REFORESTATION AND RESTORATION OF DEGRADED MANGROVE LANDS, SUSTAINABLE LIVELIHOODS AND COMMUNITY DEVELOPMENT IN MYANMAR

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Project Title	Reforestation and Restoration of degraded mangrove lands, sustainable livelihood and community development in Myanmar
Version	1.2
Report ID	-
Date of Issue	26-September-2019
Project ID	1764
Monitoring Period	15-June-2018 to 14-June-2019
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1 PROJECT DETAILS

1.1 Summary Description of the Implementation Status of the Project

The proposed project falls under the ARR (Afforestation, reforestation and Revegetation) category of the Verified Carbon Standard (VCS). The project will be implemented on 2146.48 ha of degraded lands of the Northern part of Ayeyarwady Division of Myanmar. The lands that will be restored under the project belong to Magyi, Thabawkan and Thaegone village tracts and this restoration will create a healthy mangrove ecosystem.

The objective of the project is to establish and maintain a sustainably managed mangrove ecosystem for carbon sequestration, natural disaster risk reduction, poverty reduction with sustainable livelihoods in the coastal communities.

Improving the ability to provide a variety of ecosystem services, climate change mitigation, economic consideration and active local community participation are main components of the project. Without the project, carbon stocks in the project area will continue to decrease due to various anthropogenic activities. During the monitoring period of 2018-2019, a total of 1,235,840 mangroves were planted on 297.88 hectares of land belonging to Thabawkan village tract. The species identified for this reforestation project are *Rhizophora mucronata, Rhizophora apiculata, Bruguiera gymnorrhiza, Bruguiera cylindrica, Bruguiera sexangula and Ceriops tagal*. This combination of mangrove restoration and coastal green belt protection will improve the biodiversity and also be a natural disaster risk reduction asset from natural disasters such as sea waves or tsunami, will also play a role as a carbon sink and also promote sustainable rural development in the area.

The project has sequestrated an estimated 29,572.5 tCO_2e over a period of 1 year.

The project will provide over and above the carbon sequestration:

- Poverty alleviation with new livelihoods and wealth creation in rural areas,
- Communities empowerment through active participation in all stages of the project, and
- Improvement of basic infrastructure for rural communities.

1.2 Sectoral Scope and Project Type

Afforestation, Reforestation and Revegetation (ARR)

Project is NOT a grouped project.

As per the section 3.1.11 of VCS AFOLU Requirements (Version 3.6), all ARR projects shall comply also WRC requirements (Wetlands Restoration and Conservation) when soil organic carbon pool in the project scenario is not deemed below *de minimis*. For this project soil organic carbon is an important part of the

total amount of the carbon sequestrated, hence the project will comply both ARR requirements and WRC requirements. However the project do not consider any GHG emissions reductions and therefore does not fall under the description of WRC project in the section 4.2.19 of the AFOLU Requirements (Version 3.6)

1.3 Project Proponent

Organization name	Worldview International Foundation
Contact person	Dr. Arne Fjortoft
Title	Secretary General
Address	70 Yaw Min Gyi Street, Yangon, Myanmar
Telephone	+095-11220512 – Skype address arenfjor1
Email	arne@worldview.foundation

1.4 Other Entities Involved in the Project

Organization name	Pathein University
Role in the project	Land right holder and research partner
Contact person	Dr. U Htay Aung
Title	Research Manager
Address	Main Rd, Pathein
Telephone	+95-9970530946
Email	htayaungpathein@gmail.com

Organization name	Thabawkan Village Tract Mangrove Conservation Committee
Role in the project	Land right holders and labour force
Contact person	U Chit San
Title	Village tract leader
Address	Thabawkan village, ShweThaung Yan township
Telephone	+95-9970292557
Email	n.a

Organization name	Thaegone Village Tract Mangrove Conservation Committee
Role in the project	Land right holders and labour force
Contact person	U Saw Hay Zel
Title	Village tract leader
Address	Wet The village, ShweThaung Yan township
Telephone	+95-967776366
Email	n.a.

Organization name	Forest Department
Role in the project	Land right recommendation and consultation for forest services
Contact person	U Lin ThetHtun
Title	Range officer, Forest Department
Address	Township Forest Department, Pathein
Telephone	+95-9445997540
Email	n.a

Organization name	Myanmar University of Forestry
Role in the project	Research partner
Contact person	Dr. MyintOo
Title	Rector
Address	University of Forestry, Yi Zan, Nay Pyi Taw
Telephone	+95-67 416 520
Email	uof.yezin@gmail.com

Organization name	Forest Research Institute
Role in the project	Research partner
Contact person	Dr. Thaung Naing Oo
Title	Director of Forest Research Institute
Address	Forest research Institute, Yezin, Nay Pyi Taw
Telephone	+95-9448533635
Email	fri.yezin@gmail.com

Organization name	Ayeyarwady Regional Government
Role in the project	Land owner and local authority
Contact person	U Ba Hein
Title	Minister of Environment and Natural Resources
Address	Chief Minister office, Regional government, Pathein, Ayeyarwady Division
Telephone	+95-9260053281
Email	uohnmyint.308@gmail.com

1.5 Project Start Date

Project start date is 15th May 2015.
The start data of the project activity is 15th May 2015, which is the date of the land preparation occurred.

1.6 Project Crediting Period

20 years and 00 months, Renewable

Start date of the crediting period is the start date of planting, which is 15th June 2015

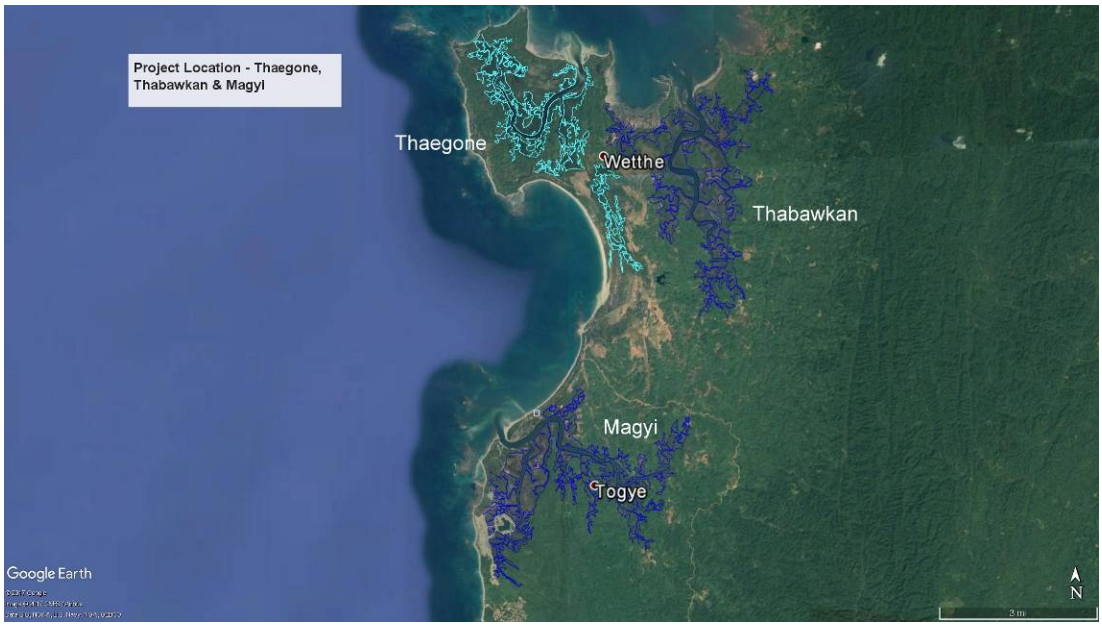
15th June 2015 to 14th June 2035

1.7 Project Location

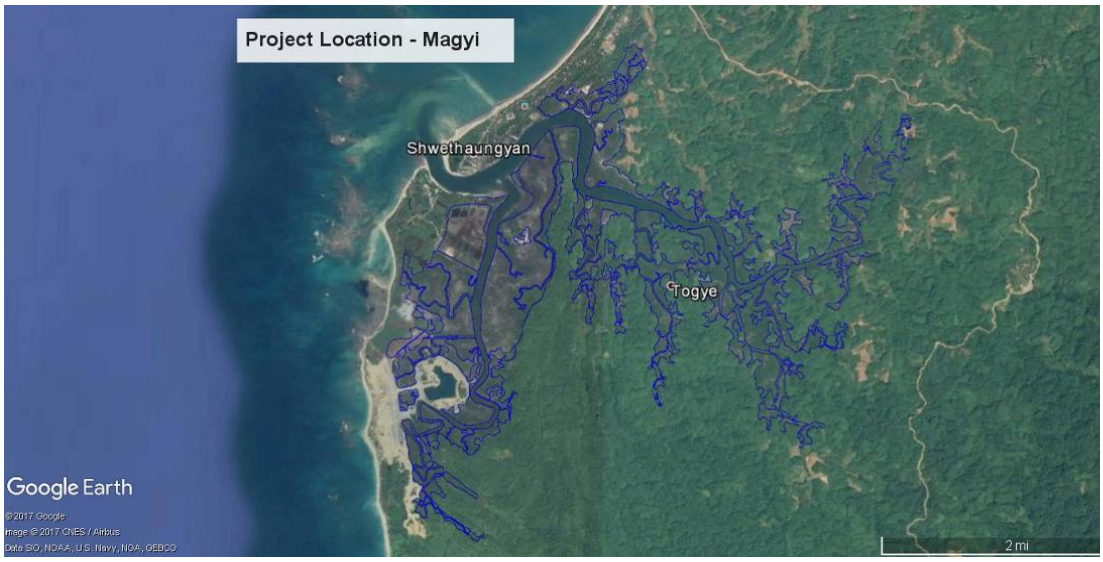
The project is implemented in three village tracts namely Magyi, Thabawkan and Thaegone in ShweThaung Yan Township. This is located in the Northern part of Ayeyarwady Division of Myanmar.

Map 1: Location of the project (Source: http://www.nationsonline.org/maps/myanmar_map.jpg)

The details of each parcel of land are enclosed in the supporting documentation where the location of the planting sites in each village including detailed information for each planting plot is shown on Google Earth image (kml file) or shape file.



Map 2: Project Location indicating Thaegone, Thabawkan and Magyi



Map 3: Project Location of Magyi

Map 4: Project Location indicating Thaegone and Thabawkan

1.8 Title and Reference of Methodology

A/R Large-scale Methodology: Afforestation and reforestation of degraded mangrove habitats (AR AM0014)
Version 03.0 and under Sectoral scope(s): 14 of the Clean Development Mechanism

The methodology also refers to the latest approved versions of the following tools:

(i) “Combined tool to identify the baseline scenario and demonstrate additionality in A/R CDM project activities” (Version 01);

(ii) “Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities” (Version 04.2);

(iii) “Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities” (Version 03.1);

(iv) “Estimation of non-CO_2 GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity” (Version 04.0.0);

(v) “Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity” (Version 02.0).

(vi) “Guideline for objective demonstration and assessment of barriers” (Version 01 EB-50)

1.9 Other Programs

Include the following information, as applicable:

- Emission Trading Programs and Other Binding Limits: NONE
- Other Forms of Environmental Credit: The project has not sought or received another form of GHG-related environmental credit, including renewable energy certificates, during this monitoring period.
- Participation under Other GHG Programs: The project is not registered under any other GHG program.

1.10 Sustainable Development

Mangrove restoration can be identified as a multi-faceted strategy for sustainable development. This has been described under 3 criteria namely Environmental, Social and Economic criteria.

Environmental criteria:
Mangrove forests are coastal plant communities that are part of a larger coastal ecosystem that typically includes mud flats, seagrass meadows, tidal marshes, salt barrens and even coastal upland forests and freshwater wetlands (i.e. peatlands), freshwater streams and rivers.

Establishing mangrove forests on degraded, underutilized lands will sequestrate significant amount of GHGs compared to baseline. Project is implemented by Worldview International Foundation in cooperation with Government and universities who are committed to environmental sustainability and social responsibility and are confident that the extraordinary costs involved in pioneering this project will eventually be covered by the supplementary cash flow from sale of VCUs.

Under the project, soil conditions will be checked, nutrition will be retained on the land and therefore water quality will be increased compared with the current status. The soil organic contents and mineral contents will be improved due to proper land management. Vegetation cover is expected to improve soil conditions. Mangrove restoration will further increase fish resources, protecting lives and properties from extreme weather, provide cooling effect from mangrove trees and provide other vital ecosystem services. Protecting endangered flora and fauna is another environmental benefit of the project.

Social criteria:
The project involves low income families in the area who get more opportunities to increase their income and thus be less prone to pursue unsustainable practices that might increase CO_2 emissions, harm the environment and further reduce the mangroves.

The project creates direct employment at agreed wages of the local communities involved in the project and provides all the training necessary. The project promotes a working family model where both men and women can actively participate in the project.

Improvements to the infrastructure in the area will be carried out to provide economic accessibility of the project area but also to facilitate farmers' access and strengthen the competitiveness of the farmers when it comes to taking their food crops to the market.

Economic criteria:

Labour requirement for the project will be fulfilled with local employment. Therefore the major portion of the budget on labour will be retained within the country and the local community. The project will pay its workers above normal wages with additional support in solving problems such as supporting construction of community flood walls, securing fresh water supplies in the dry season, repairing broken floors and roofs of school buildings, distributing solar lamps to families with school children, distribution of school bags and raincoats etc. in addition to create new livelihoods. 25% of the total project budget is for public education, social mobilisation, livelihood creation, micro loans, cottage industries, aquaculture, scholarships, distribution of solar lamps, and subsidy for fuel saving stoves, women projects and scholarships.

Impact Drivers of the proposed Project have been designed to address UN Sustainable Development Goal's (SDG) Impact Drivers. The following table presents the connection between impacts of project with UN SDGs[1].

Mangrove restoration impact drivers	SDGs Impact Drivers
Climate change Mitigation	13. Climate action
Climate change Adaptation	13. Climate action
Reforestation and restoration of mangroves	6. Clean water and sanitation
	13. Clean action
	15. Life on land
Conserve Water, Soil & Air	3. Good health and wellbeing
	6. Clean water and sanitation
	14. Life below water
	15. Life on land
Biodiversity Conservation	14. Life below water
	15. Life on land
Introduce & Promote Sustainable resource consumption	6. Clean water and sanitation
	7. Affordable and clean energy
	12. Responsible consumption and production
	14. Life below water
	15. Life on land
Rural economic development	9. Industry innovation and infrastructure
	8. Decent work and Economic Growth
	12. Responsible consumption and production
	5. Gender Equality
Improve the quality of life among the vulnerable coastal communities	5. Gender Equality
	10. Reduced Inequalities
	1. No Poverty
	2. Zero Hunger

[1] Can restoring mangroves help achieve the Sustainable Development Goals? LINK

MANGROVES – A LIFE-SAVING COASTAL ECOSYSTEM Scaling up protection and restoration for achieving the SDGs – report by BMZ, IUCN, WWF - LINK

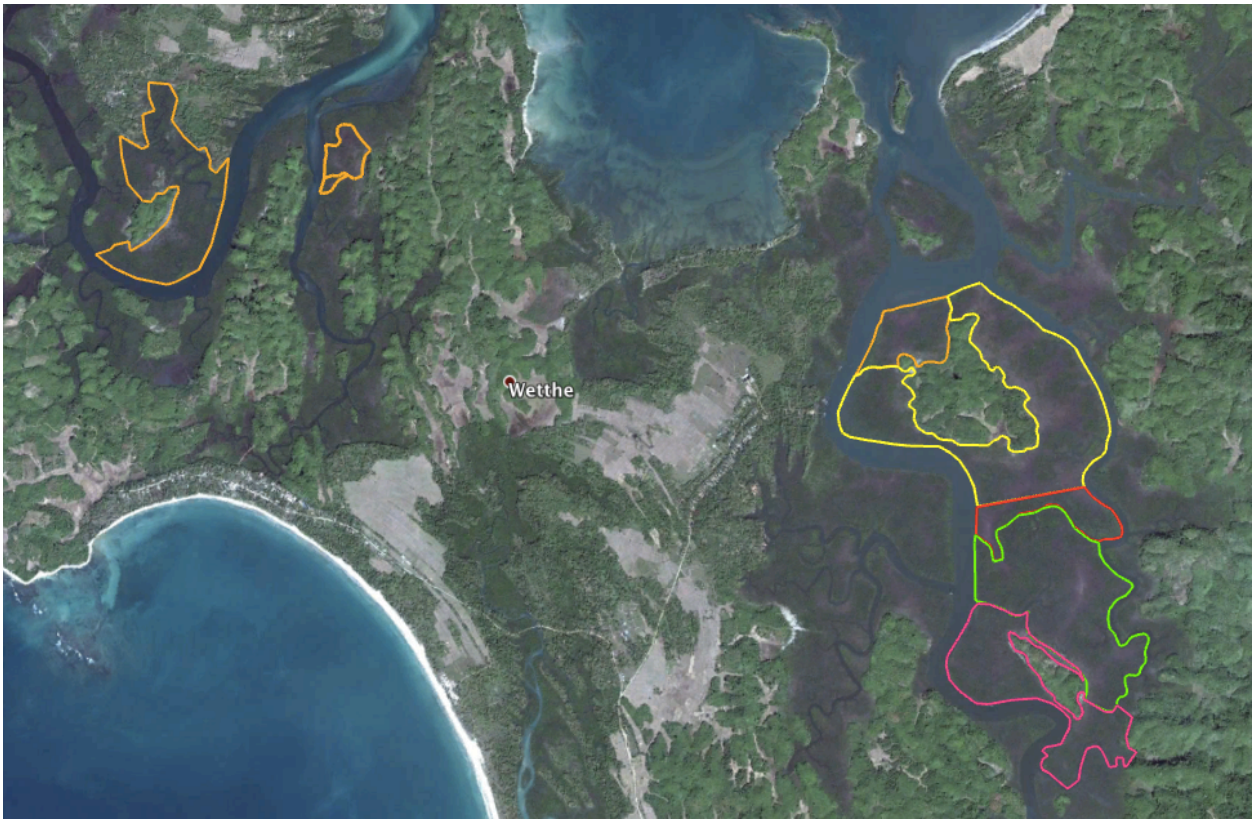
Supporting Monitoring and Implementation of Sustainable Development Goals with Earth Observations (page 22-25) - LINK

2 IMPLEMENTATION STATUS

2.1 Implementation Status of the Project Activity

The project activity started in May 2015 and planting started in June 2015. As mentioned above, the total area is 2146.48 ha. As of July 2018 a total of 701.5 hectares have been planted. An area of 297.88 ha was planted in 2018. Planted area in 2018 is indicated in the following Map 5.

The project activities are implemented as described in the VCS PD, which have been prepared after the project started. Both the monitoring report and the Non-Permanence Risk assessment report have also been prepared, assuring congruence among the different documents.



Map 5: Planting area in Thabawkan

The Non-Permanence Risk Report (Version 2.0) which was prepared in November 2017 was revised based on the activities during the 2nd monitoring period and has been used as the base report to monitor the parameters related to non-permanence risk.

The leakage for the project has been proven to be assumed zero as per the tool “Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity” (Version 02).

2.2 Deviations

2.2.1 Methodology Deviations

There are no deviations from the methodology

2.2.2 Project Description Deviations

As per the VCS PD in 2018 an area of 350 ha in Thabawkhan and 100 ha in Thaegone were to be planted. However only 297.88 ha was planted in 2018 in Thabawkan due to plantation differentiations of mobilizing funding, planting material and staff. Further due to factors such as mobilizing funding, planting material, involvement of local communities for planting had an impact in delaying the planting in Thabawkan and Thaegone. Planting in Thaegone started in 2019.

Since the final area have not increased beyond the intended planting area mentioned in the VCS PD, this has not impacted the applicability of the methodology, additionality or the appropriateness of the baseline scenario since the lands have met the applicability criteria. As per the methodology, the baseline emissions have been calculated to be zero. Since the baseline emissions are zero, this change in planting area does not change the baseline emissions. However the ex-post GHG reductions will change but not beyond the ex-ante estimations. This change does not impact the additionality.

Description on project description deviations applied in the previous monitoring report is as follows:

Due to the construction of a hotel, approximately 36.56 hectares had to be removed from the project area. After assessing the situation, the University of Pathein, World View International Foundation and the Forest Department held discussions with the hotel owner. The management of the hotel resort have agreed to stop expanding their project to any further mangrove areas and an arrangement has been agreed. As a result the management have built a fence demarcating their hotel area which has not expanded further to the project area. This has been documented and the Forest Department will further enhance their monitoring of the project area together with WIF and the University. As per the methodology, the baseline emissions have been calculated to be zero. Since the baseline emissions are zero, this change of land area from 701.5 ha to 664.9 ha does not change the baseline emissions. However the ex-post GHG reductions will change but not beyond the ex-ante estimations. This change does not impact the additionality since only a part of land has been excluded instead of adding a totally new land area to the project. PP

together with the University of Pathein and Forest Department have agreed with the hotel management no further encroachment will happen and annual monitoring of the project boundary shall be reported in each Monitoring Reports.

As per the VCS PD an area of 737.04 ha in Magyi was to be planted. The Myanmar Government has provided Pathein University (UoP) a land area of 1815.49 acre (734.7 ha) using the letter No: 300 / 1-12/ Government (Ayeyarwaddy) (9/2014) dated 12th May 2014. Although during later stages of the project, WIF and UoP signed MoUs for extension of project areas in Magyi, the final area recognized by all parties (Government, UoP and WIF) is 1815.49 acre (734.7 ha). Since the final area agreed upon was less than that intended in the VCS PD, WIF and Government together with UoP have agreed not to plant the land area identified as the 'abandoned shrimp pond'. After removing this area, final land belonging to Magyi is 701.5 ha. This is a permanent deviation and there shall be no further planting in Magyi as the entire 701.5 ha have been planted. Maintenance and remaining silvicultural practices shall be conducted to maintain these plants. Since the final area have not increased beyond the intended planting area mentioned in the VCS PD but actually reduced, this has not impacted the applicability of the methodology, additionality or the appropriateness of the baseline scenario since the lands have met the applicability criteria.

As per the methodology, the baseline emissions have been calculated to be zero. Since the baseline emissions are zero, this change of land area from 737.04 ha to 701.5 ha does not change the baseline emissions. However the ex-post GHG reductions will change but not beyond the ex-ante estimations. This change does not impact the additionality since only a part of land has been excluded instead of adding a totally new land area to the project.

By July 2019, a total of 962.82 ha have been planted. The remaining will be planted by 2020. This area did not contain any forests 10 years prior to the project start date. Satellite images were used to confirm with the criteria.

As per the MR, the planting in Magyi was done by 2017 (but in the PDD it was supposed to conduct planting between 2015-2018). However the area planted in each year 2015, 2016 and 2017 differed from the PDD due to plantation differentiations of mobilizing funding, planting material and staff. Further due to factors such as mobilizing funding, planting material, involvement of local communities for planting had an impact in delaying the planting in Thabawkan and Thaegone. Planting in Thabawkan started in 2018.

The equation used for the ex-ante calculation was a regional equation. At the time when the project was developed, only estimate diameter at breast height (DBH) values were available. There was a difficulty in finding height estimations. A research done by Sukardjo & Yamada (1992) on mangroves species in Indonesia seems to be most plausible equation. Results on this equation and results from field measurements gave similar results thus proving that this equation is the most plausible for ex-ante estimations.

It was decided to use site-specific or at least area-specific equations to estimate biomass for ex-post calculations and was clearly mentioned in the PDD. As explained in FAR 01, it was found that there were not enough data for the 3 year period to develop its own allometric equation. A detailed assessment by Ya Min Thant, Mamoru Kanzaki, Seiichi Ohta from Kyoto University and Maung Maung Than (DFID program, British Council) have developed five common allometric equations for stem, branch, leaf, above ground and below ground for six mangrove species based on specific gravity of stem.

Their study was published in the journal TROPICs published by Japan Society of Tropical Ecology (Link: https://www.jstage.jst.go.jp/article/tropics/21/1/21_1/_article/-char/en). Title of the paper is "Carbon sequestration by mangrove plantations and a natural regeneration stand in the Ayeyarwady Delta, Myanmar". The equations to estimate above ground and below ground biomass seem to be most plausible equations. Results on this equation and results from field measurements gave similar results thus proving that this equation is the most plausible for ex-post estimations.

Total aboveground and belowground biomass was estimated using –

Above ground - $\mathbf{W_{Top} = 0.22\ \rho\ (DBH^2H)^{0.82}}$
Below ground - $\mathbf{W_{Root} = 1.69\ \rho\ (DBH^2H)^{0.40}}$
Where:

DBH = Diameter at breast height; cm
H = Height (m)
ρ = Wood density (km/m^3)

2.3 Grouped Project

This project is NOT a grouped project

2.4 Safeguards

2.4.1 No Net Harm

Stakeholder consultation has been a priority of the project from day one, believing that a participatory approach is the only way to success. The project is not only about mangrove trees, but firstly about people.

The situation for the people in the project areas is critical. Their living standard for the majority is below poverty line. The aim is to increase family income. This will be done in close consultation with the people in the areas. According to the socio-economic survey conducted by WIF and University of Pathein, there are 827 households in Shwe thaun gyan city (Magyi Township) and the total population is approximately 3000. There were 1034 households and the population in Thaegone is around 4550. Thabawkan had 633 houses and the population was 3283. These communities have been depending on mangroves for their

food production and fuel-wood consumption. Therefore during the stakeholder meetings it was discussed and agreed to introduce alternative livelihoods and solutions for their fuel need.

Three main stakeholder meetings were held to discuss positive and negative impacts of the proposed project. Two meetings were held in each village tract and other with the Forest Department officers. The objectives of the project, planned activities and the benefits of carbon credits were presented in these meetings. The importance of protecting the mangroves and their role in carbon sequestration was explained in different ways. Local communities admitted that they have experienced decreasing fishery resources and more damage from cyclones since there are no mangroves left. They further identified the need of growing mangroves but they lack the capacity to do so. Forest Department officers mentioned the decrease of mangroves has resulted in decrease in wild animals that used to be there and also has an impact on food security, protection against natural disasters (tsunami, cyclones etc). According to the forest officers they did not foresee any negative impacts but suggested WIF to provide good training to workers who are involved in the project. Moreover, schools have been engaged in art competitions and creation of nurseries. These paintings were used as a media of communication in promoting the importance of mangroves.

Figure 1: Meetings during the stakeholder consultation

Figure 2: Meetings held in Thabawkan and Thaegone villages

There is no displacement occurring due to the project activity. Therefore surrounding communities and the Forest Department officers have no objection in this project. In fact they have positive attitudes towards the ARR VCS project activity due to following reasons:

(1) Increase their income

This project is designed specially targeting the local community. The objective of the Project Proponent being an INGO is sustainable development and natural resource management of the project area. Therefore the project has embraced any villager who would like to work on the basis of this model. Low income families in the area will get more opportunities to increase their income. This will be a support for their livelihood.

(2) New employment opportunities

Skilled and unskilled labour is needed for this project. The project creates direct employment opportunities in the establishment, maintenance and monitoring the mangroves in the project/villages area. Previously many of youth in these villages have gone to neighbouring districts for income generating employment. As a result in many cases only the children and older generation remained on their land. Reportedly due to this many youth stopped going to school at a young age. This situation has good potential to change due to newly created employment provided by the project. Youth would have the opportunity to both work and study to reach their potential.

The project promotes a working family model where both men and women can actively participate in the project. There are sufficient opportunities where women can work in the project.

(3) Knowledge on silvicultural techniques

As identified in the barrier analysis planting mangroves needs proper silvicultural knowledge if the plants are to succeed in the long run. The project proponent and its staff have very good experience and knowledge of mangroves and will transfer it to the local communities.

(4) Infrastructure development & Change in lifestyle

WIF mobilized support based on the university's own priorities, with assistance to improve the university's library, support to upgrade its IT section, as well as scholarships to students to complete research on

mangrove restoration, involving 42 students producing equal numbers of research papers. WIF also provided an International lecturer and trainer for 3 years. The university recommended one of their most knowledgeable and experiences professors with Ph.D. in marine science, as liaison officer to the project. Regular meetings were held at the university as well as at in the field. This has led to rewarding benefits for all stakeholders.

The same participatory approach was introduced with the communities around the first project site, as well as in the two new areas, with a number of meetings and consultations. Requests for help to repair schools buildings and establish flood control in a village affected by yearly flood, have been positively followed up. Public education on mangrove restoration and sustainable development has been implemented in all affected villages. The next phase is to develop livelihoods and promote sustainable development in all villages involved in project activities. Handicapped children have been provided medical support of obtaining artificial legs. Training of women entrepreneurs, establishment of oyster farm, initiative to start nypa sap production, virgin coconut oil and other products based on coal raw materials are underway. Regular meetings are held with village officials and the people in order to mobilise maximum participation. The final aim is to make everyone active partners and to demonstrate that the communities are better off with living trees in the area, than short sighted destruction of the living environment. VCS will in this extent be a major contribution to long time benefits for the participating communities.

2.4.2 Local Stakeholder Consultation

As explained in the VCS PD and the previous Monitoring Report, WIF has emphasizes stakeholder consultation from day one of the project, believing that a participatory approach is the only way to success. These were organized with the following 3 main objectives:

- Explain about the project to the local communities
- Discussion on formation of Environment and Mangrove Conservation Committees (EMCC) is each village tract and how to obtain the lands for the project from the Government
- Follow-up meetings on the formation of EMCCs.

Two stakeholder consultation meetings were held during 2018-2019.

Date	Participants	Points discussed	Location
10.1.2019	Village leader of Polaung, Win Maung (Project Manager of WIF) WIF staff 4 people 20 villagers from Polaung 20	- Observations on the mangroves established - Future plans for mangrove planting - villagers requested to increase the staff taken from their village and WIF agreed - Discussed about introducing efficient stove to reduce the usage of firewood consumption - Discussed about introducing Gliricidia species	Polaung village

		and villagers agreed to identify land for the plants	
5.7.2019	U Kan Tun (Assistant Director of Forest Department from Pathein) U Win Maung (Project Manager of WIF) Prof. Htay Aung (University of Pathein) WIF staff 4 people Village Leader of Wetthe, Village leader of Polaung Village leader of Thae Kyin village 50 villagers	- U Win Maung explained the aim of WIF and discussed about pros and cons of mangrove - Prof Aung explained the relationships of mangrove and aquatic animals - Main question raised was once the project started, whether they can enter the mangrove forest for fishing and catching crab. It was agreed that the villagers can enter the forest for non-timber forest products and fishing and catching crab. Villagers also questioned about the firewood and U Win Maung explained the process of introducing Gliricidia sepium as a firewood plantation. Villagers also questioned about post-project forest management and it was agreed to develop the management plans and ensure local communities are engaged in forest protection through the carbon credit.	Thae Kyin village

Apart from the stakeholder consultation meetings held PP has its office in Magyi where any stakeholder could come and make a complaint or suggestion. Prof. Htay Aung from the Pathein University visits the office twice a month to record these comments. As a representative of Pathein University, he is responsible for taking the comments and discussing them with UoP and WIF.

Complaints/ suggestions that are able to handle at local office shall be discussed with the local team led by Mr. Win Maung. For higher decision making, the Rector of Pathein University and Dr. Arne of WIF will be involved. For Thabawkan and Thaegone, the chief of village tract committees will also be responsible for recording the complaints, suggestions regarding the project and report to Mr. Win Maung and Dr Arne from WIF. Telephone numbers of Prof. Aung and Mr. Win Maung have been given to the local communities to be contacted.

Any comments, complaints, grievances in relation to the general implementation of the project shall be as a first stage reported by phone or in writing to the WIF office in Magyi.
Contact person by email: htayaungpathein@gmail.com
Contact person by phone: Prof. Htay Aung
Office phone: +95-9970530946

In the case of grievances reported by phone, a grievance note will be filled out including the name, contact details of the claimant, date of complaint and the detailed description of the complaint/ grievance, as well as any comments or suggestions of how to address the complaint. For any grievances submitted by email, above details will be recorded.

WIF will respond in writing to any claimant within 15 days and take immediate action to address those grievances in consultation with the claimant if any resource restriction has been caused by the project. Claims, responses and actions taken to address grievances will be filed and included in project monitoring.

If the claimant is not satisfied with the response by the local office, the grievance may be submitted to Worldview International country office in Yangon.
WIF country office:
#70, Yaw Min Gyi Street, Dagon Township, Yangon

3 DATA AND PARAMETERS

3.1 Data and Parameters Available at Validation

Data / Parameter	$\Delta C_{BSL,t}$
Data unit	t CO_2-e
Description	Baseline net GHG removals by sinks in year t
Source of data	*N/A*
Value applied	*0*
Justification of choice of data or description of measurement methods and procedures applied	Value based on section 5 of AR-TOOL14 as described in section 3.1. of this document
Purpose of Data	*Calculation of baseline emissions*
Comments	*N/A*

Data / Parameter	CF_{TREE}
Data unit	t C (t d.m.)$^{-1}$

Description	Carbon fraction of tree biomass
Source of data	Default value of AR CDM tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities" Version 04.2
Value applied	*0.47*
Justification of choice of data or description of measurement methods and procedures applied	Default value of AR-TOOL14 is used unless transparent and verifiable information can be provided to justify a different value
Purpose of Data	*Calculation of project emissions*
Comments	*N/A*

Data / Parameter	*fj(x1,l,x2,l,x3,l,...)*
Data unit	t d.m.
Description	Total biomass of the tree returned by the allometric equation for species j relating the measurements of tree l to the total biomass of the tree
Source of data	For ex-post: Ya Min Thant et al. (2012) Above ground - $W_{Top} = 0.22\ \rho\ (DBH^2H)^{0.82}$ Below ground - $W_{Root} = 1.69\ \rho\ (DBH^2H)^{0.40}$
Value applied	Above ground - $W_{Top} = 0.22\ \rho\ (DBH^2H)^{0.82}$ Below ground - $W_{Root} = 1.69\ \rho\ (DBH^2H)^{0.40}$ Where: DBH = Diameter at breast height; cm H = Height (m) ρ = Wood density (km/m^3)
Justification of choice of data or description of measurement methods and procedures applied	Equation used in ex-post estimation. Justification included in Section 4.2 Project Emissions
Purpose of Data	*Calculation of project emissions*
Comments	*N/A*

Data / Parameter	*dSOCt*

Data unit	t C ha^{-1} yr^{-1}
Description	The rate of change in SOC stocks within the project boundary, in year t
Source of data	*Estimated (Research done by the University of Pathein)*
Value applied	*7.32*
Justification of choice of data or description of measurement methods and procedures applied	University of Pathein carried out an in-depth soil analysis. The average carbon stock stored was estimated as 732.26 tC/ha for a mean soil depth of around 1 meter. Applying a conservative estimate of 100 years accumulation, this would result in 7.32 tC/ha/year for soil depth around 1 m.
Purpose of Data	*Calculation of project emissions*
Comments	*This value was accepted by VCS and fixed for the project period.*

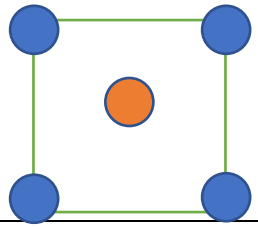
3.2 Data and Parameters Monitored

Data / Parameter	A_i
Data unit	*ha*
Description	Area of tree biomass stratum i
Source of data	GPS and GIS
Description of measurement methods and procedures to be applied	Areas in project area will be tracked in the field using the GPS. Each plot which will be subject to planting is tracked - a standard procedure of the baseline and monitoring inventory
Frequency of monitoring/recording	Before the start of the project (planting) and adjusted thereafter every two years since the year of the initial verification
Value monitored	962.82 ha A_1 93.92 ha A_2 76.72 ha A_3 249.63 ha A_4 297.88 ha A_7 107.95 ha A_8 22.28 ha A_9 114.42 ha
Monitoring equipment	GPS (Garmin), GPS Smartphones, ArcGIS or QGIS software
QA/QC procedures to be applied	Field-team members are fully aware of all procedures and the importance of collecting data as accurately as possible; all field

	team members are trained in GPS/GIS application
Purpose of data	Calculation of project emissions
Calculation method	Using the GPS measure the boundary of planting of each year
Comments	N/A

Data / Parameter	n_i
Data unit	*Dimensionless*
Description	Number of sample plots in stratum *i*
Source of data	Calculated
Description of measurement methods and procedures to be applied	*Based on the CDM tool, the total number of sample plots were 33. Each plot is 10 m x 10 m giving a value of 0.01 ha (100 m^2). GPS coordinates of each plot is marked and kept for future monitoring. 3 more plots were set for 2018 planting making the number of plots for 2018 planting 13.*
Frequency of monitoring/recording	n_i is calculated for each monitoring event, at least every five years
Value monitored	*2015 planting – 8 plots, 2016 planting – 7 plots 2017 planting – 8 plots,* 2018 planting – 13 plots
Monitoring equipment	*GPS is used to locate the sample plots*
QA/QC procedures to be applied	*Corners of the plot are marks with 4 wooden poles and GPS coordinates are recorded. A solid concrete pole is fixed at the centre of each plot to ensure plot is identifiable in the future. GPS point of the centre is also recorded.*

Stratum	No of sample plots
n1 (2015 planting)	4
n2 (2016 planting)	4
n3 (2017 planting)	6
n4 (2018 planting)	13
n7 (2015 restoring)	4
n8 (2016 restoring)	3
n9 (2017 restoring)	2
Total	36



Purpose of data	*Calculation of project emissions*
Calculation method	The calculation method is described in the tool "Calculation of the number of sample plots for measurements within A/R CDM project activities" (version 02.1.0)
Comments	*N/A*

Data / Parameter	w_i
Data unit	*Dimensionless*
Description	Relative weight of the area of stratum i, the area of the stratum i divided by the project area.
Source of data	Calculated
Description of measurement methods and procedures to be applied	*N/A*
Frequency of monitoring/recording	Calculated for each monitoring event, at least every five years
Value monitored	w_1, w_2….w_9 – values for each strata
Monitoring equipment	*N/A*
QA/QC procedures to be applied	*N/A*
Purpose of data	*Calculation of project emissions*
Calculation method	Area of the stratum i divided by the project area
Comments	*N/A*

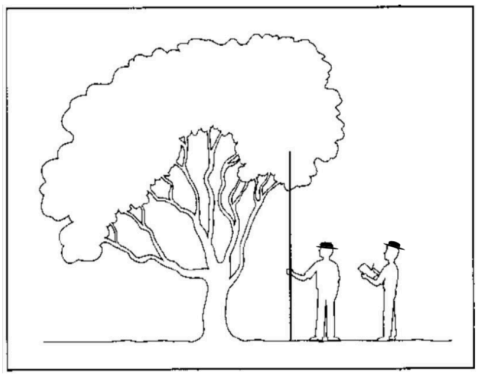
Data / Parameter	$A_{PLOT,i}$
Data unit	*ha*
Description	Size of sample plot in stratum i
Source of data	Field measurement, GPS and GIS
Description of measurement methods	Areas in the project area are tracked in the field using the GPS. Each planting area is tracked as a standard procedure of the

and procedures to be applied	baseline and monitoring inventory. Each plot represents a 0.01 ha of area covering the trees within the plot. 10 m x 10 m plots are laid using random sampling in the project area after calculating the number of sample plots needed for each stratum
Frequency of monitoring/recording	*Annually*
Value monitored	*0.01 ha*
Monitoring equipment	*Measuring tape, GPS*
QA/QC procedures to be applied	Field teams are trained in all inventory procedures including layout of plots. Field-team members are fully aware of all procedures and the importance of collecting data as accurately as possible.
Purpose of data	*Calculation of project emissions*
Calculation method	The GPS coordinates of the plots are collected and recorded at the establishment of these plots. Annually the growth measurements needed to be recorded hence the staff visit the plots using the pre-recorded coordinates and then check the plot area using a tape.
Comments	*N/A*

Data / Parameter	DBH
Data unit	cm
Description	Diameter breast height of tree
Source of data	Field measurement
Description of measurement methods and procedures to be applied	Diameter at breast height (DBH) is measured at 1.3 m along the stem using a DBH tape For plants below 1.3 m practically it is difficult to measure diameter using the diameter-tape. Therefore a calliper was used to measure the basal diameter (D_{10}). As mentioned in the document "Field Guidance on growth measurements of mangroves" the Diameter of *Rhizophora* spp. was done taking the measurement at the 1st prop root is visible. Page 71 of the PD states that "For the initial verification, until the trees reach a height beyond 1.3 m, D30 or the basal diameter is measured and recorded."
Frequency of monitoring/recording	*Annually measured and recorded*
Value monitored	*Year 1 – 0.6 cm*

	Year 2 – 1.4 cm *Year 3 – 1.4 cm* *Year 4 – 1.86 cm* *Diameter for trees planted in 2018 in Thabawkhan – 0.59 cm*
Monitoring equipment	*Diameter Tape/ Calliper*
QA/QC procedures to be applied	Field teams are trained in all inventory procedures including correct measurement. Field-team members are fully aware of all procedures and the importance of collecting data as accurately as possible. Two people take measurements each time. One person measures and reads it loudly to the person who records. He then confirms the value by reading it loud to the measurer. This way recording errors are minimized. *A pole with a mark at 1.3 m length is used to determine the 1.3 m from the bottom. This way if anyone takes the measurement, DBH is measured at 1.3m from the ground.* For plants below 1.3 m practically it is difficult to measure diameter using the diameter-tape. Therefore a calliper was used to measure the basal diameter (D_{10}). As mentioned in the document "Field Guidance on growth measurements of mangroves" the Diameter of *Rhizophora* spp. was done taking the measurement at the 1st prop root is visible. Project Director shall select 50% of the data sheets and cross-check with actual field measurements before sending the data to the Managing Director. Managing Director, upon receiving the data sheets, shall select 25% of the sheets, cross-check with the actual field measurements during his visit to the site before signing the data sheets as true-sheets. This shall minimize the errors during data measurement and entering.
Purpose of data	*Calculation of project emissions*
Calculation method	*N/A*
Comments	*For the initial verification, until the trees reach a height beyond 1.3 m, D_{30} or the basal diameter (D_{10}) is measured and recorded.*

Data / Parameter	H
Data unit	m
Description	Tree height
Source of data	Field measurement
Description of measurement methods and procedures to be applied	*First the trunk is determined by selecting the start of the second strongest/thickest branch from top. Incase there are two equally thick branches the second one is determined as the start of the trunk. The height of the tree is then measured using a PVC or*

	bamboo pole.
Frequency of monitoring/recording	*Annually measured and recorded*
Value monitored	*Year 1 – 0.*582 m *Year 2 – 0.629 m* *Year 3 – 0.768 m* *Year 4 – 1.06 m* *Height for trees planted in 2018 in Thabawkan = 0.62 m*
Monitoring equipment	Measuring tape, PVC or bamboo pole
QA/QC procedures to be applied	Field teams are trained in all inventory procedures including correct measurement. Field-team members are fully aware of all procedures and the importance of collecting data as accurately as possible. Two people take measurements each time. One person measures and reads it loudly to the person who records. He then confirms the value by reading it loud to the measurer. This way recording errors are minimized. To measure the height of each mangrove tree: • Stand the height pole up directly below the highest point of the tree (Figure 1). • Measure the height of the tree to the nearest 10cm, based on the known length of the pole. • Record the result. **Note:** As this can be very difficult if the tree canopy is higher than 10m the use of a clinometer is recommended in such situations.  *Once the trees each are than 2 meter height, the pole is divided into 1 meter intervals and marked each point in red masking tape. Then using yellow color tape each 0.5 m is marked. Once the pole is kept near the tree, the top of trunk is determined and measurement is taken. Once the pole is on the ground, a measuring tape is used to calculate the exact tree height.*

	Project Director shall select 50% of the data sheets and cross-check with actual field measurements before sending the data to the Managing Director. Managing Director, upon receiving the data sheets, shall select 25% of the sheets, cross-check with the actual field measurements during his visit to the site before signing the data sheets as true-sheets. This shall minimize the errors during data measurement and entering.
Purpose of data	*Calculation of project emissions*
Calculation method	Direct measurement
Comments	

Data / Parameter	T
Data unit	Year
Description	Time period elapsed between two successive estimations of carbon stock in a carbon pool
Source of data	N/A
Description of measurement methods and procedures to be applied	*N/A*
Frequency of monitoring/recording	*N/A*
Value monitored	*N/A*
Monitoring equipment	*N/A*
QA/QC procedures to be applied	*N/A*
Purpose of data	*Calculation of project emissions*
Calculation method	If the two successive estimations of carbon stock in a carbon pool are carried out at different points of time in year t_2 and t_1, (e.g. in the month of June in year t_1 and in the month of February in year t_2), then a fractional value will be assigned to T
Comments	

Measuring equipment	Model	Purpose	Calibration method
GPS	Garmin Oregon 650	To collect coordinates of sample plots and mark the	The GPS is calibrated at the factory. No calibration needed.

		project boundaries	The Garmin manual attached for reference.
Diameter tape	No special model	To measure diameter	No calibration needed
Caliper	Several calipers are used. No special mode	To measure diameter	No calibration needed
Bamboo stick	No special model	To measure height	No calibration needed
PVC pole	No special model	To measure height	No calibration needed.
Measuring tape	No special model	To measure height	No calibration needed

3.3 Monitoring Plan

Monitoring was organized according to Section 06 of AR-AM0014 and as mentioned in the VCS PD version 3.0. All the data that are mentioned in this section will be collected and archived electronically and kept for 2 years after the end of last crediting period.

Project Boundary Keeping records of the project boundary is one of the most important activities during monitoring. The geographic coordinates of the project boundary and all stratifications within the project have been established and were recorded. Field surveys using GPS, satellite images and land use maps were used in this activity. The project participant has a GIS expert has been coordinating this section. There were two staff members who worked with him in recording proper boundaries.

Existing plants These existing plants are not accounted for the carbon stocks but will be left to grow and are monitored throughout the crediting period of the project activity. During the baseline studies the area has been visited by the survey team. Existing plants are recorded. Therefore there are records of existing plants in each sample plot. These plants will not be removed and will be monitored throughout the project period.

Supervision of project activities: The Project Manager has full responsibilities for all activities and has trained all staff members regarding mangrove forest management, mangrove nursery techniques, natural resource management and community forestry activities. Technical Assistants and Field Assistant shall supervise all field operations.

The Project Proponent is responsible for implementation of this ARR project activity together with the local communities. PP has more than 130 professional staff at the Administrative Unit, Field Units and in Pathein University Park with backgrounds on forestry, marine science, economic and social Science, Remote sensing & GIS. The project will also employ over 300 workers for the reforestation and restoration activities.

The following professionals constitute the administrative team of WIF:

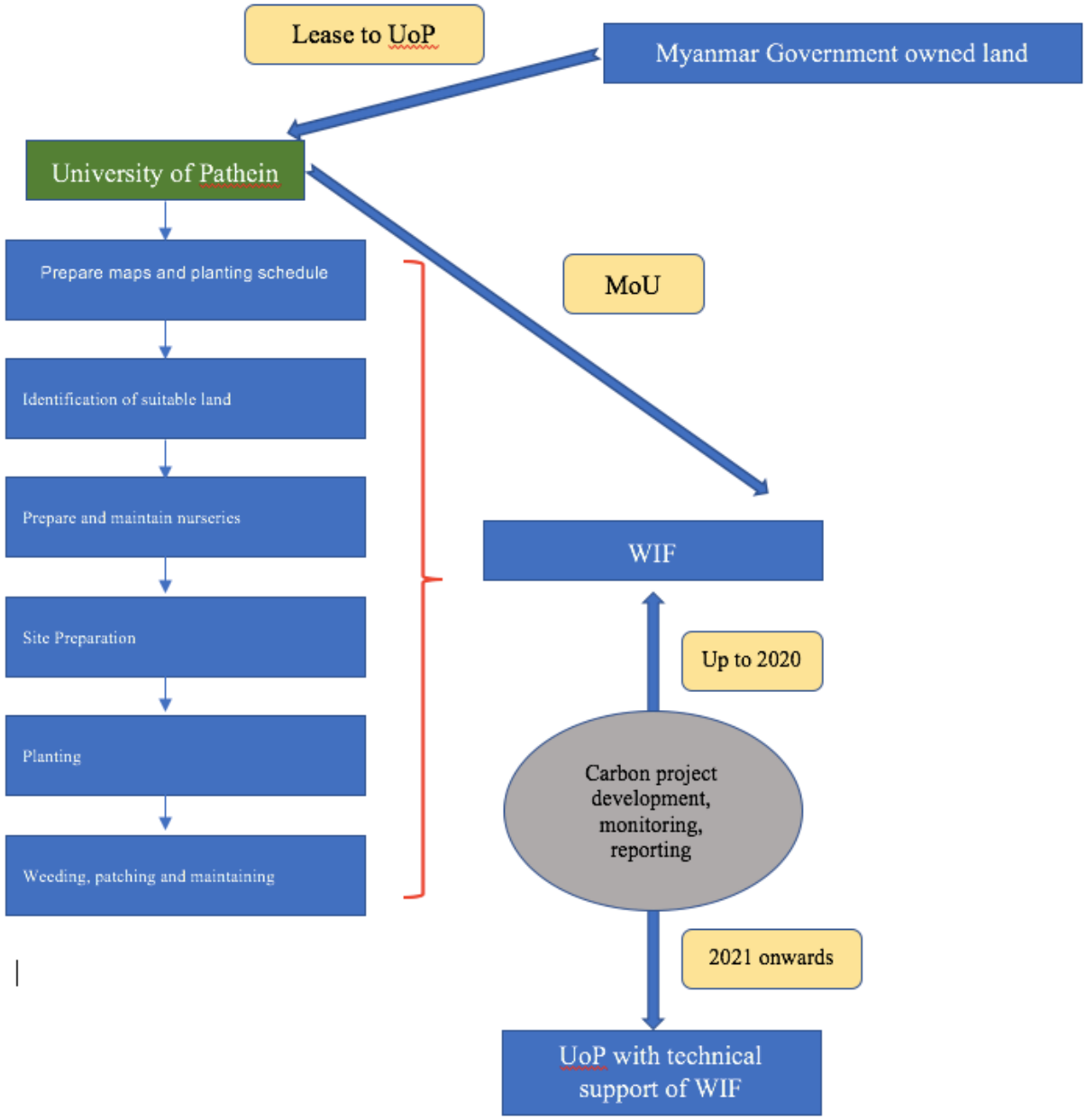
- Dr. Arne Fjortoft, Secretary General WIF (Specialty in development communication, public education, sustainable development project implementation and climate change/environmental conservation).

- Aye Lwin, Chairman (Administrative experience from government, diplomacy, business and NGO sector, former Director General of ASEAN).
- U Bo Ni, Managing Director, former Director of Watershed Management Division of Forest Department. Over 30 years of experience in forestry.
- Win Maung, Project Director, former Director Forestry Department. 30 year working experience in mangrove conservation as government official; researcher and Project Manager of NGO/UN-LIFT projects.
- Dr. Htay Aung, science advisor and field controller in charge of liaison with Pathein University and local communities. Over 20 years of experience in marine science research in the project area.
- Suraj A. Vanniarachchy, Senior Carbon Advisor of WIF for Carbon Assessment and Forest Carbon project development. Overall coordinator for the VCS project development with experience in carbon project development in the Asian region.
- Aung Aung Mynt, GIS Expert. Over 25 years of experience in forestry and mangrove restoration with experience in GIS and mapping.
- Maung Maung Pyone. Assistant manager. 25 years of experience in forestry and mangrove restoration with speciality in mapping, GPS locations and social mobilization.
- Dr. Ranil Senanayake, Senior Science Director WIF, Founder of Analog Forestry and Chairman Raniforest Rescue International.
- Win Sandar Htay, Lawyer and accountant in charge of administration and financial management, public relation, database, procurement and sub-contracts.
- NawHtoo Say WahKhaing, communication specialist in charge of social mobilisation.
- Myint Sein, Field Manager, served as Field administrator with over 20 year experience of mangrove conservation and community development activities at Forest Department.

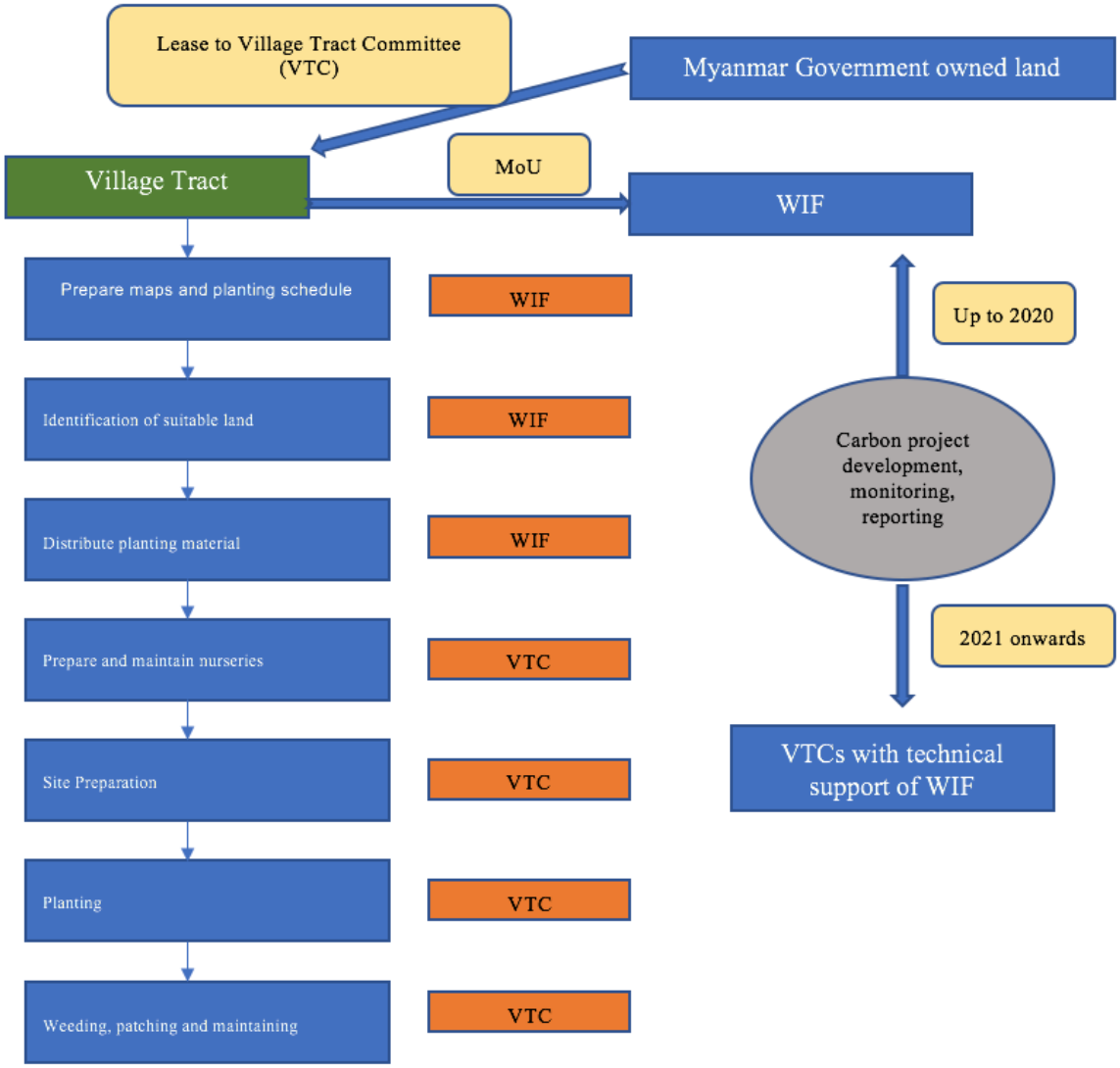
Organizational Structure

The following describe the organizational management structure for the project. Planting and management of Magyi land is different to the structure of Thabhakwan and Thaegone hence two have been presented.

Magyi – Myanmar Government has leased the land to University of Pathein (UoP) and UoP has an MoU with WIF. WIF will conduct the activities mentioned in the following graph.

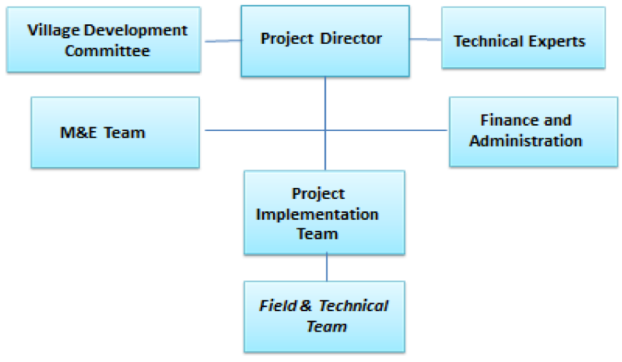


Thabhakan and Thaegone – Myanmar Government has leased the land to two Village Tract Committees (VTC) of 2 villages. These two VTCs have MoUs with WIF. WIF and VTCs will conduct the activities mentioned in the following graph. The overall management of the carbon component will be done by WIF including setting up the sample plots and taking annual recordings up to 2020. After 2020, the management of carbon project will be done by 2 VTCs under the supervision and technical support of WIF. This is to make sure the project will reach a self-reliance status in the future.



The following figure presents the overall organizational structure of the project -

Figure: Overall Organizational Structure of Project



The project implementation is based on the local presence of WIF staff in project area. The main role of the field officers is to manage the reforestation/restoration activity in close cooperation with WIF technical program coordinators. Following are some of their responsibilities:

- Randomly select and verify GPS locations of at least 10% of the plots planted during a particular planting season.
- Conduct comparisons between the trees actually planted and the trees recorded in the management plan
- Assess the survival rate of the mangrove seedlings and prepare reports with the findings.
- Area verification. Project parcels will be verified using GPS in the field as well as through drone images and Google Earth imagery analysis.

Identification and monitoring of strata: Baseline stratification was done based on the landuse type. Most of the planting sites are severely degraded mangrove areas. Ex-ante stratification is done based on the year of replanting and year of restoration. Even though plot types are similar in the same landuse type, there is variation in soil composition, water salinity and water availability. Certain manmade activities such as replanting, protection also have influence on growth and survival. Therefore a stratification implemented today may not be realistic in the future once the local community starts managing these lands. Hence the final factors considered for the stratification will be the differences in the estimated carbon sinks for each mangrove species as the project evolves. Due to this reason, strata will be monitored periodically. If a change in number and area of the project strata occurs, the sampling framework will be adjusted accordingly.

This ARR VCS project is designed as to the planting and restoration will happen from 2015-2020. Therefore the database will be updated periodically capturing the following:

- Unpredicted disturbance occurring during the crediting period
- Unpredicted disturbances occurring during the crediting period (changes in hydrology, sedimentation, disease, and/or human factors), affecting differently different parts of an originally homogeneous stratum or stand;
- Mangrove forest establishment (planting, re-replanting) may be implemented at different intensities, dates and spatial locations than mentioned in the PD;

Sampling plan and stratification: As mentioned above, the ex-ante stratification of the project was done by year of planting. Such stratification was selected to increase the measuring precision without increasing unnecessary costs.

For *ex ante* stratification the strata are as follows:
Strata 1: 2015 planting – applicable for this monitoring period 2018-2019
Strata 2: 2016 planting – applicable for this monitoring period 2018-2019
Strata 3: 2017 planting – applicable for this monitoring period 2018-2019
Strata 4: 2018 planting – applicable for this monitoring period 2018-2019
Strata 5: 2019 planting – Not applicable for this monitoring period 2018-2019

Strata 6: 2020 planting – Not applicable for this monitoring period 2018-2019
Strata 7: 2015 restoration - applicable for this monitoring period 2018-2019
Strata 8: 2016 restoration - applicable for this monitoring period 2018-2019
Strata 9: 2017 restoration - applicable for this monitoring period 2018-2019
Strata 10: 2018 restoration – applicable for this monitoring period 2018-2019

The project will adopt the following sampling framework.

- Sampling framework

The number of samples and sample size was determined using "Calculation of the number of sample plots for measurements within A/R CDM project activities (Version 02.1.0)".

Initial estimate of number of plots is done with targeted precision level for biomass estimation within each stratum at +/- 10% of the mean at a 90% confidence level. The number of required plots (n) was calculated using the following equation:

$$n = \frac{N * t_{VAL}^{\ 2} * \left(\sum_i w_i * s_i \right)^2}{N * E^2 + t_{VAL}^{\ 2} * \sum_i w_i * s_i^{\ 2}}$$

Where;

n Number of sample plots required for estimation of biomass stocks within the project boundary; dimensionless

N Total number of possible sample plots within the project boundary (i.e. the sampling space or population); dimensionless

t_{VAL} Two-sided Student's t-value, at infinite degrees of freedom with 90% confidence level; dimensionless

w_i Relative weight of the area of stratum *i* (i.e. the area of stratum *i* divided by project area); dimensionless

si Estimated standard deviation of biomass stock in stratum *i*; t d.m. (or t d.m. ha^{-1})

E Acceptable margin of error in estimation of biomass stock within the project boundary; t d.m. (or t d.m. ha^{-1}), i.e. in the units used for si

i 1,2,3,….. Biomass stock estimation strata within the project boundary

The number of plots allocated to each stratum was calculated as follows;

$$n_i = n * \frac{w_i * s_i}{\sum_i w_i * s_i}$$

Where;

ni Number of sample plots allocated to stratum *i;* dimensionless

n Number of sample plots required for estimation of biomass stocks within the project boundary; dimensionless

w_i Relative weight of the area of stratum *i* (i.e. the area of stratum *i* divided by project area); dimensionless

si Estimated standard deviation of biomass stock in stratum *i*; t d.m. (or t d.m. ha^{-1})

i 1,2,3,….. Biomass stock estimation strata within the project boundary

Sampling plot area: 10 m x 10 m plots of 0.01 ha ($100m^2$) were laid out. The QC and QA procedures under the project aim at implementing standard and methodical procedures for monitoring and collection of precise field measurements. Quality control (QC) and quality assurance (QA) procedures that will be applied to monitor actual GHG removals by sinks include (1) Collecting reliable field measurements and Precise field monitoring (2) Verifying methods used to collect field data using independent expert opinion; (3) Verifying data entry and analysis techniques using independent expert opinion ; and (4) Data maintenance and archiving.

(1) Collecting reliable field measurements and Precise field monitoring

A team consisting of members representing the entire project area was formed. This team involved in field monitoring were trained in data collection and analysis. Each team member has been assigned in duties related to monitoring actual GHG removal. Data collection was conducted by a well trained team. Those responsible for the measurement work were trained in all aspects of the field data collection and data analyses. The project uses the IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry (2003) as the main reference document for all monitoring activities.

In order to ensure the collection and maintenance of reliable field data:

a) Field-team members were made fully aware of all procedures and the importance of collecting data as accurately as possible;

b) Field teams establish sample plots in the field and measured all pertinent components;

c) The document has listed all names of the field team and the project manager will certify that the team is trained;

d) New staff will be adequately trained.

(2) Verifying the methods used to collect field data

The data collected by the team were verified by taking random checks from stands, including their re-measurement by a senior member of the monitoring team. In case of errors, they are corrected and recorded for each stratum.

(3) Verifying data entry and analysis techniques

Reliable carbon estimates require proper entry of data into the data analysis spreadsheets. Possible errors in this process were minimized by cross checking these entries. In order to ensure more precise output, internal tests were incorporated into the spreadsheets to ensure that the data are realistic. Communication between all personnel involved in measuring and analyzing data were used to resolve

any apparent anomalies before the final analysis of the monitoring data is completed. If there are any problems with the monitoring plot data that cannot be resolved, the plot will not be used in the analysis.

Quantifying data is an important procedure and were done accordingly.

(4) Data maintenance and achieving

Because of the relatively long-term nature of these project activities, data archiving (maintenance and storage) is an important component of the work. Data archiving takes several forms and copies (electronic and paper) of all field data, data analyses, and models; estimates of the changes in carbon stocks and corresponding calculations and models used; any GIS products; and copies of the measuring and monitoring reports are stored in PP's Yangon office. These monitored data will be achieved for 2 years following the end of the crediting period as well (Note that this project has a renewable crediting period).

Sampling Design

- **Type of plots**

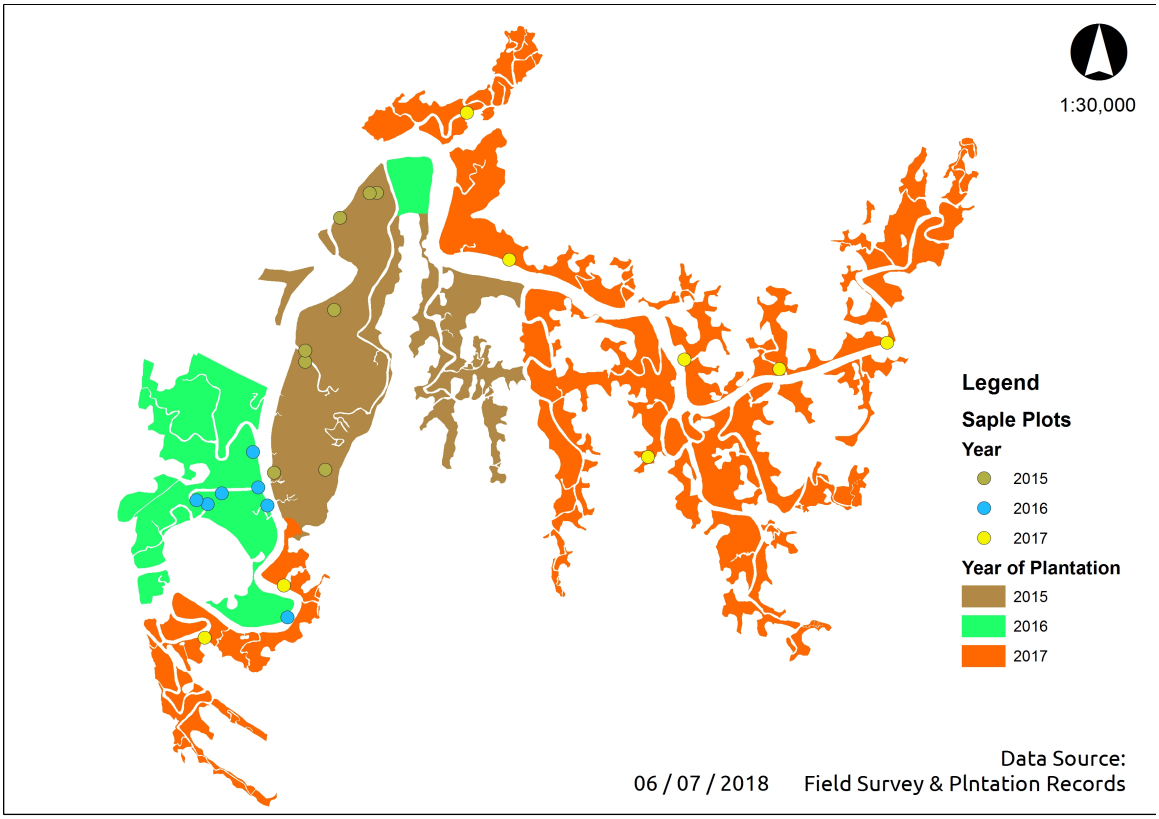
In order to monitor the project through time, permanent-sampling plots were established and maintained.

- **Number of Plots**

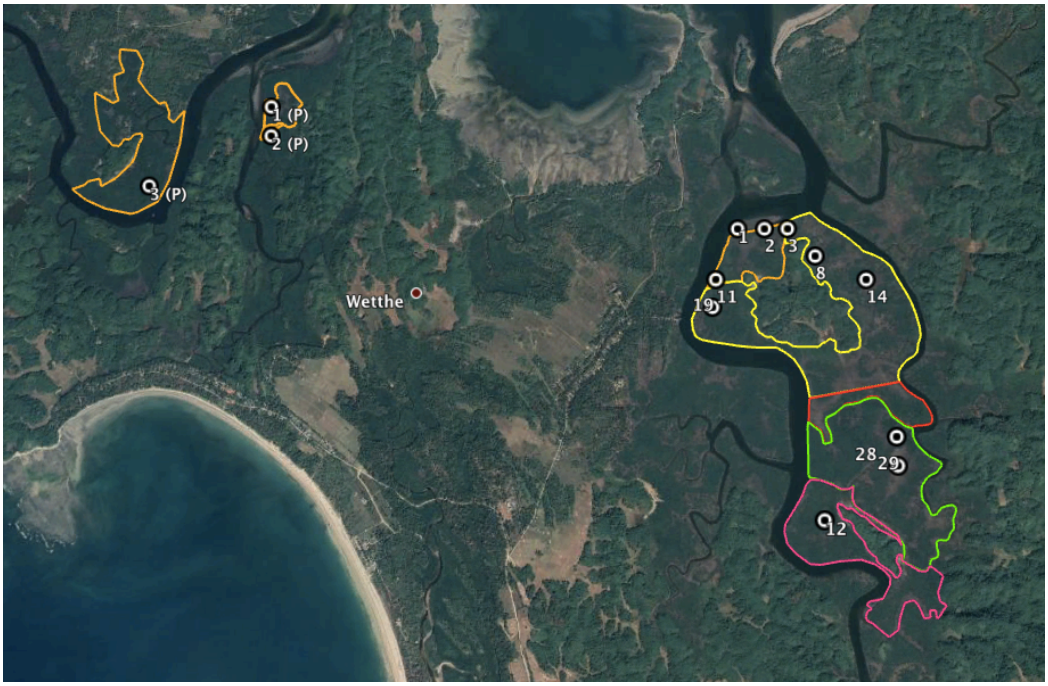
The number of samples and sample size was determined using "Calculation of the number of sample plots for measurements within A/R CDM project activities (Version 02.1.0)" as explained above. 23 sample plots are needed for the planting done in 2015, 2016 and 2017. For 2015 planting 8 sample plots were set up while for 2016 planting 7 plots were set up. Another 8 plots were set up for the trees planted in 2017. 13 plots were set up for the trees planted in 2018.

- **Location of sampling plots**

In order to avoid bias with regard to plot locations, permanent sample plots were located systematically with a random start. The geographical position (GPS coordinate), location, stratum and sub-stratum series number of each plot were recorded and archived. It is to be ensured that the sampling plots are distributed randomly.



Map 6: Location of sample plots for each planting stratum planted in 2015, 2016, 2017



Map 7: Location of sample plots for each planting stratum planted in 2018

- **Monitoring frequency**

Plantation established from 2015 to 2019 are applicable for this monitoring period. Permanent plots were monitored annually to assess actual above and below ground biomass accumulation.

- **Measuring and estimating carbon stock changes over time**

Carbon stock changes in above- and below-ground biomass on each plot were estimated using the diameter as a parameter. Soil organic carbon was also calculated.

- **Stratification and sample size**

Sample plots of 0.01 ha (100m^2) with 10 m x 10m were established systematically with a random start for each strata based on the year of planting.

- **Monitoring GHG emissions by sources as the results of the ARR VCS project activity**

GHG emissions from the project will be monitored annually.

4 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

Under the applicability conditions of the applied methodology AR-AM0014 “Afforestation and reforestation of degraded mangrove habitats” (Version 03.0), it is expected that the baseline carbon stocks in litter and soil organic carbon pools will not show a permanent net increase. The baseline net GHG removals by sinks should be calculated using Equation 1 of the methodology:

$$\Delta C_{BSL,t} = \Delta C_{TREE\_BSL,t} + \Delta C_{SHRUB\_BSL,t} + \Delta C_{DW\_BSL,t} \quad \text{Equation (1)}$$

Where

$\Delta C_{BSL,t}$	=	Baseline net GHG removals by sinks in year *t*; t CO_2-e
$\Delta C_{TREE\_BSL,t}$	=	Change in carbon stock in baseline tree biomass within the project boundary in year *t*, as estimated in the tool “Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities”; t CO_2-e
$\Delta C_{SHRUB\_BSL,t}$	=	Change in carbon stock in baseline shrub biomass within the project boundary, in year *t*, as estimated in the tool “Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities”; t CO_2-e
$\Delta C_{DW\_BSL,t}$	=	Change in carbon stock in baseline dead wood biomass within the project boundary, in year *t*, as estimated in the tool “Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities” ; t CO_2-e

However Section 5 of the methodological tool AR-Tool 14 (Version 04.2) explains 3 conditions under which carbon stock and change in carbon stock may be estimated as zero. According to the tool the carbon stock in trees in the baseline can be accounted as zero if all of the following conditions are met:

(a) The pre-project trees are neither harvested, nor cleared, nor removed throughout the crediting period of the project activity;

(b) The pre-project trees do not suffer mortality because of competition from trees planted in the project, or damage because of implementation of the project activity, at any time during the crediting period of the project activity;

(c) The pre-project trees are not inventoried along with the project trees in monitoring of carbon stocks but their continued existence, consistent with the baseline scenario, is monitored throughout the crediting period of the project activity.

LandSat images and Worldview 2 images from the year 2013 were used to conduct a satellite image analysis. Field verification was also conducted to identify the baseline landuse types of the area. According to the analysis the following categories were identified.

a. Severely degraded mangrove areas
b. Degraded mangrove areas
c. Bare lands
d. Shallow water areas where planting is possible
e. Abandoned shrimp pond areas

For the trees planted in 2015, 2016 and 2017 Severely degraded mangrove areas, bare lands and shallow water areas were replanted with a density of 5000 plants per hectare. Degraded mangrove areas were restored using approximately 3000 plants per hectare since there are mangrove plants which fall below the forest threshold but still remain as plants. For trees planted in 2018, a density of 4000 trees were applied based on the land condition. There is no timber harvesting in this project and there will be monitoring to protect the existing and newly planted plants. Furthermore these existing mangrove plants are not removed or allowed to suffer mortality. The condition of these lands will be improved with the restoration program. These existing plants are not accounted for the carbon stocks but will be left to grow and are monitored throughout the crediting period of the project activity.

Hence all applicability conditions (a), (b) and (c) are met.

Paragraph 12 of the same tool states that the changes in carbon stocks in trees and shrubs in the baseline may be accounted as zero for those lands that have met above (a), (b) and (c) conditions.

Hence the Baseline net GHG removals by sinks are conservatively accounted as zero throughout the project period.

4.2 Project Emissions

The ex-post actual net GHG removals by sinks over the period of 2015-2018 were estimated using the equation 2 described in section 5.5 of the methodology AR-AM0014 A/R Methodology: Afforestation and reforestation of degraded mangrove habitats Version 03.0:

$$\Delta C_{ACTUAL,t} = \Delta C_{P,t} - GHG_{E,t}$$

Where:

$\Delta C_{ACTUAL,t}$	=	Actual net GHG removals by sinks, in year *t*; t CO_2-e
$\Delta C_{P,t}$	=	Change in the carbon stocks in project, occurring in the selected carbon pools, in year *t*; t CO_2-e
$GHG_{E,t}$	=	Increase in non-CO_2 GHG emissions within the project boundary as a result of the implementation of the A/R CDM project activity, in year *t*, as estimated in the tool "Estimation of non-CO_2 GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity"; t CO_2-e

Change in the carbon stocks in project, occurring in the selected carbon pools in year *t* were calculated as follows:

$$\Delta C_{P,t} = \Delta C_{TREE\_PROJ,t} + \Delta C_{SHRUB\_PROJ,t} + \Delta C_{DW\_PROJ,t} + \Delta SOC_{PROJ,t}$$

Where:

$\Delta C_{P,t}$	=	Change in the carbon stocks in project, occurring in the selected carbon pools, in year *t*; t CO_2-e
$\Delta C_{TREE\_PROJ,t}$	=	Change in carbon stock in tree biomass in project in year *t*; t CO_2-e
$\Delta C_{SHRUB\_PROJ,t}$	=	Change in carbon stock in shrub biomass in project in year *t*; t CO_2-e
$\Delta C_{DW\_PROJ,t}$	=	Change in carbon stock in dead wood in project in year *t*; t CO_2-e
$\Delta SOC_{PROJ,t}$	=	Change in carbon stock in the soil organic carbon (SOC) pool within the project boundary, in year *t*; t CO_2-e

Estimation of the changes in carbon stocks in tree biomass: $\Delta C_{TREE\_PROJ,t}$

The change in carbon stock in tree biomass in this project within the project boundary was estimated using the A/R methodological tool "estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities" (Version 04.2). Based on the tool the stock difference method was applied and the ex-ante tree biomass was estimated using the method of "Estimation by modelling of tree growth and stand development", presented in section 8 of the tool. For the estimation of the changes in carbon stocks in tree biomass ex-post, field measurements in permanent sample plot at two points of time will be realized, and the calculations will be done following the "difference of two independent stock estimations" method, available in section 6 of the tool. Actual field measurements were used in combination with tree growth models to estimate the growth of trees and the development of the tree stand over time.

Mean carbon stock in trees within the tree biomass per hectare was estimated as follows:

$$C_{TREE} = \frac{44}{12} \times CF_{TREE} \times B_{TREE}$$

$$B_{TREE} = A \times b_{TREE}$$

$$b_{TREE} = \sum_{i=1}^{M} w_i \times b_{TREE,i}$$

Where:

C_{TREE}	= Carbon stock in trees in the tree biomass estimation strata; tCO_2e
CF_{TREE}	= Carbon fraction of tree biomass; t C (t d.m.)$^{-1}$ A default value of 0.47 was used as per the methodology
B_{TREE}	= Tree biomass in the tree biomass estimation strata; t d.m.
A	= Sum of areas of the tree biomass estimation strata; ha
b_{TREE}	= Mean tree biomass per hectare in the tree biomass estimation strata; t d.m.ha^{-1}
w_i	= Ratio of the area of stratum *i* to the sum of areas of tree biomass estimation strata ($w_i = A_i/A$); dimensionless
$b_{TREE,i}$	= Mean tree biomass per hectare in stratum *i;* t d.m. ha^{-1}

Estimating mean tree biomass per hectare in each stratum ($b_{TREE,i}$)

According to Tool 14, V.4.2 the tool "Demonstrating appropriateness of allometric equations for estimation of aboveground tree biomass in A/R CDM project activities (Version 01.0.0)" was applied. The tool states "For ex ante estimation of aboveground tree biomass in project scenario any allometric equation can be used."

A thorough literature review was conducted to identify most suitable allometric equation for ex-ante estimations since there are no equations developed in the project area. It was mentioned in the VCS PD (Version 3.0) that for ex-post estimation allomatric equations will be developed using the continued research data and research personal and using the permanent sample plots that have been set ups.

However it was found that there were not enough data for the 3 year period to develop its own allometric equation. A detailed assessment by Ya Min Thant, Mamoru Kanzaki, Seiichi Ohta from Kyoto University and Maung Maung Than (DFID program, British Council) have developed five common allometric equations for stem, branch, leaf, above ground and below ground for six mangrove species based on specific gravity of stem. Their study was published in the journal TROPICs published by Japan Society of Tropical Ecology (Link: https://www.jstage.jst.go.jp/article/tropics/21/1/21_1/_article/-char/en). Title of the paper is "Carbon sequestration by mangrove plantations and a natural regeneration stand in the Ayeyarwady Delta, Myanmar". The equations to estimate above ground and below ground biomass seem to be most plausible equations. Results on this equation and results from field measurements gave similar results thus proving that this equation is the most plausible for ex-post estimations.

Total aboveground and belowground biomass was estimated using –

Above ground - $\mathbf{W_{Top} = 0.22\ \rho\ (DBH^2 H)^{0.82}}$

Below ground - $\mathbf{W_{Root} = 1.69\ \rho\ (DBH^2 H)^{0.40}}$

Where:

DBH = Diameter at breast height; cm

H = Height (m)

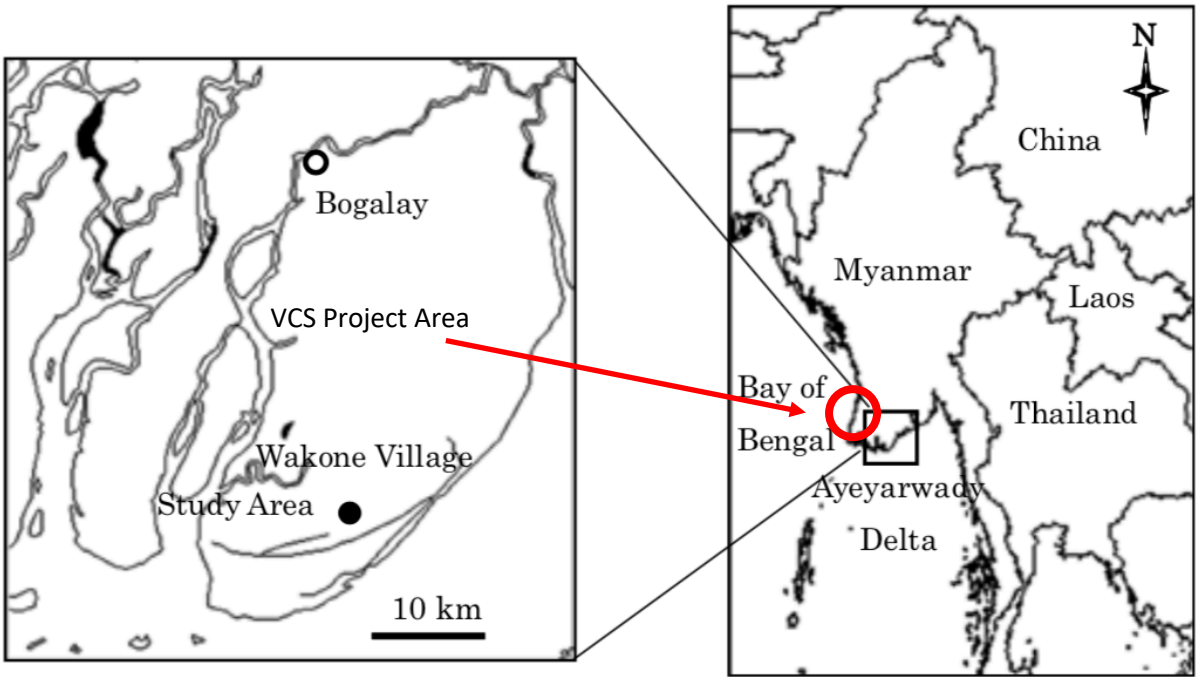
ρ = Wood density (km/m^3)

The above assessment was conducted in Ayeyarwady Delta. The VCS project is also implemented in the Ayeyarwady Delta. Assessment by Ya Min Thant et al. was conducted for 6-7 year old mangroves hence the equation is well fitted for the estimation between 1-7 year old. The mangroves in the project were planted in 2015 hence the equation is well suited within the time period.

Ya Min Thant studied the following species: *Avicenia marina* (Am), *Avicenia officinalis* (Ao) and *Sonneratia apetala* (Sa) and a naturally regenerated stand under regeneration improving felling operation (NR: consists of *Ceriops decandra, Bruguiera sexangula*, and *Aegicerus corniculatum*) protected for seven years since 2000. The total carbon stock in biomass was 73 tC ha^{-1} in NR, 43 tC ha^{-1} in Sa, 21 tC ha^{-1} in Am and 18 tC ha^{-1} in Ao for 6 year old plantations.

Using the same equation the VCS project gives a 2.6 tC ha^{-1} for a 3 year old stand. Hence PP has taken a very conservative approach and the most suitable and available equation for the project ex-post estimations. Therefore using the equation provided by Ya Min Thant et al. provides conservative ex-post estimates for the group of mangrove species used in this VCS project. And Myanmar being a Least Developed Country (LDC), PP have used the best available allometric equation to conservatively calculate ex-post reductions.

The following map shows the study area of Ya Min Thant et al and the VCS project area both located in the Ayeyarwady Delta area.



The DBH and Height values were obtained from the permanent sample plots.

Plot No	End of year 1		End of year 2		End of year 3		End of year 4	
	Height (cm)	Diameter (cm)	Height (cm)	Diameter (cm)	Height (cm)	Diameter (cm)	Height (cm)	Diameter (cm)
2015:4					110.8	1.87	145.69	2.18
2015:5					98.98	1.02	126.55	1.51
2015:11					80.08	1.80	107.88	2.12
2015:33					51.4	1.12	65.75	1.58
2015:45					83.0	1.28	112.87	1.64
2015:53					63.39	1.05	84.73	1.56
2015:90					61.67	1.34	80.46	1.70
2015:99					65.4	1.77	102.95	2.58
2016:21			71.08	1.80	81.19	2.29		
2016:25			76.09	1.52	101.89	1.98		
2016:32			35.86	0.57	47.65	1.20		
2016:34			37.53	0.60	58.83	1.66		
2016:43			66.81	1.68	86.98	2.75		

2016:48			70.65	1.70	95.44	3.44		
2016:73			82.35	2.10	107.06	3.61		
2017:6	56.4	0.47	74.00	0.93				
2017:19	50.75	0.44	68.20	0.97				
2017:26	53.74	0.61	75.55	1.13				
2017:62	58.5	0.71	77.69	1.50				
2017:68	51.26	0.66	66.36	1.27				
2017:77	59.5	0.58	76.95	0.96				
2017:106	69.23	0.64	88.05	0.91				
2017:100	66.23	0.74	83.83	1.70				
2018: 1	107.45	0.82						
2018: 2	102.81	0.81						
2018: 3	78.29	0.79						
2018: 5	64.10	0.53						
2018: 11	37.61	0.64						
2018: 14	54.22	0.69						
2018: 19	55.72	0.76						
2018: 12	25.52	0.35						
2018: 28	54.15	0.47						
2018: 29	27.05	0.36						
2018: 1 (P)	42.96	0.59						
2018: 2 (P)	73.72	0.51						
2018: 3 (P)	82.33	0.40						

The equations were applied for each year and then the tool AR-Tool 14 (Version 04.2) was used to develop the calculations in Microsoft Excel sheets. Default carbon fraction: 0.47 as per A/R methodological tool.

Out of the 10 strata were identified, only 6 Strata i_1, i_2, i_3 were areas reforesting from 2015 to 2017 and i_7,i_8, i_9 are areas that were restored using mangrove plants. The state i_4 was planted in 2018. Calculations for i_4 was done separately since it is a newly planted area.

Strata	Year of planting	Area planted (ha)
i_1	2015	93.92
i_2	2016	76.72
i_3	2017	249.63
i_4	2018	297.88
	Total area (ha)	**718.15**

Strata	Year of planting	Area restored (ha)
i_7	2015	107.97
i_8	2016	22.28
i_9	2017	114.42
	Total area (ha)	**244.67**

Survival Rate: Based on the survival rate counts in the 23 sample plots, a 91% survival rate have been calculated. Hence a rate of 91% was used in the calculations. For the 4th year the survival rate was calculated to be 97%.

Estimation of the changes in carbon stocks in shrub biomass: $\Delta C_{SHRUB\_PROJ,t}$

As no shrubs are planted as part of this project this carbon stock will be accounted as zero for the ex-ante and ex-post estimations.

Estimation of the changes in carbon stocks in dead wood: $\Delta C_{DW\_PROJ,t}$

Deadwood is expected to remain in the project area and will not be removed. Therefore carbon stock in this pool is assumed not to increase under a conservative approach.

Calculation of uncertainty

This was done following the guidance of Appendix 2 of the A/R Methodological Tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities". The values are presented in the table below:

Stratum	Mean t d.m. ha^{-1}	s_i t d.m. ha^{-1}	n_i	Standard error of mean (SEM)	SEM expanded at 90% confidence level
2015 planted	14.63	3.1	8	1.1	2.07
2016 planted	19.9	4.82	8	1.7	3.22
2017 planted	6.81	1.21	7	0.46	0.88
2018 planted	6.61	2.03	13	0.56	1.00
Total			36		

Year	Area (ha)	Ratio of area	Weighted mean value	Sum of mean value	Weighted SEM	Project t-value	Project uncertainty	$u_{c\ mean}$ t CO_2-e	$u_{cDiscount}$ t CO_2-e (25%)
2015	201.89	21%	3.07	9.73	0.75	1.2729	**13%**	4966	1241.5
2016	99.00	10%	2.05						
2017	364.05	38%	2.57						
2018	297.88	31%	2.04						
Total	962.82	100%							

Estimation of the changes in carbon stocks in soil organic carbon (SOC): $\Delta SOC_{PROJ,t}$

As explained in the VCS PD (version 3.0) the changes in carbon stocks in the SOC pool were calculated as indicate in the Methodology AR-AM0014 (03.0):

$$\Delta SOC_{PROJ,t} = \frac{44}{12} \times \sum_{t=1}^{t} A_{PLANT,t} \times dSOC_t \times 1\ year$$

Where

$\Delta SOC_{PROJ,t}$	=	Change in SOC stock within the project boundary, in year *t*; t CO_2-e
$A_{PLANT,t}$	=	Area planted in year *t*; ha
$dSOC_t$	=	The rate of change in SOC stocks within the project boundary, in year *t*; t C ha^{-1} $yr^{-}1$.

The following default value of is used, unless transparent and verifiable information can be provided to justify a different value:

(i) $dSOC_t$= 0.50 t C ha^{-1} yr^{-1} for $t = t_{PLANT}$ to $t = t_{PLANT}$ + 20 years, where t_{PLANT} is the year in which planting takes place;

(ii) $dSOC_t$ = 0 t C ha^{-1} yr^{-1} for $t > t_{PLANT}$ +20.

The IPCC published in its '2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands', a default value of 1.62 tC/ha/year for mangrove ecosystems with a range of 0.10 – 10.2 tC/ha/year. Regarding the default accumulation timeframe of this value the same guidelines state on page 4.27 'Craft et al. (2003) found that (a) soil carbon accumulation, developed almost instantaneously with the establishment of vegetation along a chrono-sequence of 1- to 28-yr old constructed marshes and (b) a similar soil carbon accumulation rate over 10 years in a natural and created marsh (Craft et al., 2002) and over 20 years in a created mangrove (Osland et al., 2012)'.

This IPCC value is mainly based on the study conducted by Breithaupt et al. (2012) which estimated a geometric mean global organic carbon burial rate of 163 (+39.2; -32) g OC $m^{-2}yr^{-1}$ resulting in 1.63 tC/ha/year. This comparative study included 19 studies from Brazil, Columbia, Malaysia, Indonesia, China, Japan, Vietnam, Thailand, Mexico and the United States.

For the proposed VCS ARR project in Myanmar the University of Pathein carried out an in-depth soil analysis. The samples collected were analysed at the Universities' Research Centre of the University of Yangon. According to this analysis, average carbon stock stored was estimated as 732.26 tC/ha for a mean soil depth of around 1 meter.

Applying a conservative estimate of 100 years accumulation, this would result in 7.32 tC/ha/year for soil depth around 1 m. This value was already fixed during the initial verification and shall remain fixed.

4.3 Leakage

According to the methodology AR-AM0014 (Version 03.0), the leakage emission has to be assessed with the tool "Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity" (Version 02). This tool evaluates the displacement of crop cultivation and grazing activities. Section 6 of this tool indicates that leakage emissions can be considered insignificant if they meet the following requirements:

1. Leakage emission attributable to the displacement of agricultural activities due to implementation of an A/R CDM project activity is estimated as the decrease in carbon stocks in the affected carbon pools of the land receiving the displaced activity.

2. Leakage emission attributable to the displacement of grazing activities under the following conditions is considered insignificant and hence accounted as zero:

(a) Animals are displaced to existing grazing land and the total number of animals in the receiving grazing land (displaced and existing) does not exceed the carrying capacity of the grazing land;
(b) Animals are displaced to existing non-grazing grassland and the total number of animals displaced does not exceed the carrying capacity of the receiving grassland;
(c) Animals are displaced to cropland that has been abandoned within the last five years;
(d) Animals are displaced to forested lands, and no clearance of trees, or decrease in crown cover of trees and shrubs, occurs due to the displaced animals;
(e) Animals are displaced to zero-grazing system.

Most of the project areas are emerged salty mudflats either bare lands or with a few mangrove plants. Grazing is not a common practice in the area. The protection from any future illegal grazing on mangrove sites is part of the project activities. Therefore, leakage in the whole project area can be assumed as zero for the duration of the project.

Prior to the project start some of the local communities have been involved in charcoal production. With the lands being degraded and abandoned, these charcoal producers had to abandon the charcoal production. One might argue that with the mangrove reforestation program, these charcoal producers may start the charcoal production again thus lead to deforestation. To prevent those in the community living nearby mangrove forest depending on cutting mangrove to make charcoal and get income for their livelihood, Worldview International Foundation (WIF) employ them, paying daily wages of Kyats 5000/-, in planting mangrove in the belief that their participation in planting process would create a feeling of ownership and that they would not readily cut mangrove as they had done so before.

In addition, WIF, in consultation with them, look for an alternative income generation project that might interest them to take care of their livelihood. These people have been made aware that in order to receive an income via carbon credits they need to protect these mangroves. They have also agreed on the alternative livelihood opportunities proposed by PP for them. This way PP ensures that the mangrove trees planted by the project will not be cut for the charcoal production. This is in line with the Section 3.6.2 of the AFOLU Requirements (version 3.6).

Regular patrolling in the project area is done and any illegal cutting is to be reported to the project office and will be taken strict measures for offenders with the support of the forest department officials.

4.4 Net GHG Emission Reductions and Removals

The ex-ante net anthropogenic GHG emission reductions and removals are calculated using equation 6 of the methodology AR-AM0014:

$$\Delta C_{AR-CDM,t} = \Delta C_{ACTUAL,t} - \Delta C_{BSL,t} - LK_t$$

Where:

$\Delta C_{AR-CDM,t}$	=	Net anthropogenic GHG removals by sinks, in year *t*; t CO_2-e
$\Delta C_{ACTUAL,t}$	=	Actual net GHG removals by sinks, in year *t*; t CO_2-e
$\Delta C_{BSL,t}$	=	Baseline net GHG removals by sinks, in year *t*; t CO_2-e
LK_t	=	GHG emissions due to leakage, in year *t*; t CO_2-e

Year	Baseline net GHG removals by sinks (tCO_2e)	Actual net GHG removals by sinks (tCO_2e)	Leakage emissions (tCO_2e)	Net GHG emission reductions or removals (tCO_2e)
2018-2019	0	29,572.5	0	29,572.5
Total	**0**	**29,572.5**	**0**	**29,572.5**

The AFOLU Non-Permanence Risk Tool, v3.2 was used to calculate the non-permanence risk for the project. Accordingly the total risk assessed was 10%. The "Non-Permanence Risk Report" for the project has been produced as a separate document with the AFOLU Non-Permanence Risk Tool, v3.2 excel sheet used for the calculation. Accordingly 2,957 buffer credits are needed to be deposited into the AFOLU pooled buffer account. After reducing the balance credits are 26,615.5 tCO_2e.