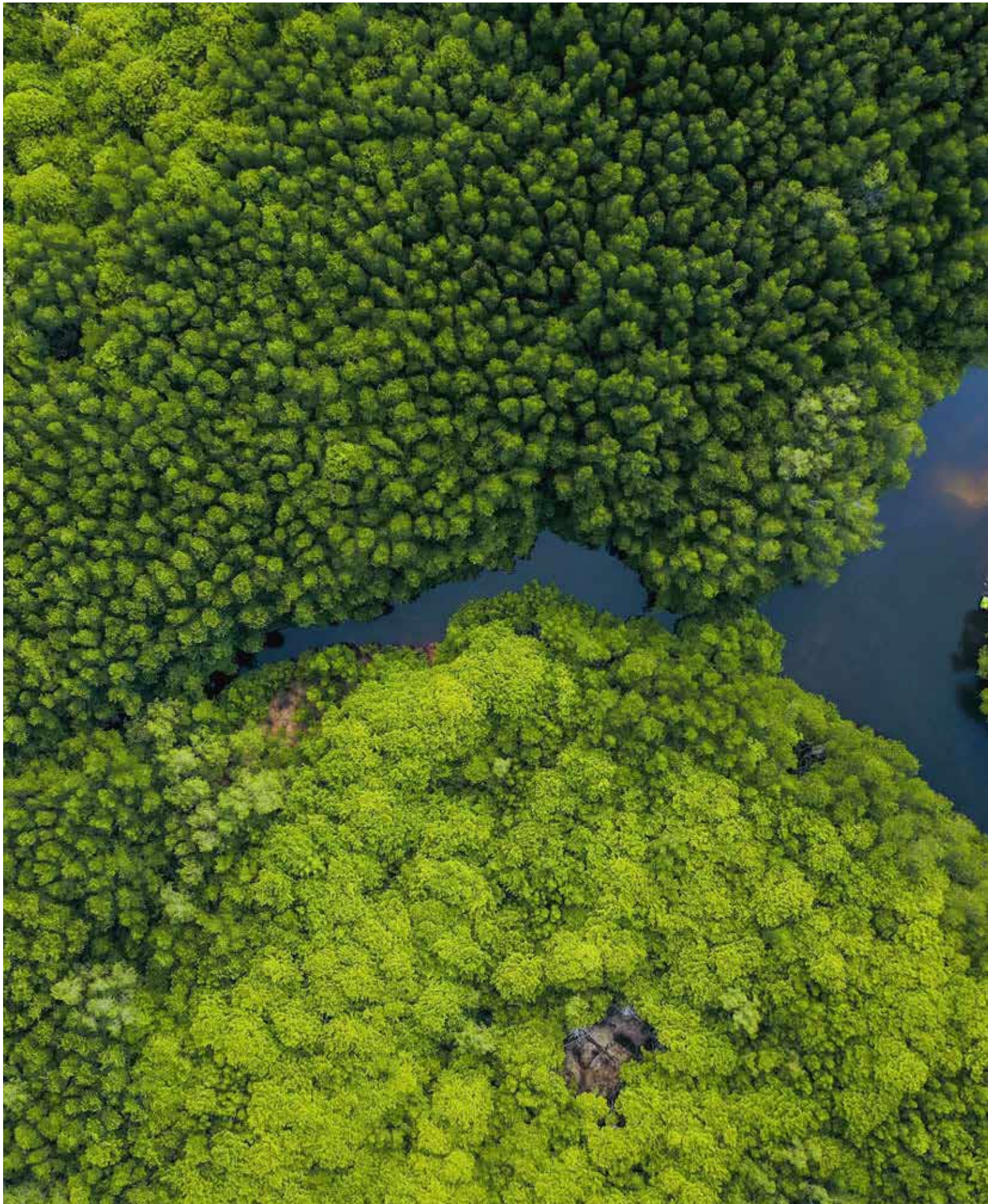


THE BUSINESS CASE FOR NATURAL CLIMATE SOLUTIONS

INSIGHTS AND OPPORTUNITIES FOR SOUTHEAST ASIA





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FOREWORD

TEMASEK

Sustainability is at the core of everything we do at Temasek. As a generational investor, we must do our part to transition toward a low carbon economy for humanity.

In 2019, Temasek set ambitious targets on climate action. We committed to and accomplished carbon neutrality at the firm level in 2020. We further committed to halving net emissions at the portfolio level by 2030, using 2010 emission levels as a baseline. In addition, we aspire to deliver a net zero emissions portfolio by 2050.

Carbon neutrality cannot be achieved with carbon capture, storage or even renewable energy alone. Forests sequester carbon by capturing CO₂ from the atmosphere and transforming it into biomass through photosynthesis. Here in Southeast Asia, the native habitat for mangrove swamps and sea grass meadows boast the world's largest blue carbon stock. Restoration and conservation of our natural carbon sinks through nature based solutions is thus a critical tributary in the decarbonisation pathway.

To implement nature-based solutions at scale, we need public-private sector partnerships such as research institutions to build our base of scientific knowledge, capital owners to develop promising projects, NGOs to bring different interest groups together, businesses to co-finance projects and undertake carbon credits, and governments to provide an enabling regulatory environment.

This joint white paper is timely and brings together perspectives from multi-sectorial players with an aligned vision. I congratulate The National University of Singapore, Temasek, Conservation International, and DBS for undertaking this important project. I hope that this paper serves as a primer to inquisitive minds seeking to define the investment case for nature-based climate solutions in Southeast Asia.

Enjoy your sustainability journey!

Robin Hu

Head, Sustainability & Stewardship Group, Temasek

CONSERVATION INTERNATIONAL

Millions of people are already suffering the impacts of climate change and the world is on course for a 3.7-4.8°C temperature increase by 2100, which would cause catastrophic and irreparable damage to our planet. Climate catastrophe looms due to the destruction and degradation of many of the world's carbon-rich natural ecosystems.

To combat the crisis, Conservation International is working to realise a fundamental shift in how nature is leveraged as a solution. When ecosystems are destroyed, immense amounts of carbon are released into the atmosphere that remain irrecoverable in our lifetime. Yet financial incentives to protect these places are surprisingly limited. Currently, only 2% of global climate investment goes to **natural climate solutions**, despite being 37% of the potential solution to avoid the worst effects of climate change.

How can nature-based solutions be leveraged to achieve their full potential? What is the role of the private sector? What are the strategies, methodologies and interventions? This report, a research partnership between Temasek, DBS, National University of Singapore and Conservation International, is intended to synthesise the state of knowledge surrounding the wide-range of activities and instruments currently available to the private sector to invest in nature-based solutions all around the world.

Nature provides vital, unmatched and ongoing returns to all of humanity, and the growing relevance and value of natural **carbon markets** are clear. An investment in our planet is an investment in our future but we cannot protect our lands, waters and other natural resources without developing new partnerships and long-term financial commitments that incentivise protection and restoration. Conservation International is excited to be a part of this collaboration as we work together to find innovative, successful and lasting ways to fund conservation, and partner with governments, academia and corporates to develop solutions that are good for business, good for nature and good for people.

Dr. Richard Jeo

Senior Vice President, Conservation International Asia Pacific Field Division

DBS BANK

Natural Climate Solutions address two of the most monumental challenges facing us today – climate change and biodiversity loss. The challenges are strongly interlinked.

Singapore is surrounded by some of the most precious, diverse and productive natural systems in the world. From rainforest to wetlands, these places provide immeasurable wealth to the world. As an affluent country and an emerging world-leading green financial hub, Singapore is uniquely positioned to contribute to the preservation and expansion of nature. Through science, technology and finance, as well as spending patterns, we can make a difference collectively and individually.

This report not only offers a contribution in highlighting the impact NCS can have on resolving the challenges we are facing, but also suggests the commercial viability of NCS.

DBS wishes to continue to play its part in preserving our natural treasures. Through our responsible lending practices we ensure due consideration is given to preservation of critical natural ecosystems. We also encourage the transition to a low-carbon economy through our lending and other actions. We aim to lead the agenda as members of Task Force on Climate-related Financial Disclosures (TCFD) and Task Force for Nature-related Financial Disclosures (TNFD).

It is my own hope that this report sparks much-needed conversations that are solutions-focused, and that it encourages you as the reader to consider your own ways in helping to make a positive contribution.

Mikkel Larsen, Chief Sustainability Officer, DBS Bank

NATIONAL UNIVERSITY OF SINGAPORE

We live in an unprecedented time with immense global challenges, with climate change presenting one of the most profound risks to both natural and human systems. In an effort to combat climate change and reduce global **greenhouse** gases (GHGs), 195 states have committed to the **Paris Climate Agreement** to limit global warming to below 2°C. One country commanding the lead is the small-island state of Singapore, with its government subsidiaries, as well as academic institutions.

Current commitment to mitigate and adapt to climate change in Singapore amounts to SGD\$100 billion over the next 50-100 years, with Temasek Holdings leading the way. Temasek Holdings has pledged to halve their net portfolio carbon emissions by 2030. Likewise, Singapore is actively investing in the future through science-based ventures. In particular, the Singapore National Research Foundation has recognised the vital importance to science-based initiatives to solve global grand challenges. Amongst one of the first initiatives, is the investment in the new Centre for Nature-based Climate Solutions at the National University of Singapore (NUS-CNCS).

The NUS-CNCS is uniquely positioned to research on and confront the issue of climate change by committing to work in collaboration with the Singapore government to play an active role in mitigating and adapting to global climate change at the regional scale through science and research collaborations. Collectively, humanity needs to drawdown 53.5GtCO₂ in order to limit the temperature rise to 2°C per the Paris Climate Agreement. One highly underutilised avenue of reducing GHG emissions is to invest in natural climate solutions through private, corporate investments, particularly in Southeast Asia. Leveraging on the expertise of the CNCS, recent work points to natural climate solutions having the potential to close these emission gaps, sustain biodiversity and local livelihoods, whilst still providing a high return-on-investment through carbon financing.

Together, these efforts represent a concerted and holistic approach to address climate change in both a scientific and financially viable manner. I am privileged to be able to support the Government of Singapore and subsequently, Temasek Holdings, with nature-based scientific methodologies to take a global leadership approach to drawing down carbon for our collective future.

Professor Lian Pin Koh

Director, National University of Singapore, Centre for Nature-based Climate Solutions

ACRONYMS

ACR – American Carbon Registry

ART TREES – Architecture for REDD+ Transaction (ART) The REDD+ Environmental Excellency Standard (TREES)

ASEAN – Association of Southeast Asian Nations

BAU – Business-as-Usual

C - Carbon

CAGR – Compound Annual Growth Rate

CAR – Climate Action Reserve

CCS – Carbon Capture and Storage

CDM – Clean Development Mechanism

CI – Conservation International

CO₂ – Carbon Dioxide

COP XX – Conference of the Parties

CORSIA – Carbon Offsetting and Reduction Scheme for International Aviation

CSR – Corporate Social Responsibility

DFI – Development Financial Institutions

EEXI – Energy Efficiency Existing Ship Index

ETS – Emissions Trading System

EV – Electric Vehicles

F4F – Finance for Forest Initiative

FCPF – Forest Carbon Partnership Facility

GCF – Green Climate Fund

GHG – Greenhouse Gas

GtC – Gigatons of Carbon

ICAO – International Civil Aviation Organization

ICT – Information and Communication Technology

IFC – International Finance Corporation

IMO – International Maritime Organization

IRR – Internal Rate of Return

ITMO - Internationally Transferred Mitigation Outcomes

IUCN – International Union for Conservation of Nature

JNR – Jurisdictional and Nested REDD+ (of Verified Carbon Standards)

KTON – Kiloton

MbMs – Market-based Measures

MEPC – Marine Environment Protection Committee

MgtC – Megatons of Carbon

NbS – Nature-based Solutions

NCS – Natural Climate Solutions

NDC – Nationally Determined Contributions

NUS – National University of Singapore

NUS-CNCS – National University of Singapore Centre for Nature-based Climate Solutions

PPP – Public Private Partnerships

RBCF – Results-Based Climate Finance

RDC – Regionally Determined Contribution

REDD+ – Reducing Emissions from Deforestation and Forest Degradation

RIL-C – Reduced-Impact Logging for Climate Change

RoI – Return on Investment

SBTi – Science Based Targets initiative

SDGs – Sustainability Development Goals

SMEs – Small and Medium Sized Enterprises

SOS – Safe Operating Space

TgC – Teragrams of Carbon

UN – United Nations

UNFCCC – United Nations Framework Convention on Climate Change

VCUs – Verified Carbon Units

VERPA – Voluntary Emission Reduction Purchase Agreement

WBCSD – World Business Council for Sustainable Development

WEF – World Economic Forum

AUTHORS AND CONTRIBUTORS

CONSERVATION INTERNATIONAL AUTHORS/CONTRIBUTORS:

Shyla Raghav, Aarin Gross, Andrew Wu, Maggie Comstock, Jan Yoshioka, Murali Kanakasabai, Jennifer Howard, Anand Roopsind, Kellee Koenig, Adam Schoenberg, Karyn Tabor, Bronson Griscom, Robert Baigrie, Will Turner, Agustin Silvani, Aya Uraguchi, Bara Kalla, Srabani Roy, Anurag Ramachandra

NATIONAL UNIVERSITY OF SINGAPORE, CENTRE FOR NATURE-BASED CLIMATE SOLUTIONS:

Kelly Siman, Yiwen Zeng, Zhang Jie, Lavanya Prakash, Tasya Vadya Sarira, L. Roman Carrasco Torrecilla, Daniel A. Friess, Lian Pin Koh

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EXECUTIVE SUMMARY

In the face of the accelerating impacts of climate change, natural climate solutions (NCS) provide an immediately and widely available option for companies seeking to make sound investments in climate mitigation. **Given the pressing need to decarbonise and the ambitious carbon targets set by companies and countries alike, it seems clear that NCS solutions must form part of the portfolio of options to achieve carbon neutrality.**

Companies can make a difference. NCS might not fit every single use case or organisation. However, greater awareness of NCS, and how to operationalise such solutions, will lead to more informed options for companies and countries. **NCS represent a significant opportunity for businesses and investors that either have exposures and material risks within their supply chain linked to deforestation and land-use change or are seeking cost-effective investment options to meet their climate commitments and targets, as part of a broader portfolio of climate investments inclusive of decarbonisation.**

Despite their vast potential, NCS solutions have been undervalued as a credible mitigation solution, attracting only a minor share of global climate finance flows. Reasons likely include lack of methodologies to quantify and verify mitigation outcomes addressing land use, land use change, and forestry, and lack of institutional maturity or readiness. **However, many of the barriers to investment have viable solutions and research suggests a potentially high opportunity and low operational cost to sequester carbon at scale.**

In fact, NCS projects are competitive with other mitigation options on cost and return on investment but stand out as particularly favourable when non-carbon benefits are considered, including coastal resilience, biodiversity conservation, and flood prevention. While there are limited options for price premiums associated with the **co-benefits** of NCS, advancements in measuring, reporting, and product innovation could assist companies in directing investments to activities and regions where non-carbon returns and Sustainable Development Goals (SDGs) outcomes can be maximized.



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Efficiencies and levers for value creation can be realised through designing and implementing NCS projects in a manner that reduces cost and time needed to generate returns through engaging in policy advocacy, technology deployment, inclusion of cost buffers, and upfront community engagement.

To date, most entities investing in NCS projects via the purchase of carbon credits are doing so through the voluntary carbon market. Whether motivated by corporate social responsibility (CSR), climate commitments, market opportunities, pre-compliance, or compliance needs, there are numerous business models that companies may utilise to invest in NCS. For voluntary carbon offsets, these models include voluntary purchase agreements, offtake agreements, and upfront investment in project development in return for preferential access to future credits generated.

Trends suggest that demand for NCS activities and their associated carbon returns will increase rapidly in the coming decade. Voluntary carbon offset issuances nearly doubled between 2018 and 2019. We are possibly already at an inflection point. Many countries in Southeast Asia and the Pacific have favourable conditions for NCS investment and implementation, including high potential for investable carbon. **Southeast Asia holds the highest density of carbon prospecting for NCS investments, which includes both terrestrial and blue carbon.** Similarly, based on preliminary spatial analyses, there is a high density of co-benefits that would be captured through NCS investment. However, to scale

NCS, even as demand for **carbon credits** is poised to increase, supply development is a key opportunity and need. **This will require further development of and investment in innovative financial instruments that support project start-up and design costs to ensure high quality outcomes, for new projects in particular.**

Recent developments have also allowed better quantification of the impact of **blue carbon** solutions, thereby improving the financial conditions for coastal carbon investment and bringing this carbon science closer to parity with terrestrial forest ecosystems. **The private sector has the opportunity to drive technological and financial innovation to streamline carbon investments and accelerate pipeline development for underutilised but high-potential solutions like blue carbon (targeting coastal and marine ecosystems) and reduced impact logging for climate (RIL-C).**

For NCS to reach scale, the private and finance sector is encouraged to support the enabling conditions for policies and compliance regimes for climate action. The development of mature carbon markets will further enable and facilitate the expansion of demand, higher prices, and matching of demand and supply. **It is recommended that companies investing in NCS also support policy development at the regional and national level to ensure long-term sustainability and scaling opportunities, as well as consistent pricing signals to sustain the development and implementation of NCS outcomes.**



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NATURE'S ROLE IN CLIMATE ACTION

Natural Climate Solutions, or NCS, refer to climate mitigation technologies that harness natural processes to reduce or remove greenhouse gas, or GHG emissions. More precisely, NCS are defined as “actions to protect, sustainably manage, and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits” (IUCN, 2016).

NCS can contribute to efforts in three primary ways:

- Reducing GHG emissions, especially in the land use sector;
- Providing a proven method of **carbon** capture and storage; and
- Increasing ecosystem resilience and providing other socioecological co-benefits of mitigation efforts.

Nature already mitigates a significant portion of anthropogenic GHG emissions. Approximately a quarter of these emissions are absorbed by trees,

plants, and soil, while another quarter is absorbed into marine systems (NOAA, 2017). Yet, if protected, sustainably managed, and restored, nature has the power to do even more. **Studies have shown how NCS can provide over a third of cost-effective climate mitigation needed worldwide to achieve net-zero emissions by 2050 and keep global warming below 2°C** (Griscom et al., 2017). Realising this opportunity, however, requires support from the private sector which plays a critical role in scaling NCS implementation. Businesses can catalyse significant reductions of GHG emissions through investments in NCS – not only to address their own company’s footprint, but also to drive transitional change for entire sectors. Conversely, NCS presents a wealth of opportunities to businesses – with a range of motivations – in achieving their internal corporate goals, while also supporting the advancement of national climate targets within their countries of operation. This report highlights opportunities for businesses to invest in NCS, particularly those in Southeast Asia to stimulate the implementation of NCS at scale.



WHY BUSINESSES SHOULD CARE ABOUT NATURAL CLIMATE SOLUTIONS

Achieving Net-Zero Emissions by 2050 is Needed to Avoid Catastrophic Climate Change

Global experts agree on the imperative to act on climate change across sectors, rapidly, and at scale. According to the Intergovernmental Panel on Climate Change (IPCC), human activities are estimated to have caused approximately 1.0°C of global warming since pre-industrial times (1850-1900) and are projected to reach 1.5°C of warming between 2030 and 2052 based on current trends (IPCC, 2018). Global warming has already negatively impacted natural and human systems, including sea level rise, increased extreme and deadly weather events, and threats to health, food security, and economic growth. The IPCC projects that continued warming of 1.5°C and higher will further increase the severity of these impacts. (IPCC, 2018).

The time to act is now. Due to the mounting climate shocks associated with warming beyond 1.5°C, the next ten years will shape the outlook for climate risk for the rest of the century (World Economic Forum, 2018).

From a global economic perspective, the climate risks and corresponding economic risks threaten a systemic collapse, unless net human-caused carbon dioxide (CO₂) emissions fall by 50% by 2030 relative to 2010 and to net zero by 2050 (Rogelj et al., 2015).

THE PRIVATE SECTOR IS UNIQUELY POSITIONED TO SUPPORT CLIMATE ACTION DUE TO THE SPEED AND SCALE AT WHICH IT CAN DEPLOY CAPITAL

The private sector has key, distinct advantages as an investor in NCS. Not only are pools of philanthropic and government capital typically more modest than private funds, but government fiscal assets are also more susceptible to political risk. Corporate commitments and efforts can help bridge the gap between current climate targets set by governments and the level of ambition that is needed to reach net-zero emissions by 2050 (World Economic Forum, 2018). The private sector can often make decisions and deploy investment more rapidly than the public sector. Coupled with the pressure to compete in markets and achieve positive returns for investors, private sector players are skilled at developing cost-effective models that are financially self-sustaining. Furthermore, as governments often seek private investment within their jurisdictions as a means of job creation and economic growth, establishing corporate partnerships and investments in climate mitigation projects can be a strong incentive for corresponding public action.

Leveraging private investments with risk-reducing public and philanthropic capital, through an arrangement called public-private partnerships (PPPs), has emerged as a notable model for amplifying climate finance (The Palladium Group, 2019). By strategically aligning business capital with countries' climate

opportunities and priorities, collaborations between the public and private sector can accelerate transitions towards a green economy (Ansah & Sorooshian, 2019). These collaborations to scale financing may be a matter of necessity, particularly for developing countries, where large amounts of capital are needed to finance the transition to a green economy. Estimates suggest that, by 2030, US \$500 billion will be needed annually to sufficiently limit GHG emissions in developing countries (World Resources Institute, 2013).

The World Economic Forum (WEF) has identified key areas where the private sector can lead to hasten the transformation towards a low-carbon economy. In addition to financing climate action, these areas include: reinventing businesses, bridging sectors (to jointly develop low-carbon products, processes and technologies), creating sustainable value chains, and harnessing data and connectivity (World Economic Forum, 2018).

TRACKING CORPORATE EMISSIONS IS THE FIRST ESSENTIAL STEP TO DETERMINE HOW COMPANIES SHOULD APPROACH ITS CLIMATE MITIGATION STRATEGY

To help transition to a low-carbon economy and support net-zero emissions targets, businesses first need to identify the sources of emissions that they have control and influence over. The Greenhouse Gas Protocol has developed a Corporate Accounting and Reporting Standard, providing guidance for companies and organizations in preparing a corporate-level GHG emissions inventory.¹ (Bhatia et al., 2013)

A GHG emissions inventory that includes all three scopes can help companies identify where the largest emissions reduction opportunities exist across their business. From there, businesses can develop targeted mitigation strategies through a variety of reporting, implementation, and trading programs, promoting company transparency while mitigating reputational risk (Bhatia et al., 2013).

Box 1: Classification of GHG Scopes

Corporate emissions can come from a variety of sources, which are grouped into three “scopes” for greenhouse gas accounting and reporting purposes (WRI & WBCSD, 2013).

SCOPE 1

Direct Emissions – emissions from activities directly under the ownership or control of the company.



Company Furnaces



Vehicle Fleets



Chemical Production

SCOPE 2

Indirect Emissions – emissions from indirect sources under the ownership or control of the company.



Purchased Electricity



Heating/Cooling



Purchased Steam

SCOPE 3

All Other Indirect Emissions – typically the largest source of company emissions. These come from sources related to the company’s activities, but not directly owned or under the control of the company.



Material Extraction/Production



Transportation of Purchased Materials



Business Travel

Carbon emissions reductions pose particular challenges for small or medium sized enterprises (SMEs). Since SMEs typically have smaller overall emissions, these enterprises do not normally partake in emissions trading schemes. However, SMEs do hold key advantages over large enterprises when looking to reduce their overall — and specifically Scope 3 — emissions. SME companies are characteristically much more flexible with a flatter hierarchy, resulting in shorter and more immediate decision processes (Hendrichs & Busch, 2012).

Carbon accounting can be an onerous and intensive task and is typically “over-engineered” for SMEs (Hendrichs and Busch (2012). However, SMEs should work to implement a proactive carbon management strategy that is in line with their capabilities and resources. A seven-step framework was developed (Figure 1) to help guide and reduce the burden of carbon accounting for SMEs. The framework is intended to identify and trigger carbon mitigation levers in addition to discovering other areas of cost-savings and efficiencies.

Figure 1. Seven-step framework for small and medium sized enterprises to manage carbon emissions (Hendrichs and Busch (2012)



BUSINESSES NEED TO SET SCIENCE-BASED CLIMATE TARGETS AND DEVELOP STRATEGIES TO MEET THEM, INCLUDING INVESTING IN NCS OR PURCHASING OFFSETS TO COMPLEMENT DECARBONIZATION

Once businesses have quantified their GHG emissions, they can set targets to reduce their emissions in their operations and supply chains. Companies may develop GHG emissions reduction targets as part of broader sustainability frameworks or corporate disclosures. To be meaningful, however, the ambitions and timelines of these targets need to be aligned

with best-available, objective, scientific guidance on relevant global and sectoral carbon budgets in order to keep global warming below 1.5°C.

Through the Business Ambition for 1.5°C campaign, a global coalition of United Nations agencies and business and industry leaders has issued a call to action for companies to commit to ambitious emissions reduction targets through the Science Based Targets initiative (SBTi) (Science Based Targets, 2020a). SBTi defines and promotes best practices in **science-based target setting** for companies, and highlights the

increased innovation, reduced regulatory uncertainty, strengthened investor confidence, and improved profitability and competitiveness generated by science-based target setting (Science Based Targets, 2020a).

While the guidance for the SBTi evolves and is frequently updated, one of the methodologies available for corporate science-based target setting allocates carbon budgets to specific sectors and creates sector-specific decarbonisation pathways

(Science Based Targets, 2020b). Pathways are currently under development for the following sectors: apparel, chemicals and petrochemicals, financial institutions, oil and gas, transport, power sector, forest, land and agriculture, and information and communication technology (ICT) (Science Based Targets, 2020b). Examples of sectoral guidance, and companies' corresponding commitments, are elaborated in the call-out boxes below.

Box 2: Oil & Gas Industry and SBTi

SBTi is developing methodologies for oil & gas companies to set science-based climate targets for their upstream, midstream, and downstream business segments. European oil supermajors – including BP, Royal Dutch Shell, and Total – are in a SBTi working group to support this initiative. To date, all three companies have already made net-zero pledges for their Scope 1 emissions by 2050, along with significant contributions in other emission sources. These targets are expected to be informed and reviewed upon completion of the SBTi methodology. Notably, their American supermajor counterparts, such as ExxonMobil and Chevron, are currently not involved in the working group, have much less ambitious targets, and do not have comprehensive targeted emissions reduction plans. Highlights from these companies' climate pledges are provided below:

BP

By 2050, BP pledges to:

- Be net-zero on all direct emissions
- Cut the carbon intensity of all company products by 50%

SHELL

By 2050, Shell pledges to:

- Be net-zero on all direct emissions
- Cut the carbon intensity of all company products by 65%, with an interim target of 30% by 2035

TOTAL

By 2050, Total pledges to:

- Be net-zero on all direct emissions
- Cut the carbon intensity of all company products by 60%, with interim targets of 15% by 2030 and 35% by 2040

EXXONMOBIL

By 2020, ExxonMobil pledges to:

- Cut methane emissions by 15%

CHEVRON

By 2023, Chevron pledges to:

- Cut the carbon intensity of direct emissions of oil production by 5-10%

Box 3: Financial Sector Science Based Targets (Draft Guidance Version 1.0) (Science Based Targets, 2020b)¹

In October 2020, SBTi released a pilot version of target guidance for the financial sector – including banks, asset managers and owners, insurance companies, and real estate investment trusts. The framework is also relevant for other financial institutions that have holdings in the following asset classes: real estate, mortgages, electricity generation project finance, and corporate debt and equity (Science Based Targets, 2020).

Amongst other recommendations, primary opportunities to reduce emissions highlighted by the SBTi include:

- High-level commitments to act through an international initiative;
- Measuring emissions intensity in portfolios;
- Distinguishing green versus brown investment; and
- Divesting from fossil fuels

To date, more than 50 financial institutions have publicly committed to set emissions reduction targets through the Science Based Targets initiative. In addition, 80 institutions in the financial sector reported to CDP in 2019 that they intend to set a science-based target within the next two years.

SBTi's tools and methodologies can be used synergistically with existing coalitions and campaigns aimed at catalyzing climate action in the finance sector. Companies involved in the following example initiatives should actively explore opportunities for collaboration:

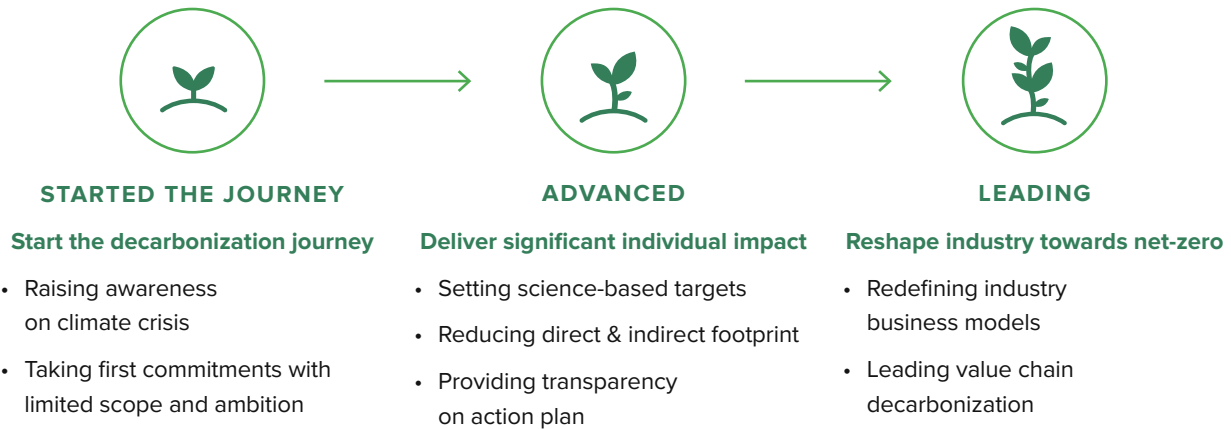
- Business Ambition for 1.5°C
- We Mean Business campaign
- UN-convened Net-Zero Asset Owners Alliance
- Principles for Responsible Banking
- The Investor Agenda
- Commitment to TCFD reporting
- Partnership for Carbon Accounting Financials

As part of this broader sectoral approach, natural climate solutions provide pathways for corporations to reduce their overall GHG emissions and accomplish their corporate carbon reduction goals – whether as a supply chain emissions reduction measure, or through investment in offsets to neutralize part of their corporate footprintⁱⁱ.

Setting science-based targets to reduce emissions enables companies to set their ambition. Deliberate strategies for reaching net-zero are needed to match that ambition with actions.

The World Business Council for Sustainable Development (WBCSD)'s Safe Operating Space (SOS) 1.5 project provides a science-based action framework for businesses to reach net-zero emissions and help keep global warming to under 1.5°C (WBCSD, 2020). The roadmap includes recommendations for all companies regardless of where they are on the decarbonisation pathway (WBCSD, 2020).

Figure 2: A company's stages of decarbonisation: Starting the Journey, Advanced and Leading



(World Business Council for Sustainable Development (WBCSD), 2020)

According to the WBCSD, there are six main levers companies can use to reduce Scope 1 and Scope 2 emissions:

1. Enhancing efficiency (reducing sector-specific energy consumption);
2. Substituting fuel (replacing carbon intensive primary energy sources with green alternatives, such as biomass or green hydrogen);
3. Changing agriculture and waste management;
4. Decarbonising electricity (replacing carbon intensive sources, such as coal, with lower-carbon alternatives);
5. Reducing direct emissions from process industries (such as cement or glass); and
6. Using synthetic fuels and carbon capture and storage (CCS) as last-mile abatement levers (WBCSD, 2020).

However, since scope 3 emissions are often the main source of most corporate emissions, this is an area that holds significant opportunities for emission reductions. The Greenhouse Gas Protocol provides a separate standard specifically to help companies understand their Scope 3 emissions.

There are two main approaches to reduce Scope 3 emissions: Reducing the activity level (e.g. the amount of kilometres driven by the company fleet), and reducing the GHG intensity of the activities (e.g. the amount of emissions emitted per kilometre) (Farsan et al., 2018). Any actionable measure taken to reduce GHGs in the activities and/or intensity are called 'reduction levers'.

Table 1 illustrates the categories of reduction levers available, and corresponding examples both in terms of activity level and GHG intensity.

WBCSD's guidance details actions that companies can take in support of decarbonisation and provides a way for companies to collaborate with their peers and their value chains on the decarbonisation process. Still, it acknowledges that companies will not be able to reduce their emissions to zero across all three scopes in the near term and that credible carbon offsets and CCS will be needed to achieve net-zero (WBCSD, 2020).

Table 1: Reduction Levers and Examples for Scope 3 Emissions

Category Reduction Levers	Activity Level	GHG Intensity
Business Model Innovation	Shifting from car sales to car-sharing models	Increasing product lifespan
Supplier Engagement	Creating incentives for suppliers to reduce fuel consumption	Rewarding suppliers for switching to climate-smart agricultural practices
Procurement Policy & Choices	Substituting carbon-intensive materials with low-carbon alternatives	Including suppliers' carbon footprint in procurement policies
Product & Service Design	Designing products with lower maintenance needs	Incorporating carbon intensity in product design
Customer Engagement	Supporting educational campaigns on the value of rainforest-friendly certification	Certifying products with rainforest-friendly labels
Operational Policies	Optimizing operations to reduce waste	Partnering with municipal waste utilities to reduce emissions from landfills
Investment Strategy	Divesting from fossil fuel companies	Investing in projects with positive ESG ratings

INCREASING PRESSURE FROM INVESTORS TOWARDS CLIMATE ACTION

Corporate emissions occur “within a broader economic and regulatory system that creates a complex web of incentives and disincentives for economic actors to reduce emissions” (Science Based Targets, 2020b). Investors have a pivotal role to play in that broader system by financing, facilitating, and catalysing the adoption of ambitious corporate climate strategies. Several options are detailed below:

Investors can stimulate corporate initiatives through direct engagement with businesses. The Global Investor Coalition on Climate Change (GIC) has produced a series of Investor Expectation on Climate Change Sector reports, which are used to support productive engagement with investee companies. The series has covered a range of sectors, including: real estate companies, the construction materials sector, steel companies, oil and gas, automotive companies, electric utilities, and mining companies.

These reports set out expectations and guiding questions for investors to raise in their discussions with the board and management of investee companies (Global Investor Coalition on Climate Change, 2017). More specifically, the reports highlight how investors can seek commitments from corporate boards and senior management to:

- Implement a strong governance framework that clearly articulates the board’s accountability and oversight of climate change risks and opportunities;
- Initiate corporate sustainability voting actions;
- Call for transparency and disclosure of companies’ carbon-related risks and science-based approaches to curbing emissions, enabling investors to assess their business models’ climate resilience; and
- Take action to reduce GHG emissions across the value chain, consistent with limiting global average temperature increase to well below 2°C above pre-industrial levels.



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The G20-initiated TCFD is emerging as the de-facto standard framework for climate-related disclosure, requiring disclosure of four key dimensions: governance, strategy, risk management, and metrics & targets (UNEP Finance Initiative, 2020). According to WEF, by 2020, “more than 870 organizations – including companies with a combined market capitalisation of more than \$9.2 trillion and financial institutions responsible for assets of nearly \$118 trillion – had signed up to support the TCFD’s recommendations” (World Economic Forum, 2020a). Enhanced disclosure on climate mitigation-related land use targets can aid investors in prioritizing opportunities for NCS strategies in select corporate value chains.

Investors may also work together to take strategic collective actions to encourage commitments from portfolio companies. Climate Action 100+ is an example of an investor initiative, involving more than 450 investors with over \$40 trillion in collective assets under management, that has catalysed corporate action on climate change through collective investor actions (Climate Action 100+, 2019).

Investors have set net-zero emissions targets for their own portfolios, building in a phased approach where appropriate. An example of a platform that

assists investors in setting targets is the United Nations (UN)-convened Net-Zero Asset Owner Alliance. This international group of 28 institutional investors is committed to transitioning their investment portfolios to net-zero GHG emissions by 2050, creating intermediate targets every five years to establish climate action in phases. These 28 investors represent nearly US \$5 trillion in assets under management (UNEP Finance Initiative, 2020).

Finally, investors have developed and supported innovative finance products aimed at supporting decarbonisation and mitigating climate change.

There has been considerable growth in the appetite for green finance products, sending a powerful signal of support for decarbonisation initiatives (World Economic Forum, 2020b). For example, green bond issuance has maintained a decadal trend of exponential growth, from the first bond sold in 2007 totalling EUR 0.6 billion (or \$0.822 billion) to a record-setting \$257.7 billion in 2019 – a 12-yr compound annual growth rate (CAGR) of roughly 65% (UniCredit Research, 2017). While the growth of the asset class is very encouraging, it still represents a small portion of assets. However, the large financing gap for NCS suggests significant opportunity for further expansion.

Box 4: Case study - Finance for Forests Initiative (F4F)

F4F is a joint initiative between BHP, Conservation International, and Pollination, serving as a hub of learning to encourage investment and exploration of innovative private finance tools for forest conservation and REDD+ advancement. Focusing on engagement with oil and gas, mining, aviation, and technology sectors as well as institutional investors, F4F seeks to increase private sector understanding of forest conservation through REDD+, share lessons learned on REDD+ and forest finance, develop new, innovative finance tools, and extend them beyond forests to other ecosystems.

F4F leverages the experiences gained through BHP's investment in REDD+ projects and its support of the Forests Bond to help companies develop actionable plans based on proven models. The Forests Bond was issued by the International Finance Corporation (IFC) in October 2016 and was the first bond to support a REDD+ project.

NCS has important properties as an investment option for climate change mitigation

NCS' MITIGATION POTENTIAL IS GLOBALLY SIGNIFICANT

There is a wealth of mitigation technologies available for companies to reduce their Scope 1, Scope 2, and Scope 3 emissions. Some are built technologies, such as renewable energy projects (i.e. solar, wind, and geothermal), changes in chemical, industrial manufacturing, or waste disposal processes. In contrast, NCS utilises natural processes for carbon sequestration and storage through forestry, agricultural, and other land use practices, including marine ecosystems.

Far from being a niche, transient phenomenon, NCS is a critical tool to combat climate change. Whereas emerging approaches like CCS and synthetic fuels face significant technological and environmental risks (Climate Bonds Initiative, 2020b), the carbon-

sequestration properties of forests and other ecosystems, driven by photosynthesis, are already proven to be effective. The scale of NCS potential is relevant globally. With a mitigation potential of 10-12 GtCO₂ per year, NCS can provide over one-third of the affordable climate mitigation solutions needed by 2050 to stabilize global warming to 2°C and below (Griscom et al., 2017). Given that land use change - such as agriculture and forestry – accounted for over 23% of net global GHG emissions during 2007-2016 (equating to 12.0 ± 3.0 Gt CO₂e /yr), and deforestation was overwhelmingly the largest driver of these net emissions, the land use sector represents significant, immediate climate risk and opportunities (IPCC, 2019).

Figure 3 from Griscom et al. (2019) provides a broad overview of the carbon potential from NCS, divided amongst the broad categories of “Protecting” nature, “Managing” nature, and “Restoring” nature. In order for the potential of these pathways to be fully realised, substantial investment and action need to occur to align incentives and balance the opportunity cost of land use.

Figure 3: Three NCS pathways



(Griscom et al., 2019 and Griscom, et al., 2020. Graphics from the Nature Conservancy Magazine.)

NCS HAS LARGE POTENTIAL TO GENERATE CO-BENEFITS

Arguably, the greatest distinction between NCS and built mitigation technologies is the plethora of co-benefits provided by NCS. When implemented with the appropriate safeguards, NCS projects have positive impacts far beyond carbon sequestration, such as improving air and water quality, enhancing biodiversity, mitigating disaster risk, and promoting environmental social justice and equity.

Proper project design, such as the incorporation of native species, empowerment of local communities, and respect for indigenous cultures, is essential to realising these co-benefits. Conversely, failing to take social, governance, and biodiversity dimensions into account could undermine the ultimate outcomes or sustainability of a project. For example, if a large tract of barren land was to be reforested with a monoculture plantation, carbon would be sequestered, but there would be a loss of biodiversity, as well as ecosystem services to support human settlements downstream. Furthermore, the lack of community consultation and consensus around project goals would create operational and reputational risks for the project funder, jeopardizing the project. As such, NCS projects have rigorous guidelines on safeguards and requirements for benefit sharing arrangements with key stakeholders.

Successful implementation of NCS projects requires a systems approach. Analysing and planning around

the interdependencies between components within a system can promote project sustainability and success (Raymond et al., 2017). While systems thinking may prove complex and unfamiliar to companies, NCS represents a promising investment opportunity that can catalyse a broader shift in corporate strategy and mindset.

The analysis and quantification of NCS co-benefits is an emerging field of study, with few established frameworks available to precisely measure and analyse the co-benefit potential of various project pathways, or how this potential can be translated into management strategies and governance (Kabisch et al., 2016; Seddon et al., 2020). Table 2 shows the many indicators that can be used to track the co-benefits of NCS projects. However, the use of these indicators must be intentionally built into project design, as comprehensive financing instruments to value and capture NCS projects' full range of co-benefits have yet to exist. In an effort to address this gap, the International Union for the Conservation of Nature (IUCN) launched a Global Standard for Nature-based Solutions (NbS) (IUCN, 2020).











NCS project developers are recommended to define the range of outcomes sought from a project upfront in order to ensure that co-benefits can be documented and accounted for accurately, utilising standards such as the IUCN Global Standard for NbS. Ultimately, clearer reporting of co-benefits may support price discovery as carbon and natural capital markets evolve.

Box 5: What is a high-quality carbon credit and why is it important?

High value credits, generating high-quality outcomes, are credits generated by REDD+ projects that meet high environmental integrity requirements (such as additionality, addressing permanence and leakage risks, transparency, conservativeness, and double counting avoidance), contribute to biodiversity/wildlife protection, support the achievement of co-benefits focused on the social and economic development of indigenous peoples and local communities, and have been third-party verified and accounted for through a robust system nested within national and/or jurisdictional accounting where appropriate.

High-quality credits generate significant non-carbon benefits, are validated using robust, science-based methodologies, and allow the offset purchaser to grow their impact beyond carbon outcomes. Investments in high-quality credits help maintain the integrity of carbon markets and channel investment to communities and places where it can have a significant impact.

Table 2: Indicators that can be used to track the co-benefits of NCS projects

Challenge Area	Example of Indicators	Type of Indicator	Unit of Measurement
Carbon Sequestration 	Net carbon sequestration by urban forests (including GHG emissions from maintenance activities)	Environmental (chemical)	t C per ha/year
Stormwater Management 	Economic benefit of reduction of stormwater to be treated in public sewerage system	Economic (monetary)	Cost of sewerage treatment by volume (€/m ³)
Erosion 	Area remaining for erosion protection	Environmental (physical)	km ² or m ²
Biodiversity 	Species richness of indigenous vegetation	Environmental (physical)	A count, magnitude or intensity score of indigenous species per unit area
Air Quality 	Annual amount of pollutants captured by vegetation	Environmental (chemical)	t pollutant per ha/year
Connectivity 	Index of ecological connectivity integral index of connectivity	Environmental (physical)	Probability that two dispersers randomly located in a landscape can reach each other
Government Transparency 	Quality of the participatory or governance processes	Social (process)	Perceived level of trust, legitimacy, transparency and accountability of process
Accessibility 	Accessibility to public green space	Social (justice)	% of people living within a given distance from accessible, public green space
Recreational Space 	Level of involvement in frequent physical activity in urban green spaces	Social (physiological)	Number and % of people being physically active (min. 30 min 3 times per week) in urban green spaces
Job Creation 	Net additional jobs in the green sector enabled by NBS projects	Economic (productivity)	New jobs/specific green sector/year

(Raymond et al., 2017)

Table 3: Comparison of cost and total abatement potential between NCS Pathways and Engineered Technology Pathways

	Natural Climate Solutions Pathways			Engineered Technology Pathways	
	Protect	Manage	Restore	Carbon Capture and Storage	Utilisation
Cost / tCO ₂ e (2009 dollars)	\$2 - 38	\$14 - 21	\$17	\$18 - 83	\$(-14) - 27
Total abatement potential (MtCO ₂ e/yr)	4,800	2,600	1,300	3,300-4,100	970

Table approximations based on (McKinsey & Company, 2009).

COMPARING MITIGATION ALTERNATIVES: NCS AND ENGINEERED SOLUTIONS

Among the suite of available **emissions abatement** alternatives, nature-based and engineered solutions represent two broad categories of potential mitigation investments. Natural climate solutions encompass a diverse range of agriculture, forestry, wetlands, and other land use sector interventions. Engineered solutions comprise an equally diverse range of built technologies related to clean and renewable energy generation and fuels, and carbon capture and storage infrastructure.

Within and across these categories, specific projects can exhibit considerable variation with respect to mitigation potentials and the marginal cost of emissions abatement. These values are typically calculated relative to a baseline or **business-as-usual (BAU)** emissions scenario over a specified time horizon.

To illustrate the relative magnitude of marginal emissions abatement and marginal costs, we present global data on a select range of nature-based and engineered mitigation solutions including:

NCS Pathways

- 1. Protect:** Interventions focused on emissions reductions from deforestation (avoided deforestation);

- 2. Manage:** Interventions focused on emissions reductions from improved forest management and trees in agricultural lands (agroforestry);
- 3. Restore:** Interventions focused on emissions reductions and removals from afforestation and reforestation (A/R) and rehabilitation of degraded forests.

Engineered Technology Pathways

- 1. Carbon Capture and Storage:** Interventions related to emissions removals from carbon capture and storage in the energy, resources and industrial sectors;
- 2. Utilisation:** Interventions related to emissions reductions from development and use of renewable fuels as a substitute for fossil fuels.

While specific emissions abatement costs, opportunities and constraints associated with these mitigation pathways are likely to vary between regions and countries, global data provides a helpful starting point for comparing and evaluating opportunities at a more granular regional or national level.



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NCS COSTS, BENEFITS AND OTHER INVESTMENT CONSIDERATIONS

Emissions Abatement Potential

As noted in the preceding section, the specific emissions abatement potential of NCS can vary widely within and across pathways and project typologies. Quantifying project-level expected emissions reduction or removal potential requires reliable data on business-as-usual or baseline emissions as well as the expected emissions and emissions abatement of the selected nature-based intervention.

In the case of NCS, these values are highly dependent on a range of land use, land cover, and other biophysical factors including soil type, structure and condition. Project-level emissions values are also influenced by the scope and scale of natural or human-caused drivers of land and environmental changes and the spatial scale of proposed emissions abatement interventions.

Evaluation of NCS emissions abatement potential should also take into account the biological limits of natural systems to capture and store carbon over time. While mangroves, seagrasses, and other "blue carbon" systems, under the right conditions, have the potential to continuously sequester and store carbon indefinitely

within submerged soilsⁱⁱⁱ (Chmura et al., 2003; Rogers et al., 2019), the sequestration potential of terrestrial forests and soils has a biological upper limit or carbon saturation level beyond which these systems no longer absorb carbon.

Opportunity Costs

In each case, NCS contemplates changes in land use on whether such changes have already occurred or are reasonably likely to occur in the future. As such, any evaluation of potential NCS investments must consider the opportunity costs associated with alternative land use scenarios. In the case of degraded or marginal lands with limited economic use, the opportunity costs associated with proposed afforestation or reforestation may be quite low. In contrast, in areas where planned or unplanned conversion for high value agricultural or other types of development may be considered, the opportunity costs of NCS interventions may be prohibitive.

Timeframe

Existing natural carbon-rich systems are already in place, are successfully sequestering carbon from the atmosphere and are storing vast amounts of carbon in a stable permanent state. NCS offers an immediate and cost-effective opportunity to finance the protection

of these systems and their long-term benefits at significant scale and without the need for many years of technological or engineering advances. Relative to engineered carbon capture and storage technologies, natural systems require a comparatively long-time horizon to capture and store carbon. While engineered solutions may have long investment payback periods and operational lives limited to 30-40 years, mitigation benefits from engineered projects will likely be available as soon as the project is operational and evenly distributed throughout the project lifetime. In contrast, NCS projects can span multiple decades with mitigation benefits accruing over 30 or more years. This is reflected in the carbon credit generation cycle of NCS projects, where initial credit issuances may occur several years after the project begins.

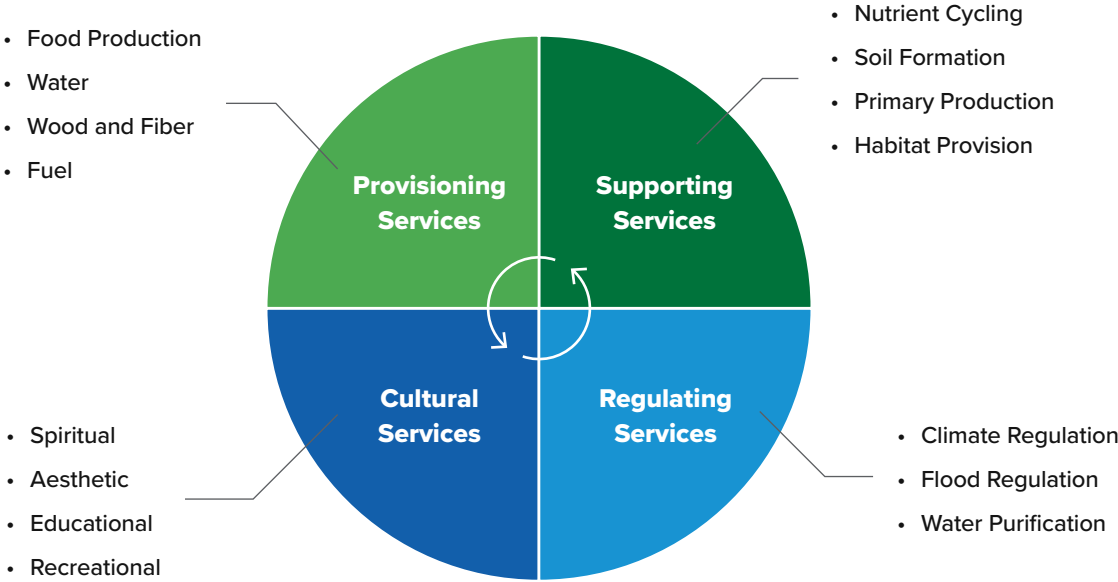
Environmental and Social Co-Benefits

One of the starkest distinctions between NCS and built methods of climate mitigation are their significant positive impacts beyond carbon. NCS’ emphasis on

natural capital and ecosystem services means that it has the potential to generate environmental benefits in ways that most built technologies lack. Crucially, this natural capital, once established, generates these benefits in a passive manner. Short of external disturbances, the landscape will remain and continue to provide benefits, including carbon sequestration, indefinitely. In contrast, built technologies require active management and ongoing capital investment to maintain their carbon sequestration benefits; once a sequestration plant shuts down, the carbon sequestration stops.

Figure 4 illustrates the four main categories of ecosystem benefits that are provided by natural capital. Depending on the project structure and NCS type, each project provides varying levels of these benefits. In fact, given the far-reaching impacts of NCS projects on society and the environment, proper project design and due diligence become all the more important, such that these projects do not create environmental and/or socioeconomic risks instead.

Figure 4: Four main categories of ecosystem benefits provided by natural capital.



Source: Millennium Ecosystem Assessment, 2005.

The value of some benefits – such as carbon sequestration – is independent of geography, whereas the values of many others are contingent on the NCS project’s proximity to human populations. For example, the value of mangroves and forests in providing food, fibre, and fuelwood are contingent on populations being able to access these areas. Similarly, the economic benefits of mangroves as tsunami protection increase exponentially when the mangroves are situated next to large cities, as opposed to uninhabited forests. This creates an interesting dynamic for companies to consider, as minimizing costs by establishing NCS projects in low-value lands may not be ideal from a non-carbon benefit-optimization standpoint.

Potential for Carbon and Alternative Revenue Streams

As detailed later in the report, revenues from carbon credits are an important facet determining NCS projects’ financial viability. On a per-hectare basis, each NCS model has the potential to produce varying amounts of credits per hectare each year. The results from our modelled case studies for **Reducing Emissions from Deforestation and Forest Degradation (REDD+)** and RIL-C produced 23 and 39 carbon credits per hectare per year, respectively. These credits become available beginning in year four and three of the project life, respectively. The modelled case study for blue carbon produced far more carbon credits per hectare, at 433 per year, but these do not become available until year eight. It is important to understand that the range of carbon values per hectare vary widely and need to be determined on a site-specific basis when evaluating the potential of NCS investments. Generalisations by ecosystem type can be very misleading.

Aside from carbon, mitigation pathways each have a variety of options to generate revenue. On the NCS technology side, both REDD+ and blue carbon projects can potentially establish conservation easements. Conservation easements are legally binding agreements that limit certain land uses for conservation in exchange for funds. They can also tap into mitigation banking, wherein a development company funds ecosystem restoration or enhancement

to mitigate adverse impacts from its development activity. Additionally, resiliency credits and water markets are further options to explore. Alternatively, given its focus on forest management, RIL-C can tap into timber and non-timber forest products as revenue sources. On the built technology side, the CO₂ captured from direct sequestration can be sold for industrial uses, such as bottling. Similarly, using CO₂ in renewable fuels has a wide variety of industrial applications, such as plastics, fuels, and building materials. All mitigation projects, if created in a favourable policy environment, may benefit from additional tax credits as well.

It is important to note that while a comparison of similar mitigation technologies can be made, comparisons across technology types should be avoided, even within the same broader category. Taking a more comprehensive view of the climate, environmental, social and economic objectives of potential mitigation technology investments, investments in NCS have the potential to deliver significant value. The value benefits particularly (but not exclusively) businesses and investors with significant exposure to land use activities, and markets or operations in regions that are particularly vulnerable to climate change impacts.

Financial Costs, Benefits and Returns of Illustrative NCS Projects

To provide prospective project developers and investors with a general overview of project-level financial costs, benefits, key value drivers and other considerations associated with select NCS pathways, we present a summary of three theoretical project cases from the broader “protect”, “manage” and “restore” NCS categories.

The model cases below are theoretical in nature and are presented for illustrative purposes only. Financial costs, benefits and expected returns are highly variable and are dependent on project-specific risks and risk exposures, project design elements, and specific economic and financial assumptions and estimates.



1. PROTECT NCS PATHWAY: REDD+, AVOIDED DEFORESTATION

BUSINESS MODEL & KEY REVENUE STREAMS

The model REDD+ case considers a hypothetical avoided deforestation project in Cambodia encompassing 500,000 hectares. Forest protection and conservation efforts are assumed to already be underway in the project area, and carbon project development and implementation activities are assumed to be implemented in parallel. It is useful to note that several REDD+ carbon projects follow a similar pathway, though not exclusively.

The model case is intended to address key drivers of deforestation, a primary objective of REDD+ projects. As such, evaluating historical and future deforestation drivers and developing a comprehensive plan to manage them is an important initial step in project development. In this case, we assume that forest conversion for the small-scale cultivation of cash crops, and illegal logging driven by a combination of poverty, socio-economic need, in-migration, and poorly defined property rights are key drivers of deforestation. The estimated deforestation rate resulting from these activities is 0.50%.

The estimated project financing required is US \$4.9 million inclusive of the costs of carbon project development and implementation of enhanced protection and conservation efforts designed to

address key deforestation drivers. The project activities are expected to generate verified carbon credits, the issuance and sale of which are assumed to be the project's primary source of revenue.

EMISSIONS ABATEMENT POTENTIAL

The model REDD+ case is expected to generate an estimated 14.22 million tCO₂e in emissions reductions over the project period. In estimating potential verified carbon units, annual emissions reductions of between 400,000 and 500,00 tCO₂e are adjusted by a rate of 15% to account for project non-permanence risks.

INVESTMENT CHARACTERISTICS

Income from the sale of verified carbon units are assumed to be the sole source of project cash inflows. Initial project verification and the issuance of initial credits are assumed to occur in Year 3 of the project, following completion of required project preparation, establishment and validation activities. Subsequent credit issuance and sales are expected to occur on an annual basis.

After adjustments for non-permanence risk (non-permanence buffer pool allocations), the estimated volume of verified carbon units issued by the project totals 12.1 million, with an average of 389,900 credits issued annually.



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Initial project preparation, establishment and validation costs are estimated to be US \$950,500 allocated over the first two years of the project time horizon. Beyond the costs of initial feasibility and technical analyses, costs associated with stakeholder engagement and institutional capacity building comprise the largest proportion of project establishment costs. Stakeholder engagement and capacity development are essential aspects of REDD+ projects and are often among the most variable project establishment cost elements.

Project, operating and management costs, inclusive of periodic verification and variable transaction costs associated with the registration, issuance and labelling of verified carbon units, are estimated to be US \$2 million annually. In the model REDD+ case, investments in sustainable livelihood programming (53.1%), project management (11.1%) and enhanced forest protection

activities (8.0%) comprise the largest proportion of annual implementation costs. Investments in sustainable livelihood development using community conservation agreements, and community engagement in forest protection activities are intended to address the key drivers of deforestation identified in the model case.

Over the 32-year project horizon, the model REDD+ project is expected to generate an internal rate of return (IRR) of 18.28% and return a multiple of roughly 6.09 times the required cash investment on an undiscounted basis.

A more detailed description of estimated carbon revenues and establishment, implementation, carbon accounting, and other project costs is presented in Annex B to this report.

PROJECT RISKS

Because the sale of carbon credits is assumed to be the project's primary source of cash flows, expected returns are particularly sensitive to carbon price assumptions. The model REDD+ case assumes a base case voluntary market price of US \$7.50 tCO₂e which is consistent with realised carbon prices from comparable REDD+ projects implemented by CI. Holding all other assumptions constant, the calculated break-even carbon price for the model REDD+ case is US \$6.74 tCO₂e.

It is worth noting that these values are above the voluntary market prices for REDD+ credits reported by Ecosystem Marketplace in its 2019 voluntary carbon markets publication which range between US \$2.35 and \$4.40 tCO₂e over the 2016-2018 reporting period. These modelled prices reflect historic price premiums received by high-quality projects, based on actual transactions from CI's project portfolio. These prices indicate buyers' preferences for the package of social and environmental benefits, local presence and relationships, mission focus of project developer etc., all of which reduce project risks and provide "beyond-carbon" impacts for the buyers.

INVESTOR ALIGNMENT

When effectively implemented, avoided deforestation projects under the REDD+ scheme can be expected to deliver substantial emissions abatement and a range of other important ecological and social benefits. While the financial value of these co-benefits is often difficult to quantify, the broader ecological, economic, community and societal benefits of REDD+ projects can be substantial.

Considering the vast range of benefits, REDD+ projects may appeal to a broad range of NCS investors and offset buyers. The broad appeal of projects implemented under this scheme is reflected in the diversity of corporate REDD+ offset purchasers—a diverse, global group spanning the energy, technology, automotive, consumer products, and other sectors. In each case, the attractiveness of REDD+ project investments relative to other NCS pathways or non-NCS mitigation alternatives is likely to depend on investor emissions abatement objectives and other considerations including CSR commitments and other firm-specific interests.

Box 6: REDD+ Project at a glance

Area of Project: 500k ha

Ecosystem Type: Tropical Rainforest

Project Life: 32 yrs

Business Model: Generation and sale of carbon credits through forest protection and conservation (avoided deforestation)

Required Initial Financing: US \$4.9M

Annual Opex: US \$1.99M

Estimated Project Emission Abatement: 14.22 MtCO₂e

Model Carbon Price: US \$7.50 tCO₂e⁻¹

Expected Payback Period: 7.3 years

Project IRR: 18.28%

Scaling Potential: 1101 MtCO₂e/yr*

*Scaling potential was estimated from figures in Griscom et al. 2020, using estimates of mitigation potential of natural climate solutions pathways at "cost-effective" levels (<100 USD MgCO₂e⁻¹).



2. MANAGE NCS PATHWAY: RIL-C, NATURAL FOREST MANAGEMENT

BUSINESS MODEL & KEY REVENUE STREAMS

The model case considers a hypothetical project in Southeast Asia that generates emissions abatement benefits through the transition from conventional to RIL-C practices within a 30,000-hectare, productive, forest concession.

RIL-C focuses on improved natural forest management practices that are designed to reduce emissions from logging activities while maintaining or increasing long-term timber yields. Specifically, RIL-C focuses on improved timber felling and skidding (extraction) practices and improvements to the design and management of skid and haul roads and log landing areas.

In addition to reducing emissions from logging operations, RIL-C is expected to generate improved near-term timber yields through reductions in logging wastes and increased subsequent harvest cycle yields through reduced damage to residual tree stands. Even in the absence of expected cash flows from the sale of carbon credits, the improvements to logging operation

efficiency are expected to measurably reduce production costs, enhancing the financial performance of the model RIL-C case.

The model RIL-C case encompasses multiple income streams including cash flows from timber sales and cash from the issuance and sale of verified carbon units. Forecasted annual cash flows from the issuance and sale of verified carbon units (eligible under the RIL-C scenario only) and incremental cash flows from timber sales are expected to be roughly equivalent.

EMISSIONS ABATEMENT POTENTIAL

The model RIL-C case is expected to generate an estimated 1.46 million tCO₂e in emissions reductions over a 30-year project period. Forecasted project emissions reductions are based on estimated per unit area emissions reductions of 64.90 tCO₂e ha⁻¹ yr⁻¹ resulting from combined timber felling, skidding, haul road and log landing improvements (defined as “Level 1” RIL-C implementation performance in Griscom et al., 2019).

Implementation of more comprehensive improvements (defined by Griscom et al., 2019 as “Level 2” RIL-C implementation) would result in increased emissions abatement, with estimated reductions of 88.62 tCO₂e ha⁻¹ yr⁻¹ or roughly 1.99 million tCO₂e over the project period.

INVESTMENT CHARACTERISTICS

From an analytical perspective, the RIL-C case is unique among the NCS pathways modelled in connection with this report. In contrast to the REDD+ and tidal mangrove restoration cases, the model RIL-C analysis evaluates the expected *incremental* cash flows contemplated by a transition from conventional to RIL-C practices—that is, the expected increase (or decrease) in cash flows relative to the baseline cash flows of the conventional logging operation.^{iv}

The implied financing requirement for the model RIL-C case is US \$11.9 million, which represents the (negative) incremental net cash flows of RIL-C in the first year of the project. The model RIL-C case assumes that initial pre-harvest planning and training activities associated with RIL-C occur over a 12-month period at the start of the project period (t_0) and that field implementation of prescribed RIL-C practices starts one-year later. During the initial RIL-C project preparation period, no timber harvests using RIL-C practices are assumed to occur.

In subsequent periods, the model RIL-C case is expected to generate net benefits to the logging operation (positive incremental cash flows) despite higher incremental pre-harvest costs associated with increased harvest planning and training. In the model case, reductions in logging wastes associated with RIL-C are expected to offset the financial impacts of increased pre-harvest costs. While not quantified in the financial analysis, we expect that increased harvest planning and training investments may result in improved worker safety outcomes and reduced staff turnover rates which may generate additional cost savings benefits.

Over the 30-year project horizon, the model RIL-C project is expected to generate an IRR of 14.33% and return a multiple of roughly 6.28 times the implied cash investment on an undiscounted basis.

A more detailed description of key project assumptions is presented in Annex B to this report.

PROJECT RISKS

Beyond timber market and industry risks to which both conventional and RIL-C operations are exposed, the most significant barrier to transitioning from conventional to RIL-C logging practices are the perceived risks of reduced economic performance. Particularly since the full benefits of RIL-C may not be realised until the next cutting cycle—in most cases, decades later—owners and operators may prefer the certainty of maintaining the status quo over future potential benefits, even where these benefits may be significant.

INVESTOR ALIGNMENT

Direct investments in RIL-C are most likely to be made by firms that own or directly manage forestry concessions or are able to establish joint venture or other profit-sharing arrangements with forestry operators. Similarly, financial investors who are knowledgeable about timber and forest industry dynamics and have long investment horizons may also benefit from investments in RIL-C operations. In general, the benefits of RIL-C would be most prominent in underperforming forest concessions, assuming rapid changes in operational practices are also possible.



Box 7: RIL-C Project at a glance

Area of Project: 30k ha

Ecosystem Type: Tropical forest

Project Life: 30 yrs

Business Model: Increased value through improved forest management practices

Required Initial Financing: Initial investment of US \$11.9M

Estimated Project Emission

Abatement:

1.46 MtCO₂e

Model Carbon Price:

US \$9.50/tCO₂e

Expected Payback Period: 6.9 years

Project IRR: 14.33%

Scaling Potential: 527 MtCO₂e/yr*

*Scaling potential was estimated from figures in Griscom et al. 2020, using estimates of mitigation potential of natural climate solutions pathways at "cost-effective" levels (<100 USD MgCO₂e⁻¹).



3. RESTORE NCS PATHWAY: BLUE CARBON, MANGROVE RESTORATION

BUSINESS MODEL & KEY REVENUE STREAMS

The carbon sequestered, stored, and released from vegetated coastal ecosystems, specifically mangrove forests, seagrass beds, and salt marshes, is termed “blue carbon”. This case study considers a hypothetical, 5,000-hectare blue carbon project in Southeast Asia, of which 3,500 hectares are planned for mangrove revegetation and 1,500 hectares are allocated to a combination of mangrove restoration and extensive organic, mangrove-integrated prawn (*Penaeus monodon*) farming.

Combined investments in hydrological restoration, tidal mangrove revegetation, and the development of organic prawn production operations are expected to generate a range of emissions abatement, ecological and sustainable livelihood benefits. While mangrove systems support a range of marketable natural resources including timber and wood for charcoal production, and wild harvest and forage fisheries, the model restoration case assumes that cash flows from the issuance and sale of verified carbon units and income from organic prawn sales are the primary project revenue streams.

CARBON MITIGATION POTENTIAL

The model restoration project is expected to generate an estimated 2.19 MtCO₂e in emissions abatement over the 32-year project term. While the model case focuses on blue carbon restoration, projects that contemplate avoided conversion of mangrove and other coastal blue carbon systems are likely to yield measurably higher mitigation values.

INVESTMENT CHARACTERISTICS

Total project financing requirements for the model restoration case are US \$5.63 million. It is worth noting that the model restoration project is based on an intensive form of restoration which may result in higher restoration costs when compared with natural regeneration techniques.

Assuming a voluntary market price of US \$11.00 tCO₂e⁻¹, the project is expected to generate an estimated US \$20.5 million in carbon income over the 32-year project lifespan. In addition to income from the issuance and sale of carbon credits, the model restoration case is expected to yield an aggregate

5,437.50 metric tonnes of organic prawns, with a farmgate value of US \$60.155 million. The model project is expected to generate an IRR of 15.18%.

PROJECT RISKS

There are a number of factors that influence the restoration and rehabilitation effectiveness and the emissions removals, climate adaptation and other ecosystem benefits provided by these blue carbon systems. Key factors include:

- **site selection**, and site conditions at the restoration area including, but not limited to tidal, hydrological and sedimentation regimes;
- **species selection**, which, in conjunction with other environmental factors and replanting methods, affect growth rates and tree density over time;
- **restoration practices**, including the number and spacing of seedlings planted, the planting effectiveness (influenced by training and management of activities), and the projected survival rate of seedlings and trees over time; and
- **human activity**, including the nature, intensity, and specific practices and impacts associated with fishing, foraging or other practices that may occur within restoration areas.

Decisions of where and how to restore mangroves must also be informed by local social, legal, and economic influences. Mangrove restoration can be greatly hampered if local land tenure is not understood and respected. Community engagement and support can ensure long-term security for restoration projects. Equitable benefit-sharing can prevent further degradation and provide an example that can leverage further restoration efforts.

INVESTOR ALIGNMENT

In recent years, increased awareness of the significant carbon capture and storage potential, essential coastal protection function, and other benefits of mangrove and other blue carbon systems have generated new and expanded interest in blue carbon investments among a broad range of corporates and other offset purchasers. Among the early investors in blue carbon offsets was an European multinational food products company, Danone S.A. which has since gone on to launch two carbon funds alongside corporate partners Schneider Electric, Crédit Agricole S.A., Michelin, Hermès, SAP, Groupe Caisse des Dépôts, La Poste, Firmenich, and Voyageurs du Monde (Livelihoods Funds, 2020).

Box 8: Blue Carbon Project at a glance

Area of Project: 5k ha

Ecosystem Type: Tidal mangrove

Project Life: 32 yrs

Business Model: Mangrove restoration with sustainable, organic prawn farming

Required Initial Financing: Initial investment of US \$5.63M

Estimated Project Emission Abatement: 2.19 MtCO₂e

Model Carbon Price: US \$11 tCO₂e⁻¹

Expected Payback Period: 10.6 years

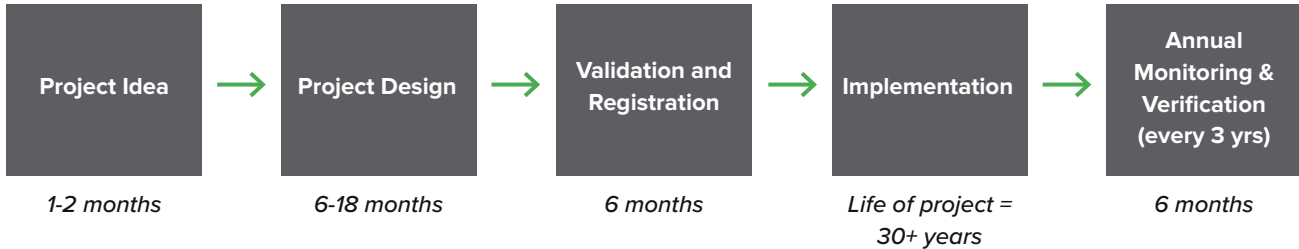
Project IRR: 15.18%

Scaling Potential: 2.1 MtCO₂e/yr*

*Scaling potential was estimated from figures in Griscom et al. 2020, using estimates of mitigation potential of natural climate solutions pathways at “cost-effective” levels (<100 USD MgCO₂e⁻¹).

Businesses can adopt strategies to address NCS project efficiency and reduce risk

Figure 5: NCS project cycle and opportunities for efficiency gains



Beyond the key value drivers unique to each of the modelled NCS pathway cases (elaborated in Annex B), experience in designing, implementing, and monitoring project outcomes suggests that project investors and developers can apply a number of strategies throughout the project cycle (the general components of which are illustrated in Figure 5) to reduce the time or cost needed to successfully execute NCS projects, or reduce the risk of project failure. These opportunities to improve efficiency or mitigate risk can be found in the applicable policy environment, project implementation, social context, technical expertise, and market dynamics.

In the applicable policy environment, carbon and environmental policies are subject to change and can affect investment and exit strategies. These risks can be mitigated by supporting polycentric governance structures (wherein policies are negotiated and enforced across multiple governing authorities and scales), aligning with national NCS standards, and assessing in-country political risk and regulatory analyses.

For project implementation, projects can encounter implementation risks during the approval and development phases, be impacted by extreme events, or encounter problems in executing benefit-sharing agreements with local communities. All of these can affect the permanence of the project’s carbon and co-benefit values. These risks can be mitigated by including buffers in project cost estimates to account for unexpected costs, reduced revenue, and permanence risks, utilising the right project standards and focusing on co-benefits.

In terms of the social context, NCS projects require close attention and understanding of potential social and human rights issues related to indigenous peoples and other local communities, land rights, land tenure and property ownership, and perceptions of “green gentrification.” These risks can be mitigated by working with local communities for land rights, utilising land in a respectful manner, providing benefit sharing for host communities, ensuring that projects are developed in accordance with indigenous cultural practices, and planning projects in consultation with indigenous elders and other local stakeholders.

For technical expertise, NCS projects can encounter technical challenges related to establishing baselines, avoiding leakage, and ensuring permanence and additionality for carbon and other co-benefit valuation. These risks can be mitigated by using conservative baselines, incorporating permanence buffers, and increasing a project’s carbon and co-benefit accounting area.

Finally, as will be discussed in detail in the next section, carbon credits and NCS projects can be impacted by market volatility and lack of market transparency. Most carbon credit sales are done over the counter and through purchase agreements. These market risks can be mitigated by leveraging new technologies that can reduce costs (such as blockchain technology to increase accountability and transparency), purchasing credits at higher volumes to reduce the price per credit, and negotiating fixed project deals.



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IV

CARBON MARKET AND POLICY OUTLOOK FOR NCS

As demonstrated in the earlier section, carbon markets are a valuable method of financing the full potential of NCS. In some business models, they provide a supplemental revenue stream, providing diversification and liquidity benefits despite being too marginal to support a project on its own. In other models, they are the dominant, if not singular, revenue source, unlocking NCS projects at a scale that would otherwise be financially unsustainable. Understanding the carbon market space, and the role businesses have in growing it, is critical to generating the enabling environment for NCS investments overall.

Carbon markets – both compliance and voluntary – have steadily evolved since the 1990s. **Compliance carbon markets** are created by government regulation to reduce GHG emissions, and allow regulated entities to obtain and surrender emissions allowances or permits in order to meet predetermined regulatory targets (Forest Trends et al., 2017). Within compliance markets, policies at the international, national, and sectoral level define the regulatory frameworks within which emissions reductions (ERs) are eligible within

carbon markets and exchanges and have varying rules for the eligibility of NCS. Careful analysis of the rule sets and evolving guidance can assist the private sector in designing and planning for NCS investments.

By contrast, the voluntary carbon market refers to voluntary transactions that are often driven by CSR or pre-compliance interests, and are tracked collectively worldwide (Forest Trends et al., 2017). Within voluntary markets, NCS currently receive lower investment compared to renewable energy, energy efficiency, and clean transport, despite the enormous potential of NCS to play a key role in the decarbonisation strategies for businesses (World Business Council for Sustainable Development (WBCSD), 2018). In a 2017 report, the World Resources Institute highlighted structural barriers that restoration financing faces – which are largely applicable to other NCS pathways – including the presence of perverse incentives that encourage land degradation, the lack of defined market value for co-benefits, and the outsized perception of risk associated with restoration projects (Ding et al., 2017).



Key international policies have significant implications for NCS

THE PARIS AGREEMENT AND ARTICLE 6 ARE CLARIFYING COUNTRY PRIORITIES AND SHAPING CARBON MARKETS

The science demonstrates that NCS can provide more than 30% of all of the mitigation needed if the world is to deliver on the goals of the Paris Agreement; yet, less than 3% of global climate finance is going to natural climate solutions, signalling a clear mismatch between NCS potential and what is invested in that potential. Other sectors, such as energy-efficient technologies, have an innate return on investment – a person can save money by installing an energy-efficient appliance, which reduces their energy consumption. On the other hand, for NCS, the world has to-date put greater value on forested lands converted for agricultural use and timber commodities, for example, than for standing forests that generate global climate benefits. To change this equation, the world must give standing forests value for the climate services that they provide, and market mechanisms are one essential way to do this and to incentivise investment. To operationalise NCS at scale, cross-boundary cooperation and trading through global carbon markets are vital.

In 2015, countries under the United Nations climate negotiations adopted the Paris Agreement, agreeing to limit global temperature rise to well below 2° Celsius and to increase resilience to climate change. Each

country has put forward their proposals for meeting these global goals in their **nationally determined contributions (NDCs)**. Under the agreement, countries also committed to building systems to support the achievement of national emissions reductions, including international emissions trading.

The Paris Agreement specifically highlights the important role of forests and other ecosystems in addressing climate change and meeting the global goals through Article 5 that explicitly recognises REDD+ action. Article 6 of the Paris Agreement reaffirms that countries can cooperate to meet their mitigation goals as efficiently as possible, including through transferring emissions reductions between countries (known as “internationally transferred mitigation outcomes” or ITMOs). The process for how countries will transfer emissions reductions under the Paris Agreement and the rules for what activities will be eligible are under development in the **United Nations Framework Convention on Climate Change (UNFCCC)** climate negotiations and are expected to be finalized at the next UN Climate Negotiations, 26th session of the Conference of the Parties (COP 26). These rules are expected to apply to all emissions trading between countries and may also guide some or all transactions with the private sector. In parallel, regional, national and subnational carbon pricing systems – elaborated on later in the report – are developing around the globe.

For businesses interested in NCS, government engagement and support are often important components of project development and critical to success. As countries’ NDCs reflect government climate targets and priorities, it can be advantageous to design NCS projects with these priorities in mind, making linkages between NDC targets and project outcomes explicit when conducting government outreach.

Policy Outlook

Negotiations on Article 6 will continue at COP 26, now scheduled for 2021. The current language on ITMOs under the draft Article 6.2 guidance sets strong parameters for environmental integrity for transfers across all sectors, inclusive of NCS. If this text is adopted in its current form (or with minimal changes)

Box 9: Blue Carbon in NDCs

In the five years since the Paris Agreement, an increasing number of countries have recognised the importance of including blue carbon and oceans in their NDCs. Of the 151 countries that have at least one blue carbon ecosystem (seagrasses, saltmarshes or mangroves), 28 countries now include these coastal wetlands in their commitments to climate mitigation, and 59 countries include coastal ecosystems and the coastal zone into their adaptation strategies.

However, some of these commitments are vague and nonspecific. With additional detail and the inclusion of blue carbon and oceans in the commitments of more than half of the relevant countries, this can be a gateway to large-scale, national-level climate action on relevant ocean and coastal ecosystems. There are a few countries (including U.S., Australia, UAE, and Indonesia) that are working to include blue carbon in their national greenhouse gas inventories. These countries can be seen as examples of how to eventually officially account and report on blue-carbon related climate mitigation activities. In the meantime, as some countries are working to get to this level of accounting, there are actions that can help them get to this point, which will also support adaptation actions and reporting.

There is a significant opportunity to include and expand blue carbon ecosystems into the mitigation and adaptation objectives of future, revised NDCs of every coastal country that includes these ecosystems and the inclusion of these ecosystems in national carbon accounting.

at COP 26, it would send a strong signal for countries and other actors to invest in high-quality emission reductions and removals from any sector, including NCS activities.

The issues that remain under debate include whether to allow for pre-2020 units from the **Clean Development Mechanism (CDM)** under the **Kyoto Protocol** to be used as ITMOs toward NDC achievement and whether a “share of proceeds” (e.g., a levy) should be applied to ITMO transactions with the revenue to be used toward adaptation efforts.

REDD+'S EVOLUTION AFFECTS NCS PROJECTS' ELIGIBILITY FOR CARBON CREDITS

REDD+ is a framework developed under the UNFCCC that creates an incentive for protecting, conserving, and restoring forest ecosystems in developing countries by valuing their carbon sequestration, storage, and other social and environmental services. It is the most widely recognised and globally agreed

framework through which mitigation actions from the forest sector are implemented. This framework can apply to all types of forests, including mangrove forests if they are recognised in the national definition of “forest.”

5 Activities of REDD+

As defined by the UNFCCC

1. **Reduce Emissions from Deforestation**
2. **Reduce Emissions from Forest Degradation**
3. **Conserve Forest Carbon Stocks**
4. **Manage Forests Sustainably**
5. **Enhance Forest Carbon Stocks**

To provide an international legal context for REDD+ programs, the UNFCCC's Warsaw Framework for REDD+ was adopted by the Conference of the Parties in 2013 and includes four required elements for implementing REDD+. These four elements are implemented in tandem and must be in place before national- and subnational-level REDD+ emission reductions and removals are eligible for results-based payments.

4 Elements of REDD+

As defined by the UNFCCC

1. **National Strategy or Action Plan**
2. **National Forest Reference Level or Forest Reference Level.**
Subnational reference levels may be used on an interim basis
3. **National Forest Monitoring System**
4. **Safeguards Information System**

Existing initiatives, including stand-alone REDD+ projects, have played a critical role in testing and proving effective approaches for delivering real, lasting results and mobilizing significant levels of private sector investment under the voluntary market (Forest Trends et al., 2017). These stand-alone projects have also informed and contributed to the development of national and subnational programs, allowing implementation efforts to increase in scale and reach. Moving forward, new and existing REDD+ projects and site-scale activities will need to be integrated into national REDD+ programs, a process referred to as “nesting.”

There are various technical and governance arrangements required to “nest” a site-scale REDD+ activity under a national program, such as ensuring that the baseline used for the site-scale activity is

integrated into the REDD+ national reference level and that agreements on who owns the resulting emissions reductions are in place. There are no UNFCCC guidelines for how REDD+ site-scale activities should be nested, allowing national governments to determine whether and how to nest depending on their national context. Emissions reductions from stand-alone projects that do not meet these criteria will likely not be eligible under emerging compliance carbon markets, as most carbon market systems will follow UN rules post-2020.

To mitigate the risk of credits being ineligible or double-counted, businesses interested in NCS, particularly models reliant on carbon credits, should familiarize themselves with rules and regulations on nesting in their relevant jurisdictions and structure their projects in compliance with government requirements.

Policy Outlook

The use of reductions by countries or the private sector to meet regulatory or voluntary commitments will need to be carefully evaluated based on emerging UNFCCC requirements related to emissions trading, including Article 6 of the Paris Agreement. While countries are developing their nesting strategies, project development for the voluntary market can go forward as long as all parties understand that, at some point in the future, the project will need to be recognised under the national REDD+ program and accounting. At this point, emission reductions will need to be re-evaluated based on a national baseline – rather than a project baseline – which could result in a reduction in credits.

Further, before any emissions reductions (from REDD+ or another sector) can be transferred for compliance purposes, the host country will need to consider whether the emissions reductions proposed for trading are needed to meet their NDC, or if they have achieved (or are projected to achieve) an excess of emissions reductions and can transfer “extra” reductions. In practice, this will mean that all emission transfers will need to be approved or authorized by the host country before they can be transferred to a government or private sector actor in another country.

The originating country will then need to reflect any emissions reductions that are exported within an emissions account based on its NDC emissions balance to ensure that emissions reductions are not claimed by more than one country or actor. Transferred emissions reductions across all sectors that are used for compliance purposes (such as Article 6 or CORSIA) will need to be cancelled from the originating country's emissions account to ensure "no double counting" or "claiming" of units, an essential step for ensuring the integrity of the emissions trading system (ETS). These requirements are not specific to REDD+.



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Sectoral initiatives, in particular within aviation, are breaking ground for NCS

Aviation

As the world's population continues to grow and becomes more globalized, so does the scale of international aviation. To keep up with projected increases in demand for international air travel, an estimated 56,000 new passenger aircraft will have to take to the sky over the next 25 years (ICAO, 2013). As a result, aviation's carbon emissions are forecast to skyrocket in the coming years and could triple or quadruple by 2040 (ICAO, 2013). However, the sector is not covered by the global climate agreement under

the UNFCCC. Emissions from international aviation are governed by the United Nations International Civil Aviation Organization (ICAO). Under ICAO, countries have agreed to cap emissions from global aviation at 2020 levels, requiring airlines to use more efficient aircraft, better operational practices, and alternative jet fuels. However, even with these improvements, a large emissions gap will remain before the sector can reach its goal of delivering "carbon neutral growth from 2020."

To fill the global aviation sector's emissions gap, ICAO created a carbon market where airlines can buy carbon credits from approved "greenhouse gas programs." This market is officially known as the **Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)** (ICAO, 2016).

In March 2020, ICAO approved its first set of GHG programs that are now deemed eligible for airlines to purchase in meeting their climate goals, several of which include nature-based solutions. This means that the international civil aviation industry has created the first global market to accept nature-based credits. When it comes to REDD+ credits specifically, ICAO also agreed on a pathway for their inclusion in late 2020. While there are a few follow up steps for REDD+ credits to be fully eligible and ready for purchase by airlines, these developments are nonetheless a boon for airline companies interested in scaling up their NCS investments.

Policy Outlook

In establishing this pathway for the inclusion of forest-based offsets in the international aviation carbon market, ICAO is sending a clear signal to the world that nature-based credits are credible and should be eligible in carbon markets.

As of 30 June 2020, the ICAO Council decided to change the CORSIA baseline to 2019 international aviation emissions levels. The true impact of the baseline change cannot be known for a few years, as it will largely depend on the airline industry's rate of economic recovery.

Box 10: Eligible Greenhouse Gas Programs (as of March 2020)

Starting in January 2021, airlines from countries that signed up for the voluntary phase of CORSIA (2021-2023) are required to reduce emissions from international flights that exceed their 2019 emission levels (ICAO, 2020a). With each subsequent three-year phase of CORSIA, additional countries (and their airlines) will be required to participate as they meet the minimum threshold for international emissions.

Airlines can use credits from one of the six greenhouse gas programs approved as immediately eligible under CORSIA:

- **American Carbon Registry (ACR)**
- China GHG Voluntary Emission Reduction Program
- Clean Development Mechanism
- **Climate Action Reserve (CAR)**
- The Gold Standard
- Verified Carbon Standard Program (ICAO, 2020b)

The World Bank's Forest Carbon Partnership Facility (FCPF), Verified Carbon Standard's Jurisdictional and Nested REDD+ (JNR) methodology, and the Global Carbon Council are not immediately eligible, but will be approved once they fulfil requirements outlined by ICAO. In June 2020, both programs submitted material updates that address these conditions, and will likely be re-examined in Fall 2020. No credits from standalone REDD+ projects will be eligible. All projects must be nested under a national or subnational (UNFCCC, 2016) REDD+ program and verified against one of the to-be-approved offset standards.

Additionally, ICAO has set limits on the vintage of eligible credits across all offset types. Only projects that started to issue credits after 2016 will be eligible. Additionally, for the time being, only units generated between 2016 through 2020 will be accepted. Each greenhouse gas program can “unlock” post-2020 vintages if they demonstrate additional requirements to prevent double counting of emission reductions with countries' national commitments under the Paris Agreement.

In June 2020, eight new greenhouse gas programs applied for recognition under ICAO. In November 2020, ICAO approved two of these REDD+ programs—the Verified Carbon Standard's Jurisdictional and Nested REDD+ (VCS JNR) methodology and the Architecture for REDD+ Transactions' The REDD+ Environmental Excellency Standard (ART TREES)—as eligible offset options for airlines to purchase in meeting their climate goals.



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Shipping

At 2.2% of the global anthropogenic total, GHG emissions from international shipping are larger than the emissions of all but six countries (Bodansky, 2010). Under current policies and trends, this is expected to increase by anywhere from 50% to 250% by 2050, representing 6-14% of total global emissions then (IMO, 2015).

The **International Maritime Organization (IMO)** is part of the United Nations system, with a mandate to facilitate intergovernmental cooperation in the regulation of international shipping; issues such as climate change and pollution are addressed within the Marine Protection Environment Committee (MEPC), a subsidiary of the IMO. In 2018, IMO adopted an initial strategy for the reduction of GHG emissions from ships (IMO, 2018). The initial strategy is a framework for its Member States, which sets out the future vision for international shipping, establishes the levels of ambition to reduce GHG emissions and guiding principles, and includes candidate short-, mid- and long-term further measures with possible timelines and their impacts on States.

The IMO has set the following targets and timelines for the adoption and implementation of the IMO Initial Strategy, using 2008 emissions levels as the baseline (IMO, 2020):

- 2018: Resolution on the Initial IMO Strategy on the reduction of GHG emissions from ships.
- 2023: Complete short-term measures and revise the Initial Strategy.
- 2023-2030: Mid-term measures to reduce carbon intensity of the fleet by at least 40%.
- 2030-2050: Long-term measures to reduce carbon intensity of the fleet by at least 70%.
- 2050: At least 50% reduction of total annual GHG emissions (requires approximately 85% CO₂ reduction per ship).

The IMO GHG Strategy provides a wide list of candidate short-term, mid-term, and long-term measures, including innovative emission reduction mechanisms. To support their implementation, two goal-based approaches are under consideration: a technical approach, and an operational approach (IMO, 2019). The next inter-sessional meeting will include the further development of these approaches, detailed below:

- **Technical approach:** Proposals include the **Energy Efficiency Existing Ship Index (EEXI)** requiring ships to meet a set energy efficiency requirements after the measure taking effect, and/or mandatory power limitation on ships.
- **Operational approach:** Proposals focus on strengthening the ship energy efficiency management plan, including mandatory carbon intensity reduction targets, measures to optimize speed for the voyage, and limiting ship speed.

Of note within the Strategy is a potential mid-term measure of “new/innovative emission reduction mechanism(s), possibly including Market-based Measures (MBMs), to incentivise GHG emission reduction.” Amongst other measures, this proposal will be discussed and considered ahead of the next Committee session, MEPC 75 (scheduled for 16-20

November 2020). In addition, the Fourth IMO GHG Study will be released at MEPC 76, including baseline carbon intensity estimates for 2008, and scenarios for international shipping emissions from 2018-2050 – both of which are important in the development of MBMs. Possible mid-term measures like this one will be finalised and agreed by the Committee between 2023 and 2030, with the dates of entry into force defined for each measure individually. If MBMs are approved and put into force, the IMO would create a significant venue for the shipping industry to increase investments in NCS and other carbon credit-generating projects, similar to what ICAO accomplished for the aviation industry.

Policy Outlook

There is significant debate regarding the IMO's current level of climate ambition, which some deem to be too low. As a result, when discussing a future market-based measure, countries are unlikely to support the use of offsets from outside the shipping sector to ensure that the emission reductions expected from the sector are coming from the sector. The first step to accelerating the decarbonisation of the international maritime sector would be to tighten the sectoral emissions cap. Upon the establishment of a more ambitious climate goal, countries may be open to discuss the use of offsets from other sectors to support the achievement of the climate target. By doing so, the IMO may decide to follow the lead of international aviation by supporting the use of credible offsets, including from high-quality NCS activities. Private sector support for higher climate ambition under IMO and for the use of credible offsets from NCS would help advance the debate.

Climate finance, while growing, has significant potential – and need – for evolution

Climate finance includes all finance aimed at reducing the drivers of climate change and its associated impact. Globally, climate finance is on the rise (Climate Policy Initiative, 2019), with global climate finance

flows for mitigation and adaptation, including both public and private finance, reaching nearly US \$580 billion per year (2017/2018 two-year average) (Climate Policy Initiative, 2019). Based on CPI's categorization, examples of private climate finance include large- and small-scale renewable energy projects, as well as investments in solar water heating systems (Climate Policy Initiative, 2019). For comparison, public climate finance includes commitments from **development financial institutions (DFIs)**, as well as bilateral climate-related development finance (Climate Policy Initiative, 2019). Roughly two to three percent of these global mitigation and adaptation finance flows go towards NCS – a ratio that has remained steady over time. (Climate Policy Initiative, 2019). For the full potential of NCS to be unlocked, this ratio as well as absolute levels of climate finance needs to increase over time, reflecting increased awareness – and corresponding investment – of NCS opportunities.

CARBON PRICING INITIATIVES ARE PROLIFERATING, BUT PRICES REMAIN LOW TO DRIVE ACTION AT SCALE

By monetizing carbon emissions, **carbon pricing** initiatives set the stage for private sector action on climate change, creating forums that incentivise actors to invest in necessary climate solutions, including NCS. The World Bank defines “carbon pricing” as the variety of initiatives that put an explicit price on GHG emissions, expressed in a monetary unit per tCO₂e (Climate Policy Initiative, 2019). Carbon pricing can include carbon taxes, emissions trading systems (ETSs), **offset mechanisms**, and **results-based climate finance (RBCF)** (World Bank Group et al., 2019). The IPCC has concluded that explicit carbon prices are a necessary condition of ambitious climate policies; furthermore, companion policies that reflect robust price signals are necessary to achieve cost-effective decarbonisation pathways (The World Bank, 2020). As of August 2020, 61 carbon pricing initiatives worldwide are active or scheduled to be implemented (The World Bank, 2020). These carbon pricing initiatives cover 12 gigatons (GtC) of carbon dioxide equivalent (GtCO₂e), or approximately 22.3% of GHG emissions (The World Bank, 2020).

Carbon pricing designs have evolved based on national ambition and need. Rather than a strict carbon tax or ETS model, many of these designs have evolved into hybrid models, incorporating elements of trade and tax that suit a specific country's needs. Colombia, for example, is primarily a tax but has a linkage to an offset market. NCS is slowly being integrated into some of these emerging systems, such as in California, South Africa, New Zealand, Canada, and Colombia.

Unfortunately, current carbon prices are woefully insufficient. In 2019, the World Bank's analysis concluded that over 95% of carbon pricing initiatives had carbon prices that were lower than the US \$40-80/tCO₂e by 2020 needed to cost-effectively deliver on the Paris Agreement (World Bank Group et al., 2019). Nonetheless, financial impacts are significant and growing; governments raised more than US \$44 billion in carbon pricing revenues in 2018 from carbon taxes, auctioned allowances, and direct payments to meet compliance obligations, representing an increase of nearly US \$11 billion compared to 2017 (World Bank Group et al., 2019).

From a business perspective, carbon pricing is directly relevant to the company's triple bottom line (TBL), which refers to a holistic business accounting framework that incorporates environmental, social, and economic returns. Carbon pricing for the company is often included in a TBL report as part of a strategic CSR initiative and can serve as a valuable tool for integrating climate considerations into project management and investment allocation.

DIVERSE CARBON MARKETS ARE BEING DEVELOPED

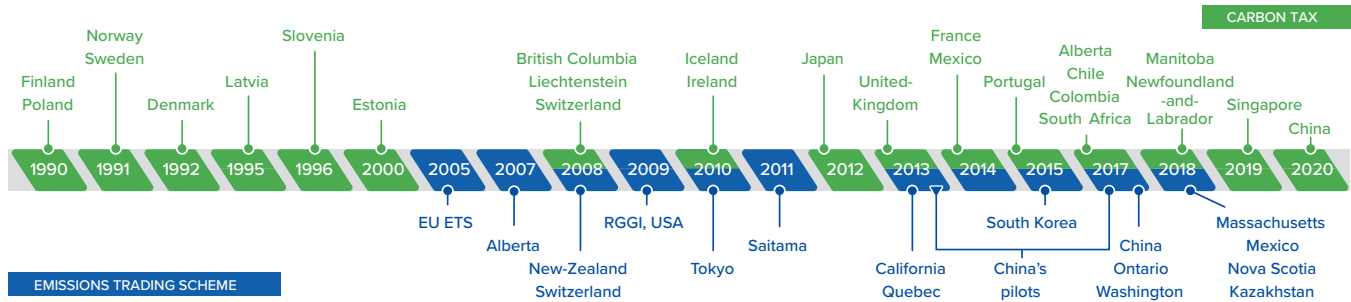
Carbon pricing initiatives enable the creation of carbon crediting mechanisms and markets. Carbon crediting mechanisms create credited units of carbon, with each unit equivalent to one metric ton of CO₂ emissions avoided, reduced, or removed from the atmosphere. These tradable credits are used by actors to offset their GHG emissions, providing a key strategy for achieving near-term net-zero emissions (The World Bank, 2014).

A number of carbon crediting mechanisms exist, including independent crediting mechanisms, government-created compliance markets, and international agreements. The carbon credits created by these mechanisms can be traded or used for compliance on the voluntary carbon market, in some government-created compliance carbon markets, and, in some cases, as part of commitments set by international agreements. Table 4 highlights key standards for carbon verification for jurisdictional and national crediting, along with various distinguishing features of each. Crediting standards for project or site-scale activities also exist

Table 4: Carbon Verification Standards Comparison for Jurisdictional and National Crediting

	Forest Carbon Partnership Facility (FCPF) Carbon Fund (CF) Methodological Framework (MF)	Architecture for REDD Transactions (ART)/the REDD+ Environmental Excellence Standard (TREES)	California Tropical Forest Standard (TFS)	Verified Carbon Standard (VCS) Jurisdictional and Nested REDD+ (JNR)
Scale	Jurisdiction or landscape	National or subnational jurisdiction to 2030	Subnational jurisdiction or national	Jurisdiction or nested project
Scope	REDD, Improved Forest Management (IFM) Afforestation, Reforestation and Revegetation (ARR)	REDD only; (removals to be included in next revision)	REDD of native forest	REDD, IFM ARR
Additionality	10-year historical average Adjustment allowed up to 0.1%/year of carbon stocks	5-year historical average updated every five years. No adjustment.	10-year historical average No adjustment Crediting level starts 10% below reference level and linearly declines to a jurisdictional 2050 target	8 to 12 years historical average and historical trend (increasing or decreasing) over at least the last 10 years. Adjustments allowed
Permanence	10-40% ERs based on a reversal risk assessment in ER Program-specific buffer, managed by ER program or by World Bank Forest Carbon Partnership Facility (FCPF)	Maximum 25% ERs in a pooled buffer managed by ART, which can be a) reduced by 5% for supporting legislation b) reduced by 10% if interannual variability of less than 15% in prior 10 years; c) reduced by 5% if national reversal mitigation actions, plan or strategy.	At least 10% ERs (potentially more) are deposited in a buffer managed by the jurisdiction according to non-permanence risk rating	Up to 60% is deposited in a pooled buffer managed by Verra % determined by JNR Non-Permanence Risk Tool
Safeguards	Requires completion of a social and environmental strategic assessment (SESA) environmental and social management framework (ESMF) and other frameworks (including Indigenous Peoples Planning Framework, Resettlement Policy Framework, Process Framework). A report of the implementation of the safeguards plans is annexed to each monitoring report.	Requires participants to demonstrate they have implemented REDD+ actions consistently with the Cancun Safeguards and that the activities do no harm. Cancun safeguards as principles then 14 themes or conditions to be met. Information must be provided and verified on 3 indicators (structures, processes, and impacts) for each theme.	Must demonstrate that forest-dependent communities, including indigenous peoples' communities participated in the design and ongoing implementation of the jurisdiction's sector plan in a manner that adheres to the GCF Guiding Principles. Show that sector plan has safeguards consistent with UNFCCC Cancun safeguards and provide annual reports using principles, criteria, and indicators that conform to the REDD+ SES Version 2.	Programs must provide information in the monitoring report with respect to how, during the design and implementation of the program, UNFCCC decisions on safeguards and any relevant jurisdictional (national and subnational) REDD+ safeguards requirements have been met, and how the safeguards have been addressed and respected. REDD+ Social & Environmental Standards (REDD+SES), Climate, Community & Biodiversity Standards (CCBS) and Forest Stewardship Council (FSC) certification may be used, where appropriate, to provide such information.

Figure 8: Evolution of global compliance carbon markets



Source: I4CE - Institute for Climate Economics, September 2017

a) Compliance markets are an opportunity for the inclusion of NCS

Compliance carbon markets have been a key driver of private sector financing for climate change. Compliance carbon markets can be created by carbon pricing initiatives, such as ETSs and carbon taxes. Some, but not all, of these compliance markets allow carbon offsets to play a role in meeting compliance obligations. Typically, the use of offsets is limited in order to incentivise decarbonisation and behavior changes required to reduce emissions.

In addition to the 31 ETSs active or scheduled for implementation, there are also 9 ETSs currently under development (including China, Germany, and Colombia) as of 2020; 15 jurisdictions are currently also considering a possible role for ETS in their jurisdictions, including Indonesia, Thailand, and Vietnam (The World Bank, 2020). Government regulations for each country or jurisdiction determine the extent to which carbon credits generated by NCS projects can play a role in these ETSs. Engagement and support for NCS from the private sector as these regulations develop can help increase the prevalence of NCS within these markets.

b) The voluntary market has been driving significant investment in NCS

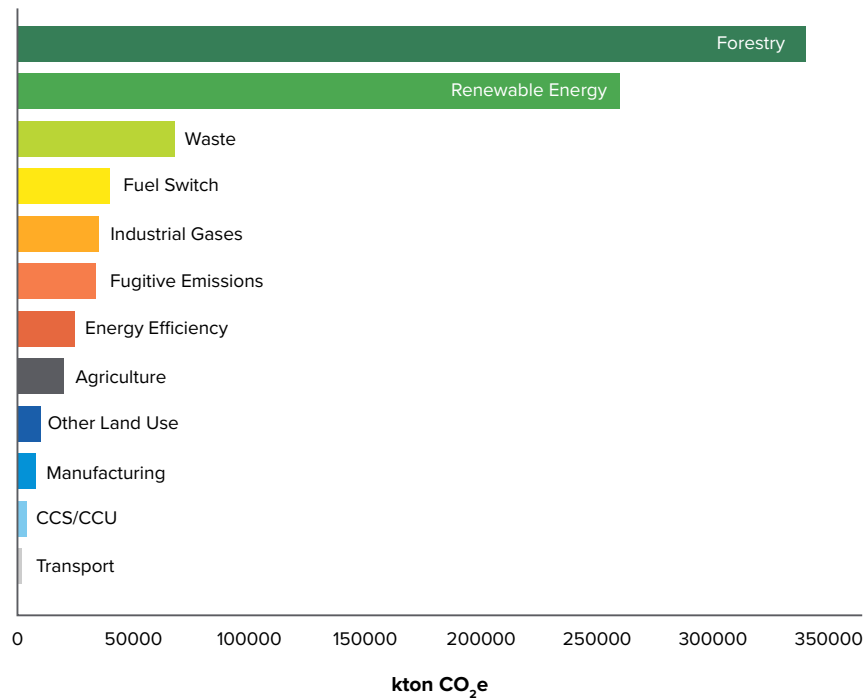
While many compliance markets include provisions for NCS, a majority of NCS is implemented and financed from the voluntary carbon market. Between 2016 and 2018, the volume of NCS carbon credits transacted

grew 264%, more than any other segment in the voluntary market (Forest Trends, 2019b). Forestry sector credits in particular have made up 42% of all credits issued on the voluntary market in the last five years (Forest Trends, 2019b).

Pricing for NCS carbon credits varies widely and depends on various attributes, such as the project’s location (including its regulatory environment, social environment, and specific site attributes) and impact (both in terms of climate mitigation and co-benefits). As a result, no benchmark price currently exists. The market for NCS carbon credits is very much driven by buyer preference for the package of attributes offered by NCS projects.

While there is no centralized system for transacting voluntary carbon credits, the Forest Trends’ Ecosystem Marketplace, a non-profit organization, has been regularly collecting data from voluntary market participants over the last thirteen years (Forest Trends, 2019b). Tracked transactions of voluntary carbon offsets for 2018 represented 98 MtCO₂e in emission reductions, with a market value of US \$295.7 million (Forest Trends, 2019b). Compared to 2016, this was a 52.6% increase in volume and a 48.5% increase in value (Forest Trends, 2019b). However, at a median price of \$5.43 in 2018, the average price in voluntary markets is still well below most in global compliance markets, and substantially lower than the US \$40-80/tCO₂e by 2020 and US \$50-100/tCO₂e by 2030 threshold for the Paris Agreement (Forest Trends, 2019b).

Figure 9: Issuance of carbon credits by project type and mechanism: 2015-2019



With a higher percentage of end buyers and the usual ability to command a higher price, NCS offsets have a distinct advantage over their non-NCS counterparts. NCS has a higher percentage of returning buyers (93%), who are primarily motivated by NCS projects' co-benefits. Likely due to these co-benefits, Improved Forest Management (IFM) projects drew the highest price of any project type in 2018 at US \$8.15/tCO₂e (Forest Trends, 2019b). Offsets that achieved dual certification of both the **VERRA Verified Carbon Standards (VCS)** (which certifies greenhouse-gas impacts) and the Climate, Community & Biodiversity (CCB) standards (which certify positive social and biodiversity impacts) had the biggest jump in volume in 2018 (Forest Trends, 2019b).

c) Multilateral financing drives significant financing for NCS through non-market approaches

According to Forest Trends' Ecosystem Marketplace, nearly US \$2 billion is committed to non-market funds that provide results-based payments (Forest Trends, 2019b). Funds that provide results-based payments include funds that operate under the United

Nations or World Bank, such as the Forest Carbon Partnership Facility, the **Green Climate Fund (GCF)**, the **BioCarbon Fund**, and bilateral funding for REDD+ (Forest Trends, 2019b). Descriptions of these funds are provided in box 10.

Box 11: Examples of Funds using Results-Based Payments

The Forest Carbon Partnership Facility (FCPF) is a global partnership of governments, businesses, civil society, and indigenous people's organizations focused on REDD+ activities; the FCPF currently works with 47 developing countries across Africa, Asia, and Latin America and the Caribbean, along with 17 donors that have made contributions and commitments totalling \$1.3 billion (Forest Carbon Partnership Facility, 2018).

The Green Climate Fund (GCF) was set up by the UNFCCC, and is dedicated to helping developing countries in climate mitigation and adaptation (Green Climate Fund, 2020). GCF uses public investment to stimulate private investment in low emission, climate-resilient development (Green Climate Fund, 2020). It pays particular attention to the needs of societies that are highly vulnerable to the effects of climate change, in particular Least Developed Countries (LDCs), Small Island Developing States (SIDS), and African states (Green Climate Fund, 2020). As of November 2019, GCF's total portfolio value was US\$5.6 billion, and twenty-eight countries had pledged US \$9.78 billion to fund climate action over the next four years (Green Climate Fund, 2019). In October 2017, the GCF Board established a new pilot program for REDD+ results-based payments, allocating US \$500 million for activities related to NCS. Funding will be available to countries who meet all requirements under the UNFCCC Warsaw Framework for REDD+ (UNFCCC, 2014), and proposals will be accepted on a rolling basis through the last Board Meeting in 2022.

The BioCarbon Fund supports projects that generate multiple revenue streams, combining financial returns from the sale of carbon credits with increased local incomes and other indirect benefits from sustainable land management practices (Green Climate Fund, 2020). The BioCarbon Fund has worked extensively within the UNFCCC's Clean Development Mechanism (CDM) and the voluntary carbon market, such as the Verified Carbon Standard (BioCarbon Fund, 2017b). The first two tranches of the BioCarbon Fund were established in 2004 and 2007, with a total commitment of US \$90 million (BioCarbon Fund, 2017b). The BioCarbon Fund purchases carbon credits on behalf of fund participants through emission reductions purchase agreements (ERPAs) with individual projects (BioCarbon Fund, 2017b).

Results-based payments may come in the form of non-market or non-market-based finance, meaning that results-based finance may or may not involve an emissions reduction transfer or trade to the donor.

Results-based payments from the GCF and the majority of funding under the FCPF are non-market-based payments in that they do not involve a transfer to the donor; however, these non-market results-based payments provide important support for NCS projects, sometimes above-market prices (Forest Trends, 2019a). Results-based payments can also create an impetus for regulating projects or embedding them in a nested approach (Forest Trends, 2019a).

NCS investment options exist beyond carbon finance

NCS projects can benefit from financial channels beyond carbon finance, such as green bonds. Green bonds are bonds created to fund projects that have positive environmental benefits, including climate mitigation. (Climate Bonds Initiative, 2020a). In 2019, global green bond and green loan issuance reached an adjusted US \$257 billion, up 51% from 2018 (Climate Bonds Initiative, 2020a). In the Association of Southeast Asian States (ASEAN) region, green bond and loan issuance in 2019 (US \$8.1b) was nearly double that of 2018 (US \$4.1b); Singapore accounted for 55% of the ASEAN green debt issuance in 2019 (compared



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with 29% in 2018), establishing itself as a regional leader. However, land use represented just 3% of total investments, implying a significant opportunity for growth (Climate Bonds Initiative, 2020a). Nonetheless, NCS is set to benefit from the continued rise in green bond issuance (Climate Bonds Initiative, 2019).

Importantly, NCS is not strictly restricted to environmental finance. As entrepreneurs worldwide seek to benefit society and the environment in a profitable way, innovative NCS models continue to emerge, with many companies developing revenue streams compelling enough to attract private finance from conventional sources, such as bank loans for business investments or venture capital. For example, the World Resources Institute researched over 140 SMEs with a central value proposition around forest and landscape restoration, highlighting promising themes and examples that have successfully raised private capital (Faruqi et al., 2018). Businesses

interested in NCS would do well to explore similar opportunities to support, catalyse, and/or acquire these innovative SMEs.

Coalitions of public and private actors can help reduce NCS investment risks

According to the International Carbon Reduction & Offset Alliance (ICROA), carbon reduction projects financed by the private sector on a voluntary basis alone have already reduced over 500 million tons of CO₂e globally (International Carbon Reduction & Offset Alliance, 2020). Considering the increased inclusion of NCS in climate policies, as detailed earlier in the report, interest in NCS is expected to continue growing as it becomes increasingly clear how critical NCS are to a net-zero emissions future.

New PPPs are being convened to remove barriers and increase investment in NCS (examples are covered in box 11). Importantly for PPPs, the use of public and/or philanthropic capital as subsidies or first-loss guarantees has an important role in improving private investor confidence in NCS investments, increasing their willingness to invest in models they may be

unfamiliar with. As private investors gain experience and familiarity in NCS, they may then develop NCS investments on their own. Given synergies between government policy, incentive structures, and private investment, these PPPs offer a promising venue for companies – if done equitably and transparently – to realise synergies and drive necessary systemic change.

Box 12: Examples of Public-Private Partnerships for NCS

The Natural Climate Solutions Alliance is an alliance of public and private stakeholders convened by WEF and WBCSD. Its focus is scaling up affordable natural climate mitigation solutions and increasing finance for NCS by identifying the opportunities and barriers for investment in carbon credits (World Economic Forum, 2020a). According to ICROA, the voluntary carbon market has the potential to grow significantly in the decade ahead and become an instrument used to accelerate the global transition towards net zero emissions by helping to close the emissions gap, the finance gap, and the time gap (International Carbon Reduction & Offset Alliance, 2020).

The International Emissions Trading Association (IETA) is a nonprofit organization created to establish a functional international framework for trading in greenhouse gas emission reductions (IETA, 2020a). In December 2019, the IETA launched the Markets for Natural Climate Solutions Initiative, which aims to build a global market for carbon credits generated from NCS projects, enabling private sector investment at scale (IETA, 2020b). The initiative will establish an effective policy roadmap and market strategy to address the barriers to investing in NCS at large scale (IETA, 2020b). In June 2020, the IETA Council released its Guidance on Net Zero Climate Ambition, which advocates for policies that enable companies and sectors to cooperate through trading policies, including the use of NCS (IETA, 2020a).



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HOW BUSINESSES CAN ENGAGE IN FINANCING NCS

There are many entry points for businesses and capital providers to engage NCS within the carbon finance supply chain. Each of the entry points we discuss here can accelerate the use of NCS in reaching net-zero emissions by 2050.

Businesses can invest in NCS to achieve voluntary emissions reduction targets

A 2019 report from the WBCSD and Nature4Climate finds that companies are facing pressure from customers, investors, and employees to act on climate change using methods that are anchored in science and aligned to the Paris Agreement (WBCSD, 2019). Even if not mandated by law, companies may find that

setting and upholding voluntary targets for emission reductions is a strong business strategy. NCS can play an important role in helping companies reduce their GHG emissions while offsetting emissions that are harder to abate – such as employee travel or product transportation. Notable options for companies to meet their voluntary emissions reduction targets through NCS investments are described below:

- *Voluntary Emission Reduction Purchase Agreements (VERPA)*: Through VERPAs, companies purchase and retire carbon credits from NCS projects for near-term emissions reductions, contributing to corporate climate strategies with mitigation targets (Forest Trends, 2019a). Call out box 12 illustrates the different ways of structuring VERPAs, and the different steps involved.

Box 13: Different Structures of VERPAs

VERPAs can be done in several ways; the following descriptions lay out the processes involved with each structural option:



Direct Support

1. Carbon credit buyers approach owners of a certified, developed NCS project
2. Buyers and suppliers reach an agreement of sale
3. Carbon credits are transferred to the buyer through a carbon credit registry – or are retired, as per the buyer's intent



Financing Early Development

1. Carbon credit buyers approach a developer interested in creating a new NCS project (thereby gaining greater insight in project dynamics)
2. Buyers agree to finance early project design and development in return for priority access to generated credits
3. Once mature, generated carbon credits are given right-of-first-sale to the investor
4. If rights-of-first-sale are exercised, carbon credits are transferred to the buyer through a carbon credit registry – or are retired, as per the buyer's intent



Purchase Guarantees

1. Carbon credit buyers approach developers of an early stage NCS project
2. Buyers set up a purchase guarantee for an initial tranche of generated credits at a fixed and favourable price, de-risking the project by assuring consistent revenue flow upon carbon credit materialization (Baumann et al., 2018)
3. If initial tranche of carbon credits materialize, carbon credits are transferred to the buyer through a carbon credit registry – or are retired, as per the buyer's intent

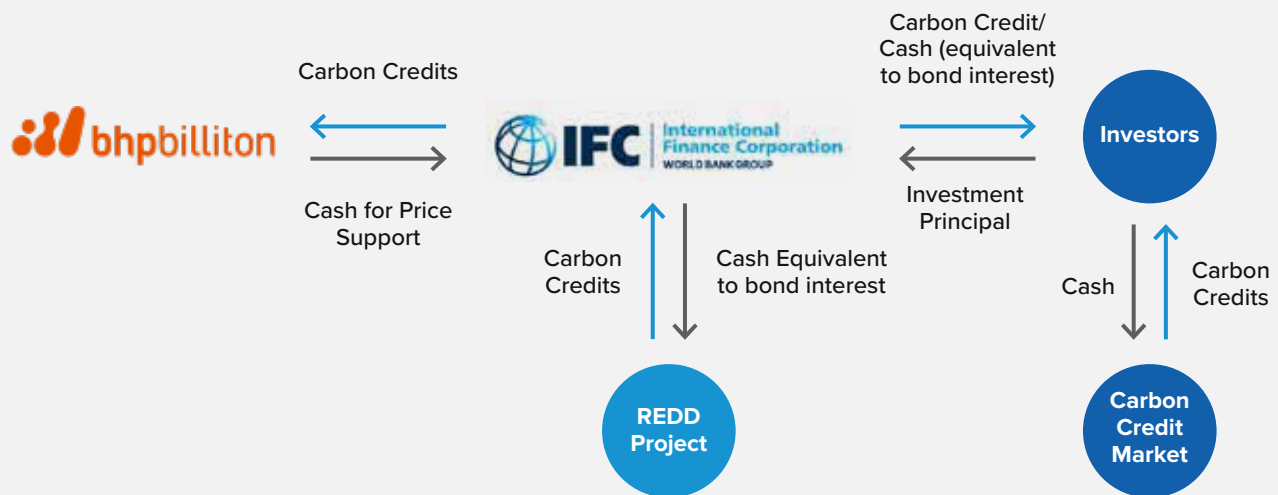
- **Internal carbon taxes:** Business can set internal carbon taxes to represent their climate-related business risk, and use the proceeds raised to purchase NCS carbon credits.
- *Shadow carbon pricing:* Similar to internal carbon taxes, companies instead set a hypothetical surcharge on carbon-emitting projects, goods, and services across their business operations, shifting resource allocation toward low-carbon options.
- *NCS business model development:* Companies support NCS business model development, providing commercial business loans alongside technical and promotional support to those businesses (Baumann et al., 2018).

Box 14: The IFC Forests Bond

In 2016, the IFC issued a first of its kind \$152 million Forests Bond with many innovative features (Conservation International, 2020; International Finance Corporation, 2016). Investors had the option to choose either a cash coupon, or REDD+ carbon credits. To reduce market price risk, the instrument included a price support mechanism provided by BHP Billiton. This assured investors who wanted to take the cash coupon a minimum price guarantee. Any price support not utilised by investors was used to purchase additional VCUs from the project, thereby providing even more forest finance to the project.

The IFC Forests Bond supports the Kasigau Corridor REDD Project in East Kenya, covering over 200,000 hectares, that were threatened with deforestation from cattle grazing and clearing for firewood and farmland. Funds are used for forest protection activities, such as forest and biodiversity monitoring, funding for community wildlife scouts, forest patrols, social monitoring, and carbon inventory monitoring. Further investments are made in community development, including the reforestation of Mount Kasigau, establishment of an eco-charcoal production facility, support for community-based organizations, and expansion of an organic clothing facility. Upon full establishment, the project is expected to offset 1.4 million tCO₂e each year for 30 years. Figure 10 below illustrates revenue flows created through IFC's Forests Bond.

Figure 10: Bond Structure



Businesses can develop NCS product lines and expand into new markets

In the face of significant changes that climate change presents for the global economy, businesses are increasingly looking to innovate their existing business models and identify new products that

align with a net-zero emissions action plan. Forest sector companies are developing business opportunities in sustainable forest management (WBCSD, 2019); technology sector companies are creating new applications of artificial intelligence to limit land use impact (World Economic Forum, 2018). Whatever the sector, there are multiple ways for companies to expand business lines and enter new markets, including:

- *Carbon products:* Companies can develop and purchase NCS credits for customers.
- *Sustainable forestry and agroforestry products:* Investments in NCS can provide additional product lines of sustainable wood products, agroforestry products (e.g. cacao), or sustainable non-timber forest products (e.g. rubber) (Novartis, 2017).
- *Technology development:* Companies can develop and invest in technologies that reduce NCS implementation, monitoring, and enforcement costs (e.g. AI and drones), or NCS verification, validation, and accounting costs (e.g. blockchain and satellite technology) (Tercek, 2020).

Businesses can “inset” NCS projects to improve supply chain resilience

Investments in NCS can increase the resilience of company operations, assets, and supply chains by enhancing human health and ecosystem functions in communities where operations and assets are located. This is also known as ‘**insetting**,’ wherein a company invests in an emission reduction project within its supply chain or operations. NCS projects can support supply chain operations in a variety of ways, including enhanced flood defences, or improved soil health and productivity (WBCSD, 2019). Examples of insetting opportunities include:

- *Setting deforestation-free commitments:* Companies can make formal commitments – and corresponding financial investments – into “deforestation-free” supply chains, trade chains, and sourcing landscapes (Baumann et al., 2018).
- *Support NCS use in supply chains/carbon insetting:* Companies can invest in NCS projects within a company’s value chain. This can include providing premiums for producers in your supply chain that engage in NCS or supporting producer access to technical assistance (e.g. project management, access to technology and capital, etc.) (Baumann et al., 2018; Tercek, 2020).

Businesses can purchase or support NCS carbon credits for pre-compliance

Businesses that anticipate the creation of a compliance carbon market may choose to purchase carbon offsets prior to the establishment of the compliance market to take advantage of favourable prices or other potential benefits of acting early. For instance, companies purchasing pre-compliance carbon credits benefit from the establishment of the capacities, processes, and systems within their business to be able to prepare for compliance markets. These capacities may include carbon trading expertise, project design and development, carbon accounting expertise, among others. Pre-compliance purchases of NCS credits can also demonstrate to policymakers that businesses support the inclusion of NCS in compliance markets, signalling the value of establishing proper policy frameworks and other enabling conditions for NCS investment (WBCSD, 2019). Examples of pre-compliance actions include:

- *NCS voluntary offsets:* Companies can purchase NCS carbon offsets to take early action on anticipated regulations.
- *Market design:* Companies can engage with policymakers to support the inclusion of NCS in anticipated compliance carbon markets.
- *NCS methodology design:* Companies can support the development or modification of new NCS methodologies to meet anticipated compliance market eligibility.

Box 15: Innovation with Blue Carbon

Colombia harbors the highest proportions of threatened mangrove species in Latin America, along both the Pacific and Caribbean coasts. The country has 289,122 ha of mangroves — 73% of them in the Pacific coast and 27% in the Caribbean. CI and partners (Apple Inc., Invemar Research Institute, local and national authorities, Omacha Foundation, and local communities) are implementing a blue carbon project located in the Morisquillo Gulf on Colombia's Caribbean coast. The project will avoid the degradation and deforestation of 9,600 hectares of natural mangrove forests and restore mangrove forest cover by an additional 1,800 hectares, which together will generate an estimated 1,434,360 million tCO₂e of Verified Carbon Units (VCUs) over the life of the project (30 years). The project consists of two phases: the initial phase focuses on carbon project development, leading to VCUs issued for Cispatá Bay within the Gulf region. The second phase will build upon that experience and incorporate the remaining mangrove areas throughout the entire Gulf (in Caimanera and Guacamayas), that are part of the same ecoregion and face similar threats. The project was developed and implemented by a team composed mostly of women, including scientists, local leaders, trainers, and coordinators.

The project will be the first to use the new VCS Wetlands Modules (released Sept. 2020), thus the first blue carbon project to generate credits for the plant biomass and extensive soil components. In addition, Colombia instituted a national carbon tax in 2016, where businesses can opt to purchase VCUs in lieu of paying the carbon tax. This project will be the first blue carbon project eligible to have credits sold through this process. Not only does this project set a precedent for blue carbon finance at a national scale, but the carbon tax system in Colombia also provides national scale demand. This national demand affords assurance that once all of the VCUs that can be sold internationally on the Voluntary Carbon Market, any remaining credits will be sold nationally.

The carbon value generated will be a crucial component of a long-term financing strategy in the region that will support enhanced ecosystem conservation and restoration, sustainable ecotourism, and small local business. In addition to mitigating climate change, this project will generate ecosystem service benefits important for climate adaptation and human well-being, including coastal protection, food security, water purification, and biodiversity conservation for endemic and migratory species.

Businesses may support NCS projects while achieving regulatory compliance

Businesses may have compliance obligations to reduce their carbon emissions, depending on the sector, industry, or geography of operations. These obligations may or may not currently allow the use of NCS credits to achieve compliance. Where businesses have an opportunity to engage with decision-makers and inform the further development of a compliance market, businesses can advocate for the inclusion

of NCS. Where NCS credits are already eligible, businesses can purchase NCS credits to meet their compliance obligations to send a strong signal for the increased demand of NCS. Opportunities for companies to support NCS through compliance include:

- *NCS offsets:* Companies can purchase NCS carbon offsets when eligible for meeting compliance obligations.
- *Policy:* Companies can engage in, and financially support, initiatives, and coalitions that pursue enabling regulatory environments for NCS success, whether by country, industry, or sector.



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VI

INSIGHTS AND OPPORTUNITIES FOR NCS IN SOUTHEAST ASIA

Regional NCS opportunities and constraints exist in both terrestrial forests and blue carbon

POTENTIAL AND CONSTRAINTS OF CLIMATE-MITIGATION REFORESTATION AND FOREST PROTECTION IN SOUTHEAST ASIA

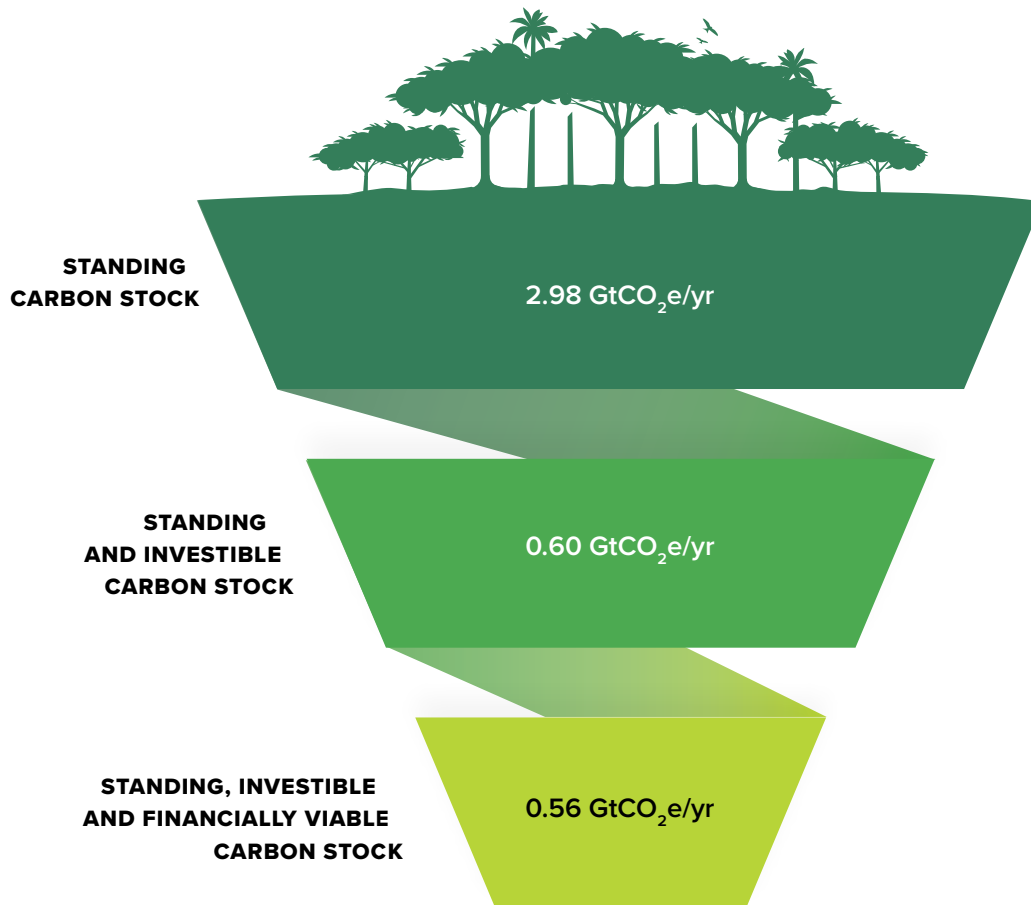
Within Southeast Asia, a number of scientific studies have aimed to quantify the potential for the ‘supply’ of NCS. This potential will need to be tempered by various constraints in order to determine the portion of biophysical supply available and economically viable for investment. For instance, forest frontier regions

are under threat of agricultural expansion and will require higher amount of investment to balance the opportunity cost of NCS investment. Other regions may not have the requisite social or governance enabling conditions in place to absorb investment and demonstrate validated and verified outcomes. Therefore, this report distinguishes natural carbon stock and sequestration potential from investable and financially-viable carbon stock in order to reflect a more accurate volume of NCS supply across key pathways. Although some NCS models are considered some of the most cost-effective climate mitigation strategies, their implementation necessitates broader considerations, including financial and operational factors that may limit their feasibility and profitability (WBCSD, 2019).

Forest protection potential is first calculated by estimating the total climate mitigation potential of forests within Southeast Asia. Key criteria were then applied to the validation and verification of forest carbon projects, limiting this potential to the forest areas that are investible. However, not all of these areas would be profitable. Return-on-investment

potential was then estimated based on development and maintenance costs, average carbon prices, as well as a 30-year timeframe. By excluding areas that are not able to break even within this period, climate mitigation potential of forests was estimated within areas that are financially viable.

Figure 10 Protect: Southeast Asia forest carbon supply



^v Within the forest protection pathway, although there are 500 million ha of tropical forests in Southeast Asia^{vi}, not all of these forests are under threat of deforestation, which is a key criterion in the validation and verification of forest carbon projects. Only 165 million ha of these forests are available for carbon finance (investible carbon^{vii}). Furthermore, only 90 million ha of the forests represents viable carbon projects that would at least financially break even

over a 30-year timeframe, equivalent to roughly 0.56 Gt CO₂e in carbon sequestration per year. Still, this represents significant climate mitigation potential. For comparison, this rate of sequestration potential is equivalent to 15% of the ASEAN region’s projected baseline emissions rate in 2030.^{viii} Furthermore, this protection could yield a total return-on-investment of US \$27.5 billion/yr from carbon finance across Southeast Asia. The top five countries in the region



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in terms of return-on-investment from nature-based carbon projects are Indonesia (\$15.4b/yr), Malaysia (\$3.9b/yr), Thailand (\$2.7b/y), Cambodia (\$2.2b/y) and Myanmar (\$2.1b/y). The protection of these forests provides significant potential in climate mitigation that could yield a total return-on-investment of US \$27.5 billion/yr from carbon finance across Southeast Asia at approximately 0.56 GtCO₂e/yr (based on an assumed project estimation cost of US \$25 ha⁻¹, annual maintenance cost of US \$10 ha⁻¹ y⁻¹, and the carbon price of US \$5.8 t⁻¹CO₂e).

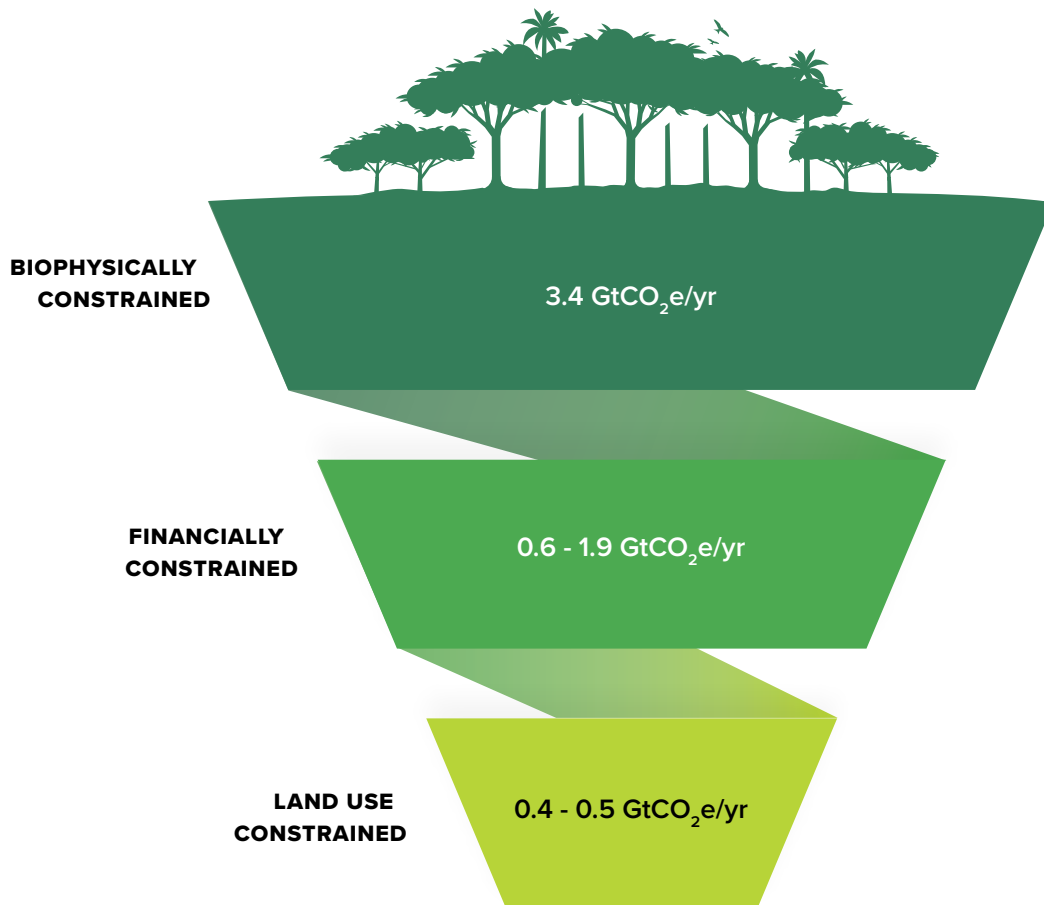
Furthermore, the scale of protection opportunity is bolstered when incorporating the potential of RIL-C, which can be applied to native forests, maintaining or enhancing timber productivity while maintaining the ecological integrity of the landscape. This is highly relevant in Southeast Asia, given the prevalence of logging as a land use activity in native forests - estimated

to cover 82 million hectares of forests across Cambodia, Indonesia, Malaysia, Myanmar, Papua New Guinea, Philippines, and Thailand (Blaser et al., 2011).^{ix}

Similarly, reforestation as a climate solution could provide a significant portion^x of climate mitigation potential across Southeast Asia – if the only consideration was biophysical suitability. As soon as financial constraints are taken into account, both in terms of direct and opportunity costs of reforestation projects, their climate mitigation potential drastically reduces^{xi}. This potential may further diminish to <0.5 GtCO₂e yr⁻¹ if other practical constraints are also considered, such as land-use conflicts, deforestation risks, and accessibility to labour input.

Notwithstanding the constraints of NCS highlighted above, their potential climate mitigation and financial payoffs are already on-par with engineered mitigation

Figure 11 Restore: Southeast Asia carbon sequestration supply



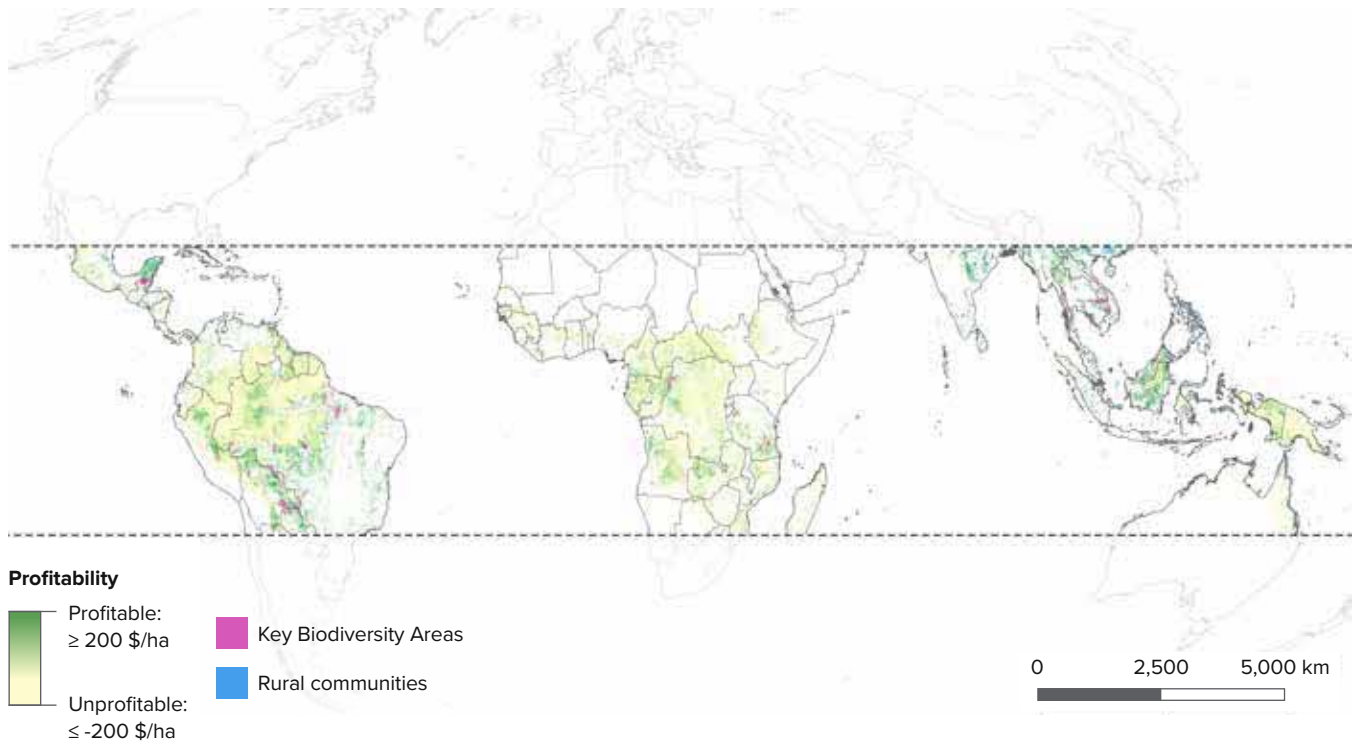
solutions. If we further consider other co-benefits that NCS provide, such as coastal resilience, biodiversity conservation, and flood prevention, they present a far greater and outsized economic benefit. For example, restoring the ~303,000 ha of mangrove habitats in Southeast Asia can protect more than 4 million people in the coastal areas and provide significant enhancement to commercial fisheries (finfish and invertebrates) (The Nature Conservancy, 2020b).

While there are few studies that analyse the financial, land-use, and operational constraints on reforestation potential, established scientific methodologies are starting to emerge. Beginning with maps of degraded land that could be reforested, biophysical, economic, and social constraints are then applied (detailed discussion of these constraints can be found in Annex D). Resulting areas are further refined by operational risk factors that threaten the long-term viability of

reforested lands. As a complement, spatial analyses of key co-benefits, such as biodiversity and impacts on rural communities, are developed. With these processes, project sites can be mapped out to show areas with potential optimal economic, social, and environmental returns.

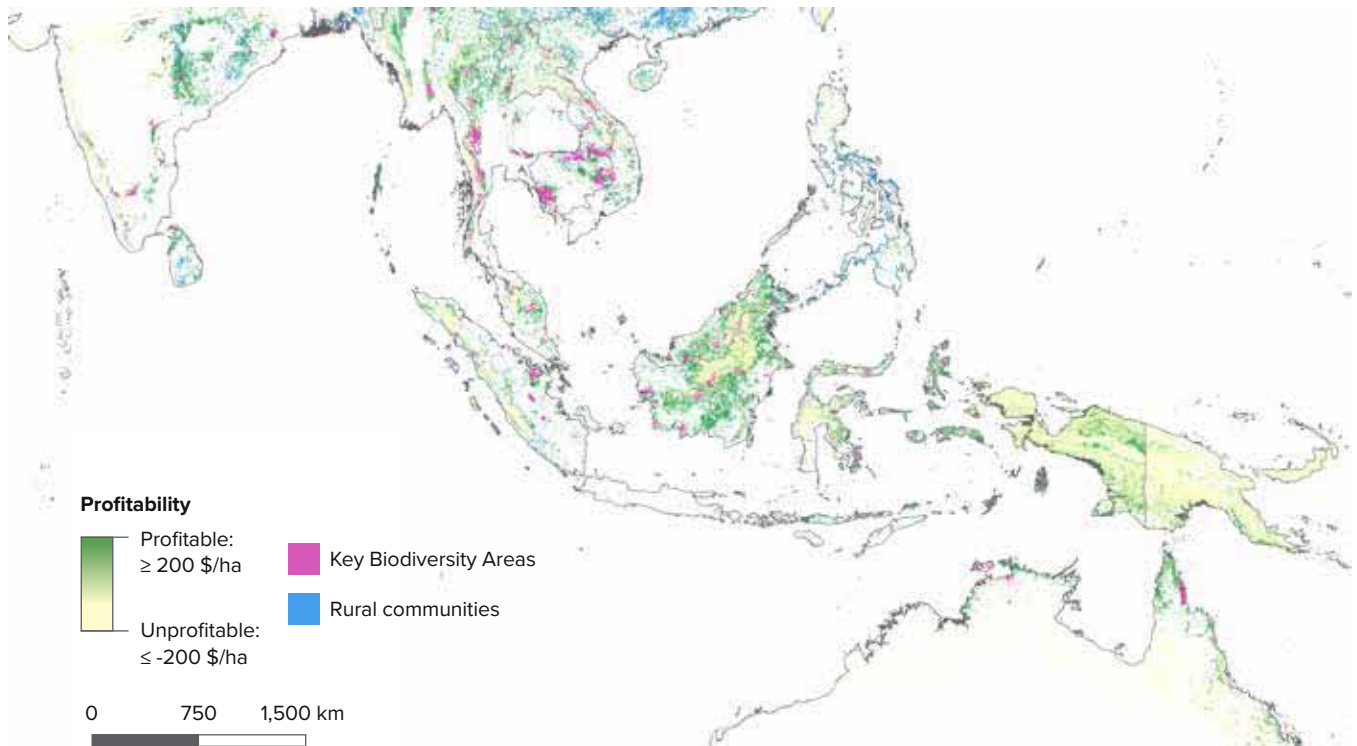
The results are striking for the ASEAN region. Southeast Asia holds the highest density of **carbon prospecting** for NCS investments, which includes both terrestrial and blue carbon. Similarly, based on preliminary spatial analyses, there is a high density of co-benefits that would be captured through NCS investment. Investing in deeper, science-based spatial analyses to quantify the full scope of both NCS and co-benefits captured would ensure a better and more targeted return on investment.

Figure 12: Global Tropics Carbon Prospecting Profitability and Co-benefits (Koh et al., 2020)



Southeast Asia holds the highest potential for not only natural climate solutions return-on-investment, but also the added key biodiversity co-benefits particularly in Malaysia, Thailand, and Cambodia.

Figure 13: Southeast Asia Carbon Prospecting Profitability and Co-benefits (Koh et al., 2020)





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POTENTIAL AND LIMITATIONS OF BLUE CARBON FOR CLIMATE MITIGATION IN SOUTHEAST ASIA

Blue carbon ecosystems (mangroves, seagrasses, and saltmarshes) hold enormous potential for sequestering carbon. Although the global area of these vegetated coastal habitats is smaller than that of terrestrial forests, their contribution per unit area to long-term carbon sequestration and storage is much greater than those of terrestrial ecosystems. This is because of their efficiency in trapping suspended matter and associated organic carbon during tidal inundation, as well as its high salinity levels that inhibit organic material breakdown. Healthy coastal ecosystems continuously accrete carbon in the soil. They have the ability to build up the soil beneath them in such a way that under the right circumstances they can keep up with and counter sea level rise. They have a potentially limitless capacity to sequester carbon in the soil pool. Global estimates of carbon stocks in these systems range from 10.4 – 25.1 billion **Mega grams of Carbon (MgC)**, but this is likely an underestimate as most studies only account for the carbon in the top meter of soil. However, organic-rich soil profiles may extend over six meters in depth. Conversely, when

blue carbon ecosystems are degraded or destroyed, the carbon that took a millennia to accumulate can be released into the atmosphere in just a few decades – turning what was once a significant carbon sink into a carbon source. Globally, blue carbon are some of the most threatened ecosystems and are being lost at critical rates (0.1%-6% per year depending on the ecosystem type) (Hoegh-Guldberg et al., 2019). Loss of blue carbon ecosystems results in 0.23-2.25 billion Mg of CO₂ emissions per year.

Southeast Asia is geographically and geologically unique in its high and dense stock of mangroves and seagrass. The Southeast Asian region boasts a combined 4.8 billion MgC storage compared to next highest global region – the Gulf of Mexico – at 0.5 billion MgC, putting the overall estimated stock well above other global blue carbon hotspots. In Southeast Asia, the countries with the largest blue carbon stocks (in order of most to least) are Indonesia, Philippines, Papua New Guinea, Myanmar, Malaysia, Thailand, Tropical China, Vietnam, and Cambodia. Historically, these were also the countries with the greatest loss of blue carbon ecosystems – largely due to expansion of aquaculture in the 1980s, logging, and coastal development. This is particularly detrimental for some countries like Indonesia, where emissions related to mangrove loss account for up to 20% of the national emissions related to deforestation.

Restoring and conserving blue carbon ecosystems provide a potentially transformative nature-based solution to mitigate climate change and increase coastal resiliency. Healthy coastal ecosystems act as natural infrastructure that provides essential protection from rising sea levels, storms, coastal flooding and erosion. Simultaneously, mangroves have the potential to reduce poverty and increase economic resilience by increasing access to sustainable livelihoods (eg. healthy coastal fisheries).

Efforts in developing mangrove restoration and conservation projects at scale, or garnering investment in these projects have been low. Reasons for this discrepancy between the high potential for benefits and low investment in

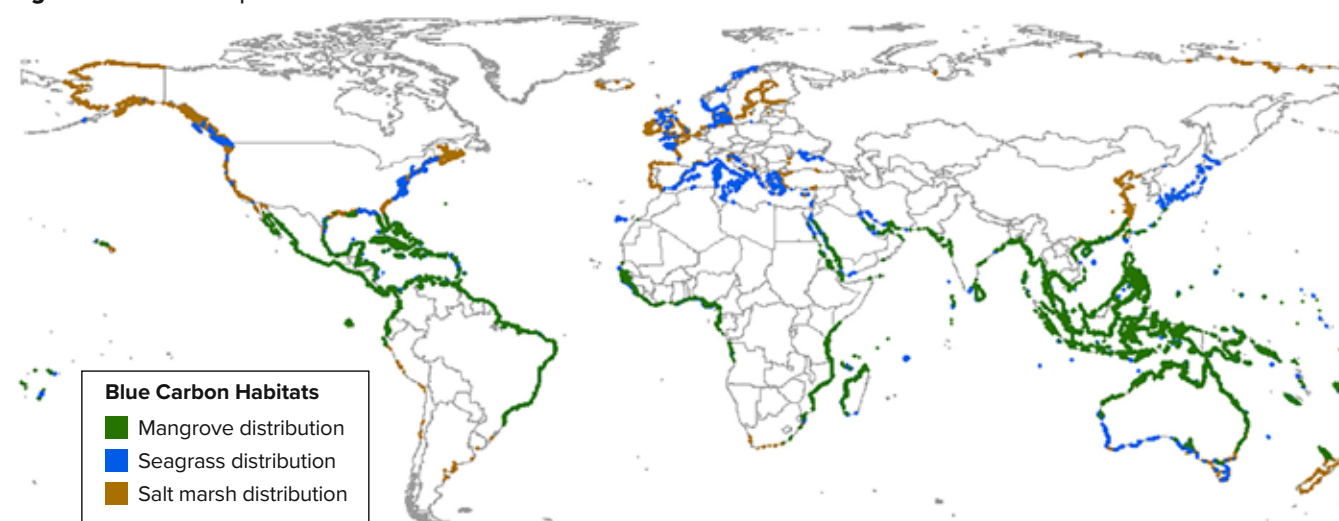
mangrove restoration and conservation include the assumptions that scientific methods to account for blue carbon are not well established, and the misconception that mangrove restoration is prone to failure. Also, mangroves conservation and restoration are perceived to be too expensive to be profitable. However, in recent years, great strides have been made to overcome these challenges.

a) Advances in the science of blue carbon

Global assessments of carbon stocks have been done at a high level – producing maps of global

blue carbon ecosystem cover (mangroves, salt marshes, and seagrasses – see for example The Nature Conservancy, 2020a), mangrove restoration potential (The Nature Conservancy, 2020a), estimated ecosystem service values (The Nature Conservancy, 2020c) and preliminary maps of drivers of mangrove loss (Goldberg et al., 2020). Databases for blue carbon data have been developed (Smithsonian Environmental Research Center, 2018). Scientists are building the datasets needed to improve blue carbon mapping and modelling.

Figure 14: Global map of blue carbon habitats



(Himes-Cornell et al., 2018)

Figure 15: Potential for climate mitigation of different types of blue carbon.

Region	Mangrove		Seagrass		Salt marsh	
	Hectares	% of total	Hectares	% of total	Hectares	% of total
Africa	2,631,069	22.9%	6,247	2.8%	1,565	0.4%
Asia	3,276,758	28.6%	23,690	10.8%	22,008	6.3%
Australia and South Pacific	1,578,385	13.8%	2,622	1.2%	16,644	4.7%
Central and South America	2,991,043	26.1%	10,368	4.7%	5,315	1.5%
Europe	0	0%	23,614	10.7%	162,039	46.2%
Middle East	23,995	0.2%	351	0.2%	174	0.0%
North America	965,678	8.4%	153,266	69.6%	143,239	40.8%
Global Total	11,466,928		220,158		350,984	

(Himes-Cornell et al., 2018)

Figure 16: Carbon Stocks of both mangroves and seagrasses in the Southeast Asia region (Zeng 2020 adapted from Thorhaug et al. 2020).

Country	Carbon Stocks	
	Mangrove	Seagrass
Myanmar	87.2 Tg	0.04 Tg
Thailand	34.7 Tg	2.3 Tg
Vietnam	34.4 Tg	2.5 Tg
Cambodia	8.4 Tg	3.1 Tg
Brunei	0.1 Tg	0.03 Tg
Singapore	0.1 Tg	0.03 Tg
Indonesia	2,573 Tg	753 Tg
Malaysia	137.5 Tg	4.1 Tg
Tropical China	33.8 Tg	0.6 Tg
Philippines	47.7 Tg	376.5 Tg
Papua New Guinea	136.5 Tg	233.8 Tg

However, high resolution data at the site level remains sparse. For example, there is a dearth of blue carbon data for seagrasses, specifically related to the impact of seagrasses loss on the soil carbon stocks. Since 90% of seagrass carbon is found in the soil, this limits the ability of seagrasses as an investment option (Thorhaug et al., 2020).

While site specific data are being developed, methods for determining blue carbon stocks at Tier 1 levels already exist (2013 update to the IPCC Wetlands Supplement). At the project level, scientifically robust methods for blue carbon field measurements are well established (Howard et al., 2014). In addition, on September 9th, 2020, Verra publicly released an update to the REDD+ Methodology Framework (VM0007) to expand its applicability to tidal wetland conservation and restoration activities, including activities on mangroves, seagrasses, and salt marshes.

This update enables these activities to access additional sources of finance through the sale of carbon credits in voluntary or compliance markets and help scale up tidal wetland conservation and restoration anywhere in the world. The methodology specifically addresses the issue of soil carbon, where 40-90% of blue carbon value lies, which previous methodologies omitted. Thus, activities in coastal blue carbon systems are now able to get credit for the full value of the carbon in the plants and most importantly in the soil. Under the methodology projects must either intend to sequester carbon through conserving or restoring sedimentation and/or vegetation, resulting in accumulation or maintenance of the carbon stock or increased salinity to reduce CH₄ emissions or restoring the water table to limit N₂O emission – CH₄ and N₂O related activities still account for any changes in carbon stocks. For example:

• **Creditable conservation activities include:**

- protecting at risk wetlands,
- improving water management in drained wetlands,
- maintaining or improving water quality for seagrass meadows,
- recharging sediment to avoid drowning of coastal wetlands,
- creating accommodation space for wetlands migrating with sea-level rise.

• **Creditable restoration activities include:**

- creating, restoring, and/or managing hydrological conditions,
- altering sediment supply (e.g. beneficial use of dredge material)
- changing salinity characteristics (e.g. restoring tidal flow)
- improving water quality
- (re-)introducing native plant communities
- improving management practices

The methodology provides guidance on measuring wetland carbon. It also addresses issues of uncertainty with sea level rise, emissions from wetland loss and land-use change (including methods to account for CH₄ and N₂O if relevant), and the impact of wetland degradation (note that as of the date of this report only degradation related to extraction for fuel is eligible). Currently, baselines are set using an estimate of historic ecosystem loss, but future iterations of the methods may allow for modelling of loss based on novel future threats. This is particularly important to explore as most blue carbon ecosystems can be completely lost in a very short time period. Therefore, it is vital to protect pristine areas vulnerable to future threats even if they have not had historical loss.

Other ways that the methodology addresses uncertainty is that it requires that sea level rise be assessed by defining the geographic project boundaries that allow for landward movement related to wetland migration, inundation and erosion. For projects where site-scale sea-level rise data is not available, Verra will allow projects to include sea level rise in the Permanence Risk Tool where they would claim a standardized conservative deduction. The methodology also allows for any project that implements credible conservation/restoration activities to be automatically considered additional. This means that projects will not be required to prove that the activities are directly related and dependent on carbon finance – removing one obstacle to project development. This decision was based on the fact that tidal wetlands and seagrasses conservation and restoration are not keeping pace with losses to such a degree that any conservation or restoration of those systems should be considered additional.



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b) Advances in mangrove restoration

Coastal wetland restoration typically occurs at either the very small site-specific scale or at large national scales. Project failure is typically due to weaknesses in project conception and execution – not because of an inherent difficulty related to the nature of the ecosystems. Many projects are conceived without addressing the underlying causes of loss and thus eventually fail to maintain mangrove coverage gained



from restoration. Even more restoration projects fail due to poor techniques - like planting in the wrong areas or planting the wrong species – which are at odds with the well-established science.

While effective approaches for mangrove restoration have been developed and implemented in isolated locations, this capacity and knowledge is not broadly available. These issues culminate in restoration failures that lead to reduced confidence in local coastal communities and governments, wasted financial resources and – most importantly –wasted opportunity to recover lost mangroves and the services they provide. However, coastal wetland restoration best practices are now available and groups like the Blue Carbon Initiative and the Global Mangrove Alliance are developing guidance on best practices for restoration specifically for carbon benefits as well as restoration tracker tools to analyse successes and failures, monitor carbon benefits long-term, and monitor and assess various co-benefits.

Investors looking for high carbon returns will receive a greater benefit from blue carbon conservation projects than restoration projects. This is because conservation projects are protecting existing high carbon stocks, while the process of building carbon stocks back

up after much of the carbon has been lost is much slower. However, international groups like the Global Mangrove Alliance, an Alliance of 20+ academic and NGO groups, has a global goal of increasing mangrove cover by 20% by 2030 (Mangrove Alliance, 2020). Reaching that goal would require increasing mangrove cover by 3.4 million ha. Given the support for the Alliance goal and the adoption of that goal by an increasing number of countries, the demand for blue carbon restoration activities is expected to grow. How that translates to demand for blue carbon credits from coastal wetland restoration is unknown. According to the Mangrove Restoration Potential Map, at least a quarter of this area is immediately practical to restore, and 37% of what is globally practical for immediate restoration is located in Southeast Asia, and thus an area ripe for increased efforts.

c) Advances in understanding costs

Currently, very few blue carbon projects exist and the first blue carbon VCS project is still under development – making general estimates of costs difficult, especially when the market values for blue carbon credits is so nascent. Bayraktarov et al. (2016) undertook a global review of 235 coastal restoration project outcomes with 954 observations of restoration costs across a variety of coastal ecosystem types and

country settings. They determined that mangrove restoration costs were typically lower than other forms of coastal restoration, such as seagrass, coral reefs, salt-marshes and oyster reefs. Nonetheless, a wide range of mangrove restoration costs have been reported. Narayan et al. (2016) reports costs ranging from US \$500 to 54,300 ha⁻¹ depending the degree of site degradation. Spurgeon (1999) also noted a vast range in cost reflecting differential expenses of restoration methods as well as socio-economic settings. Lewis (2000) reported costs from US \$225 to 216,000 ha⁻¹ with costs from unpublished data as high as US \$500,000 ha⁻¹ due to the high cost of permitting, labour, use of heavy machinery and other inputs in the United States. Lewis (2016) elaborates on the differential costs of restoration, ranking the following four methods from least to most expensive: 1) planting alone, 2) hydrologic restoration with or without planting, 3) excavation or fill projects with or without planting, and 4) experimental erosion control projects. In summary, a wide-range of mangrove restoration costs have been reported in the literature, ranging from US \$100 to 1,065,022 ha⁻¹ depending on socio-economic status of the location and techniques applied. Costs reported from Southeast Asia ranged from US \$100 ha⁻¹ to 1,388 ha⁻¹ (Brown, 2020). Costs of conservation are less represented in the scientific literature, but based on unpublished case studies, conservation efforts may cost closer to US \$500 ha⁻¹. However, all estimates are excluding the costs of carbon crediting. Implementing lower cost restoration methods (e.g. natural regeneration vs planting) will reduce cost estimates. There may be some benefit of economies of scale. Additionally, as coastal wetland conservation and restoration become more common, costs are expected to go down, although the quantum of reduction is unclear. As countries include blue carbon ecosystems into their GHG Inventories, and mangroves in their national forest reference levels, and as project developers and investors push for more blue carbon projects, data produced by those efforts will increase our understanding of blue carbon potential in the region and costs associated with tracking benefits.

Regional developments on climate policy give businesses opportunities for NCS advocacy

Significant progress has been made to implement and incentivise NCS in Southeast Asia. Several countries are developing relevant regulations, which present major opportunities for encouraging the inclusion of NCS — for example, the cap-and-trade bill in the Philippines, draft carbon pricing regulation in Indonesia, and the REDD+ nesting draft regulations in Cambodia.

Successful outcomes for NCS require engagement, resources, time, and advocacy. There is great opportunity for the private sector to play a critical role in meeting these requirements and expanding successful NCS outcomes in the region.

ASEAN countries are some of the most vulnerable countries in the world and collectively account for less than 5% of global GHG emissions. Yet, all ASEAN countries, apart from Singapore, are in the top fifty countries at risk for extreme climate change related risks. Four countries — Myanmar, Philippines, Vietnam, and Thailand — are in the global top ten countries at risk (Eckstein et al., 2017). At the same time, Asia — including all ASEAN member states — is on pace to be the largest global consumer of energy, with the majority of emissions coming from fossil fuels within the next 20 years. Regardless of the current trend, all ten ASEAN nations have agreed to reduce GHG emissions within their NDC agreements with decarbonisation planned through a combination of “cleaner” fossil fuel sources and renewable energy.

Land use changes are one of the main drivers of GHG emissions, and therefore present an enormous opportunity for mitigation action. Seven ASEAN member states have committed to reforestation and protection measures as part of their emissions reduction strategies and plans. Six countries^{xii} specifically refer to REDD+ and the sustainable management of forests and carbon stocks in their NDCs.

In order to meet their NDC targets, ASEAN member states face an emissions gap in both unconditional and conditional pledges. Collectively, ASEAN unconditional pledges account for around 400 MtCO₂e, equating to the region roughly having to cut emissions by 11% by 2030. The more ambitious conditional pledges (which are dependent on financial support and technology transfers) has a collective emissions gap that needs to be reduced by 24% (~900MtCO₂e) (Paltsev et al., 2018).

Compounding governance issues (Eckstein et al., 2017), weak institutional arrangements (Paltsev et al., 2018), and the lack of financial resources are the main barriers in most ASEAN countries for investment in NCS. In general, GHG emissions hotspots would be potential targets for improved monitoring, reporting, and implementing quantifiable measures and policies that can be systematically monitored through an adaptive approach.

As with all countries, engagement with the private sector is also essential in meeting NDC targets. Each member state has some mix of public and private partnerships on climate change action. However, this can vary significantly in the capacity and country readiness for NCS investment. The Philippines and Indonesia, for example, are supporting their financial capacity by creating private sector partnerships specifically to enhance and accelerate natural climate solution investments. Both are also in the process of developing carbon pricing regulations to accelerate climate actions in support of their NDC goals. Additionally, Thailand has a voluntary emissions trading scheme (ETS) already in place. Vietnam, on the other hand, delves deeper into preparing for private sector engagement by developing full plans and financial pathways for investment, conducting in-country legal review for corporate climate action and by establishing a technology-transfer platform. Vietnam is also in the process of developing a roadmap for the development of a domestic carbon credit market.

In 2017, Member States of ASEAN “agreed to explore the possibility of developing a harmonised approach

to measuring, reporting and verifying GHG emissions as a first step towards further regional collaboration on carbon market” (ASEAN, 2017). They also decided to explore the possibility to develop a carbon cap-and-trade, including a carbon pricing system in the region. A formal process has not started but the creation of the ASEAN Working Group on Climate Change is a first step towards a regional approach to carbon pricing mechanisms.

Policy Outlook



By engaging in the ASEAN process, companies can support the development of regional carbon pricing instruments that include NCS.



Country-specific opportunities for NCS are emerging in NDCs



Policy readiness for NCS investment is dependent upon a number of conditions within the countries and institutions. First and foremost, climate solutions must be prioritised within the country’s NDCs. This would include quantified NDC targets for natural climate solutions. Second, clearly articulated support for market-based approaches need to be a significant component of assessing policy readiness. Placing a direct connection within the country’s NDCs to state the country’s intentions to utilise markets is a suitable step in this direction. For example, the country could advance their carbon trading deals (e.g. Article 6 pilot projects). Third, technical progress on NCS implementation is also an indicator of policy readiness. This includes fulfilling the four technical steps of REDD+. Finally, there are opportunities or progress made in developing domestic NCS incentives such as carbon pricing.



Table 5 on the following page includes an individual country-level analysis evaluating the most critical policies for NCS investment, including opportunities for policy engagement in each country to facilitate NCS investment.

Table 5: Country-level policy insights and opportunities for scaling NCS

Country	National Policy Insights & Opportunities for Scaling NCS
<p>Cambodia</p> 	<p>NDC: Cambodia’s NDC recognises the critical role of NCS including a conditional goal to increase forest cover to 60% of national land area by 2030. However, technology and financial resources are a key constraint to implementation.</p> <p><i>Opportunity: Invest in NCS actions to contribute towards achieving NDC targets. Engage with the government in enhancing NCS ambition in a revised NDC and formulating an actionable NDC implementation plan that leverages and incentivises private sector action.</i></p> <p>REDD+: Cambodia has fulfilled all of its REDD+ readiness requirements under the Warsaw Framework for REDD+ and made significant progress developing national REDD+ nesting provisions.</p> <p><i>Opportunity: Invest in REDD+ activities. Assist in the finalisation of Cambodia’s REDD+ nesting approach through technical and/or financial support. Replicate Cambodia’s REDD+ nesting model (under development) in other countries to facilitate private sector investment in site-scale implementation with full recognition by the national government.</i></p> <p>Carbon pricing: Carbon markets and carbon pricing could be an option for increasing investment in NCS but political support system will need to be built.</p> <p><i>Opportunity: Engage with the government on the potential for carbon pricing mechanisms to support achieving national climate goals. Provide technical recommendations and support capacity building efforts.</i></p>
<p>Indonesia</p> 	<p>NDC: As evidenced by their NDC and relevant policies, Indonesia views NCS as a clear national priority for implementation and finance. A revised NDC has been developed and is waiting for Presidential approval.</p> <p><i>Opportunity: Invest in NCS actions to contribute toward achieving NDC targets. Engage with the government in formulating an actionable NDC implementation plan that leverages and incentivises private sector action.</i></p> <p>REDD+: The update process for the REDD+ Forest Reference Emission Level (FREL) currently underway presents an opportunity for defining the government’s approach for allocating REDD+ results or payments between the national and subnational government and other actors involved in delivering the results. It is also an opportunity for the government to define its process for recognising existing site-scale REDD+ projects under the national REDD+ program (known as REDD+ nesting).</p> <p><i>Opportunity: Invest in REDD+ activities. Assist in the finalisation of Indonesia’s REDD+ nesting approach through technical and/or financial support.</i></p> <p>Carbon pricing: The formulation and finalisation of the Instrument of Carbon Economic Value regulation is an important opportunity to incorporate and incentivise natural climate solutions within the carbon pricing scheme.</p> <p><i>Opportunity: Engage with the government on the finalisation of national carbon pricing mechanisms, ensuring strong incentive signals for NCS.</i></p>

Country	National Policy Insights & Opportunities for Scaling NCS
<p>Malaysia</p> 	<p>NDC: Malaysia's NDC includes NCS actions and is supported by a comprehensive legal and policy framework to facilitate its implementation, particularly in the forest sector.</p> <p>Opportunity: <i>Invest in NCS actions to contribute towards achieving NDC targets. Engage with the government in enhancing NCS ambition in a revised NDC and formulating an actionable NDC implementation plan that leverages and incentivises private sector action.</i></p> <p>REDD+: The recent update of the REDD+ FREL (2019) can help facilitate implementation of sustainable forest management and forest/mangroves conservation. Malaysia is well positioned to access Green Climate Fund Results-based Payments. ICAO and other international market instruments could play a critical role in supporting REDD+ efforts in Malaysia.</p> <p>Opportunity: <i>Invest in REDD+ activities. Support the development of REDD+ nesting approaches through technical and/or financial support.</i></p> <p>Carbon pricing: Building on existing energy-related incentives and tax policy, there is an opportunity to work on comprehensive green fiscal reform and generate additional funding sources for natural climate solutions.</p> <p>Opportunity: <i>Engage with the government on the potential for carbon pricing mechanisms to support achieving national climate goals. Provide technical recommendations and support capacity building efforts.</i></p>
<p>Myanmar</p> 	<p>NDC: Given Myanmar's financial constraints as described in their NDC, additional resources will be needed to deliver its forest sector mitigation targets. Public-private partnerships or innovative finance mechanisms could potentially be explored as part of fulfilling its nature-based targets.</p> <p>Opportunity: <i>Invest in NCS actions to contribute toward achieving NDC targets; Engage with the government in enhancing NCS ambition in a revised NDC and formulating an actionable NDC implementation plan that leverages and incentivises private sector action.</i></p> <p>Carbon pricing: No carbon pricing mechanism has been established in Myanmar, although there is potential to use national climate solutions in the country due to its vast natural forests.</p> <p>Opportunity: <i>Engage with the government on the potential for carbon pricing mechanisms to support achieving national climate goals. Provide technical recommendations and support capacity building efforts.</i></p>

Country	National Policy Insights & Opportunities for Scaling NCS
<p>Philippines</p> 	<p>REDD+: The Philippines has already started piloting forestry projects with the private sector and there is potential for private sector investment. Further research would be required to analyse the future potential for investment in REDD+ or blue carbon activities in the country.</p> <p><i>Opportunity: Invest in REDD+ activities; support the development of REDD+ nesting approaches through technical and/or financial support.</i></p> <p>Carbon pricing: The current formulation of a national cap-and-trade present an opportunity for incorporating NCS. Depending on the design of the system, one avenue for incentivising investments in NCS would be to allow covered entities to purchase NCS offsets as a means to lower the civil penalty should the company be unable to meet its annual target through direct emission reduction activities. As the Bill is currently under development, now is the opportune time to engage. Further work would be required to assure the proper inclusion of nature in the specific regulations to be issued 60 days after the bill is approved.</p> <p><i>Opportunity: Engage with the government on the finalisation of national carbon pricing mechanisms, ensuring strong incentive signals for NCS.</i></p>
<p>Singapore</p> 	<p>Carbon pricing: The upcoming review of Singapore’s carbon tax rate by 2023 may lead to the expansion of the carbon tax and/or transitioning the tax into an ETS. This review process is an important opportunity to incorporate nature as part of the national carbon pricing program. For example, the government could direct carbon tax revenues to defined conservation activities, a company could be allowed to reduce its tax burden by purchasing nature-based offsets and/or nature-based offsets could be eligible as part of an ETS. Given the limited potential for domestic NCS, these offsets may need to come from international sources.</p> <p><i>Opportunity: Engage with the government on the revision of the national carbon pricing mechanisms, ensuring strong incentive signals for NCS.</i></p> <p>NCS Investments: Singapore could also prioritise NCS in its international investments. For example, Singapore could adopt an ecological redlining policy to ensure that ecosystem health and carbon potential are considered in its investment decisions.</p> <p><i>Opportunity: Establish a carbon services and sustainable financing hub to facilitate carbon projects and capture green finance flows in the region.</i></p>

Country	National Policy Insights & Opportunities for Scaling NCS
<p>Thailand</p> 	<p>NDC: The Paris Agreement calls for revised or recommunicated NDCs in 2020, providing an opportunity for Thailand to demonstrate enhanced ambition by revising its NDC to include the LULUCF sector and natural climate solutions in their quantitative targets, building on other relevant national legislation.</p> <p><i>Opportunity: Engage with the government in incorporating NCS ambition in a revised NDC and formulating an actionable NDC implementation plan that leverages and incentivises private sector action. Invest in NCS actions to contribute toward achieving NDC targets.</i></p> <p>Carbon pricing: As evidenced by their NDC and development of the Thailand Voluntary Emission Trading Scheme, Thailand views market-based instruments as a clear national priority and key to achieving its NDC.</p> <p><i>Opportunity: Engage with the government on the potential for carbon pricing mechanisms to support achieving national climate goals. Provide technical recommendations and support capacity building efforts.</i></p> <p>REDD+: The completion and implementation of Thailand's REDD+ Strategy is needed to generate nature-based credits to contribute to the domestic carbon market.</p> <p><i>Opportunity: Support the finalisation of Thailand's national REDD+ program as well as the development of REDD+ nesting approaches through technical and/or financial support.</i></p>
<p>Vietnam</p> 	<p>REDD+: Vietnam has already complied with all the requirements under the Warsaw Framework to be eligible for results-based payments from REDD+ (e.g. from the Green Climate Fund, bilateral deals) and has prioritised the forestry sector within its NDC. Therefore, there could be potential to work on carbon credits from the forestry sector in this country. To be most attractive to private sector donors and to be eligible under CORSIA, these REDD+ units would need to be third-party verified by a credible greenhouse gas standard. The methodologies for these standards (e.g., Verra, Architecture for REDD+ Transactions Environmental Excellence Standard (ART TREES), FCPF) build on the Warsaw Framework requirements, however, some standards have additional requirements to what was agreed by countries under the UN (e.g. the third-party standards may have more prescriptive safeguards, specific approaches for addressing risk of reversals, etc.).</p> <p><i>Opportunity: Invest in REDD+ activities. Support the development of REDD+ nesting approaches through technical and/or financial support.</i></p> <p>Carbon pricing: In Vietnam, there is a proposal to develop a domestic carbon market. Since the draft Law and Decree still needs to undergo a review and approval process, the Ministry of Environment could consider NCS when they draft the roadmap mandated under these legal instruments. Another potential area for inclusion of NCS is the ETS for the energy sector and the carbon market mechanism for the waste sector. If these pilot projects are still taking place it could be an interesting opportunity to explore the inclusion of nature as offsets or potential source of credits.</p> <p><i>Opportunity: Engage with the government on the development of national carbon pricing mechanisms, ensuring strong incentive signals for NCS.</i></p>



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VII

CONCLUSION AND CALL-TO-ACTION ON NCS INITIATIVES IN SOUTHEAST ASIA

There is a strong imperative to scale up NCS, and the private sector has a critical role to play. Be it stimulating investment, advocating for policy development, creating financial partnerships to de-risk NCS projects, or advancing technologies to support project implementation and monitoring, companies have a myriad of options to support the global transition towards a low-carbon economy. A lot is at stake: figures highlighting NCS' annual mitigation potential of 10-12 GtCO₂, as well as the land use sector's annual emissions of 12 Gt CO₂e over the last decade, are a reminder that nature represents a massive immediate climate opportunity – and a dangerous climate risk if current trends continue (United Nations Global Compact, 2020).

When evaluating opportunities to invest in mitigation technologies, companies should consider how the options align with their climate action strategies, what the total return-on-investment the options offers (including financial, carbon, and non-carbon benefits), and the geographic relevance of the investment. To summarise key takeaways:

- Strategic alignment considerations include how NCS links to financial performance and integration into corporate emissions reduction strategies.
- Return on investment for mitigation technologies have many dimensions, including capital expenditures, project establishment costs, time horizon, among others. NCS pathways are often unique in their ability to simultaneously provide biodiversity benefits, climate resilience, and climate adaptation benefits through a single project.
- Non-carbon benefits include the social, economic, and environmental outcomes that projects may generate – such as income generation for local communities, and other ecosystem services like flood prevention.
- Geographic relevance will be defined by each company's operations and supply chain locations. For the Southeast Asia region, however, there are broad trends that will be relevant to most businesses and investors in the region. These include potential forest risk, company ambition, and existing action.



The relative attractiveness of NCS opportunities will depend on risk-return expectations, time horizon and other investor objectives and attributes. NCS and other technologies are not mutually exclusive – both have important roles in addressing the climate crisis. NCS, while currently underrepresented in many companies’ mitigation portfolios, can often prove more aligned with companies’ climate strategy as well as their broader sustainable or responsible business priorities than typically assumed.

In Southeast Asia, both the widespread existence of carbon potential and favourable demand projections suggest a strong market opportunity for investing in NCS project origination. Whenever NCS aligns with their broader corporate climate strategies, companies are encouraged to take a more active role in supporting upfront project design and origination costs, in order to capture higher ROI opportunities, take advantage of new technologies to validate emissions reductions, and support the development of a robust carbon pipeline in the region, which will further encourage NCS carbon investments. Companies should commit to purchasing high-quality carbon credits (as defined in Box 5), providing fair, equitable prices that cover the costs of generating, monitoring and verifying high value carbon credits through an approach that provides fair incentives and rewards to all rightsholders and stakeholders through an agreed benefit sharing plan developed in a participatory and transparent manner.

Yet, companies’ actions do not take place in a vacuum. The presence – or absence – of a supportive policy environment can make or break companies’ efforts in

advancing NCS. In Southeast Asia, the ASEAN member states need to make significant and swift progress if their NDC goals are to be met and their NCS potential fully realised. Currently, the region lacks the institutional, technological, financial and governance capacities to achieve their NDCs. Furthermore, the only ASEAN country currently with an established compliance carbon pricing system is Singapore. For countries that have higher institutional and technical capacity, ASEAN countries should institute carbon pricing mechanisms – which presents an opportunity for incorporating NCS – through taxes, or quantity controls that have tradeable emissions permits (Paltsev et al., 2018). Depending on the type and design of the carbon pricing instrument, it may be appropriate to include land as a “covered sector”, allowing for offsets from NCS under an ETS, reducing one’s tax burden under a carbon tax, and/or use tax revenues toward conservation efforts. For those countries that do not have adequate institutional capacities, they are recommended to focus initially on technology-specific policies. Creating a “Regionally Determined Contribution” (RDC) for ASEAN member states could encourage additional participation to accelerate the implementation and achievement countries’ NDCs. Given the impact that government climate policy and carbon market structures can have on their NCS operations, companies should be mindful of these recommendations in their engagement with the government and advocacy for NCS.

The cost of inaction on climate change on future generations and economies is far too great to ignore. Businesses have a menu of pathways from which to design an investment strategy to support a climate-resilient and sustainable economy while using their unique financial, operational, and social capacities. Many of these pathways have been pioneered by communities, governments, and fellow peers in the private sector – and are ready to scale. Now, as the world stands on a precipice, it is up to businesses to demonstrate leadership and realise the full potential of NCS – because the road to sustainability is not just a moral one, but a profitable one as well. As described in a popular proverb, “the best time to plant a tree was 20 years ago. The next best time is now.”

VIII. GLOSSARY

Additionality: Additionality is an essential criterion for credits in all standards and schemes. A credit is considered additional if the emissions reduction that underpins the credit would not have occurred in the absence of the activity that generates the credit (the business-as-usual scenario) (The World Bank, 2018)

American Carbon Registry (ACR): The American Carbon Registry (ACR) was founded in 1996 as the GHG Registry, the first private voluntary GHG registry in the USA, by the environmental non-profit organization Environmental Resources Trust (ERT). In 2007, ERT and its registry became part of Winrock International, a non-profit based in the USA. The American Carbon Registry Standard outlines the eligibility requirements for registration of project-based carbon offsets, and includes requirements for methodology approval, project validation and verification, and other procedural requirements and information on the general use of the American Carbon Registry (American Carbon Registry, 2019).

BioCarbon Fund: The BioCarbon Fund is a public-private sector initiative managed by the World Bank and supports projects that generate multiple revenue streams, combining financial returns from the sale of emission reductions (i.e., carbon credits) with increased local incomes and other indirect benefits from sustainable land management practices (BioCarbon Fund, 2017).

Blue Carbon: Blue carbon refers to the carbon captured by the world's ocean and coastal resources. This includes, inter alia, mangroves and seagrasses.

Business-as-Usual (BAU) Scenarios: Business-as-usual or BAU scenarios have long been considered an essential point of reference in policymaking, planning and investment – a baseline to compare alternative scenarios, or a starting point for analysis of a system. (Grantham Institute, 2017)

Carbon Credit: One carbon credit is equivalent to one tonne of carbon dioxide (or carbon dioxide comparable gas).

Carbon Market: Carbon markets aim to reduce GHGs emissions cost-effectively by setting limits on emissions and enabling the trading of emission units, which are instruments representing emission reductions (UNDP, 2020).

Carbon Offsetting and Reduction Scheme for International Aviation (CORSA): CORSIA was created by the International Civil Aviation Organization (ICAO) and formally adopted in 2016. It is an emissions trading scheme for the global airline industry.

Carbon Pricing: The World Bank defines “carbon pricing” as the variety of initiatives that put an explicit price on GHG emissions expressed in a monetary unit per tCO₂e (World Bank Group, 2020).

Carbon Prospecting: The activity of discovering the highest potentiality of carbon-rich areas through science-based methodologies.

Clean Development Mechanism (CDM): As defined by the Kyoto Protocol (Annex B Party), a Clean Development Mechanism “allows a country with an emission-reduction or emission-limitation commitment to implement an emissions-reduction project in a developing country” to offset their own emissions (UNFCCC, 2020c).

Climate Action Reserve (CAR): CAR is a North American offset program and verification standard that focuses on ensuring transparency and integrity of GHGs emissions reductions projects, particularly in the U.S. carbon market.

Co-benefits: Co-benefits are a win-win strategy aimed at capturing both development and climate benefits in a single policy or measure (Miyatsuka & Zusman, 2009). With natural climate solutions, examples of co-benefits would include, inter alia, greater ecosystem resilience, increase in biodiversity, and local and regional economic opportunities.

Compliance Carbon Markets: Compliance carbon markets are marketplaces through which regulated entities obtain and surrender emissions permits (allowances) or offsets in order to meet predetermined regulatory targets. In the case of cap-and-trade programs, participants – often including both emitters and financial intermediaries – are allowed to trade allowances in order to make a profit from unused allowances or to meet regulatory requirements (Forest Trends, 2020).

Decarbonisation: Decarbonisation refers to reduction of carbon through projects, technologies, or mitigation practices.

Development Financial Institutions (DFI): DFI are specialized development banks or subsidiaries set up to support private sector development in developing countries. They are usually majority-owned by national governments and source their capital from national or international development funds or benefit from government guarantees. This ensures their creditworthiness, which enables them to raise large amounts of money on international capital markets and provide financing on very competitive terms (OECD, 2020a).

Electric Vehicles (EVs): EVs are vehicles that only run on electricity. There are three main types of EVs which are classed by the degree they rely on electricity as their main source.

Emissions Abatement: “Abatement” is another term for “reduction” (of emissions).

Emissions Trading Systems (ETS): Also known as “environmental taxation” is one of the most efficient (i.e. cheapest) and effective ways at reducing GHG emissions (OECD, 2020b).

Energy Efficiency Existing Ship Index (EEXI): EEXI is a mandatory technical and operational procedure protocol created by the International Maritime Organization to improve the overall energy efficiency of ships to reduce overall GHG emissions in the shipping transportation sector. This would require ships to meet energy efficiency objectives, as well as mandatory power limitations for ships (IMO, 2019).

Green Climate Fund (GCF): At COP 16 held in Cancun, the Parties agreed to decision 1/CP.16 which established the GCF. Under Article 11, the GCF was established the operating financial mechanism of the Convention. It works under the guidance of the COP to assist countries in decarbonisation (UNFCCC, 2020b).

Greenhouse Gases (GHG): Greenhouse gas is any gas that has the property of absorbing infrared radiation (net heat energy) emitted from Earth's surface and reradiating it back to Earth's surface, thus contributing to the greenhouse effect. Carbon dioxide, methane, and water vapour are the most important greenhouse gases (Mann, 2020).

Insetting (of carbon): Carbon insetting is very similar to carbon offsetting, except the activities that lead to carbon footprint reduction take place within the context of the value chain. It is about businesses investing in the ecosystems their suppliers depend on to increase their resiliency and provide significant, measurable benefits to communities surrounding the value chain. (Native Energy, 2018).

Internal Carbon Taxes: An internal carbon fee is a monetary value on each ton of carbon emissions, which is readily understandable throughout the organization. The fee creates a dedicated revenue or investment stream to fund the company's emissions reduction efforts. The observed price range for companies using an internal carbon fee is from \$5-\$20 per metric ton. (C2ES, 2017).

International Maritime Organization (IMO): IMO is the United Nations specialised agency with responsibility for the safety and security of shipping and the prevention of marine pollution by ships (IMO, 2020).

Kyoto Protocol: The Kyoto Protocol was adopted on 11 December 1997. The Kyoto Protocol operationalises the UNFCCC by committing industrialized countries and economies in transition to limit and reduce GHG emissions in accordance with agreed individual targets” (UNFCCC, 2020d).

Leakage: Leakage is the unintended increase in GHG emissions caused by a project”; i.e. the avoidance of deforestation in one area leads to deforestation and/or degradation in another area (Gillenwater, 2012).

Mitigation Pathways: Mitigation is the process of reducing emissions or enhancing sinks of GHG so as to limit future climate change. Both adaptation and mitigation can reduce and manage the risks of climate change impacts (IPCC, 2014).

Mitigation Technologies: Mitigation technologies are technological adaptations that assist in the decarbonisation within the industry and supply chain setting.

Paris Agreement: The Paris Agreement’s central aim is to strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius (UNFCCC, 2020e).

- **Article 6:** Under Article 6 of the Paris Climate Agreement, countries have agreed to establish a new global carbon market to assist individual countries in decarbonising their economies.

Permanence: Permanence is the likelihood of carbon mitigation projects to permanently “lock-in” the carbon in order to avoid the reversibility of emissions reductions.

Plan Vivo: The Plan Vivo Standard certifies the implementation of project activities that enhance ecosystem services and allow communities to formally recognise and quantify carbon sequestration, biodiversity or watershed protection (Plan Vivo, 2020).

Nationally Determined Contributions (NDCs): NDCs are at the heart of the Paris Agreement and the achievement of these long-term goals. NDCs embody efforts by each country to reduce national emissions and adapt to the impacts of climate change. The Paris Agreement (Article 4, paragraph 2) requires each Party to prepare, communicate and maintain successive NDC that it intends to achieve. Parties shall pursue domestic mitigation measures, with the aim of achieving the objectives of such contributions (United Nations Framework Convention on Climate Change, 2020).

Natural Climate Solutions: Natural Climate Solutions are the conservation, restoration, and/or improved land management actions that increase carbon storage and/or avoid GHG emissions across global forests, wetlands, grasslands, and agricultural lands (Griscom et al., 2017).

Net zero: Net zero emissions are achieved when anthropogenic emissions of GHG to the atmosphere are balanced by anthropogenic removals over a specified period. Where multiple greenhouse gases are involved, the quantification of net zero emissions depends on the climate metric chosen to compare emissions of different gases (such as global warming potential, global temperature change potential, and others, as well as the chosen time horizon) (IPCC, 2018).

Offset Mechanisms: A GHG or carbon offset is a unit of carbon dioxide-equivalent (CO₂e) that is reduced, avoided, or sequestered to compensate for emissions occurring elsewhere. These offset credits, measured in tons, are an alternative to direct reductions for meeting GHG targets in a cap-and-trade system. In some systems, regulated facilities can buy offset credits from projects located in sectors or countries not legally required to reduce their emissions. The cost of meeting the GHG reduction targets of a cap-and-trade program can be reduced by buying offsets in cases where reducing GHG emissions at uncapped facilities or sectors is less costly than at capped sources. Many businesses and organizations currently buy GHG offsets to help meet voluntary commitments to reduce their GHG emissions (Goodward & Kelly, 2010).

REDD+ (Reducing Emissions from Deforestation and Forest Degradation): The aim of REDD+ is to encourage developing countries to contribute to climate change mitigation efforts by: i) reducing GHG emissions by slowing, halting and reversing forest loss and degradation; and ii) increasing removal of GHGs from the earth's atmosphere through the conservation, management and expansion of forests (FAO, 2020).

Reduced-Impact Logging for Climate (RIL-C): RIL-C is proposed as a way to maintain timber production while minimizing forest damage (Ellis et al., 2019). RIL-C techniques include reducing wood waste, more care in the direction of felling, the building of fewer and narrower access roads, the mapping-out of skid routes, and the use of specialist forestry equipment such as winches instead of bulldozers (The Nature Conservancy, 2020).

Results-Based Climate Finance (RBCF): Results-Based Climate Finance (RBCF) is a financing modality under which funds are disbursed by an investor or donor to a recipient upon the achievement of a pre-agreed set of results, with achievement of these results being subject to independent verification. Results-Based Climate Financing (RBCF) can therefore be understood as RBF provided specifically for climate mitigation or adaptation results (World Bank Group: Frankfurt School of Finance and Management, 2017).

Safe Operating Space: 'Planetary boundaries' are boundaries that define the safe operating space for humanity with respect to the Earth system and are associated with the planet's biophysical subsystems or processes. Identifying and quantifying planetary boundaries that must not be transgressed could help prevent human activities from causing unacceptable environmental change (Rockström et al., 2009).

Science-Based Targets: Science-based targets provide companies with a clearly defined pathway to future-proof growth by specifying how much and how quickly they need to reduce their greenhouse gas emissions. Targets adopted by companies to reduce greenhouse gas (GHG) emissions are considered "science-based" if they are in line with what the latest climate science says is necessary to meet the goals

of the Paris Agreement – to limit global warming to well-below 2°C above pre-industrial levels and pursue efforts to limit warming to 1.5°C (Science Based Targets, 2020a).

SME: A non-subsidiary, independent company that employs fewer than 500 employees

United Nations Framework Convention on Climate Change (UNFCCC): The United Nations Framework Convention on Climate Change has near universal membership (197 Parties) and is the parent treaty of the 2015 Paris Agreement, as well as the 1997 Kyoto Protocol. The ultimate objective of all three agreements under the UNFCCC is to stabilize greenhouse gas concentrations in the atmosphere at a level that will prevent dangerous human interference with the climate system, in a time frame which allows ecosystems to adapt naturally and enables sustainable development (UNFCCC, 2020a).

Units of Carbon Measurement:

- **Carbon (C):** An organic chemical element. When burned, carbon dioxide can be produced.
- **Carbon Dioxide (CO₂):** A greenhouse gas produced by burning carbon.
- **Metric ton of Carbon:** One metric ton is equal to approximately 2,205 pounds.
- **Teragrams of Carbon (TgC):** Equivalent to 1 million metric tons of C.
- **Megatons of Carbon (MgtC):** Equivalent to 1 million tons of C.
- **Gigatons of Carbon (GtC):** Equivalent to 1 billion metric tons of C.

VERRA: Verra was a founding member of the Initiative for Climate Action Transparency (ICAT). Verra's standards and frameworks vet environmental and sustainable development efforts, build their capacity and drive large-scale investment to them to sustain and scale up their benefits. Verra now serves as a secretariat for the various standards they develop and programs they manage (Verra, 2020c).

VERRA Verified Carbon Standards (VCS): The VERRA Verified Carbon Standards work to ensure the credibility of emission reduction projects. Once projects have been certified against the VCS Program's rigorous set of rules and requirements, project developers can be issued tradable GHG credits that are called Verified Carbon Units (VCUs). Those VCUs can then be sold on the open market and retired by individuals and companies as a means to offset their own emissions (Verra, 2020b).

VERRA Jurisdictional and Nested REDD+ (JNR): JNR is a global, jurisdiction-level REDD+ framework rigorous enough to meet the needs of market-based mechanisms around the world, such as the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) of the ICAO. JNR was specifically designed to facilitate private investment in REDD+ at multiple scales and is therefore well-aligned with the Paris Agreement's objectives of engaging the private sector, while linking to national efforts, as well as providing emission reductions to emerging compliance and voluntary markets (Verra, 2020a).

World Bank Forest Carbon Partnership Facility (FCPF): The Forest Carbon Partnership Facility (FCPF) is a global partnership of governments, businesses, civil society, and Indigenous Peoples focused on reducing emissions from deforestation and forest degradation, forest carbon stock conservation, the sustainable management of forests, and the enhancement of forest carbon stocks in developing countries, activities commonly referred to as REDD+. Launched in 2008, the FCPF now works with 47 developing countries across Africa, Asia, and Latin America and the Caribbean, along with 17 donors that have made contributions and commitments totalling \$1.3 billion. (Forest Carbon Partnership Facility, 2020).

IX. ANNEX

A. NCS' Carbon Potential

The figure below displays the range of potential mitigation that can be achieved through various pathways. Technical potential refers to what is possible with current technologies, economic is what is potential mitigation with economic constraints, and sustainable potential is either technical or economic potential constrained by sustainability issues.

SUPPLY-SIDE MEASURES (LAND MANAGEMENT)



(Roe et al., 2019)

B. Supplemental Notes to Model NCS Cases

GENERAL ASSUMPTIONS

Choice of Carbon Crediting Scheme

For all pathways, we assume that representative projects are agriculture, forestry and other land use (AFOLU) projects pursuing certification under both the VCS and the Climate, Community, and Biodiversity (CCB) Standards and are thus eligible for issuance of VCUs tagged with a CCB label.

The majority of voluntary carbon market issuances are under VCS certification programs. The CCB label, which certifies the project possessing biodiversity, community and climate benefits, is a market accepted proxy for high quality credits. Informed by our experience carbon credits from AFOLU this combination is preferred by the voluntary market.

Carbon Voluntary Market Prices

For all pathways, we use reference voluntary market carbon prices from recent CI projects which are, in most cases, above the global median prices reported by Ecosystem Marketplace in its most recent voluntary market trends report (see below).

Ecosystem Marketplace: Selected Voluntary Market Price Trends (in USD\$)						
Category	Unit	2018	2017	2016	CAGR	
Forestry & Land Use (All)	USD\$ tCO ₂ e	\$ 3.20	\$ 3.40	\$ 5.10	-20.79%	
REDD+	USD\$ tCO ₂ e	\$ 2.35	\$ -	\$ 4.40	-26.92%	
Reforestation (A/R)	USD\$ tCO ₂ e	\$ 5.70	\$ -	\$ 8.10	-16.11%	
Improved Forest Management (IFM)	USD\$ tCO ₂ e	\$ 8.15	\$ 9.32	\$ -	-12.55%	
Labeling Scheme						
VCS + CCB	USD\$ tCO ₂ e	\$ 2.49	\$ -	\$ 3.90	-20.10%	
VCS Alone	USD\$ tCO ₂ e	\$ 2.70	\$ -	\$ 2.30	8.35%	

(Forest Trends, 2019b)

Project Ownership; Land Tenure

For all pathways, we presume project sponsors currently possess or have secured necessary legal authority and rights to develop, implement and manage underlying land interests prior to the project start date. Due to the considerable variation in land tenure arrangements, our analysis does not contemplate the costs associated with the negotiation, purchase, acquisition, or leasing rights to project sites, with the exception of RIL-C in which forest rents (in the form of royalties, taxes, and fees) are customarily included in financial performance calculations.

Rights to Verified Carbon Units

The VCS process requires that a project proponent be named in the project documentation. The project proponent needs to have rights to develop and commercialize the tons.

Unit Conversion

In some cases, estimates of greenhouse gas emissions, and emissions reductions and removals were stated in units that differed across case studies and publications. For purposes of this analysis, estimates presented in tons (tC), megatons (MgtC), or gigatons of carbon (GtC) were converted to carbon dioxide (CO₂) using the molecular ratio of carbon dioxide to carbon (44/12)—i.e. 1tC = 3.67 tCO₂. To enable comparison of emissions related data, all emissions

measures (including non-carbon dioxide greenhouse gases) are converted to metric tons of carbon dioxide equivalent (tCO₂e) using standardized Global Warming Potential (GWP) values (Greenhouse Gas Protocol, 2016).

Discounted Cash Flow Model

Estimated returns are calculated using traditional discounted cash flow (DCF) approaches and expressed using the following DCF return metrics: internal rate of return (IRR), net present value (NPV). In addition, we presented undiscounted return measures: payback period and multiple of invested capital (MOIC). Computed returns are presented for the entire project period and for interim 10 and 20-year periods.

For return metrics which require specification of a discount rate, we have computed a model discount rate based on an assumed project capitalization structure (debt and equity) and expected returns (financing costs) on debt and equity using data derived from published Singapore prime bank lending rates and the sector-adjusted cost of equity benchmark rates specified for CDM projects (UNFCCC, 2017).

REDUCED EMISSIONS FROM DEFORESTATION AND DEGRADATION (REDD)

1. Introduction

REDD+ is a United Nations-backed framework that aims to curb climate change by stopping the destruction of forests. REDD stands for "Reducing Emissions from Deforestation and forest Degradation"; the "+" signifies the role of conservation, sustainable management of forests and enhancement of forest carbon stocks.

REDD+ helps countries value the carbon and ecosystem services their forests provide, and create financial incentives to reduce deforestation (when forests are converted to other uses, such as agriculture); reduce degradation (when forests lose their ability to provide ecosystems services); and promote sustainable management (ensuring social, ecological and economic benefits for future generations).

Put simply, REDD+ is the framework through which countries, the private sector, multilateral funds and others can pay countries to *not* cut down their forests. This can take the form of direct payments or can be in exchange for "carbon credits," which represent reductions in greenhouse gas emissions to compensate for emissions made somewhere else. As countries are trying to meet their Paris Agreement targets, or nationally determined contributions, REDD+ is an important NCS pathway that can help countries achieve their Paris goals and seek higher ambition in reductions.

2. Baseline Scenario: Unplanned Deforestation

A critical and initial element in designing a REDD+ program is to consider the underlying drivers for deforestation. The causes for deforestation varies widely by region but broadly can be classified as Planned drivers of deforestation (e.g. laying of a highway, or other infrastructure development) or unplanned deforestation that is, projects which occur on currently forested lands where conversion to non-forest land use is not legally authorized—and where the baseline agents of deforestation include clearing of land for settlements, and non-industrial, small-scale crop production (agriculturalist) or ranching^{xiii}. Understanding the underlying driver of deforestation is key to designing successful countermeasures to avoid deforestation in future. These measures can include inclusion of a sustainable livelihoods components that disincentivises the communities need to deforest.

While REDD+ may encompass actions responsive to multiple natural climate solution pathways, we have narrowed the scope of our analysis to focus representative projects that are intended to generate emissions reduction benefits from the avoidance of unplanned deforestation in a specified project area. This is in line with the nature of deforestation in Southeast Asia, which is illegal logging, small scale and subsistence agriculture.

3. Verified Carbon Standard Methodology; Project Eligibility

In addition to the foregoing, the following general assumptions concerning the representative project shall apply: 1) the analysis is being conducted at project-scale; and 2) the project is presumed to meet the basic eligibility requirements specified in the VCS REDD+ Methodology Framework (VM0007), Version 1.5 (Verra, 2015a).

4. Project Spatial Boundaries

The model case assumes a hypothetical project in Cambodia encompassing 500,000 hectares (ha). The representative project assumes that forest conservation efforts are already underway in the project area, and carbon project development will be implemented. It is useful to note that several REDD+ carbon projects follow a similar pathway, though not exclusively.

5. Project Temporal Boundaries

PROJECT START DATE

The project start date is 2020 (model t_0) and represents the period from which project development and/or establishment activities commence.

PROJECT DEVELOPMENT PERIOD

During the Project Development and/or establishment period, the project proponent conducts necessary technical analysis, feasibility studies, and stakeholder engagement and prepares required project documentation to be registered as an approved project. Depending on the extent of technical analysis and stakeholder consultations required, the Project Development period can take between 1 to 3 years. For purposes of this analysis, this process is assumed to take two (2) years.

IMPLEMENTATION PERIOD START

Project implementation is assumed to begin two (2) years from the Project Start Date and coincides with the start of the project crediting period. Project Implementation is assumed to commence after submission and validation of initial required project documentation.

PROJECT IMPLEMENTATION PERIOD (DURATION)

The Project Implementation Period duration is defined as the period during which project activities occur and credits are generated. For purposes of the model case, we assume that the Project Implementation Period is thirty (30) years from t_2 .

6. Carbon Crediting Assumptions

PROJECT CREDITING PERIOD

The period of time for which project emissions reductions and removals are eligible for crediting within the VCS Program. Under the applicable VCS methodology, the project crediting period for REDD+ must be between 20 and 100 years. For the purposes of this analysis, the duration of this project is 30 years beginning in t_2 , as is common with many projects of this type.

PERIOD OF FIRST CREDIT ISSUANCE

Registered projects can request for issuance of carbon credits upon submission of a verification report. The verification involves an accredited third-party verification firm ensuring the project is being implemented as per plan and approving the issuable carbon credits for the verification period. In some cases, the VCS protocol allows for

granting of retroactive credits when project has been protecting the area through conservation efforts prior to actual carbon project start date. For purpose of this example, we assume that credits are issued upon submission and acceptance by the crediting body of the verification report at Year 2 (period t_2) and no retroactive credits are considered.

CREDIT ISSUANCE INTERVAL

During the eligible crediting period, project proponents may elect to issue credits as-generated or on some other issuance interval (but in any case, at least every 5 years). In each case depending on project carbon cash flow requirements, CI has sometimes elected to issue credits every two years to reduce the frequency of project verification (and thus verification costs). However, for purposes of this analysis, we assume that credits are issued on an annual basis as-generated.

NON-PERMANENCE; BUFFER POOL ALLOCATION

Non-permanence risk involves the risk of losing the carbon stocks in the future which would make the already issued credits without an underlying asset. The VCS protocol provides a non-permanence risk tool which determines the percentage of issues credits that is required to be set-aside for non-permanence buffer requirement. This ranges between 10-30% of each issuance. At the end of the crediting period, non-permanence risk is re-evaluated and portion of the buffer may be released. For purposes of this analysis, we assume a buffer requirement of 15% held indefinitely for project.

7. Carbon Price Assumptions

Within the voluntary markets, no standard price for carbon offsets exists. Offset prices depend on a host of factors, including project type, location, project non-carbon attributes, volume transacted etc. For the case study, the project is assumed to be a registered VCS REDD+ projects alongside CCB label, The CCB label provides quality assurance that the project has met the Community, Climate and Biodiversity standards. REDD+ projects that qualify for VCS and CCBA are considered high-quality projects and frequently command price premium and greater market access.

For purposes of this analysis, we identify an expected voluntary market credit price of US \$7.50 tCO₂e⁻¹, which pricing is consistent with sales of high-quality REDD+ credits marketed by CI. As noted elsewhere in this report, nature-based carbon credits currently do not have a standard carbon reference price, although efforts are on to design such products. Carbon price depends on a host of project specific factors including geography, project type, co-benefits, vintage, transaction volume to name a few.

8. Carbon Transaction Costs

Transaction costs include VCS published fees and costs associated with VCU registration and issuance and CCB labelling fees (Verra, 2018). In addition, we include brokerage fee assumptions which may apply for private issuers.

9. Emissions Abatement

In the REDD+ case, the primary drivers of estimated emissions reductions and removals are the project area and project net deforestation rate. In general, the process of estimating emission reductions involves first estimating the carbon stocks in the project area. This involves estimating the carbon density of various carbon pools in the forest that are eligible for crediting. The second step entails a determination of the deforestation rate in the region and the risk of non-permanence. Once these are factors are determined, the protocol allows for crediting the net carbon from avoided deforestation, as result of conservation activities, minus the volume of credits set-aside to meet non-permanence losses (buffer pool), any project emissions, and emission to account for leakage.

The potential for project-scale emissions reductions and removals are dependent on a range of regional, and site-specific land use, land cover and other ecological factors as well as the specific protection, management, or restoration practices being undertaken.

BASELINE FORESTED AREA

The Baseline Forested Area is assumed to be the baseline forested area at the start of the Project and is the same as the Project Area (500,000 hectares).

BASELINE DEFORESTATION RATE

Baseline Deforestation Rates are derived from Global Forest Watch (<https://globalforestwatch.org/>). As described earlier, the major cause of deforestation involves small scale clearings for the cultivation of crops, typically cash crops, and illegal logging that is driven by a combination of poverty, socio-economic need, in-migration, and poorly defined property rights, compounded to an extent by local population growth. The observed deforestation rate primarily emanating from these drivers is 0.50%.

PROJECTED DEFORESTATION RATE

Projected deforestation rates for the first five (5) years and subsequent periods are estimated.

PROJECT EFFECTIVENESS

This is a measure of project implementation effectiveness. We factor in an effectiveness rate to the future projected deforestation rate. This is a conservative way to model. The other approach is to assume 100% effectiveness, and factor in leakage and project emissions every verification. For purposes of this analysis, we assume an effectiveness rate of 50%. This suggests that the project interventions would be able to halt deforestation by half the estimated rates. This is a conservative assumption.

AVERAGE CARBON STOCK

Data on average carbon stocks are derived from the REDD UNFCCC report entitled “Initial Forest Reference Level for Cambodia under the UNFCCC Framework,” dated July 22, 2016 (UNFCCC, 2016).

10. Project Development; Establishment Costs

Development and/or establishment costs comprise of costs associated with development and approval of the project as a registered carbon generating project as per the protocol. These costs typically include the following categories, noting that not all categories will be applicable to all projects.

Table 6. Description of Common Establishment Costs for REDD+ Projects

Stakeholder Consultation Process	<p>These include costs associated with engaging and building capacity with stakeholders. Stakeholder include local communities, indigenous people, private and public sector etc. Stake holder consultation involves costs associated with detailed mapping of stakeholders and engagement with them to ensure participation and consensus around project goals.</p> <p>Under this category, activities such as Developing conservation agreements, obtaining Free and Prior Informed Consent (FPIC), Community Mapping, Participatory appraisals, Socio Economic Safeguards, Government Consultation, carbon project education are included.</p>
Feasibility studies & Technical Analysis	<p>Feasibility Studies: Costs associated with carbon rights, Biodiversity and Environmental safeguards assessment, Rapid economic assessment of project Viability.</p> <p>Technical Analysis: Baseline Determination, GHG/Carbon stocks Assessment and ground truthing (field measurements), Satellite imagery, Scenario modelling,</p>
Methodology Development	Costs associated with development of new methodology or refinement of existing methodology. These costs are not required when an existing methodology is applicable to the project.
Project Design Document (PDD)	Costs associated with PDD drafting. These costs vary subject to the quality of the technical analysis and stakeholder engagement work done. PDD's requires detailed description of program activities backed by robust data.
Project Validation	These costs cover costs of project validation (Validator fee, travel and other related expenses). The first verification is sometimes clubbed with project validation to reduce costs.
Development of Monitoring Plans	Project monitoring plans including carbon biodiversity and Socio-Economic monitoring
Institutional Capacity Building	These costs include building capacity and knowledge in local institutions include items such as Nesting Process, costs for policy changes, staff training etc.
Communications plan	Development of communication material and other knowledge products
Development of Strategic Management Plans	Costs associated with developing gender rights strategy, Indigenous rights strategy, and health and safety strategy.
Miscellaneous Costs	Launch & other Promotional events.

Establishment costs especially those involving stakeholder consultation, institutional capacity building can be more variable on costs and time required. This is because these involve building consensus and agreement with a diverse group of stakeholders or involve change in policy and capacity with institutions which takes time.

11. Project Implementation Costs

Implementation costs involve the composite of costs associated with operating the project through its lifetime.

Table 7. Description of Common Implementation Costs for REDD+ Projects

Sustainable Livelihoods	Sustainable livelihood costs, and specific component broken down as per individual projects. This include alternate livelihoods such as bee keeping, agroforestry, Sustainable coffee, etc.
Protection Activities	Enforcement & Patrolling, Policy changes, additional staffing,
Infrastructure and Equipment	Rangers equipment, monitoring systems, associated maintenance costs
Community Engagement, Capacity Building	Continuous training and workshops, consensus building activities etc., community life plan workshops
Implementation of Monitoring Plans	Biodiversity monitoring, social impact monitoring
Management Plans	Revision of management plans, costs for Adaptive management plans, community life plans
Restoration Implementation Activities	Restoration, planting, inputs etc., as per project activity, as defined by project requirements
Communications	On-going communications costs
Institutional Governance	Local and state government training, policy initiatives
Research	Any research initiatives

For the model project, estimated implementation costs over the life of the project are US \$58.425 million or an average of US \$1.885 million per annum. Estimated costs of sustainable livelihood activities comprise the largest proportion of project implementation costs (53.1%) and reflect the critical need to invest in viable economic alternatives to unsanctioned clearing of forests for small-scale agriculture and other activities that are identified as key drivers of deforestation.

12. Project Verification Costs

These refer to the costs incurred with each verification event. The VCS protocols do not require verification every year and provide the option to the project proponent to verify at least once in five (5) years. If market demand and other constraints permit, bundling the verification for multiple years helps reduce overall costs associated with verification.

Once project is verified and the volumes of credits approved for the crediting period, the project proponent may request the carbon standards program to issue the credits in an eligible electronic registry. The point of issuance triggers an issuance fees for the carbon alongside any additional labelling fees.

Table 8. Description of Verification Costs

Technical costs	Technical costs associated with project verification, classification of satellite imaging, mapping, update of data bases and other technical analysis for Verification readiness
Verification	Costs of project verification

13. Model Results & Discussion

PROJECT EMISSIONS ABATEMENT

Estimated project emissions abatement project over a 30-year crediting period are 14.2 million tCO₂e (average 458,745 tCO₂e yr⁻¹) assuming a deforestation rate of 0.50% per annum and an effectiveness rate of 50% over the project lifespan.

REQUIRED INVESTMENT & USE OF PROCEEDS

Estimated total financing requirements for the model REDD+ project are US \$4.9 million, with a payback period of 7.3 years. Financing is primarily used to cover initial project preparation, validation and start-up costs incurred prior to the generation and issuance of verified carbon credits.

Compared with the RIL-C and mangrove restoration cases included in this analysis, the REDD+ model case has the lowest per-hectare financing requirements taking the total project area under consideration (~US \$9 ha⁻¹ versus US \$500 and US \$1,253, respectively) indicating the relative cost effectiveness of implementing avoided deforestation strategies, particularly in areas where protected area strategies are already in place.

EXPECTED CASH FLOWS

Income from the sale of verified carbon units are the sole source of project cash inflows considered in the model. After adjustments for non-permanence risk (non-permanence buffer pool allocations), the estimated volume of verified carbon units issued by the project totals 12.1 million, with an average of 389,900 credits issued annually.

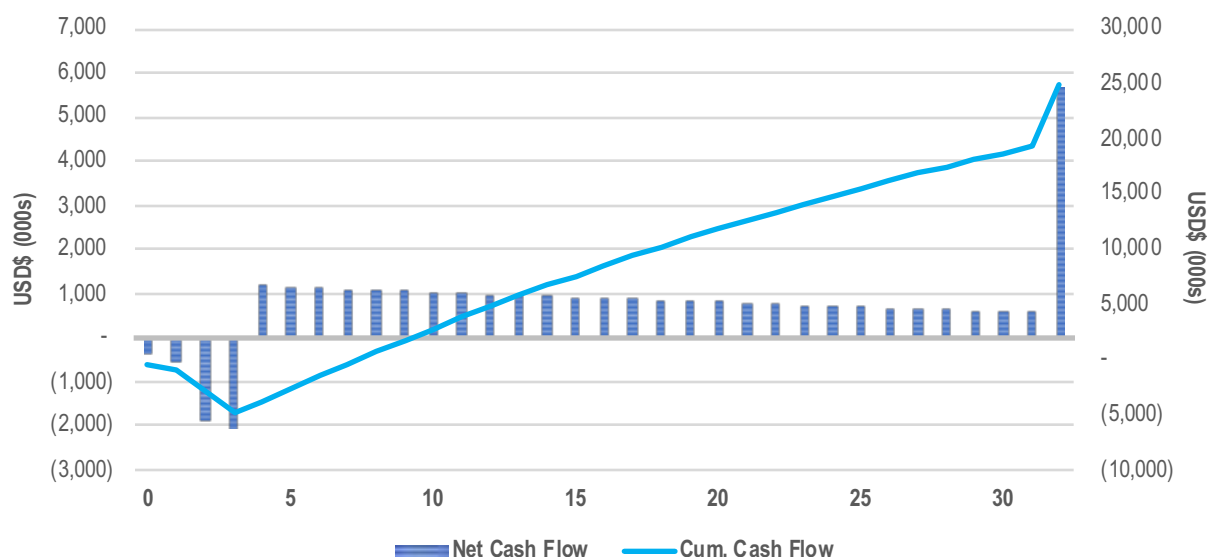
For the purposes of this analysis, we assume that the first verification and issuance of credits occurs in early 2023, with the first sale of credits occurring at the start of 2024 and subsequent verification, issuance and sales occurring on an annual basis.

In practice, the timing and volume of credit issuance by CI varies and is generally based on forecasted next twelve-month (NTM) cash requirements. Credits in excess of near-term project cash requirements are held in reserve to be monetised in later years. This approach reduces recurring verification costs associated with credit issuances.

PERIOD CASH FLOW SUMMARY

Period:	0	1-10	11-20	21-32
Income				
Carbon Sales	-	22,405,350	29,997,314	38,256,779
Other Income	-	-	-	-
Total Income	-	22,405,350	29,997,314	38,256,779
Carbon Project Development Costs	380,200	570,300	-	-
Carbon Project Implementation Costs	-	16,962,213	18,846,904	22,616,285
Carbon Project Verification Costs	-	800,000	1,000,000	1,200,000
Carbon Transaction Costs	-	904,316	1,093,760	1,326,104
Capital Expenditures	-	-	-	-
Other Costs	-	-	-	-
Total Project Costs	380,200	19,236,829	20,940,664	25,142,389
Project Net Cash Flows	(380,200)	3,168,520	9,056,650	13,114,391

FORECASTED CASH FLOWS



EXPECTED RETURNS

The model case assumes a base case voluntary market carbon price of US \$7.50 which is consistent with voluntary market REDD+ credit issuances for comparable CI transactions.^{xiv} Based on the stated price and above-referenced emissions abatement assumptions, the model REDD+ project is expected to generate an IRR of and NPV^{xv} of 18.28% and US \$1.68 million, respectively, over the 30-year crediting period.

Compared with other NCS pathways evaluated as part of this analysis, the model REDD+ project is expected to generate the greatest emissions abatement benefit per dollar of investment: 2.90 tCO₂e US\$ required investment⁻¹ compared with .09 tCO₂e and 0.41 tCO₂e for RIL-C and mangrove restoration, respectively.

PROTECT: REDD+

	Unit	Model Value
Project Scale:	hectares (ha.)	500,000
Carbon Price:	USD\$ tCO ₂ e	\$ 7.50
Discount Rate:	%	12.69%

INVESTMENT SUMMARY

	Unit	Model Value
Total Investment:	USD\$	\$ 4,907,186
Total Capital Returned:	USD\$	\$ 29,866,547
Payback Period:	years	7.34
NPV Break-Even Price:	USD\$ tCO ₂ e	\$ 6.90

SUMMARY RESULTS

		10-yrs	20-yrs	32-yrs
Emissions Abatement:	tCO ₂ e-1	4,484,814	9,118,230	14,221,089
IRR	%	10.24%	17.48%	18.28%
NPV	USD\$	\$ (354,356)	\$ 1,186,007	\$ 1,679,956

SENSITIVITY ANALYSIS

Because the sale of verified carbon credits is assumed to be the sole income source for the model REDD+ project, expected project-level financial returns are highly sensitive to changes in voluntary market carbon prices.

Holding all other model assumptions constant, the project NPV break-even price is US \$6.74 which, while still significantly higher than values published in the most recent Ecosystem Marketplace voluntary market reports, remains consistent with prices obtained for recent comparable voluntary market transactions managed by CI.

MANAGE: REDUCED IMPACT LOGGING FOR CLIMATE (RIL-C)

1. Introduction

Reduced-Impact Logging for Climate (RIL-C) refers to a subset of reduced-impact logging (RIL) practices that explicitly focus on reduced carbon emissions from logging activities while maintaining or increasing long-term timber yields. RIL-C is a component of ‘natural forest management,’ the second largest ‘manage’ natural climate solutions pathways (Griscom et al., 2020).

We have selected RIL-C among the broader set of management-focused pathways, due to the comparatively low costs (Ellis et al., 2019) and potential scale of emissions reduction associated with implementation of this strategy in tropical regions (Sasaki et al., 2016).

RIL-C strategies may encompass a range of improved logging and harvest planning practices, including, but not limited to, directional felling, improved log bucking (to permit greater recovery), improved harvest planning via pre-harvest inventory, skid trail planning and/or monocable winching, and reductions in the width of haul roads and the size of log landings.

For purposes of this analysis, we focus on the RIL-C practices as described in Griscom et al. (2019) that form the basis of the applicable VCS methodology and potential emissions reductions (relative to CL) as follows:

FELLING

1. Avoided felling of trees from which no wood is extracted (including both felled tree and collateral damage; and
2. Improved bucking to maximize timber extraction per tree felled, allowing for a reduced total number of trees harvested to deliver the same roundwood volume;

SKIDDING

Improved skidding practices to reduce mortality of non-commercial trees.

HAULING

Reduced haul road corridor widths and sizes of log landings.

2. Verified Carbon Standard Methodology; Project Eligibility

We assume the representative project meets the general project eligibility requirements as described in the *Verified Carbon Standard Methodology for Improved Forest Management through Reduced Impact Logging* (Verra, 2016).

3. Baseline Scenario

For RIL-C, the baseline (business-as-usual) scenario is represented by the baseline performance of conventional logging (CL) operations within the subject project area. For purposes of this analysis, we apply a definition of ‘conventional logging’ as the unplanned and uncontrolled logging of all commercial species. The representative project assumes a transition from conventional logging (CL) to reduced-impact logging (RIL).

4. Project Spatial Boundaries

In connection with the representative case, we assume the representative project is situated in Southeast Asia and occurs within a legally designated production forest area. In defining the project spatial boundaries for assessing both emissions reduction and economic activities, we distinguish between the total project, harvesting or logging, and annual operating areas.

TOTAL PROJECT AREA

For purposes of this analysis, we define the Total Project Area as the area within the spatial boundaries specified in the project owner’s authorized logging concession or permit. In our representative case, we assume that the Total Project Area comprises 30,000 hectares (ha.).

NET HARVEST AREA

For both the RIL-C and CL scenarios, we assume that a certain proportion of the Total Project Area will remain unlogged due to terrain or other operating restrictions or, particularly in the RIL-C case, set aside for conservation purposes. For purposes of our model, we assume that the proportion of the Total Project Area available for logging—that is, excluding unlogged areas is 75% and 90% for the RIL-C and CL scenarios, respectively (the “Net Harvest Area”).

HARVEST (LOGGING) BLOCKS

The Total Project Area is subdivided into a series of smaller harvest (logging) blocks. For purposes of this analysis, we assume that for both the RIL-C and CL cases, the gross area of each harvest block is 1,000 hectares (ha.) and that the Net Harvest Area assumptions described above apply to each block. Further, we assume that for both scenarios, one (1) block is harvested annually. For the avoidance of doubt, forecasted periodic (annual) emissions reduction calculations (and calculations of verified carbon unit issuances), timber harvests, and associated annual cash revenues and costs are evaluated on a per-harvest block basis.

5. Project Temporal Boundaries

For both the RIL-C and CL scenarios, we have defined a project duration of 30 years which is generally consistent with the term of production forest permits and/or concessions issued across Southeast Asian countries. For both the RIL-C and CL scenarios, we assume a project start date at time period 0 (t_0) and that field-based implementation of RIL-C activities commence at period t_1 .

6. Carbon Crediting Assumptions

PROJECT CREDITING PERIOD

For the RIL-C case, we assume a project crediting period of up to thirty (30) years.

PERIOD OF FIRST ISSUANCE

We assume that the first issuance of credits occurs in period t_2 (after completion of project development period).

7. Carbon Price Assumptions

For purposes of this analysis, we assume that verified credits generated by the model RIL-C project are sold at a voluntary market price of US \$ 9.50 tCO₂e which is generally in-line with recent historical pricing for improved forest management (IFM) credits.

8. Emissions Reduction & Carbon Benefit Assumptions

For purposes of this analysis, we incorporate estimates of potential emissions reductions for “Level 1” RIL-C implementation as presented in Griscom et al. (2019) in our model. Level 1 emissions reduction estimates are defined as the “best recorded emissions performance” for RIL-C practices (see below) based on field measurements in nine logging concessions in dipterocarp forests in East and North Kalimantan, Indonesia. Emissions reductions under the assumption of Level RIL-C performance are estimated to be 64.90 tCO₂e ha⁻¹ yr⁻¹ or a total of 1.46 million tCO₂e over the 30-year crediting period.

Implementation of comprehensive logging improvements defined by Griscom et al.(2019) as “Level 2” RIL-C implementation, would result in increased emissions reductions, with estimated abatement levels of 88.62 tCO₂e ha⁻¹ yr⁻¹ or 1.99 million tCO₂e over the crediting horizon.

9. Forestry Assumptions: Cutting (Harvest) Cycle

In connection with this analysis, we reviewed information on cutting cycles as prescribed in policies, laws, and regulations applicable to selective harvest from natural production forests in four (4) Southeast Asian member countries (Cambodia, Indonesia, Malaysia, and Myanmar) of the International Tropical Timber Organization (ITTO), an intergovernmental organization focused on promotion of sustainable management and conservation of tropical forests and the expansion and diversification of international trade in tropical timber from sustainably managed and legally harvested forests. In the sampled countries, minimum and maximum cutting cycles range from 25 to 35 years, respectively, depending on forest type. In our model, we assume a cutting cycle of 30-years for both CL RIL-C which tenor is within the range of prescribed cutting cycles in the region.

10. Forestry Assumptions: Harvest Blocks

The model assumes that a maximum of one (1) 1,000-hectare block is harvested annually under both the CL and RIL-C scenarios.

11. Forestry Assumptions: Harvest Intensity and Yield

HARVEST INTENSITY

Within the applicable VCS methodology, RIL-C eligibility requirements prohibit intentional reductions in harvest levels (projects are assumed to have a leakage of zero—i.e. no difference in harvest levels between the baseline and project scenarios).

For purposes of this analysis, we use selected harvest intensity values (the proportion of harvested tree volume per unit area) as a proxy for estimated timber extraction on a cubic meter per hectare (m³ ha⁻¹) basis for both CL and RIL-C. Harvest intensity values are derived from regionally relevant data published in Ellis (2019), and a comparative cost study published by Medjibe & Putz (2012). In the model, sample median harvest intensity values are used for both the CL and RIL-C scenarios: 73.75 and 56.50 m³ ha⁻¹, respectively.

MARKETABLE TIMBER YIELD

To derive the estimated marketable timber yield under CL and RIL-C practices, we apply adjustments for logging waste and damage to residual stands resulting from logging activities.

There are two major sources of timber waste resulting from forest extraction operations that can be eliminated or reduced through improved logging practices. Losses from marketable logs that are felled but not skidded due to suboptimal extraction planning and skid trail marking can comprise up to 20% of logging wastes. Incidental log damage due to poor felling and bucking practices can also reduce marketable yields. Combined, these logging wastes can result in reductions in marketable yields of between 10% and 53%.

RIL-C practices are designed to improve felling, bucking and skidding practices in a manner that measurably reduces logging wastes from these activities which promote overall ecological improvements both through more efficient extraction and reduced damage to residual tree stands. For purposes of this analysis, we assume that logging wastes are 20% and 50% for RIL-C and CL, respectively.

In addition to accounting for logging wastes, our model assumes that improved logging practices under RIL-C result in improvements to next-cycle yields as a result of reduced damage to residual tree stands during the first cutting cycle. For purposes of our model, we apply the residual stand performance estimates under both CL and RIL practices published in Healey, Price & Tay (2000) to derive estimates of next harvest cycle marketable yields as follows: 31% increase in next cycle yields under the RIL-C scenario and a 38% decrease in marketable yields for CL assuming extraction intensity remains consistent with initial cycle assumptions.

12. Timber Prices

TIMBER PRICES

For each of the above-referenced countries, unit export^{xvi} prices for tropical roundwood (non-coniferous) for the most recent prior four-year period were derived from the ITTO Biennial Review Trade Statistics database (https://www.ito.int/biennial_review/). Base case price assumptions are assumed to be consistent for CL and RIL-C and are the calculated 2019 median price for the sampled countries.

PRICE TRENDS

Based on data derived from the ITTO trade database, we computed summary statistics to observe trends by respective country and for the sample of countries in aggregate which we use as a proxy for the region (see Table 8). In all of the sampled countries, there are currently legal restrictions or moratoria on the export of roundwood (logs), and in some cases, rough cut products.

Table 8. ITTO Timber Prices

ITTO Price Trends: Tropical Non-Coniferous Roundwood (2016-2019) (in USD\$)								
Country	Unit	2019	2018	2017	2016	Mean	Median	CAGR
Cambodia	USD\$ m ³	\$ 397.53	\$ 409.88	\$ 642.16	\$ 300.89	\$ 437.62	\$ 403.71	9.73%
Indonesia	USD\$ m ³	\$ 656.82	\$ 685.00	\$ 694.43	\$ 326.00	\$ 590.56	\$ 670.91	26.30%
Malaysia	USD\$ m ³	\$ 141.58	\$ 145.23	\$ 128.39	\$ 136.35	\$ 137.89	\$ 138.97	1.26%
Myanmar	USD\$ m ³	\$ 931.05	\$ 842.73	\$ 813.93	\$ 328.47	\$ 729.05	\$ 828.33	41.52%
Summary Statistics								
Regional Mean		\$ 531.75	\$ 520.71	\$ 569.73	\$ 272.93	***	***	***
Regional Median		\$ 527.18	\$ 547.44	\$ 668.30	\$ 313.45	***	***	***

In general, all of the countries have reported price increases over the sampled time series, with Myanmar seeing the greatest overall price appreciation. With the exception of Malaysia, log prices in the region saw a notable increase over the period 2016 and 2017, with prices more than doubling. While additional investigation into the factors underpinning the surge in year-on-year trade prices over this period, preliminary background research indicates that a combination of strong global demand and a ban on log exports instituted in Myanmar (effective as of April 1, 2014) and resulting supply contraction contributed to rising tropical log prices from the region overall (Kollert & Walotek, 2015; Wong, 2014).

More broadly, there are a range of global, regional macroeconomic and industry factors that influence timber (and thus secondary product) market value and variability, including global and regional supply and demand dynamics, category demand (by product format), and both voluntary market and domestic and international trade policies with respect to sustainability certification.

13. Forestry Cost Assumptions

To model the cost structure for both the CL (business-as-usual) and RIL-C (project) cases, we derived comparative cost data from Medjibe & Putz (2012) which presented a synthesis of published case studies (n = 10) involving CL and RIL cost comparisons (Medjibe & Putz, 2012). The studies reviewed included five regionally-relevant studies drawn from Malaysia (Sabah and Sarawak) and East Kalimantan, Indonesia.

Cost categories considered as part of this analysis are delineated into the following three primary categories:

PRE-HARVEST COSTS

In contrast to CL, RIL (including RIL-C) includes comparatively larger investments in pre-harvest planning and, in most cases, worker training. While the specific cost elements included may vary between operations, these cost elements generally include: the development of detailed harvest plans, worker education, training and supervision, demarcation of log extraction paths. These costs are typically incurred at or prior to the start of harvest operations. For purposes of this analysis, we use median pre-harvest costs from a sample of reviewed publications for both CL and RIL-C: US \$12.50 ha⁻¹ and US \$46.10 ha⁻¹, respectively (in current US\$).

HARVEST OPERATIONS COSTS

Harvest operations costs include the in-field costs of tree felling, skidding, and log landing operations. These costs are variable and may be considered components of cost of production. Estimated harvest costs for both the CL and RIL-C scenarios include hauling costs and are derived from published literature (Medjibe & Putz, 2012). In each case, the median of sample values is used (adjusted to 2020 US\$). The differences in harvest costs between the CL and RIL-C scenarios are less significant than for the pre-harvest category: US \$44.09 m³ vs. US \$44.49 m³.

INFRASTRUCTURE IMPROVEMENTS

For purposes of this analysis, we assume that no new capital investments are required for a transition to RIL-C practices. While investments in new equipment to facilitate reduced-impact logging may be required in some cases (e.g. different cable logging and winching systems to facilitate suspended cable yarding, etc.) we assume that the model forestry operation uses existing equipment and machinery. Consultation with internal forestry subject-matter experts, have validated this assumption for Southeast Asian commercial logging operations which, due to terrain factors and the dominance of selective logging practices are reasonably likely to possess equipment and machinery necessary to facilitate a change from CL to RIL-C practices.

Based on the foregoing assumption, our model case considers only costs associated with infrastructure improvement and/or maintenance likely to differ between RIL-C and CL: skid trail layout and permanent road construction and maintenance costs.

TAXES & ROYALTIES

In all of the Southeast Asian countries evaluated as part of this analysis, production forest lands are part of the public forest estate (compared with private fee-simple ownership which is the case in much of the U.S.) and harvest rights are assigned on a time-limited basis through concessions or permits. Forests rents paid to the government in the form of permit and/or concession fees, and one or more royalties, or other payments. These costs are typically calculated per cubic meter and, where applicable, are incurred at multiple steps in the timber value chain (e.g. extraction, log yard, wholesale export, etc.). Required concession fees, taxes and forestry royalties are presented in the model as a percentage of market value (sales). We assume that representative rates are undifferentiated between the CL and RIL-C scenarios.

14. Terminal Value Assumptions

As described in above, logging practices under CL and RIL-C are likely to be differentiated with respect to damage to residual tree stands. The economic impacts of improved logging practices resulting from RIL-C transition are most likely to materialize in the next harvest cycle.

15. Carbon Project Development Costs

COST ELEMENTS

Costs associated with carbon project development for the RIL-C model case are assumed to be significantly lower than for the REDD+ case and are limited to feasibility and technical analyses, PDD and monitoring plan development, and project development costs directly related to carbon project development. Note that only the RIL-C scenario is eligible for crediting under the VCS methodology. As such, these costs are only allocated under the RIL-C scenario.

COST ALLOCATION

Total carbon project development costs are estimated to be US \$276,077 with 50% of the costs occurring at the start of the project (t_0) and the remaining 50% of costs occurring in the next period (t_1).

16. Carbon Project Implementation Costs

Estimated carbon project implementation costs for the RIL-C case are expected to be relatively minimal and include only costs associated with carbon project management and monitoring plan implementation. Implementation costs are estimated to be US \$87,692 per year.

17. Model Results & Discussion

PROJECT EMISSIONS ABATEMENT

Based on the assumptions specified above and detailed in the accompanying model, the proposed changes from conventional (CL) to reduced-impact logging for climate (RIL-C) is expected to generate in excess of 1.46 million tCO₂e in emissions reductions over a 30-year crediting period.

Employing all of the practice improvements defined by Griscom et al. (2019) as “Level 2” RIL-C implementation, estimated project emissions reductions would increase by ~36% to 1.99 million tCO₂e over the forecast period.

Required Investment & Use of Proceeds

Total financing requirements under the RIL-C case are the highest among the NCS cases included in our analysis and are estimated to be US \$11.9 million. This figure represents incremental net cash flows from CL operations during the initial forecast year and represents the largest proportion of the total opportunity costs of a transition from CL to RIL-C.

Expected Cash Flows

The model case assumes that initial planning and training activities associated with a transition from CL to RIL-C occurs at the start of the forecast period and that baseline CL operations continue during this period. Field-based implementation of RIL-C is expected to commence at the start of the next period (t_1) from which point the project can begin to generate and issue verified carbon units.

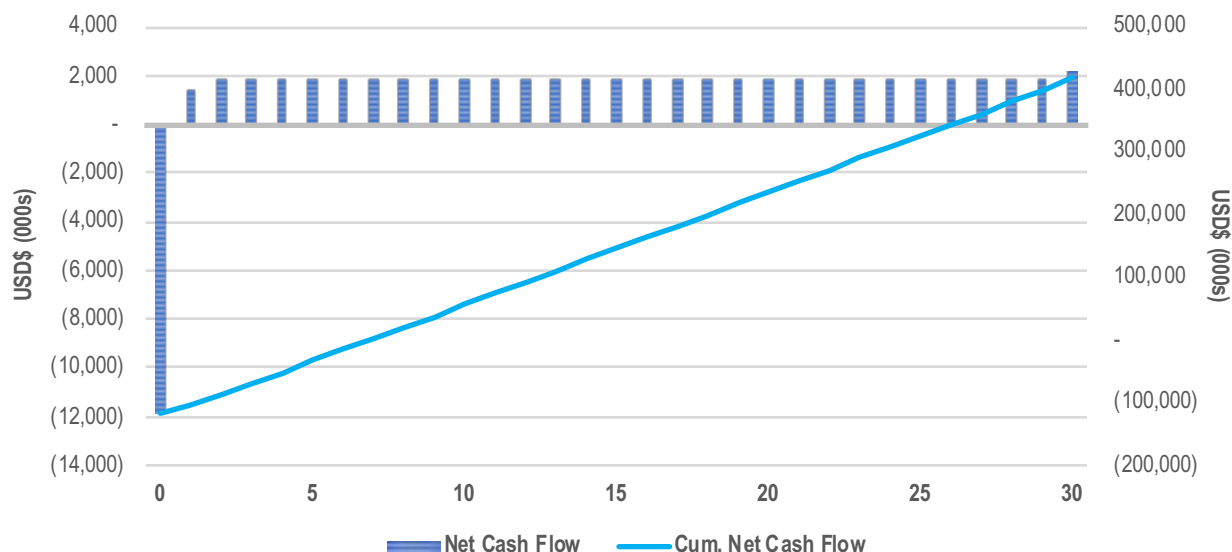
Incremental net cash flows in t_0 are expected to be – \$11.9 million and reflects the difference in expected RIL-C and CL cash flows at the start of the forecast period. Beginning in t_1 , the project is expected to realise an incremental net benefit due to reduced logging wastes and lower incremental harvest operations and infrastructure improvement costs for RIL-C compared with CL.

The incrementally higher marketable yields realised under RIL-C result in higher expected timber revenues. Similarly, incremental benefits from reduced production costs reflect both comparatively higher yields relative to extracted volumes and the smaller net harvest area associated with RIL-C. Together, the above factors are expected to result in incremental net benefits of ~US \$1.934 million per annum.

PERIOD CASH FLOW SUMMARY

Period:	0	1-10	11-20	21-30
Income¹				
Carbon Sales	-	3,537,456	3,930,506	4,323,557
Inc. Timber Sales	(17,495,620)	3,756,122	3,756,122	3,756,122
Total Incremental Income	(17,495,620)	7,293,578	7,686,628	8,079,679
Carbon Project Development Costs	138,038	138,038	-	-
Carbon Project Implementation Cost	-	392,308	392,308	392,308
Carbon Project Verification Costs	-	675,000	750,000	750,000
Carbon Transaction Costs	-	109,847	122,053	134,258
Inc. Forestry Costs	(5,724,796)	(11,528,008)	(11,528,008)	(11,528,008)
Capital Expenditures	-	-	-	-
Total Incremental Project Costs	(5,586,758)	(10,212,815)	(10,263,648)	(10,251,443)
Project Incremental Net Cash Flow	(11,908,862)	17,506,392	17,950,276	18,331,122

FORECASTED CASH FLOWS



EXPECTED RETURNS

The model RIL-C project is expected to generate an IRR and NPV of 15.36% and US \$2.396 million, respectively, over the initial 30-year harvest cycle.

While the operating improvements associated with RIL-C can be expected to generate near-term benefits in the form of reduced logging wastes, enhanced operating efficiency, and improved worker safety during logging operations, a large proportion of the ecological and economic benefits of RIL-C are expected to be realised in the next harvest cycle.

Reducing or avoiding significant damage to residual timber stands during the initial cutting cycle, are expected to generate equivalent or greater next-cycle yields while maintaining or reducing the operator's production footprint.

MANAGE: RIL-C

	Unit	Model Value
Project Scale:	hectares (ha.)	30,000
Carbon Price:	USD\$ tCO ₂ e	\$ 9.50
Discount Rate:	%	12.69%

INVESTMENT SUMMARY

	Unit	Model Value
Total Investment:	USD\$	\$ 11,908,862
Total Capital Returned:	USD\$	\$ 74,745,189
Payback Period:	years	6.88
NPV Break-Even Price:	USD\$ tCO ₂ e	\$ -

SUMMARY RESULTS

		10-yrs	20-yrs	30-years
Emissions Abatement:	tCO ₂ e-1	486,750	973,500	1,460,250
IRR	%	7.49%	13.40%	14.33%
NPV	USD\$	\$ (2,445,567)	\$ 536,753	\$ 1,449,553

These benefits are well documented in literature and have the potential to be significant. When comparing CL and RIL practices, Healey, Price and Tay (2000) suggest that the impact on next-cycle yields may be substantial with yield differences between CL and RIL of as much as 69%.

To evaluate the effect of improvements to next-cycle harvest value, we discounted next harvest cycle net cash flows to t_{30} for both the CL and RIL-C scenarios and evaluated expected project returns including the incremental terminal value. Including the value of expected incremental next cycle cash flows results in an IRR and NPV of 15.71% and US \$2.975 million, respectively, and increases the expected total (undiscounted) cash returned by the project from US \$57.96 million to US \$78.92 million (MOIC of 4.87x versus 6.63x)

SENSITIVITY ANALYSIS

Baseline expected returns for the RIL-C model case are highly sensitive to marketable yield assumptions which, for the initial cutting cycle, are influenced by harvest intensity and logging waste assumptions for the CL and RIL-C scenarios are 73.75 and 56.5 m³ ha⁻¹, and 20% and 50% respectively.

Holding base case harvest intensity and all other assumptions constant, either a slight increase in the assumed RIL-C logging waste rate (more than 21.56%) or a slight decrease in the assumed CL logging waste rate (less than 49.12%) would result in a negative net present valuation (at a 12.69% discount rate). Similarly, a change in the spread between baseline harvest intensities between CL and RIL-C are expected to have a significant impact on expected returns.

The identification of underperforming selective logging operations where investments in RIL-C strategies can result in major production efficiency (and thus environmental) gains over a relatively short timeframe are key to this project investment strategy.

KEY VALUE DRIVERS

In addition to the carbon and potential other environmental benefits generated by a transition from CL to RIL-C practices, RIL-C is expected increase the economic and financial value of logging operations through reductions in logging wastes and reduced damage to timber stands as a result of log felling and extraction activities. From a financial perspective, these costs (and potential benefits) can be significant. For example, whereas logging wastes for RIL range between 10% and 30% of cut timber, under CL practices these rates can be as high as 50% (FAO & ASEAN, 2006). Further, damage to standing forests as a result of poor logging practices can result in major reductions in next cutting cycle timber yields driving increased harvest (extraction) intensity or larger harvest areas to compensate for reduced yields. Effectively implemented, RIL-C is expected to generate equivalent to superior marketable yields over a smaller spatial and overall environmental footprint.

Lastly, while not quantified as part of the current analysis, investments in pre-harvest planning and improved management and oversight of logging activities under RIL-C are expected to reduce worker health risks and safety risks. Beyond the clear social implications for worker safety, we expect that investments in RIL-C may result in additional benefits including reduced property and casualty insurance premiums and cost savings from reduced labour turnover.

RESTORE: MANGROVE RESTORATION

1. Introduction

Tidal mangroves provide a broad range of biodiversity and ecosystem benefits, deliver critical ecosystem services including coastal storm protection, and the regulation of hydrologic and sediment regimes. These systems also represent some of the world's most significant carbon stocks and, through combined long-term protection and conservation of existing mangrove cover, and restoration and rehabilitation of recently lost and degraded mangroves, represent significant climate mitigation opportunities.

In a recent report on global mangrove restoration opportunities, nearly 8,120 km² (812,000 ha.) of coastal area where mangrove losses have recently occurred are identified as having potential for restoration. Within this area, 6,630 km² (663,000 ha.) is described as “highly restorable.” Degraded mangrove areas identified as having significant potential for “full recovery” comprise an additional 1,389 km² globally (Worthington & Spalding, 2019).

From a regional perspective, Southeast Asia is cited as having the highest total extent of potentially restorable mangrove area estimated at 3,037.1 km² (303,700 ha.) or more than 37% of global total, after adjusting for subtidal losses and mangroves in urban areas (Worthington & Spalding, 2019).

For the ‘restore’ pathway, we describe a representative project that includes activities intended to restore and maintain the natural systems and functions of coastal (tidal) wetland ecosystems. Within the broader category of wetland restoration, the representative project focuses on the restoration of mangrove biomass, soil carbon and associated ecosystem characteristics through revegetation strategies.

2. Verified Carbon Standard Methodology; Project Eligibility

For purposes of this analysis, we assume the representative project meets the general project eligibility requirements as described in the *Verified Carbon Standard Methodology for Tidal Wetland and Seagrass Restoration*, version 1.0 (Verra, 2015b).

3. Baseline Scenario

The representative project is assumed to occur within a tidal wetland area in Southeast Asia that has been previously altered for intensive shrimp farming and that shrimp ponds have since been abandoned. We assume that the prior alteration has resulted in adverse impacts to previously existing wetland vegetation, soil carbon, or other ecosystem functions (the “baseline scenario”). Consistent with the applicable VCS methodology, we define “tidal wetlands” as “a subset of wetlands under the influence of the wetting and drying cycles of the tides.”

4. Project Spatial Boundaries

TOTAL PROJECT AREA

The project encompasses a total area of 5,000 hectares (ha.). The scale of the model restoration case is consistent with the scale of a current restoration project located within Indonesia which involves an initial area of 5,000 ha. with ambitions to restore up to 10,000 ha (CIFOR et al., 2015).

Restoration Area

With the broader Project Area, tidal wetland and mangrove restoration is assumed to occur over 3,500 ha (70.0% of Project Area).

Mixed Use Area

The remaining 1,500 ha. is assumed to include a combination of restoration and sustainable prawn aquaculture activities.

Restoration Rate

Site restoration is assumed to occur at a rate of 500 ha. per annum beginning in Year 2 of the forecast horizon (t_2).

5. Project Temporal Boundaries

PROJECT DEVELOPMENT

Project preparation and development (establishment) activities are assumed to occur over a two (2) year period beginning in Year 0 (t_0) and ending in Year 2 (t_2) of the forecast horizon.

PROJECT IMPLEMENTATION

Field-based implementation of restoration and other project activities is assumed to occur over a 30-year period beginning in t_2 after completion of project development, validation and initial verification and ending in t_{32} .

6. Carbon Crediting Assumptions

PROJECT CREDITING PERIOD

The Project Crediting Period is assumed to begin in t_2 and end in t_{32} . Note that while the accrual of credits is assumed to begin at the commencement of crediting period, credit issuances do not occur for an additional five (5) years to account for field-based verification of revegetation effectiveness.

FIRST CREDIT ISSUANCE; CREDIT ISSUANCE INTERVAL

The first issuance of credits occurs in t_7 ^{xvii}. Subsequent credit issuances and sales occur on an annual basis as credits are generated.

NON-PERMANENCE BUFFER POOL ALLOCATION

To account for project non-permanence risk, we assume a non-permanence risk buffer allocation equal to 15% of credits generated.

7. Carbon Price Assumptions

For purposes of this analysis, we have selected a base case carbon price of US \$11.00 tCO₂e which is consistent with the range of current prices quoted for voluntary “blue carbon” offset projects (US \$10 to \$16 tCO₂e).^{xviii}

8. Emissions Abatement

In contrast to terrestrial ecosystems where the carbon value lies exclusively in the plant biomass, mangroves and other coastal wetlands derive most of their carbon value from the soil where organic material breakdown is extremely slow due to tidal inundation of saltwater. In addition, mangrove soils will continue to accrete, meaning that if left intact, mangroves can continue to provide carbon capture and storage in their soils in perpetuity. New VCS methodology modules have been developed (released Sept. 2020) to account for this unique characteristic meaning that the full soil carbon value can now be assessed and factored into economic analyses.

Model emissions reductions and removals estimates are derived from regionally relevant data on emissions reductions and removals from tidal mangrove restoration activities as published in Cameron et al. (2019) and McNally et al. (2011). The sample mean emissions abatement calculated from published data are used in the model (18.20 tCO₂e ha⁻¹yr⁻¹).

9. Carbon Project Development Costs

Restoration case project development (establishment) cost elements are similar to that of the REDD+ case. However, compared with the REDD+ case approach (avoided deforestation), the model restoration case is assumed to involve higher costs for initial feasibility and technical analyses, monitoring plan development, and project validation as a proportion of overall project development costs due to the comparatively higher degree of technical complexity involved in restoration activities and the greater need for in-field sampling and assessments.

For the representative restoration case, total project development costs are estimated at US \$518,692. We assume that 40% of total project development costs are incurred in t_0 and the remaining 60% incurred in t_1 .

10. Carbon Project Implementation Costs

Carbon project implementation costs are estimated to be US \$337,058 per annum. As in the project development phase, we assume comparatively higher monitoring and management plan implementation costs for the model restoration case relative to the REDD+ case (on a per-unit area basis). Similarly, costs associated with community and institutional capacity building—in both cases related to the community involvement in protection and management of newly restored areas—are assumed to be higher on a per-unit area basis relative to the REDD+ case. Note that in contrast to the presentation of these costs in the REDD+ case, sustainable livelihood costs associated with the model restoration case are presented as a separate category.

11. Restoration Assumptions

Mangrove restoration costs are highly variable and depend on a range of geographic, site and restoration approach-specific factors. Restoration costs are reported to range from US \$225 ha⁻¹ to as high as US \$500,000 ha⁻¹. The wide distribution of reported restoration costs are reflected in the results of a global synthesis published by Bayraktarov et al. (2016). Based on review of 109 studies inclusive of both developed and developing country data, median and mean restoration costs were US \$8,961 and US \$62,689 ha⁻¹, respectively (in 2010 US\$).

Restoration Approach

In the model restoration case baseline scenario, restoration activities involve restoration of former tidal mangrove areas that have previously been converted for use in intensive shrimp farming and are now abandoned.

Project restoration activities will include: (1) restoration of certain natural hydrological systems through the strategic breaching of former shrimp pond dike walls to facilitate re-creation of natural tidal channels; (2) filling and regrading of a ponds and the installation of sedimentation retention systems; and (3) direct out-planting of mangrove propagules.

We assume that restoration activities occur to some extent across the entire 5,000 ha. project area, however, the specific nature and scope of restoration treatments are differentiated between the area designated as restoration-only (“Site 1”) and the area designed for mixed-use (“Site 2”) as follows:

Table 9. Restoration Assumptions

Project Area Assumptions	Area (ac.)	%Total
Site 1: Restoration Only	3,500.00	70.00%
Site 2: Mixed Use (Restoration + Sustainable Prawn)	1,500.00	30.00%
Total Project Area	5,000.00	100.00%

Site 1 Restoration Treatment	Area (ac.)	%Site1
Strategic Breaching; Restoration of Tidal Channels	3500	100.00%
Filling, Regrading and Sediment Mitigation	3500	100.00%
Mangrove Outplanting	3500	100.00%

Site 2 Restoration Treatment	Area (ac.)	%Site2
Strategic Breaching; Restoration of Tidal Channels	450	30.00%
Sediment Mitigation	1500	100.00%
Mangrove Outplanting	450	30.00%

RESTORATION COSTS

Model restoration costs are based on estimates presented in Brown (Brown, 2020) and reflect the most regionally and project-relevant cost data available at the time of our analysis. A summary of relevant per unit area cost data reported in Brown (2020) is presented below:

Per Brown (2020), unit cost data for each of the filling and regrading and cut and regrade treatments are based on direct market prices for dredging, placement and regrade of compacted fill including labour, backhoe and barge rental as applicable. Sediment retention treatments are based on reported cost data for the procurement and installation of geo-textile tubing in an Indonesian project led by Wetlands International (Astra, 2017 as cited in Brown, 2020).

Table 10. Restoration Unit Cost Data

Restoration Unit Cost Assumptions	USD\$ ha⁻¹
Strategic Breaching for Tidal Channel Restoration	\$ 854
Filling & Regrading	\$ 857
Sediment Retention	\$ 401
Direct Planting	\$ 77

12. Sustainable Livelihoods Cost Assumptions

The majority of mangrove restoration projects—both those described in peer-reviewed studies or other publicly available reports and those managed by CI—include support for livelihood activities such as aquaculture, fisheries, selective logging, or other low-ecological impact activities consistent with natural mangrove ecosystems.

SUSTAINABLE LIVELIHOODS ASSUMPTIONS

For the model restoration case, we assume that a proportion of the total project area will be reserved for mixed-use. This mixed-use area –designated as “Site 2”–is assumed to encompass 1,500 hectares or 30% of the total project area. As described in Note 34 above, we assume that ~30% of the Site 2 area will be restored and revegetated in a manner similar to the larger restoration-only area (“Site 1”).

Project activities in the remaining Site 2 area focus on rehabilitation of former shrimp ponds for use in organic black tiger prawns (*Penaeus monodon*), a commercially valuable shrimp species native to many Southeast Asian

countries. For the model case, we elected to focus on organic prawn aquaculture due to its regional relevance, well documented complementarity with mangrove conservation and restoration objectives, and the demonstrated feasibility of prawn-mangrove aqua-silviculture systems.

While an in-depth discussion of aqua-silviculture methods is beyond the scope of this analysis, we assume that the production practices employed are generally consistent with current “mangrove friendly” shrimp aquaculture practices as defined by the Southeast Asian Fisheries Development Center (SEAFDEC) (Yap, 2002) and organic shrimp certification standards prescribed by the EU and certifying body, Naturland (Naturland, 2020).

PRODUCTION ASSUMPTIONS

For purposes of this analysis, we assume that prawn production is implemented in a manner consistent with EU and Naturland Organic certification standards which include requirements that farms maintain a minimum mangrove coverage of 50% of total pond area as well as prohibitions on artificial food, probiotic growth stimulants or water treatment chemicals.

UNIT PRICE ASSUMPTIONS

Model unit price assumptions are based on the calculated mean of sample data on farmgate prices for both organic and conventional *P. monodon* produced in Vietnam (ADB, 2015) and in an industry press release from December 23, 2019 (Pham Thj, 2019), respectively. Reported farm gate prices for conventional prawns were adjusted to account for a 20% organic certification premium, which is consistent with published organic price premiums received by Vietnamese organic prawn farmers. Price data expressed in local currency (Vietnamese Dong) were converted using historical closing prices for VND.US\$ using the Wall Street Journal historical price database (WSJ Markets, 2020).

UNIT COST ASSUMPTIONS

Estimated production costs are based on budget figures for low intensity *P. monodon* culture in Vietnam as presented in Engle et al. (2017), Table 5. with adjustments for feed and amendments prohibited under the above-referenced organic aquaculture standards. Rounded upward to two decimal points, we calculate the cost of production as 36% when expressed as a proportion of unit sales price.

ORGANIC CERTIFICATION COSTS

Model assumptions related to annual per unit area cost of organic certification are derived from Tran (2015) and include costs of training for farms and traders, inspection and internal control costs, third party inspection and certification, and export costs (ADB, 2015). Published certification costs were converted from Vietnamese Dong (VND) ha⁻¹ yr⁻¹ to US\$ ha⁻¹ yr⁻¹ using average historical closing prices for VND.US\$ over the period January 1, 2015 to December 31, 2015 using the WSJ historical price database.

13. Model Results and Discussion

PROJECT EMISSIONS ABATEMENT

Based on the assumptions specified above, the model restoration project is expected to generate in excess of 2.193 million tCO₂e in emissions abatement over a 30-year crediting period. Fully implemented, annual emissions abatement is estimated at 77,350 tCO₂e yr⁻¹.

REQUIRED INVESTMENT & USE OF PROCEEDS

The estimated financing required for the model restoration project is US \$5.629 million with an expected payback period of 10.55 years. The majority of financing required is for up-front restoration costs and cash for annual project implementation until cash flows from the sale of organic prawns and carbon credits are realised.

EXPECTED CASH FLOWS

The model restoration project includes project-level cash flows from the sale of organic prawns as well as the issuance and sale of carbon credits. On an undiscounted basis, the sale of organic prawns accounts for ~74.6% of total project cash inflows and roughly 58% of the total cash outlays of the model project.

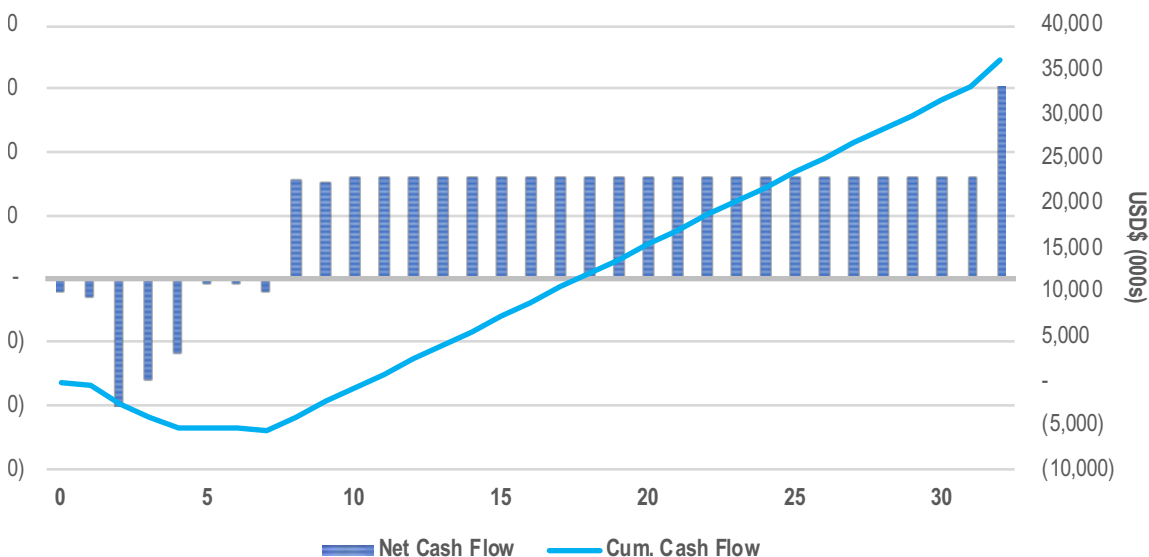
Annual cash flows from the sale of carbon credits are expected to begin in Year 8 of the forecast period (t_8) reflecting the expected restoration time horizon and an assumed delay in credit issuance of five (5) years to account for initial verification of restoration effectiveness.

At full implementation, net cash from the issuance and sale of carbon credits is expected to be ~US\$ 370,783 per annum. Net cash from the production and sale of organic prawns at full implementation is expected to be ~US \$1.251 million annually.

PERIOD CASH FLOW SUMMARY

Period:	0	1-10	11-20	21-32
Income				
Carbon Sales	-	3,148,145	7,232,225	10,125,115
Sustainable Production Income	-	14,520,196	20,743,137	24,891,764
Total Income	-	17,668,341	27,975,362	35,016,879
Carbon Project Development Costs	207,477	311,215	-	-
Carbon Project Implementation Cost	-	2,088,519	2,320,577	2,784,692
Carbon Project Verification Costs	-	400,000	1,000,000	1,200,000
Carbon Transaction Costs	-	101,870	203,817	272,195
Restoration Costs	-	9,303,250	-	-
Sustainable Production Costs	-	6,144,519	8,238,152	9,885,783
Capital Expenditures	-	-	-	-
Total Project Costs	207,477	18,349,373	11,762,546	14,142,670
Project Net Cash Flows	(207,477)	(681,033)	16,212,815	20,874,209

FORECASTED CASH FLOWS



EXPECTED RETURNS

Based on the foregoing assumptions, the model restoration project is expected to yield a project-level IRR and NPV of 15.18% and US \$1.181 million, respectively, over the 32-year forecast horizon.

Note that because the model cash flow forecast is made at the project-level, the distribution of project-level net cash from organic prawn production and carbon sales between farmers and project owners –and thus returns– is not contemplated. Additional analysis is needed to determine the profitability of the model restoration scheme at the project owner (investor) level, taking into account benefit-sharing schemes and shrimp export market and price (cost) dynamics.

RESTORE: MANGROVES		
	Unit	Model Value
Project Scale:	hectares (ha.)	5,000
Carbon Price:	USD\$ tCO ₂ e	\$ 11.00
Discount Rate:	%	12.69%

INVESTMENT SUMMARY		
	Unit	Model Value
Total Investment:	USD\$	\$ 5,628,094
Total Capital Returned:	USD\$	\$ 41,826,609
Payback Period:	years	10.55
NPV Break-Even Price:	USD\$ tCO ₂ e	\$ -

SUMMARY RESULTS				
		10-yrs	20-yrs	32-yrs
Emssions Abatment	tCO ₂ e-1	491,400	1,264,900	2,193,100
IRR	%	0.00%	13.41%	15.18%
NPV	USD\$	\$ (2,433,600)	\$ 260,052	\$ 1,181,096

SENSITIVITY ANALYSIS

To determine the financial feasibility of a carbon-only project, we modelled the expected cash flows assuming the entire 5,000 ha. area is restored as tidal mangrove forest with no other economic activities beyond the issuance and sale of carbon credits. Excluding organic prawn activities, project financing requirements increase to US \$13.127 million with an expected payback period of 27.6 years. The estimated project IRR and NPV for the carbon-only case are reduced to 2.62% and negative US \$5.440 million, respectively, holding all other assumptions constant. The break-even carbon price under the carbon-only case is US \$20.46 which exceeds the range of current voluntary market prices.

C. Blue carbon data

Mangrove above and below ground carbon sequestration amount, average years and species

Location	Dominant species	Age (years)	Total (tC ha ⁻¹)	AGB (tC ha ⁻¹)	BGB and soil (tC ha ⁻¹)	Roots/AGB (tC ha ⁻¹)	Roots (tC ha ⁻¹)	Soil (tC ha ⁻¹)	Soil depth (cm)
Peninsular Malaysia	<i>Rhizophora apiculata</i>	80	2205	312	1893	NA	NA	NA	3800
	<i>R. apiculata</i>	18	1117	193	924	NA	NA	NA	4000
	<i>R. apiculata</i>	5	479	87	392	NA	NA	NA	2800
Southern Vietnam	<i>R. apiculata</i>	6	1179	54	1125	NA	NA	NA	3400
	<i>R. apiculata</i>	20	979	72	907	NA	NA	NA	2750
	<i>R. apiculata</i>	35	1904	153	1752	NA	NA	NA	3600
Southern China	<i>Kandelia candel</i>	NA	619	64	555	2.0	130	425	1850
	<i>K. candel</i>	NA	391	43	348	2.2	94	254	1900
	<i>K. candel</i>	NA	332	7	325	1.1	8	317	1175
Indonesia	<i>Avicennia marina</i>	NA	437	24	413	NA	NA	NA	80
	<i>Rhizophora stylosa</i>	NA	703	19	684	NA	NA	NA	62
	<i>Sonneratia caseolaris</i>	NA	654	28	626	NA	NA	NA	1450
Southern Thailand	<i>R. apiculata</i>	25	808	138	670	1.0	142	528	1900
	<i>R. apiculata</i>	5	579	20	559	2.9	57	502	800
	<i>Ceriops decandra</i>	3	600	29	571	4.4	127	444	1000
Western Australia	<i>R. stylosa</i>	NA	863	115	621	1.1	127	621	1500
	<i>A. marina</i>	NA	662	55	515	1.7	92	515	775
Queensland, Australia	<i>R. stylosa</i>	NA	2139	297	1842	1.1	312	1530	3500

(Thorhaug et al., 2020)

Seagrass extent, carbon sequestration, and literature review references for further reading

Seagrass	Extent in Ha	Organic carbon Mg ha ⁻¹	Sedimentary organic carbon stock Tg	Citations for extent and buried organic carbon (1st m)
Nation				
Indonesia	3,000,000	251 Range 62–2450	753	*Green and Short, 2003; *Spalding et al., 2001; **Alongi, 2014; *Neihaus, 1993; *Kiswara, 2018; *Patty, 2016; *Kawaroe et al., 2016; *Fitrian et al., 2017; *Wawo, 2017.
Malaysia	16,300	251	4.1	Spalding et al., 2001; *Green and Short, 2003; *Yap et al., 2018; Jiang et al.; *Patty, 2016, *Kawaroe et al., 2016, *Fitrian et al., 2017, *Wawo, 2017; *Liu et al., 2018.
Thailand	14,800	155	2.29	Spalding et al., 2001; *Poovachiranon et al., 2006; **UNEP, 2008; C, *Raatanchoot, 2010;
Brunei	1500	96.79	0.145	*Lamit et al., 2017
Myanmar	430	96.79	0.042	*BOBLME, 2015; *Rattanchoot, 2010; Claulia et al., 2017*.
Singapore	300	96.79	0.029	*Fortes et al., 2018
Cambodia	32,490	96.32	3.144	*Bouillon et al., 2008; **UNEP, 2008; *Giardino et al., 2016
Viet-nam	15,740	159.45	2.501	Spalding et al., 2001; *Luong et al., 2012; *Ha et al., 2018; *Huong et al., 2017; *Gacia et al., 2003
Tropical China	5218	159.45	0.624	Jiang et al., 2017; *Huang et al., 2016; *Shu et al., 2017; *Huong et al., 2017.
Philippines	2,726,200 (Fortes) Or 1,500,015 (G&S)	251	684.3 or 376.5	Spalding et al., 2001; Green and Short, 2003*; *Gacia et al., 2003;
PNG/OE Timor	931,551	251	233.8	Spalding et al., 2001*; Giri et al., 2011; *Gacia et al., 2003;
Total	6,744,529	601.9	1683.97 or 1371.86	from Fortes et al., 2018 calculation of Philippines from Green and Short (2004) for Philippines

(Thorhaug et al., 2020)

D. Methodology of Carbon Prospecting Potential

To develop an analysis of carbon prospecting potential, we begin by identifying areas that should be forests but are currently degraded. Climate mitigation potential was then estimated based on the various forest types within the reforestable areas and applied various proxies of the constraints. Specifically, financial constraints were considered based on the direct cost of reforestation (e.g. site selection, planting and maintenance), as well as opportunity costs from foregone agricultural rent, and excluded areas where reforestation would cost more than US \$100 MgtCO₂e⁻¹. Potential land-use was also considered by excluding areas where low density communities are engaged in smallholder and/or subsistence agriculture. Finally, four alternative operational constraints that may affect the long-term viability of reforested lands, including deforestation risk, forest protection status, site accessibility for monitoring and management, and proximity to seed sources. These constraints were applied sequentially to determine the potential diminishing effect of multiple constraints on reforestation potential.

Based on the maps derived from the above analyses, areas were then identified where profitability and the co-benefits intersect. Specifically, both social and biodiversity co-benefits in areas close to rural communities (within a ~2km radius) were considered where key biodiversity areas intersect respectively. Positive RoI projects are identified where NCS projects would be able to financially break even and provide co-benefits to either biodiversity or rural communities.

In addition to primary constraints, few studies exist that quantify NCS or spatially analyse natural climate solutions and co-benefits. Current preliminary assessments combine these analyses into a preliminary investment decision making spatial analysis which illustrates the profitability of tropical forests whilst also taking into account two fundamental co-benefits: key biodiversity areas and rural communities.

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ENDNOTES

ⁱ The standard covers the accounting and reporting of seven greenhouse gases covered by the Kyoto Protocol – carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFCs), perfluorocarbons (PCFs), sulphur hexafluoride (SF₆), and nitrogen trifluoride (NF₃).

ⁱⁱ Note that under certain initiatives, such as the SBTi, offsets are not universally qualified as a mitigation strategy, and activities that directly address the company's carbon footprint are favoured instead.

ⁱⁱⁱ Contingent on tidal influence being maintained

^{iv} Incremental cash flow analysis is a common capital budgeting approach used to evaluate whether to accept (reject) a prospective project or capital investment based on the net cash flow impacts to the firm.

^v **Standing Carbon Stock:** Completely unconstrained above and below ground biomass carbon (including organic carbon density for 0-30 cm topsoil layer) across tropical Southeast Asian forests and excluding all land cover types that would preclude forests, for example, bare ground, water, agriculture and urban areas.

Standing and Investible Carbon Stock: Accounts for 'additionality' criterion by multiplying standing carbon stock (above) with projected annual deforestation rate (Hewson et al). Also accounted for decay of belowground carbon stocks over time. Also excluded recently deforested areas and human settlements. Also accounted for buffer credits as per VCS guidelines (20% discounting).

Standing, investible and financially viable carbon stock: Calculated Net Present Value (NPV) of investible carbon stock based on simplifying cost and carbon pricing assumptions (crucially, \$5.8 t⁻¹ CO₂e for first 5 years followed by 5% appreciation over total 30 y timeframe). Then excluded financially unviable carbon stock, defined as NPV<0 over 30-year analysis timeframe (project never able to break even).

^{vi} Provides approximately 3 GtCO₂e/ yr. of carbon storage potential

^{vii} This represents approximately 0.60 GtCO₂e/yr in climate mitigation potential

^{viii} approximately 0.56 GtCO₂e/yr

^{ix} **Biophysically Constrained:** Land areas that are biophysically suitable for reforestation, based on aboveground biomass, potential for natural vegetation, and excluding land use/land cover that would preclude reforestation (e.g. industrial agriculture, urban areas, bare limestone)

Financially Constrained: Excluded areas where reforestation would cost more than US\$ 100 tCO₂e⁻¹. Cost of reforestation estimated based on three scenarios that variously considered direct costs, opportunity costs weighted by likelihood of agricultural development.

Land-use Constrained: Excluded areas that are potentially occupied by low density communities engaged in smallholder agriculture. Considered two scenarios of permissiveness for agriculture.

Operationally Constrained: Considered four potential operational constraints including deforestation risk, protection status, accessibility to labour input, proximity to seed sources.

^x almost 3.5 GtCO₂e yr⁻¹

^{xi} to <2 GtCO₂e yr⁻¹⁰

^{xii} Cambodia, Indonesia, Lao PDR, Myanmar, Philippines, and Vietnam.

^{xiii} Pursuant to VM0007, definitions of “large-scale” and/or “small-scale” agriculture to be justified by the project

^{xiv} REDD+ credits with CCB labelling

^{xv} For all representative NCS projects included in this analysis, we assume a discount rate of 12.69%

^{xvi} Export Prices. Given restrictions and moratoria on exports of logs and rough timber in all sampled countries, we assume that “export” prices derived from ITTO database reflect domestic trade prices.

^{xvii} Assumes a project credit period start date of Year 2 (t_2) plus an additional five (5) years to evaluate restoration effectiveness.

^{xviii} Based on current CI projects under implementation with defined corporate off-takers and non-public information provided by partner institutions and project developers.

