of stand-alone Green ACCUs projects indicated that they were not economically viable (see 'Green ACCUs Discounted Cash Flow Analysis: Results').

The DCFAs reported for this site and subsequent sites 2 and 3 were undertaken under landholder cost Scenarios 1, 2 and 3 with the key parameter settings and ranges shown in Table 28.

Table 28: Parameter settings for discounted cash flow analyses of projects at Sites 1, 2 and 3.

Parameter	Setting
Real discount rate	7% per annum
Cost of capital	8% per annum
Loan duration	10 years
ACCU pricing	Between 30 and 100 $/ACCU in steps of $5
DIN Reef Credit pricing	\$100/credit, \$150/credit and \$200/credit
Project permanence period	25 years
Project crediting periods	25 years for Blue carbon ACCUs 10 years for DIN Reef Credits
Lead-in Time	3 years for Blue carbon ACCUs 3 years for Blue carbon ACCUs and DIN Reef Credits combined
Total project duration	29 years for Blue carbon ACCUs 29 years for Blue carbon ACCUs and DIN Reef Credits combined

DCFA results under the different landholder cost scenarios,with and without stacking, for all three sites are reported in the following sets of tables and figures:

- Site 1: Table 30, Table 31,
- Figure 28, Figure 29, Figure 30, Figure 31, Figure 32, Figure 33
- Site 2: Table 34, Table 35, Figure 37, Figure 38, Figure 39, Figure 40, Figure 41, Figure 42
- Site 3: Table 38, Table 39, Figure 46, Figure 47, Figure 48, Figure 49, Figure 50, Figure 51

6.4 BLUE CARBON SITE RESULTS

6.5 SUMMARY

Blue Carbon Sites: Discounted Cash Flow Analysis: Results

Key results from the DCFAs for the three blue carbon case study sites under landholder cost scenarios 1, 2 and 3 are summarised as follows:

- Tidal re-introduction will typically only regenerate blue carbon ecosystems over part of the project site. However, areas that remain dry will likely be heavily fragmented, preventing their use for agricultural production. Blue carbon revenues and (and potentially other environmental credits) are only likely to be produced by the regenerating blue carbon ecosystems which will typically comprise only a portion of the site. However, (depending on which landholder cost scenario is applied) landholder(s) incur opportunity cost and reduction in land value across the full project area. This has two important implications. Firstly, at blue ACCUs sites costs to the landholder account for a much higher proportion of total project cost than was the case at green ACCUs sites. Landholder's costs comprised between 75% and 84% of total costs at our case study sites at the upper bound estimates of opportunity cost ($430/ha/year) and reduction in land value ($5018/ha) (Scenario 1). At the mid-point estimates of opportunity cost ($215/ha/year) and reduction in land value ($2509/ha) (Scenario 2), the proportions of project costs borne by landholders were between 60% and 68%, and at the lower bound estimates (Scenario 3), total project cost share for the landholder(s) ranged between 43% and 57%. Secondly, sites at which simple, low-cost interventions to re-instate tidal flows yield large areas of environmental credit-generating blue carbon ecosystems will be the most cost-effective, particularly if only a small number of landholders are involved.
- DCFA results identified Site 1 as potentially the best performing blue carbon case study site. Whilst it is not the largest site, 50% of total site area reverts to blue carbon ecosystems when tidal flows are re-introduced (through a relatively simple intervention). Site 3 is the worst performing site, mainly because only 15% of that site reverts to blue carbon ecosystems for a similar intervention cost.
- None of the blue carbon case study sites delivered positive whole-of-project NPVs from blue carbon credits alone under all three landholder cost scenarios across the range of ACCU pricing explored (between $30 and $100 per ACCU).

  When BlueCAM 'blue ACCUs' are hypothetically stacked with DIN Reef Credits (as a proxy for potential stacking with other forms of marketable environmental credits or certificates), positive whole-of-project NPVs can be obtained at approximately current levels of environmental credit pricing under landholder cost scenario 3 (lower-bound estimates) and estimated levels of implementation cost for all three case study sites. Higher ACCU prices and stacked credit pricing could potentially produce positive NPVs under higher landholder cost scenarios (Scenarios 1 and 2). However, the levels of environmental credit pricing required to achieve these outcomes are far beyond any existing market prices for environment credits, including carbon.
- Environmental credit net revenue flows that would deliver positive whole-of-project NPVs could potentially be obtained from schemes such as NaturePlus™, the Nature Repair Market, or Coastal Resilience Credits. However, the required net revenue flows from these sources are very high, far exceeding any pricing that has been seen currently or historically for environmental market credits in Australia.
- This illustrative analysis shows that the stacked environmental credit revenue required to achieve positive whole-of-project NPV outcomes at our blue carbon case study sites is sensitive to a landholder's perception of the level of costs they are likely to incur when they sign up to a blue carbon and/or other environmental credit market project. Further investigation into the driving factors behind landholders' perceptions of costs could be a useful endeavour for further research.

- There are currently no measured costs for land conversion to blue carbon ecosystems in Mossman district. Cost estimates and project timelines in our analyses were estimated based on the best information from publicly available sources and detailed interviews with Terrain NRM, the Clean Energy Regulator, GreenCollar, the Land Restoration Fund, Douglas Shire Council, Greening Australia, and Eco-Markets Australia. However, these costs should still be regarded as somewhat uncertain until the costs of converting land to blue carbon wetland have been determined by implementing blue carbon wetlands at several sites along the Reef coastline. (In comparison, the uncertainty surrounding cost estimates for rainforest restoration is likely to be substantially lower.)
- Economic outcomes from blue carbon projects are likely to be sensitive to the costs incurred in project engagement, conceptualisation, establishment, production and commercialisation. Many of these costs are likely to be highly site and context-specific.This suggests that cross calibrating cost estimates for implementing and operating blue carbon projects in Mossman with the costs incurred in implementing on-going blue carbon projects elsewhere around Australia's coastline – as actual implementation costs at other sites begin to emerge – would be a useful endeavour for future research. So too would investigation into the factors that influence different elements of these costs.
- Finally, risks should be considered in future studies because they will influence participation, revenue sharing and benchmark rates of returns. We have not considered risks in this study to keep our discounted cash flow analysis tractable.

6.6 SITE 1

6.6.1 SITE DESCRIPTION

This project site is approximately 246 ha and is located in the oxbow breakout point on the Daintree River, upstream of the car ferry to Cape Tribulation. The site is the second largest proposed under this assessment, spanning three landholder properties. There are several occupied and unoccupied houses/buildings within the vicinity of the site, however these are not projected to be inundated as a result of engineering works conducted at the site but may be at risk of inundation at the HAT in 2107 as a result of sea level rise. The site is likely at the lower end of sugarcane yield, particularly in the lower-lying areas of the site, with prolific environmental weeds. Earth-dug drains with one-way tidal exclusion pipes seem to prevent tidal upstream incursion; the legality of these structures has not been confirmed (

Figure 25). As the site is low-lying, it has the potential for relatively minor earthworks to remove the tidal gates as part of a blue carbon project, in addition to landscape reprofiling to maximise tidal inundation over areas of the site. Removing the sugarcane from the site and replacing the more elevated areas with tree planting could attract green carbon[6] and DIN Reef Credits, while restoration and maintenance of the oxbow area to keep it free from freshwater aquatic weeds could provide a potential habitat for native fauna species to colonise. Moreover, the creation of coastal wetland habitat (i.e., saltmarsh and mangrove) could increase local biodiversity and provide habitat for migratory birds, making the site potentially eligible for a project under the Land Restoration Fund, the emerging Nature Repair Market and Coastal Resilience Credit schemes, once established.

Figure 25: Example of a one-way tidal gate at Site 1 (left) and drain (right) on the site with a range of aquatic freshwater invasive plants and some natives.

6.6.2 HYDROLOGICAL MODELLING

Based on three hydrodynamic model simulation scenarios, we mapped the maximum inundation area associated with the water level at the HAT (1.7 m), HAT+SLR 2057 (2.07 m) and HAT+SLR 2107 (2.5 m). The areas with lowest elevation and higher inundation depth are located inside the oxbow meander of the river as well as along current drainage channels at the site (Figure 26). Total inundation under these three scenarios is summarised in Table 32. Following the removal of three tidal gates and landscape reprofiling to the east of the site, the site will experience an inundation depth of 1.7 m at the HAT, inundating 96.24 ha of the site, of which 34.52 ha is former sugarcane plantation (Table 32).

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[6] DCFAs for indicative green ACCUs sites in Mossman district suggested that green ACCUs projects aimed at rainforest restoration were extremely unlikely to be economically viable. Given this finding, we did not investigate stacking green ACCUs with blue ACCUs on our case study blue ACCUs sites because the very high costs of green ACCUs plantings to generate ACCUs via the Forest Regeneration via Environmental and Mallee Plantings: FullCAM Method would reduce – rather than increase – the economic viability of the blue ACCUs component.

Figure 26: Inundation levels of case study site 1 under the current highest astronomical tide (HAT) (A.), as well as inundation by year 2057 (B.) and 2107 (C.) due to climate change. Boundaries were generalised for modelling and resulting inundation was reduced to the boundary to highlight inundated areas specific to the site. Mill crop coverage data provided by the Mossman Agricultural Services.

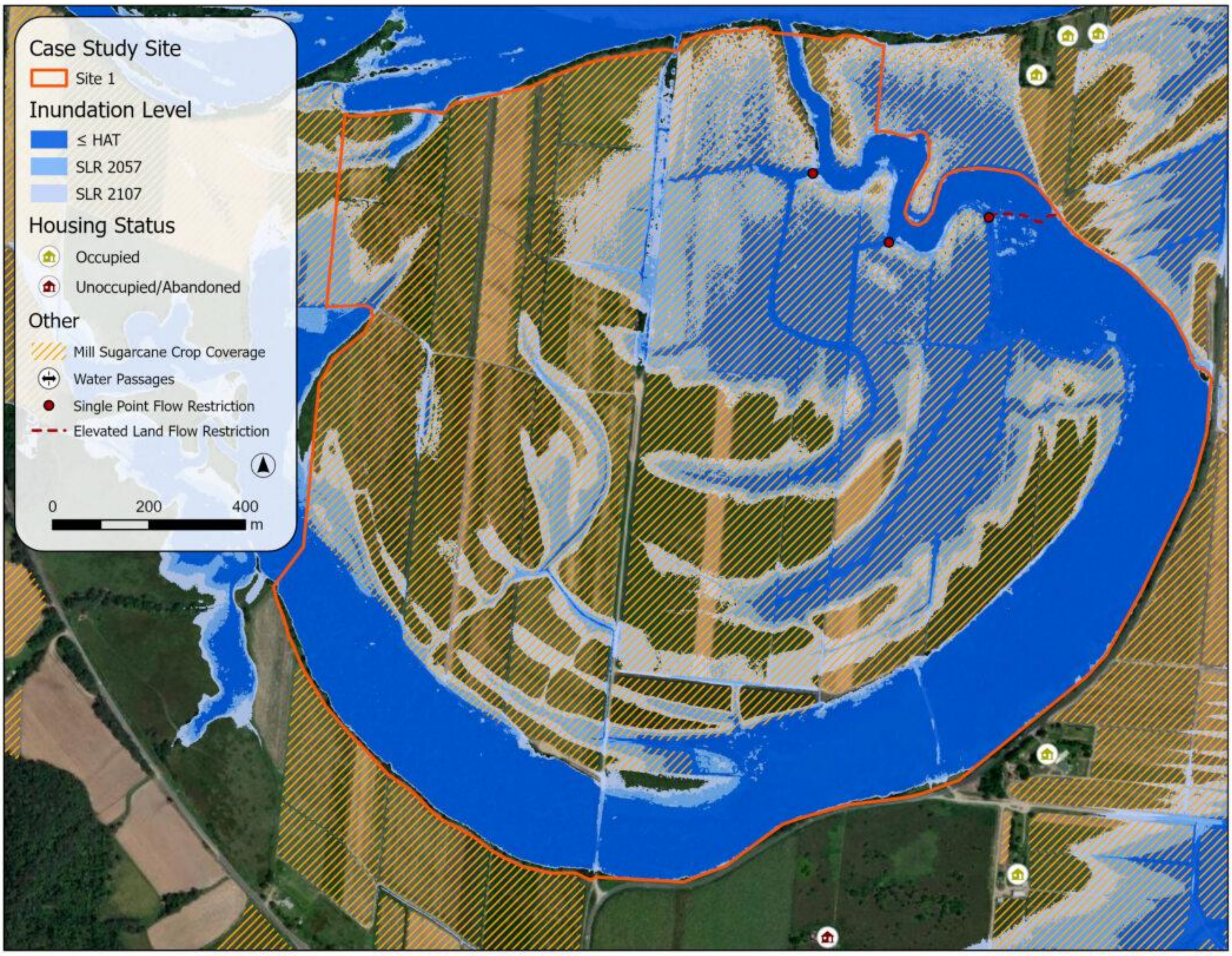


Figure 27: Site 1 theoretical boundary. Inundation levels include all inundation to the current highest astronomical tide (HAT), as well as inundation by year 2057 (SLR 2057) and 2107 (SLR 2107) due to climate change. Flow restrictions represent the optimum areas that can potentially be lowered or removed for the maximum amount and longevity of inundation. These restrictions mainly consist of entrances to drainage lines from the site to natural wetlands/oceans (e.g., tidal flood gates) and areas of higher elevation (e.g., levees). Houses and/or private properties within the vicinity, and potentially affected by inundation, were identified as either currently occupied or abandoned based on visual inspection of imagery. Mill crop coverage data provided by the Mossman Agricultural Services.

6.6.3 BLUECAM OUTPUTS

The Carbon Estimation Areas (CEAs) for this blue carbon restoration site was designated as mostly mangrove (100 ha) with the remaining project area saltmarsh (27.4 ha) with an elevation of the CEAs set to 2.1 AHD (note that the CEA allocations here might vary with more detailed assessment of the site). On this basis, the net abatement amount for Site 1 in BlueCAM is:

Table 29: BlueCAM output, i.e., tonnes of CO2 equivalent (CO2e) sequestered at Site 1 over a 25-year crediting period for a project with a 100-year permanence period.

Year	Tonnes CO_2e sequestered (BlueCAM)
2024	100.2
2029	4,084.4
2034	8,075.3
2039	12,073.4
2044	16,081.6
2049	20,095.9
2057	26,538.9

Site 1: Discounted Cash Flow Analysis: Results tables and figures

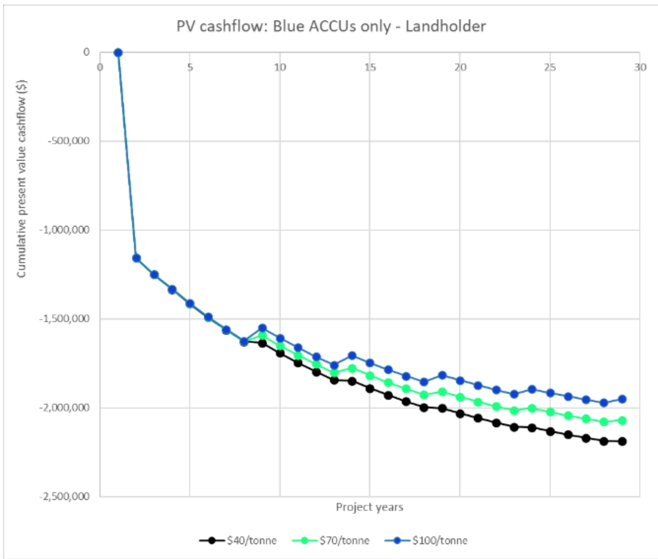
Site 1: BlueCAM 'Blue ACCUs' standalone

DCFA results are summarised in Table 30.

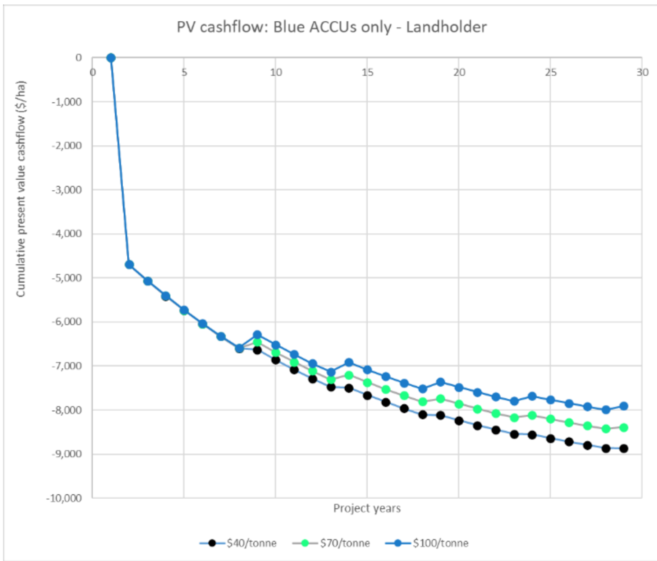
*Table 30: Summary results from DCFA for a standalone blue ACCUs project at case study site 1. Reported for 247 ha project area and per hectare of project area. PV denotes present value. NPV denotes net present value. PV and NPV are calculated at 7% real discount rate. NPV is calculated over the full project duration of 29 years. PV upfront loan covers the following costs: detailed project design, development approval and on-site works. *A worked example for whole-of-project NPV outcome is provided in Appendix 9. Landholder cost scenarios: Scenario 1: reduction in land value is $5018/ha and opportunity cost is $430/ha/year; Scenario 2: reduction in land value is $2509/ha and opportunity cost is $215/ha/year; and. Scenario 3 assumes reduction in land value is $2509/ha and opportunity cost is zero. Results for Scenarios 1, 2 and 3 are reported for whole-of-project only.*

Metric	Project site (247ha)			Per site hectare		
Upfront loan ($)	221,382			897		
Developer's share of PV project cost (%)						
Scenario 1	21.4			-		
Scenario 2	35.2			-		
Scenario 3	52.4			-		
Landholder's share of PV project cost (%)						
Scenario 1	78.6			-		
Scenario 2	64.8			-		
Scenario 3	47.6			-		
Results for whole-of-project						
ACCU price ($/ACCU)	*40*	*70*	*100*	*40*	*70*	*100*
NPV ($k)						
Scenario 1	-2782*	-2632	-2482	-11.3	-10.7	-10.1
Scenario 2	-1610	-1460	-1309	-6.5	-5.9	-5.3
Scenario 3	-1016	-865	-715	-4.1	-3.5	-2.9
Annualised equivalent NPV ($k/year)						
Scenario 1	-227*	-214	-202	-0.92	-0.87	-0.82
Scenario 2	-131	-119	-106	-0.53	-0.48	-0.43
Scenario 3	-83	-70	-58	-0.33	-0.29	-0.24
Internal rate of return (%)	-	-	-	-	-	-

Results for landholder						
ACCU price ($/ACCU)	*40*	*70*	*100*	*40*	*70*	*100*
NPV ($k)						
Scenario 1	-2188	-2069	-1951	-8.87	-8.39	-7.91
Scenario 2	-1043	-945	-848	-4.2	-3.8	-3.4
Scenario 3	-483	-411	-340	-2.0	-1.7	-1.4
Annualised equivalent NPV ($k/year)						
Scenario 1	-178	-169	-159	-0.72	-0.68	-0.64
Scenario 2	-84.9	-77.0	-69.1	-0.34	-0.31	-0.28
Scenario 3	-39.3	-33.5	-27.7	-0.16	-0.14	-0.11
Cumulative PV cash flow ($)	See Figure 28, Figure 29, Figure 30			See Figure 28, Figure 29, Figure 30		
Results for developer						
ACCU price ($/ACCU)	*40*	*70*	*100*	*40*	*70*	*100*
NPV ($k)						
Scenario 1	-595	-563	-531	-2.41	-2.28	-2.15
Scenario 2	-567	-514	-461	-2.30	-2.09	-1.87
Scenario 3	-533	-454	-375	-2.16	-1.84	-1.52
Rate of return (%)	-	-	-	-	-	-
Cumulative PV cash flow ($)	See Figure 28, Figure 29, Figure 30			See Figure 28, Figure 29, Figure 30		



(a)



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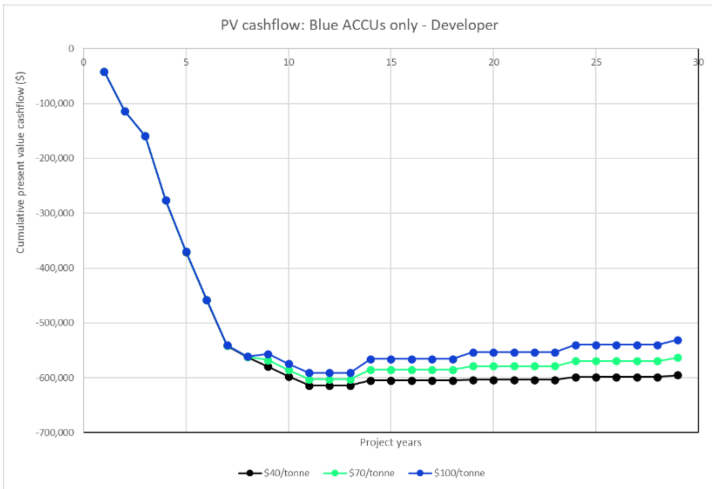

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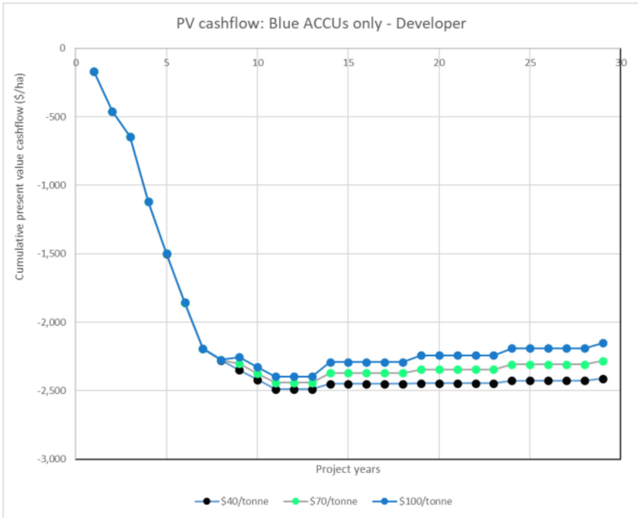
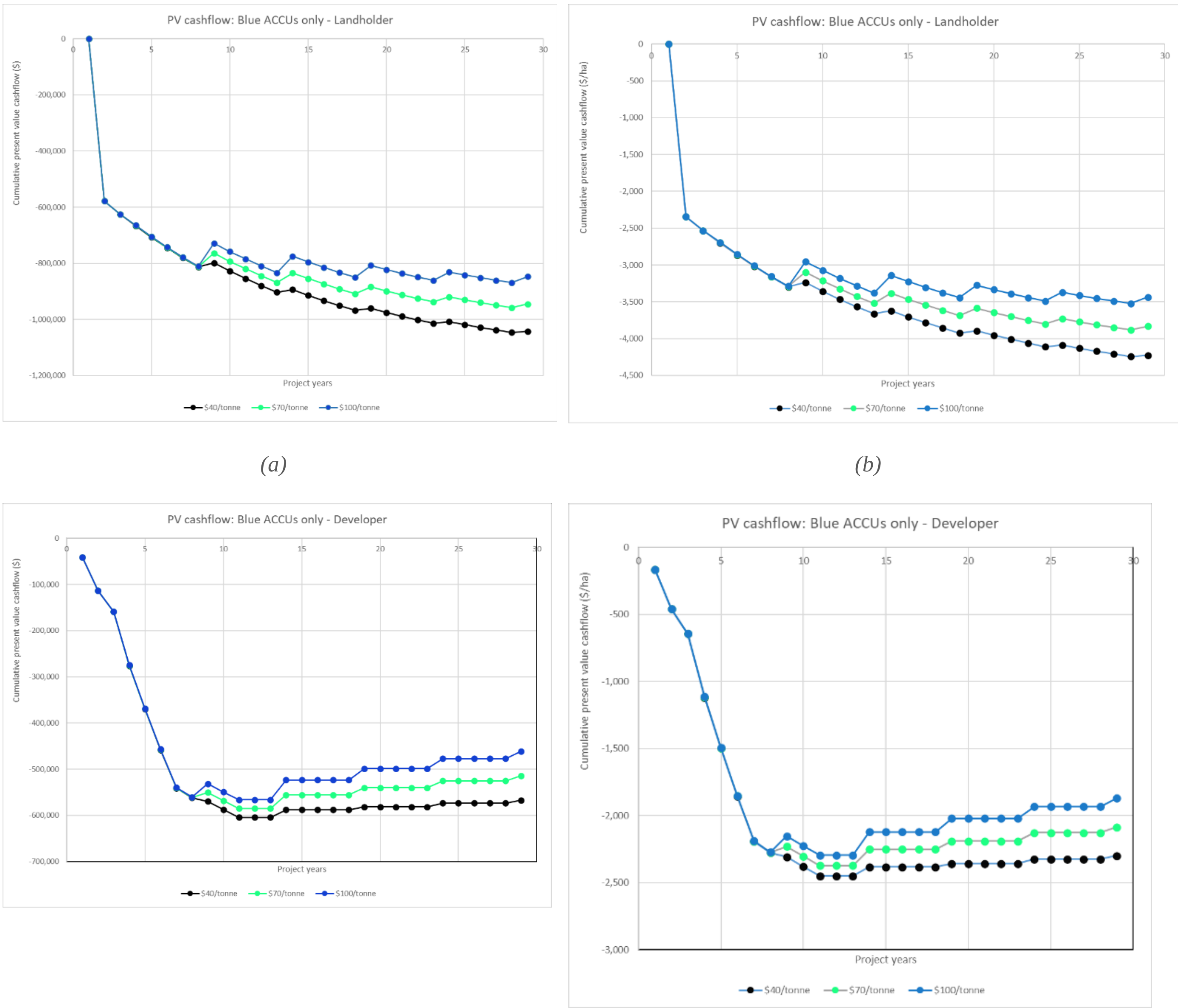


(d)

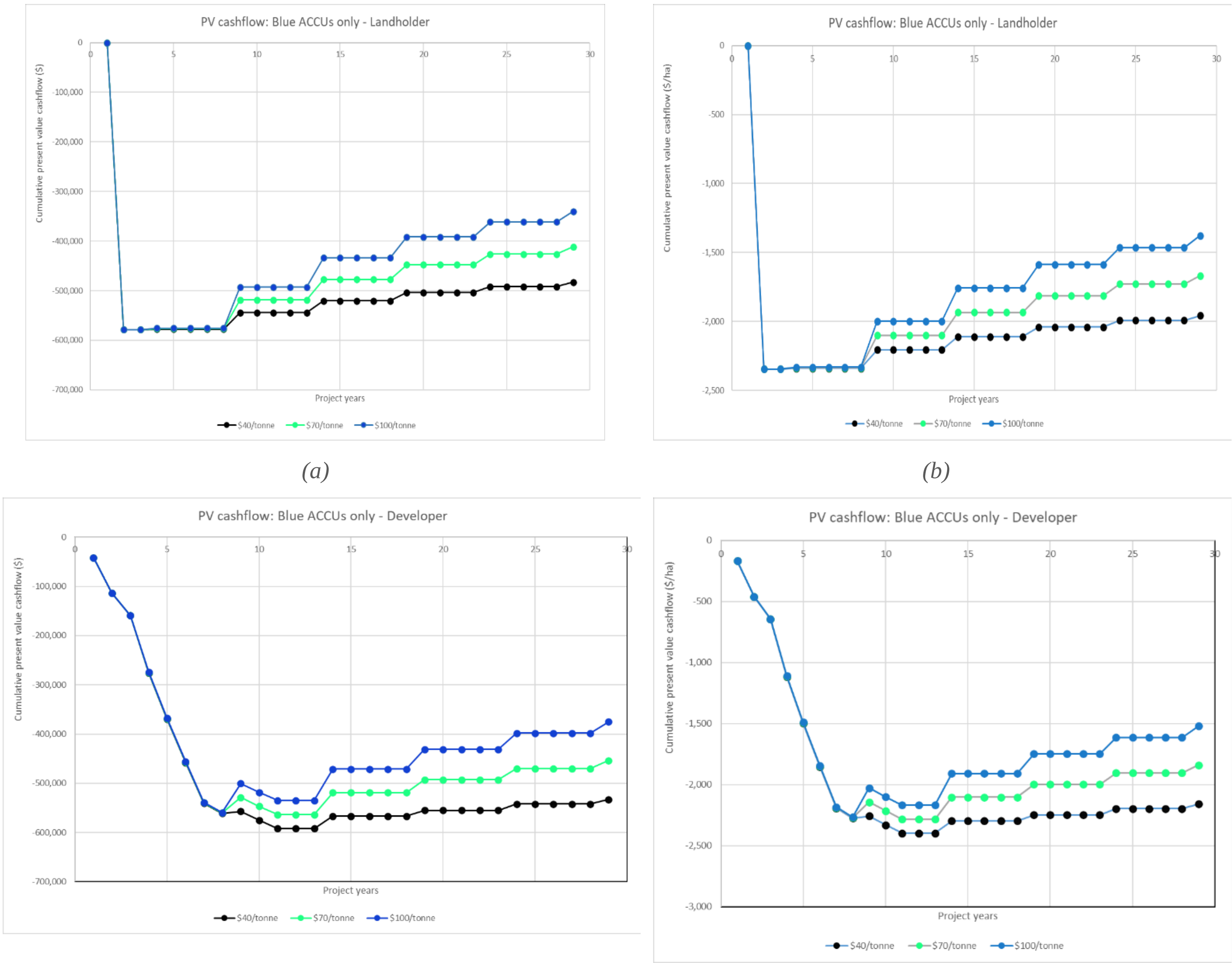
Figure 28 (Landholder cost scenario 1): Cumulative present value cashflows for case study site 1, blue ACCUs only. Plots show cumulative present value cashflows: (a) for the landholder (for the site as a whole), (b) for the landholder (per site hectare), (c) for the developer (for the site as a whole), and (d) for the developer (per site hectare). All results reported a 25-year permanence period, a 7% real discount rate, an 8% annual cost of capital, and a 10-year loan term. Scenario 1: reduction in land value is $5018/ha amd opportunity cost is $430/ha/year.



(a) *(b)*

(c) *(d)*

Figure 29 (Landholder cost scenario 2): Cumulative present value cashflows for case study site 1, blue ACCUs only. Plots show cumulative present value cashflows: (a) for the landholder (for the site as a whole), (b) for the landholder (per site hectare), (c) for the developer (for the site as a whole), and (d) for the developer (per site hectare). All results reported a 25-year permanence period, a 7% real discount rate, an 8% annual cost of capital, and a 10-year loan term. Scenario 2: reduction in land value is $2509/ha amd opportunity cost is $215/ha/year.



(a) *(b)*

(c) *(d)*

Figure 30 (Landholder cost scenario 3): Cumulative present value cashflows for case study site 1, blue ACCUs only. Plots show cumulative present value cashflows: (a) for the landholder (for the site as a whole), (b) for the landholder (per site hectare), (c) for the developer (for the site as a whole), and (d) for the developer (per site hectare). All results reported a 25-year permanence period, a 7% real discount rate, an 8% annual cost of capital, and a 10-year loan term. Scenario 3: reduction in land value is $2509/ha amd opportunity cost is $0/ha/year.

SITE 1: BLUECAM BLUE CARBON STACKED WITH DIN REEF CREDITS

DCFA results are summarised in Table 31.

Table 31: Summary results from DCFA for a blue ACCUs and stacked DIN Reef Credits project at Cast Study site 1. Reported for 247ha project area and per hectare of project area. PV denotes present value. NPV denotes net present value. PV and NPV are calculated at 7% real discount rate. NPV is calculated over the full project duration of 29 years. PV upfront loan covers the following costs: detailed project design, development approval and on-site works. Results for the PV revenue and NPV are presented for the following combinations of: (i) ACCU and DIN Reef Credit prices at $40/ACCU & $100/RC ; $70/ACCU & $150/RC; $100/ACCU & $200/RC, (ii) ACCU price and a 10-year environmental credit payments at $40/ACCU & $1657/wetland ha/year; $70/ACCU & $2486/wetland ha/year; $100/ACCU & $3314/wetland ha/year, or (iii) ACCU price and a 25-year environmental credit payments at $40/ACCU & $1144/wetland ha/year; $70/ACCU & $1715/wetland ha/year; $100/ACCU & $2287/wetland ha/year. Landholder cost scenarios: Scenario 1: reduction in land value is $5018/ha and opportunity cost is $430/ha/year; Scenario 2: reduction in land value is $2509/ha and opportunity cost is $215/ha/year; and Scenario 3 assumes the reduction in land value is $2509/ha and opportunity cost is $0/ha/year.

Quantity of Reef Credits per ha: 8.05						
Metric	**Project site (247ha)**			**Per site hectare**		
Upfront loan ($)	221,382			897		
Developer's share of PV project cost (%)				-		
Scenario 1	24.8					
Scenario 2	39.8					
Scenario 3	57.2					
Landholder's share of PV project cost (%)				-		
Scenario 1	75.2					
Scenario 2	60.2					
Scenario 3	42.8					
ACCU price ($/ACCU)	*40*	*70*	*100*	*40*	*70*	*100*
AND						
Reef Credit price ($/RC)	*100*	*150*	*200*	*100*	*150*	*200*
OR						
10-year environmental credit ($/wetland-ha/year)	*1657*	*2486*	*3314*	*1657*	*2486*	*3314*
OR						
25-year environmental credit ($/wetland-ha/year)	*1144*	*1715*	*2287*	*1144*	*1715*	*2287*
Results for whole-of-project						
NPV ($k)						
Scenario 1	-1524	-676	172	-6.18	-2.74	0.70
Scenario 2	-351	497	1345	-1.4	2.0	5.5
Scenario 3	243	1091	1939	1.0	4.4	7.9
Annualised equivalent NPV ($k/year)						
Scenario 1	-124	-55.06	14.0	-0.50	-0.22	0.06
Scenario 2	-28.6	40.4	110	-0.12	0.16	0.44
Scenario 3	19.8	88.8	158	0.08	0.36	0.64
Internal rate of return (%)						
Scenario 1	-	-	12.3	-	-	12.3
Scenario 2	-	25.9	56.6	-	25.9	56.6

Scenario 3	13.1	37.2	68.0	13.1	37.2	68.0
Results for landholder						
NPV ($k)						
Scenario 1	-1146	-508	129	-4.64	-2.06	0.52
Scenario 2	-212	299	810	-0.86	1.21	3.28
Scenario 3	104	467	829	0.42	1.89	3.36
Annualised equivalent NPV ($k/year)						
Scenario 1	-93.3	-41.4	10.52	-0.38	-0.17	0.04
Scenario 2	-17.2	24.4	66.0	-0.07	0.10	0.27
Scenario 3	8.5	38.0	67.5	0.03	0.15	0.27
Cumulative PV cash flow ($)	See Figure 31, Figure 32, Figure 33			See Figure 31, Figure 32, Figure 33		
Results for developer						
NPV ($k)						
Scenario 1	-378.2	-167.77	42.65	-1.53	-0.68	0.17
Scenario 2	-140.0	197.5	534.7	-0.57	0.80	2.20
Scenario 3	139.0	624.3	1109	0.56	2.53	4.50
Rate of return (%)						
Scenario 1	-	-	5.5	-	-	5.5
Scenario 2	-	25.5	69.1	-	25.5	69.1
Scenario 3	18.0	80.6	143.3	18.0	80.6	143.3
Cumulative PV cash flow ($)	See Figure 31, Figure 32, Figure 33			See Figure 31, Figure 32, Figure 33		

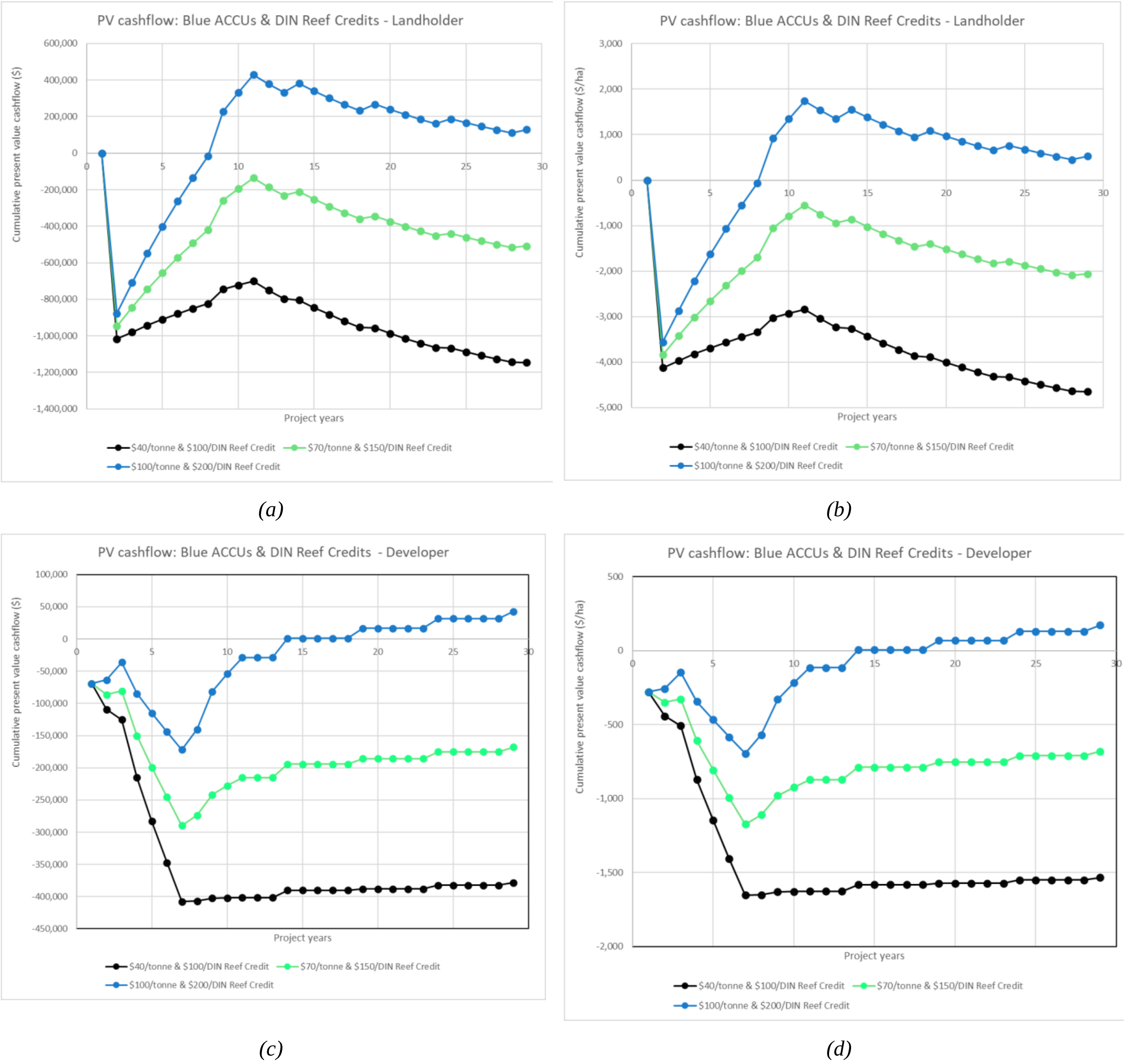
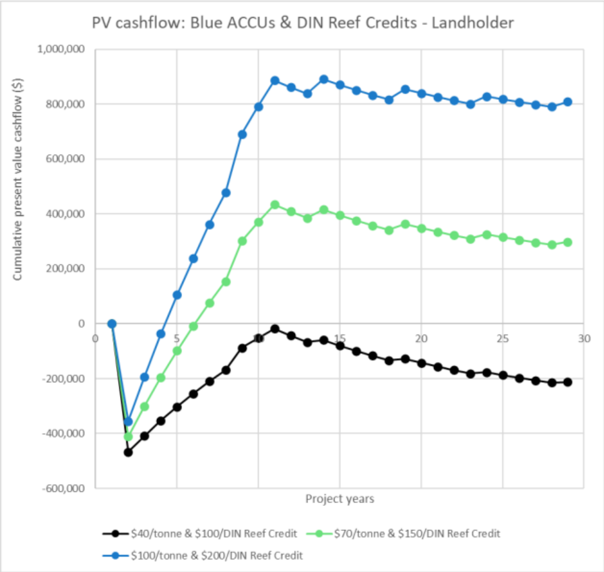


Figure 31 (Landholder cost scenario 1): Cumulative present value cashflows for case study site 1, blue ACCUs stacked with Reef Credits. Plots show cumulative present value cashflows: (a) for the landholder (for the site as a whole), (b) for the landholder (per site hectare), (c) for the developer (for the site as a whole), and (d) for the developer (per site hectare). All results reported aa 25-year permanence period, a 7% real discount rate, an 8% annual cost of capital, and a 10-year loan term. Scenario 1: reduction in land value is $5018/ha and opportunity cost os $430/ha/year.



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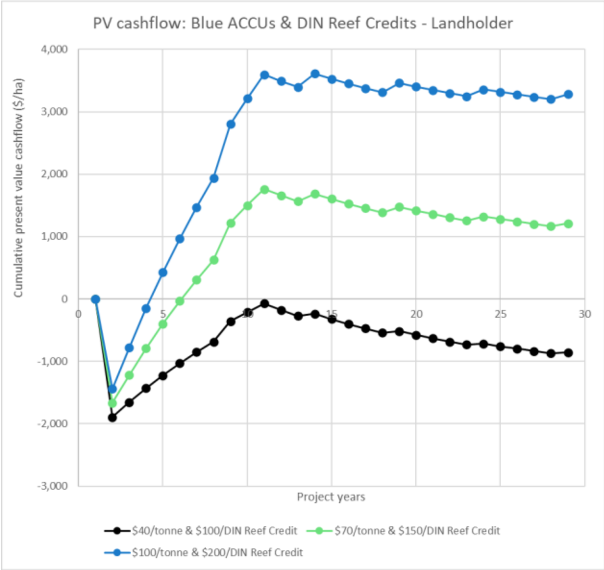

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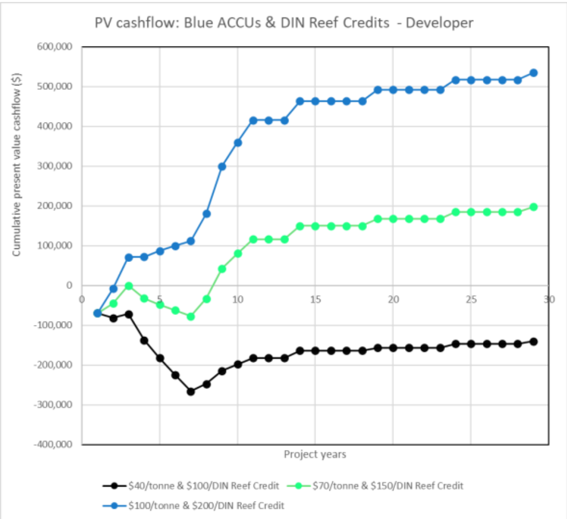

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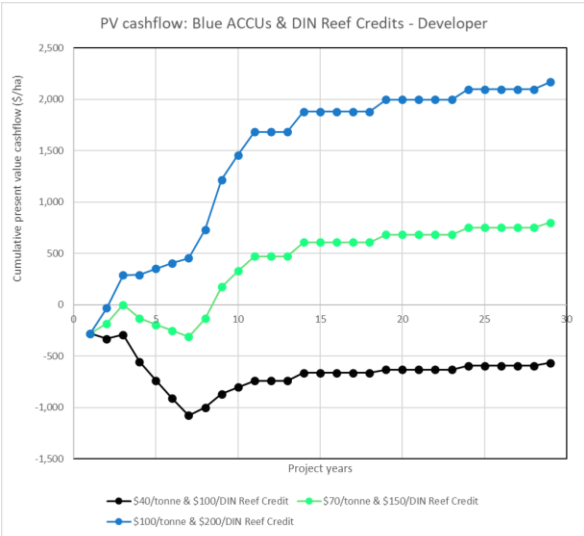
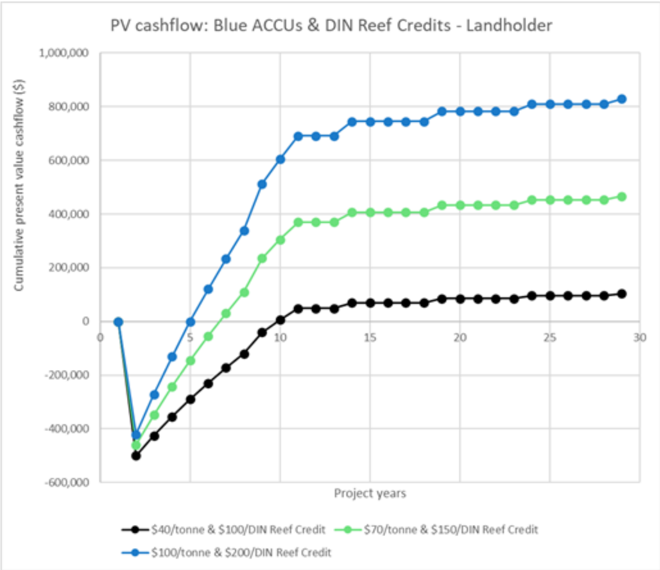
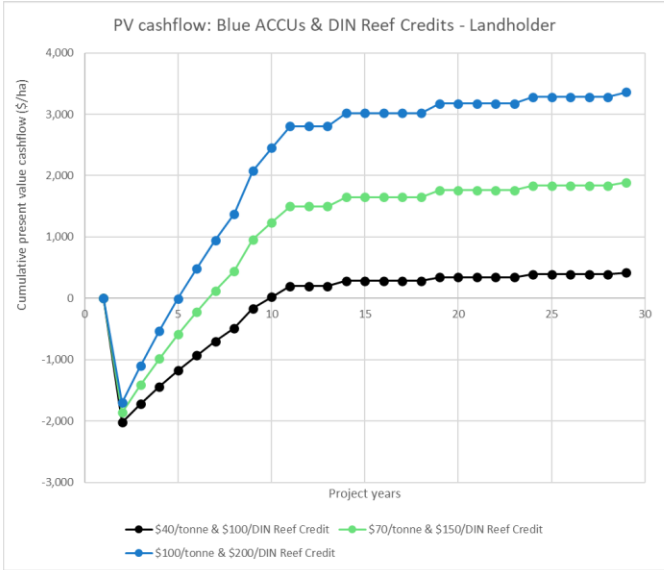


(d)

Figure 32 (Landholder cost scenario 2): Cumulative present value cashflows for case study site 1, blue ACCUs stacked with Reef Credits. Plots show cumulative present value cashflows: (a) for the landholder (for the site as a whole), (b) for the landholder (per site hectare), (c) for the developer (for the site as a whole), and (d) for the developer (per site hectare). All results reported a 25-year permanence period, a 7% real discount rate, an 8% annual cost of capital, and a 10-year loan term. Scenario 2: reduction in land value is $2509/ha and opportunity cost os $215/ha/year.



(a)



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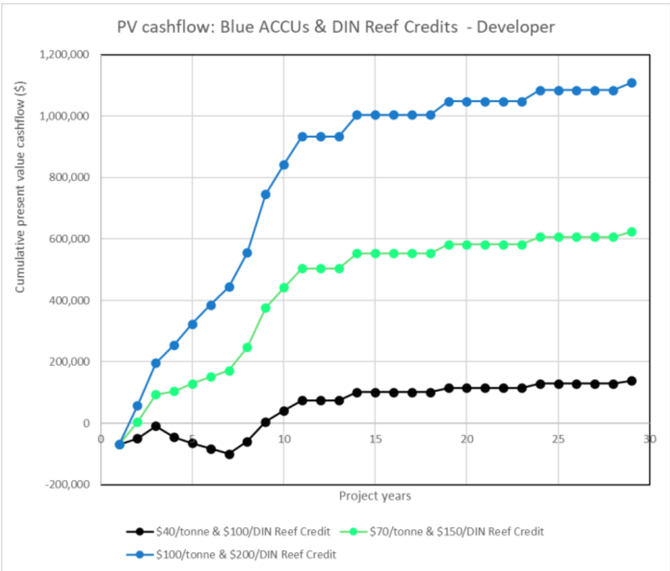

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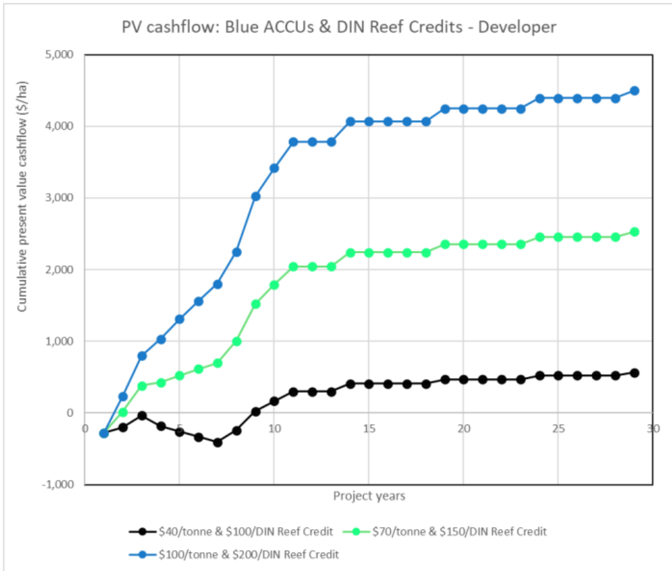


(d)

Figure 33 (Landholder cost scenario 3): Cumulative present value cashflows for case study site 1, blue ACCUs stacked with Reef Credits. Plots show cumulative present value cashflows: (a) for the landholder (for the site as a whole), (b) for the landholder (per site hectare), (c) for the developer (for the site as a whole), and (d) for the developer (per site hectare). All results reported a 25-year permanence period, a 7% real discount rate, an 8% annual cost of capital, and a 10-year loan term. Scenario 3: reduction in land value is $2509/ha and opportunity cost is $0/ha/year.

6.6.4 SITE 1: KEY CONSIDERATIONS

Table 32: The depth and area of inundation modelled at Site 1 at the Highest Astronomical Tide (HAT), HAT + projected sea level rise under RCP 8.5 climate change scenario by 2057 (SLR 2057), and 2107 (SLR 2107).

Scenario	**Inundation depth (m)**	**Total Inundation Area (ha)**	**Inundation area (ha) *Sugarcane only***
HAT	1.7	96.24	34.52
HAT+SLR 2057	2.07	127.45	61.86
HAT+SLR 2107	2.5	159.86	91.28

Constraints	**Opportunities**
Ecological: - Potential displacement of freshwater species; *Economic:* - Multiple landholders in the area increases legal and administrative costs; - Concern regarding introducing saltwater to marginal lands and its impact on neighbouring, productive agricultural land. *Administrative:* - Multiple landholders in the area and lack of property boundary data = unable to assess the need for engineering works to protect adjacent properties from tidal inundation *Social:* - Lack of awareness of the blue carbon market and potential methods. - Skepticism regarding project/method success.	*Ecological:* - Potential increases in biodiversity; - Habitat provision, including for endangered, endemic, and protected migratory species; *Economic*: - Potential additional income through eco-tourism, educational tours, activities, and recreation; - Environmental improvement projects at Site 1 are relatively cost-effective because tidal re-introduction restores blue carbon ecosystems over approximately 50% of the full site area; *Social:* - Potential coastal resilience and protection benefits; - Potential for eco-tourism, educational tours, activities, and recreation.

6.7 SITE 2

6.7.1 SITE DESCRIPTION

This project site is approximately 345 ha and is located near to the car ferry to Cape Tribulation. The site is the largest proposed under this assessment, spanning three landholder properties. There are several properties within the site boundary and within the vicinity of the site. One of these properties is abandoned, two of the properties are not projected to be inundated as a result of engineering works conducted at the site, and two may be at risk of inundation by 2107 as a result of sea level rise. Whilst no sugarcane yield data was provided, environmental weeds are prolific in the sugarcane areas at this site.

There are several drains and culverts at the site, with a central main drain to assist with water drainage. This site is low-lying, with a tidal gate in the centre to prevent tidal upstream incursion. There is therefore potential for relatively minor earthworks to remove the tidal gates, in addition to landscape reprofiling to maximise tidal inundation over areas of the site, as part of a blue carbon project (Figure 36). As we were unable to obtain the locations of bund walls within the Mossman district, a stretch of elevated land to the east of the site was lowered within the hydrological model to simulate the removal of a section of bund wall, increasing the tidal inundation at the site. The recruitment of mangrove and Melaleuca on the land adjacent to the sugarcane mean that the site has potential to transition to mangrove and melaleuca habitat through natural re-seeding from the local population. As such, this site was selected as a case study site for a blue carbon project under the ACCU scheme's Tidal Restoration method. Moreover, removing the sugarcane from the site and replacing the elevated areas with tree planting could attract green carbon and DIN Reef Credits, while maintenance of the inundated area to keep it free from freshwater aquatic weeds could provide a potential habitat for native fauna species to colonise. The establishment of coastal wetland habitat (i.e., saltmarsh, melaleuca, and mangrove) could also increase coastal protection and local biodiversity, making the site potentially eligible for a project under the Land Restoration Fund, the emerging Nature Repair Market and Coastal Resilience Credit schemes, once established.

Figure 34: Example of drain at Site 2 and colonisation of terrestrial vegetation.

6.7.2 HYDROLOGICAL MODELLING

Based on three hydrodynamic model simulation scenarios, we mapped the maximum inundation area associated with the water level at the HAT (1.7 m), HAT+SLR 2057 (2.07 m) and HAT+SLR 2107 (2.5 m). The areas with the lowest elevation and higher inundation depths are located along current drainage channels (Figure 35). Total inundation, as well the area of sugarcane inundated under these three scenarios, is summarised in Table 36. Following the removal of the tidal gate and a section of bund wall to the east, the site will experience an inundation depth of 1.7 m at the HAT, inundating 88.90 ha of the site, of which 57.98 ha is former sugarcane plantation (Table 36).

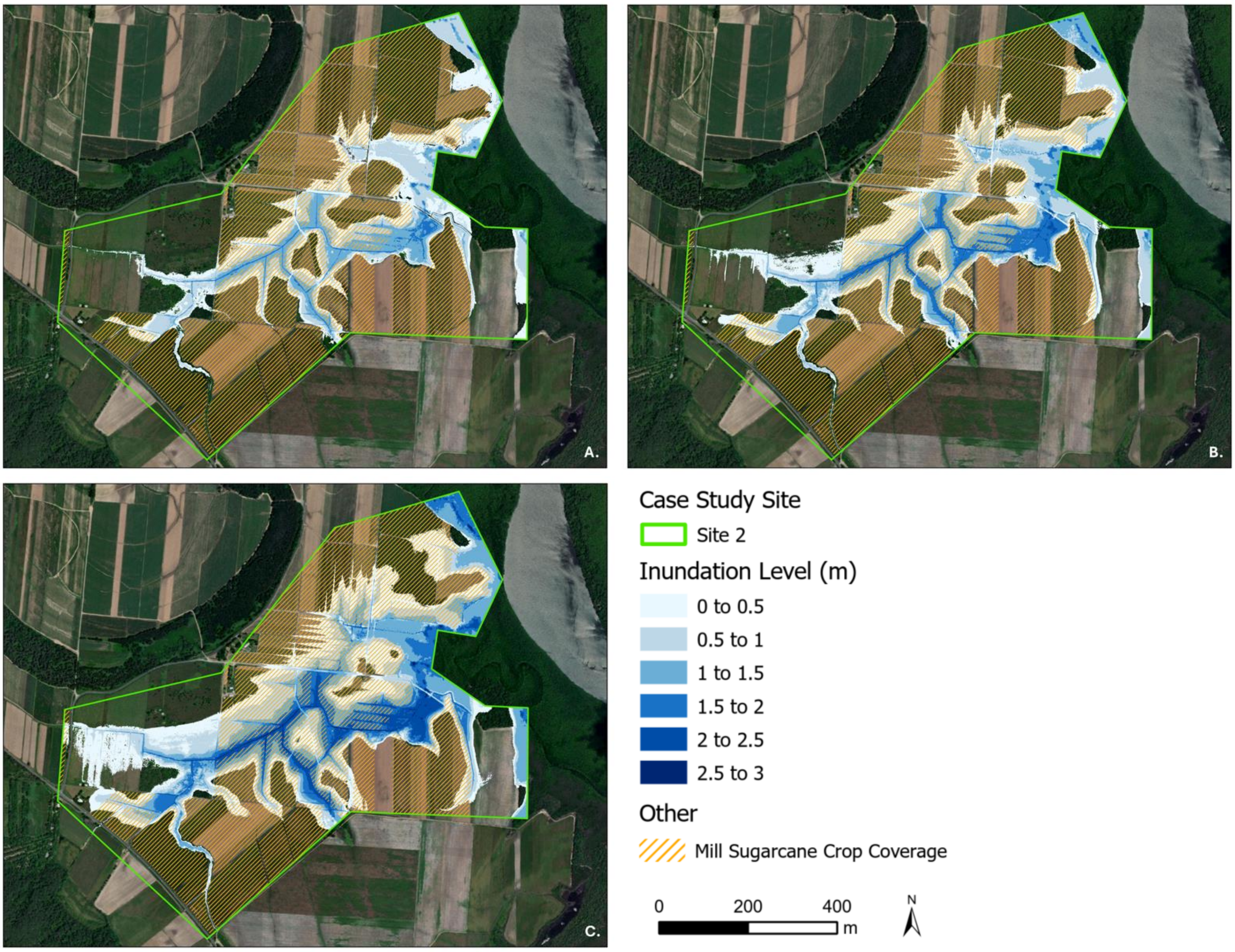


Figure 35: Inundation levels of case study site 2 under the current highest astronomical tide (HAT) (A.), as well as inundation by year 2057 (B.) and 2107 (C.) due to climate change. Boundaries were generalised for modelling and resulting inundation was reduced to the boundary to highlight inundated areas specific to the site. Mill crop coverage data provided by the Mossman Agricultural Services.

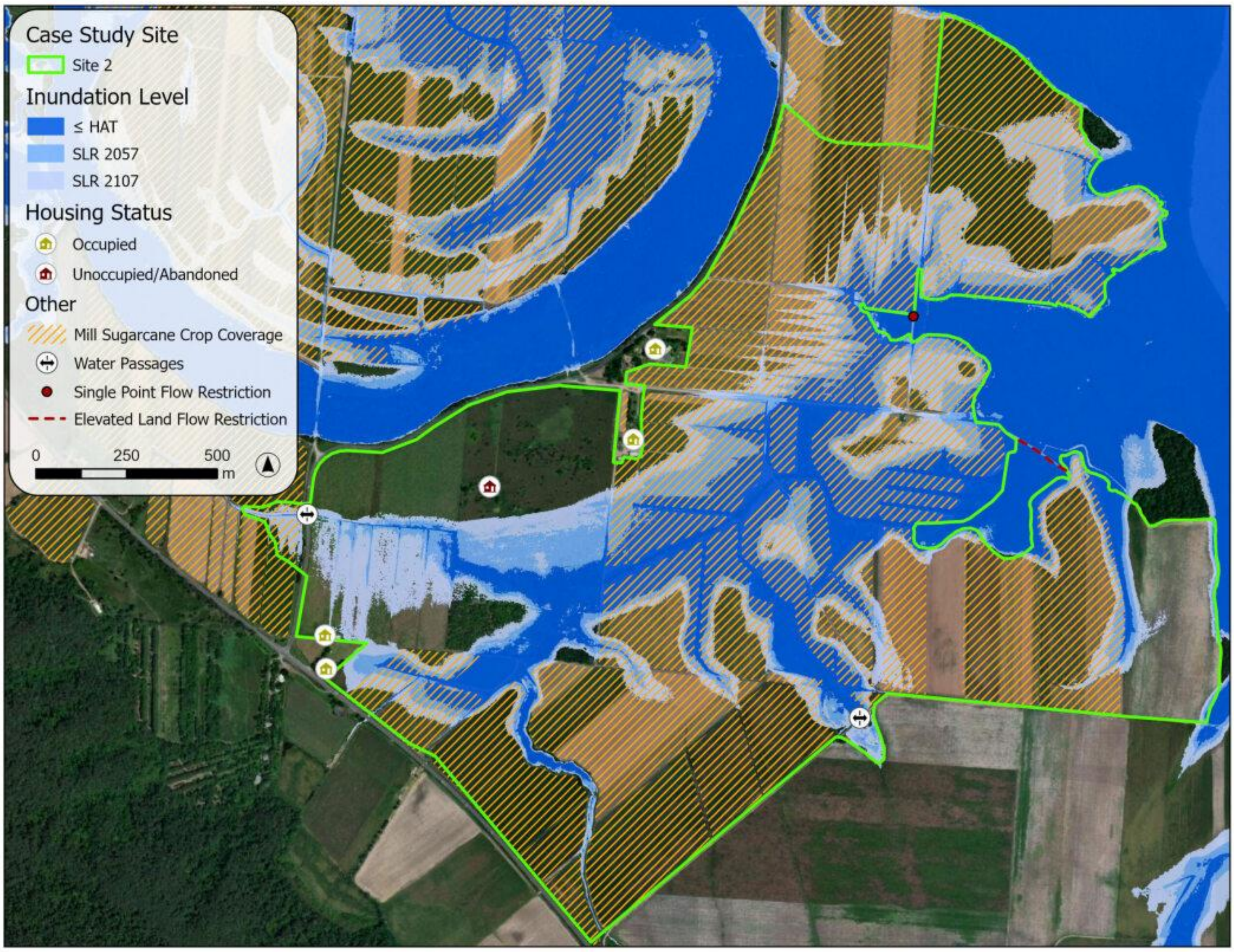


Figure 36: Site 2 theoretical boundary. Inundation levels include all inundation to the current highest astronomical tide (HAT), as well as inundation by year 2057 (SLR 2057) and 2107 (SLR 2107) due to climate change. Flow restrictions represent the optimum areas that can potentially be lowered or removed for the maximum amount and longevity of inundation. These restrictions mainly consist of entrances to drainage lines from the site to natural wetlands/oceans (e.g., tidal flood gates) and areas of higher elevation (e.g., levees). Houses and/or private properties within the vicinity, and potentially affected by inundation, were classified as either currently occupied or abandoned. Mill crop coverage data provided by the Mossman Agricultural Services.

6.7.3 BLUECAM OUTPUTS

The Carbon Estimation Areas (CEAs) for this blue carbon restoration site was designated as mostly mangrove (100 ha) with the remaining project area saltmarsh (20.8 ha) with an elevation of the CEAs set to 2.1 AHD (note that the CEA allocations here might vary with more detailed assessment of the site). On this basis, the net abatement amount for Site 2 in BlueCAM by 2057 is:

Table 33: BlueCAM output, i.e., tonnes of CO2 equivalent (CO2e) sequestered at Site 2 over a 25-year crediting period for a project with a 100-year permanence period.

Year	Tonnes CO_2e sequestered (BlueCAM)
2024	75.1
2029	3,893
2034	7,17.7
2039	11,549.6
2044	15,391
2049	19,235.6
2057	25,416.5

6.7.4 SITE 2: DISCOUNTED CASH FLOW ANALYSIS: RESULTS TABLES AND FIGURES

The DCFAs reported for this site were undertaken with the following key parameter settings and ranges shown in Table 34.

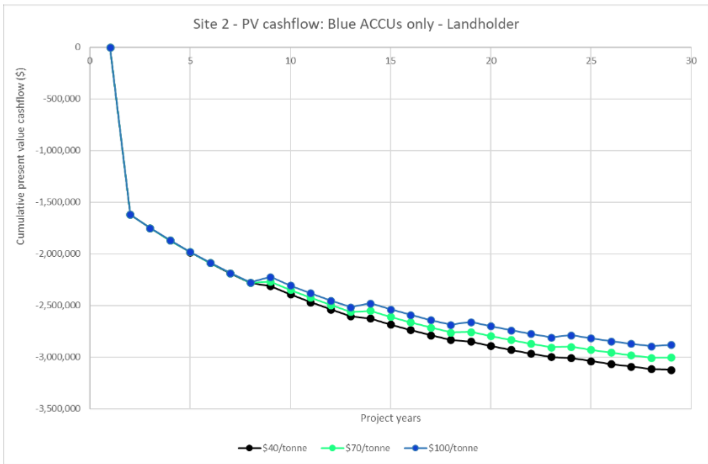
SITE 2: BlueCAM 'Blue ACCUs' standalone

DCFA results are summarised in Table 34.

Table 34: Summary results from DCFA for a standalone blue ACCUs project at case study site 2. Reported for 346ha project area and per hectare of project area. PV denotes present value. NPV denotes net present value. PV and NPV are calculated at 7% real discount rate. NPV is calculated over the full project duration of 29 years. PV upfront loan covers the following costs: detailed project design, development approval and on-site works.

Metric	Project site (346ha)			Per site hectare		
Upfront loan ($)	221,925			642		
Developer's share of PV project cost (%)						
Scenario 1	15.9			-		
Scenario 2	27.4			-		
Scenario 3	43.3			-		
Landholder's share of PV project cost						
Scenario 1	84.1			-		
Scenario 2	72.6			-		
Scenario 3	56.7			-		
Results for whole-of-project						
ACCU price ($/ACCU)	*40*	*70*	*100*	*40*	*70*	*100*
NPV ($k)						
Scenario 1	-3711	-3568	-3424	-10.7	-10.3	-9.9
Scenario 2	-2069	-1926	-1782	-6.0	-5.6	-5.2
Scenario 3	-1237	-1093	-950	-3.6	-3.2	-2.8
Annualised equivalent NPV ($k/year)						
Scenario 1	-302	-291	-279	-0.88	-0.84	-0.81
Scenario 2	-169	-157	-145	-0.48	-0.45	-0.42
Scenario 3	-100	-89	-77	-0.29	-0.26	-0.22
Internal rate of return (%)	-	-	-	-	-	-

Results for landholder						
ACCU price ($/ACCU)	*40*	*70*	*100*	*40*	*70*	*100*
NPV ($k)						
Scenario 1	-3123	-3002	-2881	-9.04	-8.69	-8.34
Scenario 2	-1503	-1399	-1294	-4.4	-4.0	-3.7
Scenario 3	-701	-620	-538	-2.0	-1.8	-1.6
Annualised equivalent NPV ($k/year)						
Scenario 1	-254	-245	-235	-0.74	-0.71	-0.68
Scenario 2	-122	-114	-105	-0.35	-0.33	-0.31
Scenario 3	-57	-50	-44	-0.17	-0.15	-0.13
Cumulative PV cash flow ($)	See Figure 37, Figure 38, Figure 39			See Figure 37, Figure 38, Figure 39		
Results for developer						
ACCU price ($/ACCU)	*40*	*70*	*100*	*40*	*70*	*100*
NPV ($k)						
Scenario 1	-588	-566	-543	-1.70	-1.64	-1.57
Scenario 2	-566	-527	-488	-1.64	-1.53	-1.41
Scenario 3	-536	-474	-411	-1.55	-1.37	-1.19
Rate of return (%)	-	-	-	-	-	-
Cumulative PV cash flow ($)	See Figure 37, Figure 38, Figure 39			See Figure 37, Figure 38, Figure 39		



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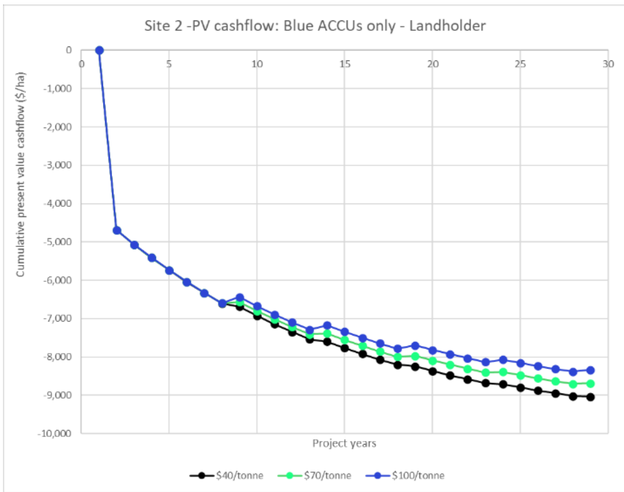

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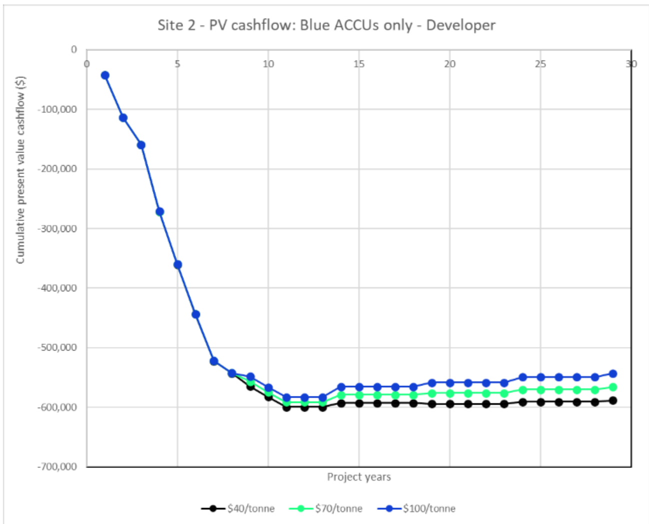

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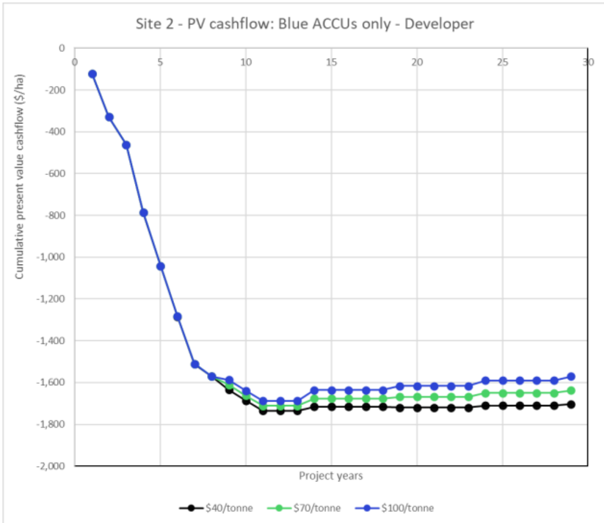
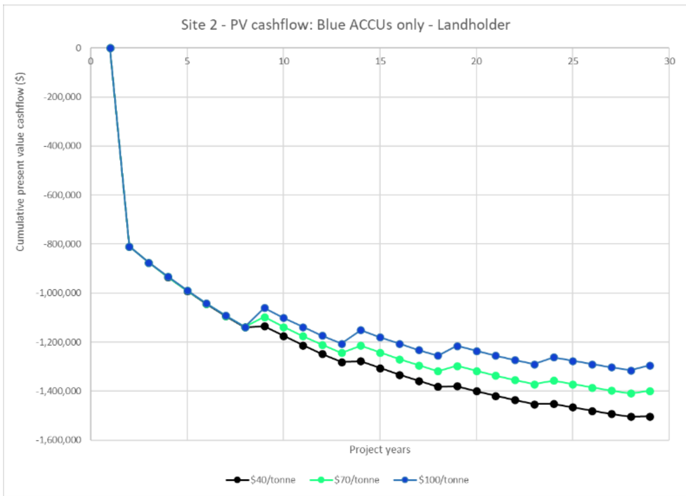


(d)

Figure 37 (Landholder cost scenario 1): Cumulative present value cashflows for case study site 2, blue ACCUs only. Plots show cumulative present value cashflows: (a) for the landholder (for the site as a whole), (b) for the landholder (per site hectare), (c) for the developer (for the site as a whole), and (d) for the developer (per site hectare). All results reported a 25-year permanence period, a 7% real discount rate, an 8% annual cost of capital, and a 10-year loan term. Scenario 1: reduction in land value is $5018/ha and opportunity cost is $430/ha/year.



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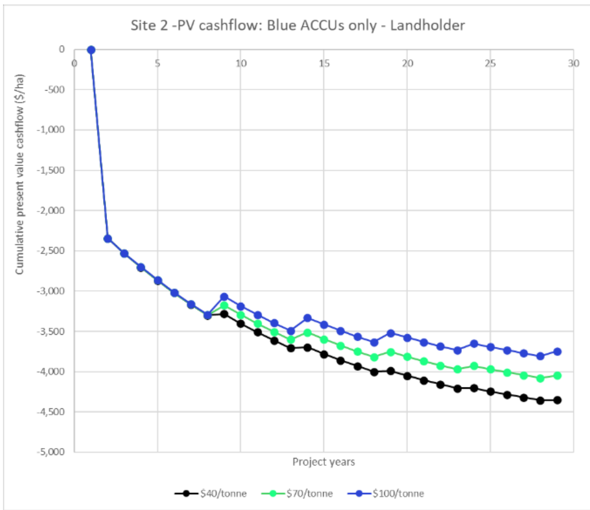

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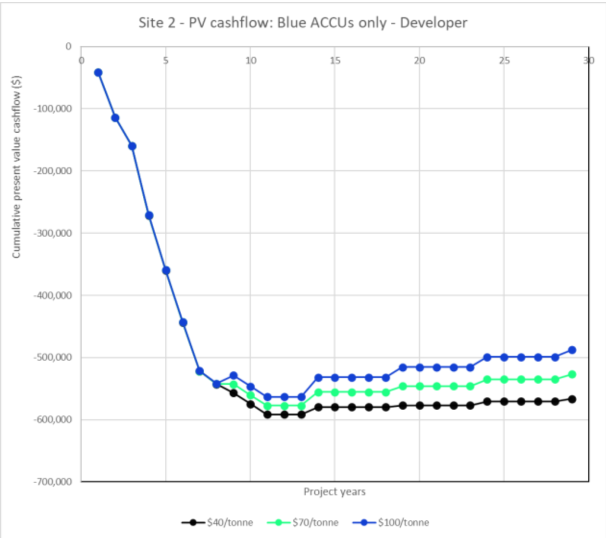

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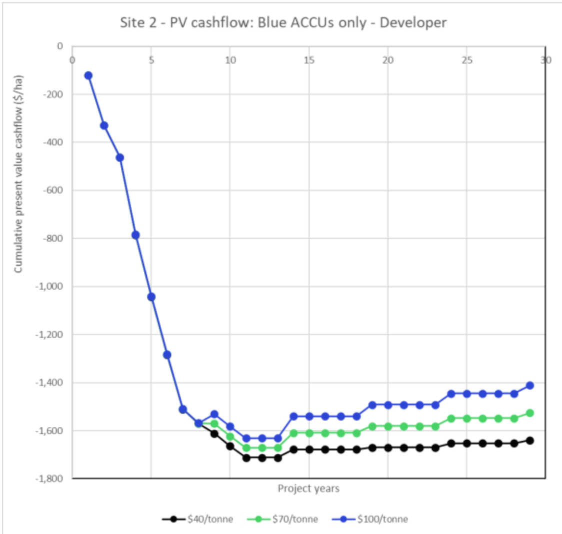
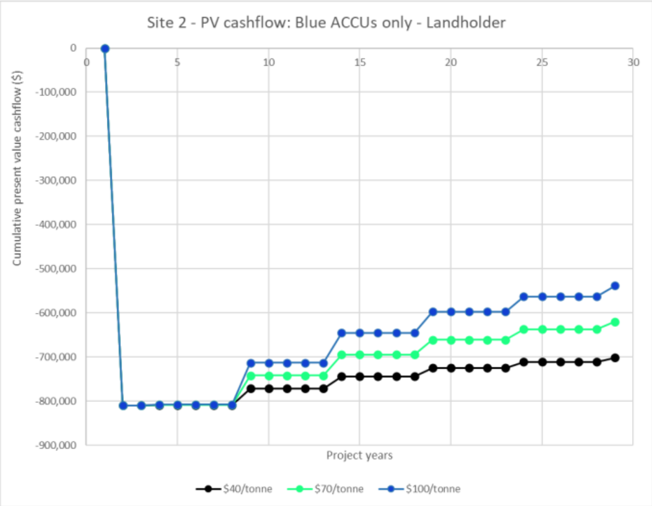


(d)

Figure 38 (Landholder cost scenario 2): Cumulative present value cashflows for case study site 2, blue ACCUs only. Plots show cumulative present value cashflows: (a) for the landholder (for the site as a whole), (b) for the landholder (per site hectare), (c) for the developer (for the site as a whole), and (d) for the developer (per site hectare). All results reported a 25-year permanence period, a 7% real discount rate, an 8% annual cost of capital, and a 10-year loan term. Scenario 2: reduction in land value is $2509/ha and opportunity cost is $215/ha/year.



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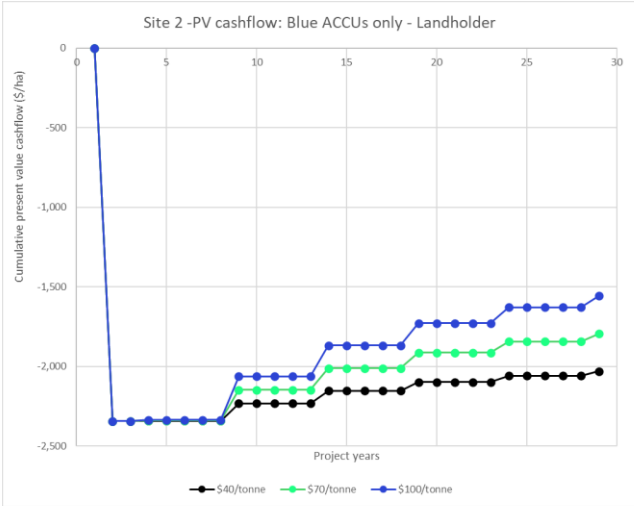

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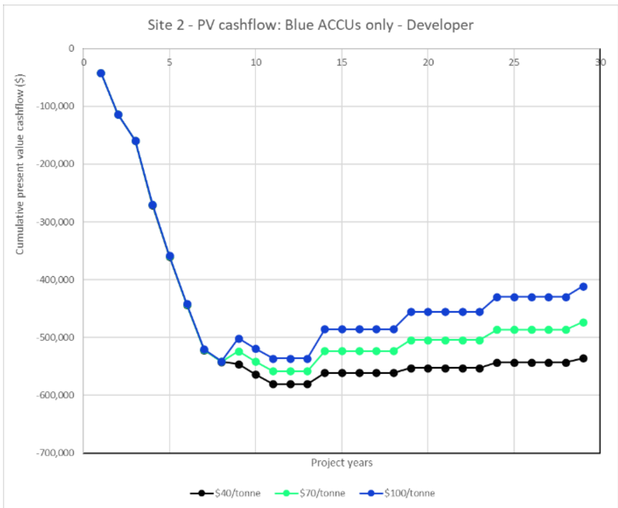

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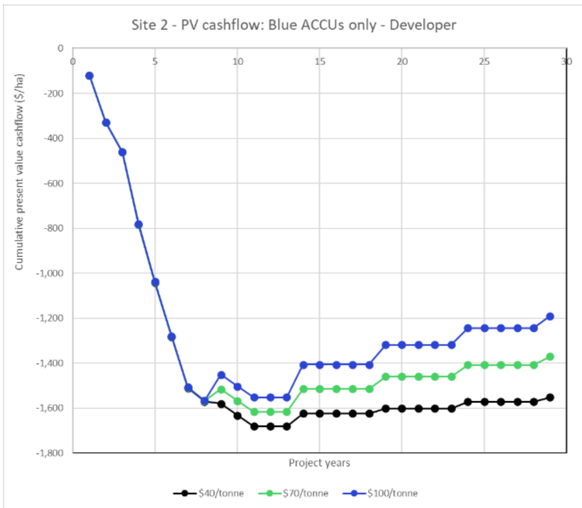


(d)

Figure 39 (Landholder cost scenario 3): Cumulative present value cashflows for case study site 2, blue ACCUs only. Plots show cumulative present value cashflows: (a) for the landholder (for the site as a whole), (b) for the landholder (per site hectare), (c) for the developer (for the site as a whole), and (d) for the developer (per site hectare). All results reported a 25-year permanence period, a 7% real discount rate, an 8% annual cost of capital, and a 10-year loan term. Scenario 3: reduction in land value is $2509/ha and opportunity cost is $0/ha/year.

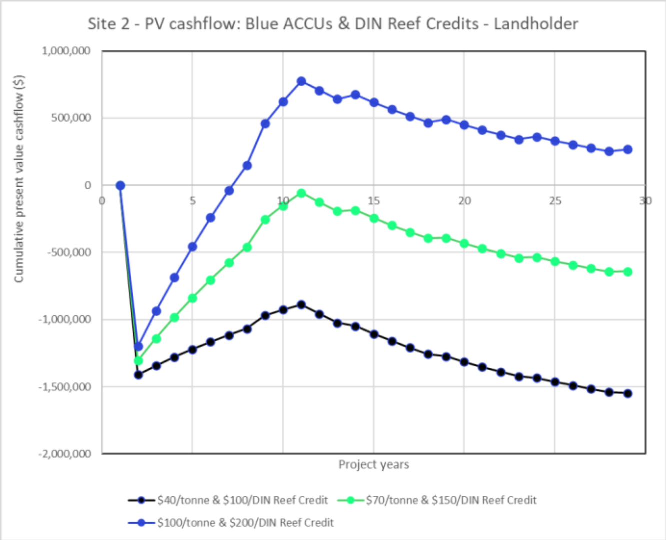
SITE 2: BlueCAM Blue Carbon stacked with DIN Reef credits

DCFA results are summarised in Table 35.

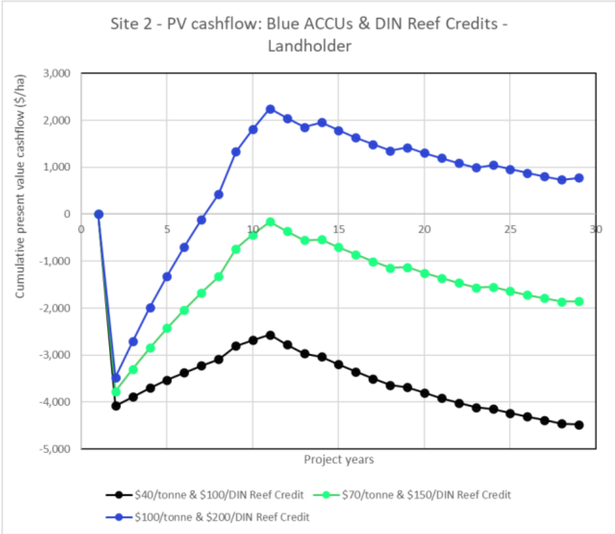
Table 35: Summary results from DCFA of blue ACCUs stacked with DIN Reef Credits for Site 2. Reported for 346ha project area and per hectare of project area. PV denotes present value. NPV denotes net present value. PV and NPV are calculated at 7% real discount rate. NPV is calculated over the full project duration of 29 years. PV upfront loan covers the following costs: detailed project design, development approval and on-site works.. Results for the PV revenue and NPV are presented for the following combinations of: (i) ACCU and DIN Reef Credit prices at $40/ACCU & $100/RC ; $70/ACCU & $150/RC; $100/ACCU & $200/RC, (ii) ACCU price and a 10-year environmental credit payments at $40/ACCU & $2460/wetland ha/year; $70/ACCU & $3690/wetland ha/year; $100/ACCU & $4920/wetland ha/year, or (iii) ACCU price and a 25-year environmental credit payments at $40/ACCU & $1697/wetland ha/year; $70/ACCU & $2546/wetland ha/year; $100/ACCU & $3395/wetland ha/year. Landholder cost scenarios: Scenario 1: reduction in land value is $5018/ha and opportunity cost is $430/ha/year; Scenario 2: reduction in land value is $2509/ha and opportunity cost is $215/ha/year; and Scenario 3 assumes the reduction in land value is $2509/ha and opportunity cost is $0/ha/year.

Quantity of Reef Credits per ha: 8.05						
Metric	**Project site (346ha)**			**Per site hectare**		
Upfront loan ($)	221,925			642		
Developer’s share of PV project cost				-		
Scenario 1	19					
Scenario 2	32					
Scenario 3	48.8					
Landholder’s share of PV project cost				-		
Scenario 1	81					
Scenario 2	68					
Scenario 3	51.2					
ACCU price ($/ACCU)	*40*	*70*	*100*	*40*	*70*	*100*
AND						
Reef Credit price ($/RC)	*100*	*150*	*200*	*100*	*150*	*200*
OR						
10-year environmental credit ($/wetland ha/year)	*2460*	*3690*	*4920*	*2460*	*3690*	*4920*
OR						
25-year environmental credit ($/wetland ha/year)	*1697*	*2546*	*3395*	*1697*	*2546*	*3395*
Results for whole-of-project						
NPV ($k)						
Scenario 1	-1911	-790	331	-5.53	-2.29	-0.96
Scenario 2	-269	852	1972	-0.78	2.47	5.71
Scenario 3	563	1684	2805	3.98	4.87	8.12
Annualised equivalent NPV ($k/year)						
Scenario 1	-155.7	-64.4	26.9	-0.45	-0.19	0.08
Scenario 2	-21.9	69	161	-0.06	0.2	0.46
Scenario 3	46	137	228	0.13	0.40	0.66
Internal rate of return (%)						
Scenario 1	-	-	16.3	-	-	16.3

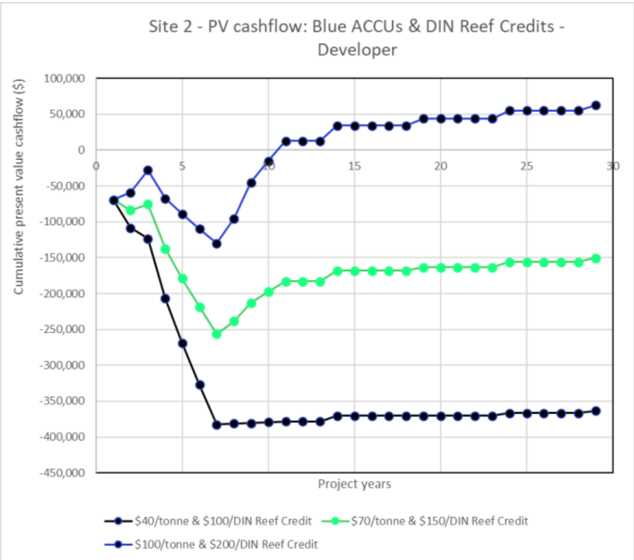
Scenario 2	-	35.4	71.9	-	35.4	71.9
Scenario 3	19.5	47.5	84.9	267	469	670
Results for landholder						
NPV ($)						
Scenario 1	-1547.5	-640	267.3	-4.48	-1.85	0.77
Scenario 2	-182.8	579.5	1342	-0.53	1.68	3.88
Scenario 3	287	862	1436	0.84	2.50	4.16
Annualised equivalent NPV ($k/year)						
Scenario 1	-126.0	-52.14	21.77	-0.37	-0.15	0.06
Scenario 2	-14.89	47.2	109.3	-0.04	0.14	0.32
Scenario 3	23.5	70.2	117.0	0.07	0.20	0.34
Cumulative PV cash flow ($)	See Figure 40, Figure 41, Figure 42			See Figure 40, Figure 41, Figure 42		
Results for developer						
NPV ($k)						
Scenario 1	-363.6	-150.4	62.8	-1.05	-0.44	0.18
Scenario 2	-85.91	272.3	630.5	-0.25	0.79	1.83
Scenario 3	274.9	821.5	1368.2	0.80	2.38	3.96
Rate of return (%)						
Scenario 1	-	-	8.1	-	-	8.1
Scenario 2	-	35.3	81.7	-	35.3	81.7
Scenario 3	35.6	106.5	177.3	35.6	106.5	177.3
Cumulative PV cash flow ($)	See Figure 40, Figure 41, Figure 42			See Figure 40, Figure 41, Figure 42		



(a)



(b)



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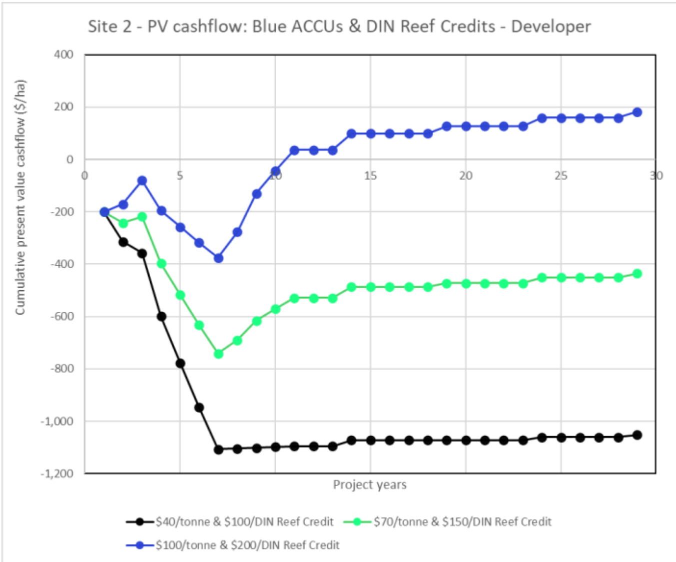


(d)

Figure 40 (Landholder cost scenario 1): Cumulative present value cashflows for case study site 2, blue ACCUs stacked with Reef Credits. Plots show cumulative present value cashflows: (a) for the landholder (for the site as a whole), (b) for the landholder (per site hectare), (c) for the developer (for the site as a whole), and (d) for the developer (per site hectare). All results reported a 25-year permanence period, a 7% real discount rate, an 8% annual cost of capital, and a 10-year loan term. Scenario 1: reduction in land value is $5018/ha and opportunity cost is $430/ha/year.

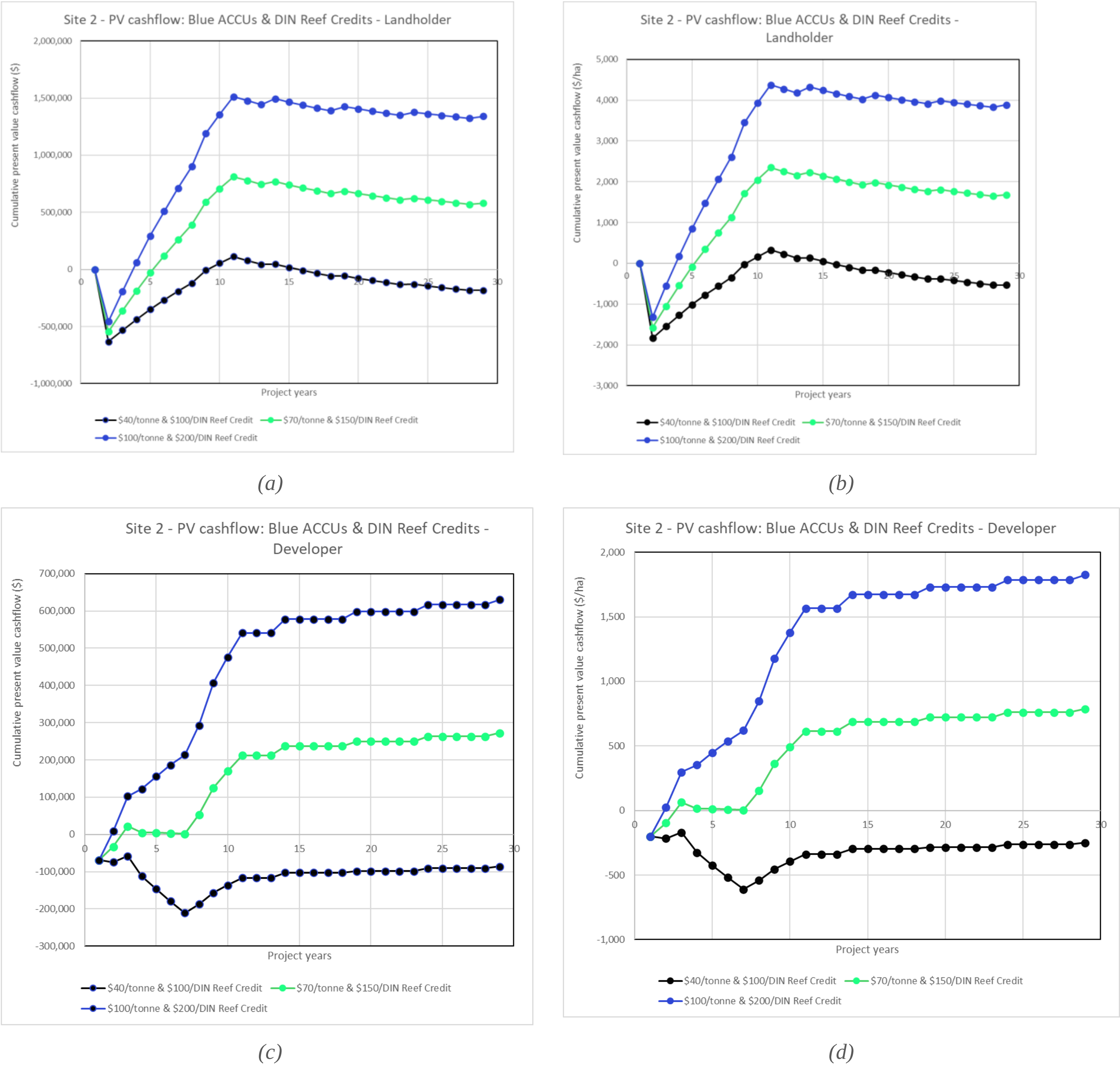
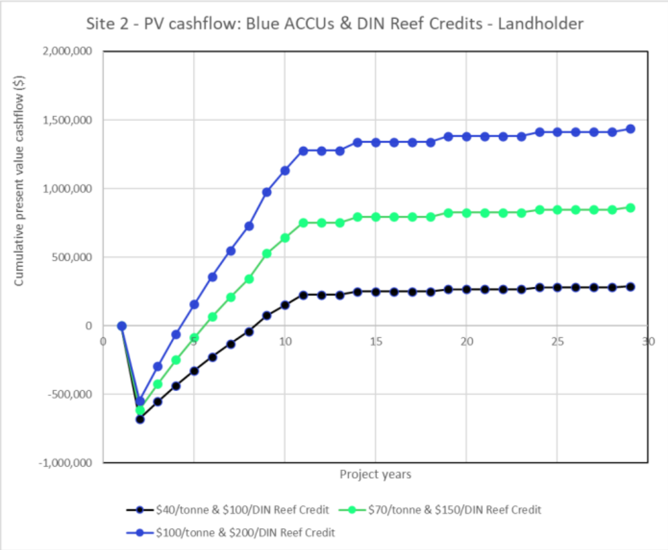
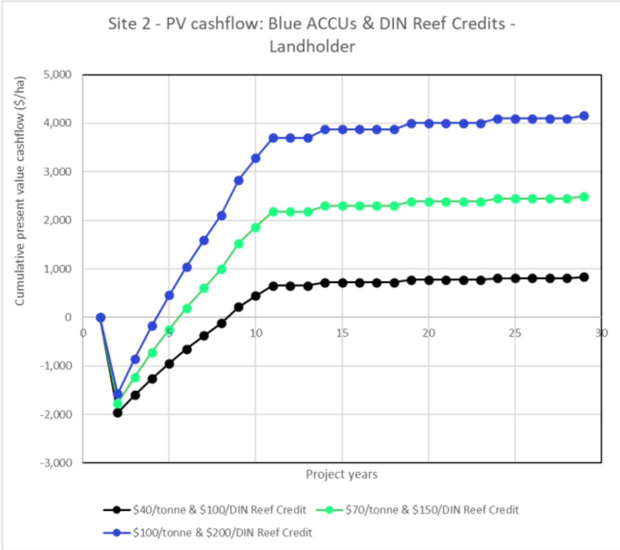


Figure 41 (Landholder cost scenario 2): Cumulative present value cashflows for case study site 2, blue ACCUs stacked with Reef Credits. Plots show cumulative present value cashflows: (a) for the landholder (for the site as a whole), (b) for the landholder (per site hectare), (c) for the developer (for the site as a whole), and (d) for the developer (per site hectare). All results reported a 25-year permanence period, a 7% real discount rate, an 8% annual cost of capital, and a 10-year loan term. Scenario 2: reduction in land value is $2509/ha and opportunity cost is $215/ha/year.



(a)



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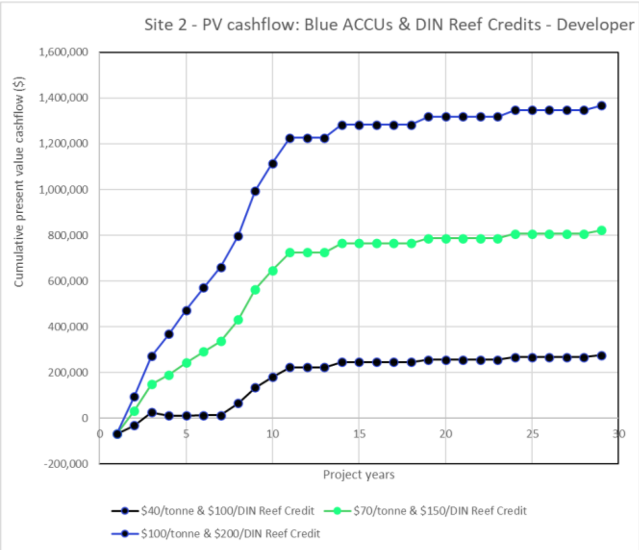
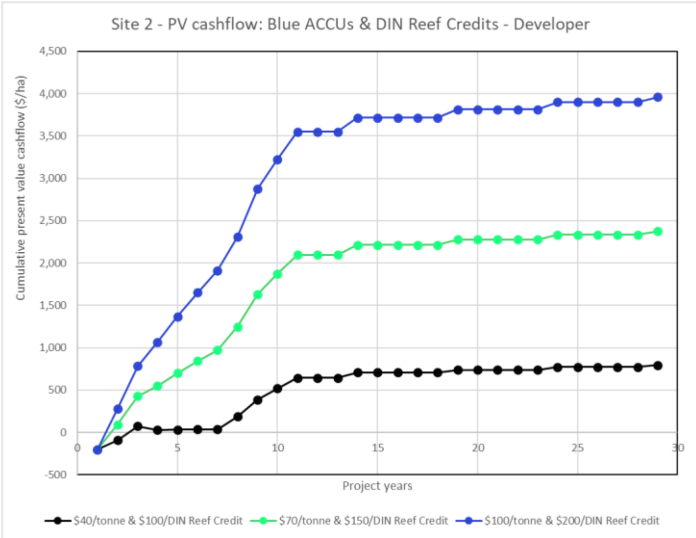


(c)



(d)

Figure 42 (Landholder cost scenario 3): Cumulative present value cashflows for case study site 2, blue ACCUs stacked with Reef Credits. Plots show cumulative present value cashflows: (a) for the landholder (for the site as a whole), (b) for the landholder (per site hectare), (c) for the developer (for the site as a whole), and (d) for the developer (per site hectare). All results reported a 25-year permanence period, a 7% real discount rate, an 8% annual cost of capital, and a 10-year loan term. Scenario 3: reduction in land value is $2509/ha and opportunity cost is $0/ha/year.

6.7.5 SITE 2: KEY CONSIDERATIONS

Table 36: The depth and area of inundation modelled at Site 3 at the Highest Astronomical Tide (HAT), HAT + projected sea level rise under RCP 8.5 climate change scenario by 2057 (CC2057), and 2107 (CC2107).

Scenario	**Inundation depth (m)**	**Total Inundation Area (ha)**	**Inundation Area (ha) *Sugarcane only***
HAT	1.7	88.90	57.98
HAT+SLR 2057	2.07	120.84	88.35
HAT+SLR 2107	2.5	168.14	134.15

Constraints	**Opportunities**
<u>*Economic:*</u> - Multiple landholders in the area increases legal and administrative costs; - Environmental improvement projects at Site 2 are only moderately cost-effective because tidal re-introduction restores blue carbon ecosystems over only 33% of the full site area; - Concern regarding introducing saltwater to marginal lands and its impact on neighbouring, productive agricultural land. <u>*Administrative:*</u> - Multiple landholders in the area and lack of property boundary data = unable to assess the need for engineering works to protect adjacent properties from tidal inundation; <u>*Social:*</u> - Lack of awareness of the blue carbon market and potential methods. - Skepticism regarding project/method success.	<u>*Ecological:*</u> - Potential increases in biodiversity; - Habitat provision, including for endangered, endemic, and protected migratory species; <u>*Economic:*</u> - Potential additional income through eco-tourism, educational tours, activities, and recreation; <u>*Social:*</u> - Potential coastal resilience and protection benefits; - Potential for eco-tourism, educational tours, activities, and recreation;

6.8 SITE 3

6.8.1 SITE DESCRIPTION

This project site is approximately 158 ha, the smallest proposed case study site, and is located southeast of the former oxbow breakout point on the Daintree River, upstream of the car ferry to Cape Tribulation (Figure 43). Formerly sugarcane plantation, this site is not supplied by the sugarcane rail network and so experienced elevated transportation costs whilst active. Owned by a single landholder, the site has been abandoned for 2-3 years and is now overgrown with weeds. As we were unable to obtain information as to the presence of tidal restrictions at this site, a stretch of elevated land to the southeast of the property was lowered within the hydrological model to simulate the removal of a section of bund wall, allowing tidal inundation to occur at the site. Fringed by mangroves, the site has potential to transition to mangrove habitat through tidal inundation and natural re-seeding from the local mangrove population. As such, this site was selected as a case study site for a blue carbon project under the ACCU scheme's Tidal Restoration method. As the site transitions from abandoned sugarcane to mangrove habitat, the site will also create coastal protection and biodiversity co-benefits, particularly as saltwater intrusion will help to remove the local weed infestation and allow local flora to establish.

Figure 43: Abandoned sugarcane area at Site 3.

6.8.2 HYDROLOGICAL MODELLING

Based on three hydrodynamic model simulation scenarios, we mapped the maximum inundation area associated with the water level at the HAT (1.7 m), HAT+SLR 2057 (2.07 m) and HAT+SLR 2107 (2.5 m). The areas with lowest elevation and higher inundation depths are located closest to shore and existing wetland (Figure 44). Total inundation, as well the area of sugarcane inundated under these three scenarios, is summarised in Table 40. Following the removal of a section of bund wall to the southeast of Site 3, the site will experience an inundation depth of 1.7 m at the HAT, inundating 16.80 ha of the site (Figure 44).

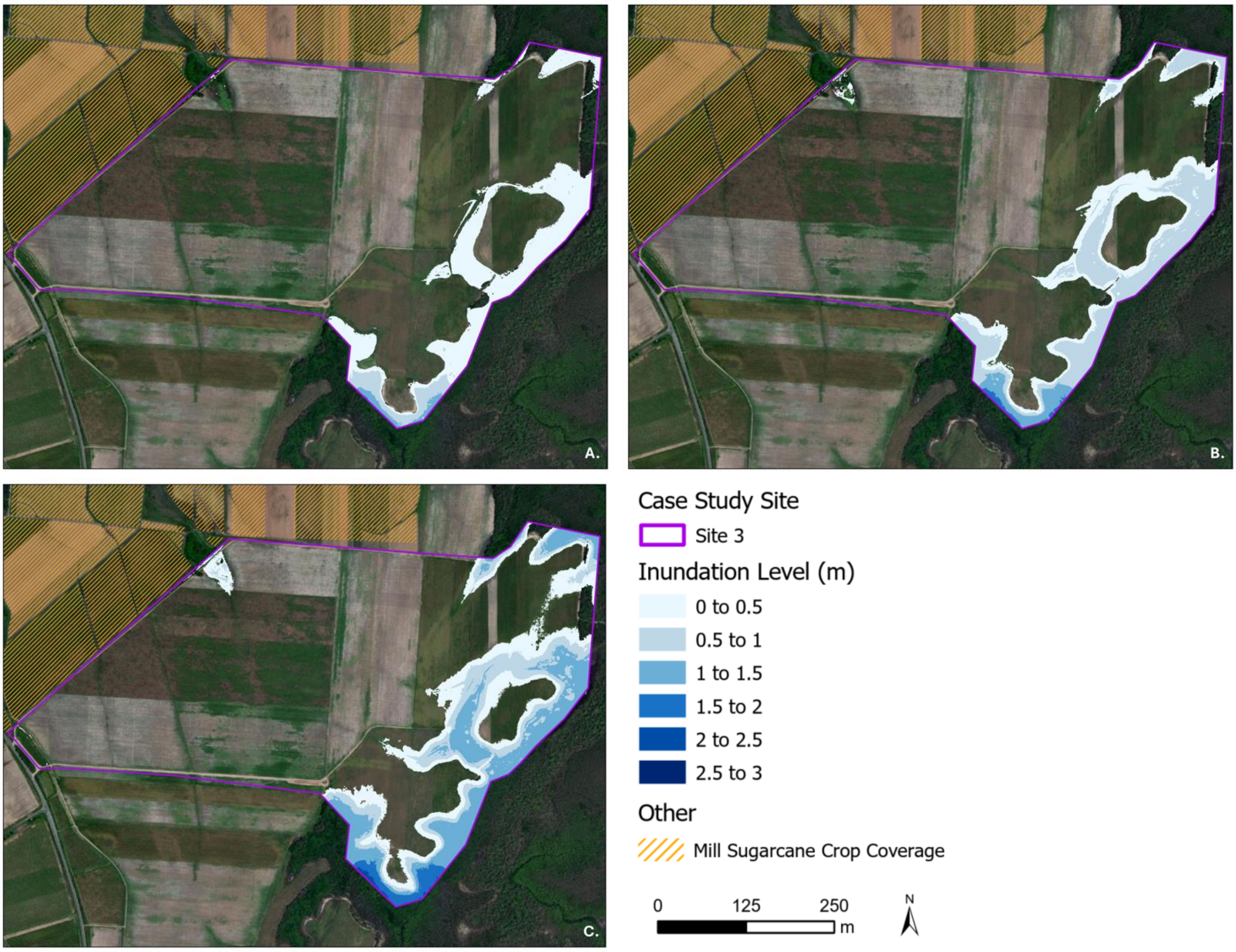


Figure 44: Inundation levels of case study site 3 under the current highest astronomical tide (HAT) (A.), as well as inundation by year 2057 (B.) and 2107 (C.) due to climate change. Boundaries were generalised for modelling and resulting inundation was reduced to the boundary to highlight inundated areas specific to the site. Current Mill crop coverage data for 2023 provided by Mossman Agricultural Services.

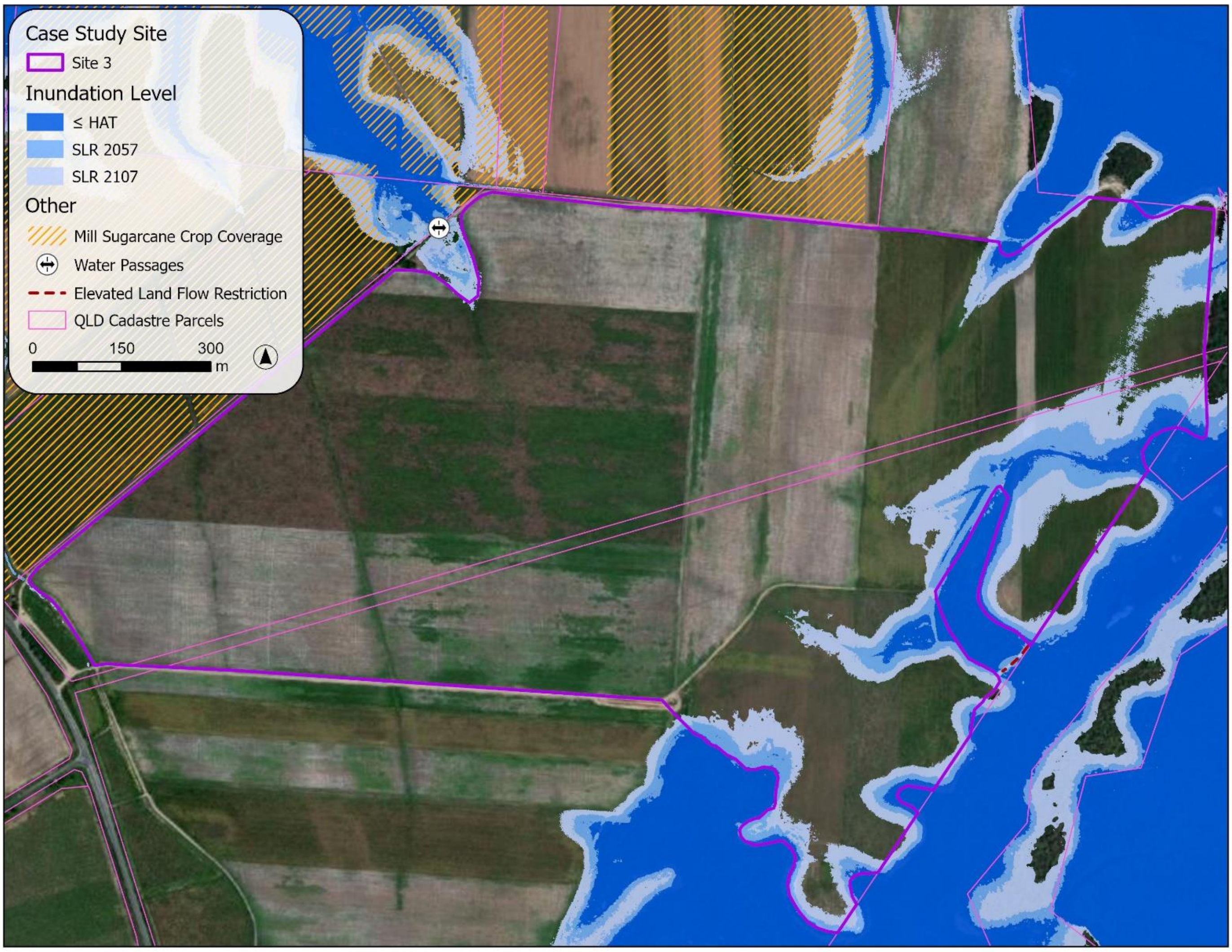


Figure 45: Site 3 theoretical boundary. Inundation levels include all inundation to the current highest astronomical tide (HAT), as well as inundation by year 2057 (SLR 2057) and 2107 (SLR 2107) due to climate change. Flow restrictions represent the optimum areas that can potentially be lowered or removed for the maximum amount and longevity of inundation. These restrictions mainly consist of entrances to drainage lines from the site to natural wetlands/oceans (e.g., tidal flood gates) and areas of higher elevation (e.g., levees). Mill crop coverage data provided by the Mossman Agricultural Services.

6.8.3 BLUECAM OUTPUTS

The Carbon Estimation Areas (CEAs) for this blue carbon restoration site was designated as mostly mangrove (2.5 ha) with the remaining project area saltmarsh (0.6 ha) with an elevation of the CEAs set to 2.1 AHD (note that the CEA allocations here might vary with more detailed assessment of the site). On this basis, the net abatement amount for Site 3 in BlueCAM is:

Table 37: BlueCAM output, i.e., tonnes of CO_2 equivalent (CO2e) sequestered at Site 3 over a 25-year crediting period for a project with a 100-year permanence period.

Year	Tonnes CO_2e sequestered (BlueCAM)
2024	11.5
2029	795.3
2034	1,580.4
2039	2,366.9
2044	3,155.5
2049	3,945.3
2057	5,213.0

6.8.4 SITE 3:DISCOUNTED CASH FLOW ANALYSIS: RESULTS

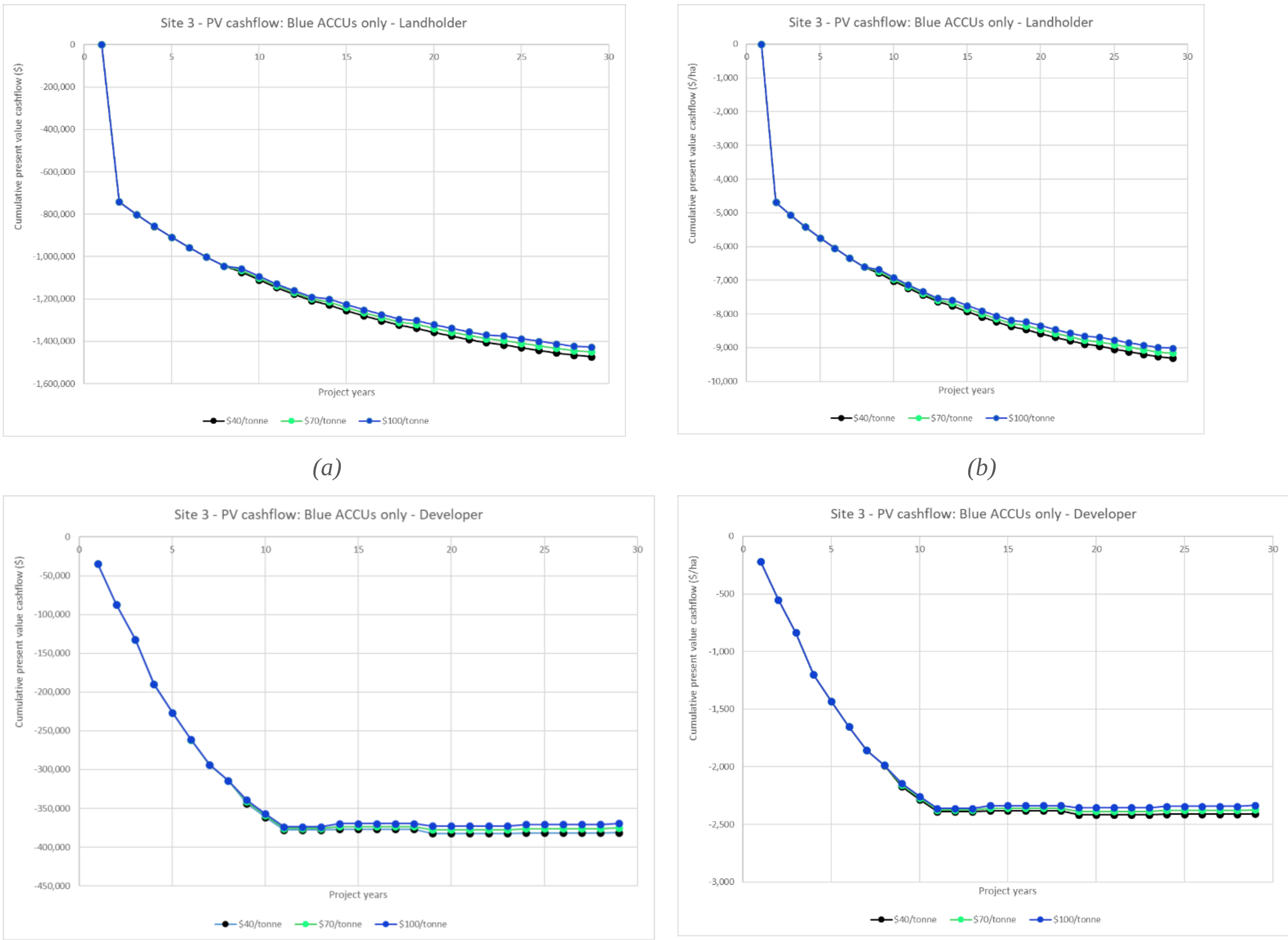
SITE 3: BlueCAM 'Blue ACCUs' standalone

DCFA results are summarised in Table 38.

Table 38: Summary results from DCFA for a standalone blue ACCUs project at Site 3. Reported for 158 ha project area and per hectare of project area. PV denotes present value. NPV denotes net present value. PV and NPV are calculated at 7% real discount rate. NPV is calculated over the full project duration of 29 years. PV upfront loan covers the following costs: detailed project design, development approval and on-site works. Landholder cost scenarios: Scenario 1: reduction in land value is $5018/ha and opportunity cost is $430/ha/year; Scenario 2: reduction in land value is $2509/ha and opportunity cost is $215/ha/year; and Scenario 3 assumes the reduction in land value is $2509/ha and opportunity cost is $0/ha/year.

Metric	Project site (158ha)			Per site hectare		
Upfront loan ($)	219,078			1385		
Developer's share of PV project cost (%)						
Scenario 1	20.6			-		
Scenario 2	34.1			-		
Scenario 3	51.2			-		
Landholder's share of PV project cost						
Scenario 1	79.4			-		
Scenario 2	65.9			-		
Scenario 3	48.8			-		
Results for whole-of-project						
ACCU price ($/ACCU)	*40*	*70*	*100*	*40*	*70*	*100*
NPV ($k)						
Scenario 1	-1854	-1825	-1795	-11.72	-11.53	-11.35
Scenario 2	-1102	-1073	-1043	-6.97	-6.78	-6.59
Scenario 3	-721	-692	-662	-4.56	-4.37	-4.19
Annualised equivalent NPV ($k/year)						
Scenario 1	-151	-149	-146	-0.96	-0.94	-0.92
Scenario 2	-90	-87	-85	-0.57	-0.55	-0.54
Scenario 3	-58.7	-56.3	-53.94	-0.37	-0.36	-0.34
Internal rate of return (%)	-	-		-	-	-
Results for landholder						
ACCU price ($/ACCU)	*40*	*70*	*100*	*40*	*70*	*100*
NPV ($k)						
Scenario 1	-1473	-1449	-1426	-9.31	-9.16	-9.01
Scenario 2	-726	-707	-687	-4.59	-4.47	-4.35
Scenario 3	-352	-337	323	-2.22	-2.13	-2.04
Annualised equivalent NPV ($k/year)						
Scenario 1	-120	-118	-116	-0.76	-0.75	-0.73
Scenario 2	-59	-58	-56	-0.37	-0.36	-0.35
Scenario 3	-29	-27	-26	-0.18	-0.17	-0.17
Cumulative PV cash flow ($)	See Figure 46, Figure 47, Figure 48			See Figure 46, Figure 47, Figure 48		
Results for developer						

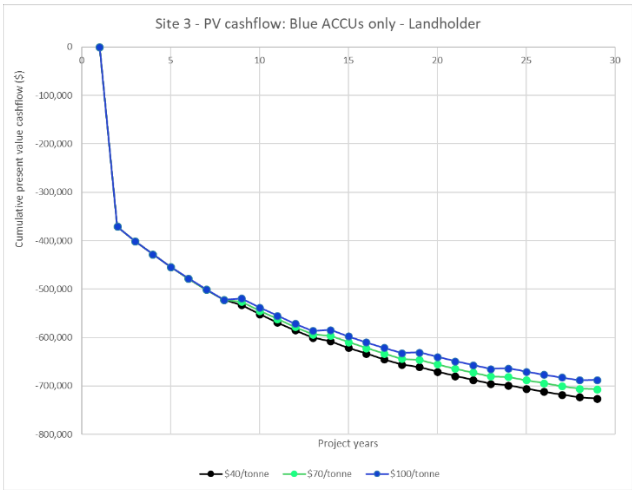
ACCU price ($/ACCU)	*40*	*70*	*100*	*40*	*70*	*100*
NPV ($k)						
Scenario 1	-381	-375	-369	-31.06	-30.57	-30.07
Scenario 2	-376	-366	-356	-2.38	-2.31	-2.25
Scenario 3	-369	-354	-339	-2.34	-2.24	-2.14
Rate of return (%)	-	-	-	-	-	-
Cumulative PV cash flow ($)	See Figure 46, Figure 47, Figure 48			See Figure 46, Figure 47, Figure 48		

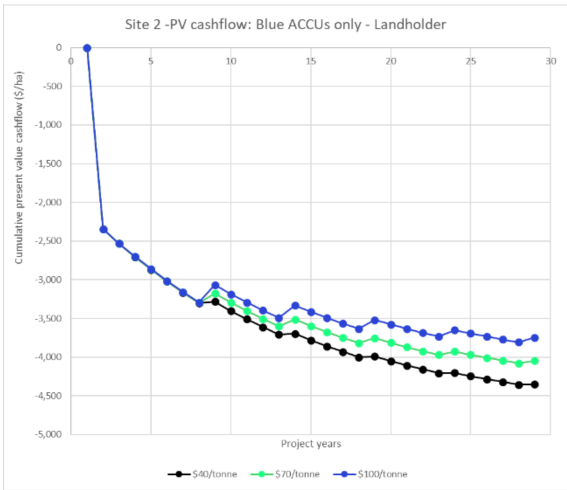


(a) (b)

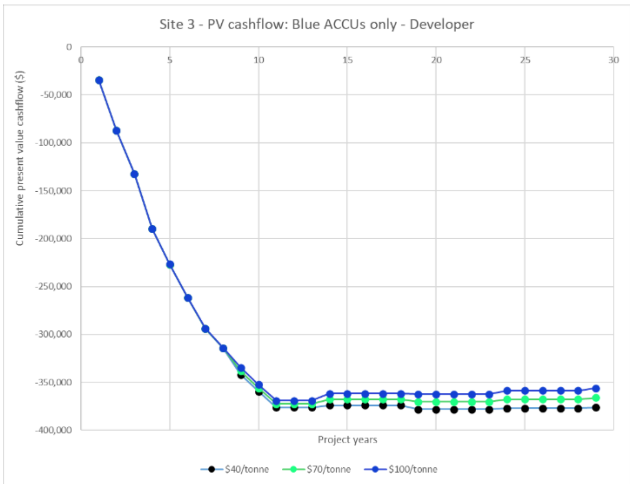
(c) (d)

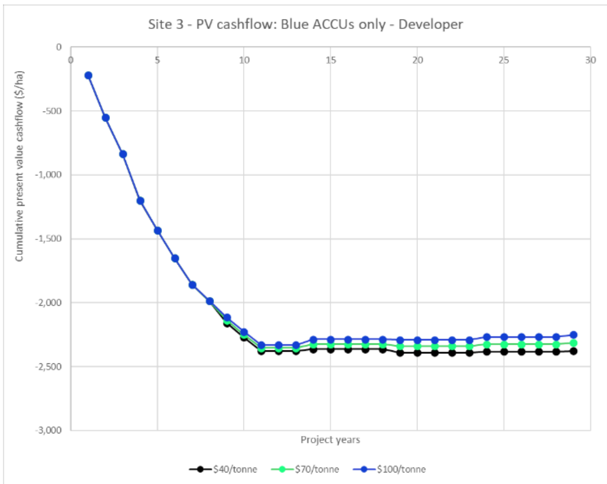
Figure 46 (Landholder cost scenario 1): Cumulative present value cashflows for case study site 3, blue ACCUs only. Plots show cumulative present value cashflows: (a) for the landholder (for the site as a whole), (b) for the landholder (per site hectare), (c) for the developer (for the site as a whole), and (d) for the developer (per site hectare). All results reported a 25-year permanence period, a 7% real discount rate, an 8% annual cost of capital, and a 10-year loan term. Scenario 1: reduction in land value is $5018/ha and opportunity cost is $430/ha/year.





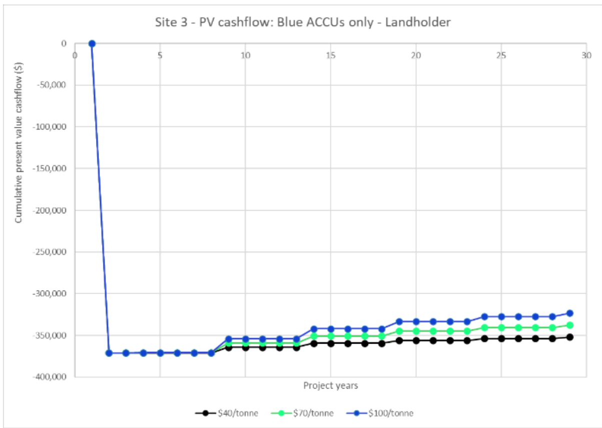
(a) *(b)*

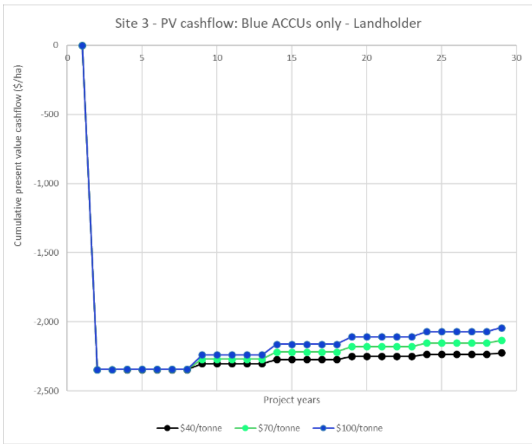




(c) *(d)*

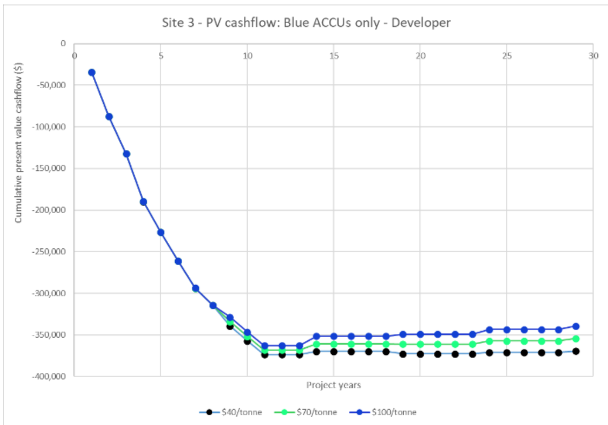
Figure 47 (Landholder cost scenario 2): Cumulative present value cashflows for case study site 3, blue ACCUs only. Plots show cumulative present value cashflows: (a) for the landholder (for the site as a whole), (b) for the landholder (per site hectare), (c) for the developer (for the site as a whole), and (d) for the developer (per site hectare). All results reported a 25-year permanence period, a 7% real discount rate, an 8% annual cost of capital, and a 10-year loan term. Scenario 2: reduction in land value is $2509/ha and opportunity cost is $215/ha/year.

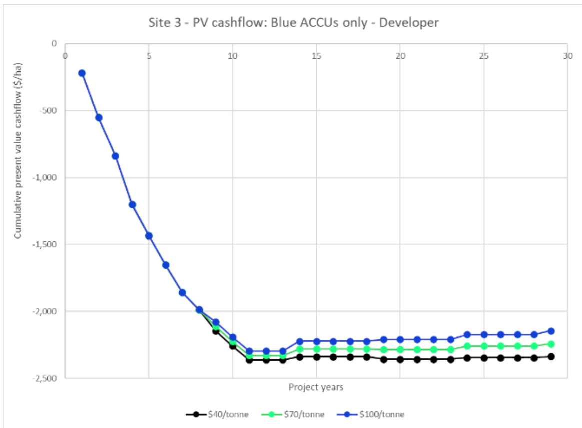




(a)

(b)





(c)

(d)

Figure 48 (Landholder cost scenario 3): Cumulative present value cashflows for case study site 3, blue ACCUs only. Plots show cumulative present value cashflows: (a) for the landholder (for the site as a whole), (b) for the landholder (per site hectare), (c) for the developer (for the site as a whole), and (d) for the developer (per site hectare). All results reported a 25-year permanence period, a 7% real discount rate, an 8% annual cost of capital, and a 10-year loan term. Scenario 3: reduction in land value is $2509/ha and opportunity cost is $0/ha/year.

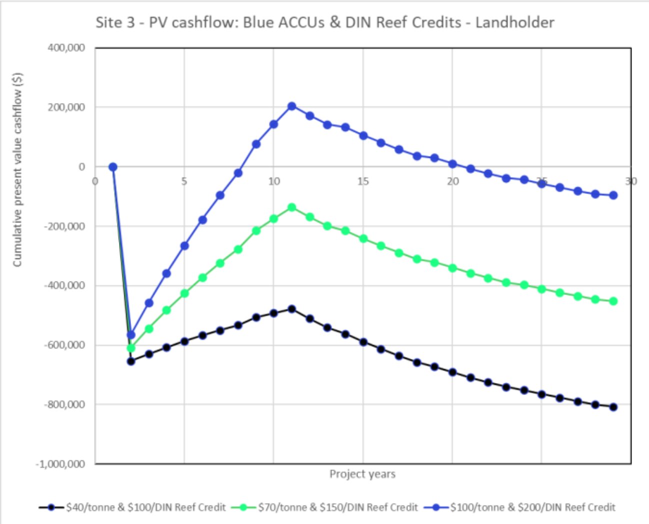
SITE 3: BlueCAM Blue Carbon and DIN Reef credits

DCFA results are summarised in Table 39 and Figure 49.

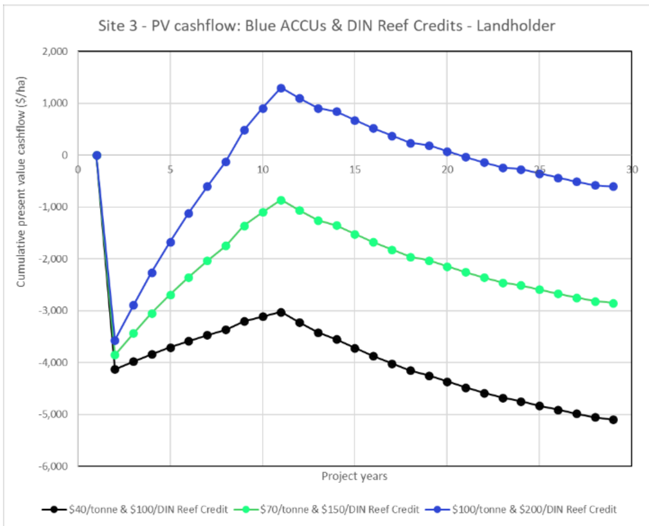
Table 39: Summary results from DCFA for blue ACCUs stacked with DIN Reef Credits at Site 3. Reported for 158 ha project area and per hectare of project area. PV denotes present value. NPV denotes net present value. PV and NPV are calculated at 7% real discount rate. NPV is calculated over the full project duration of 29 years. PV upfront loan covers the following costs: detailed project design, development approval and on-site works. Results for the PV revenue and NPV are presented for the following combinations of: (i) ACCU and DIN Reef Credit prices at $40/ACCU & $100/RC ; $70/ACCU & $150/RC; $100/ACCU & $200/RC, (ii) ACCU price and a 10-year environmental credit payments at $40/ACCU & $5762/wetland ha/year; $70/ACCU & $8643/wetland ha/year; $100/ACCU & $11523/wetland ha/year, or (iii) ACCU price and a 25-year environmental credit payments at $40/ACCU & $3876/wetland ha/year; $70/ACCU & $5965/wetland ha/year; $100/ACCU & $7951/wetland ha/year. Landholder cost scenarios: Scenario 1: reduction in land value is $5018/ha and opportunity cost is $430/ha/year; Scenario 2: reduction in land value is $2509/ha and opportunity cost is $215/ha/year; and Scenario 3 assumes the reduction in land value is $2509/ha and opportunity cost is $0/ha/year.

Quantity of Reef Credits per ha: 8.05						
Metric	**Project site (158ha)**			**Per site hectare**		
Upfront loan ($)	219,078			1385		
Developer's share of PV project cost (%)						
Scenario 1	25.3			-		
Scenario 2	40.4			-		
Scenario 3	51			-		
Landholder's share of PV project cost (%)						
Scenario 1	74.7			-		
Scenario 2	59.6			-		
Scenario 3	49			-		
ACCU price ($/ACCU)	*40*	*70*	*100*	*40*	*70*	*100*
AND						
Reef Credit price ($/RC)	*100*	*150*	*200*	*100*	*150*	*200*
OR						
10-year environmental credit ($/ha/year)	*5762*	*8643*	*11523*	*5762*	*8643*	*11523*
OR						
25-year environmental credit ($/ha/year)	*3976*	*5965*	*7951*	*3976*	*5965*	*7951*
Results for whole-of-project						
NPV ($k)						
Scenario 1	-1081	-604	-127	-0.81	-3.82	-6.83
Scenario 2	-329	148	625	-2.08	0.94	3.95
Scenario 3	423	900	1377	2.68	5.69	8.70
Annualised equivalent NPV ($k/year)						
Scenario 1	-88.02	-49.20	-10.37	-0.56	-0.31	-0.66
Scenario 2	-26.78	12.05	50.87	-0.17	0.08	0.32
Scenario 3	34.5	73.3	112.1	0.22	0.46	0.71
Internal rate of return (%)						
Scenario 1	-	-	-	-	-	-
Scenario 2	-	21.1	49.6	-	21.1	49.6
Scenario 3	9.6	33.0	59.8	9.6	33.0	59.8
Results for landholder						

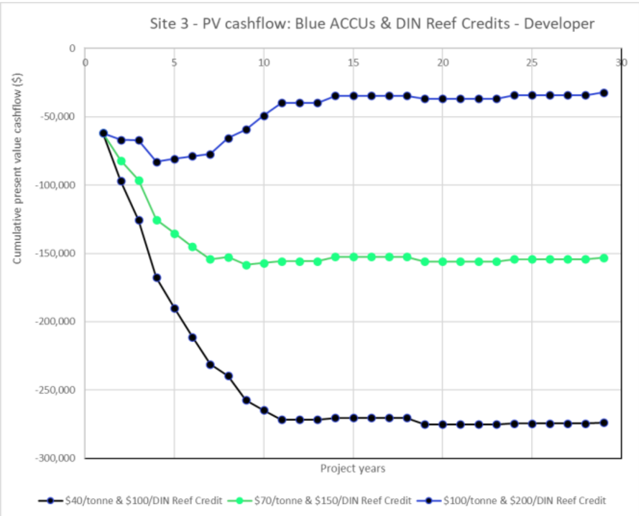
NPV ($k)							
	Scenario 1	-806.9	-451.0	-95.1	-5.10	-2.85	-0.60
	Scenario 2	-195.8	88.1	372.1	-1.24	0.56	2.35
	Scenario 3	22	223	423	0.14	1.41	2.68
Annualised equivalent NPV ($k/year)							
	Scenario 1	-65.72	-36.73	-7.75	-0.42	-0.23	-0.05
	Scenario 2	-15.95	7.18	30.3	-0.10	0.05	0.19
	Scenario 3	1.79	18.13	34.47	0.01	0.12	0.22
Cumulative PV cash flow ($)		See Figure 49, Figure 50, Figure 51			See Figure 49, Figure 50, Figure 51		
Results for developer							
NPV ($k)							
	Scenario 1	-273.88	-153.08	-32.3	-1.73	-0.97	-0.20
	Scenario 2	-133	59.8	252.6	-0.84	0.38	1.60
	Scenario 3	30.28	306.35	582.43	0.19	1.94	3.68
Rate of return (%)							
	Scenario 1	-	-	-	-	-	-
	Scenario 2	-	6.2	26.4	-	6.2	26.4
	Scenario 3	4.5	46	87	4.5	46	87
Cumulative PV cash flow ($)		See Figure 49, Figure 50, Figure 51			See Figure 49, Figure 50, Figure 51		



(a)



(b)



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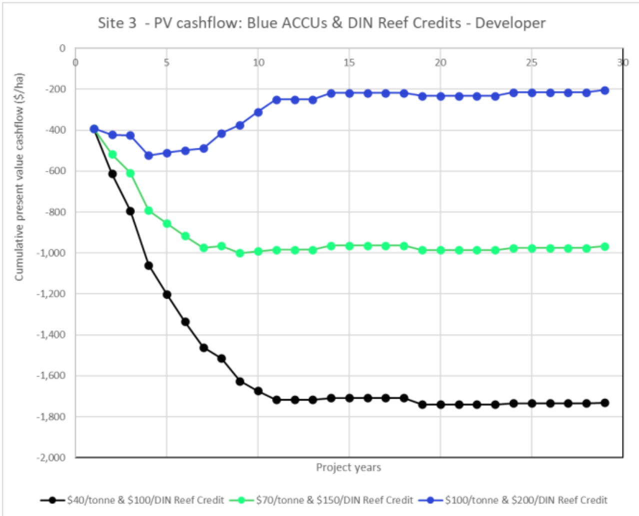
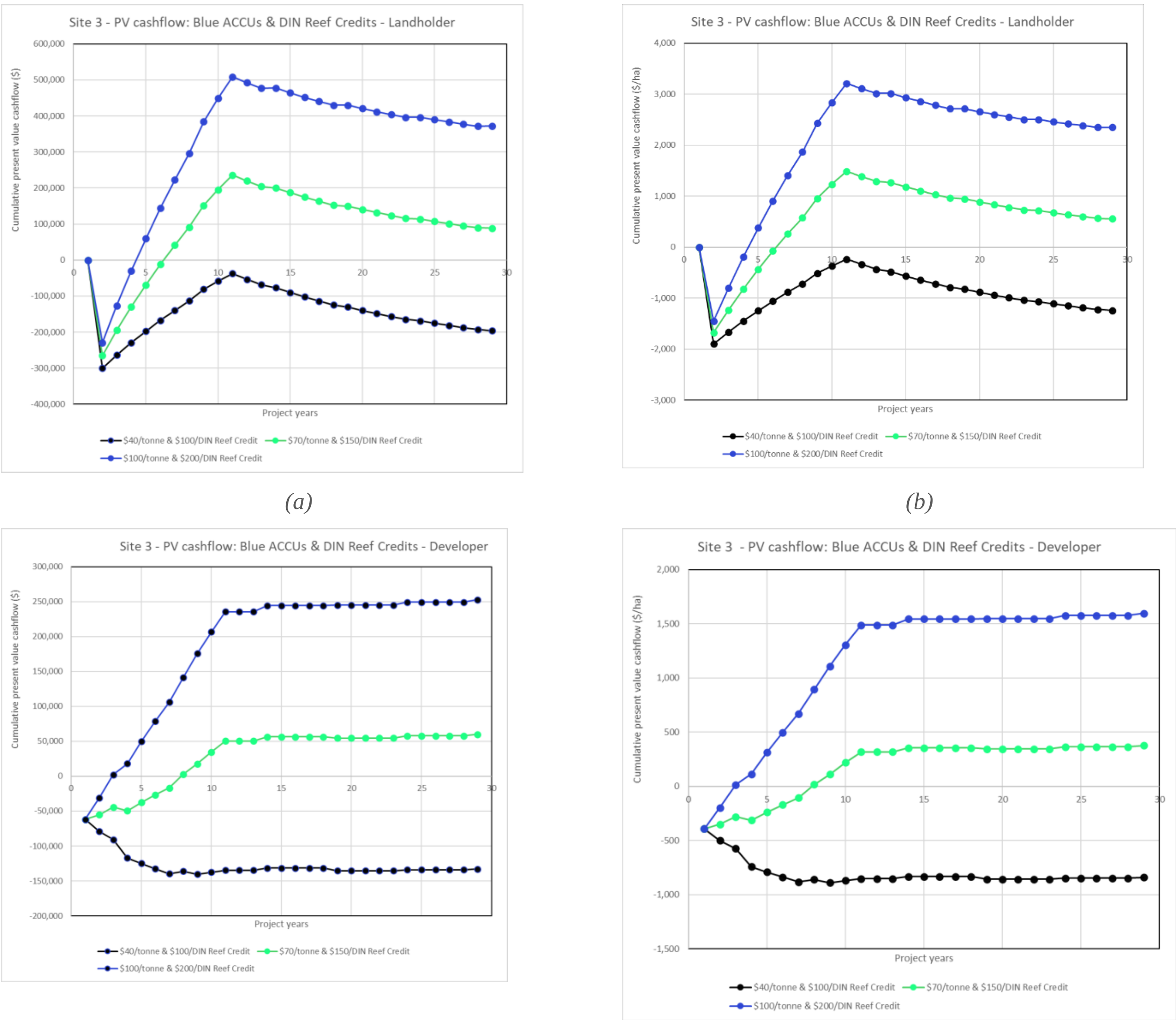


(d)

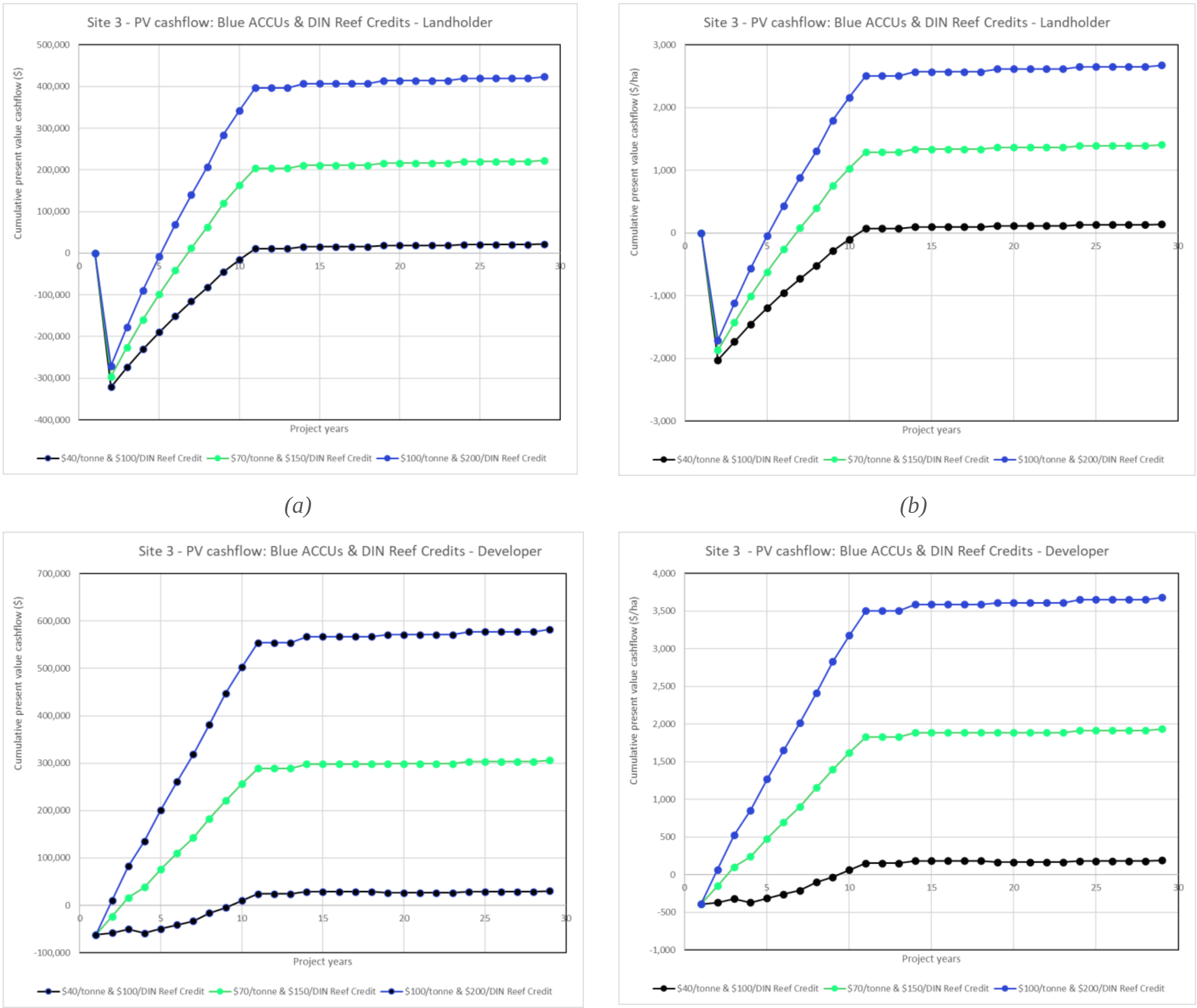
Figure 49 (Landholder cost scenario 1): Cumulative present value cashflows at case study site 3, blue ACCUs stacked with DIN Reef Credits. Plots show cumulative present value cashflows: (a) for the landholder (for the site as a whole), (b) for the landholder (per site hectare), (c) for the developer (for the site as a whole), and (d) for the developer (per site hectare). All results reported a 25-year permanence period, a 7% real discount rate, an 8% annual cost of capital, and a 10-year loan term. Scenario 1: reduction in land value is $5018/ha and opportunity cost is $430/ha/year.



(a) *(b)*

(c) *(d)*

Figure 50 (Landholder cost scenario 2): Cumulative present value cashflows at case study site 3, blue ACCUs stacked with DIN Reef Credits. Plots show cumulative present value cashflows: (a) for the landholder (for the site as a whole), (b) for the landholder (per site hectare), (c) for the developer (for the site as a whole), and (d) for the developer (per site hectare). All results reported a 25-year permanence period, a 7% real discount rate, an 8% annual cost of capital, and a 10-year loan term. Scenario 2: reduction in land value is $2509/ha and opportunity cost is $215/ha/year.



(a) *(b)*

(c) *(d)*

Figure 51 (Landholder cost scenario 3): Cumulative present value cashflows at case study site 3, blue ACCUs stacked with DIN Reef Credits. Plots show cumulative present value cashflows: (a) for the landholder (for the site as a whole), (b) for the landholder (per site hectare), (c) for the developer (for the site as a whole), and (d) for the developer (per site hectare). All results reported a 25-year permanence period, a 7% real discount rate, an 8% annual cost of capital, and a 10-year loan term. Scenario 3: reduction in land value is $2509/ha and opportunity cost is $0/ha/year.

6.8.5 SITE 3: KEY CONSIDERATIONS

Table 40: The depth and area of inundation modelled at Site 3 at the Highest Astronomical Tide (HAT), HAT + projected sea level rise under RCP 8.5 climate change scenario by 2057 (CC2057), and 2107 (CC2107).

Scenario	**Inundation depth (m)**	**Total Inundation Area (ha)**	**Inundation Area (ha)** ***Sugarcane only***
HAT	1.7	16.80	3.33
HAT+SLR 2057	2.07	23.81	9.19
HAT+SLR 2107	2.5	35.02	19.50

Constraints	**Opportunities**
<u>*Ecological:*</u> <u>*Economic:*</u> - Multiple landholders in the area increases legal and administrative costs; - The cost-effectiveness of environmental improvement projects at Site 3 is poor because tidal re-introduction restores blue carbon ecosystems over less than 15% of the full site area. <u>*Administrative:*</u> - Multiple landholders in the area and lack of property boundary data = unable to assess the need for engineering works to protect adjacent properties from tidal inundation <u>*Social:*</u> - Lack of awareness of the blue carbon market and potential methods. - Skepticism regarding project/method success.	<u>*Ecological:*</u> - Potential increases in biodiversity; - Habitat provision, including for endangered, endemic, and protected migratory species; <u>*Economic:*</u> - Potential additional income through eco-tourism, educational tours, activities, and recreation; <u>*Social:*</u> - Potential coastal resilience and protection benefits; - Potential for eco-tourism, educational tours, activities, and recreation

6.9 COSTS & CO-BENEFITS OF BLUE CARBON PROJECTS FOR ALL SITES

6.9.1 CARBON SEQUESTRATION

The carbon sequestered at the case study sites and over the following 75 years under the 100-year permanence period, would help reduce carbon dioxide concentrations in the atmosphere. As coastal wetlands trap and accumulate carbon in their sediments, so long as these sediments are undisturbed, the carbon sequestered in blue carbon ecosystems can be stored for millennia, contributing to long-term climate change mitigation efforts (Chmura et al., 2003).

6.9.2 WATER QUALITY

Coastal wetlands not only sequester carbon, but under the correct conditions, are also capable of processing contaminants in water such as nitrogen, phosphorus, sediments, heavy metals and even pesticides (Kao et al., 2002; Matagi et al., 1998; Thompson et al., 2018). Through intercepting and slowing water movement from upstream, potentially polluted sources, wetlands can remove contaminants via sediment trapping and settlement, plant uptake, and microbial-driven processes such as denitrification (Johnston, 1991). Therefore, the restoration of coastal wetland habitats, such as mangroves and saltmarsh, through blue carbon projects, may also yield water quality benefits to local coral reefs.

6.9.3 COASTAL PROTECTION

Coastal wetlands can also provide significant coastal protection via wave attenuation, dissipating incoming wave energy through their complex root systems, dense vegetation, and rough terrain; preventing erosion by stabilising and reinforcing shorelines with their root systems; mitigating floods and storm surges by slowing down and redistributing incoming water (Barbier, 2019; Gedan et al., 2011; Möller et al., 2014).

6.9.4 BIODIVERSITY & HABITAT

Coastal wetlands provide a diversity of habitats and niches that act as shelter, breeding grounds, nurseries, and foraging sites for a wide range of terrestrial and aquatic species. As a result, coastal wetlands are a hub of biodiversity, and provide critical habitat for numerous threatened and endangered species (Beck et al., 2001; Meli et al., 2014). Coastal wetlands are particularly important sites for migratory bird species, providing shelter, breeding, and foraging grounds during long-distance migrations (Yang et al., 2017).

6.9.5 CULTURAL HERITAGE, RECREATION AND EDUCATION

Coastal wetlands provide a wide range of cultural, recreational, and educational benefits, serving as valuable natural assets for communities and visitors alike (Ghermandi et al., 2020; Kelleway et al., 2017). Traditional owners and local communities may have deep cultural connections to wetland ecosystems and Country, serving as sites for cultural practices and traditions. Wetlands also have a high aesthetic appeal and offer diverse recreational opportunities for people to enjoy nature and engage in outdoor activities. Activities such as birdwatching, fishing, kayaking, hiking, and wildlife photography are popular recreational pursuits in wetland areas, attracting visitors and promoting ecotourism. Coastal wetlands also serve as valuable educational resources for formal and informal learning. Wetland habitats provide hands-on opportunities for environmental education, allowing students, educators, and the general public to learn about wetland ecology, biodiversity, conservation, and the importance of ecosystem services (Chatanga et al., 2020).

6.9.6 COSTS AND RISKS

Natural freshwater wetlands and freshwater habitats, established as a result of the construction of tidal restriction mechanisms, can provide habitat for a range of freshwater species, such as freshwater turtles, fish, crustaceans, and birds. The removal of tidal restrictions and subsequent saltwater inundation as a result of a blue carbon project would therefore result in the transition of these freshwater systems to a more saline ecosystem. Therefore a potential impact of such projects is the loss of freshwater habitat and any freshwater species would need to migrate to other areas of the floodplain, which may not always be possible. The benefits and trade-offs associated with any of these projects should be assessed using the whole-of-system, values-based framework (Department of Environment, Science and Innovation, www.des.qld.gov.au).

7. FUTURE STEPS AND RECOMMENDATIONS

7.1 SCALING UP ENVIRONMENTAL MARKET OPPORTUNITIES

This section explores opportunities for scaling up restoration across the Mossman district, to provide an overview of investment options at a landscape scale, at least conceptually. Ecosystem restoration costs vary across schemes and across projects within the same scheme. Restoration costs depend on the size of the area restored, biophysical characteristics of the land (see e.g. Rowland et. al. 2023), surrounding land use and land cover, and socio-economic and socio-demographic contexts of the region.

Using blue carbon ecosystem restoration to illustrate opportunities for scaling up across the landscape, existing spatial datasets such as drainage lines, tidal control structures (bunds and tidal gates), current extent of blue carbon ecosystems (e.g. mangroves, saltmarsh, supratidal swamp forest), current land use, tidal heights, topography, LiDAR mapping, and cadastral (land ownership) mapping can be used as input data into restoration cost models, in addition to actual and estimated costs. Cost models can be used to predict restoration costs for a particular block of land. A block of land here refers to a land area deemed suitable for a blue carbon credit project in which ecosystem restoration is enabled through removal of specific bund walls and tidal gates. If restoration costs, informed by these factors, can be predicted for each project (i.e. ex ante estimates of the cost of restoration), the resulting information, when arranged cumulatively from lowest-cost per hectare to highest-cost per hectare, would produce a supply function for blue carbon ecosystem restoration for the region.

In Figure 52, project 1 has the lowest cost per hectare and project N has the highest cost per hectare. The size of each rectangular block indicates the total cost of coastal restoration for each project. The area shaded in blue from the first block (project 1) to the last block (project N) gives the total cost of restoring the entire area covered in the modelling. Project i indicates the areal extent of blue carbon ecosystems (seagrass, mangroves, saltmarsh and supra-tidal swamp forest, or their combinations) that would be expected to form following removal of specific bund walls and tidal gates at particular locations. Each rectangular block is spatially specific and comes with specific attributes: e.g. project 1 spans 10 ha in an isolated patch and involves three landholders; compared to relatively higher cost project 4 covering 18 ha but only involving one landholder.

The darker horizontal blue lines together represent the piecewise linear supply function. This supply function can be used inform decisions on where and how much to restore within a particular region of interest. The supply function can be regarded as a prioritisation tool to inform selection of highly cost-effective restoration projects. Additionally, the function can be used to provide indicative total restoration costs for a given target for total area restored. Box 2 shows an example derivation of an empirical supply function for rainforest restoration using actual project cost data (i.e. ex post collation of the cost of restoration).

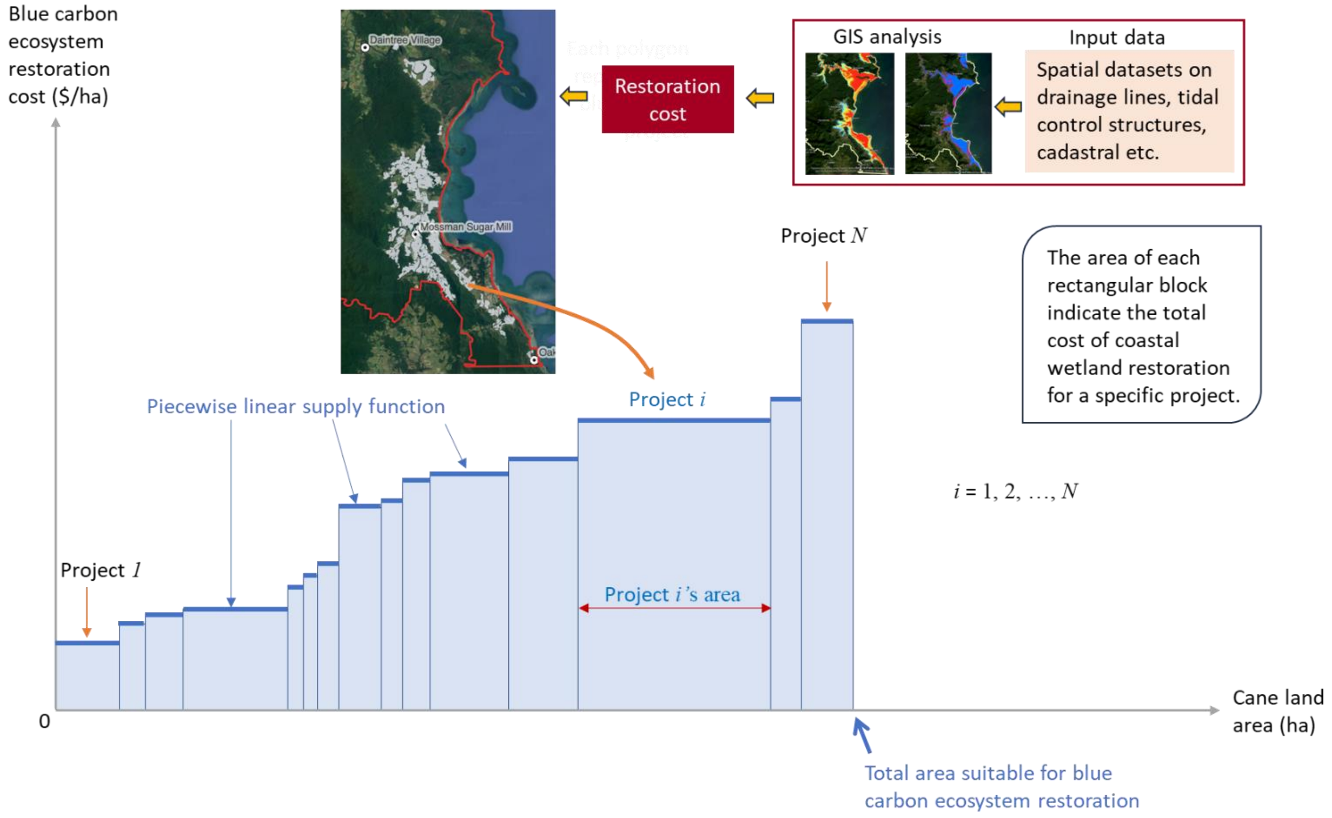


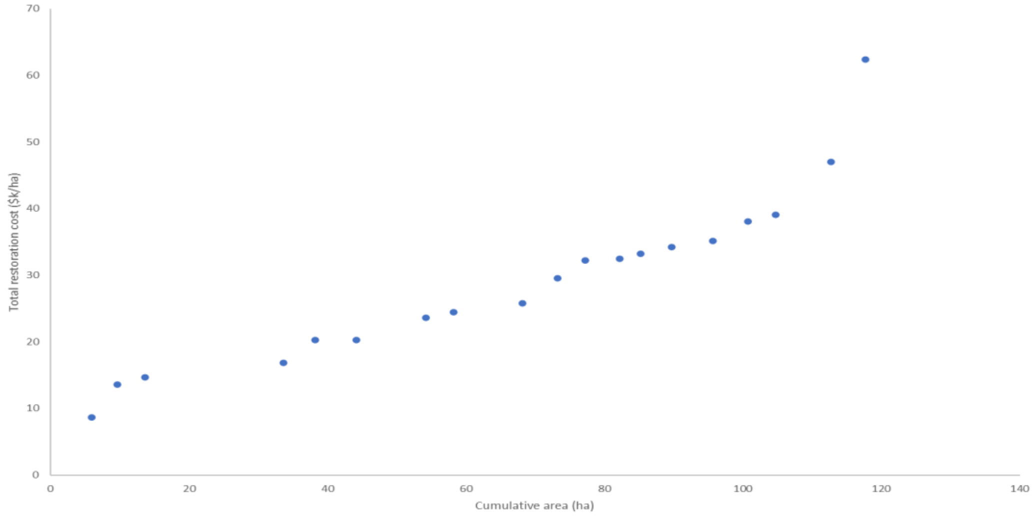
Figure 52: Landscape-scale Blue Carbon ecosystem restoration opportunity. Ranking of project-specific per hectare costs from lowest to highest to produce a supply function for restoring Blue Carbon ecosystems on existing sugarcane farms. The total restoration cost for all suitable land in Mossman district would be given by the shaded (light blue) area. Thick horizontal dark blue lines together represent the piecewise linear supply function for the blue carbon ecosystem restoration.

The supply function, when combined with information on revenue per hectare, indicates the number of hectares of land that can be regarded as financially viable for restoration. In, M1 hectares of land can be restored for the given level of blue carbon revenue (in $/ha; Figure 53).

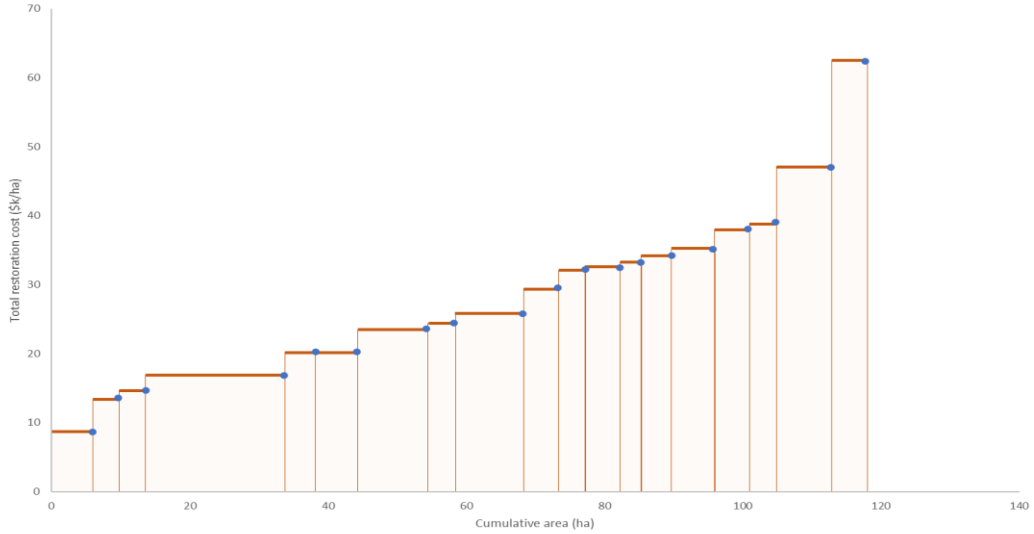
The financial viability of restoring land to blue carbon ecosystems or rainforests is dependent on the level of revenue streams from relevant credit schemes. For example, at a relatively low level of blue carbon revenue per hectare (BCR_{Low}), only A_{Low} hectares of sugarcane land are financially viable for restoration compared to A_{High} hectares ($A_{High} > A_{Low}$) at a higher level of blue carbon revenue (Figure 54). Expanding the scale of opportunity beyond A_{High} hectares would require a 'top-up' revenue stream (via credit stacking or public funding support) for higher-cost projects to become financially viable (all rectangular bars between A_{High} and A_{High_topup} (Figure 55).

Box 2: Example derivation of empirical supply function for rainforest restoration projects

Data on previously completed rainforest restoration projects conducted under the first phase of Natural Heritage Trust (1997–2002) compiled and presented in Catterall & Harrison (2006, Figure 33c, p30), are used here to illustrate derivation of empirical supply function of rainforest restoration.



(a)



(b)

Scatter plots showing (a) and empirical piecewise linear supply function (b) derived using data on previously completed rainforest restoration projects that were extracted from the Wet Tropics Regional Directory (see Catterall & Harrison 2006, Figure 33c, p30). Only a subset of data from Catterall & Harrison (2006) on restoration projects covering blocks of at least 3 ha is shown here. Data was extracted from the scatterplot in Catterall & Harrison (2006, Figure 33c, p30) using web-based software: https://apps.automeris.io/wpd/, date accessed: 17 August 2023. Total restoration cost per hectare is expressed in 2022 AUD$.

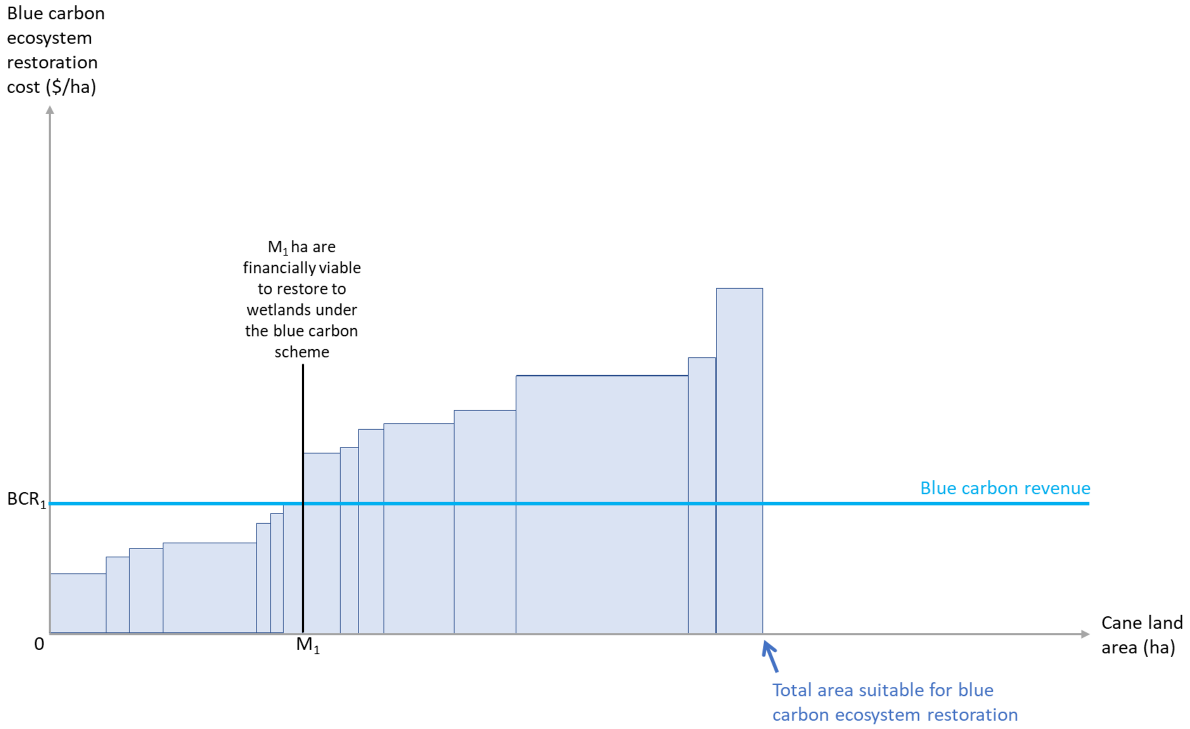


Figure 53: A given level of credit revenue (BCR1) determines the scale of opportunities (M1).

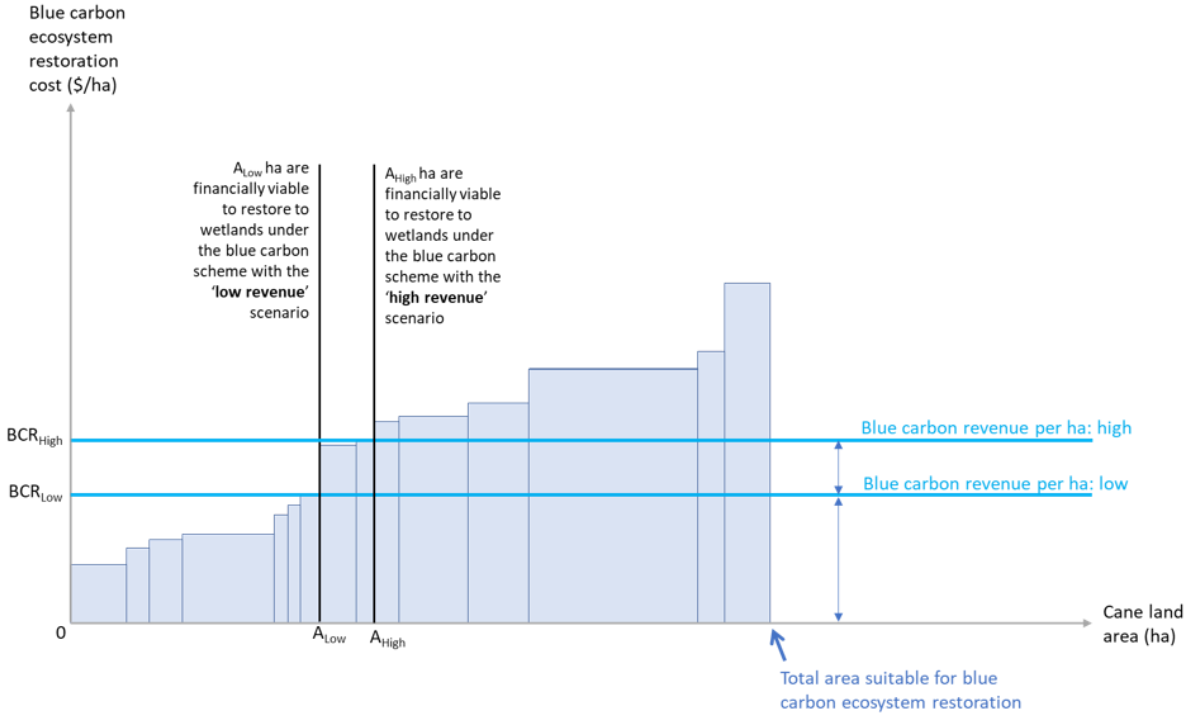


Figure 54: Financial viability of restoration projects depend on the levels of revenue streams from credit sale.

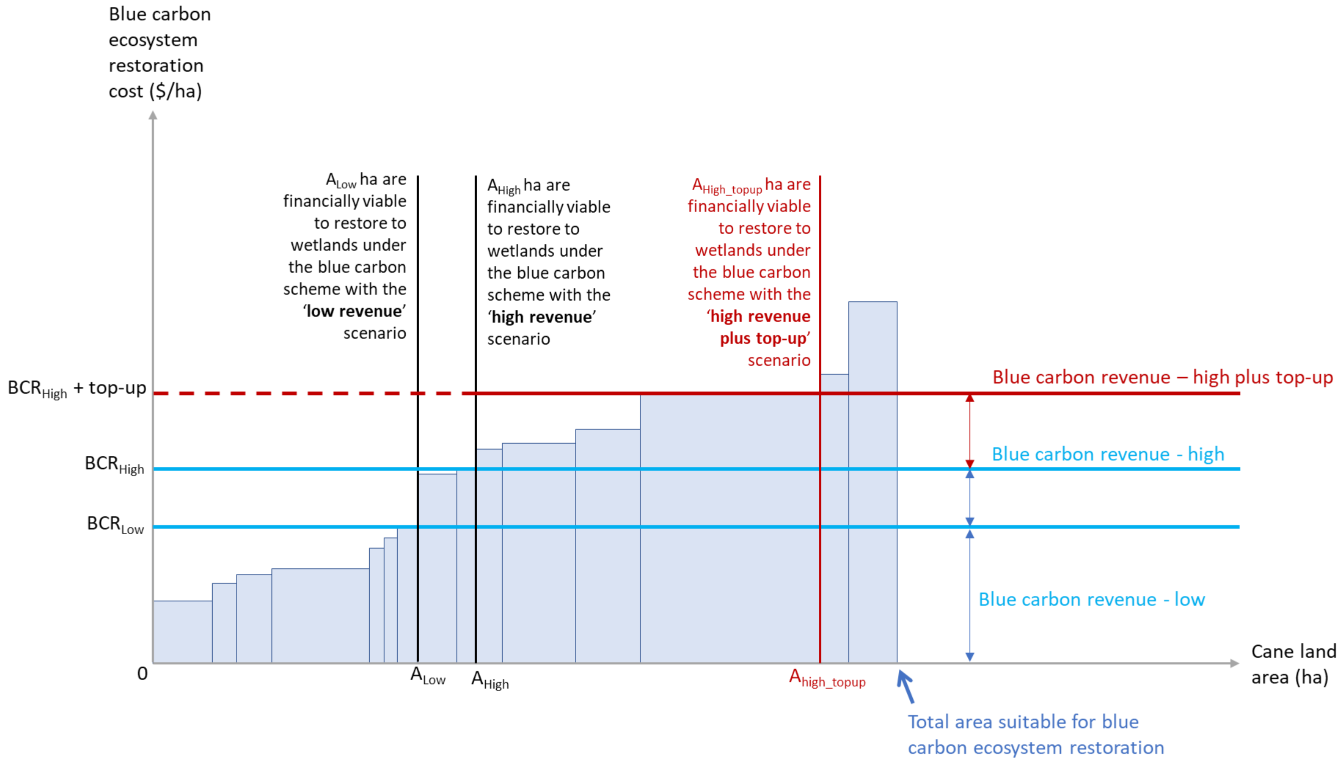


Figure 55: Expanding the scale of opportunity by credit stacking and top-ups.

7.2 ADDITIONALITY REQUIREMENTS

When landholders can receive multiple payments for a single restoration, credit stacking could create potential problems for double payments and additionality (Lankoski et al., 2015, pg. 9). For land restoration in the Mossman district, multiple revenue streams from different credit schemes are likely to be required for some projects to be financially viable. If project actors' full costs can be covered by engaging in multiple credit schemes, more project teams may be inclined to participate as credit suppliers, potentially opening opportunities for larger-scale restoration projects. From a project team's perspective, diversification of revenue streams from a portfolio of credit schemes can reduce the risk of exposure to credit scheme failures. Consider for example rainforest restoration projects, without credit stacking and relying solely on (green) carbon revenue, only a relatively small proportion of suitable sugarcane areas (X_1 hectares) are deemed to be financially viable through projects 1, 2, 3 and 4. However, when an additional revenue stream from another environmental scheme (e.g. Cassowary Credits) is stacked on top of the green carbon revenue, additional land areas become financially viable for restoration to rainforests (X_2 hectares can be restored) through projects 5, 6 and 7.

Despite this advantage, stacking also runs the risk of landholders being paid more than once for a land restoration that could have been financially viable with just a single payment (this is referred to as an infringement of 'financial additionality'). In this situation, the extra payment provides a surplus to the landholder with no corresponding addition to the level of regulating services supplied (Motallebi et al., 2018; Robertson et al., 2014). Both financial additionality (Lankoski et al., 2015) and environmental additionality tests need to be satisfied for the additionality requirement.

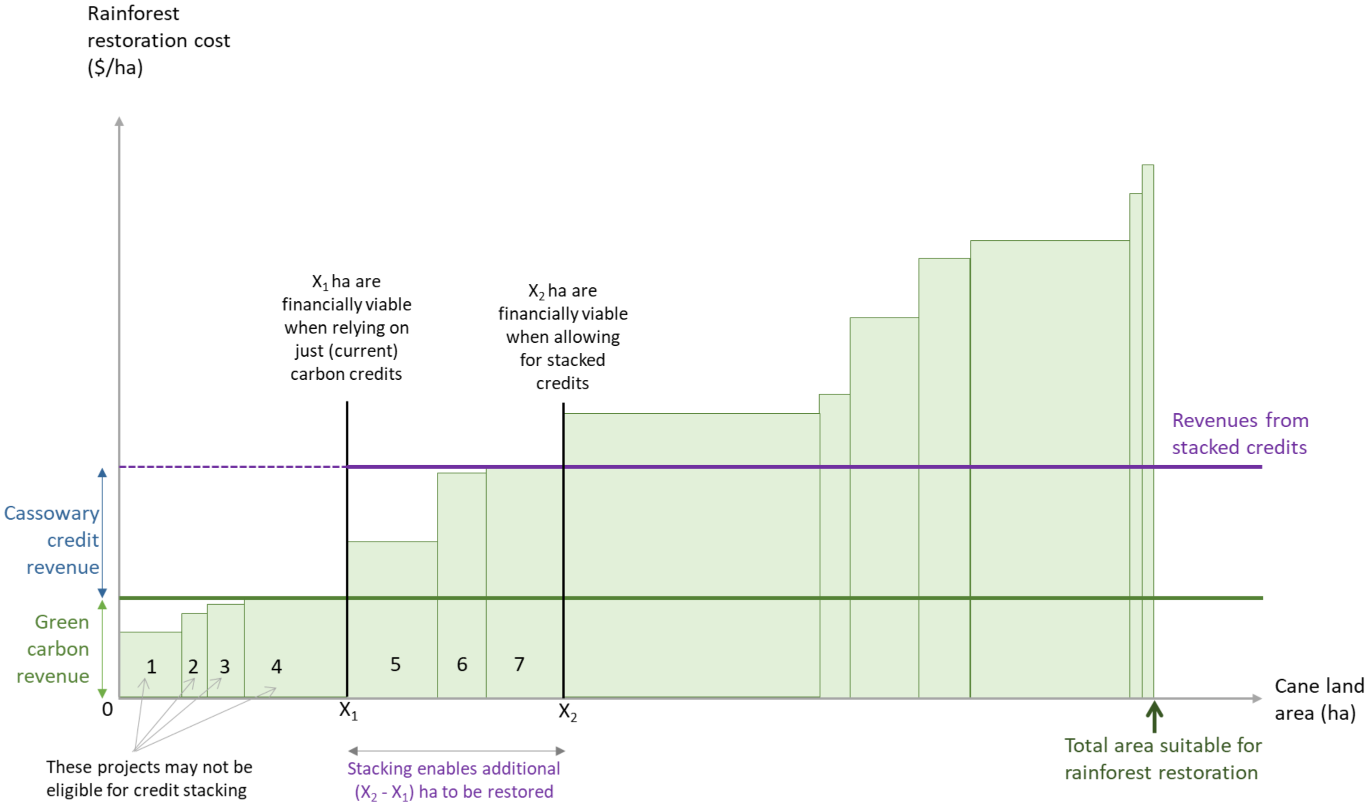


Figure 56: Landholders who participated in restoration projects 1, 2, 3 and 4 should not be eligible for credit stacking because this would not pass the financial additionality test. Rigorous protocols for monitoring, reporting, and auditing can be designed to fulfil the requirement for environmental additionality (see Bennett, 2010 for further explanation on additionality in the context of payment for ecosystem services schemes and ecosystem markets).

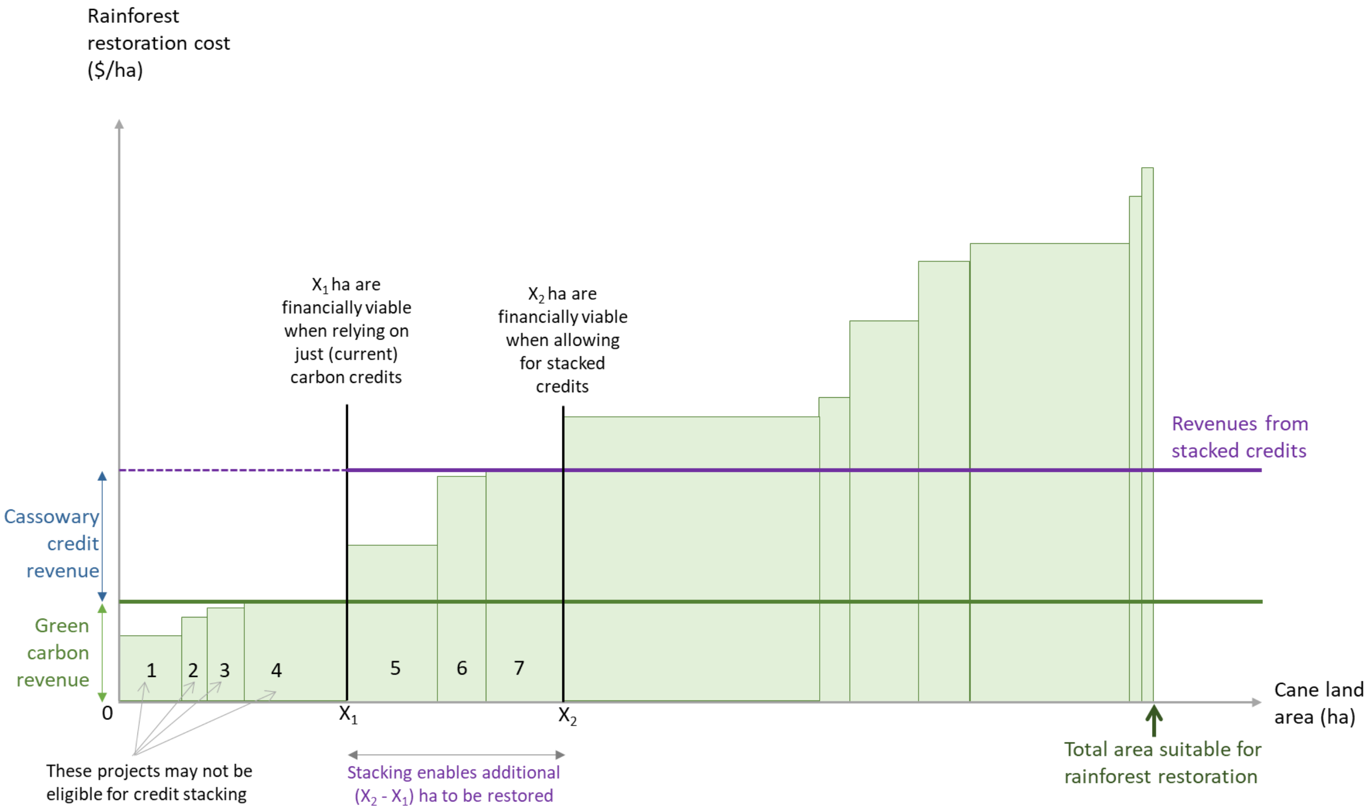


Figure 57: Rainforest restoration costs on former sugarcane production land, arranged cumulatively by area from lowest cost per hectare ($/ha) to highest cost per hectare ($/ha), two revenue streams (green carbon revenue from reforestation by environmental plantings and a biodiversity credit scheme e.g., Cassowary Credits). A higher proportion of suitable sugarcane land can be restored (and more projects become financially viable) the higher the carbon revenue, and vice versa. Credit stacking opens up opportunities for larger-scale restoration projects (X_2 ha restored instead of X_1 ha). The area in each rectangular block represents the total cost of rainforest restoration under a particular project.

7.3 RECOMMENDATIONS EMERGING FROM FARMER INTERVIEWS FOR INTERVENTIONS TO PROMOTE AND FACILITATE PARTICIPATION IN ENVIRONMENTAL MARKETS

A range of interventions to promote and facilitate participation in environmental markets, and to address the perceived barriers to participation, emerged from the interviews with the farmers. The recommended interventions could be grouped within a number of key steps. The first being that clear information to address the key concerns around obligations, time commitments, and the impact on property values and use of the property for security. Second, the farmer needs to see evidence that participating in environmental markets is a viable proposition. Third, farmers perceived the likely need for financial support through the transition from sugarcane farming to future participation in environmental markets. Finally, assuming the earlier steps were successfully navigated, the farmers would require ongoing support in the form of provision of advice, knowledge, and skills to guide them through the process of transitioning from sugarcane farming to engaging in the environmental markets. These steps are expanded on below.

7.3.1 Step 1:- Provide clear information to answer key critically important questions: obligations, time commitment, impact on property costs and values.

This information needs to include:

- Contractual requirements and obligations
- Time periods that these obligations continue over
- Upfront and ongoing obligations for monitoring and reporting – including administrative and biophysical requirements
- Upfront and ongoing impact on property costs, including rates and insurance
- Likely impact on value of property overtime
- Likely impact on use of property as security

Whilst general information can be provided via factsheets and presented in community meetings, many of the farmers are likely to need one on one information sessions with an individual/ organisation they trust to ensure they can understand how the information applies to their particular circumstances.

7.3.2 Step 2:- Provide evidence that markets are viable.

Farmers will need to be able to see real life examples of farmers engaging with markets, to clearly demonstrate that this can be financially viable for the farmer; that is, it can make more money than growing sugarcane.

Evidence that the markets are environmentally viable, that is, they do actually deliver sustainable environmental benefits, is also required to provide comfort that the markets will continue to operate over the length of the contractual commitments and into the foreseeable future.

7.3.3 Step 3:- Provide financial support for transition period

To encourage famers to participate in environmental markets, financial assistance will be required. This will help support farmers through the transition, from sugarcane to environmental markets, providing a bridge spanning the planning, capital investment and initial operational years until the income from the credits is flowing. Farmers indicated that this financial support, underwriting the costs of transition, would be required for a substantial period, likely at least 10 years.

7.3.4 Step 4:- Provide ongoing support in the form of advice and building farmers' skills and knowledge

The farmers were clear that even if these first three steps were followed, moving them to the point where they were willing and able to participate in environmental markets, there would still be a need for someone they trust to be available to guide them through the process. Just as Sugar Research Australia provides knowledge and guidance on new varieties and techniques for sugarcane farming, they would need similar support for participating in these markets. Currently they lack knowledge in managing their land for other than sugarcane:

> *"... without the support, I doubt if I'd go into an environmental market. ... We have no experience ... we know how to grow sugarcane ...".*

8. REFERENCES

AEC. (2023). *Mossman agricultural opportunities and options workshop and action plan*.

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, *50*(2), 179–211.

Anderegg, W. R. L., Trugman, A. T., Badgley, G., Anderson, C. M., Bartuska, A., Ciais, P., Cullenward, D., Field, C. B., Freeman, J., Goetz, S. J., Hicke, J. A., Huntzinger, D., Jackson, R. B., Nickerson, J., Pacala, S., & Randerson, J. T. (2020). Climate-driven risks to the climate mitigation potential of forests. *Science*, *368*(6497), eaaz7005. https://doi.org/10.1126/science.aaz7005

Australian Bureau of Statistics. (2021a). *2021 Census Community Profiles*. https://www.abs.gov.au/census/find-census-data/community-profiles/2021

Australian Bureau of Statistics. (2021b). *2021 Census data*. https://www.abs.gov.au/census/find-census-data/search-by-area

Australian Bureau of Statistics. (2022). *Region summary: Daintree*. https://dbr.abs.gov.au/region.html?lyr=sa2&rgn=306041164

Australian Manufacturing. (2018). *Qld Government announces $25m bail-out for Mossman sugar mill*. Australian Manufacturing News. https://www.australianmanufacturing.com.au/qld-government-announces-25m-bail-out-for-mossman-sugar-mill/

Barbier, E. B. (2019). Chapter 27 - The Value of Coastal Wetland Ecosystem Services. In G. M. E. Perillo, E. Wolanski, D. R. Cahoon, & C. S. Hopkinson (Eds.), *Coastal Wetlands (Second Edition)* (pp. 947–964). Elsevier. https://doi.org/https://doi.org/10.1016/B978-0-444-63893-9.00027-7

Barker, E. (2024). *Carbon markets: clear premiums showing for certain projects*. Ag Carbon Central, Nascon Media Pty Ltd. Https://Www.Beefcentral.Com/Carbon/Carbon-Markets-Clear-Premiums-Showing-for-Certain-Projects/.

Beck, M. W., Heck, K. L., Able, K. W., Childers, D. L., Eggleston, D. B., Gillanders, B. M., Halpern, B., Hays, C. G., Hoshino, K., & Minello, T. J. (2001). The identification, conservation, and management of estuarine and marine nurseries for fish and invertebrates: a better understanding of the habitats that serve as nurseries for marine species and the factors that create site-specific variability in nursery quality will improve conservation and management of these areas. *Bioscience*, *51*(8), 633–641.

Beck, M. W., Reguero, B. G., Narayan, S., Settelmyer, S., Menendez, P., Simpson, S., & Landis, E. (2021). *Methodology for Coastal Resilience Benefits from Restoration and Protection of Tidal Wetlands*.

Bennett, K. (2010). Additionality: The next step for ecosystem service markets. *Duke Envtl. L. & Pol'y F.*, *20*, 417.

BirdLife International. (2016). Numenius phaeopus. The IUCN Red List of Threatened Species 2016: E.T22693178A86585436. http://dx.doi.org/10.2305/IUCN.UK.2016-3.RLTS.T22693178A86585436.en

BirdLife International. (2017). Symposiachrus trivirgatus. The IUCN Red List of Threatened Species 2017: E.T22707277A118762990. http://dx.doi.org/10.2305/IUCN.UK.2017-3.RLTS.T22707277A118762990.en

Boardman, A. E., Greenberg, D. H., Vining, A. R., & Weimer, D. L. (2001). *Cost-benefit analysis: concepts and practice* (2nd ed.). Prentice Hall.

Brandon, K. (2014). Ecosystem services from tropical forests: review of current science. *Center for Global Development Working Paper*, *380*.

Bureau of Meteorology. (2023a). *Daily rainfall: Mossman Central Mill*. https://reg.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_nccObsCode=136&p_display_type=dailyDataFile&p_startYear=&p_c=&p_stn_num=031044

Bureau of Meteorology. (2023b). *Stations*. http://www.bom.gov.au/climate/data/lists_by_element/stations.txt

Bureau of Meteorology. (2024). *Past Tsunami Events*. Http://Www.Bom.Gov.Au/Tsunami/History/Index.Shtml.

Byrne, C., Dansie, M., & Stephen, A. (2024). Mossman Central Mill goes into liquidation after potential sale falls through. *ABC Far North. Https://Www.Abc.Net.Au/News/2024-03-22/Mossman-Central-Mill-Goes-into-Liquidation/103620738*.

Canegrowers. (2022). *Annual Report 2021/22*. https://doi.org/10.3934/microbiol.2022009

Canning, A. D., Smart, J. C. R., Dyke, J., Curwen, G., Hasan, S., & Waltham, N. J. (2023). Constructed Wetlands Suitability for Sugarcane Profitability, Freshwater Biodiversity and Ecosystem Services. *Environmental Management*, *71*(2), 304–320. https://doi.org/10.1007/s00267-022-01734-4

Carbon Credits (Carbon Farming Initiative): Reforestation by Environmental or Mallee Plantings—FullCAM - Methodology Determination 2014 (2018).

Carbon Credits (Carbon Farming Initiative): Tidal Restoration of Blue Carbon Ecosystems - Methodology Determination (2022).

Catchment Solutions. (2022). *2021 Fish Barrier Prioritisation - Mackay Whitsunday Region*.

Catterall, C., & Harrison, D. A. (2006). *Rainforest restoration activities in Australia's tropics and subtropics*. Research Centre for Tropical Rainforest Ecology and Management. Rainforest CRC Queensland, Australia.

Chatanga, P., Kotze, D. C., Okello, T. W., & Sieben, E. J. J. (2020). Ecosystem services of high-altitude Afromontane palustrine wetlands in Lesotho. *Ecosystem Services*, *45*(August), 101185. https://doi.org/10.1016/j.ecoser.2020.101185

Chmura, G. L., Anisfeld, S. C., Cahoon, D. R., & Lynch, J. C. (2003). Global carbon sequestration in tidal, saline wetland soils. *Global Biogeochemical Cycles*, *17*(4).

Clean Energy Regulator. (2016). *Make sure your timing is right: A guide to crediting, reporting, delivery and permanence periods*. https://cer.gov.au/document/make-sure-your-timing-right-information-sheet

Clean Energy Regulator. (2021). *The Blue Carbon Accounting Model (BlueCAM)*. Australian Government. https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwiE1Pne19uCAxWSgFYBHQ4UC7sQFnoECAwQAQ&url=https%3A%2F%2Fwww.cleanenergyregulator.gov.au%2FDocumentAssets%2FPages%2FThe-blue-carbon-accounting-model-BlueCAM.aspx&usg=AOvVaw0dtXRALxceV

Clean Energy Regulator. (2022). *Supplement to the Carbon Credits (Carbon Farming Initiative – Tidal Restoration of Blue Carbon Ecosystems) Methodology Determination 2022*.

Clean Energy Regulator. (2023). *Planning a project*. https://www.cleanenergyregulator.gov.au/ERF/Want-to-participate-in-the-Emissions-Reduction-Fund/Planning-a-project

Clean Energy Regulator. (2024a). *Permanence Obligations*. Australian Government. Https://Cer.Gov.Au/Schemes/Australian-Carbon-Credit-Unit-Scheme/How-Participate/Permanence-Obligations. https://www.cleanenergyregulator.gov.au/ERF/Choosing-a-project-type/Opportunities-for-the-land-sector/Permanence-obligations

Clean Energy Regulator. (2024b). *Project reporting and audits*. Australian Government. Https://Cer.Gov.Au/Schemes/Australian-Carbon-Credit-Unit-Scheme/How-Participate/Project-Reporting-and-Audits.

Clean Energy Regulator. (2024c). *Reforestation by environmental or mallee plantings FullCAM method 2014*. Australian Government. Https://Cer.Gov.Au/Schemes/Australian-Carbon-Credit-Unit-Scheme/Accu-Scheme-Methods/Tidal-Restoration-Blue-Carbon.

Clean Energy Regulator. (2024d). *Tidal restoration of blue carbon ecosystems method*. Australian Government. Https://Cer.Gov.Au/Schemes/Australian-Carbon-Credit-Unit-Scheme/Accu-Scheme-Methods/Tidal-Restoration-Blue-Carbon.

CoastAdapt. (2017). *Sea-level rise and future climate information for coastal councils*. DCCEEW, Australian Government.

Cooper, W. E. (2013). A taxonomic revision of Garcinia L. (Clusiaceae) in Australia, including four new species from tropical Queensland. *Austrobaileya*, *9*(1), 1–29. https://doi.org/10.5962/p.299833

Cooper, W. E. (2015). A taxonomic revision of Cynometra L. (Fabaceae) in Australia with a new species from the Wet Tropics of Queensland and a range extension to the mainland. *Austrobaileya*, *9*(3), 393–403.

DCCEEW. (2020). *Full Carbon Accounting Model (FullCAM)*. Australian Government. https://www.dcceew.gov.au/climate-change/publications/full-carbon-accounting-model-fullcam

DCCEEW. (2022a). *Wetlands Australia 31: Australian Government initiatives for blue carbon*. Australian Government.

DCCEEW. (2022b). *Blue Carbon Ecosystem Restoration Grants*. Australian Government.

DCCEEW. (2023a). *Full Carbon Accounting Model (FullCAM)*. Australian Government.

DCCEEW. (2023b). *Nature Repair Market Bill*.

DCCEEW. (2023c). *Numenius phaeopus - Whimbrel in Species Profile and Threats Database*. http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=849

DCCEEW. (2023d). *SPRAT EPBC Migratory List in Species Profile and Threats Database*. Department of the Environment, Canberra.

DCCEEW. (2024). *Proposed Integrated Farm and Land Management method*. Https://Www.Dcceew.Gov.Au/Climate-Change/Emissions-Reduction/Emissions-Reduction-Fund/Methods/Integrated-Farm-and-Land-Management.

Department of Environment and Resource Management. (2010). *National recovery plan for the spectacled flying fox* Pteropus conspicillatus. *Report to the Department of Sustainability, Environment, Water, Population and Communities, Canberra.*

Department of Environment and Resource Management. (2011). *National recovery plan for the yellow-bellied glider (Wet Tropics)* Petaurus australis *unnamed subspecies. Report to Department of Sustainability, Environment, Water, Population and Communities, Canberra*.

Department of Environment and Science. (2022). *Agricultural ERA Standard: Sugarcane cultivation in the Great Barrier Reef catchment*.

Department of Environment and Science. (2023a). *Investment Round 3: Investment Application Guidelines*.

Department of Environment and Science. (2023b). *The Land Restoration Fund Co-benefits Standard*.

Department of Environment Land Water and Planning. (2016). *National Recovery Plan for the Spotted-tailed Quoll* Dasyurus maculatus.

Douglas Shire Council. (2023). *Sugar Cane*. https://douglas.qld.gov.au/about-the-shire/sugar-cane/

Duretto, M. F., & Forster, P. I. (2007). A taxonomic revision of the genus Zieria Sm. (Rutaceae) in Queensland. *Austrobaileya: A Journal of Plant Systematics*, *7*(3), 473–544. https://doi.org/10.5962/p.299753

Eco-Markets Australia. (2021). *Reef Credit Definitions*.

Emissions Reduction Fund. (2021). *Eligibility and newness*. Clean Energy Regulator, Australian Government.

Emissions Reduction Fund. (2023a). *Auction March 2023*. Clean Energy Regulator, Australian Government.

Emissions Reduction Fund. (2023b). *Contracting under the ACCU Scheme - Frequently asked questions (FAQ's)*. Clean Energy Regulator, Australian Government. https://www.cleanenergyregulator.gov.au/ERF/Forms-and-resources/auctions-and-contracts/contracts-frequently-asked-questions#1

Emissions Reduction Fund. (2023c). *Reforestation by environmental or mallee plantings FullCAM method*. Clean Energy Regulator, Australian Government.

Far Northern Milling. (2022). *Mossman Mill*. https://www.fnmilling.com.au/mossman-mill.html

Gedan, K. B., Kirwan, M. L., Wolanski, E., Barbier, E. B., & Silliman, B. R. (2011). The present and future role of coastal wetland vegetation in protecting shorelines: answering recent challenges to the paradigm. *Climatic Change*, *106*, 7–29.

Ghermandi, A., Camacho-Valdez, V., & Trejo-Espinosa, H. (2020). Social media-based analysis of cultural ecosystem services and heritage tourism in a coastal region of Mexico. *Tourism Management*, *77*. https://doi.org/10.1016/J.TOURMAN.2019.104002

GreenCollar. (2021). *Reef Credits: A win for farmers and for the Great Barrier Reef*. https://greencollar.com.au/our-services/water/

GreenCollar. (2023). *Reef Credits – 3 different approaches to meet different needs*. GreenCollar. https://greencollar.com.au/reef-credits-3-different-approaches-to-meet-different-needs/

IPCC. (2021). *Climate change 2021: The Physical Science Basis. Contribution of working group I to the sixth assessment report of the intergovernmental panel on climate change* (V. Masson-Delmotte, P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, & M. I. Gomis, Eds.). Cambridge University Press Cambridge, UK. https://doi.org/10.1017/9781009157896.001.

Jabalbina. (2021). *About Us*. https://www.jabalbina.com.au/eastern-kuku-yalanji-bubu/

Jacob, M., O'Connor, P., & Rolfe, J. (2023). *Review of the Agriculture Biodiversity Stewardship Pilots to inform the Nature Repair Market*.

Johnston, C. A. (1991). Sediment and nutrient retention by freshwater wetlands: effects on surface water quality. *Critical Reviews in Environmental Science and Technology*, *21*(5–6), 491–565.

Kao, C. M., Wang, J. Y., Chen, K. F., Lee, H. Y., & Wu, M. J. (2002). Non-point source pesticide removal by a mountainous wetland. *Water Science and Technology*, *46*(6–7), 199–206.

Keating, B. A., Verburg, K., Huth, N. I., & Robertson, M. J. (1997). *Nitrogen management in intensive agriculture: sugarcane in Australia.*

Kelleway, J. J., Cavanaugh, K., Rogers, K., Feller, I. C., Ens, E., Doughty, C., & Saintilan, N. (2017). Review of the ecosystem service implications of mangrove encroachment into salt marshes. *Global Change Biology*, *23*(10), 3967–3983. https://doi.org/10.1111/GCB.13727

Lankoski, J., Ollikainen, M., Marshall, E., & Aillery, M. (2015). Environmental Co-benefits and Stacking in Environmental Markets. *OECD Food, Agriculture and Fisheries Papers*, *72*. https://doi.org/https://doi.org/10.1787/5js6g5khdvhj-en.

Matagi, S. V, Swai, D., & Mugabe, R. (1998). A review of Heavy Metal Removal Mechanisms in wetlands. *African Journal of Tropical Hydrobiology and Fisheries*, *8*(1), 13–25.

Meli, P., Rey Benayas, J. M., Balvanera, P., & Martínez Ramos, M. (2014). Restoration enhances wetland biodiversity and ecosystem service supply, but results are context-dependent: a meta-analysis. *PloS One*, *9*(4), e93507.

Möller, I., Kudella, M., Rupprecht, F., Spencer, T., Paul, M., Van Wesenbeeck, B. K., Wolters, G., Jensen, K., Bouma, T. J., & Miranda-Lange, M. (2014). Wave attenuation over coastal salt marshes under storm surge conditions. *Nature Geoscience*, *7*(10), 727–731.

Motallebi, M., Hoag, D. L., Tasdighi, A., Arabi, M., Osmond, D. L., & Boone, R. B. (2018). The impact of relative individual ecosystem demand on stacking ecosystem credit markets. *Ecosystem Services, 29*, 137–144. https://doi.org/10.1016/J.ECOSER.2017.12.010

Nature Repair Market Bill 2023 and Nature Repair Market (Consequential Amendments) Bill 2023 [Provisions] (2023).

NaturePlus. (n.d.-a). *NaturePlus: A scheme helping drive investment into global conservation outcomes*. Https://Naturepluscredits.Com/.

NaturePlus. (n.d.-b). *Projects*. Https://Naturepluscredits.Com/Natureplus-Projects/.

Parkinson, R. W. (2024). Horizontal Rates of Wetland Migration Appear Unlikely to Keep Pace with Shoreline Transgression under Conditions of 21st Century Accelerating Sea Level Rise along the Mid-Atlantic and Southeastern USA. *Coasts*, *4*(1), 213–225.

Pert, P. L., Hill, R., Maclean, K., Dale, A., Rist, P., Schmider, J., Talbot, L., & Tawake, L. (2015). Mapping cultural ecosystem services with rainforest aboriginal peoples: Integrating biocultural diversity, governance and social variation. *Ecosystem Services, 13*, 41–56. https://doi.org/https://doi.org/10.1016/j.ecoser.2014.10.012

Queensland Government. (2022). *Reef Protection Regulations Farming in Reef Catchments: Prescribed Methodology for Sugarcane Cultivation Version 2*.

Robertson, M., BenDor, T. K., Lave, R., Riggsbee, A., Ruhl, J. B., & Doyle, M. (2014). Stacking ecosystem services. *Frontiers in Ecology and the Environment*, *12*(3), 186–193.

Rolfe, J., & Windle, J. (2016). *Benchmarking costs of improving agricultural water management in GBR catchments. Report to the National Environmental Science Programme*.

Rowland, P.I., Hagger, V. & Lovelock, C.E. Opportunities for blue carbon restoration projects in degraded agricultural land of the coastal zone in Queensland, Australia. *Reg Environ Change* **23**, 42 (2023). https://doi.org/10.1007/s10113-022-02013-y Schulz, J., & Sinclair, J. (2020). *Method for accounting reduction in nutrient run-off through managed fertiliser application – version 1.1*.

Simmons, B. A., Archibald, C. L., Wilson, K. A., & Dean, A. J. (2020). Program awareness, social capital, and perceptions of trees influence participation in private land conservation programs in Queensland, Australia. *Environmental Management*, *66*(3), 289–304.

Smart, J. C. R. , Hasan, S. , Curwen, G. , McMahon, J. M., Volders, A. , Saint Ange, C. , Fleming, C. M. , Buckwell, A. , Burford, M. , Tan, P.-L. , Garzon-Garcia, A. , Burton, J. M. , Dew, P. , & Edeson, G. ,. (2020). *Exploring trading in water quality credits as a cost-effective approach for managing water quality in the Great Barrier Reef. Report to the National Environmental Science Program.*

Star, M., Rolfe, J., McCosker, K., Smith, R., Ellis, R., Waters, D., & Waterhouse, J. (2018). Targeting for pollutant reductions in the Great Barrier Reef river catchments. *Environmental Science and Policy, 89*, 365–377.

State of Queensland. (2023a). *Investment Rounds Report*.

State of Queensland. (2023b). *Land Restoration Fund contracted projects: Saltwater Creek Carbon Project—R1083*. Https://Www.Qld.Gov.Au/Environment/Climate/Climate-Change/Land-Restoration-Fund/Funded-Projects/Project-Details?Project=159244.

State of Queensland. (2023c). *Mossman Gorge Centre*. https://parks.des.qld.gov.au/parks/daintree/attractions/mossman-gorge-centre

State of Queensland. (2023d). *WildNet wildlife records. Updated data available at: http://qldspatial.information.qld.gov.au/catalogue//*. Queensland Government.

State of Queensland. (2022). *Queensland Spatial Catalogue*. Department of Resources, Queensland Government.

Sugar Research Australia. (2022). *District Producivity Plan - Southern 2022* (Issue July).

The APSIM Initiative. (2023). *APSIM: The Leading Software Framework for Agricultural Systems Modelling and Simulation*. APSIM. https://www.apsim.info/

The Carbon Farming Foundation. (2022). *Reforestation Guide: Australian Government - Reforestation Method 2019*.

The Climate Change Authority. (2014). *Coverage Additionality and baselines—Lessons from the Carbon Farming Initiative and Other Schemes. Case Study. Chapter 4 - Additionality*. https://www.climatechangeauthority.gov.au/sites/default/files/2020-06/CCARRP/CCA_CFIStudyPublicReportChapter4.pdf

Thompson, J., Pelc, C. E., Brogan, W. R., & Jordan, T. E. (2018). The multiscale effects of stream restoration on water quality. *Ecological Engineering*, *124*, 7–18. https://doi.org/https://doi.org/10.1016/j.ecoleng.2018.09.016

Threatened Species Scientific Committee. (2008). *Approved Conservation Advice for* Toechima pterocarpum.

Threatened Species Scientific Committee. (2017). *Conservation Advice:* Litoria rheocola, *common mistfrog*.

Thompson, M., Poggio, M., Farr, M., Power, B., Shaw, M., Telford, P. & Neelamraju, C. (2024). *Economic evaluation of sugarcane management practices that improve water quality: Technical Report*. Department of Agriculture and Fisheries (DAF), Queensland.

TNFD. (2024). *320 companies and financial institutions to start TNFD nature-related corporate reporting*. Taskforce on Nature-Related Financial Disclosures (TNFD): News. Https://Tnfd.Global/320-Companies-and-Financial-Institutions-to-Start-Tnfd-Nature-Related-Corporate-Reporting/.

Topp, V., Litchfield, F., Coelli, R., & Ashton, D. (2021). *Financial performance of sugarcane farms 2020–21 to 2021–22*.

Truii. (2023). *About P2R Projector*. Truii Pty Ltd. https://p2rprojector.net.au/about/

UNESCO World Heritage Centre. (2023a). *Wet Tropics of Queensland*.

UNESCO World Heritage Centre. (2023b). *Wet Tropics of Queensland*. Https://Whc.Unesco.Org/En/List/486/.

van Oosterzee, P., Liu, H., & Preece, N. D. (2020). Cost benefits of forest restoration in a tropical grazing landscape: Thiaki rainforest restoration project. *Global Environmental Change*, *63*, 102105. https://doi.org/https://doi.org/10.1016/j.gloenvcha.2020.102105

Waltham, N. J., Wegscheidl, C., Volders, A., Smart, J. C. R., Hasan, S., Lédée, E., & Waterhouse, J. (2021). Land use conversion to improve water quality in high DIN risk, low-lying sugarcane areas of the Great Barrier Reef catchments. *Marine Pollution Bulletin*, *167*, 112373.

Wet Tropics Management Authority. (n.d.-a). *Insects in the Wet Tropics*. Https://Www.Wettropics.Gov.Au/Insects.

Wet Tropics Management Authority. (n.d.-b). *Wet Tropics Biodiversity*. Https://Www.Wettropics.Gov.Au/Biodiversity.

Yang, H., Ma, M., Thompson, J. R., & Flower, R. J. (2017). Protect coastal wetlands in China to save endangered migratory birds. *Proceedings of the National Academy of Sciences*, *114*(28), E5491–E5492. https://doi.org/10.1073/pnas.1706111114

APPENDIX 1: RAINFALL DATA

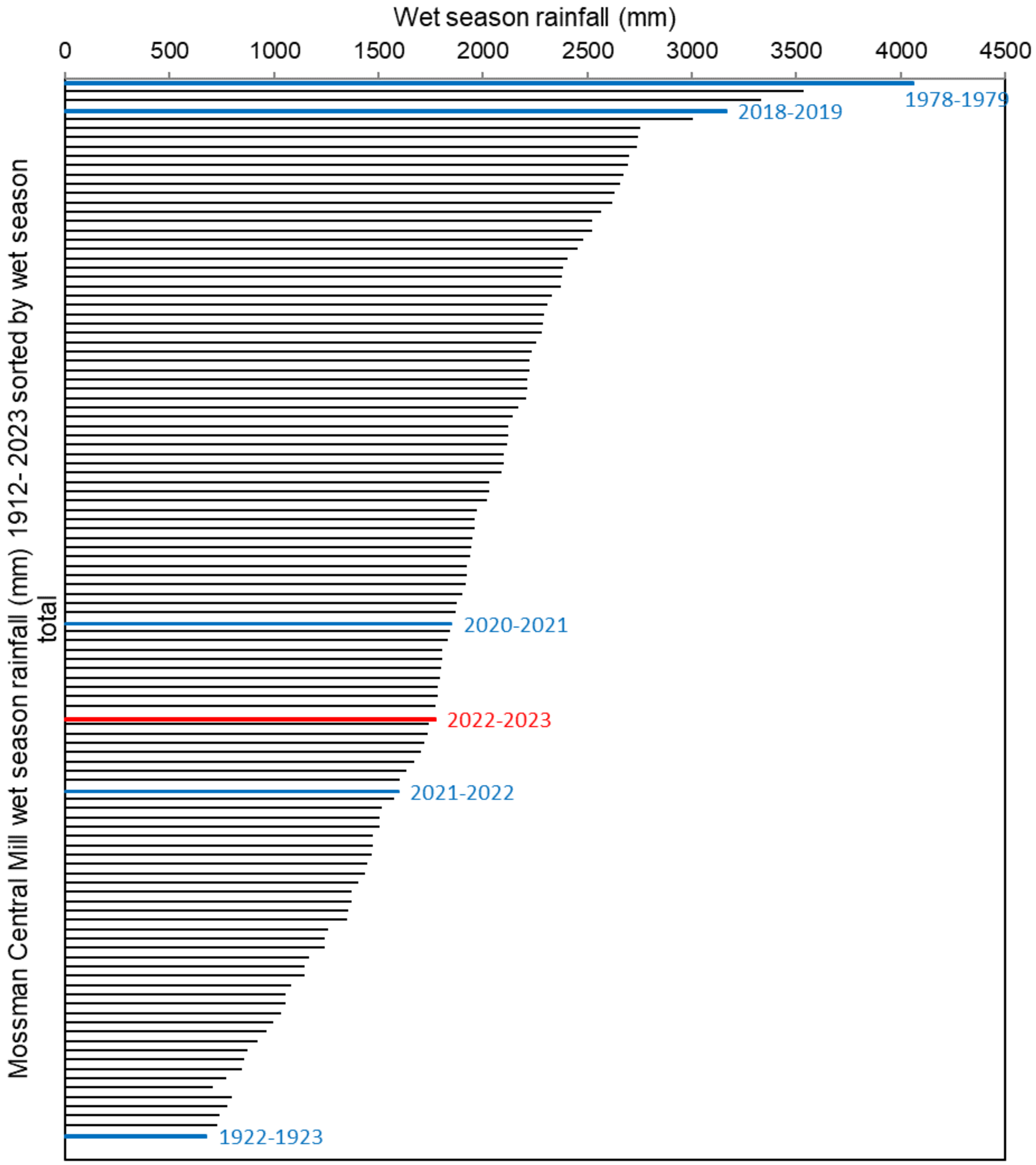


Figure S1: BOM wet season (Nov-March) rainfall data recorded at Mossman Central Mill (Station number 31044) ranked in order of decreasing total rainfall (mm). Blue bars show total rainfall since in recent years, the red bar shows the 2022–2023 wet season (Bureau of Meteorology 2023b).

APPENDIX 2: ENVIRONMENTAL MARKETS LITERATURE REVIEW

Table S1: Summary of environmental crediting schemes and grants applicable to the Mossman district.

Scheme	Region	Country	Market status	Product traded	Unit	Market establishment date	Governance mechanism(s)	Driver(s) of demand
ACCU Scheme	Nationwide	Australia	Currently operating	ACCUs	1 ACCU = 1 tonne of carbon dioxide equivalent (tCO_2e) greenhouse gas that is not released into the atmosphere	2015	The Clean Energy Regulator	Voluntary & compliance markets
Cassowary Credits	Wet Tropics, Queensland	Australia	Draft/pre-release	Cassowary Credits	1 credit = 1 ha of improved condition of restored vegetation *NB: can be stacked with other credits provided additionality requirements met*	Expected pilot phase to begin in 2024	Eco-Markets Australia	Voluntary market
Coastal Resilience Credits	NA	Global	Draft/pre-release	Coastal Resilience Credits + ACCUs	The number of people (or $USD infrastructure) at reduced risk of coastal flooding each year[58] *Determined by number of people at reduced risk per ha of habitat*	Expected 2023	TBC	TBC
Land Restoration Fund	Queensland	Australia	Currently operating	ACCUs + co-benefits	1 ACCU = 1 tonne of carbon dioxide equivalent (tCO_2e) greenhouse gas that is not released into the atmosphere *Price reflects co-benefits + carbon* credit	2017	The Department of Environment, Science and Innovation	Voluntary market
NaturePlus™ Credits	Nationwide	Australia	Draft/pre-release	NaturePlus™ Credits	1 credit = 1 ha of verified environmentally improved land	Expected 2023	GreenCollar	Voluntary market
Nature Repair Market	Nationwide	Australia	Draft/pre-release	Biodiversity certificate	A single tradable biodiversity certificate will be issued for each project	Expected 2024	The Clean Energy Regulator	Voluntary market
Reef Credits	Queensland	Australia	Currently operating	Reef Credits	1 Reef Credit = 1 kg of dissolved inorganic nitrogen or 538 kg of sediment prevented from entering the Great Barrier Reef	2020	Eco-Markets Australia	Voluntary & compliance markets

Scheme	Product Supply Methods (Relevant to the Mossman district)	Land eligibility requirements
ACCU Scheme	1. Measurement-based methods for new farm forestry plantations method 2. Plantation forestry method 3. Estimation of soil organic carbon sequestration using measurement and models method 4. Estimating sequestration of carbon in soil using default values method (model-based soil carbon) 5. Reforestation and afforestation 6. Reforestation by environmental or mallee plantings FullCAM method 7. Environmental plantings 8. Tidal restoration of blue carbon ecosystems method 9. Feral ungulate management *(method in development)*	1. - Land used for grazing, cropping, or fallow in-between for 5 years before the project starts; - Able to plant and grow trees; Plantings must reach 20% crown cover and a height of 2 metres or more. 2. - There must not have been a plantation or native forest on the land 7 years prior to the project starting. 3. - An operating farm for the entire baseline period; No dwellings or other structures on the land; must introduce one of several management activities that store carbon in the land. *Ineligible if land:* - Contains organosol; Has been subject to illegal native forest clearing or wetland drainage; - If native forest clearing or wetland drainage within 7 years of project lodgement; - If native forest clearing or wetland drainage within 5 years of project lodgement (if there's been a change in land ownership since clearing/drainage). 4. - An operating farm; On land for which FullCAM data exists. 5. - Land used for grazing, cropping or that have been fallow (or a combination of these) for the last five years. 6. - Able to establish and maintain plantings of either mixed native trees or mallee eucalypt; - Land cleared of forest cover for at least 5 years; Land in an area for which FullCAM data exists; - Land must not contain woody biomass or an invasive native scrub species that need to be cleared in order for planting to occur, other than known weed species required or authorised by law to be cleared; - Mallee planting: land must receive long-term average rainfall of 600 mm or less. 7. - The total anticipated or reported carbon estimation area (CEA) is no more than 200 hectares; - The planting areas are modelled as mixed species block plantings using the generic calibration in FullCAM. 8. - Tidal flow has been excluded or impeded from the land by one or more tidal restriction mechanisms (or due to other reasons) for at least the 7 years immediately before the project registration application was submitted; - Project activities for the project would lead to the land becoming impacted land for the project 9. Method in development
Cassowary Credits	1. Reforestation of cleared land - e.g., planting of seedlings or direct seeding. 2. Actions that reduce/remove factors that impact the condition of rainforest - e.g., controlling invasive weed species.	Requirement that a project is not on high quality agricultural land, and land must have been cleared for more than 5 years. No requirement to be close to remnant rainforest.
Coastal Resilience Credits	The restoration and protection of coastal wetlands including tidal marshes and mangroves may be expanded to cover the restoration or protection of other coastal habitats such as coral reefs and oyster reefs[57].	Project activities that restore or protect tidal wetlands including mangroves and tidal marshes, e.g.: - Protecting at-risk wetlands - Recharging sediment to avoid drowning of coastal wetlands - Creating accommodation space for wetlands migrating with sea-level rise - Avoiding degradation from alterations in the hydrology of the project area At the project start date, the most plausible baseline scenario for mangrove and tidal marsh protection projects must be identified as the conversion of existing mangrove or tidal marsh to another land use in which the loss of wetland flood reduction benefits is expected to occur in the absence of the project activity.

Land Restoration Fund	*See:* ACCU Scheme	*See:* ACCU Scheme
NaturePlus™ Credits	1. Native Vegetation Condition Monitoring Method 2. Koala Population and Habitat Condition Method	Information not publicly available
Nature Repair Market	E.g., 1. Improving/restoring native vegetation through activities e.g., fencing, or weeding 2. Planting a mix of local native species 3. Protecting rare grasslands that provide habitat for an endangered species.	Market legislation under development. Projects can be on land, inland waterways (lakes and rivers), or in marine and coastal environments (within 12 nautical miles of the low water mark), on the Australian mainland or the external territories.
Reef Credits	1. DIN methodology 2. Constructed wetlands methodology *(method under review)*	1. - Within GBR NRM regions; Land under cultivation during the baseline period - Land treated with nitrogen-based fertiliser during the baseline period 2. – Requires constructed wetlands to treat pollutant stream

Scheme	Regulatory approvals	Verification requirements	No. of active developers	Investors/ funding sources	Permanence Period	Contract Entry Terms	Contract Exit Penalties
ACCU Scheme	8. - Tidal restriction of blue carbon ecosystems method: *Queensland:* - Tidal works approval - Licence to take or interfere with water - Permit to remove, destroy or damage a marine plant - Permit to clear protected native plants - Management of acid sulfate soils - Consent for activity on State land	1, 2, 5, 6 and 7. - FullCAM modelling, biomass sampling, 3. - Soil sampling and laboratory analysis 3. and 4. - Offset report incl. modelling outputs 8. - Evidence of introduction of tidal flow - Evidence of establishment of coastal wetland ecosystem - Carbon estimation area location and boundaries - BlueCAM inputs and outputs - Evidence where planting or seeding was undertaken in reporting period - Evidence where thinning or minor vegetation removals have been undertaken in the reporting period - Evidence of adherence to permanence plan - Evidence of adherence to acid sulfate soil management plan - Evidence of adherence to mosquito management plan - Evidence of adherence to the project operations and maintenance plan *General verification:* - Reporting - Mapping and Geospatial data (area-based methods) - Auditing	Multiple	Govt. & private investment	25-100 years	*E.g., for the Clean Energy Regulator to purchase ACCUs:* Fixed delivery carbon abatement contract: Obligates the seller to deliver an agreed quantity of ACCUs over a set delivery schedule. *OR:* Optional delivery carbon abatement contract: Offers Sellers the right, but not the obligation to sell ACCUs at an agreed price or over a set period.	- If a contract is terminated prior to the delivery obligations being met, the funds that were allocated to that contract will be made available at a future auction. In some circumstances market damages for the balance of the contracted volume must also be paid
Cassowary Credits	Restoration benefits generated from on-ground plantings	Auditing requirements likely to be light touch but not yet finalised	Still in development phase, not yet active	Expected international and national private investors	25 years	Not yet determined	Not yet determined, but likely to be difficult to exit. Intention is project continues if land ownership changes.
Coastal Resilience Credits	Not yet determined	- Monitor change in vegetated extent of project. - Assess whether re-evaluation of project impacts is necessary	Still in development phase, not yet active	Still in development phase, not yet active	No permanence period is required	Projects utilising the methodology can select a crediting period that is a minimum of 10 years and a maximum of 50 years	Not yet determined

Land Restoration Fund	*See:* ACCU Scheme	*See:* ACCU Scheme	*See:* ACCU Scheme	The Land Restoration Fund	25-100 years	*See:* ACCU Scheme *Note: The LRF operates on funding rounds and cannot be applied for outside of these. Agreements and priorities may therefore vary between rounds.*	- If upon the termination of this Agreement, any amount is owed by one Party to the other, such amount must be paid by that Party to the other on the date of termination in full and final satisfaction of all obligations owed by that Party to the other Party. - If at any time a right to terminate this Agreement is exercised by the Purchaser for any event or circumstance other than under clause 10.3 due to a Force Majeure Event, the Purchaser may give written notice to the Seller requiring repayment of all or any part of the Upfront Payment (if any) already paid by the Purchaser (which notice may be given in the Purchaser's sole discretion), and the Seller must repay to the Purchaser the amount specified in the Purchaser's notice on demand.
Nature Repair Market	Underpinning legislation in development	Underpinning legislation in development	Still in development phase, not yet active	Govt. & private investment	25–100 years	Still in development phase, not yet active	Still in development phase, not yet active
NaturePlus™ Credits	Undisclosed	Undisclosed	Undisclosed	Private	Undisclosed	Undisclosed	Undisclosed
Reef Credits	Dependent on method – DIN reduction requiring change in farming practices unlikely to require any approvals, whilst could be substantial for constructed wetland method	*DIN Reduction Method:* - Third-party verification report prepared in accordance with the Reef Credit Standard - Monitoring reports * Evidence of equipment calibration * Records of date & rate of nitrogen application * Records of fertiliser receipts and/or farm management diaries * Soil testing results * Rainfall records - Auditing	At least two project developers are issuing Reef Credits.	Govt. & private investment	Not applicable under the DIN Reduction method	Dependent on agreement between landholder and developer	Dependent on agreement between landholder and developer

Scheme	Upfront costs (Proponent; AUD)	Ongoing costs (Proponent; AUD)	Product quantity supplied to date	Unit	Time period	Market price per unit (AUD)	Unit	Date/ Duration	Product Shelf Life	Planned/ projected market development
ACCU Scheme	- Insurance - Registration *Potential costs:* - Planning approvals - Hydrological assessment - BlueCAM/FullCAM assessment - Engineering works - Acid sulfate soil management plan - Mosquito management plan - Tidal works approval - Licence to take or interfere with water - Permit to remove, destroy or damage a marine plant - Permit to clear protected native plants - Engineering works to limit impacts to neighbouring properties	Insurance Maintenance Auditing *Potential costs:* Monitoring	130,133,862	ACCU	Dec. 2012–Jul. 2023	Average: $17.12	ACCU	Mar-23	ACCUs do not have a shelf life	New methods are in development. ACCU methods have a fixed shelf life of 10 years. The environmental plantings and mallee plantings method expires approximately October 2024.
Cassowary Credits	Details to be finalised	Details to be finalised, will include Auditing	NA	NA	NA	Market not yet operational	NA	NA	Expected to be 3 years	Expected to enter pilot phase within next 6 months
Coastal Resilience Credits	Details to be finalised	Details to be finalised	NA	NA	NA	Market not yet operational. Estimate $15–92	Coastal Resilience Credit	NA	Details to be finalised	Method awaiting verification

Land Restoration Fund	- Insurance - Registration *Potential costs:* - Planning approvals - Hydrological assessment - BlueCAM/FullCAM assessment - Engineering works - Acid sulfate soil management plan - Mosquito management plan - Tidal works approval - Licence to take or interfere with water - Permit to remove, destroy or damage a marine plant - Permit to clear protected native plants - Engineering works to limit impacts to neighbouring properties	Insurance Maintenance Auditing *Potential costs:* Monitoring	1,648,790 169,626	ACCU + co-benefits	2020 2021	Median: $46.22 Median $81.08	ACCU + co-benefits	2020 2021	ACCUs do not have a shelf life	See ACCU scheme
Nature Repair Market	- Insurance - Registration	Insurance Maintenance Auditing *Potential costs:* Monitoring	NA	NA	NA	Market not yet operational	NA	NA	Legislation to be finalised	Legislation under development to create market
NaturePlus™ Credits	- Insurance - Registration	Insurance Maintenance Auditing *Potential costs:* Monitoring	NA	NA	NA	No credits yet traded	NA	NA	Undisclosed	Enter Phase 2.0 of scheme/method review Formal scheme/method approval Increase the method's scope to potentially include social co-benefits.
Reef Credits	- Insurance - Registration *Potential costs:* *Constructed Wetland Method:* - Planning approvals - Engineering works - Mosquito management plan	Insurance Maintenance Auditing *Potential costs:* Monitoring	44,512	Reef Credits	Since 2017	$100	Reef Credit	Qtr. to Sept 2023	3 years	New crediting methods under development

Table S2: References used to inform the grey literature review.

Scheme		URL
ACCU Scheme	1	https://www.cleanenergyregulator.gov.au/DocumentAssets/Documents/Understandingyoursoilcarbonproject-Simple method guide.pdf
	2	https://www.cleanenergyregulator.gov.au/ERF/Choosing-a-project-type/Opportunities-for-the-land-sector/Vegetation-methods/Reforestation-by-Environmental-or-Mallee-Plantings-FullCAM/environmental-plantings-pilot
	3	https://www.cleanenergyregulator.gov.au/DocumentAssets/Documents/Understandingyourplantationforestryproject-Simplemethodguide.pdf
	4	https://www.cleanenergyregulator.gov.au/DocumentAssets/Documents/A%20guide%20to%20the%20farm%20forestry%20method.pdf
	5	https://www.cleanenergyregulator.gov.au/ERF/Choosing-a-project-type/Opportunities-for-the-land-sector/Vegetation-methods/tidal-restoration-of-blue-carbon-ecosystems-method
	6	https://www.cleanenergyregulator.gov.au/DocumentAssets/Documents/A%20guide%20to%20the%20reforestation%20by%20environmental%20or%20mallee%20plantings-FullCam%20method.pdf
	7	https://www.cleanenergyregulator.gov.au/ERF/project-and-contracts-registers/project-register
	8	https://www.cleanenergyregulator.gov.au/ERF/auctions-results/march-2023
	9	https://www.cleanenergyregulator.gov.au/ERF/About-the-Emissions-Reduction-Fund
	10	https://www.cleanenergyregulator.gov.au/OSR/ANREU/types-of-emissions-units/australian-carbon-credit-units
	11	https://www.legislation.gov.au/Details/F2018C00118
	12	https://www.legislation.gov.au/Details/F2015L00682
	13	https://www.legislation.gov.au/Details/F2018C00126
	14	https://www.legislation.gov.au/Details/F2021L01696
	15	https://www.legislation.gov.au/Details/F2022L00047
	16	https://www.legislation.gov.au/Details/F2015C00577
	17	https://www.legislation.gov.au/Details/F2022L00046/Download
	18	https://www.cleanenergyregulator.gov.au/ERF/Forms-and-resources/auctions-and-contracts/contracts-frequently-asked-questions#1
	19	https://www.cleanenergyregulator.gov.au/DocumentAssets/Documents/Guidance%20for%20ACCU%20Scheme%20participants%20impacted%20by%20the%20expiry%20or%20sunsetting%20of%20an%20ACCU%20Scheme%20method.pdf
Land Restoration Fund	20	https://www.qld.gov.au/__data/assets/pdf_file/0022/375115/lrf-project-investment-agreement-template-rnd3.pdf
	21	https://www.qld.gov.au/environment/climate/climate-change/land-restoration-fund/funded-projects/investment-rounds-report
	22	https://www.qld.gov.au/environment/climate/climate-change/land-restoration-fund/co-benefits/overview
	23	https://www.qld.gov.au/environment/climate/climate-change/land-restoration-fund
	24	https://www.qld.gov.au/environment/climate/climate-change/land-restoration-fund/about/overview
Cassowary Credits	25	https://terrain.org.au/what-we-do/biodiversity/cassowary-credit-scheme/
Reef Credits	26	https://www.qld.gov.au/environment/coasts-waterways/reef/reef-credit-scheme
	27	https://eco-markets.org.au/methodologies/
	28	https://greencollar.com.au/reef-credits-3-different-approaches-to-meet-different-needs/
	29	https://greencollar.com.au/what-are-reef-credits-and-how-are-they-generated/
	30	https://eco-markets.org.au/wp-content/uploads/2021/05/DIN_RED_method_v1.1.pdf
	31	https://eco-markets.org.au/reef-credits/
	32	https://greencollar.com.au/hsbc-and-the-queensland-government-purchase-world-first-reef-credits/
	33	https://eco-markets.org.au/faq/
	34	https://eco-markets.org.au/wp-content/uploads/2021/10/Reef-Credit-Standard_v2.0.pdf
	35	https://carbon-pulse.com/223785/

Blue Carbon Tidal Restoration Method	36	https://impact.economist.com/ocean/ocean-health/are-blue-carbon-markets-becoming-mainstream
	37	https://www.legislation.gov.au/Details/F2022L00046
	38	https://www.cleanenergyregulator.gov.au/DocumentAssets/Documents/Understandingyourbluecarbonprojectsimplemethod guide.pdf
Nature Repair Market	39	https://www.dcceew.gov.au/environment/environmental-markets/nature-repair-market
	40	https://parlinfo.aph.gov.au/parlInfo/download/legislation/bills/r7014_third-reps/toc_pdf/23045b01.pdf;fileType=application%2Fpdf
NaturePlus™ Credits	41	https://greencollar.com.au/real-measured-verified-results-for-nature-world-first-scheme-delivers-biodiversity-credits-from-vegetation-and-koala-projects/
	42	https://greencollar.com.au/our-services/natureplus/
	43	https://naturepluscredits.com/wp-content/uploads/2023/11/NaturePlus-Standard-v1.1.pdf
Coastal Resilience Credits	44	Pers. Comm. – Stefanie Simpson, The Nature Conservancy, Asia-Pacific Blue Carbon Workshop – Presentation: ‘Coastal Resilience Credits’
	45	https://axaxl.com/fast-fast-forward/articles/a-blue-carbon-future-how-innovative-thinking-aims-to-increase-coastal-resilience-and-meet-climate-targets
	46	https://oceanriskalliance.org/project/capturing-the-value-of-coastal-wetlands-through-blue-carbon-resilience-credits/
	47	https://verra.org/methodologies/methodology-for-coastal-resilience-benefits-from-restoration-and-protection-of-tidal-wetlands/
	48	https://verra.org/wp-content/uploads/2021/01/Coastal-Resilience_SD-VISta-Methodology_PublicCommentPeriod-1.pdf

APPENDIX 3: PEER-REVIEWED LITERATURE

Table S3: The challenges of environmental market schemes and recommendations from the peer-reviewed literature.

Scheme	Recommendations/needs	Challenges
Biodiversity schemes	Transparency	Lack of integrity/corruption
	Rigorous monitoring	Lack of scientific credibility
	Reporting	Market complexity
	Payment for modelled results	Action-based schemes neglect spatial heterogeneity
	Hybrid approach - payment for action and payment for modelled results	Payment for results = farmer owns risk
	Employ specific minimum standards	Spatial interdependencies
	Incorporate new methods	Costly monitoring
	-	Use of ecological indicators
	-	Accuracy of ecological modelling
Stacked markets	Increased agency coordination	Additionality
	Temperature-based permitting	Stacking neglects landscape level perspective
	Combined accounting approach	Low-medium equity and livelihood outcomes
	Increased community engagement	Inadequate medium-long term social sustainability
	Use of an intermediary	-
	Need for government support	-
Nitrogen trading	Implementation of smart markets	-
Payment for Ecosystem Services	-	Lack of conditionality and buyers
Water Quality trading	Use of an intermediary	Lack of trust
	Diversify allowable methods	Reduced market effectiveness
	Increased stakeholder inclusion	Reduced credit/permittee demand
	Use of trading ratios	Minimal trades

	No broker/ aggregator involvement	Lack of additionality
	Use of integrated/multiple markets	Regulation of multiple markets
	Consider financial additionality vs. regulatory additionality	Lack of case studies
	Incorporate multiple pollutants	Prohibitive cost
	Implement wetland subsidies	Complexity of multiple pollutants
	Create a reserve pool (liability)	Prohibitive regulatory environment
	Use aggregators	-
	Regulate non-point sources	-
	Peer-to-peer communication	-
	Assess relative demand for stacking	-
	Use of credit providers	-
	Cost-risk trade-off (monitoring vs. self-reporting)	-
	Payment for actions	-
Co-benefit schemes	-	Obtaining consent from all eligible interest holders
	-	Changes to a proponent's delivery costs
	-	Changes to a proponent or landholder's personal situation
	-	Volatility in the carbon market

Peer-review references

Author	Year	Title
Mariola M.J.	2012	Farmers, trust, and the market solution to water pollution: The role of social embeddedness in water quality trading
Lindenmayer D.; Scheele B.C.; Young M.; Vardon M.	2023	The business of biodiversity – What is needed for biodiversity markets to work
Duke J.M.; Liu H.; Monteith T.; McGrath J.; Fiorellino N.M.	2020	A method for predicting participation in a performance-based water quality trading program
Reeling C.J.; Gramig B.M.	2012	A novel framework for analysis of cross-media environmental effects from agricultural conservation practices
O'Connell C.; Billingsley K.	2020	A Place at the Well: The Imperative for Farmer Inclusion in Water Conservation Policy Design
Jamshidi S.; Ardestani M.; Niksokhan M.H.	2016	A seasonal waste load allocation policy in an integrated discharge permit and reclaimed water market
Woodward R.T.; Newburn D.A.; Mezzatesta M.	2016	Additionality and reverse crowding out for pollution offsets in water quality trading
Stephenson K.; Aultman S.; Metcalfe T.; Miller A.	2010	An evaluation of nutrient nonpoint offset trading in Virginia: A role for agricultural nonpoint sources?
Newburn D.A.; Woodward R.T.	2012	An Ex-Post Evaluation of Ohio's Great Miami Water Quality Trading Program
Gasper R.R.; Selman M.; Ruth M.	2012	Climate co-benefits of water quality trading in the chesapeake bay watershed
Imani S.; Niksokhan M.H.; Jamshidi S.; Abbaspour K.C.	2017	Discharge permit market and farm management nexus: an approach for eutrophication control in small basins with low-income farmers
Heberling M.T.; García J.H.; Thurston H.W.	2010	Does encouraging the use of wetlands in water quality trading programs make economic sense?
Woodward R.T.	2011	Double-dipping in environmental markets
la Rocco G.L.; Deal R.L.	2011	Giving credit where credit is due: Increasing landowner compensation for ecosystem services
Rath S.; Das A.; Srivastava S.K.; Kumara T.M.K.; Sarangi K.K.	2023	Payment for ecosystem services and its applications in India
Ribaudo M.O.; Gottlieb J.	2011	Point-Nonpoint Trading - Can It Work?
O'Grady D.	2011	Sociopolitical Conditions for Successful Water Quality Trading in the South Nation River Watershed, Ontario, Canada
Motallebi M.; Hoag D.L.; Tasdighi A.; Arabi M.; Osmond D.L.; Boone R.B.	2018	The impact of relative individual ecosystem demand on stacking ecosystem credit markets
Hasan S.; Hansen L.B.; Smart J.C.R.; Hasler B.; Termansen M.	2022	Tradeable Nitrogen Abatement Practices for Diffuse Agricultural Emissions: A 'Smart Market' Approach
DeBoe G.; Stephenson K.	2016	Transactions costs of expanding nutrient trading to agricultural working lands: A Virginia case study
Adhikari B.; Agrawal A.	2013	Understanding the social and ecological outcomes of PES projects: A review and an analysis
Stephenson K.; Shabman L.	2017	Where Did the Agricultural Nonpoint Source Trades Go? Lessons from Virginia Water Quality Trading Programs
Simpson et al.	2023	Improving the ecological and economic performance of agri-environment schemes: Payment by modelled results versus payment for actions
Gamarra & Toombs	2017	Thirty years of species conservation banking in the U.S.: Comparing policy to practice
Waltham et al	2021	Land use conversion to improve water quality in high DIN risk, low-lying sugarcane areas of the Great Barrier Reef catchments
Waltham et al	2021	Tidal marsh restoration optimism in a changing climate and urbanizing seascape

APPENDIX 4: INTERVIEW TOPICS FOR ENVIRONMENTAL MARKET AND MOSSMAN STAKEHOLDERS

Table S4: Question guidelines for interviews with stakeholders.

Topic	Questions
ACCU Scheme	
Active developers	How many active developers are there in the market? Imagine this differs considerably between the green carbon and blue carbon markets?
Contract entry	What are the contract entry terms?
Credit shelf life	What is the shelf life of the credits, do they expire?
Credit sale mechanism?	What proportion of ACCUs are sold to the Federal government under a carbon abatement contract at a price determined via a reverse auction mechanism vs. sold at a fixed price under the environmental plantings pilot vs. sold to private market buyers (including state governments) under a fixed commercial agreement or on the spot market at the prevailing market price.
ACCU pricing by method	Can we obtain historical pricing for ACCUs generated by the different ERF Methods on the different purchasing schemes?
Market development	Are there any plans or projections for market development?
Financial additionality	What are the requirements (rules and restrictions) for financial additionality?
Ongoing costs	What are the ongoing costs (including the types of on-going costs) that a landholder would incur? How do these differ between schemes e.g., Environmental Plantings Pilot seems to have removed the audit requirements that are required in other ERF land-based methods
Climate change	For natural hazards, landholders must pay back any credits they can't recoup and so should take out insurance against this. What provisions are there in the market for climate change related die back, e.g., as seen in the Gulf of Carpentaria in 2016 in response to the abnormally low sea levels due to an extreme El Niño?
Natural Hazards	Regarding green ACCU credits and repayment of ACCUs following natural hazards – does it matter what ACCU delivery contract you're on? E.g., if you're on a fixed delivery contract vs. optional delivery contract?
Barriers to enviro. markets	What barriers to the credit scheme have you encountered so far?
Cassowary Credits	
Market establishment	What is the expected start date of the scheme?
Credit unit	What will the unit of measurement for the credits be?

Credit price	Have you done any research into what investors are willing to pay for the credits?
Credit shelf life	What is the shelf life of the credits, do they expire?
Governance	Who is the regulator of the scheme?
Regulatory approvals	What regulatory approvals does a land holder require before commencing a project?
Verification requirements	What are the verification requirements for a project?
Active developers	How many active developers are there in the market? (e.g., green carbon developers also operating in biodiversity credits?)
Investors/funding sources	Who will the investors be?
Contract entry terms	What are the contract entry terms?
Contract exit terms	What are the contract exit terms?
Land eligibility requirements:	Can you give us any information on the land eligibility requirements for the scheme? 'TBC: *Targeted at land unsuitable for agriculture based on soil type, slope, or closeness to watercourses.'* – this doesn't exclude agriculture from participating, but is on the assumption that agricultural land is more valuable?
Planting density	What planting density (stems per hectare) will be required for eligibility? Is 'block planting' required? (as opposed to 'linear' or 'belt planting'). Is there a minimum requirement for crown cover or canopy closure after a certain number of years? Is a particular species mix required at planting? Is it going to be called ecological restoration planting (which I believe is different to environmental planting)? Is there a requirement for a minimum area that needs to be signed up to the scheme and/or are there particular areas that are considered high priority (e.g. proximity to remnant forests) for restoration? (based on our reading, the drivers of restoration outcomes are (i) site factors (physical conditions and characteristics of the revegetation), (ii) patch size, and (iii) landscape factors).
Auditing and verification requirements?	How will rainforest regeneration be verified (via on-site assessment vs. Remote sensing)? Will regular audits by an independent, certified, auditor be required? If so, how often? What certification standards will the independent auditor have to comply with?
Financial additionality	What are the requirements (rules and restrictions) for financial additionality?
Market development	Once the market is up and running, are there any plans or projections for market development?
Market development	What is the interest in biodiversity credits from investors? How much are they willing to pay?

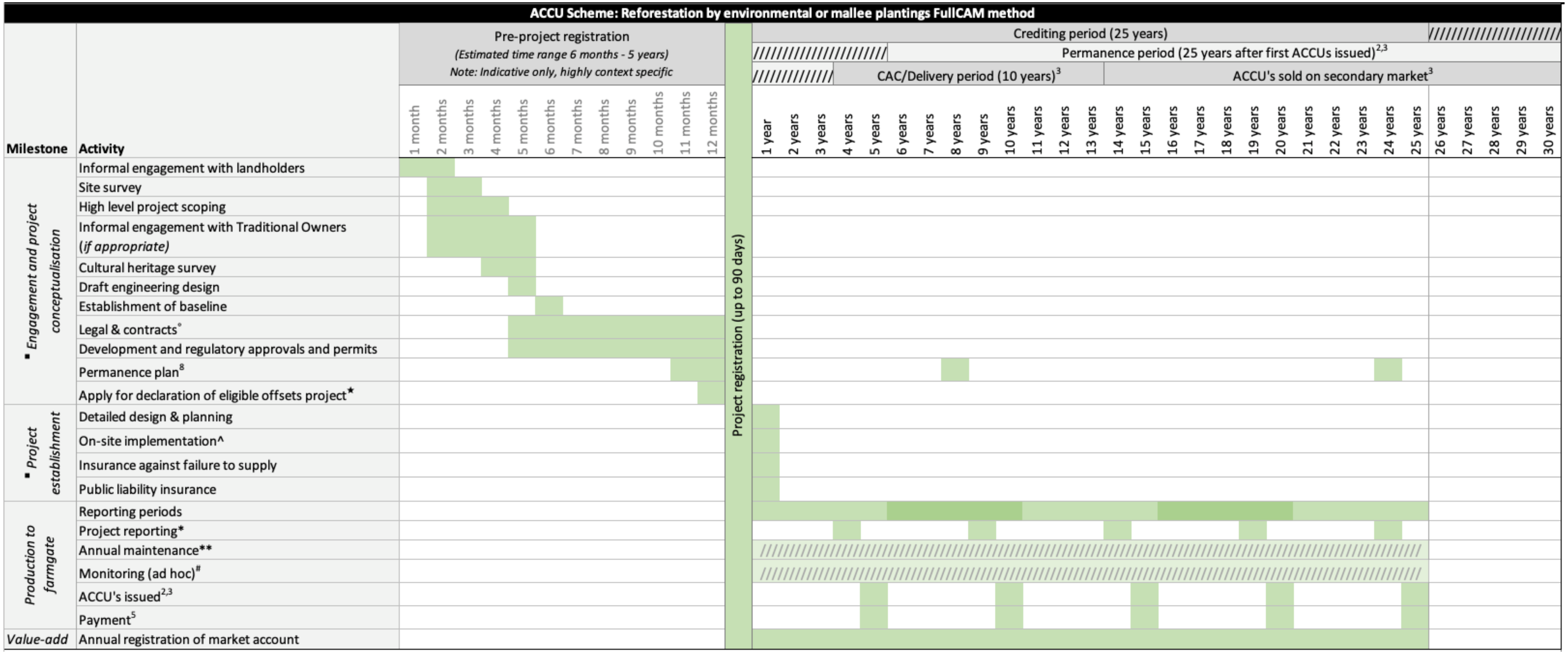
Barriers to enviro. markets	What barriers to the credit scheme have you encountered so far?
Timelines	We understand credits will be issued over 25 years – does that mean could be credits issued every year? And the permanence period is 25 years – when does the permanence period commence? Could credits be issued in the 25th year and the trees then immediately cut down, or is there some requirement that trees remain for some period beyond last credit is issued? How soon could credits be sold to the market?
Land Restoration Fund	
Active developers	How many active developers are there in the market?
Contract entry	What are the contract entry terms?
Credit shelf life	What is the shelf life of the credits, do they expire?
Ongoing costs	What are the ongoing costs that a landholder would incur?
Financial additionality	What are the requirements (rules and restrictions) for financial additionality?
Market development	Are there any plans or projections for market development?
Market development	What is the interest in co-benefits from investors? How much are they willing to pay?
Barriers to enviro. markets	What barriers to the uptake of environmental markets have you encountered so far?
NaturePlus Credits	
Market establishment	What is the expected start date of the scheme? We understand that it's expected to launch in 2023.
Methods	What are the methods of carbon credit production?
Governance	Who is the regulator of the scheme?
Land eligibility requirements:	Can you give us any information on the land eligibility requirements for the scheme?
Regulatory approvals	What regulatory approvals does a land holder require before commencing a project?
Verification	What are the verification requirements for a project?
Permanence	What is the permanence period for a project?
Contract Entry	What are the contract entry terms?
Contract Exit	What are the contract exit terms?
Upfront costs	What are the upfront costs that a landholder would incur?

Ongoing costs	What are the ongoing costs that a landholder would incur?
Financial additionality	What are the requirements (rules and restrictions) for financial additionality?
Market development	What is the interest in biodiversity credits from investors?
Credit price	What is the estimated market price of a NaturePlus credit? Have you done any research into what investors are willing to pay for the credits?
Credit shelf life	What is the shelf life of the credits, do they expire?
Market development	Are there any plans or projections for market development?
Barriers to enviro. markets	What barriers to the credit scheme/uptake of environmental markets have you encountered so far?
Nature Repair Market	
Market development	What is the interest in biodiversity certificates from investors?
Credit price?	Have you done any research into what investors are willing to pay for the certificates? What do you estimate/forecast the market price for a certificate to be?
Credit shelf life	What is the shelf life of the certificate, do they expire?
Upfront costs	What are the upfront costs that a landholder would incur?
Ongoing costs	What are the ongoing costs that a landholder would incur?
Financial additionality	What are the requirements (rules and restrictions) for financial additionality?
Barriers	What barriers to the market have you encountered so far?
Reef Credits	
Constructed wetlands methodology	When do you think the method will be finalised and become available?
Constructed wetlands methodology	Are you able to provide us with any information on the land eligibility requirements for the constructed wetlands method?
Eligibility for DIN credits via the fertiliser method	Would the following land use changes be eligible for DIN reef credits under the fertiliser method if the land had formerly been producing cane for > 8 years: Switch land use to an alternative broadacre crop: e.g. peanuts, soy bean, sorghum Switch land use to cattle fattening Switch land use to farm forestry for carbon credits Switch land use to rainforest regeneration

	Are DIN-loss models available for these alternative land uses to support calculation of the reduction in DIN load reaching end-of-catchment?
Market price per unit	What is the 'market price' of a reef credit and how do these vary among the different methods? Are the trading prices of reef credits publicly available? How has credit pricing for the various methods changed since market establishment?
Financial additionality	What are the requirements (rules and restrictions) for financial additionality?
Market development	Are there any plans or projections for market development? E.g., additional methodologies?
Barriers to enviro. markets	What barriers to the credit scheme/uptake of environmental markets have you encountered so far?
Douglas Shire Council	
Douglas Shire context	What is Douglas Shire Council doing to prepare landholders for the mill's closure? (E.g., is there a plan for the area?)
Douglas Shire context	What is the feel in the area regarding environmental markets?
Approvals	Do you know the sort of approvals and permits that may be required for, e.g., planting and reforestation works, removal of tidal gates/restrictions/bund walls?

APPENDIX 5: CREDITING SCHEME TIMELINES

Figure S2: Indicative project timeline for a Reforestation by environmental or mallee plantings project with a 25-year permanence period under the ACCU Scheme.



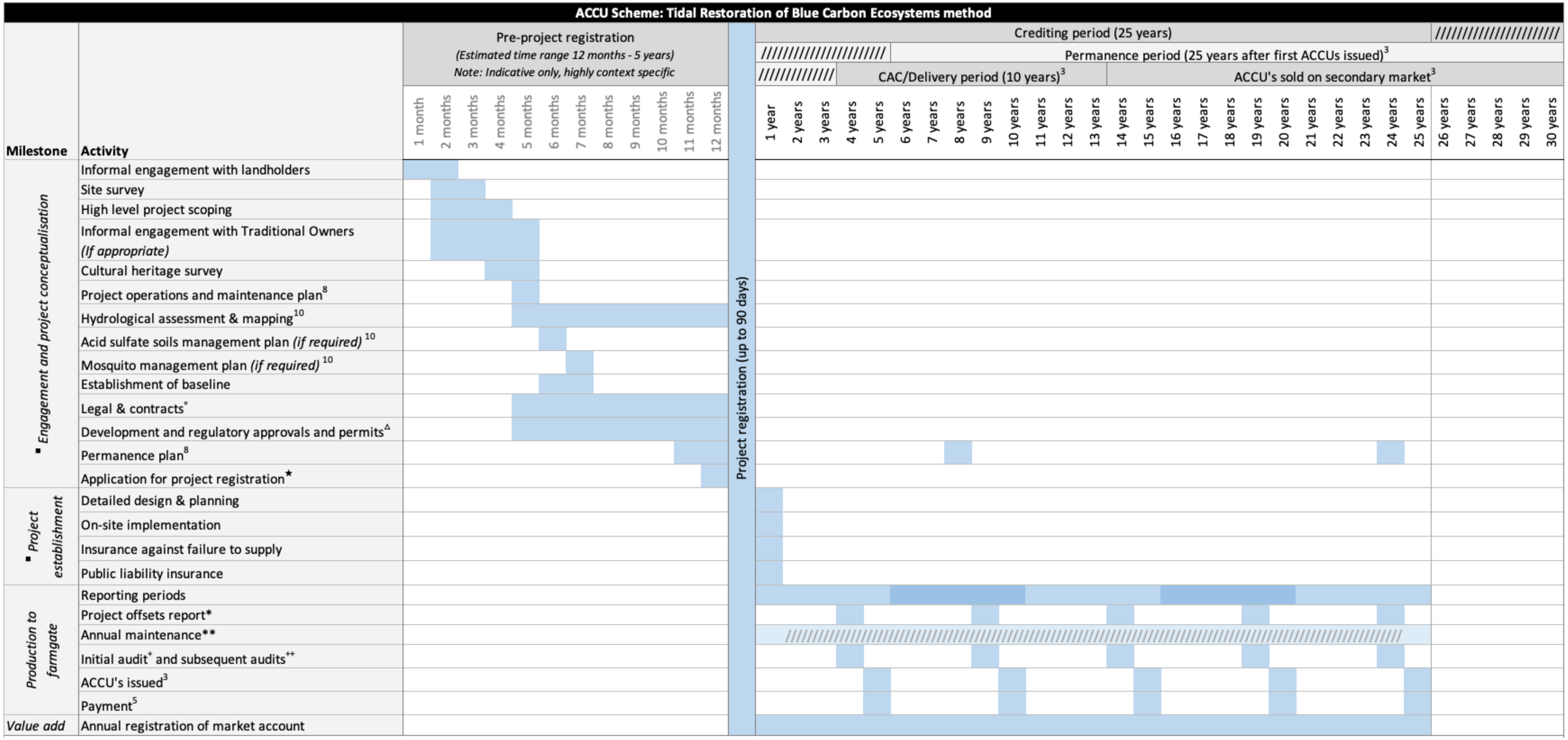
Notes:

- ▪ Indicative only, highly context specific
- CAC - Carbon Abatement Contract
- ∘ Legal & contracts - between landholders, Traditional Owners, and project developers
- ★ Application for declaration of eligible offsets project - application must include a geospatial map of the project area that meets the requirements of the Carbon Farming Initiative Mapping Guidelines[7].
- ^ On-site implementation - Establish plantings: this includes activities such as ordering seeds/seedlings, developing a planting plan, propagating seedlings (~6-9 months), preparing the site for planting (e.g., ripping and scalping), planting and direct seeding - reaching this stage could take 6 months to 5 years[2]
- * Project reporting - at least once every 5 years, no earlier than 6 months. You are required to submit a minimum of 5 reports over the life of the 25-year project. More frequent reporting allows you to receive credits more frequently and generate a more regular cashflow [1,2]. Scheme participants have six months following the end of a reporting period to submit a project report and the Clean Energy Regulator has 90 days to assess[3]. It can take up to 9 months from the end of each of your project's reporting period before units can be delivered[4]
- ** Project maintenance - e.g., maintaining fire breaks, fences, control of declared plants and pests, drought management

Payment - Once ACCUs have been transferred from your ANREU account to the Clean Energy Regulator account, you will be paid at the price agreed to at auction and set out in the contract. Payment for the ACCUs will be made within 20 business days of the date the delivery occurred[5]

\# Monitoring and assurance - Instead of scheduled audits, the Clean Energy Regulator will use geospatial tools to confirm that the planting activity has happened, verify that abatement is being achieved, and monitor for disturbances[6]

Figure S3: Indicative project timeline for a Tidal restoration project with a 25-year permanence period under the ACCU scheme.



Notes:

- ▪ Indicative only, highly context specific
- CAC - Carbon Abatement Contract
- ° Legal & contracts - between landholders, Traditional Owners, and project developer
- ★ Application for project registration - apply to the Clean Energy Regulator to have the project registered. Applications include project operations and maintenance plan, hydrological assessment, project extent mapping, permanence plan, and if required, acid sulfate soil and mosquito management plans[10]. Applications will be assessed as quickly as possible within the 90-day statutory timeframe.[9]
- △ Development and regulatory approvals and permits - this includes consents from impacted landholders (see Appendix 2 for State and Territory Regulatory Approvals)[9]

* Project reporting - at least once every 5 years, no earlier than 6 months. You are required to submit a minimum of 5 reports over the life of the 25-year project. More frequent reporting allows you to receive credits more frequently and generate a more regular cashflow. However, longer reporting periods allow more time for greater amounts of emissions avoidance, vegetation, and soil carbon to build up between reporting periods and could decrease the overall costs associated with modelling the carbon change over the course of the project (see Appendix 5 for key offsets report requirements)[9]. Scheme participants have six months following the end of a reporting period to submit a project report and the Clean Energy Regulator has 90 days to assess[3]. It can take up to 9 months from the end of each of your project's reporting period before units can be delivered.[4]

** Annual maintenance - any maintenance actions required to ensure the ongoing function of the tidal restriction mechanism, infrastructure, or drainage until the end of the permanence period of your project[9]

Payment - Once ACCUs have been transferred from your ANREU account to the Clean Energy Regulator account, you will be paid at the price agreed to at auction and set out in the contract. Payment for the ACCUs will be made within 20 business days of the date the delivery occurred.[5]

+ Auditing - At least 3 audits are required over the 25-year project lifespan, however this varies and is subject to Clean Energy Regulator discretion based on forward abatement estimates and project size. A forward abatement estimate, the best estimate of the number of carbon credits likely to be earned during the crediting period, must be supplied as part of the project registration. This estimate is used to assign an audit schedule to your project. The audit schedule is provided at the time of project registration and sets out the level of assurance, frequency, and scope of audits required for your project. An initial audit report must be submitted with the first report for your project, submitted between 6 months and 5 years into the sequestration project[9,11].

++ Subsequent audits - The subsequent audit schedule is intended to ensure your project is audited across periods of peak abatement, providing assurance over the maximum number of ACCUs issued across the crediting period.[11]

References:

1.	Climate Solutions Fund	https://www.cleanenergyregulator.gov.au/DocumentAssets/Pages/Factsheet---Environmental-plantings-projects.aspx
2.	The Carbon Farming Foundation, 2022	https://carbonfarming.org.au/wp-content/uploads/2022/11/Reforestation-Guide_Nov22.pdf
3.	Emissions Reduction Fund, 2016	https://www.cleanenergyregulator.gov.au/DocumentAssets/Documents/Make%20sure%20your%20timing%20is%20right%20information%20sheet.pdf
4.	Emissions Reduction Fund, 2023	https://www.cleanenergyregulator.gov.au/ERF/Want-to-participate-in-the-Emissions-Reduction-Fund/Step-2-Contracts-and-auctions/understanding-contract-delivery-schedules
5.	Emissions Reduction Fund, 2023	https://www.cleanenergyregulator.gov.au/ERF/Want-to-participate-in-the-Emissions-Reduction-Fund/Step-4-Delivery-and-payment
6.	Emissions Reduction Fund, 2021	https://www.cleanenergyregulator.gov.au/DocumentAssets/Documents/Environmental%20Plantings%20Pilot%20-%20Information%20Pack.pdf
7.	Minister for Industry Energy and Emissions Reduction, 2018	https://www.legislation.gov.au/Details/F2018C00118
8.	Emissions Reduction Fund, 2020	https://www.cleanenergyregulator.gov.au/ERF/Choosing-a-project-type/Opportunities-for-the-land-sector/Permanence-obligations
9.	Emissions Reduction Fund, 2022	https://www.cleanenergyregulator.gov.au/DocumentAssets/Documents/Understanding%20your%20blue%20carbon%20project%20%E2%80%93%20simple%20method%20guide.pdf
10.	Minister for Industry Energy and Emissions Reduction, 2022	https://www.legislation.gov.au/Details/F2022L00046
11.	Emissions Reduction Fund, 2023	https://www.cleanenergyregulator.gov.au/ERF/Want-to-participate-in-the-Emissions-Reduction-Fund/Step-3-Reporting-and-auditing/Audit-Requirements

APPENDIX 6: INTERVIEW TOPICS FOR MOSSMAN FARMERS - INTERVIEW PROMPTS

Questions were asked following researcher and farmer introductions, discussion regarding the ethics of the project, and once the recording had started.

Seeking to understand the farmers history of farming as background context:

Q1: How long have you been farming? Sugar cane? Mossman? Just one farm or involved in a number of operations?

Q2: Do you anticipate that you will continue to be farming sugar on this land into the future? What are the key problems you are facing?

[Prompt for both ecological and economic issues if not volunteered by landholder]

Q2a: (If Mossman Mill not explicitly mentioned in response to Q2): Has your view on the long term future of cane farming on your land changed because of recent concerns about the future of the Mossman Mill? [This may be too obvious a question – just ignore it if so.]

Then seeking to understand what the farmer knows about the opportunities presented by environmental markets:

Q3: You have possibly heard about opportunities for landholders to benefit from environmental markets, like carbon credits, that try to encourage landholders to change their land management practices by rewarding the landholder with credits that can be sold on a market, which means that the landholder receives payments in return for delivering improved environmental outcomes.

Are you aware of any of these type of markets that might be relevant to farmers in Mossman?

For any market the farmer mentions, ask them to very briefly explain what they know

If farmer doesn't mention any of these specific markets (carbon credits, Reef credits, cassowary credits, biodiversity credits), follow up by asking if they have heard of them.

Then seeking to understand farmers attitudes, and that of their peers, towards participating in environmental markets

Q4: Do you think it is a good idea for landholders to be able to receive additional income from credits for improving their land management practices?

Q5: Do you know any landholders here in Mossman or elsewhere who have got involved in any of these environmental credit markets? Which markets? Do you think they are pleased with the outcomes? Or did they face any problems?

Q6: Have you yourself considered getting involved in any of the environmental markets?

If yes Q: ask which market(s) were of interest (tick which); if more than 1 rank schemes mentioned from most to least attractive / viable for them)

- Green carbon ACCUs from farm forestry
- Reef Credits for reducing fertiliser applications on cane
- Blue carbon ACCUs from tidal restoration of coastal wetland
- Cassowary Credits for rainforest restoration?

What was it that attracted you to that market?

Did you take any steps to start getting involved? Like finding out more information, any other steps taken?

Has your attitude towards environmental market opportunities changed following current uncertainty about future of Mossman Mill?

If still in process of considering Q: ask them how it is going, do they think it will make a difference to the sustainability of their farm in the future? has farmer's attitude towards environmental market opportunities changed following current uncertainty about future of Mossman Mill?

If not still in process of considering Q: ask them why – what barriers did they face, what were the issues that made them stop? has farmer's attitude towards environmental market opportunities changed following current uncertainty about future of Mossman Mill?

If not considered getting involved in markets Q: ask them why – was there any factors that put them off?

[looking for different types of barriers – social pressure, transaction costs (time taken to learn about the scheme?, 'application paperwork'?), start up costs (for schemes such as blue carbon wetland restoration or green carbon forest planting?), perception that lots of effort for little reward, unwillingness to commit to change of land use permanently or for >= 25 years, wariness about engaging with project developer, concern that project developer will cream off too much of the revenue, uncertainty about income stream that would be generated (due to fluctuations in credit price?), concern about longevity of the scheme (government have history of starting incentive schemes then stopping them after only a few years), etc]

Has farmer's attitude towards environmental market opportunities changed following current uncertainty about future of Mossman Mill?

Q7: now that we have talked a bit about the opportunities available, do you think these credit markets could be something worth thinking about for your land? Soon or sometime in future?

Q8: What would need to happen, or what would they need to know to allow them to feel willing and able to take steps to get involved?

If about needing more info Q: who would they most trust to give them that information? (looking to see if other farmers, industry experts, researchers, local/state government)

If about needing government underwriting of credit income e.g., via a 'floor' price for the credits, (i) roughly what level of income underwriting would be required ($/ha/year)?, and (ii) how long would the underwriting have to continue for them to feel sufficiently reassured to sign up for the scheme? (if no answer, prompt with: first 5 years?, first 10 years?)

Q9: And if they were to get involved, how do they think other sugar cane farmers in the region would respond? Do they think others may follow them?

How open do you think other farmers, and the farming community more widely, would be to the opportunities offered by environmental markets?

Do you know if other farmers are already talking about these opportunities? And what are options other farmers are talking about if the Mossman Mill does close for good?

APPENDIX 7: ENGAGEMENT WITH TRADITIONAL OWNERS AND CULTURAL HERITAGE SURVEYS

The Traditional Owners of the Mossman district are the Kuku Yalanji people. Jabalbina Yalanji Aboriginal Corporation is the Registered Native Title Body Holder (RNTBC), Prescribed Body Corporate (PBC), Land Trust and Cultural Heritage Body for the Eastern Kuku Yalanji People. More information about Jabalbina, their responsibilities and their activities can be found on their website https://www.jabalbina.com.au/our-team/.

Any project proponent, be that landholder or developer, considering a project within the Mossman district, is recommended to follow best practice procedures for engaging with the Traditional Owners respectfully and appropriately and relate to both engagement over the appropriate share of benefits from the project to the Traditional Owners of the land, and the process regarding cultural heritage at the site. Whilst sugarcane farming in the Mossman district does not take place directly on Native Title determined land, many of the farming lands are directly adjacent to lands held under Native Title or under an Indigenous Land Use Agreement (ILUA). Thus, any environmental market targets that extended beyond the direct boundaries of farmland, as may be the case with wetland restorations for blue carbon in particular, may encompass lands with Traditional Owner rights.

Benefit sharing: For Native Title lands, the proponent is likely to need to negotiate an Indigenous Land Use Agreement (ILUA) with Jabalbina, which will include details of the share of financial benefit to be paid. For freehold lands, an ILUA is not required, but best practice recommends that discussions be held with the Traditional Owners and a mutually agreed position be reached.

Cultural heritage: The cultural heritage process described below is required for any projects to be undertaken on Native Title lands. Whilst not all steps are legally required for projects undertaken on freehold land, best practice requires that the same process be followed as much of the sugarcane growing lands are adjacent to Traditional Owner lands. Costs noted below may be lower/avoided in situations where the project does not cross onto Native Title lands. The recommended process involves three phases: initial engagement, cultural heritage survey, and cultural heritage management and protection. Each of these phases is described below.

Initial engagement

Project proponents are encouraged to reach out to Jabalbina at the earliest opportunity to explain the proposed project, including the scope and anticipated timing of the expected works on Yalanji Country. Following initial discussions, Jabalbina will then undertake a process to determine which person(s) have cultural authority to speak for that specific land.

If the project is located on Native Title lands, then this process requires a clan governance meeting to be held. Clan governance meetings are generally held infrequently, (typically 2 to 3 meetings per year for the Eastern Kuku Yalanji Clan) and advertising for such a meeting is required for at least 2 weeks prior to the meeting date to ensure the ‘right’ Traditional Owners (those with cultural authority) are aware of the meeting and can attend. This procedure follows the Native Title process for Decision making which determines the advertising requirements and notice timeframes for cultural decisions or authorisation meetings, held within a clan governance meeting. In practice, organising such meetings can be complex and take several weeks to arrange, especially if the right Traditional Owners live away from the Mossman district. Hence, project proponents should seek to provide Jabalbina with as much notice and advance information as possible to help the smooth running of this process.

On other freehold lands, Jabalbina as the Registered native title body does not have authority over these lands, however, Jabalbina can advise on best practice for ensuring the right cultural authorities are engaged. Jabalbina has the background knowledge to engage the correct Traditional Owners who have cultural authority; this is very important, as many people cannot speak with authority for Country. Freehold lands are areas that, under the Cultural Heritage Act, are considered ‘disturbed land’.

Either as part of the clan governance meeting, if invited, or after the Traditional Owner(s) with cultural authority for the land have been determined, the proponent is recommended to present the information about the project and provide opportunity for questions to be asked and answered.

Costs incurred during this phase of the project will mainly involve payment of fees to the Traditional Owners involved, but typically the costs of the process would be around $1,500 to $2,000. Often this financial cost has been worn by Jabalbina who remain unfunded for this body of work; however, proponents may wish to discuss a fee structure with Jabalbina to compensate for their unfunded work and time.

Cultural heritage survey

Following the engagement process, the Traditional Owners with cultural authority for the land, and Jabalbina, will recommend to the proponent an appropriate organisation to complete a cultural heritage survey on the project site. Whilst the project proponent is not required to accept their recommendation under the Cultural Heritage Act, best practice requires that the recommendation is adopted. Arrangements for the cultural heritage survey are likely to take 2-3 weeks, although in complex circumstances this could take longer. The time required for the survey itself depends on the size and condition of the site. When the land has been heavily disturbed, as is the case with agricultural land, more extensive work is likely required than in other cases. The survey team (with the recommended Traditional Owners) will conduct the assessment. This includes seeking both tangible (artefacts) and intangible (spiritual connections) cultural heritage on the lands. The physical walking of the land is accompanied by the Surveyor interviewing the Traditional Owners to fully draw on any and all information they are able to provide. A detailed survey report is then prepared and presented to Jabalbina and to the project proponent. Every surveying organisation will add value through their own expertise which can increase prices although can produce more comprehensive reporting and this needs to be discussed with the proponent and surveying organisation. The survey equipment can include orthomosaic mapping, lidar drone survey, and software that produces very high-quality data and imagery otherwise not obtained without the right equipment. Discussions should include the proponent's expected deliverables from the survey. As every project is different, likely time and costs required for a cultural heritage survey are hard to estimate as they depend on the scale and complexity of the project; ranging from a minimum of around $2,000 and 3-4 weeks to $30,000 and 5 months for a complex situation, with a 'typical' process likely to cost $6,000-$12,000.

Cultural heritage management and protection

When the cultural heritage survey identifies tangible and/or intangible heritage, discussions should be held between Jabalbina and the project proponent regarding the recording, management, and protection of this heritage. For tangible artefacts, this is likely to require the artefacts to be removed to an appropriate place. For both tangible artefacts and intangible spiritual connections, all details will be recorded in the Jabalbina cultural heritage database.

Once all heritage has been appropriately recorded, and relocated if required, the proponent and Jabalbina can finalise the cultural heritage agreement that enables those Traditional Owners with cultural authority, known as Cultural Practitioners, to be involved and on site when the physical project works are conducted. The project's scope of work is used to determine monitoring and cultural heritage management with recommendations. There is also a specific management process for various 'New Finds' and the process for human remains and this is presented within the management agreement.

APPENDIX 8: DISCOUNTED CASH FLOW ANALYSIS FOR GREEN CARBON SITE DE2 – WORKED EXAMPLE

Table S5: A worked example of the Discounted Cash Flow Analysis for the Green Carbon Site De2.

	A	B	C	D	E
1	**FullCAM 'Green ACCUs' standalone for Site De2**				
2			**Unit**	**Year incurred**	**Incurred by**
3	Real discount rate	0.07	per annum		
4	Engagement, survey, design, secure finance, legals, ba	15000	$, incurred in first 6 months of project	1	developer
5	Loan amount	3708810	$, loan amount is the sum of tree planting cost, planting design cost, development approval cost and 5% contingency.		developer
6	Project Management	18544.05	$, 0.5% of total loan, incurred in the second six months of second year	2	developer
7	Reduction in land value	5018	$/ha, incurred at the start of establishment phase	2	landholder
8	Monitoring and reporting	56	$/ha/year, incurred starting in the first year	4,5,6,...,28	developer
9	Forgone net revenue from sugarcane	430	$/ha, incurred annually from the start of production phase until the end of permanence period.	3,4,5,...,28	landholder
10	De2 area	64.04	ha		
11	ACCU price	40	$ per ACCU		
12	ACCUs discount due to 25-year permanence	0.25			
13	Interest on loan amount	0.08	per annum		
14	loan repayment duration	10	years		
15	Annual loan repayment	552722	$/year	3,... 12	developer
16	Annuity factor	12.13711125			

Table S5 continued…

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
24			Description	Year	Sequestration tCO2e/ha/yr	ACCUs/yr/ha	Costs_Developer	Cost_Landholder	Total_Costs	PVC_Developer	PVC_Landholder	PVC_Project	RevenueACCUs	PVB_Project	PVNB_Project
25	January	2022	Lead-in yr1	1	0	0.0	15000	0	15000	15000.0	0	15000	0	0.0	-15000
26	January	2023	Lead-in yr2	2	0	0.0	18544	321353	339897	17330.9	300330	317661	0	0.0	-317661
27	January	2024	Lead-in yr3	3	0	0.0	552722	27537	580259	482768.8	24052	506821	0	0.0	-506821
28	January	2025	Crediting period yr1	4	1	1.1	556308	27537	583845	454113.2	22479	476592	2747	2242.6	-474349
29	January	2026	Crediting period yr2	5	21	16.0	556308	27537	583845	424404.9	21008	445413	41069	31331.2	-414082
30	January	2027	Crediting period yr3	6	50	37.9	556308	27537	583845	396640.1	19634	416274	97001	69160.6	-347113
31	January	2028	Crediting period yr4	7	56	41.8	556308	27537	583845	370691.7	18349	389041	107145	71395.5	-317645
32	January	2029	Crediting period yr5	8	29	22.1	556308	27537	583845	346440.8	17149	363590	56637	35270.7	-328319
33	January	2030	Crediting period yr6	9	28	20.7	556308	27537	583845	323776.5	16027	339803	52974	30831.3	-308972
34	January	2031	Crediting period yr7	10	26	19.3	556308	27537	583845	302594.8	14978	317573	49522	26936.8	-290636
35	January	2032	Crediting period yr8	11	24	17.9	556308	27537	583845	282798.9	13999	296797	45929	23348.2	-273449
36	January	2033	Crediting period yr9	12	22	16.7	556308	27537	583845	264298.0	13083	277381	42830	20348.2	-257033
37	January	2034	Crediting period yr10	13	21	15.5	3586	27537	31123	1592.3	12227	13819	39590	17578.2	3759
38	January	2035	Crediting period yr11	14	19	14.3	3586	27537	31123	1488.2	11427	12915	36631	15200.5	2285
39	January	2036	Crediting period yr12	15	18	13.3	3586	27537	31123	1390.8	10679	12070	34024	13195.3	1125
40	January	2037	Crediting period yr13	16	17	12.4	3586	27537	31123	1299.8	9981	11281	31700	11489.5	209
41	January	2038	Crediting period yr14	17	15	11.4	3586	27537	31123	1214.8	9328	10543	29305	9926.5	-616
42	January	2039	Crediting period yr15	18	14	10.7	3586	27537	31123	1135.3	8718	9853	27332	8652.7	-1200
43	January	2040	Crediting period yr16	19	13	9.9	3586	27537	31123	1061.0	8147	9208	25430	7523.9	-1684
44	January	2041	Crediting period yr17	20	12	9.3	3586	27537	31123	991.6	7614	8606	23740	6564.2	-2042
45	January	2042	Crediting period yr18	21	12	8.7	3586	27537	31123	926.8	7116	8043	22190	5734.3	-2309
46	January	2043	Crediting period yr19	22	11	8.1	3586	27537	31123	866.1	6651	7517	20781	5018.9	-2498
47	January	2044	Crediting period yr20	23	10	7.6	3586	27537	31123	809.5	6216	7025	19372	4372.5	-2652
48	January	2045	Crediting period yr21	24	10	7.1	3586	27537	31123	756.5	5809	6565	18315	3863.6	-2702
49	January	2046	Crediting period yr22	25	9	6.7	3586	27537	31123	707.0	5429	6136	17188	3388.6	-2747
50	January	2047	Crediting period yr23	26	8	6.3	3586	27537	31123	660.8	5074	5734	16061	2959.3	-2775
51	January	2048	Crediting period yr24	27	8	6.0	3586	27537	31123	617.5	4742	5359	15286	2632.2	-2727
52	January	2049	Crediting period yr25	28	7	5.6	3586	27537	31123	577.1	4432	5009	14300	2301.3	-2707
53															
54															
55														NPV from blue carbon credits	- 3,870,361
56														Annualised equivalent of project NPV	- 318,887

Table S5 continued…

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
24			**Description**	**Year**	**Sequestration tCO2e/ha/yr**	**ACCUs/yr/ha**	**Costs_Developer**	**Cost_Landholder**	**Total_Costs**	**PVC_Developer**	**PVC_Landholder**	**PVC_Project**	**RevenueACCUs**	**PVB_Project**	**PVNB_Project**
25	January	2022	Lead-in yr1	1	0	=(1-$B$12)*E25	=B4	0	=SUM(G25:H25)	=G25/((1+$B$3)^(D25-$D$25))	=H25/((1+$B$3)^(D25-$D$25))	=SUM(J25:K25)	=F25*$B$11*$B$10	=M25/((1+$B$3)^(D25-D	=N25-L25
26	January	2023	Lead-in yr2	2	0	=(1-$B$12)*E26	=B6	=B7*$B$10	=SUM(G26:H26)	=G26/((1+$B$3)^(D26-$D$25))	=H26/((1+$B$3)^(D26-$D$25))	=SUM(J26:K26)	=F26*$B$11*$B$10	=M26/((1+$B$3)^(D26-D	=N26-L26
27	January	2024	Lead-in yr3	3	0	=(1-$B$12)*E27	=B15	=$B$9*$B$10	=SUM(G27:H27)	=G27/((1+$B$3)^(D27-$D$25))	=H27/((1+$B$3)^(D27-$D$25))	=SUM(J27:K27)	=F27*$B$11*$B$10	=M27/((1+$B$3)^(D27-D	=N27-L27
28	January	2025	Crediting period yr1	4	1.43	=(1-$B$12)*E28	=(B$8*B$10)+B$15	=$B$9*$B$10	=SUM(G28:H28)	=G28/((1+$B$3)^(D28-$D$25))	=H28/((1+$B$3)^(D28-$D$25))	=SUM(J28:K28)	=F28*$B$11*$B$10	=M28/((1+$B$3)^(D28-D	=N28-L28
29	January	2026	Crediting period yr2	5	21.3766666666667	=(1-$B$12)*E29	=(B$8*B$10)+B$15	=$B$9*$B$10	=SUM(G29:H29)	=G29/((1+$B$3)^(D29-$D$25))	=H29/((1+$B$3)^(D29-$D$25))	=SUM(J29:K29)	=F29*$B$11*$B$10	=M29/((1+$B$3)^(D29-D	=N29-L29
30	January	2027	Crediting period yr3	6	50.49	=(1-$B$12)*E30	=(B$8*B$10)+B$15	=$B$9*$B$10	=SUM(G30:H30)	=G30/((1+$B$3)^(D30-$D$25))	=H30/((1+$B$3)^(D30-$D$25))	=SUM(J30:K30)	=F30*$B$11*$B$10	=M30/((1+$B$3)^(D30-D	=N30-L30
31	January	2028	Crediting period yr4	7	55.77	=(1-$B$12)*E31	=(B$8*B$10)+B$15	=$B$9*$B$10	=SUM(G31:H31)	=G31/((1+$B$3)^(D31-$D$25))	=H31/((1+$B$3)^(D31-$D$25))	=SUM(J31:K31)	=F31*$B$11*$B$10	=M31/((1+$B$3)^(D31-D	=N31-L31
32	January	2029	Crediting period yr5	8	29.48	=(1-$B$12)*E32	=(B$8*B$10)+B$15	=$B$9*$B$10	=SUM(G32:H32)	=G32/((1+$B$3)^(D32-$D$25))	=H32/((1+$B$3)^(D32-$D$25))	=SUM(J32:K32)	=F32*$B$11*$B$10	=M32/((1+$B$3)^(D32-D	=N32-L32
33	January	2030	Crediting period yr6	9	27.5733333333333	=(1-$B$12)*E33	=(B$8*B$10)+B$15	=$B$9*$B$10	=SUM(G33:H33)	=G33/((1+$B$3)^(D33-$D$25))	=H33/((1+$B$3)^(D33-$D$25))	=SUM(J33:K33)	=F33*$B$11*$B$10	=M33/((1+$B$3)^(D33-D	=N33-L33
34	January	2031	Crediting period yr7	10	25.7766666666667	=(1-$B$12)*E34	=(B$8*B$10)+B$15	=$B$9*$B$10	=SUM(G34:H34)	=G34/((1+$B$3)^(D34-$D$25))	=H34/((1+$B$3)^(D34-$D$25))	=SUM(J34:K34)	=F34*$B$11*$B$10	=M34/((1+$B$3)^(D34-D	=N34-L34
35	January	2032	Crediting period yr8	11	23.9066666666667	=(1-$B$12)*E35	=(B$8*B$10)+B$15	=$B$9*$B$10	=SUM(G35:H35)	=G35/((1+$B$3)^(D35-$D$25))	=H35/((1+$B$3)^(D35-$D$25))	=SUM(J35:K35)	=F35*$B$11*$B$10	=M35/((1+$B$3)^(D35-D	=N35-L35
36	January	2033	Crediting period yr9	12	22.2933333333333	=(1-$B$12)*E36	=(B$8*B$10)+B$15	=$B$9*$B$10	=SUM(G36:H36)	=G36/((1+$B$3)^(D36-$D$25))	=H36/((1+$B$3)^(D36-$D$25))	=SUM(J36:K36)	=F36*$B$11*$B$10	=M36/((1+$B$3)^(D36-D	=N36-L36
37	January	2034	Crediting period yr10	13	20.6066666666667	=(1-$B$12)*E37	=B$8*B$10	=$B$9*$B$10	=SUM(G37:H37)	=G37/((1+$B$3)^(D37-$D$25))	=H37/((1+$B$3)^(D37-$D$25))	=SUM(J37:K37)	=F37*$B$11*$B$10	=M37/((1+$B$3)^(D37-D	=N37-L37
38	January	2035	Crediting period yr11	14	19.0666666666666	=(1-$B$12)*E38	=B$8*B$10	=$B$9*$B$10	=SUM(G38:H38)	=G38/((1+$B$3)^(D38-$D$25))	=H38/((1+$B$3)^(D38-$D$25))	=SUM(J38:K38)	=F38*$B$11*$B$10	=M38/((1+$B$3)^(D38-D	=N38-L38
39	January	2036	Crediting period yr12	15	17.71	=(1-$B$12)*E39	=B$8*B$10	=$B$9*$B$10	=SUM(G39:H39)	=G39/((1+$B$3)^(D39-$D$25))	=H39/((1+$B$3)^(D39-$D$25))	=SUM(J39:K39)	=F39*$B$11*$B$10	=M39/((1+$B$3)^(D39-D	=N39-L39
40	January	2037	Crediting period yr13	16	16.5	=(1-$B$12)*E40	=B$8*B$10	=$B$9*$B$10	=SUM(G40:H40)	=G40/((1+$B$3)^(D40-$D$25))	=H40/((1+$B$3)^(D40-$D$25))	=SUM(J40:K40)	=F40*$B$11*$B$10	=M40/((1+$B$3)^(D40-D	=N40-L40
41	January	2038	Crediting period yr14	17	15.2533333333333	=(1-$B$12)*E41	=B$8*B$10	=$B$9*$B$10	=SUM(G41:H41)	=G41/((1+$B$3)^(D41-$D$25))	=H41/((1+$B$3)^(D41-$D$25))	=SUM(J41:K41)	=F41*$B$11*$B$10	=M41/((1+$B$3)^(D41-D	=N41-L41
42	January	2039	Crediting period yr15	18	14.2266666666667	=(1-$B$12)*E42	=B$8*B$10	=$B$9*$B$10	=SUM(G42:H42)	=G42/((1+$B$3)^(D42-$D$25))	=H42/((1+$B$3)^(D42-$D$25))	=SUM(J42:K42)	=F42*$B$11*$B$10	=M42/((1+$B$3)^(D42-D	=N42-L42
43	January	2040	Crediting period yr16	19	13.2366666666666	=(1-$B$12)*E43	=B$8*B$10	=$B$9*$B$10	=SUM(G43:H43)	=G43/((1+$B$3)^(D43-$D$25))	=H43/((1+$B$3)^(D43-$D$25))	=SUM(J43:K43)	=F43*$B$11*$B$10	=M43/((1+$B$3)^(D43-D	=N43-L43
44	January	2041	Crediting period yr17	20	12.3566666666667	=(1-$B$12)*E44	=B$8*B$10	=$B$9*$B$10	=SUM(G44:H44)	=G44/((1+$B$3)^(D44-$D$25))	=H44/((1+$B$3)^(D44-$D$25))	=SUM(J44:K44)	=F44*$B$11*$B$10	=M44/((1+$B$3)^(D44-D	=N44-L44
45	January	2042	Crediting period yr18	21	11.55	=(1-$B$12)*E45	=B$8*B$10	=$B$9*$B$10	=SUM(G45:H45)	=G45/((1+$B$3)^(D45-$D$25))	=H45/((1+$B$3)^(D45-$D$25))	=SUM(J45:K45)	=F45*$B$11*$B$10	=M45/((1+$B$3)^(D45-D	=N45-L45
46	January	2043	Crediting period yr19	22	10.8166666666667	=(1-$B$12)*E46	=B$8*B$10	=$B$9*$B$10	=SUM(G46:H46)	=G46/((1+$B$3)^(D46-$D$25))	=H46/((1+$B$3)^(D46-$D$25))	=SUM(J46:K46)	=F46*$B$11*$B$10	=M46/((1+$B$3)^(D46-D	=N46-L46
47	January	2044	Crediting period yr20	23	10.0833333333333	=(1-$B$12)*E47	=B$8*B$10	=$B$9*$B$10	=SUM(G47:H47)	=G47/((1+$B$3)^(D47-$D$25))	=H47/((1+$B$3)^(D47-$D$25))	=SUM(J47:K47)	=F47*$B$11*$B$10	=M47/((1+$B$3)^(D47-D	=N47-L47
48	January	2045	Crediting period yr21	24	9.53333333333331	=(1-$B$12)*E48	=B$8*B$10	=$B$9*$B$10	=SUM(G48:H48)	=G48/((1+$B$3)^(D48-$D$25))	=H48/((1+$B$3)^(D48-$D$25))	=SUM(J48:K48)	=F48*$B$11*$B$10	=M48/((1+$B$3)^(D48-D	=N48-L48
49	January	2046	Crediting period yr22	25	8.94666666666666	=(1-$B$12)*E49	=B$8*B$10	=$B$9*$B$10	=SUM(G49:H49)	=G49/((1+$B$3)^(D49-$D$25))	=H49/((1+$B$3)^(D49-$D$25))	=SUM(J49:K49)	=F49*$B$11*$B$10	=M49/((1+$B$3)^(D49-D	=N49-L49
50	January	2047	Crediting period yr23	26	8.36000000000006	=(1-$B$12)*E50	=B$8*B$10	=$B$9*$B$10	=SUM(G50:H50)	=G50/((1+$B$3)^(D50-$D$25))	=H50/((1+$B$3)^(D50-$D$25))	=SUM(J50:K50)	=F50*$B$11*$B$10	=M50/((1+$B$3)^(D50-D	=N50-L50
51	January	2048	Crediting period yr24	27	7.95666666666662	=(1-$B$12)*E51	=B$8*B$10	=$B$9*$B$10	=SUM(G51:H51)	=G51/((1+$B$3)^(D51-$D$25))	=H51/((1+$B$3)^(D51-$D$25))	=SUM(J51:K51)	=F51*$B$11*$B$10	=M51/((1+$B$3)^(D51-D	=N51-L51
52	January	2049	Crediting period yr25	28	7.44333333333339	=(1-$B$12)*E52	=B$8*B$10	=$B$9*$B$10	=SUM(G52:H52)	=G52/((1+$B$3)^(D52-$D$25))	=H52/((1+$B$3)^(D52-$D$25))	=SUM(J52:K52)	=F52*$B$11*$B$10	=M52/((1+$B$3)^(D52-D	=N52-L52
53															
54															
55														**PV from blue carbon credits**	**=SUM(O25:O52)**
56														**d equivalent of project NPV**	**=O55/B16**

APPENDIX 9: DISCOUNTED CASH FLOW ANALYSIS FOR BLUE CARBON SITE 1 – WORKED EXAMPLE

Table S6: A worked example of the Discounted Cash Flow Analysis for the Blue Carbon Site 1.

	A	B	C	D	E
1	**BlueCAM 'Blue ACCUs' standalone for Site 1**				
2			**Unit**	**Year incurred**	**Incurred by**
3	Real discount rate	0.07	per annum		
4	Number of landholders	3	Site 1		
5	Informal initial engagement	1000	$ per landholder	1	developer
6	Site survey	5000	$ per site	1	developer
7	Engagement process	2500	$ per landholder	1	developer
8	Initial hydrological assessment	12000	$ per site	1	developer
9	Cultural heritage survey	0	$ per site	2	na
10	Legal and contracts	10000	$ per actor	2	developer
11	Baseline establishment	5000	$ per project site	3	developer
12	*Detailed project design	32000	$ per project site	3	loan
13	*Development approvals	50000	$ per site	3	loan
14	*On-site works - soil excavation	3840	$ per site, site-specific	3	loan
15	*On-site works - rock reinforcement	125000	$ per site	3	loan
16	Project Management	14056	assumed 20% of * items, $ split equally between yrs 1,2,3	1,2,3	developer
17	Opex	925	$ per ha of inundation	4,5,6,7	developer
18	Monitoring and reporting	2500	$ per report, occurs in years when ACCUs are claimed	4,9,14,19, 24, 29	developer
19	Independent audits	20000	$ per audit, once in year 4 and every five years thereafter when ACCUs are claimed	4,9,19	developer
20	Baseline CO2e when on-site works completed	100.2	t CO2e		
21	ACCUs discount due to 25-year permanence	0.25			
22	Loan amount	221382	Loan covers * items + 5% contingencies on the sum of * items		
23	Interest on loan amount	0.08	per annum		
24	loan repayment duration	10	years		
25	Annual loan repayment	32992	$/year	2,3,... 11	developer
26	Reduction in land value	5018	$ /ha	2	landholder
27	Forgone net revenues (opportunity cost)	430	$/ha/year	3, 4, ..., 29	landholder
28	Annuity factor	12.2776741			
29	ACCU price	40	$ per ACCU		
30	Site 1 area	246.7	ha		

Table S6 continued…

	A	B	C	D	E
1	**BlueCAM 'Blue ACCUs' standalone for Site 1**				
2			**Unit**	**Year incurred**	**Incurred by**
3	Real discount rate	0.07	per annum		
4	Number of landholders	3	Site 1		
5	Informal initial engagement	1000	$ per landholder	1	developer
6	Site survey	5000	$ per site	1	developer
7	Engagement process	2500	$ per landholder	1	developer
8	Initial hydrological assessment	12000	$ per site	1	developer
9	Cultural heritage survey	0	$ per site	2	na
10	Legal and contracts	10000	$ per actor	2	developer
11	Baseline establishment	5000	$ per project site	3	developer
12	*Detailed project design	32000	$ per project site	3	loan
13	*Development approvals	50000	$ per site	3	loan
14	*On-site works - soil excavation	3840	$ per site, site-specific	3	loan
15	*On-site works - rock reinforcement	125000	$ per site	3	loan
16	Project Management	=(0.2*(SUM(B12:B15)))/3	assumed 20% of * items, $ split equally between yrs 1,2,3	1,2,3	developer
17	Opex	925	$ per ha of inundation	4,5,6,7	developer
18	Monitoring and reporting	2500	$ per report, occurs in years when ACCUs are claimed	4,9,14,19, 24, 29	developer
19	Independent audits	20000	$ per audit, once in year 4 and every five years thereafter when ACCUs are claimed	4,9,19	developer
20	Baseline CO2e when on-site works completed	100.2	t CO2e		
21	ACCUs discount due to 25-year permanence	0.25			
22	Loan amount	=SUM(B12:B15)*1.05	Loan covers * items + 5% contingencies on the sum of * items		
23	Interest on loan amount	0.08	per annum		
24	loan repayment duration	10	years		
25	Annual loan repayment	32992	$/year	2,3,... 11	developer
26	Reduction in land value	5018	$ /ha	2	landholder
27	Forgone net revenues (opportunity cost)	430	$/ha/year	3, 4, ..., 29	landholder
28	Annuity factor	=(1-(1+$B$3)^(-$D$61))/$B$3			
29	ACCU price	40	$ per ACCU		
30	Site 1 area	246.7	ha		

Table S6 continued…

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
32			Description	Year	area (ha)	Cumulative t CO_2e	Increment tCO2e	Costs_Developer	Cost_Landholder	Total_Costs	PVC_Developer	PVC_Landholder	PVC	RevenueACCUs	PVB	PVNB
33		2021	Lead-in yr1	1	0.0	0	0	41556	0	41556	41556	0	41556	0	0	-41556
34		2022	Lead-in yr2	2	0.0	0	0	77048	1237941	1314988.6	72007	1156954	1228961	0	0	-1228961
35		2023	Lead-in yr3	3	0.0	0	0	52048	106081	158129	45461	92655	138116	0	0	-138116
36	January	2024	Crediting period yr1	4	96	75.15	75.15	144477	106081	250558	117936	86594	204530	3006	2454	-202076
37		2025	Crediting period yr2	5	97	0	0	122852	106081	228933	93723	80929	174652	0	0	-174652
38		2026	Crediting period yr3	6	98	0	0	123726	106081	229807	88215	75634	163849	0	0	-163849
39		2027	Crediting period yr4	7	99	0	0	124601	106081	230682	83027	70686	153713	0	0	-153713
40		2028	Crediting period yr5	8	100	0	0	32992	106081	139073	20546	66062	86608	0	0	-86608
41	January	2029	Crediting period yr6	9	101	3063.3	2988.15	55492	106081	161573	32297	61740	94037	119526	69565	-24472
42		2030	Crediting period yr7	10	102	0	0	32992	106081	139073	17945	57701	75646	0	0	-75646
43		2031	Crediting period yr8	11	103	0	0	32992	106081	139073	16771	53926	70698	0	0	-70698
44		2032	Crediting period yr9	12	104	0	0	0	106081	106081	0	50398	50398	0	0	-50398
45		2033	Crediting period yr10	13	105	0	0	0	106081	106081	0	47101	47101	0	0	-47101
46	January	2034	Crediting period yr11	14	106	6056.475	2993.175	2500	106081	108581	1037	44020	45057	119727	49682	4625
47		2035	Crediting period yr12	15	107	0	0	0	106081	106081	0	41140	41140	0	0	-41140
48		2036	Crediting period yr13	16	108	0	0	0	106081	106081	0	38449	38449	0	0	-38449
49		2037	Crediting period yr14	17	108	0	0	0	106081	106081	0	35933	35933	0	0	-35933
50		2038	Crediting period yr15	18	109	0	0	0	106081	106081	0	33583	33583	0	0	-33583
51	January	2039	Crediting period yr16	19	110	9055.05	2998.575	22500	106081	128581	6657	31386	38042	119943	35487	-2556
52		2040	Crediting period yr17	20	111	0	0	0	106081	106081	0	29332	29332	0	0	-29332
53		2041	Crediting period yr18	21	112	0	0	0	106081	106081	0	27413	27413	0	0	-27413
54		2042	Crediting period yr19	22	113	0	0	0	106081	106081	0	25620	25620	0	0	-25620
55		2043	Crediting period yr20	23	114	0	0	0	106081	106081	0	23944	23944	0	0	-23944
56	January	2044	Crediting period yr21	24	115	12061.2	3006.15	2500	106081	108581	527	22377	22905	120246	25366	2461
57		2045	Crediting period yr22	25	116	0	0	0	106081	106081	0	20914	20914	0	0	-20914
58		2046	Crediting period yr23	26	117	0	0	0	106081	106081	0	19545	19545	0	0	-19545
59		2047	Crediting period yr24	27	118	0	0	0	106081	106081	0	18267	18267	0	0	-18267
60		2048	Crediting period yr25	28	119	0	0	0	106081	106081	0	17072	17072	0	0	-17072
61	January	2049		29	120	15071.925	3010.725	2500	106081	108581	376	15955	16331	120429	18113	1782
62																
63		2057		37	127.4	26,538.90										
64															**NPV from blue carbon credits**	**-2782745**
65															**Annualised equivalent of project NPV**	**-226651**

Table S6 continued…

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
32			**Description**	**Year**	**Inundated area (ha)**	**Cumulative t CO_2e**	**Increment tCO2e**	**Costs_Developer**	**Cost_Landholder**	**Total_Costs**	**PVC_Developer**	**PVC_Landholder**	**PVC**	**RevenueACCUs**	**PVB**	**PVNB**
33		2021	Lead-in yr1	1	0	0	0	=(B5*B4)+B6+(B7*B4)+B8+B16	0	=SUM(H33:I33)	=H33/((1+$B$3)^(D33-$D$33))	=I33/((1+$B$3)^(D33-$D$33))	=J33/((1+$B$3)^(D33-$D$33))	=G33*$B$29	0	=O33-M33
34		2022	Lead-in yr2	2	0	0	0	=B9+(B10*B4)+B16+B25	=B26*$B$30	=SUM(H34:I34)	=H34/((1+$B$3)^(D34-$D$33))	=I34/((1+$B$3)^(D34-$D$33))	=J34/((1+$B$3)^(D34-$D$33))	=G34*$B$29	0	=O34-M34
35		2023	Lead-in yr3	3	0	0	0	=SUM(B11,B16,B25)	=$B$27*$B$30	=SUM(H35:I35)	=H35/((1+$B$3)^(D35-$D$33))	=I35/((1+$B$3)^(D35-$D$33))	=J35/((1+$B$3)^(D35-$D$33))	=G35*$B$29	0	=O35-M35
36	January	2024	Crediting period yr1	4	96.2	75.15	=F36	=SUM(B18:B19)+(B17*E36)+B25	=$B$27*$B$30	=SUM(H36:I36)	=H36/((1+$B$3)^(D36-$D$33))	=I36/((1+$B$3)^(D36-$D$33))	=J36/((1+$B$3)^(D36-$D$33))	=G36*$B$29	=N36/((1+$B$3)^($D36-$D$33))	=O36-M36
37		2025	Crediting period yr2	5	97.1454545454546	0	0	=($B$17*E37)+B25	=$B$27*$B$30	=SUM(H37:I37)	=H37/((1+$B$3)^(D37-$D$33))	=I37/((1+$B$3)^(D37-$D$33))	=J37/((1+$B$3)^(D37-$D$33))	=G37*$B$29	0	=O37-M37
38		2026	Crediting period yr3	6	98.0909090909091	0	0	=($B$17*E38)+B25	=$B$27*$B$30	=SUM(H38:I38)	=H38/((1+$B$3)^(D38-$D$33))	=I38/((1+$B$3)^(D38-$D$33))	=J38/((1+$B$3)^(D38-$D$33))	=G38*$B$29	0	=O38-M38
39		2027	Crediting period yr4	7	99.0363636363636	0	0	=($B$17*E39)+B25	=$B$27*$B$30	=SUM(H39:I39)	=H39/((1+$B$3)^(D39-$D$33))	=I39/((1+$B$3)^(D39-$D$33))	=J39/((1+$B$3)^(D39-$D$33))	=G39*$B$29	0	=O39-M39
40		2028	Crediting period yr5	8	99.9818181818182	0	0	=B25	=$B$27*$B$30	=SUM(H40:I40)	=H40/((1+$B$3)^(D40-$D$33))	=I40/((1+$B$3)^(D40-$D$33))	=J40/((1+$B$3)^(D40-$D$33))	=G40*$B$29	0	=O40-M40
41	January	2029	Crediting period yr6	9	100.927272727273	3063.3	=F41-F36	=SUM(B18:B19,B25)	=$B$27*$B$30	=SUM(H41:I41)	=H41/((1+$B$3)^(D41-$D$33))	=I41/((1+$B$3)^(D41-$D$33))	=J41/((1+$B$3)^(D41-$D$33))	=G41*$B$29	=N41/((1+$B$3)^($D41-$D$33))	=O41-M41
42		2030	Crediting period yr7	10	101.872727272727	0	0	=B25	=$B$27*$B$30	=SUM(H42:I42)	=H42/((1+$B$3)^(D42-$D$33))	=I42/((1+$B$3)^(D42-$D$33))	=J42/((1+$B$3)^(D42-$D$33))	=G42*$B$29	0	=O42-M42
43		2031	Crediting period yr8	11	102.818181818182	0	0	=B25	=$B$27*$B$30	=SUM(H43:I43)	=H43/((1+$B$3)^(D43-$D$33))	=I43/((1+$B$3)^(D43-$D$33))	=J43/((1+$B$3)^(D43-$D$33))	=G43*$B$29	0	=O43-M43
44		2032	Crediting period yr9	12	103.763636363636	0	0	0	=$B$27*$B$30	=SUM(H44:I44)	=H44/((1+$B$3)^(D44-$D$33))	=I44/((1+$B$3)^(D44-$D$33))	=J44/((1+$B$3)^(D44-$D$33))	=G44*$B$29	0	=O44-M44
45		2033	Crediting period yr10	13	104.709090909091	0	0	0	=$B$27*$B$30	=SUM(H45:I45)	=H45/((1+$B$3)^(D45-$D$33))	=I45/((1+$B$3)^(D45-$D$33))	=J45/((1+$B$3)^(D45-$D$33))	=G45*$B$29	0	=O45-M45
46	January	2034	Crediting period yr11	14	105.654545454545	6056.475	=F46-F41	=B18	=$B$27*$B$30	=SUM(H46:I46)	=H46/((1+$B$3)^(D46-$D$33))	=I46/((1+$B$3)^(D46-$D$33))	=J46/((1+$B$3)^(D46-$D$33))	=G46*$B$29	=N46/((1+$B$3)^($D46-$D$33))	=O46-M46
47		2035	Crediting period yr12	15	106.6	0	0	0	=$B$27*$B$30	=SUM(H47:I47)	=H47/((1+$B$3)^(D47-$D$33))	=I47/((1+$B$3)^(D47-$D$33))	=J47/((1+$B$3)^(D47-$D$33))	=G47*$B$29	0	=O47-M47
48		2036	Crediting period yr13	16	107.545454545455	0	0	0	=$B$27*$B$30	=SUM(H48:I48)	=H48/((1+$B$3)^(D48-$D$33))	=I48/((1+$B$3)^(D48-$D$33))	=J48/((1+$B$3)^(D48-$D$33))	=G48*$B$29	0	=O48-M48
49		2037	Crediting period yr14	17	108.490909090909	0	0	0	=$B$27*$B$30	=SUM(H49:I49)	=H49/((1+$B$3)^(D49-$D$33))	=I49/((1+$B$3)^(D49-$D$33))	=J49/((1+$B$3)^(D49-$D$33))	=G49*$B$29	0	=O49-M49
50		2038	Crediting period yr15	18	109.436363636364	0	0	0	=$B$27*$B$30	=SUM(H50:I50)	=H50/((1+$B$3)^(D50-$D$33))	=I50/((1+$B$3)^(D50-$D$33))	=J50/((1+$B$3)^(D50-$D$33))	=G50*$B$29	0	=O50-M50
51	January	2039	Crediting period yr16	19	110.381818181818	9055.05	=F51-F46	=B18+B19	=$B$27*$B$30	=SUM(H51:I51)	=H51/((1+$B$3)^(D51-$D$33))	=I51/((1+$B$3)^(D51-$D$33))	=J51/((1+$B$3)^(D51-$D$33))	=G51*$B$29	=N51/((1+$B$3)^($D51-$D$33))	=O51-M51
52		2040	Crediting period yr17	20	111.327272727273	0	0	0	=$B$27*$B$30	=SUM(H52:I52)	=H52/((1+$B$3)^(D52-$D$33))	=I52/((1+$B$3)^(D52-$D$33))	=J52/((1+$B$3)^(D52-$D$33))	=G52*$B$29	0	=O52-M52
53		2041	Crediting period yr18	21	112.272727272727	0	0	0	=$B$27*$B$30	=SUM(H53:I53)	=H53/((1+$B$3)^(D53-$D$33))	=I53/((1+$B$3)^(D53-$D$33))	=J53/((1+$B$3)^(D53-$D$33))	=G53*$B$29	0	=O53-M53
54		2042	Crediting period yr19	22	113.218181818182	0	0	0	=$B$27*$B$30	=SUM(H54:I54)	=H54/((1+$B$3)^(D54-$D$33))	=I54/((1+$B$3)^(D54-$D$33))	=J54/((1+$B$3)^(D54-$D$33))	=G54*$B$29	0	=O54-M54
55		2043	Crediting period yr20	23	114.163636363636	0	0	0	=$B$27*$B$30	=SUM(H55:I55)	=H55/((1+$B$3)^(D55-$D$33))	=I55/((1+$B$3)^(D55-$D$33))	=J55/((1+$B$3)^(D55-$D$33))	=G55*$B$29	0	=O55-M55
56	January	2044	Crediting period yr21	24	115.109090909091	12061.2	=F56-F51	=B18	=$B$27*$B$30	=SUM(H56:I56)	=H56/((1+$B$3)^(D56-$D$33))	=I56/((1+$B$3)^(D56-$D$33))	=J56/((1+$B$3)^(D56-$D$33))	=G56*$B$29	=N56/((1+$B$3)^($D56-$D$33))	=O56-M56
57		2045	Crediting period yr22	25	116.054545454545	0	0	0	=$B$27*$B$30	=SUM(H57:I57)	=H57/((1+$B$3)^(D57-$D$33))	=I57/((1+$B$3)^(D57-$D$33))	=J57/((1+$B$3)^(D57-$D$33))	=G57*$B$29	0	=O57-M57
58		2046	Crediting period yr23	26	117	0	0	0	=$B$27*$B$30	=SUM(H58:I58)	=H58/((1+$B$3)^(D58-$D$33))	=I58/((1+$B$3)^(D58-$D$33))	=J58/((1+$B$3)^(D58-$D$33))	=G58*$B$29	0	=O58-M58
59		2047	Crediting period yr24	27	117.945454545455	0	0	0	=$B$27*$B$30	=SUM(H59:I59)	=H59/((1+$B$3)^(D59-$D$33))	=I59/((1+$B$3)^(D59-$D$33))	=J59/((1+$B$3)^(D59-$D$33))	=G59*$B$29	0	=O59-M59
60		2048	Crediting period yr25	28	118.890909090909	0	0	0	=$B$27*$B$30	=SUM(H60:I60)	=H60/((1+$B$3)^(D60-$D$33))	=I60/((1+$B$3)^(D60-$D$33))	=J60/((1+$B$3)^(D60-$D$33))	=G60*$B$29	0	=O60-M60
61	January	2049		29	119.836363636364	15071.925	=F61-F56	=B18	=$B$27*$B$30	=SUM(H61:I61)	=H61/((1+$B$3)^(D61-$D$33))	=I61/((1+$B$3)^(D61-$D$33))	=J61/((1+$B$3)^(D61-$D$33))	=G61*$B$29	=N61/((1+$B$3)^($D61-$D$33))	=O61-M61
62																
63		2057		37	127.4	26538.9										
64															**NPV from blue carbon credits**	**=SUM(P33:P61)**
65															**alised equivalent of project NPV**	**=P64/B28**

Photo source – M. Curnock