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Nampula Mangrove Carbon Project: Feasibility Assessment

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Nampula Mangrove Carbon Project

Feasibility Assessment

Report submitted to WCS Mozambique by The Landscapes and Livelihoods Group
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Summary

This study assesses the feasibility of developing a carbon project involving mangrove protection and/or restoration in Memba, Mossuril and Nacala-a-Velha Districts of Nampula Province in northern Mozambique as part of a broader programme that aims to establish a Marine Protected Area (MPA) in the region and ensure its financial sustainability.

Two potential project activities are considered: 1) Restoration of around 121 ha of deforested mangrove; and 2) Protection of around 12,225 ha of degraded mangrove to prevent deforestation and enable natural regeneration.

Restoration of 121 ha of deforested mangrove has potential to generate carbon benefits in the region of 20,000 to 40,000 tCO_2e over a 20 year period, with income from the sale of carbon credits of between US$ 130,000 to US$ 600,000. The relatively small scale of this activity mean the net-benefits, after covering costs of project development and implementation are likely to be marginal. The carbon benefits generated are also below the minimum stipulated for registration of a REDD+ project in Mozambique.

A broader scale project that aims to protect all mangroves in the focal districts has potential to generate carbon benefits in the region of 300,000 tCO_2e and income from carbon credit sales of US$ 2 to US$ 4 million from avoided deforestation over a 20-year period. Additional carbon credits may also be generated from regeneration of degraded mangroves. Achieving these carbon benefits would require close engagement with all mangrove users throughout the districts, to develop activities that address local drivers of mangrove degradation, and to secure the rights to operate a carbon project. It is unclear whether WCS can secure the carbon rights for this broader area however, as there is another project developer that has had an expression of interest approved for a project that covers the whole district, including the mangrove area.

Generation of carbon credits from mangrove protection and restoration activities in Mozambique come under Mozambique's REDD+ Decree that defines the pathway for REDD+ project development. WCS has secured approval from the Government to develop a carbon project in Memba, Nacala-a-Velha and Mossuril that includes reforestation, restoration and conservation of mangroves. Approval for activities that result in reduced emissions from deforestation and forest degradation were also requested, but the rights to these activities have been granted to a different project developer – Carbon Offsets SA. If this licence is maintained by Carbon Offsets SA, developing a project that generates carbon credits from reduced emissions from deforestation and forest degradation in mangrove areas of Memba, Nacala-a-Velha and Mossuril would require WCS to work together with Carbon Offsets SA. If Carbon Offsets SA pursue registration of a project based on reducing emissions from deforestation and forest degradation, this may also prevent WCS from generating credits from restoration of forested areas within the Carbon Offsets SA project.

Engagement in the carbon project development pathway defined by the REDD+ Decree would enable WCS to obtain the rights to carbon credits generated by mangrove restoration activities. Mangroves in Mozambique are owned by the state but may also be under customary land titles. Development of a mangrove carbon project should therefore follow a stakeholder engagement process that includes identifying, involving, and requesting free, prior and informed consent (FPIC) from customary rights

holders. Stakeholder engagement activities planned for the proposed MPA development cover many of the requirements that would need to be fulfilled for development of a mangrove carbon project, but some additional activities would also be needed, and development of a Stakeholder Engagement Plan specifically for the carbon project is recommended if a carbon project is developed.

The potential carbon benefits from mangrove restoration activities were estimated using available datasets and default values, and data collected from the proposed project site. An area of 121 ha suitable for mangrove restoration has been identified, within which accumulation in aboveground and below ground biomass of between 3.5 tCO_2e/ha/yr and 16.1 tCO_2e/ha/yr and accumulation in soil of 4.42 tCO_2 tCO_2e/ha/yr could potentially be achieved over a 20-year period. Estimated GHG removals from the proposed restoration activities are therefore between 19,152 and 43,598 t CO_2e.

After deductions for risk buffer and leakage and assuming a carbon credit price between $10 and $20 per tonne of CO_2e, potential income from the sale of carbon credits generated from mangrove restoration activities is estimated to be between $134,065 and $610,366. The estimated costs of implementing and monitoring the proposed mangrove restoration activities is $168,618 and costs associated with stakeholder engagement and preparing and implementing a carbon project, would be additional to this. As a stand-alone carbon project, supplementary sources of finance and or implementation of restoration activities over a greater area would therefore likely to be needed to develop a feasible project based solely on mangrove restoration in the proposed project area. Since initial project development and implementation costs would be covered in part by the Blue Futures program, the additional finance generated from the sale of carbon credits could be channelled to activities outside that programme that directly benefit local communities.

Several potential risks to mangrove carbon project were also identified, including social and environmental risks that would need to be mitigated through project activities; and internal, external and natural risks that could endanger the permanence of carbon benefits if they are not addressed. Activities to mitigate these risks would need to be incorporated into the project design and would add additional operational costs.

Potential carbon benefits from reduced emissions from deforestation of mangroves in the proposed project area are estimated at 309,490 t CO_2 over a 20-year period; with potential to generate income from carbon credit sales in the region of $2.1 million to $4.3 million. Additional carbon benefits may also come from regeneration of degraded mangrove in areas that are effectively protected. Costs for implementing mangrove protection activities have not been estimated, but a combined project that includes mangrove protection and restoration activities would be more likely to be financially feasible than a project based on mangrove restoration alone, if the necessary permissions can be obtained.

1 Introduction

The Wildlife Conservation Society (WCS) has been working with the Mozambiquan Ministry of Sea, Inland Waters and Fisheries (MIMAIP) for coastal conservation in Mozambique and has a MoU in place to support the Government in marine conservation activities, including the "Building a Blue Future for Ecosystems and People on the East African Coast" (Blue Futures / Futuro Azul) program. This program includes the Mozambican Oceanographic Institute, ProAzul Trust Fund, the University Eduardo Mondlane, Ajuda de Desenvolvimento de Povo para Povo, the Association for the Environment, and the Foundation for the Conservation of Biodiversity (BIOFUND). The program aims to develop a proposal for creating a new sustainable-use Marine Protected Area (MPA) in the coastal area of Memba and Mossuril Districts, Nampula Province, which includes a well-operated network of community-managed fishing areas, and submit this to the Mozambican Government. Performance based payments for greenhouse gas emission reductions and removals that result from Blue Futures program activities offer a potential opportunity for financing ecosystem protection and restoration within and around the proposed MPA.

The Landscapes and Livelihoods Group (TLLG) worked with WCS to carry out a pre-feasibility assessment for a mangrove carbon project in the coastal areas between the southern border of Cabo Delgado Province to the north, and the southern border of Lunga District to the south in Memba and Mossuril Districts, Nampula Province (see Figure 1).[1] An ecological assessment of the mangrove forests, and an assessment of socioeconomic conditions in Memba, Mossuril and Nacala-a-Velha districts have also been carried out by WCS and their partners. [2,3]

The pre-feasibility assessment identified the potential for a carbon project based on mangrove protection and/or restoration in the proposed project area. To further explore the feasibility of the potential mangrove carbon project, it was recommended that additional work be undertaken to estimate the potential volume of carbon credits that could be generated by the project; and the transaction costs associated with carbon project development, validation, monitoring, reporting and verification; and to identify areas that would need to be addressed through project development.

This feasibility assessment builds on the pre-feasibility assessment, and the ecological and socioeconomic assessments to provide:

1. An assessment of legal context within which a mangrove carbon project could be developed (see Section 2),
2. An assessment of stakeholder engagement activities that would be needed for development of a mangrove carbon project, and the extent to which they are included in the Blue Futures program's stakeholder engagement plan (see Section 3),

[1] TLLG (2023) *Nampula Mangrove Carbon Project: Pre-feasibility Assessment*, Version 1.1, 4 May 2023. The Landscapes and Livelihoods Group, Edinburgh, UK.
[2] Fernando, A. and Macamo, C. (2023) *Ecological Assessment of the Mangrove Forests of Memba, Nacala-a-Velha and Mossuril*, Draft 4, June 2023. Projecto Construindo Um Futuro Azul Para Ecossistemas e Pessoas na Costa Leste Africana, Maputo, Mozambique.
[3] Moz Target (2023) *Socioeconomic Baseline Assessment of Building a Blue Future for Ecosystems and People on the East African Coast Project*, Final Version, July 2023. Moz Target, Maputo, Mozambique.

3. Improved estimates of potential to generate carbon credits from mangrove protection and restoration activities (see Section 4),
4. An initial assessment of environmental and social risks that would need to be managed in a mangrove carbon project, and risks to non-permanence of carbon benefits, and the extent to which these will be mitigated by the Blue Futures program's environmental and social management plan (see Section 5), and
5. A high-level assessment of potential income from carbon credit sales, balanced against project implementation and carbon credit transaction costs (see Section 6).

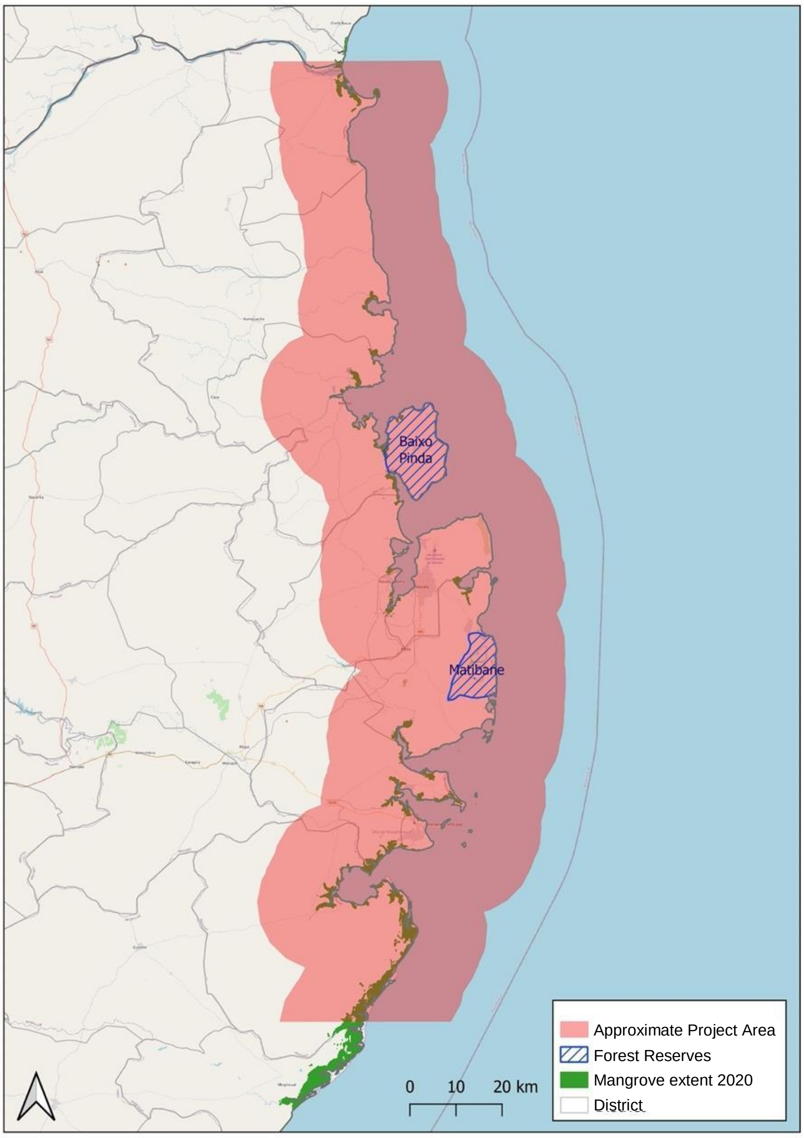

Figure 1 The region within which a mangrove carbon project could be located. Mangrove extent in 2020 (Source: Bunting et al. (2022)[4] and Protected Areas (Source: UNEP-WCMC & IUCN, 2023)[5].

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[4] Bunting, P., Rosenqvist, A., Hilarides, L., Lucas, R.M., Thomas, N., Tadono, T., Worthington, T.A., Spalding, M., Murray, N.J. and Rebelo, L.M. (2022). Global Mangrove Extent Change 1996–2020: Global Mangrove Watch Version 3.0. *Remote Sensing*, 14(15), p.3657.

[5] UNEP-WCMC and IUCN (2023), *Protected Planet: The World Database on Protected Areas (WDPA) and World Database on Other Effective Area-based Conservation Measures (WD-OECM)* [Online], April 2023, Cambridge, K: UNEP-WCMC and IUCN. Available at: www.protectedplanet.net.

2 Legal Analysis

Carbon projects must operate in compliance with all applicable laws and regulations, and there must be clear and undisputed rights to implement the project activities and benefit from the sale of carbon credits. In Mozambique, mangrove carbon project development must be carried out in compliance with the REDD+ Decree (Decree 23/2018)[6] and should also align with relevant government policies and strategies. Key considerations for alignment with REDD+ regulations and demonstrating project ownership are described below. A list of other relevant policies, strategies and legislation that should be consulted in the development of a mangrove carbon project is provided in Annex 1.

2.1 Carbon Project Development Pathway

Mozambique's REDD+ Decree describes state ownership over the creation, generation, issuance, validation, verification and withdrawal of emission reductions and corresponding titles, as overseen by the Ministry of Economy and Finance and administered by the National Fund for Sustainable Development (*Fundo Nacional de Desenvolvimento Sustentável*; FNDS) under the Ministry of Agriculture and Rural Development. The transferal of ownership of carbon credits is granted by license that is valid for a renewable period of 20-years. The scope of the REDD+ Decree includes all activities that reduce emissions from deforestation and forest degradation or that conserve or increase forest carbon stock. Mangrove protection and restoration activities therefore come under the REDD+ Decree. To be eligible for state issued implementation licenses under the REDD+ Decree, carbon projects must meet all of the following criteria:[7]

- Mutual Exclusivity - The project must not overlap geographically with any existing registered projects
- Jurisdictional for REDD - Deforestation avoidance projects must take a jurisdictional approach using districts as the jurisdictions
- Minimum Size - The project must generate at least 200k tCO2 of emissions reduction or removal over the project life

The pathway for development of REDD+ projects under the REDD+ Decree is summarised in Table 1. WCS submitted an Expression of Interest (EoI) for development of a blue carbon project to the Director of Provincial Environmental Services for Nampula Province on 2 June 2023.[8] The scope of the EoI included mangrove protection and restoration activities in the Memba, Nacala-a-Velha and Mossuril Districts of Nampula Province. This EoI was approved by the Ministry of Land and Environment on 31 October 2023, with the stipulation that the project activities would be limited to reforestation, restoration and conservation of mangroves. [9] Listing of the project on the FNDS Registration System for

[6] https://www.fnds.gov.mz/index.php/pt/documentos/legislacao?task=document.viewdoc&id=443

[7] CrossBoundary Group (2023) Carbon Finance Playbook: Demystifying The Capital Raising Process for Nature-Based Carbon Projects in Emerging Markets. USAID/Mozambique PLANETA program. 5 Dec 2023. https://crossboundary.com/usaid-planeta-carbon-finance-playbook/

[8] Madope, A. (2023) Proposta de manifestagéo de interesse para implementar um Programa/projecto de Carbono Azul. Ref: WCS_MP_NC_51_MDI_SPA_REDD+. 2 Jun 2023. [Letter]

[9] Massinga, J (2023) Re:Manifestação de Interesse do Projeto da WCS, para a implementação de programaProjecto Carbono Azul. Ref: 629/MTA/900/DMC/2023. 31 Oct 2023. [Letter]

REDD+ Programs and Projects also indicates that the scope of activities approved excludes reduced emissions from deforestation and forest degradation.[10]

As of 12 January 2024, there were 34 projects registered on the FNDS Registration System for REDD+ Programs and Projects including a project registered as Carbon Offsets SA that overlaps the area specified in the WCS EoI. The Carbon Offsets SA project in Nampula is also at the feasibility stage and includes reducing emissions from deforestation and forest degradation, as well as reforestation, restoration and conservation of forests. Potential overlaps and synergies between the carbon project proposed by WCS and the Bule and Green Carbon project should be explored further. REDD+ licenses are intended to grant exclusive rights to the project developers for specific areas and activities, but sub-licensing could be a possibility.

[10] Plataforma de Registro de Programas e Prjectos REDD+ em Mocambique. http://bit.ly/registryredd Accessed 12 Jan 2024.

Table 1 Pathway for REDD+ project development: Source: Muhate (2023)[11]

Stage	Activities	Legal/Regulatory Framework
1. Expression of interest (EoI)	• Identification of project area • Preliminary consultation with district authorities • Submit EoI • Evaluation of EoI • Project registration	REDD+ Decree (Article 9, 17 and 21.1)
2. Feasibility study	• Stakeholder engagement • Socio-economic study • Benefit sharing plan • GHG inventory • Draft project documents (PD)	REDD+ Decree (Article 17.3-17.5 and 18.1)
3. Licensing of programs and projects	• Submit PD to Provincial Environmental Services, FNDS and National Directorate of Climate Change • Assessment of PD • Pay license fee • Issuance of license	REDD+ Decree (Article 8, 16-19 and 31)
4. Project certification	• Submit PD to Certifying Entity (CE; e.g. Verra or Plan Vivo) • Validation by CE • Registration by CE	As specified by CE
5. Implementation	• Stakeholder involvement • Activity implementation • Environmental and social management plan (ESMP) implementation • Monitoring, Measurement, Reporting and Verification	REDD+ Degree (Article 19)
6. Certification of reduced emissions	• Verification by CE • Issuance of carbon credits by CE	As specified by CE
7. Title transfer	• Request for transfer of credit rights from Ministry of Economy and Finance to project developer • Transfer of credit rights	REDD+ Decree
8. Benefit sharing	i. Sharing of benefits to communities and other stakeholders	As specified by CE (not covered by REDD+ Decree)

With the approval of the project's EoI there is a requirement to complete the feasibility study and submit project documents to Provincial Environmental Services, FNDS and National Directorate of Climate Change by 31 October 2024. It is unclear if these project documents need to meet all requirements of the relevant carbon standards or if alternative templates will be provided. WCS is seeking clarification of this. It has also been noted that the registration protocols mandated by the

[11] Muhate, A. (2023) *Carbon Finance - Markets & Policy Enabling Environment Assessment*. USAID SPEED Project Report. Maputo, Mozambique.

REDD+ Decree are not always followed or enforced, that requirements seem to evolve over time, and that there is confusion over how and when the regulations jurisdictional approach applies to the various project types.[7] Exceptions made to REDD+ Decree requirements include acceptance of EoIs for mangrove carbon projects at sub-district level.

2.2 Land and Carbon Rights

To operate as a carbon project, the project proponent must demonstrate that they have the legal right to operate the project and benefit from the sale of carbon credits. Since mangroves, along with all other lands and natural resources in Mozambique, are owned by the state;[12] engagement in the carbon project development pathway described in section 2.1 should be sufficient for WCS to secure legal rights to the carbon credits generated by the project.

Legal rights to land use in Mozambique can be granted through two types of licence:[7]

i. DUAT (Direito de Uso e Aproveitamento de Terra): This translates to the Right to Use and Benefit from Land, and grants the license holder the right to conduct economic activities and derive economic benefits from the land covered by the license. DUATs are issued by the national and local authorities that regulate land (e.g., MTA at the national level);
ii. TUPEM (Título de Utilização Privativa do Espaço Marítimo): This translates to the Title for Private Use of Maritime Space and grants the license holder the right to conduct economic activities and derive economic benefits from the maritime space covered by the license. TUPEMs are issued by the national and local authorities that regulate maritime space (e.g., MIMAIP at the national level).

A DUAT license cannot be granted for land within 100 m of the high tide mark, so is unlikely to be appropriate for a mangrove carbon project. A TUPEM includes land within 100 m of the high tide mark, but cannot be granted to communities for customary use. It is generally accepted, however, that coastal communities do not need to secure TUPEMs to conduct activities that protect or restore mangroves; and that signing agreements with coastal communities gives a carbon project developer the de facto right to operate in the mangrove areas; although this does not exclude other corporations from securing TUPEMs to conduct activities in the same mangrove areas, and it is unclear if these rights extend to planting mangroves.[7]

Mangrove areas that have been occupied and used by communities for more than 10 years are likely to come under customary land titles that are recognized by the 1997 Land Law. These customary rights are recognised even when they are not formalised, and provide rights equivalent to a DUAT. Development of a mangrove carbon project should therefore follow a stakeholder engagement process that includes identifying, involving, and requesting free, prior and informed consent (FPIC) from customary rights holders. The Blue Futures program is carrying out community land delineation in several communities within the proposed carbon project area that carbon project stakeholder engagement activities should be integrated with (see Section 3).

[12] Constitution of Mozambique 2004 https://www.masa.gov.mz/wp-content/uploads/2018/01/Constituicao_republica_mocambique.pdf; Land Law - Law 19/97 of 1st October https://faolex.fao.org/docs/pdf/moz15369E.pdf; Law of Forests and Wildlife - Law 10/99 of July https://www.dinaf.gov.mz/wp-content/uploads/2021/11/Lei-de-Florestas.pdf

3 Stakeholder Engagement

The Blue Futures program Environmental and Social Management Plan (ESMP),[13] Stakeholder Engagement Plan (SEP),[14] Preliminary Process Framework,[15] maps of potential mangrove sites, and Socioeconomic Baseline Assessment[3] were reviewed to identify the need for any additional stakeholder engagement activities related to the development and implementation of the proposed carbon project. The review covered what information exists for stakeholders in potential mangrove sites, what procedures exist for securing support from community stakeholder groups for the carbon project, and how different stakeholders will be involved in the carbon project development. The results are summarised below.

3.1 Stakeholder Identification

Program-level stakeholders for the MPA have been identified in the Blue Futures SEP. However, there are a few stakeholder categories relevant to mangroves that appear absent from the documentation. These include:

- Mangrove dependent user groups, disaggregated for example by users of fuelwood for own use, fuelwood for sale, poles for own use and for sale, other uses;
- Vulnerable mangrove dependent user groups, for example any particularly vulnerable user groups such as elderly mangrove users, widows, or single mothers;
- Salt pan creators/ managers; and
- Internally displaced peoples.

Stakeholders specific to each mangrove *site* are harder to identify and would need to be identified by the project proponent (WCS). For example, the Blue Futures ESMP provides information on villages to be included in the program, but from this list it is not possible to confirm whether all the villages that depend on mangroves in the proposed sites, and could be affected by restoration or protection activities, are included. Now that restoration sites have been selected, it will be possible for the project to identify all communities potentially affected by the restoration activities. During the project development, it will also be necessary for the project to finalise the identification of all the communities who depend upon the mangroves which will be protected and restored as part of the project. One major challenge in these coastal areas relates to the wide variety of user – groups who use the coastal mangroves, including local communities inland and relatively distant from the coastal communities, who might claim customary rights to use of these areas, and including other actors who are using mangroves in illicit ways, or have started using these mangroves only relatively recently. The project has a responsibility to define these groups, in collaboration with the most dependent local communities, and come up with a practical way of defining those communities who would be entitled to some form of livelihood restoration in order to reduce use.

[13] Wildlife Conservation Society (2023) *Building a Blue Future for Ecosystems and People on the East African Coast: Environmental and Social Management Plan (ESMP)*. Version 3, 30 Jun 2023.
[14] Wildlife Conservation Society (2023) *Building a Blue Future for Ecosystems and People on the East African Coast: Annex A - Stakeholder Engagement Plan*. Version 3, 30 Jun 2023
[15] Wildlife Conservation Society (2023) *Building a Blue Future for Ecosystems and People on the East African Coast: Annex B - Preliminary Process Framework*. Version 3, 30 Jun 2023.

3.2 Potential Gaps

As the ESMP and SEP are for the Blue Futures program, the following gaps identified from the review relate to the proposed carbon project and should be addressed when developing specific stakeholder engagement procedures for the proposed carbon project.

- **Geographical gaps in engagement:** Engagement has been conducted to date in the Blue Futures program target areas. As mentioned in Section 3.1, it cannot be confirmed that this engagement covered all the mangrove dependent communities/local stakeholders in the proposed carbon project's zone of influence.

- **Representation:** The engagement strategy and community points of contact in the SEP are weighted heavily towards community committees. It is not clear the degree to which these institutions are representative of mangrove users, and where possible, engagement activities should extend to direct engagement with mangrove users themselves. In some contexts, CCP membership can tend towards local elite, skewing decision-making regarding access and management. However, in the project area, selection of CCPs membership has taken this into account, and there is at least 40% female membership of CCPs with which the project supports.

- **Identification and engagement of mangrove users**: The ESMP and SEP do not disaggregate mangrove uses and users (see Section 3.1).

- **Vulnerable groups:** The SEP and ESMP mention gender, and age along with a few other axes of vulnerability. These axes of vulnerability should be cross referenced against mangrove users.

- **FPIC procedures**: Informed Consent (IC) is used for community engagement which is stated to be identical to Free, Prior and Informed Consent (FPIC). The documents clearly lay out stakeholder engagement *activities*. The IC *procedures* were less clear, however, other than the use of consent forms for a specific activity, which falls short of full FPIC requirements.

  - For example, it is not clear whether the proposed community meetings (for example the participatory workshops described on page 16 of the process framework) are representative of local decision-making processes and timelines, particularly for women and vulnerable groups.

  - Another example from reviewing the stakeholder engagement activities already undertaken (Table 9 of the SEP), it not clear whether alternatives to livelihoods clubs discussed when selecting project activities.

  Further development or clarification of the IC procedures for the project, that includes or shows clear negotiation of access measures and equivalent livelihood programmes would be necessary for development of a carbon project; and consent should be structured in stages that reflect key steps in generating consent, as the project develops the specific activities, and more information becomes known.

3.3 Recommendations

Recommendations for involving stakeholders in carbon project development are listed below:

i. **Establish a Stakeholder Engagement Plan specifically for the carbon project** – This would be a simplified, community-facing version and could sit within the broader program's engagement with higher-level stakeholders.
ii. **Maintain direct engagement with community members –** due to know issues with working with representative committees such as the CCPs, maintaining the project's approach to establishing and working directly with livelihood clubs, holding workshops with the broader community, and ensuring women and other mangrove users can participate in and are beneficiaries of mangrove restoration, will be important. These engagement mechanisms could be included explicitly in the project stakeholder engagement plan .
iii. **Ensure that there is a full understanding of who the mangrove users are at specific project sites**, categorising these groups, understanding their customary rights, and devising a strategy to engage with them on this level. Include any particularly vulnerable mangrove users.
iv. **Draft procedures for working with the identified groups in the development of a carbon project**, including the development of an FPIC protocol that conforms with the requirements of the relevant carbon standards.

4 Potential Carbon Benefits

A pre-feasibility assessment identified potential for a blue carbon project to generate GHG emission reductions and removals from mangrove protection and restoration activities.[1] For this study, the potential carbon benefits from mangrove protection and restoration activities were estimated using available datasets and default values, and data collected from the proposed project site.[2] The methods used follow an approved Plan Vivo methodology. Estimates that are consistent with the applicable Verified Carbon Standard (VCS) methodologies would require additional data collection and analysis.

4.1 Additionality

For a mangrove protection or restoration project to generate verifiable carbon credits, the emission reductions or removals achieved must be additional, meaning the most likely without-project scenario (or baseline scenario) should not include the activities that generate the emission reductions or removals.

The VCS Tool for the demonstration and assessment of additionality in VCS agriculture, forestry and other land use project activities (VT0001)[16] can be applied to test the additionality of the project activities. The tool follows four main steps for assessing additionality:

1. Identifying alternative land use scenarios to the project activities,
2. Investment analysis to determine that the project is not the most economically attractive of the land use scenarios,
3. Barrier analysis, and
4. Common practice analysis.

Barrier analysis can be applied instead of or alongside an investment analysis, but for the purpose of this evaluation both are applied to give maximum insight. As the project is in the initial stages of design, application of the tool is limited to the extent of available information; but preliminary analysis suggests it is likely the project activities would be considered additional, as summarised below.

Identifying alternative land use scenarios to the project activities should include a continuation of the pre-project land use, implementation of the project activities without being part of a carbon project, and other potentially feasible activities. In this case potential land use scenarios for the proposed project area include:

i. The continuation of current subsistence and commercial mangrove use,
ii. An increase in commercial use or more destructive uses of the mangroves e.g. for salt pans, and
iii. Effective mangrove protection and restoration (without a carbon project)

To demonstrate additionality of the project, it is necessary to explain why the project activities (i.e. effective mangrove protection and restoration) are not the most likely without-project scenario. Since

[16] Verra (2012) VT0001 Tool for the Demonstration and Assessment of Additionality in VCS Agriculture, Forestry and Other Land Use (AFOLU) Project Activities. Version 3.0. Available from: https://verra.org/methodologies/vt0001-tool-for-the-demonstration-and-assessment-of-additionality-in-vcs-agriculture-forestry-and-other-land-use-afolu-project-activities-v3-0/

funding has already been secured for Blue Futures program activities, these should be included in the without-project scenario.

Investment analysis explores whether the project activity without the sale of carbon credits is the most economically or financially attractive land use scenario. In this case scenarios i and ii are likely to generate greater economic benefits than mangrove protection and restoration in the absence of carbon finance.

Barrier analysis explores if there are any barriers that would prevent the implementation of the project activities without the revenue from the sale of carbon credits. The Government of Mozambique's Mangrove Management Strategy includes a commitment to protect and restore mangroves, [17] but its implementation is reported to be limited because of poor coordination across different sectors, and a lack of effective policy. [18] Potential barriers to implementation of the project activities therefore include:

- Investment barriers – lack of finance at national to local government level to implement mangrove restoration activities,
- Institutional barriers – lack of enabling policy, institutional capacity or enforcement of the Mangrove Management Strategy,
- Technological barriers – lack of access to quality mangrove seedlings and planting knowledge,
- Barriers due to ecological conditions – degraded soils (erosion, salination), catastrophic natural events,
- Barriers due to social conditions and land-use practices – demographic pressures on the land, illegal practices, lack of skilled labour force for restoration, and
- Barriers related to land tenure, ownership and property rights – remote location and lack of infrastructure, absence of clearly define access rights.

Barriers to the effective protection and restoration of mangroves in the project area should be considered after taking into account Blue Futures program activities for which funding has already been secured and is not contingent on generation of carbon credits. Since the Blue Futures program will end in 2027, it is likely that investment, ecological, and social barriers to long-term protection and restoration will remain and a carbon project may enable these to be overcome. Evidence of these barriers would need to be provided in the carbon project design documents if barrier analysis is used to demonstrate additionality.

Common practice analysis evaluates if there are already similar activities within the geographical area of the proposed project activity. Some mangrove restoration work has been done along the coast of Mozambique to mark specific events or celebrations, such as for the International Day for the Conservation of the Mangrove Ecosystem, [19] but these do not appear to be sustained efforts and their

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[17] Resolution 33/2020 Mangrove Management Strategy Available from: http://faolex.fao.org/docs/pdf/moz195800.pdf

[18] WWF, IUCN and Wetlands International (2022) Saving our mangroves in Kenya, Tanzania, Mozambique and Madagascar. Available from: https://portals.iucn.org/library/fr/node/50567

[19] IUCN (2020) Mozambique: Maximise planting of mangroves, urges Deputy Minister. Available from: https://www.iucn.org/news/eastern-and-southern-africa/202008/mozambique-maximise-planting-mangroves-urges-deputy-minister

long-term impact is unclear. There are several mangrove protection and restoration projects implemented by donor or NGO parties, often working with communities. These projects do not appear to form part of a wider structured programme of mangrove management but are independent, scattered interventions, for example UNEP mangrove restoration in Mahielene-Xai Xai district, [20] and Eden Project mangrove restoration around Maputo. [21]

4.2 Carbon Benefits from Mangrove Restoration

Sites identified as being suitable for restoration cover between 92 and 148 hectares of degraded mangroves. [2] To estimate the potential carbon benefits from mangrove restoration it is assumed that areas where restoration activities are carried out would not regenerate naturally in the absence of the project, so it is conservative to assume no removals from mangrove biomass or soils under the baseline scenario. The project removals are then calculated by estimating the increase in biomass and soil organic carbon expected because of the project.

4.2.1 Increasing carbon stored in woody biomass

Review of literature values provides insight into the carbon sequestration potential of mangrove restoration activities (see Table 2). Geographical and environmental factors drive the rate of mangrove biomass recovery under restoration interventions, so the focus of our review was data from the eastern coastline of Africa. Of these, the most pertinent are the modelling results from Silvestrum that predict accumulation rates in woody biomass between 12.8 and 16.1 tCO2e/ha/yr in the project area over a 20-year period.[23] These are consistent with rates of accumulation over a shorter time period in the Rufiji delta.[24] The lower rates of biomass accumulation seen in the study from the Limpopo Estuary may reflect the relatively slow accumulation in the early years after planting.

Table 2 Estimates of carbon sequestration in aboveground and belowground woody biomass

Location	Sequestration in restored mangroves (t CO_2e ha^{-1} yr^{-1})	Time period (years)	Source
Mozambique – Limpopo Estuary	3.3	10	Biomass survey (Da Costa and Macamo 2023)[22]
Mozambique – Memba	16.1	20	Growth model (Silvestrum 2023)[23]
Mozambique – Mossuril	12.8	20	
Mozambique – Nacala-a-Velha	15.3	20	

[20] UNEP (2023) Reviving wetlands in the Western Indian Ocean: Efforts and Progress. Available from: https://www.unep.org/gef/news-and-stories/blogpost/reviving-wetlands-western-indian-ocean-efforts-and-progress#:~:text=Restoring%20Mangroves%20in%20the%20Limpopo,nearly%2060%25%20of%20the%20mangroves.

[21] https://www.edenprojects.org/our-work/mozambique

[22] Inácio Da Costa, F. and Macamo, C., (2023) Forest Structure and Carbon Reserve in Natural and Replanted Mangrove Forests in Different Years in the Limpopo Estuary, Gaza Province, Mozambique. Forests, 14(12), p.2375. Available from: https://doi.org/10.3390/f14122375

[23] Silvestrum (2023) Blue Carbon Pre-Feasability Study, Mozambique. Version 2.0. Silvestrum Climate Associates report commissioned by Rare, 23 Oct 2023.

Tanzania – Rufiji Delta	14.0	15	Biomass survey (Monga et al. 2022)[24]

*AGB= Aboveground biomass, BGB= Belowground biomass

Growth models developed by Silvestrum assume restored mangroves in the proposed project areas would reach carbon stocks between 109 tC/ha to 137 tC/ha after 30-years of growth. [23] Carbon stocks in aboveground and belowground biomass in the proposed project areas surveyed in February and March 2023, were lower than this, however ranging from 1.4 tC/ha to 28.0 tC/ha. [2] The relatively low carbon stocks in the proposed project area may indicate a degraded state but could also reflect structural differences between the mangroves in this area and the Zambezi River delta. If the maximum carbon stock of mangroves is assumed to be 28 tC/ha, average accumulation of biomass over a 20-year period would be around 3.5 tCO_2e/ha/yr. For this study it is therefore assumed that carbon sequestration in restored mangroves could range from a minimum of 3.5 tCO_2e/ha/yr to a maximum of 16.1, 12.8 and 15.3 tCO_2e/ha/y for Memba, Mossuril and Nacala-a-Velha respectively.

4.2.2 Increasing carbon storage in soils

A search for literature on soil carbon accumulation in restored mangrove soils, did not yield many relevant studies. Japhet et al. (2019)[25] reported no significant difference in soil organic carbon levels in a chronosequence of soils that spanned 15 years of restoration in Tanzania, as did Inacio-De Costa and Macamo (2023)[22] over a six year chronosequence in Mozambique. As they discussed, this could potentially be due to other drivers such as sediment deposition or erosion that impact on soil condition. While these two publications are geographically relevant, they are limited temporally and spatially, and as such it cannot be concluded that the potential for soil carbon impact from restoration efforts would necessarily be similar in this project.

The VCS Methodology for Tidal Wetland and Seagrass Restoration (VM0033)[26] includes a default value for carbon accumulation in mangrove soils of 1.46 tC/ha/yr for mangroves with vegetation cover greater than 50%. [27] For areas with vegetation cover of less than 15%, this soil organic carbon accumulation is assumed to be insignificant and accounted for as zero; and for areas with vegetation cover between 15 and 50%, a linear interpolation may be applied. Applying this default factor to the project area, with the assumption that planted mangroves will reach 15% canopy cover within 2-years, and 50% canopy cover within 5-years gives an average annual carbon accumulation in soils of **4.42 tCO_2/ha/yr** over a 20-year project period.

4.2.3 Potential increases in carbon stored in woody biomass and soils

Combing the modelled biomass and soil accumulation rates for the project area (see Table 2 and Section 4.2.3), with the areas available for restoration in the potential project area,[2] the sequestration potential

[24] Monga, E., Mangora, M., Trettin, C. (2022) Impact of mangrove planting on forest biomass carbon and other structural attributes in the Rufiji Delta, Tanzania. Global Ecology and Conservation, 35

[25] Japhet, E., Mangora, M., Trettin, C., Okello, J. (2019) Natural recovery of mangroves in a abandoned rice farming areas of the Rufiki Delta, Tanzania. WIO Journal of Marine Science, 18 (2), 25-36

[26] https://verra.org/methodologies/vm0033-methodology-for-tidal-wetland-and-seagrass-restoration-v2-0/

[27] This default factor was derived from the median rate of the literature synthesis of Chmura et al. 2003. The synthesis included studies worldwide, including marshes and mangroves. The median was used as the best estimate of central tendency because the data were not normally distributed; Chmura, GL, SC Anisfeld, DR Cahoon, and JC Lynch (2003) Global carbon sequestration in tidal, saline wetland soils. *Global Biogeochemical Cycles* 17: 1111-1123. doi:10.1029/2002GB001917

over a 20-year period is estimated at between **19,152** and **43,598 tCO_2e** (see Table 3). Actual sequestration may be lower than this, however, as these estimates are based on establishment of mangroves in areas that have been completely cleared, while some of the sites identified for restoration have been subject to logging but may not have been entirely cleared. The expected effectiveness of the restoration activities should also be considered when estimating potential carbon benefits from mangrove restoration, as well as the uncertainty of applying growth models to estimate future biomass.

Table 3 Potential GHG removals in woody biomass and soils from mangrove restoration over a 20-year period

Location	Area available for restoration (ha)	Potential GHG removals over 20-years (t CO_2e)		
		Biomass	Soil	Total
Memba	28.5	1,994 to 9,171	2,518	4,511 to 11,688
Mossuril	90.9	6,363 to 23,270	8,036	14,399 to 31,306
Nacala-a-Velha	1.5	107 to 468	135	242 to 603
Total	**120.9**	**8,464 to 32,909**	**10,688**	**19,152 to 43,598**

4.3 Carbon Benefits from Mangrove Protection

Without the proposed project, mangroves in the project area are expected to experience deforestation and degradation that will generate greenhouse gas emissions from loss of woody biomass and soil organic carbon. If mangroves in the proposed project area are effectively protected, emissions from woody biomass and soils are therefore expected to be reduced. Potential emission reductions from reduced loss of woody biomass and soils are estimated at **309,490 t CO_2** over a 20-year project period. The actual emission reductions achieved would depend on the effectiveness of project activities in addressing the direct and underlying causes of deforestation and degradation.

4.3.1 Project boundaries

The potential project area is the coastal areas between the southern border of Cabo Delgado Province to the north, and the southern border of Lunga District to the south in Memba and Mossuril Districts, Nampula Province (see Figure 1). According to maps of mangrove cover produced from Sentinel-2 L2A multitemporal images,[2] in 2022 the proposed project area included 12,225 ha of mangroves.[28] Global Mangrove Watch Data for 2020 suggests a lower mangrove extent in the proposed project area of 9,645 ha, however, which is broadly consistent with mapping of mangrove extent from Landsat imagery carried out by Silvestrum that identified 8,907 ha of mangroves in the proposed project area.[23] For the purpose of this study a mangrove area of 9,645 ha is assumed.

To describe the expected rate of deforestation in the potential project area, the Plan Vivo Tool for Estimation of Carbon benefits from REDD in Community-Managed Forests (PT002) uses analysis of historical rates of deforestation in a reference region that has similar forest type and exposure to drivers of deforestation as the project area.[29] Protection status, distance to human settlements, and mangrove condition in 2000 were used as strata representing exposure to drivers of deforestation in the reference

[28] Note that figure reported in the ecological assessment report for mangrove cover in Memba and Mossuril Districts in 2022 was 2,526 ha. The value used in this report comes from analysis of the datasets provided by the authors of the ecological assessment report.
[29] TLLG and Plan Vivo (2023) PT002: Estimation of Carbon benefits from REDD in Community Management Forest. Version 1.0. Plan Vivo Methodology. Available from: https://www.planvivo.org/pt002

region and project area.[30,31,32,] For the purposes of this analysis a reference region including all mangrove forests in Mozambique was selected and historical deforestation was analysed for the period from 2015 to 2020. Potential carbon benefits are assessed for a crediting period of 20 years, the minimum allowable for a VCS Agriculture, Forestry and Other Land Use (AFOLU) project.[33]

4.3.2 Historical deforestation

According to the Global Mangrove Watch datasets, in 2015 there was around 294,015 hectares of mangrove forest in in Mozambique.[4] By 2020, this had been reduced to 257,419 hectares, representing a loss of around 36,597 hectares of mangrove forest over the 5-year period. The average annual rate of deforestation ranged from 0.6 % per year to 6.8 % per year, depending on the stratum (see Table 4). The average across all strata was 2.5 % per year for the period from 2015 to 2020.

[30] Simard, M., T. Fatoyinbo, C. Smetanka, V.H. Rivera-Monroy, E. Castaneda, N. Thomas, and T. Van der Stocken. 2019. Global Mangrove Distribution, Aboveground Biomass, and Canopy Height. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1665

[31] UNEP-WCMC and IUCN (2023), Protected Planet: The World Database on Protected Areas (WDPA) [Online], November 2023, Cambridge, UK: UNEP-WCMC and IUCN. Available at: www.protectedplanet.net

[32] Wang, P., C. Huang, E. C. Brown de Colstoun, J. C. Tilton, and B. Tan. 2017. Global Human Built-up And Settlement Extent (HBASE) Dataset From Landsat. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). https://doi.org/10.7927/H4DN434S;

[33] VCS Standard Version 4.5, Requirement 3.9.3. https://verra.org/wp-content/uploads/2023/08/VCS-Standard-v4.5-updated-4-Oct-2023.pdf

Table 4 Change in mangrove cover in Mozambique from 2015 to 2020. Source: Bunting et al. (2022)[4]

Distance from settlement (km)	Condition*	Protection Status	Mangrove cover in 2015 (ha)	Mangrove loss 2015-2020 (ha)	% Annual deforestation
<2.5 km	Low	Protected	919	155	3.38%
		Unprotected	297	29	1.97%
	Mod	Protected	3,042	285	1.88%
		Unprotected	1,358	112	1.65%
	High	Protected	288	18	1.22%
		Unprotected	111	8	1.50%
	No data	Protected	1,461	494	6.77%
		Unprotected	1,138	359	6.32%
2.5-5 km	Low	Protected	935	109	2.32%
		Unprotected	745	91	2.44%
	Mod	Protected	6,147	446	1.45%
		Unprotected	3,861	285	1.48%
	High	Protected	871	62	1.42%
		Unprotected	280	22	1.54%
	No data	Protected	2,163	625	5.78%
		Unprotected	2,741	737	5.38%
>5 km	Low	Protected	9,719	1,358	2.80%
		Unprotected	14,259	1,955	2.74%
	Mod	Protected	91,298	6,002	1.31%
		Unprotected	61,991	5,415	1.75%
	High	Protected	22,614	676	0.60%
		Unprotected	9,965	572	1.15%
	No data	Protected	26,955	7,512	5.57%
		Unprotected	30,856	9,268	6.01%
Total			**294,015**	**36,597**	**2.49%**

*Based on AGB in 2000 from Simard et al. (2019)[30]; Low = <20 tC/ha; Mod = 20-50 tC/ha, High = >150 tC/ha

In the absence of effective protection, it is assumed that mangroves in the proposed project area have similar exposure to drivers of deforestation as mangroves in the rest of the country, that are in the same stratum. This simple assumption would be improved by identifying spatial variables that explain the patterns of deforestation in the reference region and developing a calibrated risk map that shows risk of deforestation for each pixel on a numerical scale, as is required by the VCS Consolidated REDD Methodology.[34] Mangroves are excluded from the Consolidated REDD Methodology, but similar approaches could be incorporated into planned updates to VCS Methodology for Tidal Wetland and Seagrass Restoration (VM0033).[35]

The historical rate of deforestation within the proposed project area, reported within the ecological assessment report, is lower than the historical rate of deforestation at the national level. For the period between 2012 and 2022 a deforestation rate of 0.79% per year was reported.[2] This is 1.7% lower than the national level analysis presented in Table 4. The difference may represent an increase in

[34] https://verra.org/methodologies/redd-methodology/
[35] https://verra.org/verra-revises-blue-carbon-methodology/

deforestation over recent years – analysis of deforestation between 2008 and 2020 using the Global Mangrove Watch data shows an average rate of deforestation of 0.59%per year. It may also indicate that mangroves in the proposed project area are exposed to a lower level of threat than mangroves in other regions.

4.3.3 Carbon density

Carbon stocks in aboveground and belowground biomass and soils were surveyed in 28 sample plots across twelve sites in the proposed project area in February and March 2023.[2] Average carbon stocks in aboveground and belowground woody biomass at each site ranged from 1.4 tC/ha to 28.0 tC/ha. Estimates of mangrove carbon stocks derived from a global canopy height model, [36] and carbon density values reported for different mangrove height classes in a study of mangrove carbon stocks in the Zambezi River Delta [37] suggested carbon stocks in the range of 109 tC/ha to 137 tC/ha for mangroves in the proposed project area.[23] Mangroves of the Zambezi River Delta may be more productive than those in the proposed project area, however, with taller and wider trees.[2]

Average soil organic carbon stocks in the sampled areas ranged from 60.1 tC/ha to 179.1 tC/ha;[2] which is, again, lower than the average values for proposed project area derived from data collected in the Zambezi River Delta that ranged from 279 tC/ha to 285 tC/ha. [23] Globally, average soil organic carbon stocks in mangrove areas are around 350 tC/ha.[38]

4.3.4 Baseline emissions from loss of woody biomass

According to data available in the Global Mangrove Watch platform, the proposed project area included around 9,645 ha of mangroves in 2020.[4] Using Global Mangrove Watch datasets from 2015 and 2020, and estimates of mangrove biomass from the 2023 biomass survey,[2] protection of mangroves in the proposed project area could avoid emissions from loss of woody biomass of up to **250,065 tCO_2e** over a 20-year project period or **12,503 tCO_2e** per year.

This estimate is based on application of the Plan Vivo Tool for Estimation of Carbon benefits from REDD in Community-Managed Forests (PT002).[29] Actual emissions avoided would depend on the success of project activities in addressing the drivers and underlying causes of deforestation. Further details are provided below, and calculations are provided in Annex 2. These estimates are also subject to uncertainty in estimates of mangrove extent, historical deforestation, and carbon density.

Following the Plan Vivo methodology for Estimation of Carbon benefits from REDD in Community-Managed Forests (PT002),[29] without-project (or 'baseline') GHG emissions from deforestation are estimated with the equation:

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[36] Lang, N., Jetz, W., Schindler, K. and Wegner, J.D., 2023. A high-resolution canopy height model of the Earth. *Nature Ecology & Evolution*, pp.1-12. https://www.nature.com/articles/s41559-023-02206-6

[37] Stringer, C.E., Trettin, C.C., Zarnoch, S.J. and Tang, W., 2015. Carbon stocks of mangroves within the Zambezi River Delta, Mozambique. *Forest Ecology and Management*, *354*, pp.139-148. https://doi.org/10.1016/j.foreco.2015.06.027

[38] Maxwell, T.L., Hengl, T., Parente, L.L., Minarik, R., Worthington, T.A., Bunting, P., Smart, L.S., Spalding, M.D. and Landis, E., 2023. Global mangrove soil organic carbon stocks dataset at 30 m resolution for the year 2020 based on spatiotemporal predictive machine learning. *Data in Brief*, 50, p.109621. https://doi.org/10.1016/j.dib.2023.109621

$$E_{BL,VP} = T_{VP} \cdot CF_{CO2} \cdot \sum_{i=1}^{i} \left(\left(D_{RR_i} \cdot A_{PA_i} \cdot (C_i - C_{NF}) \right) \right)$$

Where:

$E_{BL,VP}$ Baseline scenario emissions from deforestation expected during verification period *VP* (t CO_2e)

T_{VP} Length of the verification period (years)

CF_{CO2} Conversion factor to convert from carbon to carbon dioxide based on molecular weights of carbon and carbon dioxide (44/12)

D_{RR_i} Average proportion of the forest area present at the start of the reference region for forest stratum *i* that was deforested in each year of the reference period

A_{PA_i} Area of forest stratum *i* present in the project area at the start of the verification period (ha)

C_i Carbon density of forest stratum *i* (t C/ha)

C_{NF} Carbon density of non-forest (t C/ha)

Sources of data for the parameters used in this equation are summarized in Table 5. Expected without-project GHG emissions from deforestation in the proposed project area (see Table 6) over a 20-year crediting period are **250,065 t CO_2** For calculations see Annex 2.

Table 5 Parameters for estimating without-project GHG emissions

Parameter	Value(s)	Justification
Length of the verification period (years); T_{VP}	20 years	Minimum allowable crediting period for VCS AFOLU projects[7]
Average proportion of the forest area present at the start of the reference region for forest stratum *i* that was deforested in each year of the reference period; D_{RR_i}	See Table 4	From analysis of historical timeseries of land cover maps (see Section 4.3.2), deforestation is defined as conversion from forest in 2015 to non-forest in 2020.
Area of forest stratum *i* present in the project area at the start of the verification period (ha); A_{PA_i}	See Table 6	Forest area from 2022 mangrove cover map[4]
Carbon density of forest stratum *i* (t C/ha); C_i	12.7 tC/ha for all strata	Ecological Assessment Report[4] average of total biomass across all study sites.
Carbon density of non-forest (t C/ha); C_{NF}	0	Assuming all biomass is lost when conversion from forest to non-forest occurs.

Table 6 Estimated mangrove cover in the proposed project area in 2020. Source: Buting et al. (2022)[4]

Distance from settlement (km)	Condition*	Protection Status	Mangrove cover in 2020 (ha)
<2.5 km	Low	Protected	0
		Unprotected	11
	Mod	Protected	0
		Unprotected	183
	High	Protected	0
		Unprotected	0
	No data	Protected	0
		Unprotected	163
2.5-5 km	Low	Protected	0
		Unprotected	31
	Mod	Protected	0
		Unprotected	560
	High	Protected	0
		Unprotected	5
	No data	Protected	0
		Unprotected	450
>5 km	Low	Protected	3
		Unprotected	242
	Mod	Protected	104
		Unprotected	5,609
	High	Protected	5
		Unprotected	433
	No data	Protected	74
		Unprotected	1,772
Total			**9,645**

*Based on AGB in 2000 from Simard et al. (2019)[30]; Low = <20 tC/ha; Mod = 20-50 tC/ha, High = >150 tC/ha

4.3.5 Baseline emissions from soil

To claim emission reductions from avoided loss of soil organic carbon, the VCS Methodology for Tidal Wetland and Seagrass Restoration (VM0033) requires projects to define the period over which soil organic carbon is released following deforestation. No studies of soil organic carbon losses from mangrove deforestation in Mozambique were identified, but a study of mangroves in northwestern Madagascar showed that around 20% of soil organic carbon from the upper 1m of mangrove soils was lost in the 10-years that following mangrove clearance. [39] Applying these values to the average soil organic carbon density recorded in the potential project area of 105 tC/ha,[2] and the baseline rates of deforestation in Table 4 provides an estimate of emissions from loss of soil organic carbon in the proposed project area of **206,747 t CO_2** (see Annex 2 for calculations).

[39] Arias-Ortiz, A., Masqué, P., Glass, L., Benson, L., Kennedy, H., Duarte, C.M., Garcia-Orellana, J., Benitez-Nelson, C.R., Humphries, M.S., Ratefinjanahary, I. and Ravelonjatovo, J., (2021) Losses of soil organic carbon with deforestation in mangroves of Madagascar. *Ecosystems*, 24, pp.1-19. Available from: https://doi.org//10.1007/s10021-020-00500-z

4.3.6 Potential emission reductions and removals

Following the Plan Vivo methodology for Estimation of Carbon benefits from REDD in Community-Managed Forests (PT002),[29] emission reductions are calculated by subtracting project scenario emissions from without-project scenario emissions. Expected project scenario emissions are estimated with the equation:

$$E_{PS,VP} = E_{BL} \cdot (1 - F)$$

Where:

$E_{PS,VP}$ Expected project scenario emissions from deforestation and forest degradation expected during verification period *VP* (t CO_2 e)

E_{BL} Baseline scenario emissions from deforestation and forest degradation expected during the verification period (t CO_2e; see Section 3.2.1.3)

F Expected effectiveness of project activities in reducing emissions from deforestation, expressed as a proportion of baseline scenario emissions that can conservatively be expected to be avoided as a result of project activities.

To estimate expected effectiveness (F) before evidence of the effectiveness of project activities is available, it is assumed that the effectiveness of project activities will increase over time as project activities to address the drivers of deforestation and forest degradation are developed and implemented. For this analysis expected effectiveness is therefore based on a gradual increase in effectiveness over the first 10-years of the project until the project can prevent 90% of the deforestation and degradation expected in the without project scenario from year 10 onwards. With this approach, the average effectiveness over the 25-year crediting period is 68% (see Annex 2).

Using this value in the equation above gives expected project scenario emissions from deforestation of 147,322 tCO_2. Subtracting this value from the expected baseline emissions gives an emission reduction potential over a 20-year crediting period of **309,490 t CO_2**, or **15,475 t CO_2** per year.

Since mangroves throughout the proposed project area appear to be in a degraded state (see Section 4.2.1) it is also likely that effective protection would result in an increase in carbon stocks within these areas. If initial carbon stocks in these areas are estimated, the without-project scenario for carbon stock changes can be described, and increases in carbon stocks are monitored, it may be possible to claim carbon credits from this assisted natural regeneration as well as, or instead of, claiming carbon credits for avoided deforestation. It is unlikely that this would be possible if another project is claiming the carbon credits for avoided deforestation from the same area, however.

4.4 Leakage

The potential emission reductions estimated in Section 4.3 do not include any increases in greenhouse gas emissions outside the project area that could occur as a result of project activities, or 'leakage'. Leakage could occur if the project activities involve restrictions on mangrove use that would occur in the baseline scenario, for example introduction or enforcement of regulations on firewood collection, timber harvesting. The risk of leakage can be mitigated through activities that address the underlying causes of mangrove degradation, and that ensure that mangrove users are able to secure alternative sources of resources and income that are sufficient to outweigh any negative livelihood impacts (see Section 5.1.1).

5 Risk Assessment

5.1 Environmental and Social Risk Screening

A rapid environmental and social screening was conducted using the Plan Vivo Screening Tool.[40] This included a review of the Blue Futures program ESMP, Preliminary Process Framework, Stakeholder Engagement Plan and the Environment and Social Code of Practice.[13,14,15,41] On this basis, the project was assigned a moderate risk rating. A full screening report is provided in Annex 3. Risks rated moderate or higher are described below.

The key risk areas identified included access restrictions and livelihoods (high), gender equality (moderate), vulnerable groups (moderate), the risk of not accounting for climate change (moderate), stakeholder engagement (moderate), and cumulative impacts (moderate). Issues related to stakeholder engagement are treated above in Section 3. Since mangrove restoration areas are likely to require similar interventions to mangrove protection areas – to ensure that the direct and underlying causes that led to the degradation are addressed – the risk areas identified are applicable to both mangrove protection and restoration activities.

This rapid screening was desk-based, relied on safeguard plans from a broader program, and did not include any interaction with the project team. Further investigation of the potential risks identified is therefore recommended as the project is developed further.

5.1.1 Access restrictions and livelihoods

The screening rated potential access restrictions to mangrove resources important to livelihoods to be high. The extent of these potential risks is unknown and depends on several factors, including:

a) The level of dependency each stakeholder group has on the mangrove site(s), with particular attention to vulnerable groups;
b) The location and extent of the access restrictions;
c) The proposed mitigation measures, including avoidance (e.g. through zoning), minimisation (e.g. through allowing some uses, quotas or licensed use, or seasonal use), or livelihood restoration (through providing livelihood activities that are equivalent to the original function of the mangrove use activity, substituting either the cash income, the resource itself, or the extraction method).

The Blue Futures program prioritises avoidance of impacts through participatory workshops (e.g. program activities 1.1.1.5, 1.1.1.6, 1.1.1.7). However, without sufficient involvement of the direct users of the natural resource (women, vulnerable groups) in the planning of zones and regulations, and mitigation measures, impacts can manifest. Involvement of community management committees, such

[40] See PV Climate Project Idea Note Template: Annex 4. Available from: https://www.planvivo.org/pv-climate-documentation
[41] Wildlife Conservation Society (2023) Building a Blue Future for Ecosystems and People on the East African Coast: Annex C - Environmental and Social Code of Practice (ESCOP). Version 3, 30 Jun 2023

as fishing councils, which is usually a necessity, can lead to elite capture and result in less prominent groups in the community experiencing the highest costs.

Once factors a) and b) are understood better for the communities where the project will work, it will be possible to assess the proposed mitigation measures. The Blue Futures program has a Process Framework in place, and a simplified version of this that focuses on mangrove use and the required restrictions and behaviour change, and mitigation measures, could usefully be developed. [42]

While a socioeconomic baseline assessment has been conducted,[3] there is little information on mangrove use and dependency, which would be the basis for the carbon project's Theory of Change. The Process Framework suggests that people who will be affected will be identified during the project baseline. In the absence of other information on mangrove use and dependency, a tailored socioeconomic assessment that looks to assess potential impacts would be beneficial.

The Blue Futures program livelihood activities, including activities to reduce pressure on natural resources, include:

- Firewood saving stoves,
- Planting leguminous non-mangrove tree species and fruit trees,
- Establishment of Village Savings and Loan Associations (VSLAs),
- Training in new agricultural practices and activities,
- Creation of livelihood clubs, and
- Small business support.

While each of these activities, and normally a combination of several, have the potential to substitute the multiple roles of mangrove use (cash income, fuelwood, small scale fishing activities, small construction materials, mangrove poles for home construction, timber for sale, etc), or at least incentivise reduced use; each of these livelihood interventions can also be problematic in terms of beneficiary selection (matching poor, vulnerable individuals dependent upon mangroves to the activity), and in terms of effectiveness, equivalence and sustainability. The key to effective implementation of livelihood interventions such as these are in a) the project partner's expertise and experience; b) finding the right level of resourcing (amount, and timeframe); and c) thorough assessment of feasibility and trialling with involvement of affected groups.

Other challenges with establishing Small and Medium Enterprises (SMEs) in coastal areas in Mozambique include complex regulation in terms of licensing and taxes, which can create significant financial and technical barriers to enterprise development for local communities. Corruption in the marketplace, for fish, mangrove timber, and crabs can also exist and undermine efforts at establishing community enterprises without adequate government support and buy-in.

As such, assessing the feasibility of the project would benefit greatly from the development of a livelihood restoration and improvement plan (or equivalent), that identified the affected groups and type of impacts, and that fully planned out the livelihood interventions for the proposed project areas with the involvement of local communities, partner providers and private sector as needed. Such a plan

[42] Noting that the Blue Action Fund Process Framework and guidance are particularly long and cumbersome, and a tool that is more fitted for project teams would be more appropriate for this kind of project.

could then be costed out to understand the degree to which grant funding would cover interventions, versus the need for carbon finance to be dedicated to supporting these activities.

5.1.2 Gender equality and vulnerable groups

Vulnerable groups, including women, are defined broadly in the Blue Futures program's ESMP, although who is vulnerable in the context of mangrove-dependent coastal communities would need further consideration for the development of a carbon project. Vulnerable mangroves users could be identified through a stakeholder analysis that considers the often-multiple factors that contribute to an individual or group's vulnerability (e.g. women, who are the heads of their households and are over the age of 65). These groups should be identified and explicitly written into stakeholder engagement plans, to avoid the risk of being grouped into 'community consultations' with mixed user-groups. Ideally, there would be a separate carbon project stakeholder engagement plan, with a focus on the phased community engagement process for establishing the carbon project (see Section 3).

Alongside their proper identification, an additional risk to women and vulnerable groups is their dependence on mangroves, and their relative lack of assets to cope with changes in access to natural resources. This should be better understood during the socioeconomic assessment and baseline.

Furthermore, women and vulnerable groups can be marginal to, or marginalised from, participation in decision-making regarding project activities, particularly those related to access restrictions. Their input and views on issues such as location of no-take zones, type of restrictions written into management plans and benefit sharing mechanisms, would be critical.

As women are a key potential participant in this project, it is important that the project understands the risks associated with women's participation on the internal gender dynamics in the household, as well as publicly. For example, it is not uncommon for women to pass on the benefits of project activities e.g. income from alternative livelihood projects or savings from VSLAs to their husbands, whilst others may be prevented entirely from participating. The project proponent has conducted a thorough gender assessment for all Districts in the project area, which included a gender analysis and the development of a gender action plan which includes clear targets for each project activity. This gender action plan is a suitable measure to manage the potential risks, and should be monitored and adapted accordingly.

5.1.3 Climate change

The risk of not accounting for climate change was assessed as moderate. The social baseline report touches on aspects of climate resilience and disaggregates this by livelihood activity (in Table 43, page 68).[3] Collection of marine species is on par with agriculture in terms of most affected livelihood activity. Fishing is a close second. Initial indication from the socioeconomic baseline suggests that women may be more vulnerable in terms of climate impacts. This was found further north in a Climate Vulnerability and Capacity Assessment (CVCA) conducted in Cabo Delgado Province.[43] The social baseline report also shows (Table 27, page 51) that women have had less training in 'coastal marine resource management and adaptation to climate change' despite their increased vulnerability. [3]

A CVCA has been conducted, and the range of climate hazards were identified, including floods, droughts, strong winds/cyclones, erosion, sea level changes, salinization of bore holes. The study

[43] WWF (2015) Climate Vulnerability and Capacity Analysis (CVCA) Quirimbas National Park, Cabo Delgado Province, Mozambique. WWF Mozambique, Maputo. pp.84.

illustrate the links between climate impacts, and community livelihood decision-making. While the study illustrates that clearly resource management is part of the solution, it also indicates the livelihood stresses communities are under, further emphasizing the importance of developing improved livelihood options in order to enable people to adapt their mangrove use. The results of the study will ensure that the project does not support livelihood activities that could exacerbate peoples' livelihood exposure to climate impacts. While clearly there are other development needs related to climate change (eg. access to drinking water, improved bore holes, and improved water storage), the degree to which the project can contribute to these issues will depend largely on the amount of revenue available to communities and the benefit-sharing agreements reached.

Note that in some carbon Standards, such as the Climate, Community and Biodiversity Standards (V3.1), gold-level requirements include the introduction of measures needed and designed for climate adaptation, and the CVCA report acts as a good foundation to consider which activities could be supported.

5.1.4 Cumulative impacts

Several potential risks were identified relating to cumulative impacts.[44] Cumulative effects of coastal squeeze and fisheries restrictions may undermine efforts at compliance. 'Coastal squeeze' is a phenomenon reported to be occurring along the coast of Mozambique.[45] Coastal squeeze has largely been driven by the tourism, oil and gas industry and conservation and has significantly reduced the number of intertidal sites accessible to fishing communities with small scale fishers now forced to concentrate their fishing effort in fewer sites. Coastal squeeze has negatively impacted fishing strategies in the region as historically fishers would rotate their fishing effort allowing sites time to recuperate before returning to them.

In this context, the potential for the carbon project to add another layer of restrictions onto communities' already restricted livelihood options, requires careful consideration. In addition to tourism and other developments, there are also already numerous fisheries management measures in existence that affect the proposed project area. There are national and district level fisheries restrictions, CCP by-laws and fisheries projects operating in and around the potential mangrove sites. The two nation-wide restrictions on gear (a complete ban) and temporal closures for beach seines have potential wide reaching negative impacts on local livelihoods. District level plans also place restrictions on fishers; these include mesh sizes, temporal and permanent closures, and species restrictions and bans. Some of the communities in the project area may also be participating in other projects with associated fisheries management measures, or they may have local by-laws in place; these would need to be assessed against the proposed sites and management measures.

5.2 Non-Permanence Risk Assessment

With any land-based carbon project, there is a risk that the carbon benefits achieved could be reversed, for example if restored areas or areas where deforestation has been avoided are degraded during or

[44] These could also be described as contextual risks

[45] Bunce, M., Brown, K. and Rosendo, S. (2010) Policy misfits, climate change and cross-scale vulnerability in coastal Africa: how development projects undermine resilience. *Environmental Science & Policy*, 13(6), pp.485-497.

after the project. The VCS AFOLU Non-Permanence Risk Tool[46] allows projects to evaluate their non-permeance risk as well as consider risk mitigation options and must be applied by all VCS AFOLU projects to determine a risk buffer allocation based on their risk score. Using this tool, risk of transient and permanent reversals of carbon benefits are assessed over a period of 100 years based on present conditions and the information available at the time of the risk analysis. Along with the risk rating generated by the tool, project proponents must provide evidence to substantiate the risk score.

The VCS AFOLU Non-Permanence Risk Tool was applied to the proposed project activities to assess internal, external and natural risk of the project. The results are summarised below.

5.2.1 Internal risk

The internal risk that the assessment considers includes project management, financial viability of the project, the opportunity cost of the project and the project longevity.

The most significant of these under the project management segment is the need for an adaptive management plan that includes a monitoring plan. This is critical for project permanence, and thus WCS must ensure that any management and monitoring planning allows for flexibility and change. Other project management features most relevant to this project include demonstrating the suitability of species for planting, whether a high level of anti-encroachment enforcement is required, and the relevant skills and experience of the management team. Risk can be mitigated by having team members with specific AFOLU project experience, which WCS could bring in either through employment of staff with this relevant skillset, or potentially through integration of appropriate consultancy services to the management team.

The financial viability of the project is assessed through an assessment of the project payback period, which is calculated based on the initial investment divided by the net cash flow per year. The net cash flow per year can include any commercial revenue streams linked to the project, as well as other funding sources such as donor funds, and carbon payments. The investment can include the project implementation costs, costs of carbon credit generation (e.g. validation and verification) and any financial commitments e.g. loan repayments. If the project's payback period (i.e. time until it breaks even) is longer than 20 years, then the project fails the risk assessment. Below this, a gradient of time-periods and risk ratings is applied. Further to this, the project must also demonstrate the percent of funding it has already secured to cover outgoing expenses until the project reaches breakeven.

The opportunity cost assessment requires evaluation of the most profitable alternative land use activities compared to the net present value of the project activities, if the baseline activities are not subsistence driven. If alternative land use activities are typically subsistence driven, then the evaluation of alternative land use activities is not required and instead the project will need to demonstrate net positive community impacts and can mitigate non-permanence risk further through the use of legally binding agreements to continue management practices that protect credited carbon stocks. Considering that alternative land use activities in the project area may be from both subsistence (e.g. wood collection) and non-subsistence/commercial activities (salt pans), the project will need to answer to both the profitability of alternative land use activities and net positive community impact.

[46] VCS (2023) AFOLU Non-Permanence Risk Tool. Version 4.2. Available from: https://verra.org/wp-content/uploads/2023/10/AFOLU-Non-Permanence-Risk-Tool-v4.2-FINAL.pdf

The project longevity assessment focuses on the duration of the project commitment- which the project will fail if the project longevity is less than 40 years or there is not a management, financial and monitoring plan for the entire project longevity. The project also needs to be able to demonstrate its commitment to the continued application of the management practices. As WCS is exploring the project costs and returns on credit sales, the associated costs of the number of years that the project is committing to and the implementation and monitoring costs associated with that time-period (i.e. a minimum of 40 years) should be considered.

5.2.2 External risk

The external risk assessment focuses on evaluating the project land/resource tenure, stakeholder engagement and political risk of the country the project is developed within.

Under the land and resource tenure assessment, the project will need to demonstrate that is has undertaken due process to discover any disputes over land ownership, resource access and user rights. The extent of the project area under dispute will impact on the risk rating that is allocated to the project, and if the project is working to address these disputes then a risk mitigation score will be applied. The project will also need to demonstrate any legally binding agreements over the legal right to control and operate over the project area with those that are the rights holders. Engagement in the carbon project development pathway described in Section 2.1 will enable WCS to secure the legal rights to operate the project, but this will need to be supplemented with a process to identify customary rights holders and explore potential disputes over land ownership, resource access and user rights (see Sections 3 and 5.1.1).

The project will need to assess the reliance on the project area of local populations living inside of and within 20km of the project boundary. As part of the project's stakeholder engagement at least 50% of stakeholders living within and reliant on the project area and at least 20% living within a 20km distance of the boundary and reliant on the project area must be consulted, to avoid a high-risk rating. Households can be determined as consulted and involved in participatory planning where there have been direct meetings and planning with associations or community groups that are legally recognised to represent the households.

Political risk is based on Mozambique's governance score, calculated from the past five years of data on the six indicators of the World Bank Institute's Worldwide Governance Indicators. [47] These indicators are focused on voice and accountability, political stability/no violence, government effectiveness, regulatory quality, rule of law and control of corruption. Mozambique's average score for the past five years is -0.85, which falls within the highest risk score under this part of the VCS Non-Permanence Risk Assessment Tool. This risk score can be reduced somewhat as Mozambique has submitted an NDC to the UNFCCC Secretariat within the past 5 years (in December 2021), which is considered a risk mitigation activity.

An additional risk feature for consideration and not included in the VCS Non-Permanence Risk Assessment Tool but relevant to this project, is an external risk linked to the current critical

[47] The World Bank (2023) Worldwide Governance Indicators. Available from: https://www.worldbank.org/en/publication/worldwide-governance-indicators

humanitarian situation in Nampula region, as well as armed conflict and insecurity in the area. [48] The project has conducted a security risk assessment and a security management plan is in place. This should consider how close internally displaced camps are to the project area and if there any displaced people in the project area, as a result of previous cyclone impact. By being aware of these potential social insecurities, the project can actively work to mitigate any risk and potentially have a positive impact in reducing these social issues.

5.2.3 Natural risk

Risks to the project from natural events, include cyclones and tropical storms, and sea level rise.

5.2.3.1 Cyclones and tropical storms

Mozambique receives an average of four cyclones a year, of varying severity, with Nampula being one of the most affected regions. [49] These cyclones and other tropical storms cause loss of life, infrastructure damage, flooding of crop lands, insecurity and high dependence on humanitarian support.[50] The IPCC Sixth Assessment report suggests that stronger cyclones are likely in the coming years as a result of climate change. [51]

Mozambique has seen some devastating cyclones in the past decade (see Table 7), and was ranked 1st out of 180 countries in the Global Climate Risk Index for 2019 and 5th in 2000- based on the extent countries have been affected by impacts of weather-related loss events.

Table 7 Most violent cyclones in Mozambique since 2019. Source WorldData.info (2023)[49]

Year	Cyclone	Saffir-Simpson scale	Affected regions
2019	Desmond	Tropical storm	Inhambane, Zambézia
	Idai	Category 4	Zambézia, Nampula, Niassa, Sofala, Manica
	Kenneth	Category 4	Cabo Delgado
	Belna	Category 3	No landfall in Mozambique
2020	Diane	Category 2	No landfall in Mozambique
	Chalane	Category 1	Zambézia, Sofala, Manica
2021	Elosie	Category 2	Nampula, Zambézia, Sofala, Gaza
	Guambe	Category 2	Gaza, Inhambane, Sofala
	Iman	Tropical storm	Nampula
	Jobo	Category 1	No landfall in Mozambique
2022	Ana	Tropical storm	Nampula, Tete
	Gombe	Category 3	Nampula, Niassa, Tete
	Jasmine	Tropical storm	Nampula, Zambézia
2023	Cheneso	Category 1	Nampula

[48] ACAPS (2023) Country Analysis: Mozambique. Available from: https://www.acaps.org/en/countries/mozambique
[49] WorldData.info (2023) Cyclones in Mozambique. Available from: https://www.worlddata.info/africa/mozambique/cyclones.php#:~:text=Cyclones%20only%20occur%20occasionally%20in,about%204%20times%20a%20year.
[50] Famine Early Warning System Network (2022) Concern for the impact of weather shocks and conflict on agricultural production. Mozambique – Key Message Upadate. Available from: https://fews.net/southern-africa/mozambique/key-message-update/january-2022
[51] IPCC (2021) Climate Change 2021: The Physical Science Basis. Available from: https://www.ipcc.ch/report/sixth-assessment-report-working-group-i/

	Freddy	Category 5	Inhambane
	Freddy	Category 3	Zambézia, Tete
2024	Alvaro	Tropical storm	Nampula

While scientific literature shows that nutrient fertilisation can be aided by tropical cyclones (through nutrient fluxes and freshwater supply) and enhances the productivity of mangrove forests, [52] cyclones can cause significant damage to mangrove areas. Reports that 60% of the mangroves of the Limpopo river estuary were wiped out in 2000 as a result of Cyclone Eline are evidence that there may be a non-permanence risk to any mangrove restoration or conservation, and the a carbon project would need to consider recovery plans for any potential loss- bearing in mind it can take over a decade for restored mangrove forests to recover their functionality. [53]

The project's ecological assessment report states that: "*Field work observation do not suggest the occurrence of any major extreme event such as cyclone or floods, although it is known that recently the area was impacted by a number of extreme events including: Tropical storm Jasmin in April 2022; cyclone Gombe in March 2022; tropical storm Ana in January 2022; storm Iman in March 2021; cyclone Eloise in January 2021 and cyclone Idai in March 2019*". [2]

Based on the risk categorisations of the VCS Non-Permanence Risk Assessment Tool, it could be assumed that in the project area the historic likelihood of a devastating cyclone may be minor (5% to less than 25% loss of carbon stocks), but highly frequent (more than once every 10 years). However, further evidence of the historic cyclone impact on mangrove biomass may be required to confirm this classification. It would be difficult to mitigate the risk of this hazard. It could be expected that there would be increased likelihood of cyclones and intensity, thus a factor would need to be used to account for this increased natural risk with climate change impact.

5.2.3.2 Sea level rise

According to Global Mangrove Watch, the primary driver of mangrove loss in Mozambique between 2000 and 2016 was erosion. [54] Mozambique's sea level rise predictions are higher than global averages, and are predicted to increase from 0.5 to 1.0 m between 2081-2100 relative to 1980-2005. [55] Considering these scenarios, shoreline changes (due to erosion) for northern Mozambique are estimated to be between -31.4 to -37.6 m by 2050, and -90.0 to -92.1 m by 2100 depending on the climate scenario; and shoreline retreat (changes of the coast towards the land) is estimated to be between -22.7 to -28.3 m by 2050 and -62 to -69.8 m by 2010. Under the most conservative global climate change scenarios these estimates for Mozambique are on a par with globally estimated

[52] Rasquinha, D.N. and Mishra, D.R. (2021) Tropical cyclones shape mangrove productivity gradients in the Indian subcontinent. Scientific Reports, 11(1), p.17355. Available from: https://www.nature.com/articles/s41598-021-96752-3
[53] UNEP (2020) Decades after devastating cyclone, mangroves are on the rebound in Mozambique. Available from: https://www.unep.org/news-and-stories/story/decades-after-devastating-cyclone-mangroves-are-rebound-mozambique
[54] Global Mangrove Watch (2023) Available from: www.globalmangrovewatch.org
[55] Mucova, S.A.R., Azeiteiro, U.M., Filho, W.L., Lopes, C.L., Dias, J.M. and Pereira, M.J. (2021) Approaching Sea-Level Rise (SLR) change: strengthening local responses to sea-level rise and coping with climate change in Northern Mozambique. *Journal of Marine Science and Engineering*, 9(2), p.205. Available from: https://doi.org/10.3390/jmse9020205

averages, and for the most severe climate scenario the values for Mozambique are lower than global estimates. It is expected that up to 1,318 km^2 of wetland loss impact could be experienced in Mozambique (41% of Mozambique's total coastal area). Mozambique and 3 other countries account for 53% of the total increase in Sub-Saharan Africa's surge zones resulting from sea level rise and intensified storm surges. [56]

Climate change scenarios for northern Mozambique indicate that there will be a deterioration and reduction in the support capacity (wave attenuation and stabilisation of the coast) of coastal protections services from sea grass and mangrove areas.[55] The combination of sea-level rise, the retreat of the coastline and coastal erosion along this coastline will likely cause changes in the seasonal activities of species, and interference to economically important plant and animal species, as well as ecological and environmental disturbance to functionality along the coast. The use of mangroves to mitigate risk is a key strategy for coastal protection, however; and mangroves that are bordered by high intertidal mudflats and gradually sloping areas just above tidal elevation that provide opportunity for mangrove colonization as seas rise are less susceptible to risks of sea-level rise. [23]

Procedures to account for potential reversal of climate benefits through sea-level rise will be included in the pending update to the VCS Methodology for Tidal Wetland and Seagrass Restoration (VM0033), and are likely to require a standard percentage deduction to credit issuance for all tidal wetland projects in addition to the non-permanence buffer allocation.[23]

[56] Dasgupta, S., Laplante, B., Murray, S. and Wheeler, D. (2009) Sea-level rise and storm surges: A comparative analysis of impacts in developing countries. World Bank Policy Research Working Paper, (4901). Available from: http://documents.worldbank.org/curated/en/657521468157195342/Sea-level-rise-and-storm-surges-a-comparativeanalysis-of-impacts-in-developing-countries

6 Financial Feasibility Assessment

For a carbon project to be financially feasible, the costs of implementing the project activities and generating certified carbon credits should be outweighed by the income generated by carbon credit sales, and any additional sources of finance generated by the project. All the information needed for a full cost benefit analysis is not currently available, but a summary of potential income from carbon credit sales from the different project activities based the carbon benefit estimates in Section 4 is provided in Table 8.

Table 8 Potential income from carbon credits generated from mangrove protection restoration activities over a 20-year period

Project Activity	Carbon Benefit (t CO_2e)*	Carbon Credits (t CO_2e)**	Income at $10 Per t$CO_2e$ (US$/ t CO_2e)	Income at $20 Per t$CO_2e$ (US$/ t CO_2e)
Mangrove Restoration (121 ha)	19,152 to 43,598	13,407 to 30,518	$134,065 to $305,183	$268,130 to $610,366
Mangrove Protection (9,645 ha)	309,490	216,643	$2,166,430	$4,332,860

*See Sections 4.2.3 and 4.3.6; **After deduction of risk buffer credits at 20%, and leakage deduction of 10%

To assess financial feasibility of a carbon project the potential income described in Table 8, should be compared against the costs for project implementation that include the costs that are not already covered by the Blue Futures program for:

- Implementation of Project Activities – direct costs for mangrove protection and/or restoration activities
- Monitoring – costs for monitoring impact of project activities in line with the requirements of the relevant standard and methodologies
- Stakeholder Engagement – costs for carrying out the stakeholder engagement activities required for development of a carbon project
- Risk Mitigation – costs of livelihood activities and other social, environmental, leakage and non-permanence risk mitigation activities
- Project Development – costs for development and registration of a carbon project
- Coordination and Management – costs for managing project activities and fulfilling reporting and verification requirements

Further description and estimates of these costs are provided below. Based on these costs and the potential income from mangrove restoration activities, it is unlikely that it would be financially feasible to develop a stand-alone project generating certified carbon credits from mangrove restoration activities over 121 ha unless this was part of a broader project (for example including mangrove protection and/or mangrove restoration over a greater area) with which project costs could be shared. Since many of the project development and initial implementation costs for mangrove restoration activities would be covered by Blue Futures program activities that are not contingent on generation of carbon credits; income from the sale of carbon credits could be channelled to activities that are not included in the Blue Futures program and that provide direct benefits to local communities. To determine the financial feasibility of carbon project in this context, it will therefore be necessary to assess whether the costs that are not covered by the Blue Futures program are outweighed by the benefits that would come from the sale of carbon credits.

6.1 Implementation and Monitoring of Project Activities

Estimated costs for mangrove restoration, and monitoring the restoration areas are summarised in Table 9. This equates to around $1,124 per hectare, but does not include the costs for any additional stakeholder engagement and risk management activities that are not covered by the Blue Futures program (see Section 6.2) or for project development, coordination and management (see Section 6.3).

Table 9 Costs estimates for implementing and monitoring 150 ha of mangrove restoration over a 20-year period

Project Activity	Estimated Cost* (US$)
Nursery establishment and hydrological restoration	45,387
Planting	8,271
Training community patrol and monitoring teams	32,400
Community patrols	48,000
Community monitoring	34,560
Total	**168,618**

* Not adjusted for inflation

The activities needed to effectively protect mangroves in the proposed project area have not been fully defined. Many of these activities are likely to be included in existing Blue Futures activities, but additional implementation and monitoring costs for this activity have not been estimated. These may include additional community patrols and monitoring, but the costs of these activities do not necessarily scale linearly with project area, so it is not possible to extrapolate costs from the estimates for restoration activities.

6.2 Stakeholder Engagement and Risk Mitigation

Since local communities include mangrove users that may be affected by the project, and that may have customary rights that include mangrove areas in the proposed project area, a comprehensive stakeholder engagement plan and livelihood restoration and improvement plan would need to be developed to fulfil the requirements for certifying a carbon project (see Sections 3 and 5.1). Activities needed to mitigate the non-permanence risks identified in Section 5.2 should also be considered.

Since the project does not currently have a targeted stakeholder engagement or livelihood restoration and improvement plans for the proposed carbon project, and activities to mitigate non-permanence risks have not been considered, the additional costs of activities not included in the Blue Futures program have not been estimated. The extent of the project area and number of people impacted will play an important role in determining these costs. Costs for a small-scale mangrove restoration project would therefore be considerably lower than a broader scale project that included mangrove protection as well as restoration.

6.3 Project Development, Coordination and Management

In addition to the costs associated with implementing and monitoring carbon project activities, and stakeholder engagement and risk mitigation activities; there are costs associated with project development, registration, validation and verification, sales and marketing of carbon credits, and for maintaining a governance structure for the long-term coordination and management of the project. There are also fees associated with REDD+ project registration and licensing in Mozambique.

The costs of preparing and implementing a carbon project can vary significantly depending on considerations such as capacity of the project proponent (in-house technical expertise to develop and design the project or if support is needed from consultants); project activities and extent of project area, costs associated with carbon standards, and requirements of the methodology adopted. Some costs scale according to project area and complexity (i.e. Validation and Verification and Project Coordination and Management) or credits generated (e.g. issuance fees). These costs are therefore an important consideration when determining the scale of project that is financially feasible. The main costs associated with the generation of certified carbon credits, and indicative ranges for costs are summarised in Table 10.

Table 10 Indicative transaction costs for carbon credit generation

Expense	Indicative Cost
Project Development	\$100,000 to \$300,000
Registration Fees	VCS: \$4,000 plus \$500 per year[57] Plan Vivo: \$2,500 to \$4,000 plus \$500 for each additional project activity[58]
Validation	\$20,000 to \$50,000
Monitoring and Reporting	Depending on scale, activities and methodology
Verification	\$20,000 to \$50,000 (at least every 5 years)
Issuance Fees	VCS: \$0.20 per VCU Plan Vivo: \$0.35 to 0.40 per PVC
Project Coordination and Management	Depending on scale and activities
REDD+ Project Application Fee	MZN 5,000
REDD+ Project License Fees	License approval MZN 50,000 License renewal (after 20 years) MZN 25,000
Taxes	2% of all carbon credits generated must be transferred to the government of Mozambique

The minimum cost for project registration, validation and verification over a 20-year period is around \$114,000 for a VCS project and \$102,500 for a Plan Vivo project; but this does not include the costs of project development, monitoring and reporting, issuance fees, or project coordination and management that would add to this significantly – especially if the project proponent does not have in-house capacity to complete the tasks.

As the carbon project development pathway defined in the REDD+ Decree requires submission of Project Documents prior to receiving a license for the carbon credits, it may not be possible to secure

[57] https://verra.org/wp-content/uploads/2023/03/Program-Fee-Schedule-v4.3-FINAL.pdf
[58] https://www.planvivo.org/costs-and-fees

finance for project development from advance sales of carbon credits, as carbon credit buyers often require evidence that the project developer has the legal right to operate the project. Alternative sources of funding may therefore need to be sourced.

Annexes

Annex 1 Legal and Regulatory Framework for Carbon Projects in Mozambique <NAMCP_FeasibilityAssessment_Annex1_LegalAnalysis.docx>

Annex 2 Calculations Spreadsheet <NAMCP_FeasibilityAssessment_Annex2_Calculations.xlsx>

Annex 3 Environmental and Social Risk Screening Report <NAMCP_FeasibilityAssessment_Annex3_RiskScreening.docx>