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

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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 was implemented on 2071.06 ha of degraded lands of the Northern part of Ayeyarwady Division of Myanmar. The lands that were 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 15-June-2019 to 14-June-2020, a total of 2,337,740 mangroves were planted on 1108.24 ha hectares of land belonging to Thabawkan and Thaegone village tracts. 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 63,006 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 3.2.8 of VCS Standard (Version 4.0), all ARR projects occur on wetlands shall adhere to both the respective project category requirements and the WRC (Wetlands Restoration and Conservation) requirements unless the expected emissions from the soil organic carbon pool or change in the soil organic carbon pool in the project scenario is deemed below *de minimis* or can be conservatively excluded as set out in the VCS Program document *VCS Methodology Requirements*, in which case the project shall not be subject to the WRC requirements. 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 (WIF)
Contact person	Dr. Arne Fjortoft
Title	Secretary General
Address	70 Yaw Min Gyi Street, Yangon, Myanmar
Telephone	+95-11220512 – Skype address arnefjor1
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.

Figure 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.

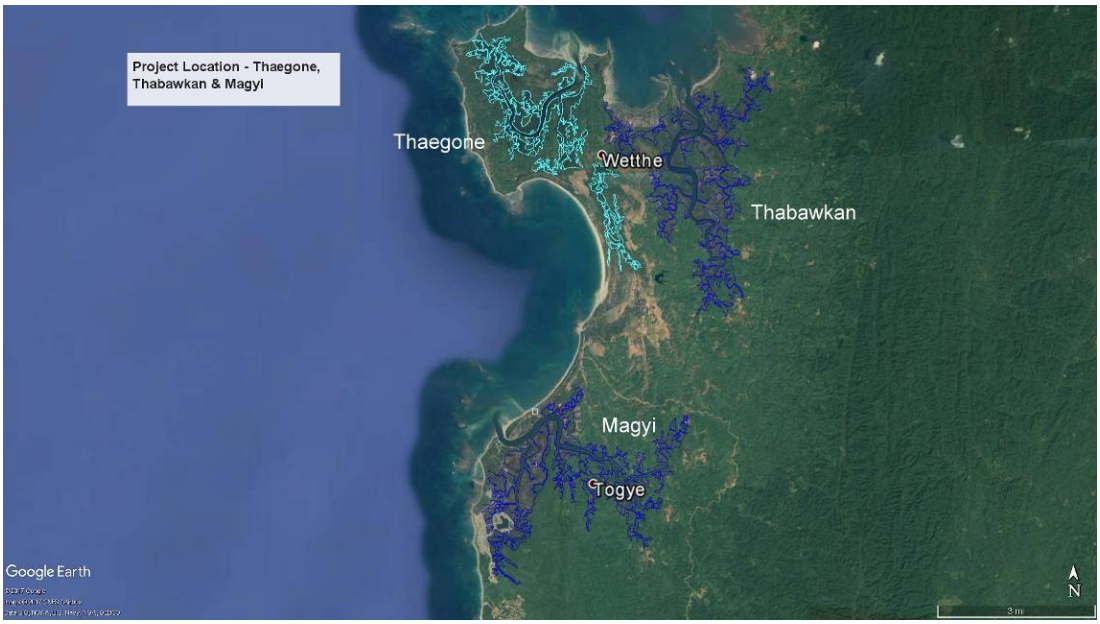


Figure 2: Project Location indicating Thaegone, Thabawkan and Magyi

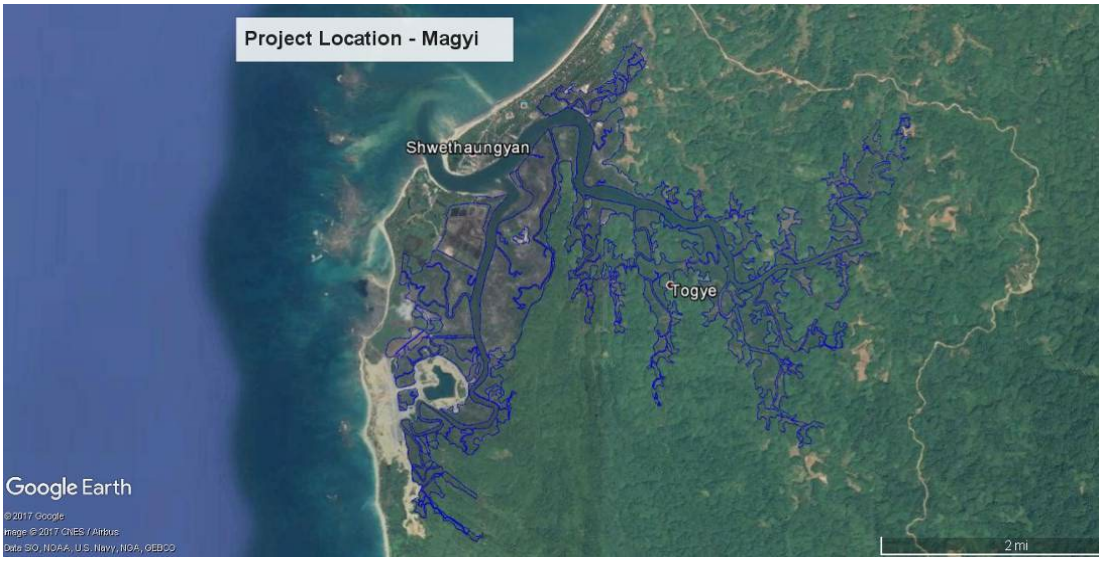


Figure 3: Project Location of Magyi

Figure 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 Participation under other GHG 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 Other Forms of Credit

Emission Trading Programs and Other Binding Limits: The project is not included in any other emission trading program.

Other Forms of Environmental Credit: The project has not sought or not received any other form of GHG-related environmental credits.

1.11 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 sequestrate significant amount of GHGs compared to baseline. Project was implemented by Worldview International Foundation in cooperation with Government and universities who are committed to environmental sustainability and social responsibility.

Under the project nutrition is retained on the land and therefore water quality is increased compared with the baseline. The soil organic contents and mineral contents are improved due to proper land management. 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. Recent mangrove plantations have brought back elephants and other wildlife that were previously not visible.

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

Improvements to the infrastructure in the area were done 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 was fulfilled with local employment. Therefore, the major portion of the budget on labour retained within the region and the local community. The project paid 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.

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].

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

Mangroves – A lifesaving coastal ecosystem: Scaling up protection and restoration for achieving the SDGs – report by BMZ, IUCN, WWF - LINK

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

2 SAFEGUARDS

2.1 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 was 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 5: Meetings during the stakeholder consultation

Figure 6: 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 was 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 are actively participating 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 this is being transferred it to the local communities.

(4) Infrastructure development & Change in lifestyle

During this monitoring period a 10-month training program for 24 candidates was organized on social entrepreneurship. Upon successful training, they were requested to propose new enterprises in the area. Ideas like bee honey production, clam production, a small yard for boat building, production of energy saving stoves, sea weed production, virgin coconut production, ice plant for fishing industry, aquaculture projects with emphasis on crab farming will be followed up for implementation. As part of the follow up process, a crab hatchery is under construction and technicians have been sent to Vietnam for training. Construction of the hatchery has been delayed due to the COVID-19 pandemic. Another 3 sites for ice plants have been identified and technical details completed in cooperation with an ice plant specialist. A plan for seaweed production completed. The consultant for the project is presently stuck in Abu Dhabi due to lack of flight to Myanmar. He has been on a short time engagement for FAO and was ready to start work in May. The project will start as soon as he is back in the country.

A small boat yard started in December and has produced its first fiberglass boat. 2 energy forests have been established and solar panels mounted on school roofs in 2 communities, followed by computer labs with training. 300 solar lamps were distributed to school children and a printer was donated to the school.

2.2 Local Stakeholder Consultation

As explained in the VCS PD and the previous Monitoring Reports, WIF has emphasizes stakeholder consultation from day one of the project, believing that a participatory approach is the only way to success.

Among regular stakeholder meetings, the following key meetings were held during 2019/2020:

Date	Participants	Points discussed	Location
03.05.2019	Forest Department (FD) - Dr Nyi Nyi Kyaw, Director General (DG) - U Kyaw Zeya, Director, Forest Department, Ayeyawady Region - U Kan Htun, Assistant Director, Pathein District, Ayeyawady Region - U Tint Khaing Assistant Director, Forest Department, Yangon Region WIF - Dr. Htay Aung, Retired Honorary Professor, Pathein University - U Bo Ni, Managing Director - U Win Maung, Project Director	- Routine visit by the Forest Department officials including the Director General - Discussed the activities conducted by WIF	WIF Frontline Office Shwethaungyan Pathein Township

	- U Myint Sein, Field Manager		
12.05.2019	*Magyi Village* Community - 12 village community leaders WIF - Dr. Arne Fjortoft, Secretary General - U Win Maung, the project director - Dr. Htay Aung, Marine Specialist - U Aung Aung Myint, deputy project director - U Myint Sein, Field Manager		WIF Frontline Office Shwethaungyan Pathein Township
24.06.2019	- Village Administrator of Polaung, - Win Maung (Project Manager of WIF) - Dr Htay Aung - WIF staff - 8 - Villagers from Polaung – 20 - Education Department - 2	- Importance of mangroves, seagrass and their role in fish resource - Discuss about wages paid for both male and female workers without gender discrimination - Discussed about ownership of project. WIF is only the care taker and the village tracts will own the project to carry on to future generation - WIF inquired if there were any complaints to make but there were no such complaints	Polaung village
05.07.2019	- 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

24.09.2019	Magyi Community Representation 10 representatives of the Women Group, Mgyi Village WIF Side - Dr. Arne Fjortoft, Secretary General - Dr. Htay Aung, Retired Professor, and Marine Scientist - U Myint Sein, Field Manager	- Discussed about starting a clam culture project with 52 women in Magyi area - Prof. Htay Aung agreed to provide technical expertise for the project - Agreed on developing a marketing plan for the clams	WIF Frontline Office, Pathein Township
30.09.2019	*Thabawkan* Community Representation - U Chit San - U Zaw Myo Naung - U Nyan Min Htet - U Khin Ko Ko - U Aung Myo Thu WIF - Dr. Arne Fjortoft, Secretary General - U Myint Sein, Field Manager - U Bo Ni, Managing Director	- Discussed about the community development activities conducted by WIF - Discussed about future community development projects including an ice manufacturing plant	Shwethaungyan Hotel, Pathein Township
20.10.2019	Polong Community Representation - Village tract leaders and 40 community members of Polong Village Tract WIF - 8 Members delegation led by Dr. Arne Fjortoft, the Secretary General of WIF	- Donated a new copying machine and computers for high school, solar lamps to all school children, solar panels on school roofs with batteries, and led lights. - Discussed about the progress of energy crops - Discussed about WIF's support for the production of glass fiber boat to be built in the community	Polong State High School Polong Village Pathein Township

Apart from the stakeholder consultation meetings held PP has its office in Magyi where any stakeholder could come and make a complaint or suggestion. Retired 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.

2.3 AFOLU-Specific Safeguards

This section comprises of the local stakeholder identification process and a description of results. The local stakeholders mainly include the local households lives near by the project, the Forest Department and the local government. During the project design phase and subsequent verifications, local stakeholders were involved in every stage of the project.

- Risks to local stakeholders due to project implementation and how the project will mitigate such risks.

  Mangroves were not planted in any areas that had other land-uses. These lands were degraded mangroves and were not using for any other purpose. There is no risk to local stakeholders due to the project implementation.

- Risks to local stakeholder resources due to project implementation and how the project will mitigate such risks, including the plans to ensure the project will not impact local stakeholder's property rights without the free, prior and informed consent.

  When the was project implemented, WIF applied for the VCS registration with the consent of local communities and the government. Stakeholder meetings were conducted with multiple stakeholders and minutes were presented during validation. The project generates VCUs and the communities are aware of this. Therefore, the project will not impact local stakeholder's property rights without the free, prior and informed consent.

- Processes to ensure ongoing communication and consultation with local stakeholders, including a grievance redress procedure to resolve any conflicts which may arise between the project proponent and local stakeholders.

  Complaints/ suggestions that are able to be handled at the local office are discussed with the local team led by Mr. Win Maung. For higher decision making, the Rector of Pathein University and Dr. Arne of WIF are involved. For Thabawkan and Thaegone, the chief of village tract committees is also responsible for recording the complaints, suggestions regarding the project and reporting 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 are 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 is 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, the above details are recorded.

  WIF responds in writing to any claimant within 15 days and takes 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 are 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 IMPLEMENTATION STATUS

3.1 Implementation Status of the Project Activity

The project activity started in May 2015 and planting started in June 2015. As of July 2020, a total of 2071.06 hectares have been planted. An area of 1108.24 ha was planted during 2019.

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.

The Non-Permanence Risk Report (Version 2.0) which was prepared in November 2017 was revised based on the activities during the 3rd 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).

3.2 Deviations

2.3.1 Methodology Deviations

There are no deviations from the methodology.

2.3.2 Project Description Deviations

As per the VCS PD in 2019 and 2020 an area of 200 ha and 179.57 ha was to be planted. During the previous monitoring period, due to lack of funding, planting material and staff related issues, WIF was not able to complete the planned planting. However, during this monitoring period, WIF was able to mobilize the necessary funds, planting material and staff and decided to scale up the planting. Therefore during 2019 an area of 1108.24 ha was planted, and the planting operations are completed

for the project. It should be noted that the total planned area to be planted as identified in the VCS PD (of 2,146.48 ha) was not accomplished due to the following reasons:

- An abandoned shrimp pond of 35.54 ha was excluded from the project after agreements between WIF, Government and University of Pathein as identified in the 2018 Monitoring Report
- The construction of a hotel caused 36.58 ha to be excluded from the project area as identified during the 2019 Monitoring Report
- Approximately 3.30 ha was not planted in 2019 because the area was determined to not be plantable as per the observation provided by the field team to the WIF HQ and has been excluded from the total project area

Before the planting started and during the project, the project team assessed the lands. Again, during the planting operation, the field team assessed the lands for planting. If there are any areas not suitable for planting as deemed by the team, such areas will be left alone. No new planting shall be done in 2020. However, the annual patching and regular maintenance shall be conducted within the project area. Therefore, the final total planted area of this project is 2,071.06 ha.

Original Area in the VCS PD (2,146.48 ha) – Shrimp pond (35.54 ha) – Hotel construction (36.58 ha) – Area not planted (3.30 ha) = 2015 to 2017 planation (664.94 ha) + 2018 Plantation (297.88 ha) + 2019 Plantation (1,108.24 ha) = 2,071.06 ha

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. In addition, the staff have over 30 years of experience, and with consultation with field management, it was ensured that silviculture operations were not impacted. 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.

3.3 Grouped Projects

This project is NOT a grouped project

4 DATA AND PARAMETERS

4.1 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	$fj(x_{1,l},x_{2,l},x_{3,l},...)$
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*

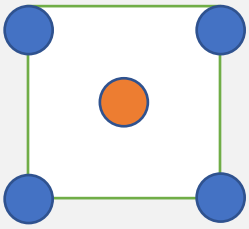
Data / Parameter	$dSOC_t$
Data unit	t C ha^{-1} yr^{-1}
Description	The rate of change in SOC stocks within the project boundary, in year t
Source of data	Estimated (Research done by the University of Pathein)
Value applied	7.32
Justification of choice of data or description of measurement methods and procedures applied	This value was accepted by VCS and fixed for the project period.
Purpose of Data	Calculation of project emissions
Comments	

4.2 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	<table><tr><th>Strata</th><th>Area (ha)</th></tr><tr><td>A_1 (2015 planting)</td><td>93.92</td></tr><tr><td>A_2 (2016 planting)</td><td>76.72</td></tr><tr><td>A_3 (2017 planting)</td><td>249.63</td></tr><tr><td>A_4 (2018 planting)</td><td>297.88</td></tr><tr><td>A_5 (2019 planting)</td><td>1108.24</td></tr><tr><td>A_7 (2015 restoring)</td><td>107.95</td></tr><tr><td>A_8 (2016 restoring)</td><td>22.28</td></tr><tr><td>A_9 (2017 restoring)</td><td>114.42</td></tr><tr><td>Total</td><td>2071.06</td></tr></table>
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 the 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 50. 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. For the 2018 planting 3 extra plots were added and for the 2019 planting 1 extra plot was added, raising the number of sample plots from 17 to 18 for 2019.
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, 2019 – 18 plots

	<table><tr><th>Stratum</th><th>No of sample plots</th></tr><tr><td>n_1 (2015 planting)</td><td>4</td></tr><tr><td>n_2 (2016 planting)</td><td>4</td></tr><tr><td>n_3 (2017 planting)</td><td>6</td></tr><tr><td>n_4 (2018 planting)</td><td>13</td></tr><tr><td>n_5 (2019 planting)</td><td>18</td></tr><tr><td>n_7 (2015 restoring)</td><td>4</td></tr><tr><td>n_8 (2016 restoring)</td><td>3</td></tr><tr><td>n_9 (2017 restoring)</td><td>2</td></tr><tr><td>Total</td><td>54</td></tr></table>
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. 
Purpose of the 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 (2015 planting): 0.22 w_2 (2016 planting): 0.18 w_3 (2017 planting): 0.59 w_4 (2018 planting): 1.00 w_5 (2019 planting): 1.00 w_7 (2015 restoring): 0.44 w_8 (2016 restoring): 0.09 w_9 (2017 restoring): 0.47 w_1, w_2....w_9 – values for each strata
Monitoring equipment	N/A
QA/QC procedures to be applied	N/A
Purpose of the data	Calculation of project emissions
Calculation method	Area of the stratum i divided by the project area
Comments	N/A

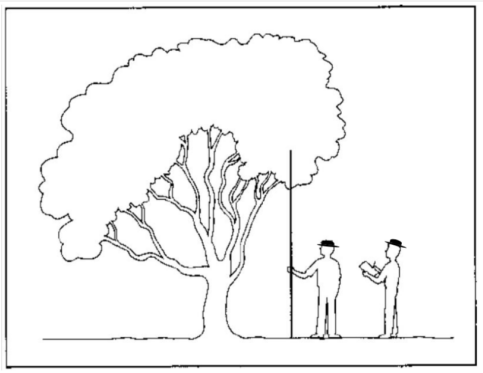
Data / Parameter	$A_{PLOT,i}$
Data unit	ha
Description	Size of sample plot in stratum i
Source of data	Field measurement, GPS and GIS
Description of measurement methods and procedures to be applied	Areas in the project area are tracked in the field using the GPS. Each planting area is tracked as a standard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

applied	layout of plots. Field-team members are fully aware of all procedures and the importance of collecting data as accurately as possible.
Purpose of the 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, D_{30} or the basal diameter is measured and recorded."
Frequency of monitoring/recording	Annually measured and recorded
Value monitored	Diameter for trees planted in 2015 – 2.18 cm Diameter for trees planted in 2016 – 2.44 cm Diameter for trees planted in 2017 – 1.57 cm Diameter for trees planted in 2018 – 1.48 cm Diameter for trees planted in 2019 – 0.68 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 selected 100% of the data sheets and cross-checked with actual field measurements before sending the data to the Managing Director. This helped minimize the errors during data measurement and entering.
Purpose of the 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. In case 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	Height for trees planted in 2015 – 118.64 cm Height for trees planted in 2016 – 91.81 cm Height for trees planted in 2017 – 83.94 cm

	Height for trees planted in 2018 – 74.02 cm Height for trees planted in 2019 – 63.55 cm
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 selected 100% of the data sheets and cross-checked with actual field measurements before sending the data to the Managing Director. This helped minimize the errors during data measurement and entering.
Purpose of the 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 the 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 project boundaries	The GPS is calibrated at the factory. No calibration needed. 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

4.3 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 employs workers for the reforestation and restoration activities.

The following professionals constitute the administrative team of WIF:

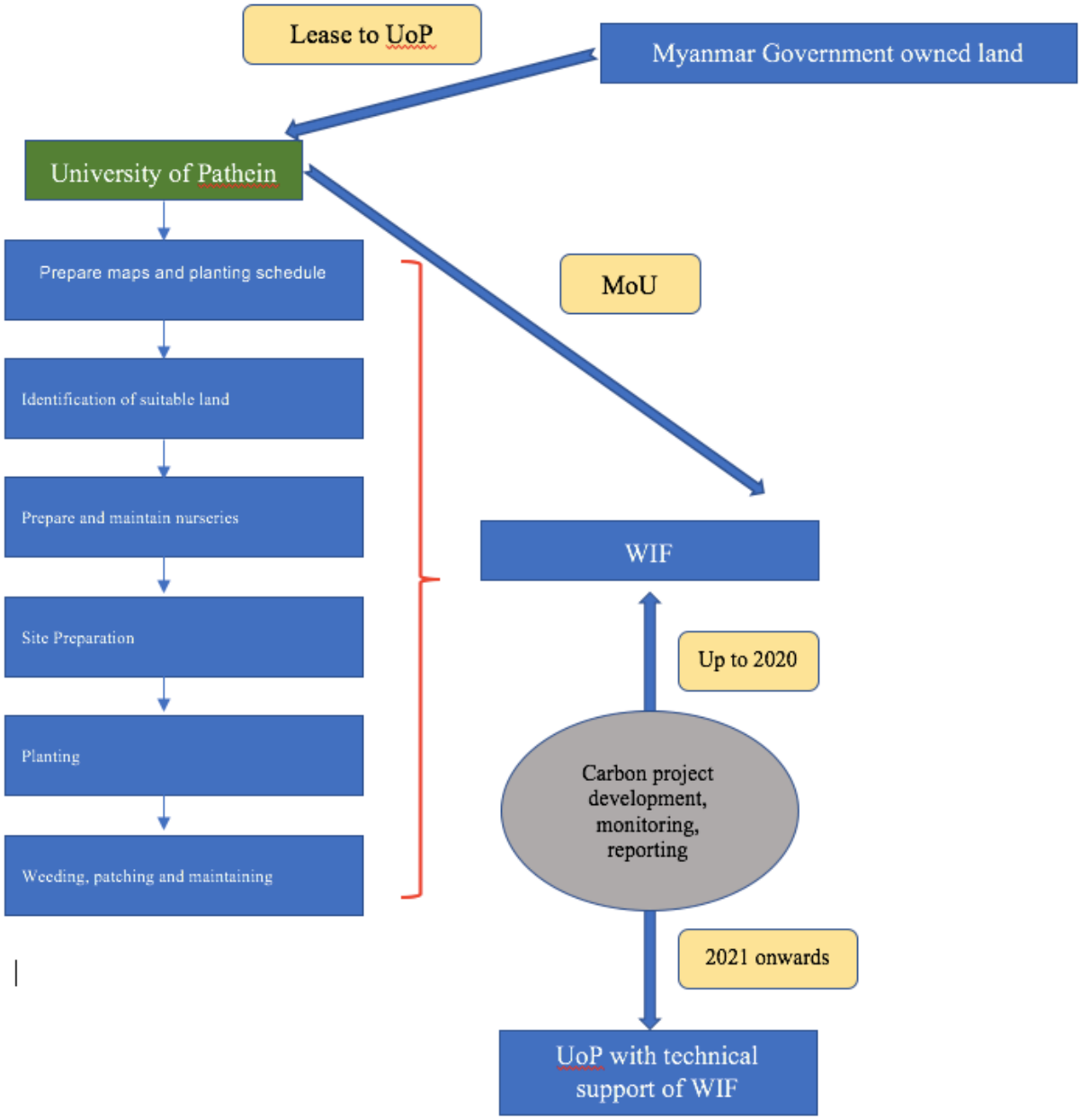
- Dr. Arne Fjortoft, Secretary General WIF (Specialty in development communication, public education, sustainable development project implementation and climate change/environmental conservation).
- Aye Lwin, Chairman (Administrative experience from government, diplomacy, business and NGO sector, former 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 (Up to July 2020). Overall coordinator for the VCS project development with experience in carbon project development in the Asian region.
- Sachini Jayakody, Carbon Consultant (Since July 2020). 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 specialty 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.

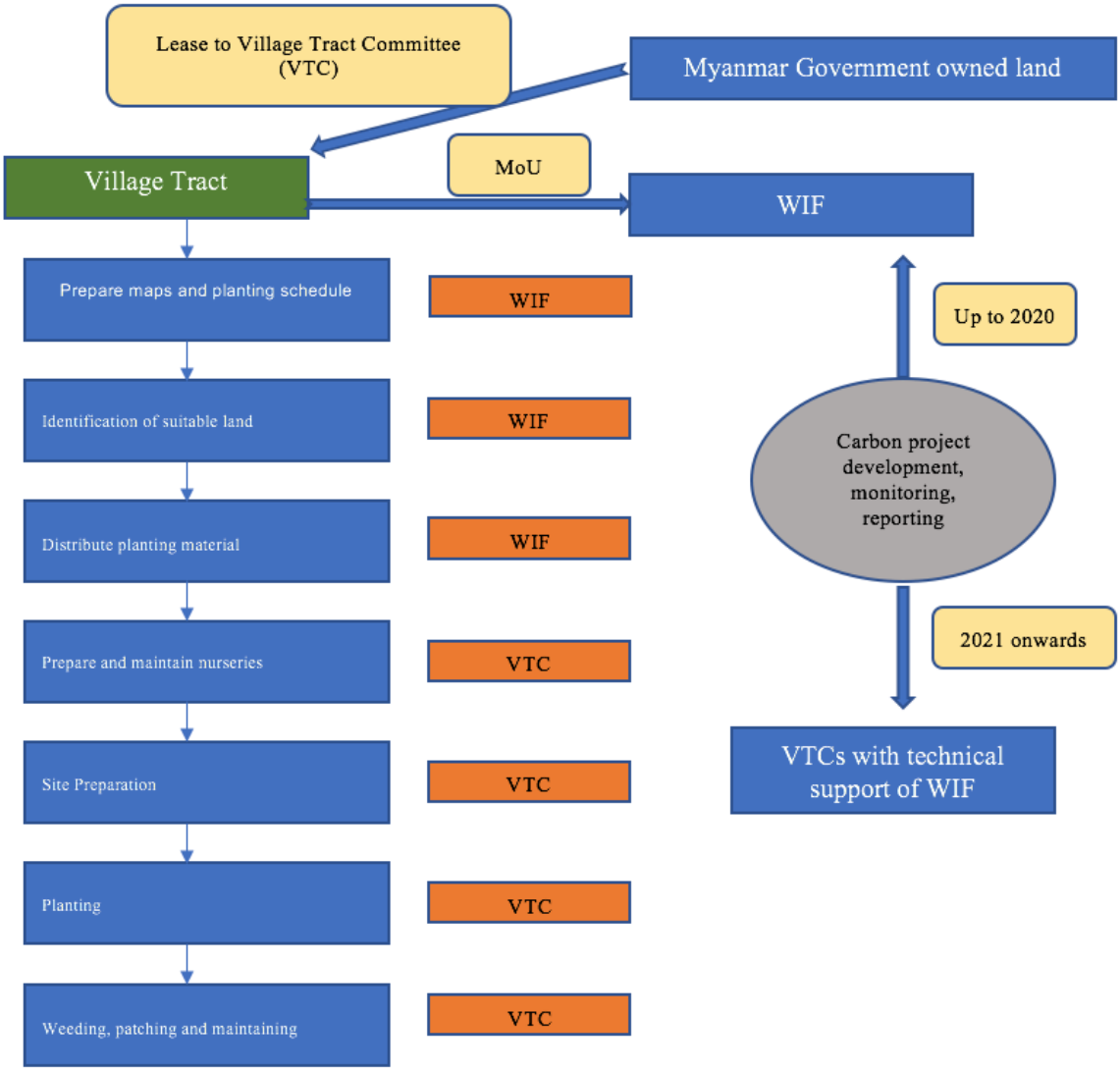
Organizational Structure

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 is conducting 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 are conducting the activities mentioned in the following graph. The overall management of the carbon component is 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.


Lease to Village Tract Committee (VTC)
Myanmar Government owned land
Village Tract
MoU
WIF
Prepare maps and planting schedule
WIF
Identification of suitable land
WIF
Distribute planting material
WIF
Prepare and maintain nurseries
VTC
Site Preparation
VTC
Planting
VTC
Weeding, patching and maintaining
VTC
Up to 2020
Carbon project development, monitoring, reporting
2021 onwards
VTCs with technical support of WIF

The following figure presents the overall organizational structure of the project

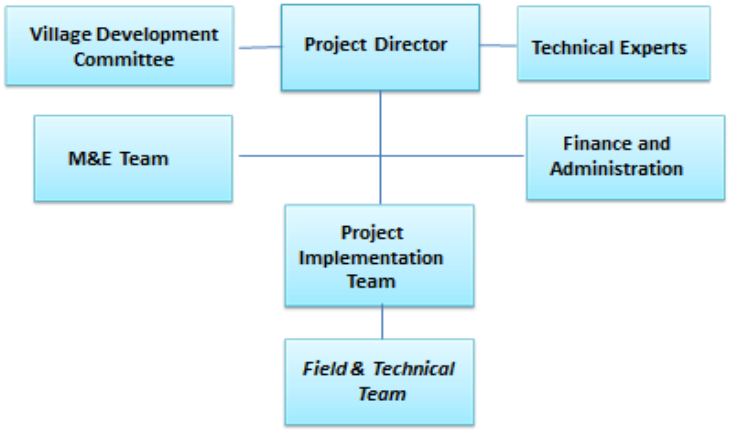


Figure 7: Overall Organizational Structure of Project

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 are 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 land use 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 land use 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. There were no differences observed in strata. Strata were determined per the year of planting and this continues for this monitoring period as well.

This ARR VCS project is designed as to the planting and restoration occurred during 2015-2019. 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;

There were no disturbances observed. However, the changes in mangrove forest establishment than mentioned in the PD, and has been recorded as a permanent change. These changes are mentioned in Section 2.3.2 as project description deviations.

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-post stratification the strata are as follows:
Strata 1: 2015 planting – applicable for this monitoring period 2019-2020
Strata 2: 2016 planting – applicable for this monitoring period 2019-2020
Strata 3: 2017 planting – applicable for this monitoring period 2019-2020
Strata 4: 2018 planting – applicable for this monitoring period 2019-2020
Strata 5: 2019 planting – applicable for this monitoring period 2019-2020
Strata 7: 2015 restoration - applicable for this monitoring period 2019-2020
Strata 8: 2016 restoration - applicable for this monitoring period 2019-2020
Strata 9: 2017 restoration - applicable for this monitoring period 2019–2020

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 are 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 established 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 certifies that the team is trained;

d) New staff were 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 is 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 and 18 for 2019 planting.

- 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.

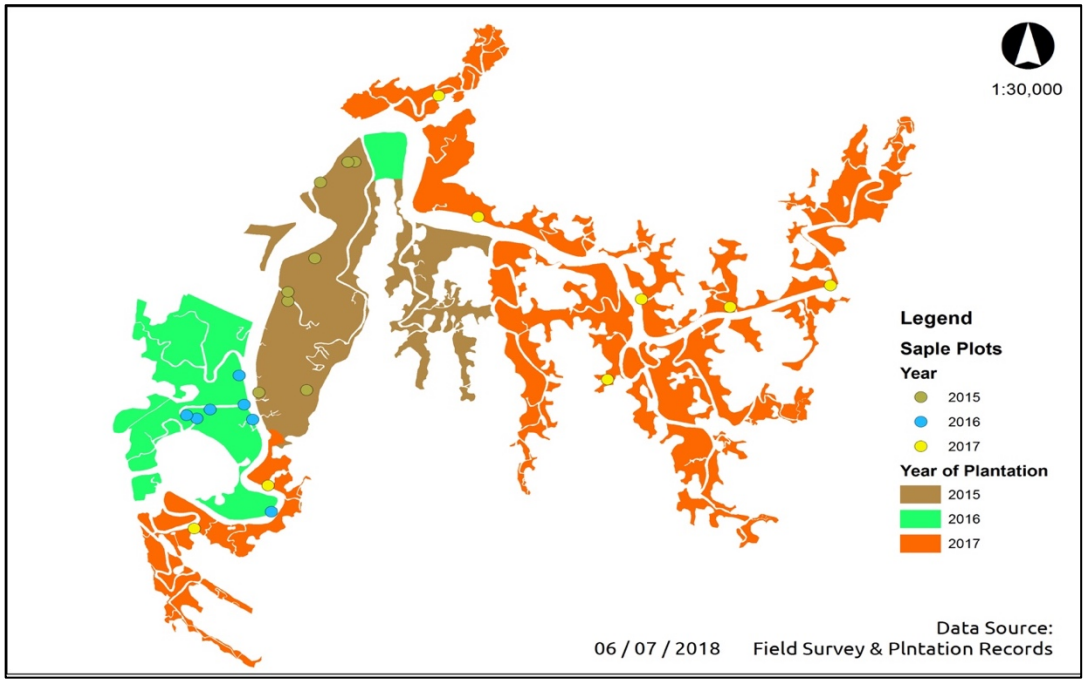


Figure 8: Location of sample plots for each planting stratum planted in 2015, 2016, 2017

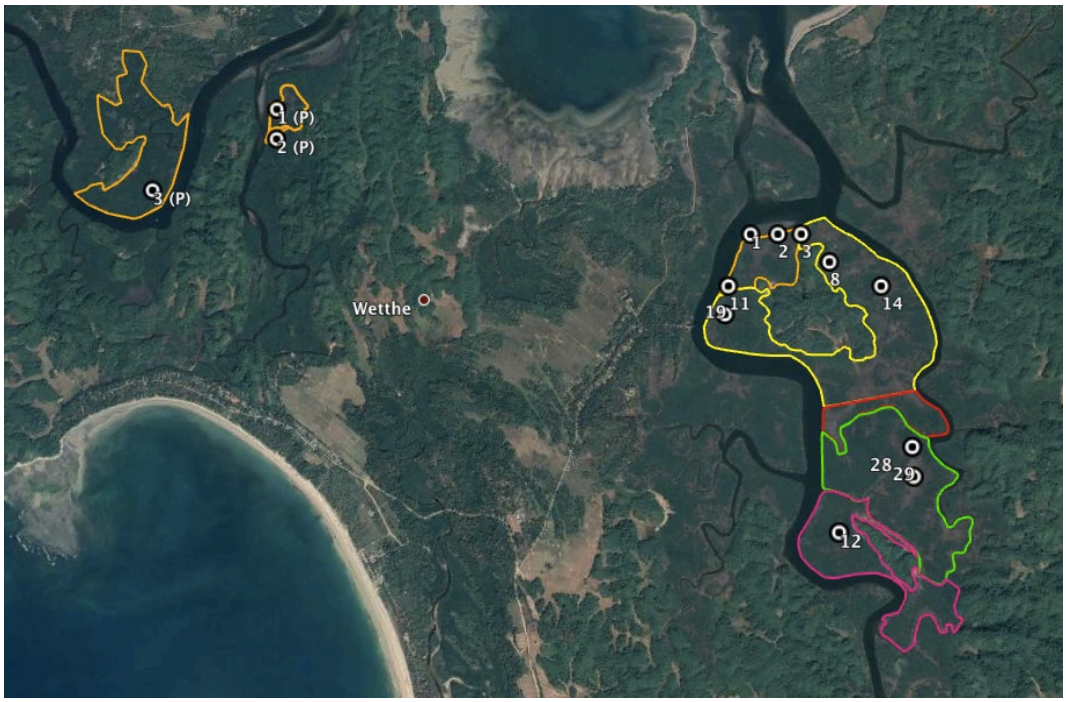


Figure 9: Location of sample plots for each planting stratum planted in 2018

Figure 10: Location of sample plots for each planting stratum planted in 2019

- 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 stratum 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 are monitored annually.

5 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

5.1 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 land use 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 and trees planted in 2019 a density of 2040 trees per hectare was applied. 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.

5.2 Project Emissions

The ex-post actual net GHG removals by sinks over the period of 2015-2019 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 were taken, and the calculations were done following the "difference of two independent stock estimations" method, available in section 6 of the tool. Under this method, method

b, "Direct estimation of change by re-measurement of sample plots" was used. 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 (wi = 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 allometric 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 - $W_{Top} = 0.22\ \rho\ (DBH^2 H)^{0.82}$

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

Where:

DBH = Diameter at breast height; cm

H = Height (m)

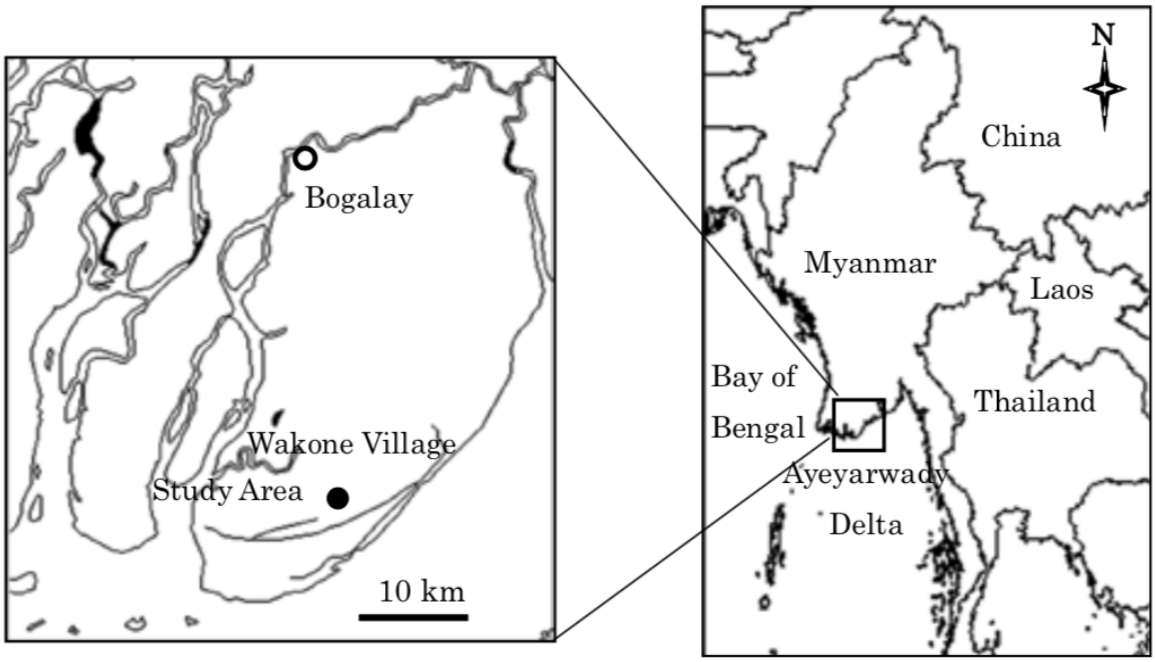
ρ = Wood density (km/m^3)

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 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 strata, 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 and i_5 was planted in 2019. Calculations for i_4 and i_5 were done separately since they are newly planted areas.

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
i_5	2019	1,108.24
Total area (ha)		**1,826.39**

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

Thus, using the above information and equations, the aboveground biomass and the below-ground biomass were calculated to be as indicated in the table below.

	2015-2017 Planting tCO_2e	2018 Planting tCO_2e	2019 Planting tCO_2e
Aboveground and Below-ground Biomass	1,848	2,151	3,413

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	Uncertainty
2015 planted	13.24	3.30	8	1.17	2.21	16,68
2016 planted	13.62	4.99	7	1.76	3.33	24.49
2017 planted	8.54	1.59	8	0.60	1.17	13.67
2018 planted	7.59	2.02	13	0.56	1.00	13.15
2019 planted	1.79	0.46	18	0.13	0.23	12.70
Total			54	Average		16.14

Stratum	Change in Carbon Stock	Total	Balance VCUs (at 50% discount due to uncertainty)
2015-2017 planted	1,848	7,413	**3,706**
2018 planted	2,151		
2019 planted	3,413		

Estimation of the changes in carbon stocks in soil organic carbon (SOC):

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 $dSOC_t$ value of 7.32 tC/ha/year was already fixed during the initial verification and shall remain fixed throughout the crediting period.

	2015-2017 Planting tCO_2e	2018 Planting tCO_2e	2019 Planting tCO_2e
SOC	17,853	7,995	29,745

5.3 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 strict measures are taken for offenders with the support of the forest department officials.

5.4 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

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, 5,929 buffer credits are needed to be deposited into the AFOLU pooled buffer account. After reducing the balance credits are 53,369 tCO_2e.

Year	Baseline emissions or removals (tCO_2e)	Project emissions or removals (tCO_2e)	Leakage emissions (tCO_2e)	Net GHG emission reductions or removals (tCO_2e)	Buffer pool allocation	VCUs eligible for issuance
15-June-2019 to 14-June-2020	0	0	0	59,299	5,929	53,369
Total	0	0	0	59,299	5,929	53,369