

KUAMUT RAINFOREST CONSERVATION PROJECT



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1 SUMMARY OF PROJECT BENEFITS

The overall goal of the project is to develop and implement sustainable land use model through forest conservation, promoting natural regeneration and enabling better livelihood opportunities for local communities surrounding the project.

1.1 Unique Project Benefits

During this monitoring period, in addition to the standardized benefits listed in section 1.2, the project has achieved important climate, community and biodiversity benefits which are demonstrated with the following progress:

Outcome or Impact	Achievements during the Monitoring Period	Section Reference	Achievements during the Project Lifetime
1) Protection and conservation of 83,381 ha of forest area	The first step in the protection of the area has been the legal conversion of the land status into a Class 1 Forest reserve, thereby making it a protected conservation area. The total area of 83,381 has been protected in two steps: 69,454 ha has been under protection since December 2015. An additional 13,927 ha was added on 8th December 2016. Establishment of guard posts at the main access points and regular patrolling including helicopter patrols and field visits conducted by Project Team (RBJ, SEARRP and Permian Malaysia). Security personnel were stationed at two strategically placed security gates to monitor vehicles in/out from the Yayasan Sabah Concession Area, including the Kuamut Forest Reserve. The gates are located at Km 11, Jalan Danum and Haranky	2.1.1	The first step in the protection of the area has been the legal conversion of the land status into a Class 1 Forest reserve, thereby making it a protected conservation area. The total area of 83,381 has been protected in two steps: 69,454 ha has been under protection since 11th December 2015. An additional 13,927 ha was added on 8th December 2016. Given this is the first monitoring period, the achievements reported in column 'Achievements during the Monitoring Period' are the same for the lifetime to date.
2) Conservation of critical biodiversity corridor between protected areas	Improved protection status of the project area, which has as a consequence resulted in the avoidance of logging and other	5.1 and 5.3	Improved protection status of the project area, which has as a consequence resulted in the avoidance of logging and other

	forms of disturbances, allowed wildlife to recover in the project area. This not only has brought benefit to biodiversity already existed in the project area to flourish, but also gave better opportunities for wildlife in the surrounding protected areas to disperse, expand their range, and likely improve their genetics and hence increase species-level's viability. The importance of the Kuamut rainforest area as a key biodiversity corridor between protected areas has been proven by several landscape-scale or Sabah-wide ecological studies during this reporting period. Further information on these studies can be found in section 5.1.		forms of disturbances, allowed wildlife to recover in the project area. This not only has brought benefit to biodiversity already existed in the project area to flourish, but also gave better opportunities for wildlife in the surrounding protected areas to disperse, expand their range, and likely improve their genetics and hence increase species-level's viability. The importance of the Kuamut rainforest area as a key biodiversity corridor between protected areas has been proven by several landscape-scale or Sabah-wide ecological studies during this reporting period. Given this is the first monitoring period, the achievements reported in column 'Achievements during the Monitoring Period' are the same for the lifetime to date.
3) Increased sustainable job opportunities for local community groups.	24 people in total were employed in relation to management, implementation of project activities and monitoring. 8 of the staff were employed for regular patrols of the project area to monitor illegal logging and poaching.	4.1.1 and 4.1.3	The project has set up a plan to employ at least 40 full-time employees, in which 50% will be female during the project lifetime. Given this is the first monitoring period, the achievements reported in column 'Achievements during the Monitoring Period' are the same for the lifetime to date.
4) Protection of RTE flora	34 RTE tree species. In 2016, Permian Malaysia conducted a survey to monitor the IUCN red list status' of all the tree species in all 46 field plots (as used for the climate data), and these plots were remeasured (including new botanical work) starting in 2020. In total we found that there are 34 species of critically endangered (6), endangered (5), and vulnerable (23) tree species. The species list, including numbers of		Project intervention ensures the full protection of the project area, which has resulted in the avoidance of logging and other forms of anthropogenic disturbance. Because of this, the RTE tree species in the project area have been protected. Given this is the first monitoring period, the achievements reported in column 'Achievements during the Monitoring Period' are the same for the lifetime to date.

	individuals is provided in Table 15 The survey results have been provided to the auditor during verification.		
5) Habitat protection for three species of fauna that have a significant threat category.	Project intervention ensures the protection and helps the recovery of forest habitats for many species including some of the most threatened taxa, such as Bornean orangutans, Bornean elephants, and helmeted hornbills. All RTE species listed in the PD (29 mammal and 12 bird species) are subject to fewer anthropogenic threats in the project area as the habitat is recovering and disturbances from logging and other associated activities have been stopped. Fortunately, there is a relatively large area of remaining habitat on steep slopes that was unaffected by logging, and we expect that this will enable recolonization of the degraded forest areas by some forest specialists. A 2014-2017 survey estimated 630 Bornean orangutans in the Kuamut project area during this period (Simon, Davies & Ancrenaz 2019)¹.	5.1 and 5.3	Project intervention ensures the protection and helps the recovery of forest habitats for many species including some of the most threatened taxa such as Bornean orangutans, Bornean elephants, and helmeted hornbills. Given this is the first monitoring period, the achievements reported in column 'Achievements during the Monitoring Period' are the same for the lifetime to date.
6) Improved conditions for communities by improving health services, education, job creation and entrepreneurship opportunities supported.	During the first monitoring period, the project has undertaken activities which have improved conditions for the communities, including health services, education, job creation and entrepreneurship opportunities.	4.1.1 and 4.1.3	The project set the target for improving well-being of the communities through health services (at least 914 people, 457 women), education (at least 100 people with 50% are women/ girls), job creation and entrepreneurship opportunities for

Simon D, Davies G, Ancrenaz M (2019) Changes to Sabah's orangutan population in recent times: 2002–2017. PLoS ONE 14(7): e0218819. <https://doi.org/10.1371/journal.pone.0218819>

	115 people in total have been trained as a result of project activities during the MP. Various training programs have been run during the monitoring period, including Accounts and Management Training at the Community Learning Centre (15), organic agricultural skills (15), food processing and entrepreneurship (18), handicraft making and community-based ecotourism (35), socio-economic training (6), joint tactics knowledge sharing session (6) and annual paralegal training (8). 2 Pre School teachers in Kg Kuamut & Tangkuyan have been supported by the project funds. 245 people received food aid via PACOS during COVID pandemic. Additional community benefits have been communicated in sections 1.2, 2.1.1 and 4.1.1.	the communities through tourism, handicraft and good agriculture practices, to be achieved during the project lifetime. Given this is the first monitoring period, the achievements reported in column 'Achievements during the Monitoring Period' are the same for the lifetime to date.
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1.2 Standardized Benefit Metrics

Category	Metric	Achievements during Monitoring Period	Section Reference	Achievements during the Project Lifetime
GHG emission reductions & removals	Net estimated emission removals in the project area, measured against the without-project scenario	Not applicable	N/A	Not applicable as this is the first monitoring period.
	Net estimated emission reductions in the project area, measured against the without-project scenario	4'839'740.67 tCO ₂ e	3.2.4	4'839'740.67 tCO ₂ e Given this is the first monitoring period, the achievements reported in column 'Achievements during the Monitoring Period' are the same for the lifetime to date.
Forest ² cover	For REDD ³ projects: Number of hectares of reduced forest loss in the project area measured against the without-project scenario	Not applicable	N/A	Not applicable

² Land with woody vegetation that meets an internationally accepted definition (e.g., UNFCCC, FAO or IPCC) of what constitutes a forest, which includes threshold parameters, such as minimum forest area, tree height and level of crown cover, and may include mature, secondary, degraded and wetland forests (*VCS Program Definitions*)

³ Reduced emissions from deforestation and forest degradation (REDD) - Activities that reduce GHG emissions by slowing or stopping conversion of forests to non-forest land and/or reduce the degradation of forest land where forest biomass is lost (*VCS Program Definitions*)

Category	Metric	Achievements during Monitoring Period	Section Reference	Achievements during the Project Lifetime
	For ARR ⁴ projects: Number of hectares of forest cover increased in the project area measured against the without-project scenario	Not applicable	N/A	Not applicable
Improved land management	Number of hectares of existing production forest land in which IFM ⁵ practices have occurred as a result of the project's activities, measured against the without-project scenario	83,381 ha	2.1.1	83,381 ha
	Number of hectares of non-forest land in which improved land management has occurred as a result of the project's activities, measured against the without-project scenario	Data not available	N/A	Data not available

⁴ Afforestation, reforestation and revegetation (ARR) - Activities that increase carbon stocks in woody biomass (and in some cases soils) by establishing, increasing and/or restoring vegetative cover through the planting, sowing and/or human-assisted natural regeneration of woody vegetation (*VCS Program Definitions*)

⁵ Improved forest management (IFM) - Activities that change forest management practices and increase carbon stock on forest lands managed for wood products such as saw timber, pulpwood and fuelwood (*VCS Program Definitions*)

Category	Metric	Achievements during Monitoring Period	Section Reference	Achievements during the Project Lifetime
Training	Total number of community members who have improved skills and/or knowledge resulting from training provided as part of project activities.	115 people in total have been trained as a result of project activities during the MP. Various training programs have been run during the monitoring period, including Accounts and Management Training at the Community Learning Centre (15), organic agricultural skills (15), food processing and entrepreneurship (18), handicraft making and community-based ecotourism (35), socio-economic training (6), joint tactics knowledge sharing session (6) and annual paralegal training (8). The training occurred at the PACOS training center in Penampang and Kibunut retreat center in Penampang. Training was led by PACOS and Kivatu Nature Farm. 8 people employed and trained for regular patrols of the project area to monitor illegal logging and poaching.	4.1.1 and 4.1.3	At least 500 people at the end of the project. Given this is the first monitoring period, the achievements reported in column 'Achievements during the Monitoring Period' are the same for the lifetime to date.

Category	Metric	Achievements during Monitoring Period	Section Reference	Achievements during the Project Lifetime
	Number of female community members who have improved skills and/or knowledge resulting from training provided as part of project activities of project activities	74 women in total have been trained as a result of project activities during the MP. Several training programs have been run during the monitoring period, including Accounts and Management Training at the Community Learning Centre (15), organic agricultural skills (11), food processing and entrepreneurship (14), handicraft making and community-based ecotourism (31), socio-economic training (6), joint tactics knowledge sharing session (3) and annual paralegal training (6). The training occurred at the PACOS training center in Penampang and Kibunut retreat center in Penampang. Training was led by PACOS and Kivatu Nature Farm.	4.1.1 and 4.1.3	300 (5-year estimate) at the end of the project lifetime. Given this is the first monitoring period, the achievements reported in column 'Achievements during the Monitoring Period' are the same for the lifetime to date.
Employment	Total number of people employed in of project	24 people were employed in relation to management, implementation of project activities and monitoring.	4.1.1 and 4.1.3	At least 40 people at the end of the project. Given this is the first monitoring

Category	Metric	Achievements during Monitoring Period	Section Reference	Achievements during the Project Lifetime
	activities, ⁶ expressed as number of full time employees ⁷	8 people employed for regular patrols of the project area to monitor illegal logging and poaching		period, the achievements reported in column 'Achievements during the Monitoring Period' are the same for the lifetime to date.
	Number of women employed in project activities, expressed as number of full time employees	7 women were employed in relation to management, implementation of project activities and monitoring.	4.1.1 and 4.1.3	At least 20 women at the end of the project. Given this is the first monitoring period, the achievements reported in column 'Achievements during the Monitoring Period' are the same for the lifetime to date.
Livelihoods	Total number of people with improved livelihoods ⁸ or	135 people with improved livelihoods from job creation and training.	4.1.1 and 4.1.3	900 people from the communities at the end of the project.

⁶ Employed in project activities means people directly working on project activities in return for compensation (financial or otherwise), including employees, contracted workers, sub-contracted workers and community members that are paid to carry out project-related work.

⁷ Full time equivalency is calculated as the total number of hours worked (by full-time, part-time, temporary and/or seasonal staff) divided by the average number of hours worked in full-time jobs within the country, region or economic territory (adapted from UN System of National Accounts (1993) paragraphs 17.14[15.102];[17.28])

⁸ Livelihoods are the capabilities, assets (including material and social resources) and activities required for a means of living (Krantz, Lasse, 2001. *The Sustainable Livelihood Approach to Poverty Reduction*. SIDA). Livelihood benefits may include benefits reported in the Employment metrics of this table.

Category	Metric	Achievements during Monitoring Period	Section Reference	Achievements during the Project Lifetime
	income generated as a result of project activities	115 people from training. 8 people employed for regular patrols of the project area to monitor illegal logging and poaching. 2 Pre School teachers in Kg Kuamut & Tangkuyan have been supported by the project funds.		Given this is the first monitoring period, the achievements reported in column 'Achievements during the Monitoring Period' are the same for the lifetime to date.
	Number of women with improved livelihoods or income generated as a result of project activities	81 women with improved livelihoods from training and job creation. 74 women from training. 2 Pre School teachers in Kg Kuamut & Tangkuyan have been supported by the project funds.	4.1.1 and 4.1.3	At least 450 women at the end of the project lifetime. Given this is the first monitoring period, the achievements reported in column 'Achievements during the Monitoring Period' are the same for the lifetime to date.
Health	Total number of people for whom health services were improved as a result of project activities, measured against the without-project scenario	245 people received food aid via PACOS during COVID pandemic. Up to 30 people gained access to clean energy during the monitoring period. The solar panel was installed on the Karamuak Community	4.1.1 and 4.1.3	900 people from the communities from the Kuamut and Karamuak communities during project lifetime. The project set the target for improving well-being of the

Category	Metric	Achievements during Monitoring Period	Section Reference	Achievements during the Project Lifetime
		Forestry Centre, benefitting people during gatherings, meetings, training and residents residing at the centre. 245 (98 households) people gained access to clean water during the monitoring period.		communities through health services (at least 914 communities members of which 457 women). Given this is the first monitoring period, the achievements reported in column 'Achievements during the Monitoring Period' are the same for the lifetime to date.
	Number of women for whom health services were improved as a result of project activities, measured against the without-project scenario	78 women received food aid via PACOS during COVID pandemic. Up to 9 women gained access to clean energy during the monitoring period. The solar panel was installed on the Karamuak Community Forestry Centre, benefitting people during gatherings, meetings, training and residents residing at the centre. 78 women gained access to clean water	4.1.1 and 4.1.3	At least 450 women at the end of the project lifetime. Given this is the first monitoring period, the achievements reported in column 'Achievements during the Monitoring Period' are the same for the lifetime to date.

Category	Metric	Achievements during Monitoring Period	Section Reference	Achievements during the Project Lifetime
		during the monitoring period.		
Education	Total number of people for whom access to, or quality of, education was improved as a result of project activities, measured against the without-project scenario	42 children. The PACOS education program improved education for young children during the monitoring period.	4.1.1 and 4.1.3	There is a target for education improvement, reach out to 100 students. Given this is the first monitoring period, the achievements reported in column 'Achievements during the Monitoring Period' are the same for the lifetime to date.
	Number of women and girls for whom access to, or quality of, education was improved as a result of project activities, measured against the without-project scenario	13 women and girls. The PACOS education program improved education for young children during the monitoring period.	4.1.1 and 4.1.3	At least 50 women at the end of the project lifetime. Given this is the first monitoring period, the achievements reported in column 'Achievements during the Monitoring Period' are the same for the lifetime to date.
Water	Total number of people who experienced	245 people. During the monitoring period, a supply of drinking	4.1.1 and 4.1.3	At least 900 people at the

Category	Metric	Achievements during Monitoring Period	Section Reference	Achievements during the Project Lifetime
	increased water quality and/or improved access to drinking water as a result of project activities, measured against the without-project scenario	water was provided to Kg Karamuak village. This program has already been expanded to include two further villages.		end of the project lifetime. Given this is the first monitoring period, the achievements reported in column 'Achievements during the Monitoring Period' are the same for the lifetime to date.
	Number of women who experienced increased water quality and/or improved access to drinking water as a result of project activities, measured against the without-project scenario	78 women. During the monitoring period, a supply of drinking water was provided to Kg Karamuak village. This program has already been expanded to include further villages and will be reported during the next monitoring period.	4.1.1 and 4.1.3	At least 450 women at the end of the project lifetime. Given this is the first monitoring period, the achievements reported in column 'Achievements during the Monitoring Period' are the same for the lifetime to date.
Well-being	Total number of community members whose well-being ⁹ was	245 people received food aid via PACOS during COVID pandemic.	4.1.1 and 4.1.3	The project has set up a target for improved well-being for

⁹ Well-being is people's experience of the quality of their lives. Well-being benefits may include benefits reported in other metrics of this table (e.g. Training, Employment, Health, Education, Water, etc.), but could also include other benefits such as empowerment of community groups, strengthened legal rights to resources, conservation of access to areas of cultural significance, etc.

Category	Metric	Achievements during Monitoring Period	Section Reference	Achievements during the Project Lifetime
	improved as a result of project activities	Long-term well-being of all community members will likely be improved as forest recovers post-logging, thereby reducing malaria and other disease risks. The likely increase in fish stocks, as water quality improves, will also have widespread community benefits – as will training in agricultural production.		1500 members of the communities, during the project lifetime. Given this is the first monitoring period, the achievements reported in column 'Achievements during the Monitoring Period' are the same for the lifetime to date.
	Number of women whose well-being was improved as a result of project activities	78 women received food aid via PACOS during COVID pandemic.	4.1.1 and 4.1.3	At least 800 women during the project lifetime. Given this is the first monitoring period, the achievements reported in column 'Achievements during the Monitoring Period' are the same for the lifetime to date.
Biodiversity conservation	Change in the number of hectares significantly better managed by the	83,381 ha are managed significantly better for biodiversity conservation. The cessation of logging	Section 5.3 & 5.4	83,381 ha

Category	Metric	Achievements during Monitoring Period	Section Reference	Achievements during the Project Lifetime
	project for biodiversity conservation, ¹⁰ measured against the without-project scenario	resulted in a virtual elimination of illegal logging and poaching. There are regular patrols by staff from the project, and also from RBJ, and they have not seen any increase in poaching.		
	Number of globally Critically Endangered or Endangered species ¹¹ benefiting from reduced threats as a result of project activities, ¹² measured against the without-project scenario	34 RTE tree species. In 2016 (and again starting in 2020), the project surveyed the climate forest field plots to monitor the IUCN red list status' of all the tree species in a all plots. In total we found that there are 34 species of critically endangered (6), endangered (5), and vulnerable (23) tree species. The species list, including numbers of individuals is provided in Table 15. The survey results have been provided to the auditor during verification.	Section 5.3 & 5.4	34 tree, 29 mammal and 12 bird species in the project areas are considered as Rare, Threatened or Endangered [RTE] species. Given this is the first monitoring period, the achievements reported in column 'Achievements during the Monitoring Period' are the same for the lifetime to date.

¹⁰ Biodiversity conservation in this context means areas where specific management measures are being implemented as a part of project activities with an objective of enhancing biodiversity conservation.

¹¹ Per IUCN's Red List of Threatened Species

¹² In the absence of direct population or occupancy measures, measurement of reduced threats may be used as evidence of benefit

Category	Metric	Achievements during Monitoring Period	Section Reference	Achievements during the Project Lifetime
		All RTE species listed in the PD (34 tree, 29 mammal and 12 bird species) are subject to fewer anthropogenic threats in the project area as the habitat is recovering and disturbances from logging and other associated activities have been stopped. Fortunately, there is a relatively large area of remaining habitat on steep slopes that was unaffected by logging, and we expect that this will enable recolonization of the degraded forest areas by some forest specialists. A 2014-2017 survey estimated 630 Bornean orangutans in the project area during this period (Simon, Davies & Ancrenaz 2019)¹³.		

¹³ Simon D, Davies G, Ancrenaz M (2019) Changes to Sabah's orangutan population in recent times: 2002–2017. PLoS ONE 14(7): e0218819. <https://doi.org/10.1371/journal.pone.0218819>

2 GENERAL

2.1 Project Description

2.1.1 Implementation Description

The first step in the protection of the area has been the legal conversion of the land status into a Class 1 Forest reserve, thereby making it a protected conservation area. This change was implemented by Sabah Forestry Department as a result of the development of the Kuamut Rainforest Conservation Project. The total area of 83,381 has been protected in two steps: 69,454 ha has been under protection since 11th December 2015. An additional 13,927 ha was added on 8th December 2016. Permian Global and Rakyat Berjaya SDN BHD ('RBJ') are collaborating with Partners of Community Organisations (PACOS) Trust, the South East Asia Rainforest Research Partnership (SEARRP) to provide technical assistance in the research, project design and monitoring in accordance with each of the carbon, biodiversity and community components of the standards.

The project involves a range of over-arching activities including:

- Forest protection through the establishment of guard posts at the main access points and regular patrolling including helicopter patrols and field visits conducted by the project team (RBJ, SEARRP and Permian Malaysia). Security personnel were stationed at two strategically placed security gates to monitor vehicles in/out from the Yayasan Sabah Concession Area, including the Kuamut Forest Reserve. The gates are located at Km 11, Jalan Danum and Haranky
- Natural Forest regeneration: the protected, logged-over forests of the project area have the potential to regenerate naturally – particularly in areas where the residual stand comprises a reasonable density of large trees. So far, no areas have been defined that would require active restoration measures.
- Biodiversity conservation & monitoring: The project team have compiled and assessed information on biodiversity-related studies and management conducted during this monitoring period inside and in the adjacent project area conducted by various parties. Some of these activities have been conducted directly and specifically within the project area. Project team members, especially from SEARRP, have contributed to the regional assessments of various aspects of biodiversity including prioritization of areas for protection that use biodiversity as one of the main indicators. Some other studies, assessments, and management activities have been conducted outside or in the immediate vicinity of the project area or at the state-wide level but with strong relevance with the project area. All these studies strongly indicate the extreme importance of the conservation of the project area for biodiversity conservation in the region and globally.
- Community livelihood improvement: During this monitoring period, the project proponents deployed the FPIC process through the instigation of a desk-based community scoping exercise in 2016, followed by a programme of community engagements and reports from 2017-2019 to identify relevant communities, socialise the project and establish social baseline conditions. Further engagement activities, as detailed below, were carried out during this monitoring period by RBJ, PACOS and SEARRP to generate net positive benefits to the target communities. The project has developed Community Work and Monitoring Plan as a guideline for monitoring project implementation to make the community work efficient and in accordance with project goal, needs, PDD, CCB standards and UN SDGs Goals

Consistent with CCB Standards a project team must receive affirmative consent from relevant property rights holders prior to commencing with project activities¹⁴. The Free, Prior & Informed Consent (FPIC) process began with an initial scoping period and identification of stakeholder communities in 2016, with subsequent community engagement activities conducted from 2017-2019 (referred to collectively here as the Social Baseline Assessment). Engagements sought to fulfil varying objectives associated with the socialisation of the project, provide opportunities for stakeholders to give and/or withhold their option to consent, and ensure consent was free of coercion, intimidation, manipulation, threat, and bribery. The principal objectives and process were as follows:

- i. Enhancing and broadening community understanding of overall project goals and design;
- ii. Key informant interviews and informal discussions on community interactions with the Project Area;
- iii. Discussion of potential project activities which could contribute to community livelihoods and safeguarding of the Project Area;
- iv. Gathering of basic data on community demography, settlement history, and infrastructure;
- v. Generation of spatial data on community settlements and HCV 4-HCV 6 areas in and around the project area;
- vi. Discussion of future mechanisms to enhance and safeguard community-project interactions such as communication channels and grievance procedures;
- vii. Creating opportunities for communities to offer feedback on the project and any other issues of concern;
- viii. Updating community representatives on project progress;
- ix. Receiving updates on community political and administrative developments, and;
- x. Logistical planning and organization of upcoming field activities.

The Social Baseline Assessment identified and described the communities situated within a 20 km radius of the project area and have a stake in the project area. On this basis the project designated a “project zone”, which is where the project has and will continue to implement initiatives that are designed to deliver net positive benefits to target communities.

Please refer to Annex 5 for detailed timelines of consultations prior to commencing with project activities.

The Social Baseline Assessment was conducted in two phases.

Phase 1: Desk-based review (April - June 2016)

This was a desk-based review aimed at scoping communities situated within a 20 km radius of the project area and identifying those who have a stake in the project area. Baseline information compiled included locations and socio-economic profiles of communities, in addition to understanding communities' land tenure, livelihoods and cultural relationships to the project area. No community engagement took place during this phase, but liaison with state and district level government departments, civil society organisations and a review of available literature was sufficient to obtain baseline information about the communities.

14 settlements were identified within a 20km radius of the project area. Three of these (Kg. Sinarupa, Kg. Pagar and Kg. Tangkong) are no longer inhabited according to RBJ and Sabah Forestry Department. All

¹⁴ Footnote 64 of CCB Standards V 3.1, page 22.

communities are situated adjacent to rivers to the north of the project area, and no communities have been identified in the southern, eastern or western areas. The 11 inhabited communities fall broadly into two geographic clusters: the Karamuak cluster (including Kg. Imbak, Kg. Bangkulat, Kg. Karamuak Dalam, Kg. Karamuak Luar, and Kg. Tamoi; - the latter recently renamed by the community as Kg. Kenang-Kenangan), and the Kuamut cluster (Kg. Kuamut, Kg. Tangkuyan, Kg. Desa Permai, Kg. Tulang-Tulang, and Kg. Balat). All settlements are situated in the administrative district of Tongod, with the exception of Kg. Balat which falls under Kinabatangan district.

Phase 2: Field research (July 2016 - January 2017)

Field research at the community-level to verify and refine phase one findings and initiate social entry in target communities. This phase introduced the project and its proponents to target communities with the aim of seeking communities' free, prior informed consent (FPIC) for the project, as required under CCB guidelines.

The project held a total of 11 community workshops and dialogue sessions, attended by a combined total of 488 community participants. Community engagements were conducted to achieve a variety of objectives, including transparency and communication of project details and activities, gathering information on community socio-cultural conditions and history, generation of spatial data via participatory mapping, discussion of threats and constraints faced by communities, and planning of future project activities in following FPIC principles. All engagements were conducted in the communities themselves at venues considered appropriate by community leaders.

In addition to workshops and informal discussion sessions, the project has conducted an extensive series of household surveys to provide data on the community socio-economic baseline. During the commencement of each individual interview conducted as part of these surveys, respondents were given a brief overview of the project structure and objectives, and asked for their consent before the interview proper was initiated.

Outputs

Each phase of the study produced corresponding reports that met the CCB requirements and were provided to the auditor during the verification process:

- a) Verifiable recommendations for identifying target communities within a designated project zone;
- b) Process descriptions and auditable measures for obtaining FPIC of target communities; and
- c) Process descriptions and auditable measures for designing initiatives to deliver net positive benefits to target communities.

The operations of the project are progressing well. As described in the PD, the project uses Global Forest Watch to alert to any areas where deforestation is potentially occurring. In 2019, some deforestation was detected close to the boundary and field teams were dispatched. The field teams photographed and documented their findings, specifically logging to widen a road (internal report provided). The contractors showed their permit but had inadvertently overlapped into the project area. As a result of these interventions there was no further logging at this point. Other small deforestation events have occurred

during the monitoring period (details in Section 3.1.3). Considering these events, the total GHG emission reductions or removals generated in this monitoring period is 4,839,740.67 t CO₂e.

In terms of monitoring and managing the leakage risk factors, the project is considering the risk of leakage from activity shifting and market leakage. For the risk of leakage due to activity shifting, the management plans for Yayasan Sabah and RBJ were reviewed and paired with the records showing trends in harvest volumes. The results for the leakage monitoring are detailed in section 3.2.3.

In terms of monitoring and managing the non-permanence risk factors, the analysis done as part of the PD had identified that not all the risk factors apply. The most important risk factors are the project cash flow (financial viability), the NPV of the most profitable alternative land use activity (opportunity costs), the fact that ownership and resource access/use rights are held by different entity(s). This is mitigated by the strong presence and experience of the management team, the available callable financial resources and the legally binding commitment in place to continue management practices that protect the credited carbon stocks over at least 100 years. No changes have occurred in the risk factors since the validation and registration of the project with the VCS and a renewed non-permanence risk report is attached to this monitoring report.

No relevant changes have occurred to the project proponent or other entities involved in the implementation of the project.

2.1.2 Project Category and Activity Type

This project falls under VCS scope 14 (forestry).

The project falls under the project category Improved Forest Management (IFM) with activity type Logged to Protected Forest (LtPF).

The project is not a grouped project.

2.1.3 Project Proponent(s)

Organization name	Permian Malaysia Sdn. Bhd.
Contact person	Gerry Elias
Title	Director
Address	Level 21, Suite 21.01, The Gardens South Tower, Mid Valley City, Lingkaran Syed Putra, 59200, Kuala Lumpur, Malaysia
Telephone	+44 203 617 331
Email	gerry.elias@permianglobal.com

2.1.4 Other Entities Involved in the Project

Organization name	Permian Global
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Role in the project	Project Developer, parent company of Permian Malaysia Sdn. Bhd.
Contact person	Gerry Elias
Title	Managing Partner
Address	Savoy Hill House, 7-10 Savoy Hill, London, WC2R 0BU, United Kingdom
Telephone	+44 203 617 331
Email	gerry.elias@permianglobal.com

Organization name	Yayasan Sabah and Rakyat Berjaya Sdn. Bhd
Role in the project	Project partner and patrolling activities
Contact person	Dr. Esther Li
Title	Group Manager – Forestry Division
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Telephone	+ 60 (0)88 326 365
Email	esther.rbj@gmail.com

Organization name	Sabah Forestry Department
Role in the project	Project partner
Contact person	Fred Kugan
Title	Chief Conservator of Forests
Address	KM11 Jalan Utara, 90009, Sandakan, Sabah, Malaysia
Telephone	+60 (0) 89 242 800
Email	Frederick.Kugan@sabah.gov.my

Organization name	Partners of Community Organisation (PACOS) Trust
Role in the project	Project implementation entity
Contact person	Anne Lasimbang
Title	Executive Director
Address	Taman Flash Gordon, Kg. Kivatu, KM18 Jalan Tambunan, 89507 Donggon, 89507 Penampang, Sabah, Malaysia

Telephone	+60 (0) 88 712 518
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Organization name	South East Asia Rainforest Research Partnership (SEARRP)
Role in the project	Project implementation entity
Contact person	Glen Reynolds
Title	Executive Director
Address	S10-S12, 1 st Floor, Block B, The Peak Vista, Lorong Puncak 1, 88400 Kota Kinabalu, Sabah, Malaysia
Telephone	+60 (0) 88 201 727
Email	glen.searrp@icloud.com

2.1.5 Project Start Date (G1.9)

The project start date is December 11th, 2015.

2.1.6 Project Crediting Period (G1.9)

The duration of the VCS project crediting period is 30 years, beginning on the project start date of 11th December 2015 and ending on 31st December 2045. The project crediting period is renewable.

2.1.7 Project Location

The Kuamut Rainforest Conservation Project ('Kuamut Project') is located in the Tongod and Kinabatangan Districts of Sabah, Malaysia as shown in Figure 1. The project area, defined by the Sabah Forestry Department, encompasses 83,381 ha of land with a total perimeter of 244.99 km. The project area boundary delineates the area in which GHG emission reductions are quantified. The project area is located within these coordinates: 5° 18' 40.2"N 117° 11' 8.69"E; 5° 18' 40.2"N 117° 37' 58.51"E, 4° 55' 55.68"N 117° 37' 58.51"E, 4° 55' 55.68"N 117° 11' 8.69"E.

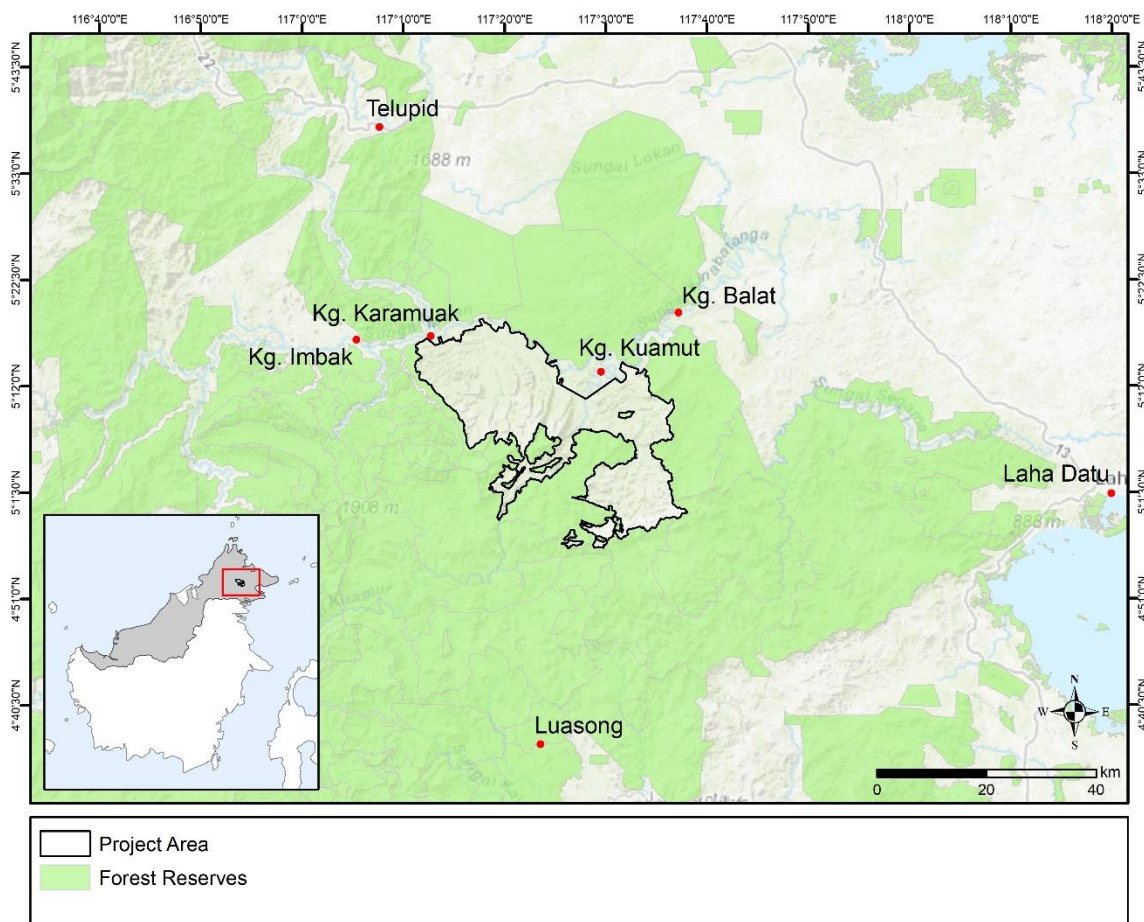


Figure 1: Reference map of the Kuamut Rainforest Conservation Project area.

2.1.8 Title and Reference of Methodology

- VM0010 Methodology for Improved Forest Management: Conversion from Logged to Protected Forest Version 1.3.
- VT0001 Tool for the Demonstration and Assessment of Additionality in VCS Agriculture, Forestry and Other Land Use (AFOLU) Project Activities, v3.0
- VCS AFOLU Non-Permanence Risk Tool v4.0

2.1.9 Other Programs (G5.9)

The Kuamut Rainforest Conservation Project has not been registered under any emissions trading programs or any program involving environmental or social credits. The project is not claiming credit for the same GHG emission reduction under another program.

Emission Trading Programs and Other Binding Limits: Not applicable, the project is not part of any Emissions Trading Programs and is not subject to Other Binding Limits

Other Forms of Environmental Credit: The project does not claim other Forms of Environmental Credit under another program.

Participation under Other GHG Programs: The Kuamut Rainforest Conservation Project has not been registered under any emissions trading programs. The project does not claim credit for the same GHG emission reduction under another program.

2.1.10 Sustainable Development

Malaysia's sustainable development priorities are now closely aligned with the UN Sustainable Development Goals (UN SDGs). Malaysia assisted in the creation of the UN SDGs and has expressed its strong commitment to the 2030 Agenda and the SDGs overall. The Kuamut Project supports the achievement of the SDGs as outlined in Table 1 and we refer to section 4.1.1 for details of the activities. All project data is available to support monitoring efforts at the provincial and national levels.

Table 1: Kuamut project support of UN SDGs

SDG	Relevant project activity
SDG 1: No poverty	Overarching commitment to provide demonstrable positive livelihood benefits to all surrounding communities
SDG 2: Zero hunger	Increase in fish stocks and improvement to the livelihoods for all the people in the communities.
SDG 3: Health	Reduction in exposure to Malaria and other zoonotic diseases
SDG 4: Quality Education	Multiple training opportunities and employment of two pre-school teachers
SDG 5: Gender Equality	Provision of all female training opportunities
SDG 6: Clean Water & Sanitation	Access to clean water supply.
SDG 8: Decent work and economic growth	Direct employment of local people, decent job for community involve in the project activates, and support for local enterprises
SDG 9: Industry, Innovation, Infrastructure	Encouraging new markets through training and avoided logging. Community infrastructure construction and maintenance.
SDG 11: Sustainable Communities	Construction of safety fencing, community buildings repairs.
SDG 12: Responsible consumption and production	Reduce waste generation through prevention, reduction, recycling and reuse, and supporting sustainable tourism that creates jobs and promotes local culture and products.
SDG 13: Climate Action	Central objective. Anticipated average avoided emissions of 729,030 tonnes of CO ₂ equivalent annually
SDG 15: Life on Land	Protection and regeneration of natural forests, and biodiversity protection

Given the restrictions related to COVID pandemic during the monitoring period, it was not possible to implement activities that contribute to all UN SDGs in the previous years, thus this monitoring report only claims contribution to SDG 1, 2, 3, 4, 5, 6, 8, 9, 11, 12, 13 and SDG 15 in this monitoring period.

2.2 Project Implementation Status

2.2.1 Implementation Schedule (G1.9)

As per the table below and sections 1.1 and 2.1.1 of this monitoring report, the project has implemented several activities that led to community and biodiversity benefits during the monitoring period through

work conducted by project proponents. Supporting documentation has been provided to the VVB during the verification process.

Date	Implementors	Milestone(s) in the project's development and implementation
11-Nov-2013	Permian Malaysia, SFD	MoU between Permian and Sabah Forestry Department (SFD) signed and announced (including Kuamut)
31 st Dec 2015	SFD	Sabah Forestry Department converted the first 69,454 ha into a Class 1 Forest Reserve which sets the start date of the project.
April – June 2016	Permian Malaysia, RBJ, SEARRP	Social Baseline Study – Desk-based Review
8 th Dec 2016	SFD	Sabah Forestry Department added an additional 13,927 ha to the Class 1 Forest Reserve
July 2016 – January 2017	Permian Malaysia, RBJ, SEARRP	Social Baseline Study – Field Research, at the community level to verify and refine the desk-based review findings and initiate social entry in communities.
2016-2019	Permian Malaysia, RBJ, SEARRP, PACOS	Community Engagement and FPIC continues (see Appendix 5 for details)
October – November 2017	RBJ, SEARRP, Permian Malaysia	Collaborative initiatives between RBJ and SEARRP at the Karamuak Community Forestry Centre. Conducting an information sharing and research workshop within the Kg. Kuamut and Kg. Karamuak communities as part of the social baseline study.
March 2018	RBJ, SESB	RBJ approve installation of protective fence surrounding the Sabah Electricity Sdn Bhd (SESB) power station at Karamuak village, following a request from the communities. Undertook repairs on community buildings in Kg. Karamuk as part of community collaboration and assistance.
April 2018	RBJ (Community Forestry Unit, Sandakan)	Weather data collection activities commence for Community Forestry Report. Toilet constructed for community hall at Kiliwong community.
July 2018	RBJ (Community Forestry Unit, Sandakan)	Renovation of the Kiliwong community centre.
September 2018	RBJ (Community Forestry Unit, Sandakan)	Tree felling in the village areas, including around the Karamuak Community Centre, to enhance community safety by roadside.

August 2019	RBJ (Community Forestry Unit, Sandakan)	Following RBJ funding, the construction of a protective fence surrounding the Sabah Electricity Sdn Bhd (SESB) power station at Karamuak village is completed, following a request made by the communities.
November 2019	RBJ, SEARRP, Permian Malaysia	Social Baseline Assessment – Process Report published, describing community engagement activities undertaken during the period 2017-2019.
November 2019	RBJ, SEARRP, Permian Malaysia	Social Baseline Assessment – Technical Report published, describing data collection activities conducted by the project over the period 2017-2019.
March 2020	University of Geneva & Zurich, SEARRP	Community discussion with a Master of Science (MSc) student specializing in Social Forestry and Environment from the University of Geneva, Zurich – thesis titled <i>‘Why over-logged tropical forests matter – a local perspective from the Heart of Sabah’</i>
June-July 2020	RBJ (Community Forestry Unit, Sandakan)	RBJ provides polypipes to the Kg. Karamuak community to support the maintenance of their gravity water system within the village.
August - December 2020	RBJ (Community Forestry Unit, Sandakan)	A meeting and follow communication with the Assistant Administrative Officer of the Tongod District Office to share the most up-to-date socio-economic data concerning Kg. Karamuak.
October 2020	RBJ (Community Forestry Unit, Sandakan)	Community dialogue held in conjunction with the National Youth Day Program. An information session and a briefing on the carbon project in the Northern Kuamut Conservation Area (NKCA) delivered by RBJ staff, Forest Officer Azrul Arzmi.
October 2021	RBJ (Community Forestry Unit, Sandakan)	Facilitating and hosting State Ministry of Youth and Sports – a youth day event with communities in Tongod. This was held at the RBJ Milian Forestry Centre, near Imbak village.

2.2.2 Methodology Deviations

The VM0010 methodology provides specific calculations that work on the basis of trees measured in field plots. It is assumed that field plots alone are sufficient, however, the methodology specifically states that “**a multi-temporal set of remotely sensed data can be used to detect changes in the structure of the forest canopy**” and “**SAR or LiDAR, can be used under this approach**”. We have therefore followed this approach and give specific details here describing how the approach, which uses up-to-date science, is more conservative and accurate than the prescribed method.

The existing VM0010 methodology recommends that field plots are established at random across the project area to generate a representative sample of the forest biomass across ecological gradients and forest strata. The observed biomass values should then be averaged across the entire area for the relevant strata. This plot averaging approach, where sampling is truly representative and a sufficient number of field

plots exist, provides an effective way to estimate biomass stock and change across a large area. However, forests are highly dynamic in both space and time, undergoing continual change in response to complex ecological and anthropogenic processes. These processes often do not occur uniformly across large areas but rather they are heterogeneous, driving diverse spatiotemporal changes in forest biomass/structure.

Page 44 of Version 1.3 of VM0010 states “*technology is developing rapidly, including techniques such as RADAR, SAR, or LiDAR.*” and “*For example, a multi-temporal set of remotely sensed data can be used to detect changes in the structure of the forest canopy. A variety of techniques, such as Spectral Mixture Analysis (Souza et al. 2005), SAR or LiDAR, can be used under this approach but no specific technology is prescribed here. Some of the newer technologies can estimate carbon contents of forest types, if supported by field information such as sample plots to calibrate the technology and fieldwork leading to allometric equations of key species. The project proponent should use techniques that are suitable to their specific situation and that have been published in peer-reviewed papers*”.

In order to account for variability in forest dynamics in both space and time, we have therefore followed the suggestion of the *methodology* by creating high resolution biomass and timber volume maps. This approach is now widely used and accepted in the scientific literature (Asner et al. 2018; Baccini and Asner 2013; Jucker et al. 2018; Jha et al. 2021; Johnson et al. 2022). This approach uses the field-derived measurements of forest biomass, airborne Light Detection and Ranging (LiDAR), Landsat 8 multi-spectral imagery and Sentinel 1 radar in combination with statistical and machine learning approaches to build continuous carbon density and timber volume maps for the entire project area. From these data, we calculate project-scenario growth rates (from biomass maps) and timber volume for the project start. To derive the growth rates, we used all data from the biomass maps over a 6 year period from 2016-2022 to fit a linear regression through time to estimate the rate of change. By adopting this approach we substantially increase the number of observations used to estimate the growth rates which improves overall accuracy and reduces the variance of biomass growth estimates. Further, in order to account for protected species that would not have been harvested under the baseline scenario, we applied a species conservation factor (SCF) to the growth estimate. This SCF was calculated based on the proportion of protected tree species that were present within the forest plots in the respective management strata. This proportion was deducted from the calculated growth rate. The same SCFs were used to reduce the estimates of extracted timber volume under the baseline scenario. Further detail of these protected species is provided in Appendix 8 - Table 2 of the Monitoring Report.

Comparative Analysis

The details of the methods are presented in the monitoring report (MR) document and corresponding html workbook. The purpose of this analysis is to provide justification for the adopted method and demonstrate its efficacy. Below we present the results of our methods alongside the field-plot-only methods:

In order to demonstrate that the methods are comparable we calculated the total above ground carbon stock, the mean above ground carbon density (ACD) and the total timber volume of the project area using both methods. For the field-plot-only method, plot level values were scaled by the forest area of the project.

The results are presented in the table below. Note that all of the metrics generated with our adopted method are more conservative than methods using only the field plot data. We suggest that this is because the wall-to-wall method, that we have used, measures vastly more forest and trees affording the ability to capture patchy natural forest disturbance that was not evident in the plot network.

Table: Comparison of biomass estimates from the VM0010 methodology (field plots) and the methods adopted for the Kuamut project i.e combined plot and remote-sensing machine learning (plot-RS ML). Note that carbon stock, ACD and timber volume consider all trees with a diameter at breast height (DBH) > 10 cm.

metric	field plots	plot-RS ML	% difference
total C (Mg C)	6,609,688	6,054,169	-8.4
mean ACD (Mg C ha ⁻¹)	78	71	-8.3
total timber volume (m ³ ha ⁻¹)	6,870,475	6,813,318	-0.8
annual growth rate (Mg C ha ⁻¹ yr ⁻¹)	2.96	2.87	-3.0

Therefore, this methodology deviation does not negatively impact the conservativeness of the quantification of reductions or removals in any way, on the contrary, it increases the accuracy of the quantification provided.

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Minor Changes to Project Description (Rules 3.5.6)

Not applicable

Project Description Deviations (Rules 3.5.7 – 3.5.10)

The approach for biomass mapping has been updated with new more accurate and up-to-date datasets (see section 3.1.3 'Monitoring Plan' for more details). This constitutes a change in the procedures for more accurate measurement and monitoring and therefore this deviation does not impact the applicability of the methodology, additionality or the appropriateness of the baseline scenario. The specific input data changes are 1) new more accurate GPS locations for the field plots, 2) an updated Digital Terrain Model (DTM) based on a composite of geoid-corrected LiDAR DTM and Copernicus GLO-30 Digital Elevation Model (DEM), 3) gaps in our LiDAR-derived Tree Canopy Height Model (CHM) are no longer filled with the Asner CHM model; instead, we use a continuous and consistent estimate of tree canopy height constructed using a machine learning approach where the Lidar-derived CHM was used as training data. 4) Since the completion of the PD, forest plots have been remeasured; this more recent data provides more information that describes the relationship between Biomass and the earth observation data used to train our Biomass and Merchantable Volume models, the inclusion of these data in the machine learning process improves the accuracy of predictions both after the year of remeasurement but also for preceding years. All assumptions on the appropriateness of the baseline scenario remain the same and the project remains in conformance with the applied methodology. However, with the use of the up-to-date datasets, the biomass and timber volume maps are now more accurate. These more accurate maps have been used to update the 2016 timber volume maps. As these volume maps are used to produce the timber harvest plan and estimate the Mean volume of extracted timber under the baseline (VEX,j,i|BSL), this value all subsequent calculations have changed slightly (please see Appendix I, with all updated tables). The resulting calculations of 'Baseline emissions or removals (tCO₂e)', are slightly reduced (more conservative) from those in the PD.

The following deviations from the PD were also implemented:

- Under the project scenario, ongoing forest growth is only accounted for from the date a parcel is to be harvested under the baseline scenario.
- The species conservation factors have been updated with more accurate and updated information on protected species from the Sabah Forest Department Herbarium.
- The same species conservation factors have been applied to restrict the accounting of ongoing forest growth to trees that would have been harvested under the baseline.

These PD deviations remain aligned with the methodology and increase the accuracy of the calculations.

Grouped Projects

Not applicable. The project is not a grouped project.

Risks to the Project (G1.10)

Natural Risks	Human-induced Risks	Mitigation
Climate		
Natural risks to the climate change benefits of the	Potential human-induced threats to the project's climate	No specific measures are considered necessary to

Natural Risks	Human-induced Risks	Mitigation
project are considered low, both in the short and long-term. Such risks, including natural fires, pests & disease, extreme weather, geological events and other natural risks are considered in detail in the non-permanence risk assessment.	benefits are considered likely, both in the short and medium term, but the project is implemented so as remove, reduce and mitigate their impact. Potential risks include anthropogenic fire, encroachment and illegal logging (loss of above ground biomass). The long-term threat of climate change is considered to present minimal threats to the climate change benefits of the projects.	mitigate natural risks, or the threat of long-term climate change, beyond the overarching objective of ecosystem protection and forest regeneration. In contrast, a wide range of measures are undertaken to mitigate the threat of human-induced impacts, including a diverse range of project activities designed to protect and the restore the forest and to ensure the long-term support for the project from local communities.
Community		
As above, natural risks to the community benefits of the project, both in the short-term and long-term, are considered low, and such risks are considered to be lowered further by the activities of the project	Human-induced threats to the community benefits of the project include the willingness of communities to participate in project activities, both in the short and long-term, external pressures, and long-term climate change. In particular, there is a risk that and initial willingness to accept and participate with the project may change if the project fails to deliver tangible benefits over the long-term to communities.	Project activities are specifically designed to ensure sustainable community benefits. Such activities are implemented in partnership with each community and focus on the development of enhanced and alternative livelihoods. In parallel, measures have been put in place to ensure a high-level of participation of both local communities and local government in project planning and operation, to ensure grievances are heard and corrected, and to ensure long-term benefit sharing. The project benefit sharing to communities will include providing access to microfinance, technical assistance to implement sustainable livelihoods as well as a scholarship program to improve access to education. Other ways to support communities surrounding the project area include improving

Natural Risks	Human-induced Risks	Mitigation
		health services and access to clean water
Biodiversity		
Natural risks to the biodiversity benefits of the project are considered very low. The project essentially protects and restores a natural ecosystem stable to the effects of naturally occurring events that might be anticipated.	Human-induced risks to the project's biodiversity benefits, both in the short and long-term, are essentially the same to those related to climate change benefits (above) as they relate to the protection and regeneration of the natural ecosystem. In addition, there are further human-induced risks related to hunting pressure, typically focused on a narrow range of species.	Measures taken to mitigate the risk to the natural forest ecosystem, and the biodiversity it supports, are equivalent to those taken to protect the climate change benefits of the project, summarised above. Activities specifically aimed at reducing hunting pressure on key species include awareness programs, sign board placement about the protection status of the area and the biodiversity, and guard post and check point staffing by RBJ/Yayasan Sabah/the authority. Security personnel were stationed at two strategically placed security gates to monitor vehicle in/out from the Yayasan Sabah Concession Area, including Kuamut Forest Reserve. The gates are located at Km 11, Jalan Danum and Haranky. Future program under plan include monitoring of biodiversity use (including hunting and harvest) to enable sustainable use, creation of alternative livelihoods for those reliant on hunting incomes, and increased protection, patrolling and enforcement to reduce and prevent the exploitation of endangered and/or legally protected species.

Benefit Permanence (G1.11)

Kuamut Rainforest Conservation Project is based on a 30-year initial licence agreement, extendable indefinitely. Project benefits are expected to extend beyond the licence agreement.

The protection status of the forest has not been changed during the monitoring period. The project uses a combination of field surveys and remote sensing to measure the regrowth across the project area which is occurring. This regrowth will result in the project area being more resilient to the threat of fire. Similarly, activities targeting community benefits are all designed to be managed in the future by the local communities themselves, without the need for further external interventions. Finally, the project itself is anticipated to set an example of sustainable land use management in the region, leading to wider adoption of the practices it is pioneering with respect to carbon emissions, biodiversity conservation and equitable development of local communities.

2.3 Stakeholder Engagement

2.3.1 Stakeholder Access to Project Documents (G3.1)

Early engagement with local communities, consistent with FPIC processes and using a draft Project Document, took place during 2016 and continued through 2017-2019 during the social baseline study. Engagements have been conducted via a number of fora, including community workshops and informal meetings with community leaders. In addition, the team has established a social media discussion group with leaders of all Project Zone communities to facilitate communication relating to project activities. Other documentation examples include the brochures that are detailed in section 2.3.2 and 2.5.2 below. The Kuamut project continues to hold regular community engagements during which the project objectives and structure are explained and discussed. The finalized PD document was approved in July 2022.

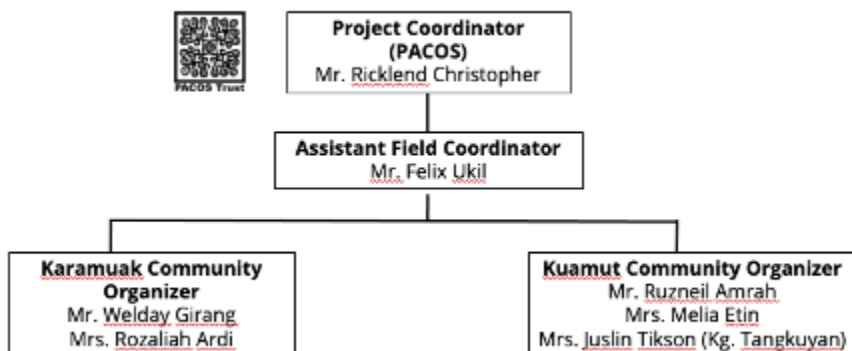
2.3.2 Dissemination of Summary Project Documents (G3.1)

A series of brochures have been produced in the Malay language, which offer written summaries of the project objectives and implementing bodies and describe some of the underlying principles governing the project such biodiversity, carbon sequestration, global warming and the principles of FPIC during the social survey in 2016 and 2017. These brochures have been given to community leaders who are then asked to disseminate them amongst the wider community. The project will also provide access to documentation via the project website, and other means such as community notice boards as appropriate.

2.3.3 Informational Meetings with Stakeholders (G3.1)

The project has set up a project structure for community work implementation, with PACOS Trust as main partner for community work implementation. Since 2016, PACOS Trust has assisted with FPIC in the Kuamut and Karamuak clusters (8 villages), in meetings attended by communities. The meetings solicited the community's consent to support project community activities. The communities from 7 villages elected their representatives as members of a Community Executive Committee, to act and represent community voices towards the project implementation.

The project has set up a structure for community work implementation and communication will be channelled through Project Coordinator and Community Organizer.



The project has Community Organizers, some of whom who are natives from the local communities, living in the Karamuak and Kuamut clusters. Aside from being responsible for carbon plot measurements, they are also employed to engage with and disseminate information relating to the technical aspects of the projects activities. For example, Philip Ulok, whose involvement in the social baseline survey is referred to throughout the final report that was provided to the VVB during the verification process. Other means of communication that have been used throughout the monitoring period include SEARRP scientists, staff and appointed consultants who conducted forest monitoring surveys and consultations required for the certification of the Kuamut Rainforest Restoration Project. SEARRP undertook the surveys inside the forest reserve and with communities in the area, and these were coordinated with RBJ and the community leaders. Evidence of site access letters for these meetings have been provided to the VVB during the verification process.

2.3.4 Community Costs, Risks, and Benefits (G3.2)

During all consultations with communities, strenuous efforts have been made to ensure that adequate, understandable, honest and accurate information is provided as a basis for any decisions, including information on costs, risks and benefits.

The project has set up a project structure for community work implementation, with PACOS Trust as main partner for community work implementation. The benefits package has been agreed with the communities. Risks will be monitored by the community organisers.

2.3.5 Information to Stakeholders on Verification Process (G3.3)

Communities have been (and will continue to be) informed about the ongoing process of VCS and CCB verification through a variety of channels, including by a combination of media such as newsletters, workshops and notice boards, through regular planning and evaluation meetings at the village level, and directly via the project's representative at the village level. As each verification event occurs, village communities are informed of the timing, provided copies of the relevant documents (including Bahasa translations), informed of how they can provide comments and input, and informed of the schedule for

external audit field visits. The project also informs its key partners, which are SEARRP, RBJ, Sabah Forestry Department, PACOS Trust and the Community Group on a regular basis.

2.3.6 Site Visit Information and Opportunities to Communicate with Auditor (G3.3)

As above, village communities are (and will continue to be) informed of any upcoming visit by external verification auditors, including dates and times as appropriate. They are encouraged to speak directly and freely to the auditors, and to voice any opinions they hold regarding the project. They are also informed as to how they can provide written comments via the grievance process. During the field visit, a series of meetings were organized with community members to communicate directly with the auditor. The auditor interviewed the members of the community who participated in these meetings. The participation was organized by the community members themselves through the community organizers. The auditor also interviewed members of PACOS Trust during the site visit.

2.3.7 Stakeholder Consultation (G3.4)

The project was successfully instigated through a number of inaugural meetings to establish relationships between the consultant, Wild Asia (WA), and the principal project proponents - Permian Global and Rakyat Berjaya Sdn. Bhd. (RBJ). Three principal meetings took place, as summarised in the table below:

Date	In attendance	Principle outcomes
31/3/16	Nick Brickle (Permian Global), Agnes Agama (SEARRP), Adam Murphy (WA)	Contact established between Permian Global and WA. Clarifications on Permian project strategy and implementation of CCB guidelines.
1/4/16	Greg Mosigil, Esther Li, Trevor Udarbe, Boljen Majingin, Joannes Lojiu (RBJ), Nick Brickle (Permian Global), Agnes Agama (SEARRP), Adam Murphy (WA)	Contact established between RBJ and WA. RBJ agreed to support WA's project activities. Technical clarifications provided by RBJ on formation of joint-venture company and regazettement of Kuamut FR.
7/4/16	Barnabas Gait (RBJ), Agnes Agama (SEARRP), Adam Murphy (WA)	Background information on community settlements provided by RBJ. Barnabas to assist in organising meetings with Tongod District Office and upcoming site visit to community areas between RBJ and WA.

In 2016 an initial scoping phase was conducted to lay the groundwork for the initiation of community engagements. This principally involved desk-based research of relevant materials (e.g. Forest Management Plans of the Project Area) and discussions with local experts from governmental institutions and civil society to identify the principal stakeholders (inclusive of local community stakeholders) and uncover general information on the management of the area and any ongoing disputes over land or access to natural resources.

Non-community stakeholders (i.e. relevant governmental and non-governmental organisations) were initially identified through discussions with the principal project partners: the Sabah Forestry Department (SFD) and Rakyat Berjaya (RBJ). As a result of these discussions, the project-initiated communications with stakeholders responsible for the developmental administration of the project zone (The District Office of Tongod) and NGOs with a history of community work in the area (PACOS Trust).

A summary of non-community stakeholder consultations conducted during the scoping assessment are below:

Organization	Personnel	Consultation dates	Purpose/outputs of consultation
Rakyat Berjaya (senior management staff)	Gregory Mosigil, Trevor Udarbe, Boljen Majingin, Esther Li, Joannes Lojiu	1/4/16	Official introduction and launching of project scoping phase
Rakyat Berjaya Karamuak (Social Forestry Centre)	Barnabas Gait	Ongoing throughout	Gain baseline information on Project Zone communities, understand local land uses and logistical constraints, discuss RBJ Social Forestry programmes
Sabah Forestry Department	Mashor Jaini, Ricky Martin, Hussin Tukiman, Alex Hastie, Abtah Dera	24/5/16	Introduce project to SFD, request issuance of community-level information from relevant Forest Management Plans
Tongod District Office	Nordin Daling	23/5/16	Introduce project to Tongod District Office, request future assistance.
PACOS Trust	Anne Lasimbang	19/5/16	Discuss previous initiatives conducted by PACOS in the Project Zone communities, enquire about previous or current land conflicts in the area
Borneo Conservancy Initiative	Lanash Thanda	2/6/16	Gain insights into contemporary Sabah state legislation and case law pertaining to customary land rights in forest reserves
Permian Global	Nick Brickle	Ongoing throughout	Overall project coordination and planning for future implementation phases

The project zone communities were identified through two main approaches.

- 1) consultation with the stakeholders mentioned above to receive information on communities with close linkages to the project area
- 2) spatial identification of all communities within a 20-kilometre radius of the project area (as per methodologies prescribed in the Verified Carbon Standard). Once initial identifications had been made and permissions to engage with communities had been sought from the Tongod District Office, the project scheduled a series of preliminary meetings with the self-identified representatives of each community. During these meetings, the background and key objectives of the project were explained and consent was sought to organise larger-scale workshops with a broad cross-section of community participants to explain the project in greater detail (inclusive of any potential risks which were apparent at the time).

Between 2017 and 2019, a total of 11 community workshops and dialogue sessions were held, attended by a combined total of almost 500 community participants. These workshops were conducted to achieve a variety of objectives, including transparency and communication of project details and activities, gathering information on community socio-cultural conditions and history, generation of spatial data via participatory mapping, discussion of threats and constraints faced by communities, and planning of future project

activities in accordance with the principles of FPIC. Engagement sessions of this type were generally organised together with community leaders, who then publicise the engagements in their respective communities and encourage participation. In addition to workshops and informal discussion sessions, the project has conducted an extensive series of household surveys to provide data on the community socio-economic baseline. During the commencement of each individual interview conducted as part of these surveys, respondents were given a brief overview of the project structure and objectives, and asked for their consent before the interview proper was initiated. Since 2019, the project has continued to convene workshops, however the regularity of these was affected by the COVID restrictions from 2020 onwards.

Appendix 5 includes the timeline of community stakeholder engagements conducted as part of the Social Baseline Assessment.

2.3.8 Continued Consultation and Adaptive Management (G3.4)

The Kuamut Project is grounded in a philosophy of ongoing consultation and dynamic management, adapting responsively to the evolving needs and circumstances of village communities. Key strategies and practices in this approach include:

Establishment of the Community Executive Committee: Representatives from seven villages have been democratically elected to form the Community Executive Committee. This committee plays a pivotal role in voicing community concerns and aspirations, ensuring effective representation in the project's implementation.

Continued Dialogue Post Initial Engagement: Post the Free, Prior, and Informed Consent (FPIC) and social baseline stages, the project has maintained a steady stream of discussions with the communities. These discussions, involving the Community Executive Committee, community members, and project staff, focus on addressing basic community needs. The unique aspect of these dialogues is the involvement of project staff who are also part of the community, ensuring a personal and empathetic approach to problem-solving.

Structured Community Meetings and Communication Flow: Regularly scheduled meetings in each participating village ensure an ongoing, open line of communication. These meetings serve as a platform to relay community benefit proposals to the project management team, ensuring that community voices reach decision-making levels.

Community-Centric Initiative Development: Ideas and activities proposed for the benefit of each community are not only discussed in these meetings but are also collaboratively shaped into concrete initiatives. This approach underscores the project's commitment to not just listen but actively implement community-driven solutions.

Detailed Documentation of Processes: For a comprehensive understanding of our ongoing consultation and adaptive management methodologies, refer to Section 2.3.7. This section elaborates on the mechanisms and effectiveness of our engagement and adaptation strategies during the monitoring phase of the project.

The Kuamut Project is dedicated to a participatory and flexible approach, ensuring that community input is not only heard but is a driving force in shaping the project's trajectory. This commitment to adaptive

management and continuous communication is fundamental to our project's ethos and operational framework.

Please refer to Annex 5 for a detailed list of engagement activities with the communities during the monitoring period.

2.3.9 Stakeholder Consultation Channels (G3.5)

As per sections 2.3.2, 2.3.7, and Appendix 5 of the monitoring report, our project has consistently prioritized direct engagement with stakeholders, ensuring that consultations and participatory processes are not only inclusive but also culturally and linguistically appropriate. To achieve this, a series of brochures in the Malay language were produced, offering succinct summaries of the project's goals, the roles of implementing bodies, and the principles governing the project, such as biodiversity conservation, carbon sequestration, global warming, and the principles of Free, Prior, and Informed Consent (FPIC). These brochures serve as a primary tool for information dissemination, ensuring that complex concepts are made accessible and understandable to the community members.

The strategy for community engagement employed by the project goes beyond mere information dissemination. Recognizing the importance of legitimate representation, these brochures and other informational materials are first provided to community leaders. These leaders, who are deeply ingrained in and respected by their communities, play a crucial role in further disseminating this information. Their involvement ensures that the communication is not just top-down but also receives grassroots traction. This approach respects the existing social structures and harnesses their potential to facilitate effective communication.

Moreover, the project has adopted a dynamic and responsive approach to stakeholder consultation. The target audience and the mode of engagement are carefully tailored depending on the specific issue at hand. For overarching concerns like the project's work plan or the latest monitoring report, the target audience encompasses all community members. Initially presented formally at the village administration level, the information is then cascaded down to ensure it reaches all community subgroups. This methodology ensures comprehensive coverage, giving every community member, irrespective of their subgroup, the opportunity to access information, raise questions, and provide feedback.

2.3.10 Stakeholder Participation in Decision-Making and Implementation (G3.6)

Meeting types, structure and locations (as per 2.3.7) are always designed to enable the target audience to participate freely and to contribute openly. The meetings solicited the community's consent to support project community activities. The communities from 7 villages elected their representatives as members of a Community Executive Committee, to act and represent community voices towards the project implementation.

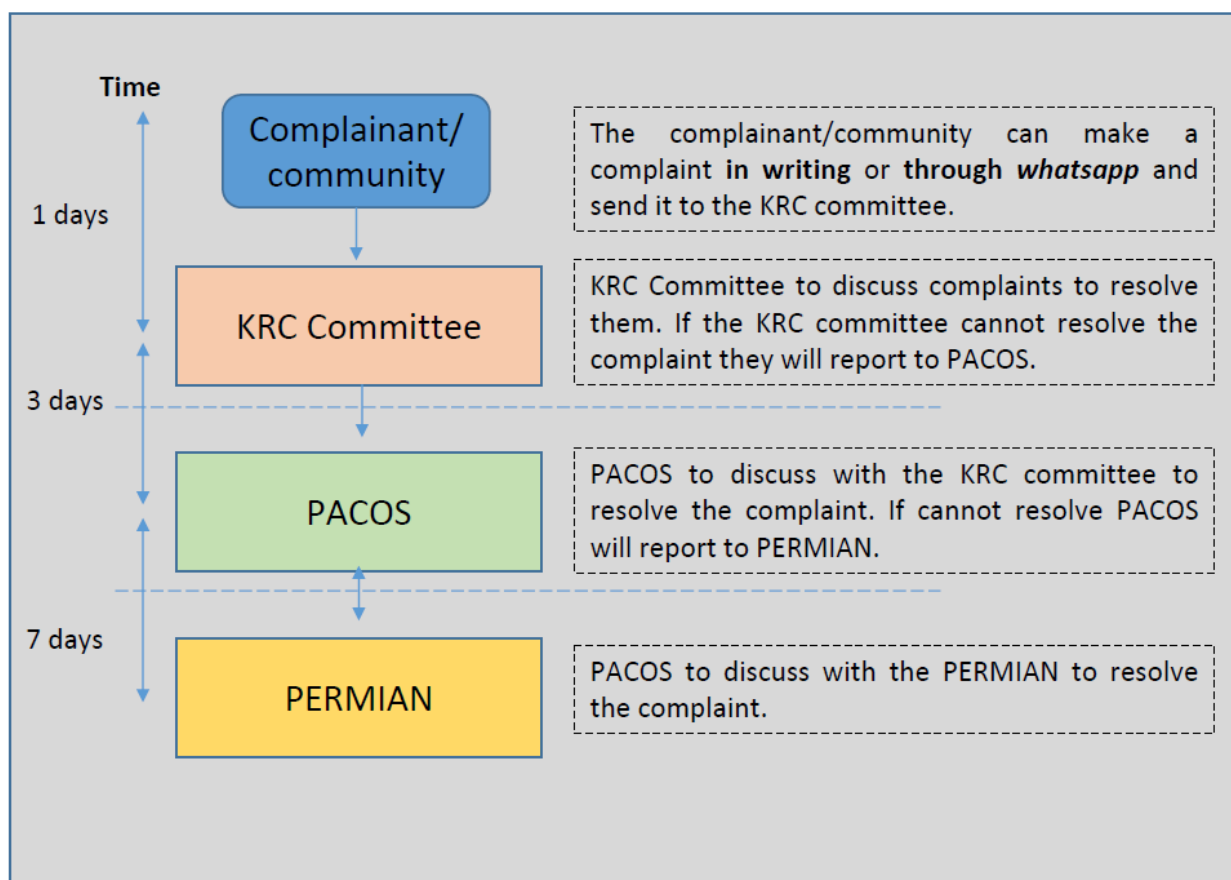
2.3.11 Anti-Discrimination Assurance (G3.7)

Permian Malaysia Sdn. Bhd. has collated and defined all employment terms into a Staff Handbook. The staff manual includes a lengthy section (Section XII) that must be acknowledged by all staff relating to harassment and defines and prohibits all forms of harassment based on race, color, religion, sex, age, sexual orientation, national origin or ancestry, disability, medical condition, marital status, veteran status, or any other protected status defined by law. It further defines and prohibits all forms of sexual harassment

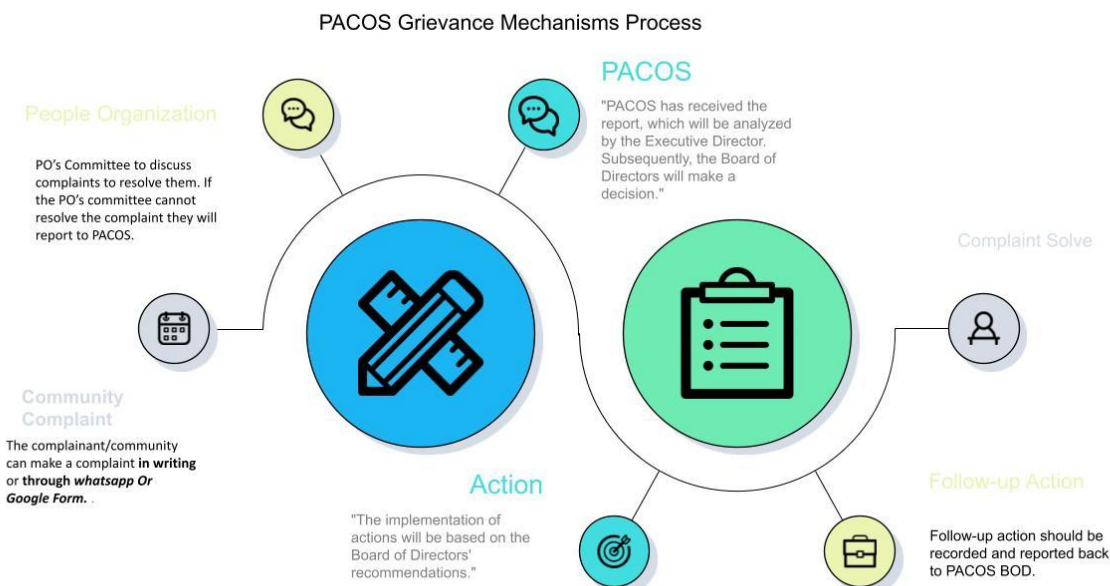
and states that in the case of all forms of harassment that the regulation extends not only to other staff members but to all beneficiaries and counterparts of the project. A full copy of the company regulation is available on request. To date, no staff have been sanctioned for infringement of these regulations, and no such grievances have been reported.

2.3.12 Grievances (G3.8)

One of the most important elements of the grievance redress procedure is to prevent potential conflicts before they arise. Such precautionary approaches include the implementation of FPIC- based community consultations and regular communication. This helps to identify underlying grievances well in advance and allows them to be addressed. The project's grievance and redress procedure to prevent and handle any conflicts with and among communities and other stakeholders which may arise during the implementation of project activities is managed by the PACOS code of conduct, complaints channel and complaints procedure. Complaints or grievances are advanced via Community Organisers in Karamuak and Kuamut Clusters, and Community Executive members (AJK) in 7 villages. There were no complaints received by the project during the period. The overall Grievance Redress Mechanism is organized as follows and addresses both community complains and complaints relating to offsite biodiversity impacts:



Once the complaint is received by PACOS, it goes through the following process with all grievances communicated to Permian Global and responded to within 7 days:



In addition, SEARRP maintains a complaints procedure and [safeguarding framework](#) - which is open to anyone engaging with its programme and any partners with whom they engage. All SEARRP staff (including the staff assigned to the Kuamut Project) received safeguarding training.

In the event that any grievances that are not resolved by amicable negotiations, these will be referred to mediation by the Indigenous Peoples Network of Malaysia or Jaringan Orang Asal Se-Malaysia (JOAS) a neutral third party that represents 21 community-based non-governmental organizations that have indigenous peoples' issues as a focus. As the focal point for indigenous rights and advocacy in Malaysia, JOAS provides the indigenous communities with representation not just locally and nationally but regionally and internationally as well (see <https://orangasal.blogspot.com/>). In addition to this, the Human Rights Commission of Malaysia (SUHAKAM), established by Parliament under the Human Rights Commission of Malaysia Act 1999, is the independent national human rights institution that is responsible of receiving and investigating complaints from the public regarding infringements of human rights, among others (see <https://suhakam.org.my/activities/>).

2.3.13 Worker Training (G3.9)

The Kuamut Rainforest Conservation Project is committed to investment in training and capacity building, and this commitment extends from project staff to project-zone communities, to local collaborators (both NGO and government). Such training can take many forms, from work shadowing, internships, ad hoc training, to formal classroom style teaching. During the monitoring period there was extensive training with RBJ taking the lead in Karamuak and PACOS in Kuamut. A training program was developed during the monitoring period which focused on developing agricultural and other basic skills. Activity in Karamuak was undertaken by RBJ and in Kuamut by PACOS. There was also a focus on improving ideas and skills in the field of handicrafts. PACOS developed an education program in Kuamut which focused on younger children, including those of pre-school age.

As per section 1.2 of this report, 111 people in total have been trained as a result of project activities during the MP, including the 8 people employed and trained for regular patrols of the project area to monitor illegal logging and poaching.

2.3.14 Community Employment Opportunities (G3.10)

The project initially employed a ranger team of eight people, of whom four were from the local communities. In addition, two of the wives of team members were involved with the development of the PACOS program, and eventually benefitted from a full-time course for three months to improve their skills. One of the senior staff from PACOS lived primarily in Kuamut for a year as part of this program and PACOS provided one teacher throughout the monitoring period. A number of people were involved with a food-aid program during the Covid epidemic and also with community programs implemented by RBJ and SFD.

2.3.15 Relevant Laws and Regulations Related to Worker's Rights (G3.11)

The Kuamut Project and Permian Malaysia Sdn. Bhd. operate in full compliance with Sabah and Malaysia's labour laws and strives to set an example of best practice with respect to employment terms, conditions and practices.

Sabah and Malaysia's labour law is principally governed by ADMM. This represents the highest and most comprehensive set of regulations governing employment, including such issues as employment agreements, working hours, wages, paid leave, termination of employment, discrimination and grievance procedures. Below this is a raft of implementing legislation in the form of government regulations, presidential and ministerial decrees.

As per this body of regulation, Permian Malaysia Sdn. Bhd. has collated and defined all employment terms into a Staff Handbook. This handbook has, in turn, been submitted to the Ministry of Manpower for approval of its compliance with the law. Every page and article of the manual is inspected and stamped and Permian Malaysia Sdn. Bhd. has received a certificate of compliance from the Ministry (available on request). Once approved the Staff Manual was provided to all staff, together with a detailed explanation of the articles contained within and opportunity to raise any questions or concerns. All staff members were then asked to sign to indicate that they have received the manual and that they fully understand its contents (itself a requirement of manpower regulations). Certification of the Staff Manual is valid for two years, at which point the process must be repeated. Permian Malaysia Sdn. Bhd. is also required to report its employment statistics to the Ministry of Manpower on an annual basis, under terms of the law regarding Compulsory Company Manpower Reporting (UU 7/1981). Permian Malaysia Sdn. Bhd. is up-to-date and fully compliant with this requirement.

Amongst many other things, the Staff Manual describes in detail the grievance process that any employees can take if they are unhappy with any term of their employment. If the issue cannot be resolved internally any employees can report their complaint directly to the local Manpower Office which can then address the complaint directly to the company, seek to assist a bipartite resolution, or enlist the assistance of an independent mediator to seek a tripartite resolution. To date no staff have initiated such grievance procedures, but the opportunity always remains open.

2.3.16 Occupational Safety Assessment (G3.12)

Worker safety remains a priority of the Kuamut Project which conforms with the requirements of the labour law, UU No. 13/2003. Occupational safety and health are stipulated in the company safety regulation (available to verifiers upon request) and include:

- Providing workers with a first aid kit including anti-venom cream and insect repellent;
- Providing navigation and communication equipment such as GPS, compass and handheld transceivers;
- Enforcing a buddy system (minimum two persons in a group) for all field activities;
- Providing standard safety equipment such as microfiber mask, rubber boots, heavy-duty gloves, uniform, hat, harness, survival kit, portable water bottles/bags, and life jacket;
- Providing additional logistics such as fuel, propeller for a boat, and water and meals enough for three extra days; and
- Providing proper training on safety procedures, evacuation, communication, equipment use, and shelter making in order to ensure worker safety and mitigate potential risks inherent to certain field activities such as fire suppression and surveys.

Permian Malaysia Sdn. Bhd. has and will continue to provide safety training and equipment as described above. Training is provided prior to the start of any activity so that it can be specific to the risks associated with that activity. In addition, a safety SOP is in effect and maintained and employee safety is an important priority in all planning.

2.4 Management Capacity

2.4.1 Required Technical Skills (G4.2)

The project activities have been implemented primarily by the project proponent, in collaboration with the supporting technical and implementing partners. Collectively the project employs a large, highly qualified and professionally experienced staff, drawn from various backgrounds and with expertise including forest management, conservation biology, silviculture, community development, financial management, business management, legal and technical regulation and policy. This team is based in headquarters in Kota Kinabalu, Sabah, and regional facilities throughout the project zone. Table 2 below summarizes some of the main project activity themes and some of the range of skills required for their implementation.

Table 2: Key skills required to implement the project, by activity

Project activity	Sub-project activity	Key skills required
Forest Resources Conservation	Protection and enforcement; Forest fire prevention and control; Habitat conservation and management	HCV mapping, forest conservation; biodiversity conservation, biodiversity MRV

Project activity	Sub-project activity	Key skills required
Research and Development	Knowledge management; MRV methods; researching natural regeneration; restoration methods; biodiversity conservation methods	Carbon MRV, silviculture, forest conservation, biodiversity conservation
Livelihood Development	Agriculture improvement, ecotourism development	Community organizing, conflict resolution, participatory land-use mapping

2.4.2 Management Team Experience (G4.2)

The project employs staff with several decades in combined experience covering all areas of expertise required for implementing land management and carbon projects at the scale of this project.

As shown in the CVs available for audit purposes, the team of Permian Global includes experts with more than 20 years of relevant experience in climate change and forests in different positions at global scale. The technical team responsible to estimate and monitor the carbon estimates involves highly respected scientists with several publications specific to the forest area and carbon estimates and monitoring in tropical forests. Similarly, the team includes expertise in biodiversity evaluation and monitoring as well as engagement with communities.

2.4.3 Project Management Partnerships/Team Development (G4.2)

In addition to in-house experts, the Kuamut Project collaborates with a wide range of institutions both as implementing partners and as sources of technical advice. These institutions include those partners listed above, and a range of other partners that assist the project on an issue-based or ad hoc basis both pro bono and as contracted consultants. Amongst these partners are a range of nationally and internationally recognized scientific and technical experts, providing advice on issues such as climate science, community development, practical site management and biodiversity conservation.

These collaborations have been established in an effort to enhance the project's wider benefits, by making the site and its data open to a range of new partners. They have not been established to specifically address identified gaps in capacity required to implement the project's core activity, as to date no such gaps have been identified.

2.4.4 Financial Health of Implementing Organization(s) (G4.3)

No changes have occurred since the project validation. Permian Malaysia Sdn. Bhd. and the Kuamut Rainforest Conservation Project are financed with secure investment financing and will derive revenue through the sale of verified carbon units (VCUs). These mechanisms will ensure implementation of all described project activities. Financial forecasts and supporting documentation are available to the verifiers on request.

2.4.5 Avoidance of Corruption and Other Unethical Behavior (G4.3)

Financial control within the project is taken very seriously. Written financial management practices, including full segregation of responsibilities, are enshrined in the deeds of enactment of the company and in supporting documentation agreed on behalf of the shareholders by the Board of Directors. Permian Malaysia Sdn. Bhd. and its parent companies conducts routine internal audits and undergoes annual independent external audit. Full external audit reports are available to the verifiers on request.

Permian Malaysia Sdn. Bhd. has a strict non-corruption policy. This is reflected in both the company's deeds of enactment and in the Staff Manual governing acceptable staff behaviour and extends to practices that include bribery, embezzlement, fraud, favouritism, cronyism, nepotism, extortion and collusion. Measures taken to ensure these policies are complied with include strict contractual arrangements with project partners, routine field inspections (including of implementing partners), strict documentation of all expenses (including documented authorization), centralized procurement and documented procurement procedures, full segregation of financial management practices (i.e. segregated responsibility for activity/purchase authorization, expense authorization, payment and bookkeeping), staff training, and internal and independent external audit.

2.4.6 Commercially Sensitive Information (Rules 3.5.13 – 3.5.14)

The following information is commercially sensitive and is not publicly available:

- Financial projections – Detailed 30-year financial projections for the project which include all project-related costs and ex-ante carbon estimates.
- Agreements between implementing, technical partners, communities and government – All agreements between project proponents and other implementing partners governing the implementation of project activities.
- Project workplans and budgets - Detailed implementation workplans.

2.5 Legal Status and Property Rights

2.5.1 Recognition of Property Rights (G5.1)

To demonstrate that all property rights are recognized, respected, and supported in the context of the Yayasan Sabah project, we have break down the key elements and activities that contribute to securing statutory rights and respecting community rights:

Legal Framework and Agreements: The project operates within a clear legal framework where property rights and land tenure are well-defined. Yayasan Sabah has a 99-year lease arrangement with the Sabah Forestry Department, which acts on behalf of the State Government of Sabah. This lease arrangement provides a clear legal basis for the use of the land, ensuring that statutory rights are recognized and upheld.

Ownership and Rights Transfer: Yayasan Sabah has transferred the right of use of the project area to Permian Malaysia Sdn. Bhd., which includes the right to generate and sell carbon offset credits. This transfer is based on contractual agreements, which further support property rights. The project ownership, as defined in the VCS Standard, is established through statutory and contractual rights.

Community Engagement and Consent: Whilst no communities live within the project area, the project recognizes the importance of engaging with local communities and respecting their rights. Community engagement has been conducted on multiple occasions, including the Free, Prior, and Informed Consent (FPIC) process conducted by PACOS Trust in Kuamut and Karamuak clusters. This process involved community members in discussions about the project and solicited their consent to support community activities related to the project. The election of representatives to a Community Executive Committee further demonstrates a commitment to involving the community in project decisions and recognizing their voices and rights.

Ancestral Lands and Resource Gathering: Acknowledging that some parts of the project area are considered by communities to be their ancestral lands and important for resource gathering, the project has taken steps to address these concerns. By engaging in FPIC and allowing communities to have a say in project activities, the project respects and recognizes the significance of these lands to the local communities.

2.5.2 Free, Prior and Informed Consent (G5.2)

The Kuamut Rainforest Conservation project follows the Free, Prior and Informed Consent (FPIC) process as a set of guiding principles rather than a specific methodology and adopts a procedural conception of FPIC which is consistent with prominent contemporary literature and best practices on the subject (e.g. Colchester 2010¹⁵; Anderson 2011¹⁶; FAO 2014¹⁷).

Since the inception of social baseline assessment and community engagements in October 2017 through to 2019, the project held a total of 11 community workshops and dialogue sessions, attended by a combined total of 488 community participants. Community engagements are conducted to achieve a variety of objectives, including transparency and communication of project details and activities, gathering information on community socio-cultural conditions and history, generation of spatial data via participatory mapping, discussion of threats and constraints faced by communities, and planning of future project activities in accordance with the principles of FPIC.

Procedure followed to obtain consent:

A broad suite of methods were employed to obtain consent from relevant stakeholders, each designed to be appropriate for the collection of information (see Appendix 6 for example of the community workshop agenda). These included structured and open-ended discussions during community workshops and small group discussions, household surveys using standardized data sheets, participatory mapping exercises, and some site observations. Methods were generally cross-cutting, in that information on most topics were

¹⁵ Colchester, M. (2010). Free, prior and informed consent: making FPIC work for forests and peoples. The Forests Dialogue, Research Paper No. 11. New Haven, Connecticut, USA.

¹⁶ Anderson, P. (2011). Free, prior, and informed consent: principles and approaches for policy and project development. The Center for People and Forests (RECOFTC) & Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ). Bangkok, Thailand

¹⁷ FAO (2014). Respecting free, prior and informed consent: Practical guidance for governments, companies, NGOs, indigenous peoples and local communities in relation to land acquisition. Governance of tenure technical guide 3, Food and Agriculture Organisation of the United Nations. Rome, Italy

gathered independently using several methods - for example, information on the use of natural resources was gathered during workshop discussions, household surveys, and during participatory mapping exercises. This provided a means to triangulate data at multiple scales and examine differences between communal and individual-level activities and perceptions of issues.

The approach was designed by the coordinator of the Social Baseline Assessment and was implemented by the coordinator and a small field team over the period 2017-2019 (refer to Appendix 5 for a timeframe of implementation). All research activities were explained to community representatives well in advance of their implementation, and consent was obtained from communities before the conduct of all data collection. The main individual methods are discussed in more detail below.

Community workshop & small group discussions

Discussions with community members were generally aimed at either gathering data on a particular topic (for example, community infrastructure and amenities), or facilitating a diversity of viewpoints on a particular topic. These discussions were held during community workshops (large gatherings to which all community members were invited) and small group discussions (more focused gatherings with limited attendance, convened to focus on a particular topic). At both of these fora, discussions were managed in the following ways:

- i. Structured discussions. These focus on a particular topic and follow a predetermined list of questions compiled by the Social Baseline Assessment team. Used to discuss factual information where personal opinions are unlikely to vary, for example settlement history and community infrastructure.
- ii. Semi-structured discussions. Follows broadly defined questions on a particular topic, but participants are given some freedom to digress. Used to discuss topics which require some focus but digression to related topics may provide unanticipated insights, for example use of natural resources.
- iii. Open discussions. Related to a particular topic, but respondents are given total freedom in deciding how to respond. Used to gather a range of subjective opinions and examine the diversity of opinions between and within communities, for example when discussing broad challenges faced and aspirations for the future. Community members were encouraged to provide input concerning the most appropriate forms of assistance the project could potentially offer, and the livelihood enhancing activities derived from discussions with (and data provided by) the communities themselves, rather than being imposed by the project. Moreover, the discussions looked to ensure that all potential project activities are designed specifically for each individual community, recognizing inter-community diversity in terms of aspirations and the suitability of different interventions.

All discussions were held entirely in the Malay language and were facilitated by the Social Baseline Assessment team. Discussions generally proceeded until community respondents indicated that they had no more information that they wished to communicate, or otherwise appeared disinclined to continue.

Household surveys

Surveys were conducted using standardized data sheets designed by the Social Assessment team, which posed a series of structured and semi-structured questions on household composition, education, livelihoods, access to basic necessities, use of natural resources, land ownership, agricultural practices, principal challenges faced by the household and recommendations. These surveys were employed as a means to elicit detailed information at the household level and gain a deeper understanding of the diversity within and between communities on the abovementioned subjects.

The design and implementation of the surveys was conducted in broad correspondence with the approaches outlined in Angelsen (2011). Where possible, households were selected randomly from a list of all households provided by community leaders. Where randomly selected households were unavailable for interview, substitutes were selected at the discretion of community leaders. A minimum sample size of 30% households per community was used, following Neuman (1991). In very small communities (total households = <20), the team aimed for complete coverage.

Once households had been selected, the Social Baseline Assessment team would visit each household to request permission to conduct interviews and make an appointment. Interviews were conducted with the self-identified head of the household at their residence, in the Malay language and local (*Sungai*) dialects where appropriate.

Participatory Mapping

Participatory mapping was conducted during community workshops and aimed to provide a means for communities to spatially represent agricultural sites, areas important for the use of natural resources, ecosystem provisioning services such as water catchments, sites of historical cultural significance, and any other areas which they felt were relevant. This is a useful technique in identifying the spatial distribution of sites important to communities and allows a cross-section of the community to pool their collective knowledge (Evans *et al.*, 2006).

A0-sized base maps of community areas and surrounding lands were produced by the Social Baseline Assessment Team ahead of participatory mapping exercises. These maps were produced using GIS software and contained prominent features (such as locations of settlements, rivers, roads and the boundaries of the Project Area) to help community participants in orienting themselves. During workshops, participants were divided into groups according to the individual communities they represented, and provided with a list of features to include in their maps, inclusive of the following:

- iv. Agricultural areas
- v. Sites important for the gathering of NTFPs (e.g. medicinal plants, food plants, construction materials, handicraft materials)
- vi. Water catchments
- vii. Areas important for fishing
- viii. Areas important for hunting
- ix. Sites of cultural significance
- x. Any additional areas they wished to add

They then held discussions in their groups and completed the maps with facilitation from the Social Baseline Assessment team, before presenting their outputs to the rest of the workshop participants for

discussion. Following workshops, high-resolution images were taken of the completed maps which were then georeferenced and digitized using GIS software.

The table below summarizes the various forms of engagements conducted, when consent was sought and opportunities to withhold it, and details their main outputs and other benefits associated with these methods:

Type of engagement	Format	Primary outputs	Additional benefits
Introductory meeting	Small informal discussion between project proponents and community representatives; usually community leaders	Contact established between project and communities, project explained to community representatives,	Consent was sought to organize larger-scale workshops. Communities subsequently hold internal discussions; instigation of FPIC processes.
Community workshop (round 1)	Community-wide workshop, all community members invited to attend	Broader introduction to project, gathering basic social and demographic data	Discussions and Q & A feedback sessions with community, negotiating FPIC for further engagement activities
Community workshop (round 2)	Community-wide workshop, all community members invited to attend	Participatory mapping of settlements and natural resources use, discussion of potential project activities to support livelihoods	Discussion of grievance mechanisms, opportunities for communities to give feedback and ask questions.
Household surveys	Interview surveys conducted at the household level.	Data collection on household demography, use of natural resources, agricultural practices and aspirations	Consent was obtained from interview subjects individually before commencing each interview. Opportunities for communities to offer feedback and ask questions in an anonymous setting
Informal & opportunistic discussions	Small group discussions conducted on ad hoc basis	Focused discussions on various relevant topics with key experts	Consent was obtained from interview subjects individually before commencing each

			interview. Opportunities to ask questions and offer feedback in an informal setting
Field observations	Visits to sites identified by communities during workshops or other discussions	Observations of various sites, photographs, GPS recordings	Further discussions on-site with local guides
Brochures	Two different types of brochures covering project background and FPIC produced in Malay language	Written summaries of the project objectives and implementing bodies and describing some of the underlying principles governing the project such as biodiversity, carbon sequestration, global warming and the principles and importance of FPIC, such as their right to withhold throughout.	Opportunity for community members to consider their FPIC rights outside of a workshop or interview forum.
Interim update meetings	Small meetings with a subsection of community representatives	Updating communities on developments among project proponents, receiving updates from communities	Further opportunities for community feedback, consent and Q & A sessions

Appendix 5 provides the timelines followed during consultations. Sections 2.1.1, 2.3.2, 2.3.7 provide additional details on the FPIC process to obtain consent from relevant stakeholders.

Stakeholders' option to withhold consent:

Stakeholders were apprised of their right to withhold consent via an array of communication channels, phone calls, face-to-face meetings, letters of complaint and community workshops. The information was presented with utmost clarity and transparency, elucidating the potential consequences of abstaining from consent. A special team was constituted to assuage stakeholders' queries or apprehensions regarding their choices and dispatched written correspondence as a follow-up for withheld consent. Regular updates were furnished throughout the process to ensure that stakeholders remained abreast with developments. Feedback from stakeholders was duly acknowledged and utilized to refine future communication endeavours. In essence, the process of informing stakeholders about their right to withhold consent was carried out meticulously while safeguarding their rights and needs.

Measures to ensure consent was free of coercion, intimidation, manipulation, threat, and bribery:

To address these concerns, PACOS implemented a comprehensive set of measures.

1. Provide transparent and clear communication about the nature of the consent being sought. This includes providing detailed information about the purpose, risks, and benefits associated with the consent.
2. Follow rigorous informed consent procedures to ensure that individuals are fully informed about the implications of their decision. This involves providing written materials and opportunities for individuals to ask questions.
3. Emphasize the voluntary nature of consent. Individuals are given sufficient time to consider their decision without any external pressure and are explicitly informed that they have the right to refuse or withdraw consent at any point without facing negative consequences.
4. Confidentiality is prioritized to minimize the risk of coercion. Information provided during the consent process is kept confidential, and individuals are assured that their decision will not be disclosed to unauthorized parties.
5. Fifthly, staff members are trained to recognize and avoid any behaviors that could be perceived as coercive or unethical. This training ensures that the consent process is conducted in an ethical and respectful manner.

Lastly, in some cases where necessary, third-party oversight may be involved to ensure an unbiased evaluation of the consent process.

These measures collectively contribute to creating an environment where consent is obtained freely without any external pressures or unethical influences. The organization is committed to upholding principles of autonomy and respect for individuals throughout the consent process.

2.5.3 Property Right Protection (G5.3)

The Kuamut Rainforest Conservation Project will undertake no involuntary relocations. The current project area contains no permanent human settlements.

Permian Malaysia Sdn. Bhd. is the sole license holder of the Project Area. This license grants a range of rights and responsibilities, of which is included the right to generate and sell carbon offset credits derived from forest protection and regeneration (and potentially assisted regeneration) and prevent any other organization from applying for concessions in the project area.

Under the forest classification system in Sabah, 7 classes of Forest Reserve (FR) are recognised:

Class I (Protection) FR

Class II (Commercial) FR

Class III (Domestic) FR

Class IV (Amenity) FR

Class V (Mangrove) FR

Class VI (Virgin Jungle) FR

Class VII (Wildlife) FR

The Kuamut Forest Reserve, prior to the initiation of the project, was designated as a Class II FR with commercial harvesting of timber permitted in strict accordance with the Sustainable Forest Management Licence Agreement (SFMLA). All Class II FRs are subject to the conditions of the SFMLA - which precludes any commercial or other exploitation of the area, other than by the licence holder, including hunting, gathering of non-timber forest products, agricultural or shifting cultivation.

As a consequence of the project, 83,381 ha of Kuamut was re-classified as a Class I, fully protected FR - which prohibits any harvesting of timber or other commercial exploitation, other than through non-extractive activities including ecotourism, and research and trading in ecosystem services such as carbon. As with Class II FRs, community use of Class I FRs is heavily restricted and controlled with no inherent rights to harvest timber (regardless of end use), non-timber forest products or engage in hunting or agricultural practices. Access rights to Class I FRs, including by local communities are restricted in the same way as with Class II FRs.

The re-designation of the Kuamut Rainforest Conservation Project area from Class II to Class I FR did not, therefore, result in any diminution of community rights; these were historically restricted under the Class II FR designation and remained so when the area was re-classified as a totally protected area with Class I FR status.

2.5.4 Identification of Illegal Activity (G5.4)

Illegal activities, including logging and hunting of protected species have been historically practiced in parts of the project zone and project area. The Kuamut Rainforest Conservation Project aims to reduce and put an end to these activities by a combination of protection and enforcement, education, and incentives, including strengthening tenure rights and providing sustainable livelihood options and employment opportunities.

The project does not and has not benefitted from any illegal activity.

2.5.5 Ongoing Disputes (G5.5)

There aren't any disputes over the land and resources in the project area. The topic of disputes over lands and resources has been discussed during community engagements on multiple occasions. Some parts of the project area are considered by communities to be part of their ancestral lands and remain of importance for the gathering of natural resources (broadly indicated by the HCV 5 and 6 areas in the maps in Section 2.1.7 of the PD). Please see section 2.5.3 of this report for information on ownership (held by the State), and access and use rights in the project area.

The project is currently not aware of any disputes over lands or resources (whether current or in the recent past) which have involved legal arbitration, protest, or any form of physical or verbal conflict and the situation is constantly monitored as part of the implementation of the community engagement plan.

2.5.6 National and Local Laws (G5.6)

The Kuamut Project and Permian Malaysia Sdn. Bhd. operate in full compliance with Sabah and Malaysia's laws and strives to set an example of best practice with respect to employment terms, conditions and practices. The project is not aware of any national and local laws and regulations in Malaysia that have gone into effect, changed, or been eliminated since the project's validation that are relevant to the project activities.

3 CLIMATE

3.1 Monitoring GHG Emission Reductions and Removals

3.1.1 Data and Parameters Available at Validation

Data / Parameter	CF_j
Data unit	tC·td.m. ⁻¹
Description	Carbon fraction of dry matter for species j
Source of data	IPCC default for aboveground tree biomass (table 4.3 in volume 4 of the 2006 IPCC guidelines)
Value applied	0.47
Justification of choice of data or description of measurement methods and procedures applied	Conservative value for tropical species
Purpose of data	Used in calculations
Comments	

Data / Parameter	D_j
Data unit	t.d.m. m ⁻³
Description	Basic wood density of species j
Source of data	Global Wood Density Database (Chave et al. 2009)
Value applied	Average wood density values were estimated for each genus using the Global Wood Density Database.

Justification of choice of data or description of measurement methods and procedures applied	
Purpose of data	Used in calculations
Comments	

Data / Parameter	Relationship between Aboveground Carbon Density and LiDAR based Top of Canopy Height
Data unit	
Description	Model to determine relationship between Aboveground Carbon Density and LiDAR based Top of Canopy Height
Source of data	Project specific non-linear model
Value applied	
Justification of choice of data or description of measurement methods and procedures applied	
Purpose of data	Used in the calculations of ongoing forest growth in the project scenario
Comments	This model has been re-assessed and updated to work with other remote sensing data, see section 3.1.3 for details

Data / Parameter	$BCEFR$
Data unit	t.d.m m ⁻³
Description	Biomass conversion and expansion factor applicable to wood removals in the project area
Source of data	IPCC
Value applied	1.89
Justification of choice of data or description of measurement methods and procedures applied	
Purpose of data	
Comments	

Data / Parameter	$F_{RSD BSL}$
Data unit	Dimensionless
Description	Residual Stand Damage Factor
Source of data	Based on Pinard and Putz (1996) ¹⁸
Value applied	1.8
Justification of choice of data or description of measurement methods and procedures applied	For $F_{RSD BSL}$ the methodology suggests a value of 2.3 based on Pinard and Putz (1996) who found unharvested trees were severely damaged (uprooted and crushed) in conventional logging within the Ulu Segama area. We have used a more conservative value of 1.8. The F_{RSD} value of 1.8 for both NFM and Mosaic stratum.
Purpose of data	Determination of baseline scenario
Comments	

Data / Parameter	$V_{l,j,i,sp}$
Data unit	m ³
Description	Merchantable volume for tree l of species j in sample plots p in stratum i
Source of data	Field measurements in 46 circular 30-meter radius (each 0.28 ha) permanent sample plots (PSPs) plots of trees above the defined cutting limit (40 cm DBH for the NFM areas, and 31 cm DBH for the Mosaic Planting Approach areas)
Value applied	See plot level data
Justification of choice of data or description of measurement methods and procedures applied	A total of 46 circular 30-meter radius (each 0.28 ha) permanent sample plots (PSPs) plots were set up within the Kuamut area. We recorded taxonomic information, taking leaf samples wherever possible. More than 75% of the individuals were identified to Genus, and more than 50% of the individuals have been identified to Species level. Average wood density values were estimated for each genus using the Global Wood Density Database (Chave et al. 2009). Using these values, we then calculated a plot-level basal area weighted average and assigned it to any individuals lacking botanical information. Biomass was calculated according to equation 4 from Chave et al. (2014) utilising the measured diameter and heights, and the estimated wood density. This means that the taxonomic information is incorporated via the wood density, so while one equation is used – the estimated biomass will be quite different for different species of the same dimensions. The equations of Chave

¹⁸ Pinard, M., & Putz, F. (1996). Retaining Forest Biomass by Reducing Logging Damage. *Biotropica*, 28(3), 278-295. doi:10.2307/2389193

	et al. (2014) are widely regarded as more accurate than species specific allometric (which also do not exist for the majority of species diverse tropical regions). We estimated timber volume from the calculated biomass using a BCEF-R of 1.89. The plot level timber volume was derived by summing the timber volume of all 70% of trees above the defined cutting limit (40 cm DBH for the NFM areas, and 31 cm DBH for the Mosaic Planting Approach areas). By using only 70% of the trees, we conservatively account for any species that would not be harvested without being reliant on perfect botanical information in every plot.
Purpose of data	Determination of baseline
Comments	

Data / Parameter	$f_j(X, Y, \dots)$
Data unit	t d.m. tree ⁻¹
Description	Allometric equation(s) for species <i>j</i> linking measured tree variable(s) to aboveground biomass of living trees
Source of data	equation 4 from Chave et al. (2014)
Value applied	$AGB_{est} = 0.0673 \times (\rho D^2 H)^{0.976}$
Justification of choice of data or description of measurement methods and procedures applied	The equations of Chave et al. (2014) are widely regarded as more accurate than species specific allometric (which also do not exist for the majority of species diverse tropical regions)
Purpose of data	linking measured tree variable(s) to aboveground biomass of living trees
Comments	

Data / Parameter	<i>OF</i>
Data unit	Kg kg ⁻¹
Description	Fraction of wood products that will be emitted to the atmosphere between 3 and 100years after production;
Source of data	default values for the tropical forest region provided in the methodology
Value applied	

	Wood Product Class	OF		
		Boreal	Temperate	Tropical
	Sawnwood	0.39	0.62	0.86
	Woodbase panels	0.62	0.86	0.98
	Other industrial roundwood	0.86	0.98	0.99
	Paper and paperboard	0.39	0.62	0.99
Justification of choice of data or description of measurement methods and procedures applied	default values for the tropical forest region provided in the methodology			
Purpose of data	Determination of baseline			
Comments				

Data / Parameter	SLF
Data unit	Kg kg ⁻¹
Description	Fraction of wood products that will be emitted to the atmosphere within 3 years of production
Source of data	default values given in the methodology were used which in turn are taken from Winjum et al (1998).
Value applied	Sawn wood: 0.12 Woodbase panels: 0.06 Other industrial roundwood: 0.18
Justification of choice of data or description of measurement methods and procedures applied	default values provided in the methodology
Purpose of data	Determination of baseline
Comments	

Data / Parameter	WW
Data unit	Kg kg ⁻¹
Description	Fraction of extracted biomass effectively emitted to the atmosphere during production
Source of data	default values given in the methodology were used which in turn are taken from Winjum et al (1998).
Value applied	24%

Justification of choice of data or description of measurement methods and procedures applied	default values provided in the methodology
Purpose of data	Determination of baseline
Comments	

Data / Parameter	PML_{FT}						
Data unit	%						
Description	Mean merchantable biomass as a proportion of total aboveground tree biomass for each forest type						
Source of data	merchantable volume data for all active logging concessions within the State of Sabah						
Value applied	<table> <tr> <th>Logging Type</th><th>PML_{FT}</th></tr> <tr> <td>Salvage Logging</td><td>0.96</td></tr> <tr> <td>NFM</td><td>0.4</td></tr> </table>	Logging Type	PML_{FT}	Salvage Logging	0.96	NFM	0.4
Logging Type	PML_{FT}						
Salvage Logging	0.96						
NFM	0.4						
Justification of choice of data or description of measurement methods and procedures applied	Data was recorded as either 'NFM', 'Salvage logging' or 'Plantation Timber'. We calculated the Volume per hectare (Harvest Volume / Harvest Area), for every individual record within the database. We then calculated the mean volume extracted per hectare, for each Forest Reserve and Logging Type ('NFM' or 'Salvage logging'). Using the mean volume extracted per hectare we estimate the biomass within the timber volume using the BCEFR of 1.89. We consider these records of timber that was harvested from the base year, the best estimate of merchantable timber biomass available. The carbon per hectare (ACD) was calculated based on the total carbon for the forest reserve and the total area based on the SFD Forest Reserve boundaries. One forest reserve (Bengkoka FR.), had no remaining biomass per hectare, we therefore applied the ACD value of the lowest FR. The biomass per hectare was calculated from the carbon per hectare using the BCEFR of 1.89 and a Carbon fraction of 0.47. Using the Merchantable Biomass and total biomass values, we calculated the mean merchantable and total biomass, and then the PML for each of the comparable forest types in the analysed forest estate						
Purpose of data	Determination of leakage						
Comments							

Data / Parameter	RGR_i
Data unit	tC.ha ⁻¹ .yr ⁻¹
Description	Forest regrowth rate post timber harvest for stratum <i>i</i>
Source of data	Published data
Value applied	1.6 t C ha ⁻¹ yr ⁻¹ for stratum 2 and 3 3.0 t C ha ⁻¹ yr ⁻¹ for stratum 4
Justification of choice of data or description of measurement methods and procedures applied	For stratum 2 and 3, RGR_i is assumed to be 1.6 t C ha⁻¹yr⁻¹ based on table 1 of Suarez (2019)¹⁹ (which would be an average growth rate of 3.4 Mg d.m. ha⁻¹ year⁻¹ for tropical rainforest in Asia and a carbon fraction of 0.47). For stratum 4, RGR_i is estimated as 3.0 t C ha⁻¹yr⁻¹. For this estimation, data from Yahya and Ikau (2016)²⁰ on DBH, height, age, and planting density were used. In addition, we used 0.2955 Mg M⁻³ as the mean wood density for <i>Paraserianthes</i> from the global wood density database (Chave 2009, Zanne 2009²¹). To our knowledge <i>Neolamarckia</i> was not in the database and we used a value of 0.362 from Mahmud <i>et al.</i> (2017)²². Using these values, Tree-level Above-Ground Biomass (in Mg) was calculated using Eq. 4 in Chave <i>et al.</i> (2014), and assuming an average age of planted individuals of 6.25 years. The average regrowth rate was estimated from the tree-level above-ground biomass based on a feasible planting rate and harvesting 15 years after planting. For the planting rate it was assumed that the entire area would take 30 years to plant, or 1261 hectares per year. Based on the planting density in Yahya and Ikau (2016), this planting rate would require nursery facilities for almost a million seedlings per year. This is an ambitious planting rate and results in a conservative overall RGR for the planted areas. We will further analyse the reference areas in the coming years to see if this planting rate has been achieved. In estimating the forest regrowth in stratum 4, it was further assumed that there would be no growth between the salvage logging and the planting within the mosaic areas due to the

¹⁹ Suarez *et al.*, 2019. [Estimating aboveground net biomass change for tropical and subtropical forests: Refinement of IPCC default rates using forest plot data](#)

²⁰ Ahmad Zuhaidi Yahya & Albert Ikau A.G. (2016) Reforestation with naturally regenerated trees and selected forest plantation species based on mosaic planting approach. International Journal of Agriculture, Forestry and Plantation, Vol. 1 (Dec 2015)

²¹ Zanne, A., Lopez-Gonzalez, G., Coomes, D., Ilic, J., Jansen, S., Lewis, S., Miller, R., Swenson, N., Wiemann, M. & Chave, J. 2009. Global Wood Density Database. Dryad Digital Repository

²² Mahmud, Siti Zalifah & Hashim, Rokiah & Saleh, Abdul & Sulaiman, Othman & Saharudin, Nur & Lokmal, N. & Masseat, Khairul & Husain, Hamdan. (2017). Physical and mechanical properties of juvenile wood from *Neolamarckia cadamba* planted in West Malaysia. Maderas. Ciencia y tecnología. 19. 10.4067/S0718-221X2017005000020.

	damaging nature of salvage logging. If there was any regrowth during this interlude, not only would it be negligible, but there would also be additional site preparation clearing immediately before planting. When we average the growth rate based on this planting rate, we estimate the overall average growth rate mentioned above for the area to be 3.0 t C ha ⁻¹ yr ⁻¹ .
Purpose of data	Determination of baseline
Comments	

Data / Parameter	$V_{EX,j/iBSL}$
Data unit	m ³ ·ha ⁻¹
Description	Mean volume of extracted timber per unit area for species j in stratum i
Source of data	Modeled timber harvest plan
Value applied	See updated values in Appendix 1 to this MR (table 16 in updated section 3.2.1)
Justification of choice of data or description of measurement methods and procedures applied	See updated section 3.2.1 in Appendix 1 to this MR
Purpose of data	Determination of baseline
Comments	

Data / Parameter	$TH_{i,p}$
Data unit	Years
Description	Number of years since timber harvest in stratum i in land parcel p
Source of data	timber harvest schedule
Value applied	Refer to modeled timber harvest plan and section 3.1.4 of the PD, sub-section titled 'Division of the harvestable forest into annual operating areas in the different strata based on common practice'
Justification of choice of data or description of measurement methods and procedures applied	Modeled timber harvest plan in the validated PD
Purpose of data	Determination of baseline
Comments	

Data / Parameter	$A_{i,p}$
Data unit	ha
Description	The area of stratum i in land parcel p that was harvested 1 year ago
Source of data	Calculated based on harvest plan using the approach described in the PD, section 3.2.1 (Baseline Emissions), subsection 'Calculation of baseline scenario greenhouse gas emissions from change in carbon stocks (section 8.1.6 of the methodology)'
Value applied	See PD and model outputs
Justification of choice of data or description of measurement methods and procedures applied	Calculated from the modeled timber harvest plan and section 8.1.6 of the methodology
Purpose of data	Calculation of baseline scenario greenhouse gas emissions from change in carbon stocks
Comments	

Data / Parameter	$A_{1,i,p}$
Data unit	ha
Description	The area of stratum i in land parcel p that was harvested between 2 and 10 year ago
Source of data	Calculated based on harvest plan using the approach described in the PD, section 3.2.1 (Baseline Emissions), subsection 'Calculation of baseline scenario greenhouse gas emissions from change in carbon stocks (section 8.1.6 of the methodology)'
Value applied	See PD and model outputs
Justification of choice of data or description of measurement methods and procedures applied	Calculated from the modeled timber harvest plan and section 8.1.6 of the methodology
Purpose of data	Calculation of baseline scenario greenhouse gas emissions from change in carbon stocks
Comments	

Data / Parameter	$A_{2-10,i,p}$
Data unit	ha
Description	The area of stratum i in land parcel p that was harvested between 11 and 20 years ago

Source of data	Calculated based on harvest plan using the approach described in the PD, section 3.2.1 (Baseline Emissions), subsection 'Calculation of baseline scenario greenhouse gas emissions from change in carbon stocks (section 8.1.6 of the methodology)'
Value applied	See PD and model outputs
Justification of choice of data or description of measurement methods and procedures applied	Calculated from the modeled timber harvest plan and section 8.1.6 of the methodology
Purpose of data	Calculation of baseline scenario greenhouse gas emissions from change in carbon stocks
Comments	

Data / Parameter	$A_{11-20,i,p}$
Data unit	ha
Description	Cumulative area harvested until time t^*
Source of data	Calculated based on harvest plan using the approach described in the PD, section 3.2.1 (Baseline Emissions), subsection 'Calculation of baseline scenario greenhouse gas emissions from change in carbon stocks (section 8.1.6 of the methodology)'
Value applied	See PD and model outputs
Justification of choice of data or description of measurement methods and procedures applied	Calculated from the modeled timber harvest plan and section 8.1.6 of the methodology
Purpose of data	Calculation of baseline scenario greenhouse gas emissions from change in carbon stocks
Comments	

Data / Parameter	A_{t+}
Data unit	ha
Description	Cumulative area harvested until time t^*
Source of data	Calculated based on harvest plan using the approach described in the PD, section 3.2.1 (Baseline Emissions), subsection 'Calculation of baseline scenario greenhouse gas emissions from change in carbon stocks (section 8.1.6 of the methodology)'
Value applied	See PD and model outputs

Justification of choice of data or description of measurement methods and procedures applied	Calculated from the modeled timber harvest plan and section 8.1.6 of the methodology
Purpose of data	Calculation of baseline scenario greenhouse gas emissions from change in carbon stocks
Comments	

Data / Parameter	A_{sp}
Data unit	ha
Description	Area of sample plots p
Source of data	Records of sample plots
Value applied	0.28 ha
Justification of choice of data or description of measurement methods and procedures applied	circular 30-meter radius permanent sample plots
Purpose of data	Field measurements
Comments	

3.1.2 Data and Parameters Monitored

Data / Parameter	$A_{burn,i,t}$
Data unit	ha
Description	Area burnt in (stratum <i>i</i>) at time <i>t</i>
Source of data	LiDAR, Landsat 8-9 (OLI) & Sentinel-2 remote sensing data in combination with ground truthing
Description of measurement methods and procedures to be applied	Data on the area burned will be derived from the field plots and remote sensing analysis that are part of the monitoring of ongoing forest growth in the project scenario. To ensure sufficient coverage, this will be complemented with an analysis of optical data products

	(Landsat 8-9 & Sentinel-2) that have a proven capability for deforestation detection and some capacity for degradation detection.
Frequency of monitoring/recording	If applicable, maps of the area impacted by fires will be produced for every year, within each monitoring report.
Value monitored	0
Monitoring equipment	LiDAR, Landsat 8-9 & Sentinel-2 remote sensing data, NASA FIRMS alerts.
QA/QC procedures to be applied	The analysis of burned forest areas is performed using a combined approach which investigates field data from monitoring equipment and satellite optical-based fire detection tools (NASA FIRMS alerts), followed by a secondary specific assessment for each fire event in the that the extent and severity are evaluated through processing high resolution images from SAR (Sentinel-1) and optical (Planet Lab). For each event registered and notified by the FIRMS alert, a first evaluation will be carried out by the monitoring team. Subsequently, a remote sensing analysis is performed for each event, thus extracting the total area affected and the severity through the investigation of environmental spectral indices such as the NDVI - Normalized Difference Vegetation Index or the DNBR - Difference Normalized Burn Index. Additionally, available SAR products (e.g. Sentinel-1) will be used as support in the event that cloud cover prevents the acquisition of images coincidental or near-coincidental to the fire event.
Purpose of the data	Estimation of forest disturbance for calculation of the project emissions
Calculation method	
Comments	

Data / Parameter	$A_{dist,i,t}$
Data unit	ha
Description	Area disturbed in stratum i at time t (natural disturbance)
Source of data	Airborne LiDAR, Landsat 8-9 (OLI) & Sentinel-2 remote sensing data in combination with ground truthing

Description of measurement methods and procedures to be applied	High resolution (30 m spatial resolution) biomass maps are produced each year from the field plots and remote sensing analysis that are part of the monitoring of ongoing forest growth in the project scenario. We do not specifically report area disturbed, as, in our analysis, each pixel has the opportunity to go up as well as down each year. Therefore any disturbed area is included via a reduced overall growth rate for the project area. Note this method therefore incorporates all natural disturbances, and therefore may be considered conservative. To ensure sufficient reporting of unplanned deforestation disturbances, the biomass mapping will be complemented with an analysis of optical data products (Landsat & Sentinel-2) that have a proven capability for deforestation detection (see next parameter on illegal logging).
Frequency of monitoring/recording	High resolution biomass maps are produced for every year, within each monitoring report.
Value monitored	0
Monitoring equipment	Airborne LiDAR, Landsat 8/9 & Sentinel-2 remote sensing data
QA/QC procedures to be applied	Standard procedures for analysis of remote sensing data (see 'Biomass Mapping' section. To optimize the use of these optical data products, we will use airborne LiDAR data (2.4 points m ⁻²) from surveys undertaken in 2016) and the optical products (Sentinel-2 (10m spatial resolution) & Landsat 8/9 (30m spatial resolution)) together with freely available satellite radar products (Sentinel-1 C-band (10m spatial resolution) SAR, available globally from April 2014) to monitor structural changes associated with deforestation, degradation, and regrowth. Satellite radar has all-weather capability and relatively fine spatial grain but is not yet widely employed for assessing forest change. We will investigate correspondence between Lidar-derived canopy metrics and the backscatter of VV and VH polarizations and the intensity ratio (VV/VH).
Purpose of the data	Estimation of forest disturbance for calculation of the project emissions
Calculation method	
Comments	

Data / Parameter	$A_{DIST_IL,i}$
Data unit	ha
Description	Area impacted by illegal logging (in stratum <i>i</i>)
Source of data	Landsat & Sentinel-2 remote sensing data in combination with ground truthing
Description of measurement methods and procedures to be applied	Data on the occurrence of disturbances and illegal logging will be derived from the remote sensing analysis of optical data products (Landsat 8/9 & Sentinel-2) that have a proven capability for deforestation.
Frequency of monitoring/recording	Maps of the area impacted by illegal logging are produced for every year, within each monitoring report.
Value monitored	463 ha
Monitoring equipment	Landsat & Sentinel-2 remote sensing data, GFW GLAD and RADD deforestation alerts
QA/QC procedures to be applied	Standard procedures for analysis of remote sensing data. The multi-year analysis of deforestation was carried out using optical images from the NASA-Landsat 8/9 and ESA-Sentinel-2 satellite missions. Using annual composites generated from cloud-free images acquired in the Kuamut region, a multitemporal land cover classification analysis was performed, covering the current monitoring period (2016-2022). Since small-scale forest degradation is annually accounted for on AGB's high-resolution maps, the final deforestation product provides information on deforestation events with size ≥ 2.5 ha. To support the validation process and evaluate any potential inadequacies derived from cloud-driven spectral interferences, very high-resolution cloud-free optical images (3m spatial resolution) from Planet Lab were used to visually assess the final deforestation product.
Purpose of the data	Estimation of area of forest clearly deforested for calculation of the project emissions
Calculation method	
Comments	

Data / Parameter	$\Delta C_{AB,t PRJ}$
Data unit	tCO ₂ e

Description	Annual carbon stock change in aboveground biomass of trees, in each strata, in the project scenario
Source of data	Remote sensing with optical and Synthetic Aperture Radar (SAR) satellite data), in combination with some remeasuring of field plots.
Description of measurement methods and procedures to be applied	The field data and remote sensing data will be combined to produce yearly high resolution biomass maps. These biomass maps are used to estimate the yearly growth rate for each strata in the project area (ΔC). To avoid any risk of accounting for on-going forest growth prior to the parcel harvest date in the baseline, we have modified the equation as presented in the methodology so that only areas of the project that would have been harvested, prior to the close of the monitoring period, are considered. The first main difference here is that the equation iterates at the parcel level rather than strata level. Notably, we have simplified the equation to remove management strata as all parcels, considered in this project, comprise a single strata and corresponding project growth rate. Therefore, for each parcel the annual growth rate is calculated as the product of the area of the parcel, the growth rate and the conversion factor from carbon to CO₂. However, this annual growth is only applied on or after the baseline harvest date of the parcel. When year t is less than the baseline harvest date, the on-going forest growth is zero. When year t is equal to the baseline harvest date, the on-going forest growth is equal to the years since the start of the project multiplied by the growth rate, to account for growth prior to harvest. When year is greater than the baseline harvest date, only the growth in that year is considered. The project remeasured all field plots in the project area. Due to difficulties with physical access on the ground (eg. Roads and bridges) and travel restrictions during COVID, the remeasuring of plots started in 2020 and ended in early 2022. The field plots are used to calibrate the model and it is therefore expected that subsequent monitoring of ongoing growth may rely entirely on remote sensing data and perhaps measurements from a subset of the plots. It is anticipated that this could be supplemented with measurements from other related and adjacent areas and/or new plots that are in more accessible areas. To further validate ongoing forest growth, targeted LiDAR data may be collected in specific areas or using satellite LiDAR using a sampling approach, in the future, if it is required. This will be complemented by other remote sensing data where necessary. The strata-level species conservation factors (as used in the baseline) were then discounted from the growth rates to account for protected species.

Frequency of monitoring/recording	We will estimate ΔC for each strata, within each monitoring report, based on the slopes from a linear mixed effects model with yearly biomass maps (produced from both remote sensing and forest plot data). In this case the slope parameters are the growth rate for each strata. We do not expect to measure field plots every monitoring period.
Value monitored	After removing protected species, project-scenario growth rates: 3.01 for mosaic-planted, 2.84 for mosaic-unplanted and 1.98 for NFM. We do not apply growth rates for no-go areas.
Monitoring equipment	Predominantly Satellite Imagery and also DBH tapes.
QA/QC procedures to be applied	Standard operating procedures for field measurements and analysis of remote sensing data
Purpose of the data	Estimation of forest regrowth for calculation of the project emissions
Calculation method	Liner mixed effects models using biomass maps
Comments	

Data / Parameter	$B_{i,t PRJ}$
Data unit	t d. m. ha ⁻¹
Description	Aboveground biomass stock present in the project scenario (but absent in the baseline scenario) before burning
Source of data	
Description of measurement methods and procedures to be applied	If it is determined that an area has been burned (so $A_{burn,i,t} > 0$) the aboveground biomass stock before burning will be determined using the high resolution carbon maps.
Frequency of monitoring/recording	This would be estimated using biomass maps, which are produced for every year, within each monitoring report.
Value monitored	Not applicable, no fires occurred
Monitoring equipment	
QA/QC procedures to be applied	Standard operating procedures for field measurements and analysis of remote sensing data
Purpose of the data	Estimation of forest disturbance for calculation of the project emissions
Calculation method	

Comments	
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Data / Parameter	$C_{AB,i BSL}$
Data unit	tC·ha ⁻¹
Description	Carbon stock in aboveground biomass in areas disturbed
Source of data	The Carbon stock is based on maps we produced
Description of measurement methods and procedures to be applied	The field data and remote sensing data, obtained from SAR (Sentinel-1) and Optical (Landsat 8) satellite missions, are combined to produce yearly high resolution (30m spatial resolution) biomass maps, which were validated with the 2016 airborne LiDAR. See section 'Biomass Mapping' for full details.
Frequency of monitoring/recording	Maps of the area deforested are produced for every year, within each monitoring report.
Value monitored	Pixel level values in the wall-to-wall biomass map
Monitoring equipment	
QA/QC procedures to be applied	Standard operating procedures for field measurements and analysis of remote sensing data
Purpose of the data	Estimation of forest disturbance for calculation of the project emissions
Calculation method	
Comments	

Data / Parameter	$C_{DIST_IL,i,t PRJ}$
Data unit	tCO ₂ e
Description	Biomass carbon of trees cut and removed through illegal logging
Source of data	The field data and remote sensing data are combined to produce yearly high resolution biomass maps. These biomass maps are used to estimate the biomass of trees removed through illegal logging and combined with the estimated area of illegal logging.
Description of measurement methods and procedures to be applied	If it is determined that an area has been illegally logged (so $A_{DIST_IL,i} > 0$) the aboveground biomass will be determined using the high resolution maps.

Frequency of monitoring/recording	Every year (based on yearly maps of biomass and the area deforested) within each monitoring report.
Value monitored	Pixel level values in the wall-to-wall biomass map
Monitoring equipment	
QA/QC procedures to be applied	Standard operating procedures for field measurements and analysis of remote sensing data
Purpose of the data	Estimation of forest disturbance for calculation of the project emissions
Calculation method	
Comments	

Data / Parameter	PMP_i						
Data unit	%						
Description	Leakage Factor, merchantable biomass as a proportion of total aboveground tree biomass for stratum i within the project boundaries						
Source of data	Merchantable biomass and aboveground tree biomass are estimated from the forest biomass maps						
Description of measurement methods and procedures to be applied	Within each stratum divide the summed merchantable biomass by the summed total of aboveground tree biomass.						
Frequency of monitoring/recording	At each monitoring event we will reassess if PMP_i should be updated.						
Value applied	<table> <tr> <th>Stratum</th><th>PMP_i</th></tr> <tr> <td>Mosaic</td><td>0.71</td></tr> <tr> <td>NFM</td><td>0.45</td></tr> </table>	Stratum	PMP_i	Mosaic	0.71	NFM	0.45
Stratum	PMP_i						
Mosaic	0.71						
NFM	0.45						
Monitoring equipment							
QA/QC procedures to be applied							
Purpose of data	According to the methodology, each project must calculate within each stratum the ratio of merchantable biomass to total biomass (PMP_i). This shall then be compared to the ratio of merchantable biomass to total biomass for each forest type ($PMLFT$).						
Calculation method							

Comments	Ex-ante a time zero measurement must be made of this factor. The timber harvest plan sets the allowable mean extracted volume from the merchantable volume of timber in the forest inventory ($V_{j,i BSL}$), based on legal limits.
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3.1.3 Monitoring Plan

Organizational structure, responsibilities and competencies of the personnel that will be carrying out monitoring activities.

The project will be managed by Permian Malaysia Sdn. Bhd using the governance structure outline in section 2.4.1 of the PD. Permian Global will provide technical support in areas such as monitoring, field assessment and other technical aspects related to the carbon accounting, biodiversity surveys and community engagement. This will involve the same highly qualified and experienced staff that has developed the baseline. Measurements in the field will be done by the SEARRP employees. These employees have received field and classroom-based training, from Permian Global staff, for the monitoring of biomass and regrowth and teams have been formed that have been provided with the necessary equipment and facilities.

The methods used for generating/measuring, recording, storing, aggregating, collating and reporting the data on monitored parameters.

Implementation of sampling approaches

The monitoring of the annual carbon stock change in aboveground biomass of trees involves remote sensing in combination with targeted remeasuring of field plots.

For the field measurements, 46 circular 30-meter radius permanent sample plots (PSPs) plots were set up within the Kuamut area for the baseline. The project started remeasuring the plots during 2021, but due to heavy movement control orders, and access difficulties, we did not complete the plot remeasure until March 2022. All 46 of the field plots were re-measured. The field plot calibration/validation dataset therefore includes a total of 92 (two measurements of 46) field plots.

Biomass Mapping

Originally in the PD, the biomass for the baseline was estimated from the Top of Canopy Height using extensive LiDAR coverage for the first year of the project, 2016. As indicated in section 2.2.4 of this monitoring report, these values have been updated because of the availability of new more accurate and up-to-date datasets (also see Appendix 1 for the updated baseline numbers).

These new more accurate and up-to-date datasets have also been used to estimate the annual carbon stock change in aboveground biomass of trees in the project scenario ($\Delta C_{AB,t|PRJ}$). In order to quantify ongoing forest growth in the project scenario and to accurately estimate any emissions from small amounts

of deforestation or degradation, the project has developed a multi-temporal modelling approach to estimate the spatial variability and distribution of aboveground biomass. The modelling approach adopted a machine learning workflow that uses the following data sources: aerial LiDAR scan (ALS) data from 2016 describing canopy height, optical (Landsat 8) and Synthetic Aperture Radar (SAR) satellite imagery and forest plot data, all datasets acquired on the same year (2016). The combination of remote-sensing data sources is used to produce an updated wall-to-wall Top of Canopy Height (TCH) map – broadly similar to the process described for the baseline where the TCH map was produced predominantly with LiDAR. This monitoring of forest growth using remote sensing imagery is conducted in combination with remeasuring of field plots. It is important to note that while the forest growth monitoring process utilises both remote sensing and field measurements, it is very much supported with the field plot measurements, and it is possible to accurately model the regrowth without measuring the field plots every monitoring period.

As part of the workflow, annual composites of Landsat 8 (L8) imagery were created for the project area using Google earth engine. A total of 20 vegetation spectral indices were calculated and are included in APENDIX 4. The Landsat 8 annual composite (used for biomass maps) have temporal reduction which fills any gaps which may occur due to clouds. This results in a wall-to-wall L8 image composite for each year (see Figure 1.5)

For the SAR data, imagery from Sentinel 1 (S1) was used where all S1 images, for a given year, that intersected the area of interest, were collected. Each image was pre-processed using the steps described in Mullissa et al (2021).²³ All S1 preprocessing was carried out using google earth engine and the {rgee} package. The Copernicus GLO 30 m global digital elevation model (DEM)²⁴ was used to derive terrain data for the area of interest including: slope, aspect, minimal curvature, mean curvature. All the bands from the imagery discussed above were combined into a data cube, comprising a total of 41 bands. In order to harmonize the data between yearly composites, it was necessary to apply temporal smoothing across each band of the data cube for all years in the period 2015:2022.²⁵

²³ <https://doi.org/10.3390/rs13101954>

²⁴ <https://portal.opentopography.org/raster?opentopoID=OTSDEM.032021.4326.3>

²⁵ Although this Monitoring report focuses on the years 2016:2021, including years 2015 and 2022 improves the temporal smoothing estimation for those non-endpoint years.

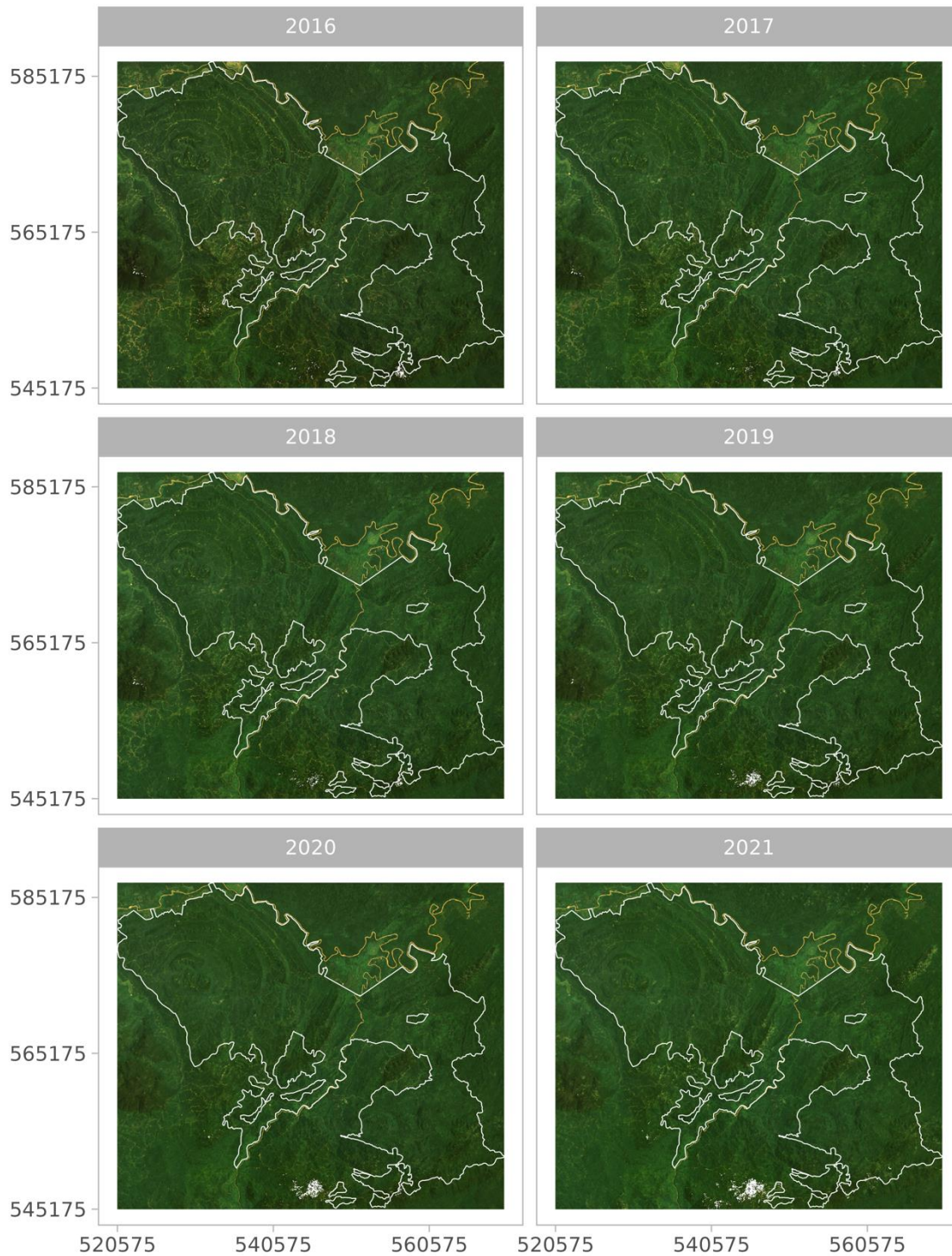


Fig. 1.5. Landsat 8-RGB composites used for the biomass analysis, panels show each year's composite.

The data cube was aligned with the tree Canopy Height Model (CHM) that was generated for the baseline from our LiDAR dataset, (which is described in the PD), collected in 2016. The coverage of the CHM is not

complete due to some areas where LiDAR point clouds were not directly available to the project as a result of clouds or areas not flown and are filled with predictions using the following methods. All regions that intersected the CHM were used to create a data frame comprising the measured canopy height values from the CHM and all of the environmental/ earth observation data contained within the data cube. Machine learning was applied, using the package `mlr3`, to analyse the information in the data cube and develop a Canopy Height Model using the combination of environmental metrics that could produce a model with the lowest RMSE value. Spatial resampling was undertaken to evaluate the performance of the ensemble model as shown in Figure 2. The model was then used to predict canopy height for years 2015:2022. The resulting predictions stored as spatial raster data.

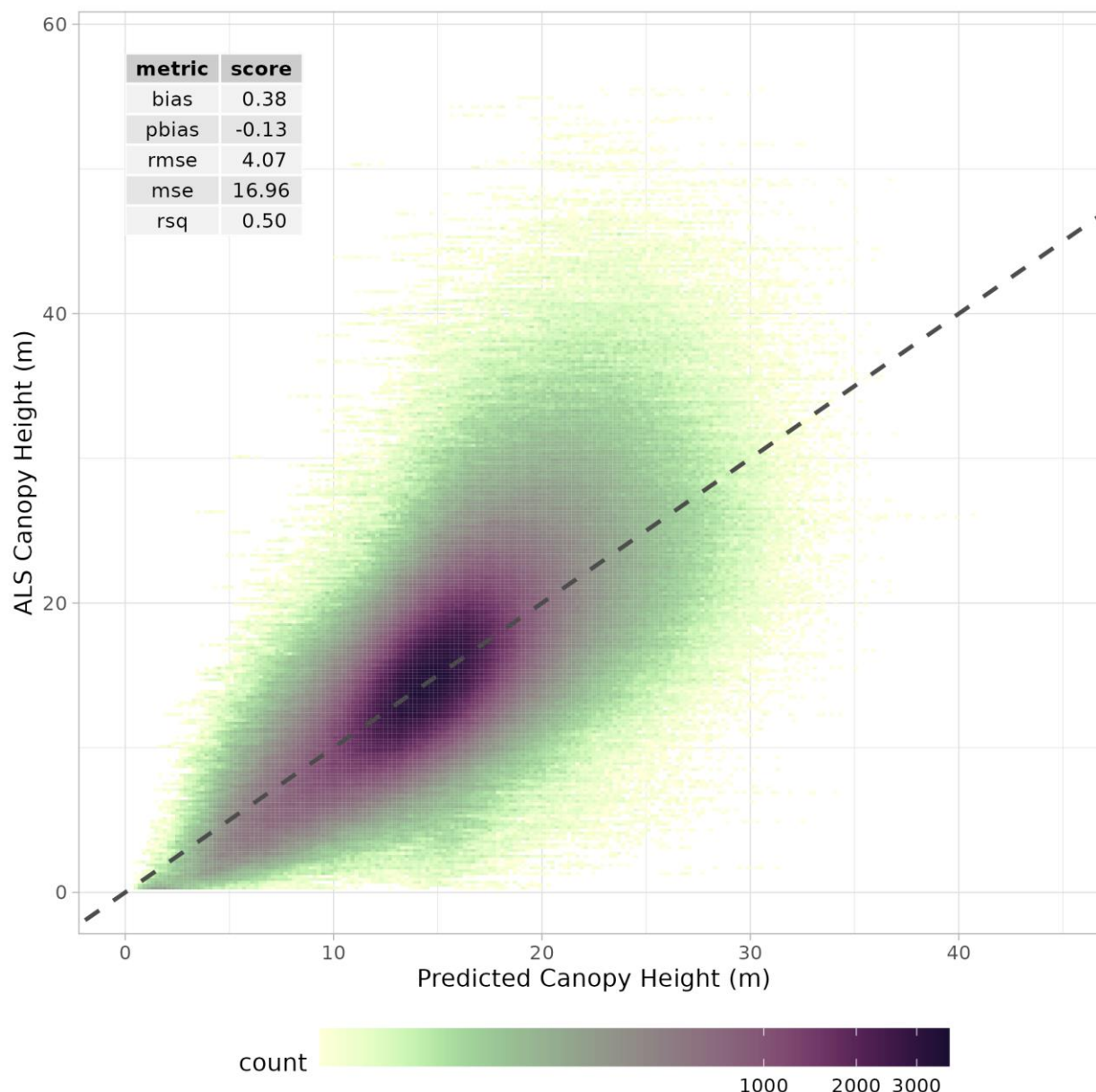


Figure 2: Evaluation of the performance of the developed Canopy Height Model against the Lidar generated canopy height data

To determine the Above Ground Biomass, the canopy height model predictions for all years were appended to their respective year's data cube as an additional band to form the input data cube for biomass model development. This was combined with the data from the field measurements that were undertaken in 2016 and 2020 in the Kuamut project area. Data cubes for the corresponding years were used to extract the earth observation data that intersected each plot area for each year it was surveyed. The total Above Ground Carbon (AGC) in the plot was converted to Aboveground Carbon density (ACD) by dividing the AGC by the planimetric area of the plot. The derived dataframe was used to train a model to predict ACD. All variable combinations were tested that included between 6-10 control features, which were selected using based on the models with the lowest AIC, two of which were required to be modelled: canopy height and mean curvature²⁶ (because of their importance). The best performing model was selected. The model was trained on the full forest plot inventory and validated using spatial resampling (see Figure 3).

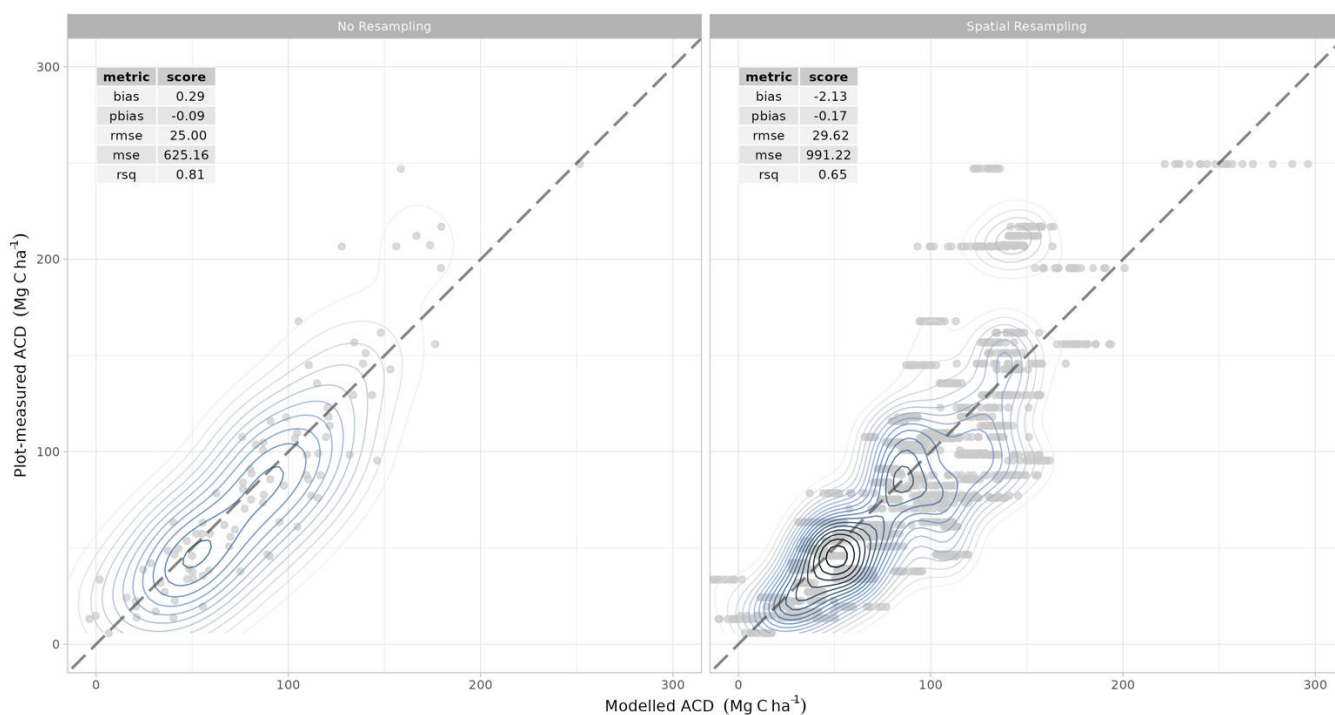


Figure 3: Model validation comparing plot-measured ACD against modelled ACD values, indicating extremely low bias and good model performance.

The best model was used to predict ACD across the entire Kuamut project area. All steps related to the model were repeated for Merchantable Volume with cutting limits of 10 cm, 31 cm, and 40 cm. The combination of data sources was used to produce high resolution carbon maps for each year of the

²⁶ Mean curvature identifies upland areas and ridgelines, which in the Kuamut project area are typically less effected by historical logging activity, due to their inaccessibility.

monitoring as shown in figure 4 (and volume maps for 2016, as per the methodology and PD). The combination of data sources was used to produce high resolution carbon maps for each year of the monitoring as shown in figure 4 (and volume maps for 2016, as per the methodology and PD). We use these biomass maps to estimate the carbon stock per strata, and in turn determine the stock changes between sampling events. An interactive web-mapping App was developed with the aim of facilitating the exploration of the final yearly biomass maps which will be made available to the verifier, and demonstrated in the field via a geolocated tablet app.

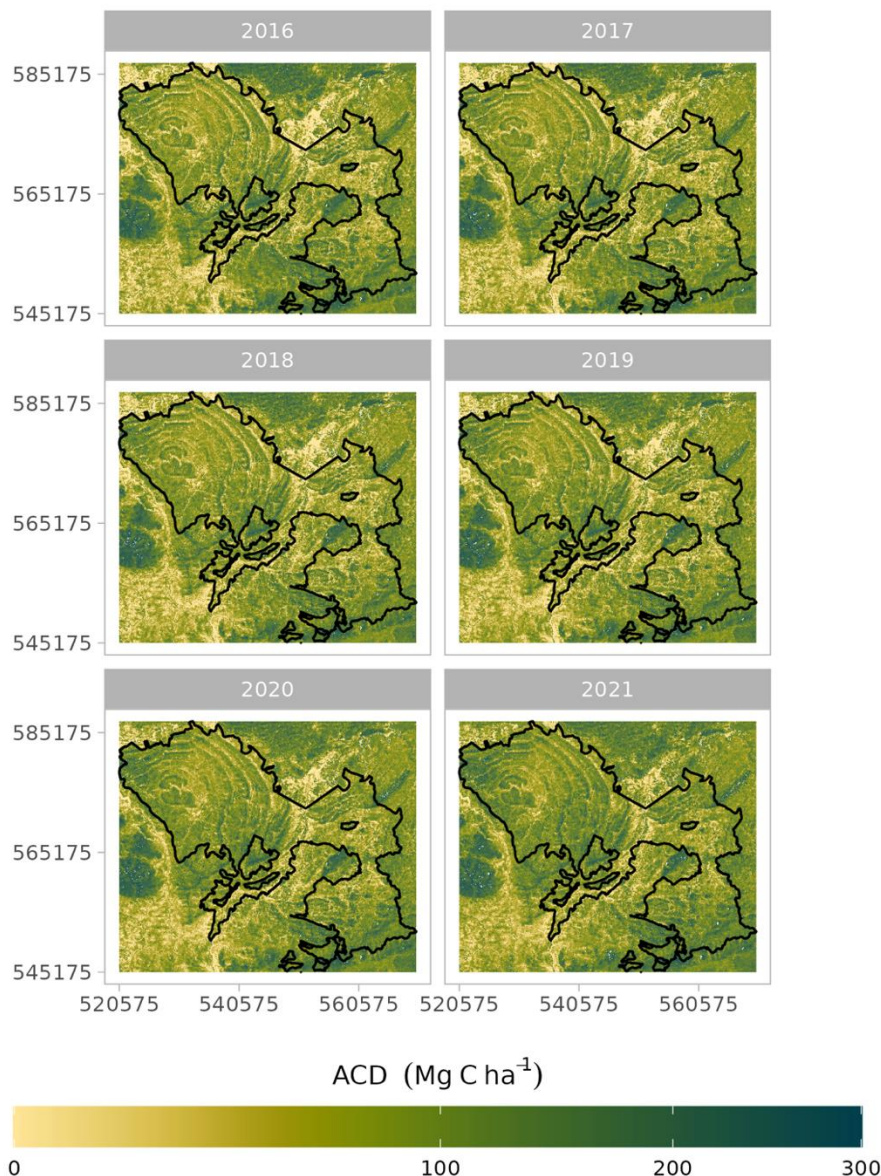


Figure 4: Yearly biomass maps generated for each year of the monitoring period. Colour scale shows ACD in Mg C ha⁻¹. X and Y axis is in UTM's (and therefor scale in meters).

Growth Rate calculation:

Growth rate was calculated across multiple years for the entire Kuamut project area in order to derive the most robust estimate possible. Predicted ACD maps for years 2016-2022 were used to estimate growth rate to account for spatial variability in growth and degradation across the entire project area over the monitoring period. A linear mixed effects model was fit across the entire dataset, i.e. the biomass maps through time, providing a distribution of predicted growth rates. A fixed effect interaction was included for strata; the fixed effect slopes were therefore the growth rate for each strata. Biomass cell ID was included as a random effect with time included also as a random slope; this formulation allows for pixel level variability in growth rate to be considered within the model and provide uncertainty for growth rate estimates for each strata. Our modelling approach provides a single growth rate for the monitoring period, for each strata, and gives the most accurate estimate using a consistent linear model for all the years together. As suggested by the methodology, we therefore estimate a mean growth rate for each of the strata, within the project area, which are subsequently used in the annual calculations. These project-scenario growth rates were $3.2 \text{ t C ha}^{-1} \text{ yr}^{-1}$ for mosaic-planted, $3.02 \text{ t C ha}^{-1} \text{ yr}^{-1}$ for mosaic-unplanted and $2.61 \text{ t C ha}^{-1} \text{ yr}^{-1}$ for NFM. We do not apply growth rates for no-go areas. The model estimates a lower growth rate in the no-go areas, which makes biological sense as these areas have experienced less logging. The no-go areas are not part of the baseline scenario, and therefore are not accounted for. The strata-level species conservation factors (as used in the baseline) were then discounted from the growth rates to account for protected species. After removing protected species, project-scenario growth rates were: 3.01 for mosaic-planted, 2.84 for mosaic-unplanted and 1.98 for NFM. We do not apply growth rates for no-go areas (see Table 2).

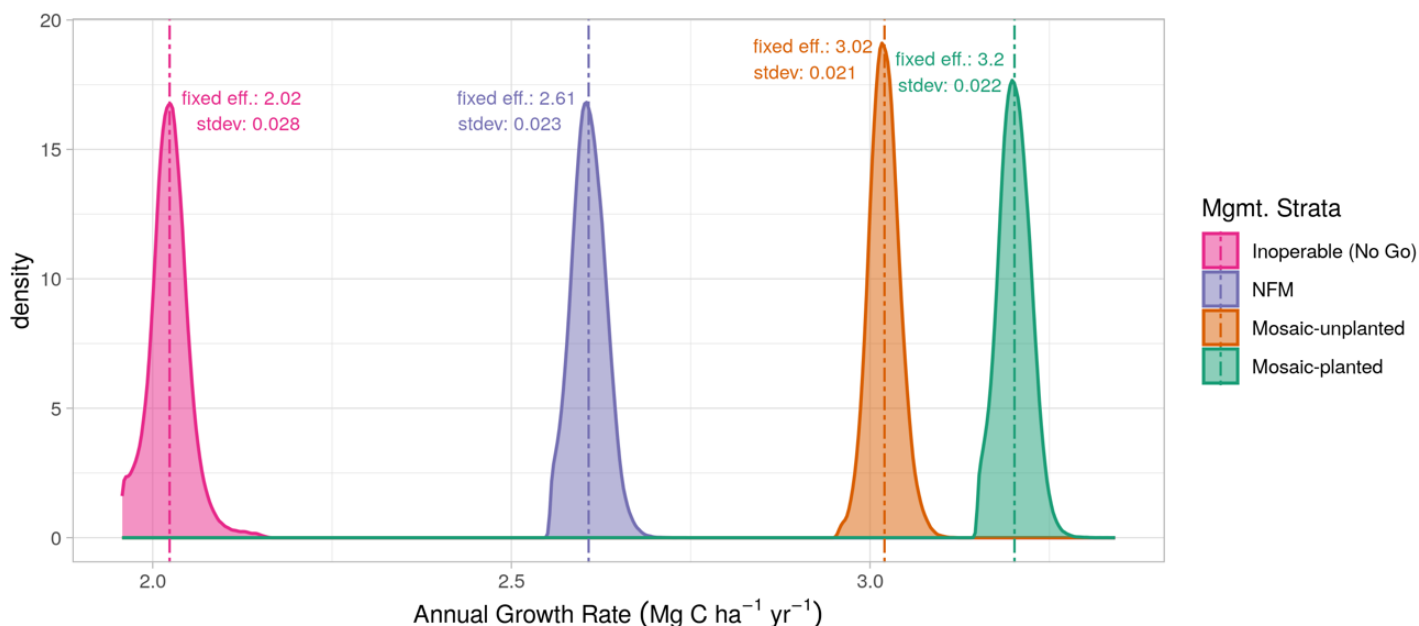


Figure 4.5. Project area annual growth rate density distribution for each of the strata, in $\text{Mg C ha}^{-1} \text{ yr}^{-1}$.

Table 2. Growth rates before and after applying the strata-specific species conservation factor.

Management Strata	Modelled Growth Rate (Mg C ha ⁻¹)	Species Conservation Factor	Adjusted Growth Rate (Mg C ha ⁻¹)
Inoperable (No Go)	2.02	-	-
NFM	2.61	0.76	1.98
Mosaic-unplanted	3.02	0.94	2.84
Mosaic-planted	3.2	0.94	3.01

Forest disturbance

To monitor forest disturbances (fire, non-fire forest disturbances plus illegal logging), the data on biomass and forest regrowth as described above are complemented with an analysis of optical data products (Landsat 8 (OLI)& Sentinel-2) that have a proven capability for deforestation detection and some capacity for degradation detection.

Fire

The field team also monitors the presence of any fire within or just outside project area and evaluate best course of action to avoid its spread. NASA FIRMS alerts²⁷ were used to monitor any possible fires, but it should be noted there were no fires during the project during the monitoring period. We would like to highlight that the monitoring strategy proposed in this section will be used in the event that any fire occurs within the project area.

Any hotspot inside or surrounding the project area will be checked. The emails alerts from NASA are converted into text messages with the coordinates of the hotspots that determined field team members with receive on their phones. The team will also receive monthly summaries with information on the fire events (and for the deforestation analysis – see below) that have occurred in the project area and its surrounding regions.

Coincidental or near-coincidental High resolution optical (Planet, Sentinel-2, Landsat 8-9) and SAR (Sentinel-1) satellite imagery will be used to perform multi-temporal investigation of fire's impact on the forest, assessing the environmental conditions before and after the event. Various spectral indices will be used to characterize the affected areas, paying special attention to those developed specifically for the study of fires such as the dNBR – Difference Normalized Burn Ratio²⁸ (Optical) or BAI - Burn Area Index²⁹ (Optical). Supporting SAR images will also be considered in in those scenarios in which cloud cover does

²⁷ <https://earthdata.nasa.gov/earth-observation-data/near-real-time/firms>

²⁸ (<https://www.nature.com/articles/s41598-019-56967-x> ,<https://www.usgs.gov/landsat-missions/landsat-normalized-burn-ratio>, <https://un-spider.org/advisory-support/recommended-practices/recommended-practice-burn-severity/in-detail/normalized-burn-ratio>

²⁹ <https://www.mdpi.com/2504-3900/2/7/364>)

prevent the acquisition of optical cloud-free imagery. In this case, specific radar indices such as the RBR - Radar Burn Ratio³⁰, which study the variation in the electromagnetic signal derived from structural changes in environmental conditions, will be used.

Other disturbances including illegal logging

No significant natural disturbances (such as floods or hurricanes) have occurred in the project area and therefore all non-fire disturbances have been considered as part of the deforestation analysis for illegal logging.

To address illegal logging, a field team from Rakyat Berjaya Sdn. Bhd will monitor the project area on a regular basis. Specifically, this monitoring will include helicopter surveillance (once a month), ground & river patrolling or surveillance for 10 days once every month by monitoring teams. In addition, the project also uses the Global Forest Watch optical- based GLAD and SAR-based RADD deforestation alerts.³¹ These alerts provide near-real time information that will be used as a guide for the SEARRP field team to check specific locations where illegal logging may be happening. To improve early detection of forest disturbances, the monitoring area has been extended, including a 2000m buffer area around the border of the project area. The monitoring team will receive instant email notifications of new alerts as soon as any of the three detection tools (GLAD-L, GLAD-S2 and RADD) detect a new deforestation event in the project area. These notifications will provide detailed information, in Bahasa language, about the location, date-time and detection confidence on any new deforestation event occurring in the project area. Additionally, the team will also receive continuous monthly summaries with information deforestation events.

To estimate the impact of the events, a Remote Sensing based multi-temporal deforestation analysis is carried out with the objective of mapping the illegal logging, or deforestation events that have occurred within the project area during the monitoring period. Both the access to data and the core deforestation analysis were developed on Google Earth Engine Platform (Gorelick et al., 2017)³². The methods of this analysis consists of three main parts. The first stage focuses on filtering the optical satellite image collections and obtaining cloud-free images for the subsequent generation of the annual composite image. Second, a supervised land cover classification is performed using machine learning classification algorithms. And the third and last part of the analysis focuses on the cleaning and post-processing of the final results using advanced GIS tools and software.

For a first stage, a comprehensive cloud-free image analysis was performed for each year. Historical image archives from the Landsat 8 Operational Land Imager (OLI), Landsat 9 Operational Land Imager (OLI), and Sentinel 2 MultiSpectral Instrument (MSI) were investigated using a preliminary search criterion of cloud cover $\leq 25\%$. The specific cloud percentage threshold at ($\leq 25\%$) was decided after evaluating the presence of cloudiness in randomly selected images with different cloud thresholds. The high and recurrent

³⁰ <https://www.sciencedirect.com/science/article/abs/pii/S0034425715301103?via%3Dihub>

³¹ <https://www.globalforestwatch.org/blog/data-and-research/glad-deforestation-alerts/>

³² <https://www.sciencedirect.com/science/article/pii/S0034425717302900>

cloudiness in the project area hindered the adoption of lower thresholds (i.e. $\leq 5\text{-}10\%$) since only 2.07%-[20 images] of all the images acquired (Landsat 8/9 and Sentinel-2) [639 images] during the monitoring period presented a cloudiness percentage below 10%. Both Landsat 8-9 and Sentinel-2 images were collected from the Level-2 Surface Reflectance (SR) collections available in the Google Earth Engine data archive³³ as shown in Table 3. In addition to Google's automatic pre-processing, the selected images were further pre-processed using a two-step process. First, an automatic and satellite-mission specific cloud-masking algorithm was applied to the images to remove all pixels affected by clouds. For the Landsat 8/9 images, a cloud mask function based on the Quality evaluation layer filtering (QABits- quality control bits) was used, while for the Sentinel-2 imagery the Cloud Probability image collection, generated by the Sentinel's Hub-Sentinel2 cloud detector tool, was utilised. And secondly, with the aim of enhancing the vegetation classification, the Normalize Difference Vegetation Index (NDVI) was calculated, and added to each composite image using the spectral information from the Red and Near-Infrared (NIR) bands.

Table 3: Table showing the optical satellite missions used for the annual composites and the percentage of area coverage for each composite image

Year	Mission/Sensor	N images	Area coverage (ha)	Cloud-free coverage (ha)	Cloud-free coverage (%)
2015	Landsat 8 (OLI)	6	83381.00	83381.00	100
2016	Landsat 8 (OLI)	4	79361.44	78798.83	94.50
2017	Landsat 8 (OLI)	5	81107.79	78360.04	93.98
2018	Landsat 8 (OLI)	2	81607.99	80883.40	97.00
2019	Sentinel-2 MSI	74	83381.00	83381.00	100
2020	Sentinel-2 MSI	73	83381.00	83381.00	100
2021	Landsat 8 (OLI)	7	83381.00	82688.51	99.17
2022	Landsat 8 (OLI)	2	83381.00	81680.86	97.96
	Landsat 9 (OLI2)				

In the second stage, a supervised classification was carried out in the Google Earth Engine environment using a Random Forest classification algorithm³⁴. The algorithm was trained with manually distributed ground-truth data for each of the 4 classes present in the analysis: Forest, Non-Forest, Water and Clouds. The classification analysis followed a 70-30 training/validation clause, using 70% of the ground truth sample for algorithm training and 30% for validation and accuracy metrics extraction. All classifications had a satisfactory overall accuracy, exceeding the minimum criteria of 90% defined in the methodology. A total of six (30 m spatial resolution) annual land cover classification maps were produced, which were used to investigate the forest changes that occurred from 2016 to 2021. Figure 5 shows as an example one of these maps (for the year 2016) resulting from the supervised Random Forest classification.

Project and Baseline Uncertainty

³³ Level-2 SR collections contain atmospherically corrected surface reflectance and land surface temperature, adjusting for atmospheric effects such as aerosol scattering and thin clouds, and thus helping in the detection and characterization of Earth's surface change (https://developers.google.com/earth-engine/datasets/catalog/LANDSAT_LC08_C02_T1_L2 ; <https://www.usgs.gov/landsat-missions/landsat-collection-2-surface-reflectance>).

³⁴ <https://developers.google.com/earth-engine/apidocs/ee-classifier-smilerandomforest>

There are three key sources of potential uncertainty in the prediction of baseline and project based emissions. These include the total merchantable volume (TMV) stock for trees with a DBH > 31 cm and 40 cm and the observed growth rate of the project area. Uncertainty limits for TMV were derived as follows: Volume maps were masked to the project area, values from all three bands were (mean, lower Prediction Interval (PI), upper PI) converted to a dataframe. A simulation consisting of 10000 iterations was carried out, for each iteration, 100 random samples were drawn, for every cell, from a normal distribution, centered around the cell mean and constrained by the upper and lower 95% PI values. All cell values for every simulation (n=1000000) were summed to give a simulated total. The 0.025th and 0.975th percentiles of the distribution were calculated and used as the PIs.

Uncertainty limits for the Project growth rate were derived from the fixed effects slopes of the linear mixed-effects (LME) model (#fig-model-growth-rate). Cell ID was used as a random effect in the LME model and therefore a slope value is generated for each cell. As with the Volume uncertainty, the 0.025th and 0.975th percentiles of the distribution were calculated and used as the PIs.

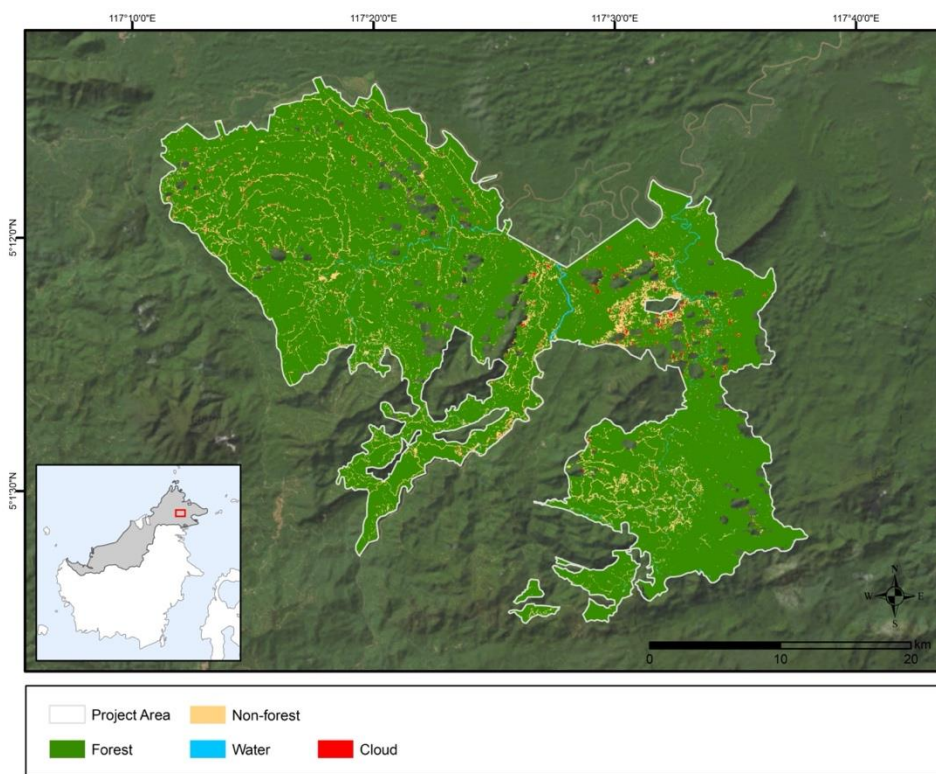


Figure 5: 2016 annual Land Cover classification map for the Kuamut project area

To increase confidence in the detections and avoid errors in the final calculations derived from redundant calls, a post-processing analysis of the final deforestation masks was performed. This post-processing consisted of two parts, the application of a morphological neighbourhood filter and a redundancy investigation. A morphological neighbourhood filter reduces the high false alarm rates that is a common

problem when working with satellite imagery. A sieve filter³⁵ was used to remove all polygons smaller than a given size and merges them with their larger neighbours. Considering that all structural disturbances and small-scale forest degradation were accounted for in the annual High-Resolution Above Ground Biomass (AGB) maps, and therefore included in the final carbon stock calculations, and effectively reduce any overall growth rate, it was decided to set the detection filter to a minimum area of deforestation in 2.5 ha. This filter increased the confidence levels of the detection by reducing the rate of false positives caused by spectral anomalies such as cloud edges. In addition, a forest change redundancy analysis was implemented to deal with specific areas that were identified as deforested on several occasion during the years. To avoid the repeated inclusion of all the 'already identified' deforested in area annual calculation of the following years, all 'Non-forest' areas from the years prior to the year studied were eliminated. For this, a cumulative strategy was used where all those areas that have been previously identified as 'deforested' in any of the previous years were subtracted from the non-forest annual mask investigated.

Recording, storing, aggregating, and collating the data on monitored parameters

All climate, community and biodiversity data generated by the project is centrally managed on the Permian server– with scans of the datasheets. Hard copies of all data sheets are archived in field offices, with duplicate copies stored centrally on the Permian server. Field data is emailed from the field office. This 'database' is currently collated and managed manually, but it can be adapted to fulfil all monitoring and reporting needs using standard and custom-made report formats.

The procedures used for handling any internal auditing performed and any non-conformities identified.

All data collected, recorded, stored and reported are subject to review and approval by team leaders and/or project managers with reference to written SOPs covering each level of data management (see Figure 6. A copy of the SOPs is available to validators on request. To ensure the security and traceability of data entry and QA/QC procedures, all users are allocated unique user IDs and passwords to access the database, and in turn their access and roles can be restricted as appropriate.

³⁵ Ose, 2018: <https://onlinelibrary.wiley.com/doi/10.1002/9781119457107.ch5> ; https://gdal.org/programs/gdal_sieve.html

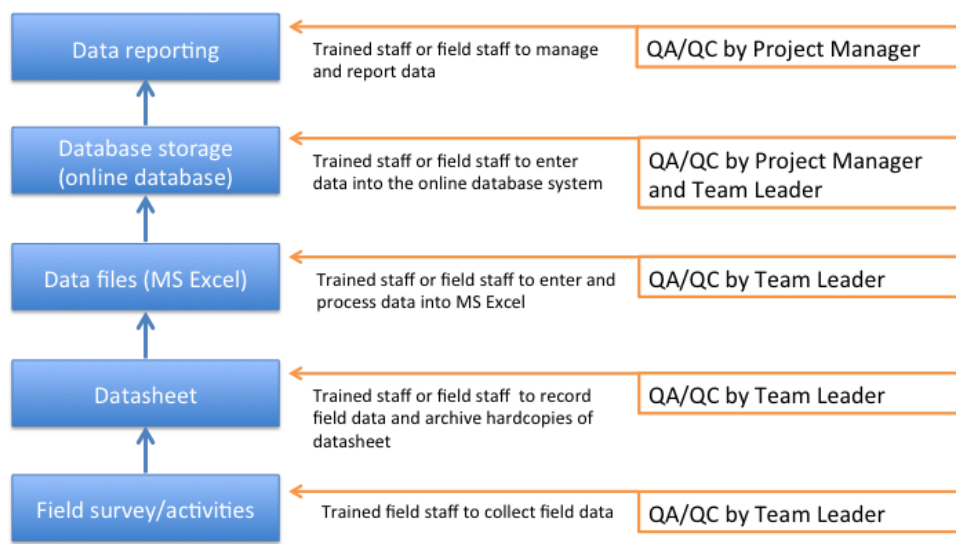


Figure 6: Data management QA/QC procedures

3.1.4 Dissemination of Monitoring Plan and Results (CL4.2)

The project informs its key partners, which are SEARRP, Yayasan Sabah, Sabah Forestry Department, PACOS Trust and the Community Group accordingly. Other means of communication that have been used throughout the monitoring period include SEARRP scientists, staff and appointed consultants who conducted forest monitoring surveys and consultations required for the certification of the Kuamut Rainforest Restoration Project. SEARRP undertook the surveys inside the forest reserve and with communities in the area, and these were coordinated with RBJ and the community leaders. Evidence of site access letters for these meetings have been provided to the VVB during the verification process.

3.2 Quantification of GHG Emission Reductions and Removals

3.2.1 Baseline Emissions

As indicated in section 2.2.4 of this monitoring report, the baseline numbers have been updated because of the availability of new more accurate and up-to-date datasets (see Appendix 1 for the updated baseline numbers). Table 4 below contains the recalculated quantified net greenhouse gas emissions in the baseline scenario from Appendix 1.

To be conservative, the Project Proponent has opted to forego the emissions reductions and removals created between the Project Start Date, 11th December 2015, and 31st December 2015.

Table 4: Net greenhouse gas emissions in the baseline scenario.

Year that logging would occur according to the timber harvesting plan	Net change in carbon stock across all parcels in the baseline scenario in year t* (tC)	Net greenhouse gas emissions in the baseline scenario in year t* (tCO ₂ e)	Cumulative net greenhouse gas emissions in the baseline scenario in year t* since the start of the project activity
2016	62'744.85	230'064.47	230'064.47
2017	89'309.57	327'468.44	557'532.91
2018	103'619.40	379'937.79	937'470.70
2019	160'404.16	588'148.59	1'525'619.29
2020	189'483.06	694'771.21	2'220'390.50
2021	187'617.75	687'931.75	2'908'322.25

3.2.2 Project Emissions

The net greenhouse gas emissions in the project are equal to carbon sequestration through ongoing forest growth minus any emissions resulting from forest disturbance (both illegal logging and natural disturbances).

Ongoing forest growth in the project scenario (section 8.2.1 of the methodology)

As detailed in section 3.1.3 above, the growth rate was calculated across multiple years for the entire Kuamut project area using the Aboveground Carbon Density (ACD) maps for the years 2016-2021. As explained in that same section, these maps are developed using a multi-temporal modelling approach to estimate the spatial variability and distribution of aboveground biomass. The modelling approach adopted a machine learning workflow that uses the following data sources: aerial LiDAR scan (ALS) data from 2016 describing canopy height, optical (Landsat 8) and Synthetic Aperture Radar (SAR) satellite imagery and forest plot data, all datasets acquired on the same year (2016).

The annual change in carbon stock in above ground biomass ($\Delta C_{AB,t|PRJ}$) is described in Eq. 32 of the VM0010 methods. To avoid any risk of accounting for on-going forest growth prior to the parcel harvest date in the baseline, we have modified the equation as presented below so that only areas of the project that would have been harvested prior to the close of the monitoring period are considered. The first main difference here is that the equation iterates at the parcel (P_i) level rather than strata level. Notably, we have simplified the equation to remove management strata as all parcels, considered in this project, comprise a single strata and corresponding project growth rate (GR_{it}) as derived in the growth rate section of the monitoring plan (3.1.3). Therefore, for each parcel the annual growth rate is calculated as the product of the area of the parcel (A_i), the growth rate (GR_{it}) and the conversion factor from carbon to CO₂. However, this annual growth is only applied on or after the baseline harvest date of the parcel ($t_{p\ harvest\ BSL}$). When year t is less than the baseline harvest date, the on-going forest growth is zero. When year t is equal to the baseline harvest date, the on-going forest growth is equal to the years since the start of the project multiplied by the growth rate, to account for growth prior to harvest. When year t is greater than the baseline harvest date, only the growth in that year is considered.

From the high-resolution maps, the annual carbon stock change in aboveground biomass of trees has therefore been calculated as:

$$\Delta C_{AB\ PRJ_t} = \sum_{i=1}^P \left(A_i \times GR_{i,t} \times \frac{44}{12} \times \begin{cases} 0, & \text{if } t < t_{p\ harv\ BSL} \\ 1 + t - t_{proj\ start}, & \text{if } t = t_{p\ harv\ BSL} \\ 1, & \text{if } t > t_{p\ harv\ BSL} \end{cases} \right)$$

Where:

$\Delta C_{AB,t PRJ}$	Annual carbon stock change in aboveground biomass of trees in year t, tCO ₂ e yr ⁻¹
$GR_{i,t}$	aboveground biomass carbon growth rate of trees in parcel <i>i</i> at time t, tC ha ⁻¹ yr ⁻¹
$t_{p\ harv\ BSL}$	baseline harvest date of the parcel, years
$t_{proj\ start}$	the start year of the project, years
A_i	Area covered by parcel <i>i</i> , ha
P	1,2,3 ... <i>i</i> each parcel
T	1,2,3 ... <i>t</i> * years elapsed since the start of the project activity.
44/12	Ratio of molecular weights of carbon dioxide and carbon, tCO ₂ e tC ⁻¹ .

The growth rates used for each strata in the project area, as described above in the growth modelling section, and after deducting for protected species using the species conservation factor are 3.01 t C ha⁻¹ yr⁻¹ for mosaic-planted, 2.84 t C ha⁻¹ yr⁻¹ for mosaic-unplanted and 1.98 t C ha⁻¹ yr⁻¹ for NFM.

Applying these resulting “adjusted” growth rates to the parcels that would have been harvested under the baseline within this monitoring period gives the results provided in the table below.

Table 5: Annual carbon stock change in aboveground biomass of trees in the project area

Year	Annual carbon stock change in aboveground biomass of trees in year t, tCO ₂ e)
2016	79'202.87
2017	281'959.53
2018	396'039.95
2019	705'293.33
2020	772'708.05
2021	644'031.90

Forest disturbance in the project scenario (section 8.2.2 of the methodology)

Forest disturbances in the project scenario result from fire and non-fire forest disturbances, plus any carbon stock changes that occur as a result of illegal logging.

Natural Disturbance - Fire

The net greenhouse gas emissions resulting from fire disturbance are calculated as

$$\Delta C_{DIST-FR,t|PRJ} = \sum_{i=1}^M A_{Burn,i,t} * B_{i,t|PRJ} * COMF_i * G_{g,i} * 10^{-3} * GWP_{CH_4} \quad \text{Equation 1}$$

Where:

$\Delta C_{DIST-FR,t PRJ}$	Net greenhouse gas emissions resulting from fire disturbance in year t , tCO ₂ e
$A_{burn,i,t}$	Area burnt for stratum i at time t , ha
$B_{i,t PRJ}$	Average aboveground biomass stock present in the project scenario but absent in the baseline scenario before burning stratum i , time t ; t d. m. ha ⁻¹
$COMF_i$	Combustion factor for stratum i , dimensionless
$G_{g,i}$	Emission factor for stratum i for methane, g kg ⁻¹ dry matter burnt
GWP_{CH_4}	Global warming potential for CH ₄ (IPCC default: 21), tCO ₂ e tCH ₄ ⁻¹ ;
i	1,2,3 ... M strata
t	1,2,3 ... t^* years elapsed since the start of the project activity.

If any area is subject to a fire disturbance, the aboveground biomass stock present in the project scenario but absent in the baseline scenario before burning will be derived from the ACD maps (see Figure 4) by applying the following equation:

$$B_{i,t|PRJ} = \sum_{j=1}^J \{V_{EX,i,j|BSL} * BCEF_R\} \quad \text{Equation 2}$$

Where:

$B_{i,t PRJ}$	Average aboveground biomass stock present in the project scenario but absent in the baseline before burning for stratum i , time t , t d. m. ha ⁻¹ ;
$V_{EX,i,j BSL}$	Mean volume of extracted timber per unit area for species j in stratum i , m ³ .ha ⁻¹
$BCEF_R$	Biomass conversion and expansion factor applicable to wood removals in the project area, t.d.m m ⁻³ ;
i	1,2,3 ... M strata
j	1, 2, 3 ... J tree species
t	1,2,3 ... t^* years elapsed since the start of the project activity.

As detailed in section 3.1.3 above, the project monitors the presence of any fire within or just outside project area using. NASA FIRMS alerts.³⁶ Figure 7 presents all NASA FIRMS alerts for the monitoring period (2016 - 2021). As can be seen in Figure 7, no fires were registered within the project area during this

³⁶ <https://earthdata.nasa.gov/earth-observation-data/near-real-time/firms>

period. The specific dataset containing all fire alerts for the monitoring period will be provided during the verification.

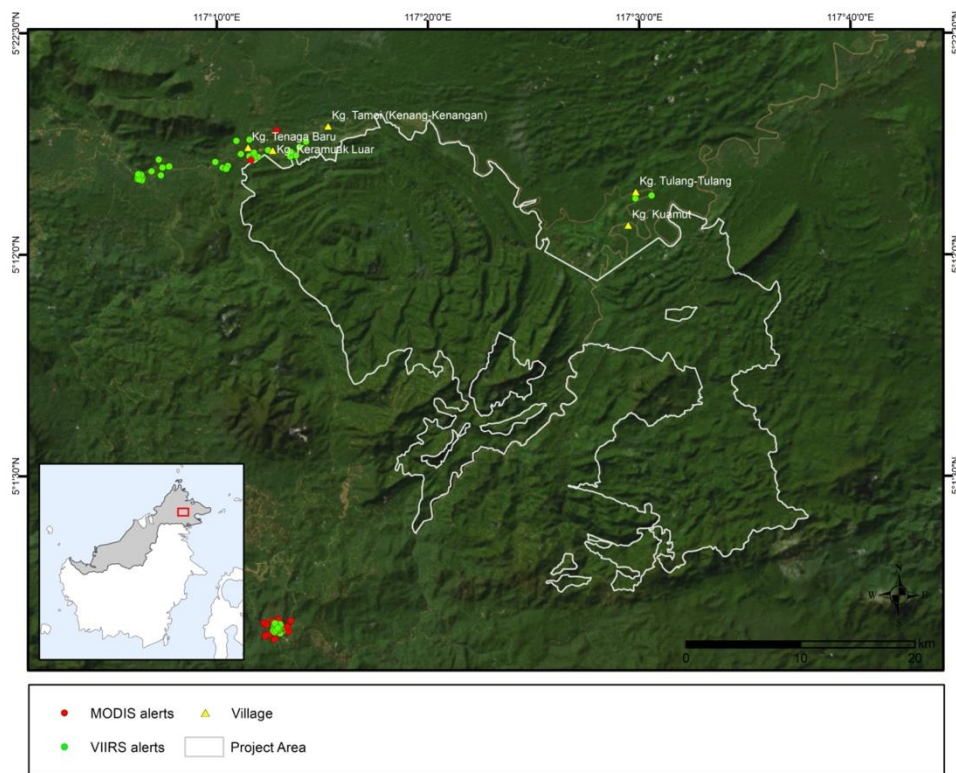


Figure 7: Map illustrating all NASA FIRMS (MODIS & VIIRS) fire alerts identified in the Kuamut project area and its surrounding region. Monitoring period investigated (01/01/2016 - 07/12/2022). Data downloaded from [NASA-FIRMS](https://firms.modis.eos.nasa.gov/public/FIRMS/)

Disturbance - Non-Fire and illegal logging

For non-fire natural disturbance, it is assumed that a disturbance event in the project scenario would also have occurred in the baseline scenario. Project emissions are therefore equal to the non-fire natural disturbance to biomass absent in the baseline scenario (harvested and removed) but present in the project scenario. The resulting greenhouse gas emissions are calculated as:

$$\Delta C_{DIST,t|PRJ} = \sum_{i=1}^M (A_{dist,i,t} * \sum_{j=1}^J \{C_{AB,j,i|BSL}\}) * \frac{44}{12} \quad \text{Equation 3}$$

Where:

$\Delta C_{DIST,t PRJ}$	Net greenhouse gas emissions resulting from non-fire natural disturbance in year t , tCO ₂ e
$A_{dist,i,t}$	Area disturbed for stratum i at time t , ha
$C_{AB,i BSL}$	Carbon stock in aboveground biomass per unit area in stratum i , tC·ha ⁻¹
44/12	Ratio of molecular weights of carbon dioxide and carbon, tCO ₂ e tC ⁻¹

- i 1,2,3 ... M strata
 j 1, 2, 3 ... J tree species; and
 t 1,2,3 ... t^* years elapsed since the start of the project activity.

No significant non-fire natural disturbances (such as floods or hurricanes) have occurred in the project area and therefore all non-fire disturbances have been considered as illegal logging.

As detailed in section 3.1.3, a Remote Sensing based multi-temporal deforestation analysis was carried out with the objective of mapping the extent of the illegal logging, or deforestation events that have occurred within the project area during the monitoring period. The results of this analysis are shown in Figure 8.

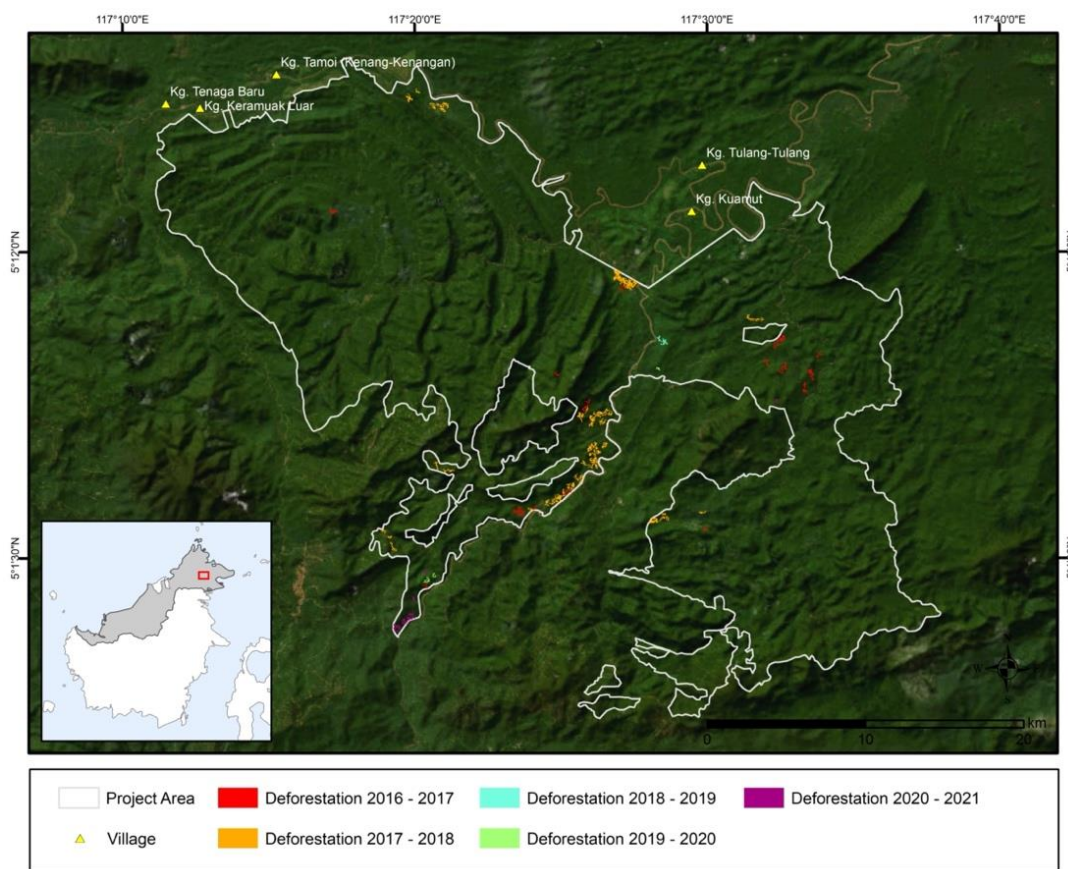


Figure 8: Map showing annual deforestation resulting from illegal logging activities within the Kuamut project area

The annual areas of deforestation are listed in Table 6 below.

Table 6: Annual deforestation figures resulting from illegal logging activities within the Kuamut project area.

Period	Area deforested (ha)	Project area deforested %
2016 - 2017	97.70	0.117
2017 - 2018	309.70	0.372

2018 - 2019	10.10	0.012
2019 - 2020	11.50	0.014
2020 - 2021	34.30	0.041
2021 - 2022	0.00	0.000
Total	463.1	0.556

An interactive web-mapping App was developed with the aim of facilitating the exploration of the final results obtained from the multitemporal analysis of deforestation which will be made available to the verifier.

The monitored areas were combined with the ACD maps to calculate $\Delta C_{DIST,t|PRJ}$ as shown in Table 7.

Table 7: Net greenhouse gas emissions resulting from non-fire disturbance in year t

Year	Area disturbed at time t (ha)	Net greenhouse gas emissions resulting from non-fire natural disturbance in year t (tCO ₂ e)
2016	97.7	20,115.6
2017	309.7	79,186.3
2018	10.1	469.3
2019	11.5	2,368.5
2020	34.3	8,080.7
2021	0.0	0.0

Net greenhouse gas emissions in the project scenario (section 8.2.3 of the methodology)

The net greenhouse gas emissions in the project scenario in year t are then calculated as:

$$\Delta C_{NET,t|PRJ} = (\Delta C_{DIST-FR,t|PRJ} + \Delta C_{DIST,t,PRJ} + \Delta C_{DIST-IL,t|PRJ}) - \Delta C_{AB,t|PRJ} \quad \text{Equation 4}$$

and

$$GHG_{Net|PRJ} = \sum_{t=1}^{t^*} \Delta C_{Net,t|PRJ} \quad \text{Equation 5}$$

Where:

$GHG_{Net PRJ}$	Net greenhouse gas emissions in the project scenario since the start of the project activity, tCO ₂ e
$\Delta C_{NET,t PRJ}$	Net greenhouse gas emissions in the project scenario in year t, <i>not including areas that would not yet have been harvested under the baseline for this monitoring period</i> , tCO ₂ e;
$\Delta C_{DIST-FR,t PRJ}$	Net greenhouse gas emissions resulting from fire disturbance, assessed over the entire project area, in year t, tCO ₂ e

$\Delta C_{DIST,t PRJ}$	Net greenhouse gas emissions resulting from non-fire natural disturbance, included In growth, and therefore <i>not including areas that would not yet have been harvested under the baseline for this monitoring period</i> , in year t , tCO ₂ e
$\Delta C_{DIST_IL,t PRJ}$	Net carbon stock changes as a result of illegal logging, assessed over the entire project area, at time t , tCO ₂ e
$\Delta C_{AB,t PRJ}$	Annual carbon stock change in aboveground biomass of trees in year t , <i>not including areas that would not yet have been harvested under the baseline for this monitoring period</i> , tCO ₂ e yr ⁻¹
t	1,2,3 ... t^* years elapsed since the start of the project activity.

The area used to delineate disturbance due to fire and or illegal logging includes the entire area contained within the project perimeter. Conversely, the area used to account for on-going forest growth (with natural disturbance combined) corresponds to the cumulative area that would have been harvested at time t in the baseline scenario. The net carbon stock change has been converted to net greenhouse gas emissions resulting in Table 8.

Table 8: Actual greenhouse gas emissions in the project

Year	Net greenhouse gas emissions resulting from fire disturbance in year t (tCO ₂ e)	Net greenhouse gas emissions resulting from non-fire disturbance and illegal logging (tCO ₂ e)	Annual carbon stock change in aboveground biomass of trees in year t , tCO ₂ e)	Net greenhouse gas emissions in the project scenario in year t^* (tCO ₂ e)	Cumulative net greenhouse gas emissions in the project scenario in year t^* since the start of the project activity
2016	0.00	20,115.6	- 79'202.87	-59'087.27	-59'087.27
2017	0.00	79,186.3	- 281'959.53	-202'773.23	-261'860.50
2018	0.00	469.3	- 396'039.95	-395'570.65	-657'431.15
2019	0.00	2,368.5	- 705'293.33	-702'924.83	-1'360'355.97
2020	0.00	8,080.7	- 772'708.05	-764'627.35	-2'124'983.33
2021	0.00	0.00	- 644'031.90	-644'031.90	-2'769'015.22

3.2.3 Leakage

In accordance with the methodology, leakage from activity shifting and market leakage are considered.

Analysis for leakage due to activity shifting (section 8.3.1 of the methodology)

As detailed in the PD, the project area is owned by Yayasan Sabah and under the baseline scenario would have been managed by its subsidiary, Rakyat Berjaya Sdn. Bhd. Licences to harvest, through annual coupe permits would have been issued by the Sabah Forestry Department and granted to Rakyat Berjaya Sdn Bhd.

The management plans for Yayasan Sabah and Rakyat Berjaya Sdn. Bhd. have not materially changed as a result of the project and neither have the permits issued by the Sabah Forestry Department materially changed. To show this, historical records showing trends in harvest volumes were paired with records from the with- project time period. For the PD, historical timber harvest data was collated from the Sabah Forestry Department for each year from 2010 until 2019, for each active concession in Sabah during this time period. We have now updated this to include the data for 2020 and 2021 to directly reflect the monitoring period. The data collected included data on the volume extracted, the area that was harvested, and the logging type (NFM or Salvage logging). This results in multiple records for each forest reserve. We calculated the timber volume per hectare for each individual record, and all of this data is shown graphically in Figure 9. The figure shows that there is no material difference between the Timber Volume extracted from the other forest reserves before and after the start of the project activity, therefore there is no evidence of any activity shifting leakage. The full detailed dataset used to make this graph, including details of year and Forest reserve will be made available to the verifier.

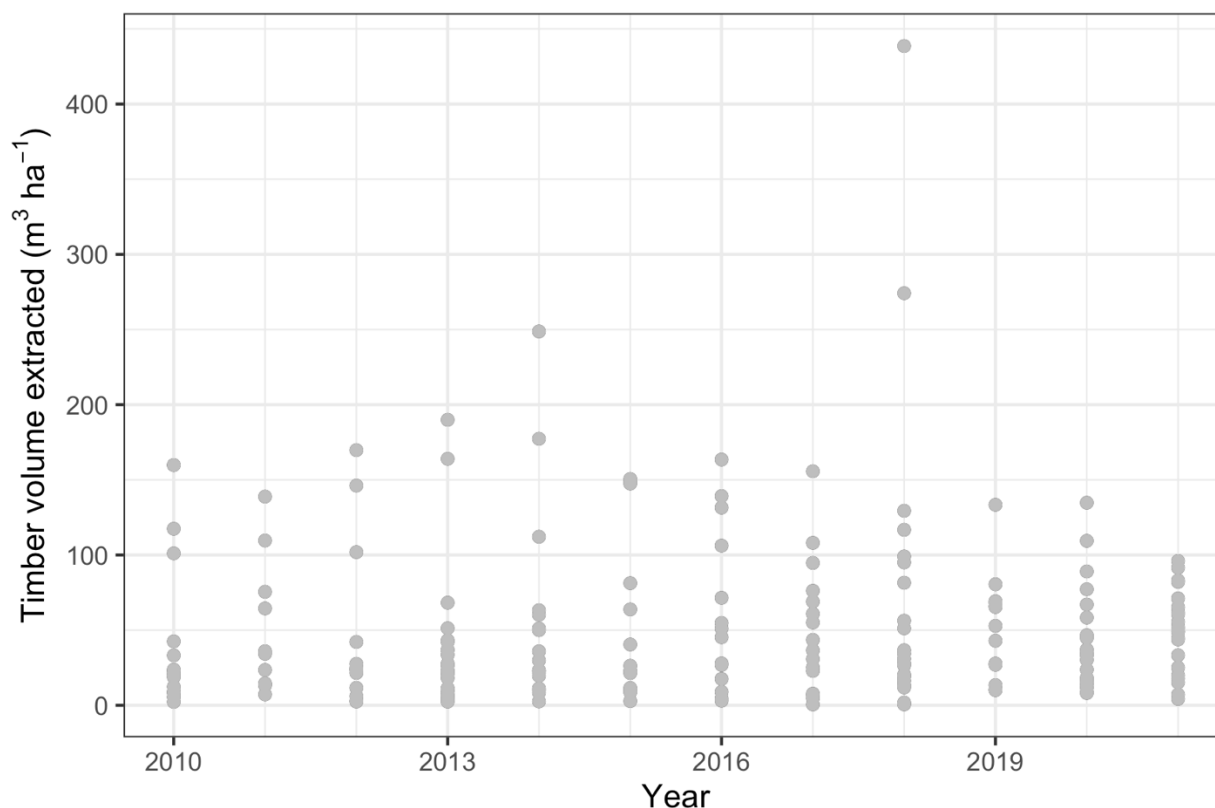


Figure 9: Historical timber harvest volume data through time in cubic meters per hectare. Data was collated by Sabah Forestry Department for all active concessions in the state from 2010 to 2021.

Analysis for leakage due to market effects (section 8.3.2 of the methodology)

Market leakage theoretically could occur when the project significantly reduces the production of timber causing a change in the supply and market demand equilibrium that results in a shift of production elsewhere to make up for the lost supply. According to the methodology, market leakage will be estimated as:

$$GHG_{LK|LtPF,t^*} = LF_{ME} * GHG_{NET|BSL,t^*} \quad \text{Equation 6}$$

Where:

$GHG_{LK LtPF,t^*}$	Total market leakage as a result of IFM LtPF activities, in the year t^* since the start of the project activity, tCO ₂ e
LF_{ME}	Leakage factor for market-effects calculations; dimensionless
$GHG_{NET BSL,t^*}$	Net greenhouse gas emissions in the baseline scenario in the year t^* since the start of the project activity, tCO ₂ e

The leakage factor that is applied to the baseline emissions is determined by comparing the ratio of merchantable biomass to total biomass in the project area and the forests to which timber harvesting would have been displaced. In the PD, the factor was calculated as shown in Table 9 below:

Table 9: Calculated deduction factors (LF_{ME})

Stratum in the project area	Corresponding forest type in the analysed forest estate	% difference between PMP _i and PML _{FT}	LF_{ME}
Stratum 2	Natural Forest Management	-10.3%	0.4
Stratum 3 and Stratum 4	Salvage logging	35.5%	0.2

Based on the area of the NFM Strata (35241.45 ha), and the Mosaic Strata (44808.52 ha), we estimated an area weighted leakage for the entire project as 0.288.

Market leakage concerns the timber that would have been harvested under the baseline scenario based on the merchantable biomass and total biomass present in the project area under that baseline scenario. As indicated in section 2.2.4 of this monitoring report, the baseline numbers have been updated because of the availability of new more accurate and up-to-date datasets (see Appendix 1 for the updated baseline numbers). However, despite the small change in the PMP_i value, and resulting minor change in the estimated ratio of merchantable biomass to total biomass (PMP_i) in the project area and the resulting leakage factor (LF_{ME}) stay the same as calculated in the PD. See Appendix 1 for the full description of the updated input data values

Applying the estimated value of 0.288 to equation 7 and using activity leakage of zero, this leads to the following results for the leakage calculation as shown in Table 10.

Table 10: Emission as a result of leakage.

Year that logging would occur according to the timber harvesting plan	Leakage due to activity shifting (tCO ₂ e)	Market leakage as a result of IFM LtPF activities in year t* (tCO ₂ e)	Total cumulative leakage in year t* since the start of the project activity
2016	0	66'258.57	66'258.57
2017	0	94'310.91	160'569.48
2018	0	109'422.08	269'991.56
2019	0	169'386.80	439'378.36
2020	0	200'094.11	639'472.47
2021	0	198'124.34	837'596.81

3.2.4 Net GHG Emission Reductions and Removals

To be conservative, the Project Proponent has opted to forego the emissions reductions and removals created between the Project Start Date, 11th December 2015, and 31st December 2015.

Table 11: Net GHG Emission Reductions and Removals.

Year	Baseline emissions or removals (tCO ₂ e)	Project emissions or removals (tCO ₂ e)	Leakage emissions (tCO ₂ e)	Net GHG emission reductions or removals (tCO ₂ e)
2016	230'064.47	-59'087.27	66'258.57	222'893.17
2017	327'468.44	-202'773.23	94'310.91	435'930.76
2018	379'937.79	-395'570.65	109'422.08	666'086.36
2019	588'148.60	-702'924.83	169'386.80	1'121'686.62
2020	694'771.21	-764'627.35	200'094.11	1'259'304.46
2021	687'931.75	-644'031.90	198'124.34	1'133'839.30
Total	2'908'322.25	-2'769'015.22	837'596.81	4'839'740.67

The non-permanence risk rating has been calculated using the VCS AFOLU Non-Permanence Risk Tool. The assessment is annexed to this PD and shows that the non-permanence risk rating for this project is 12% which is the minimum risk rating to be applied according to the tool.

Applying this to the numbers in Table 11 means a total of 580,769 buffer credits that need to be deposited into the AFOLU pooled buffer account.

3.3 Optional Criterion: Climate Change Adaptation Benefits

The project-zone communities are vulnerable to the potential climate change impacts because their livelihoods and well-being are dependent on the healthy ecosystem of the forest in the project area. Although some negative impacts of climate change are inevitable, and beyond the control of the Kuamut Project, we aim to strengthen community and biodiversity resilience by implementing adaptation options through a variety of projects.

Additionally, by protecting the forest the project reduces erosion and sediment production from the project area. This in turn positively affects ecosystem services such as water balance, surface runoff, erosion, and sediment transport downstream of the project area.

3.3.1 Activities and/or processes implemented for Adaptation (GL1.3)

The adaptation benefits of the Kuamut project in terms of ecosystem services were evaluated using the Co\$tingNature Policy support system (Mulligan, 2022³⁷). The analysis considered two vegetation cover scenarios: a baseline scenario prior to the project's start (year 2015), which was compared to the scenario considered in the project validation report; and scenario two to the year 2021, which is six years after the project's start. Additionally, the impact of the change in surface biomass on erosion and sediment production from the project area was assessed. Outcomes were evaluated in terms of ecosystem services of climate change adaptation, such as changes in water balance, surface runoff, erosion, and sediment transport downstream of the project area, and their effects on water quality and water stress, both for human consumption and the development of agricultural activities downstream of the project area.

Using the Costing Nature Policy support system, the hydrological effects of forest conservation and regrowth at the Kuamut Project Scale were modelled. The spatial eco-hydrological model CostingNature was created to evaluate ecosystem services in scenarios of changing climate and land use. The model can simulate changes in water supply and stress, which could have an impact on potential climate adaptation strategies. Variables are modelled at a spatial resolution of 1 km, 90 m and 30 m. The model creates the area's baseline hydrology and enables the development of scenarios for changing land use and cover, as well as their interaction with ecological factors like biodiversity. It is especially appropriate to comprehend the function of ecosystems in providing climate adaptation benefits for people and biodiversity. The model was used to depict the annual hydrology for the entire Sabah district at a spatial scale of 1 km². The climate data for rainfall and temperature used for model parameterization was the same used as project baseline for the validation report, so no changes in temperature or rainfall are considered. Therefore, the adaptation benefits studied here are explored as a result of a better and more protected forest, under the assumption that such benefits will help the project area, and its areas of influence, adapt to the changing climate described in the validation report. The results of the analysis are discussed according to different services including hydrological, erosion, water quality and water stress.

³⁷ Mulligan, M. (2022) Model results from the CostingNature version 2 policy support system. <https://www.policysupport.org/costingnature>

Hydrological

Increases in forest cover generated neutral impacts on the annual water balance, given that water losses through evapotranspiration (e.g. larger plant individuals consume more water), are significantly offset by a greater infiltration of water into the soil and a more regular soil water content, on an annual average, over the six years of evaluation (close to 0.9% annual increase when comparing years 2016 and 2021). Moreover, Evapotranspiration is a process that increases as the vegetation grows, but water losses are compensated in terms of regulation with greater water infiltration, which ensures greater water retention in the soil, preventing its loss through rapid runoff on compacted soils. Similarly, soil infiltration increases by having more vigorous vegetation, which guarantees less soil compaction, better root development, and thus, a more regulated soil water content (e.g. using the full soil porosity and soil water storage capacity as opposed to more compacted soils).

As a consequence of this neutral effect, at the regional scale of analysis, the annual runoff showed no significant changes downstream of the project, particularly along the Kinabatangan river. However, better infiltration within the project area is likely to improve water regulation in dry periods, between March and September, downstream of the project area, and along the Kinabatangan river. A monthly hydrological analysis of high spatial and temporal resolution and calibrated to the Kinabatangan river basin, could help to quantify these hydrological benefits of the project in greater detail, but such scale of detail escapes the present general appraisal of adaptation services generated by the project.

Erosion

In terms of erosion, a higher above-ground biomass in the project area, and therefore a higher fraction of soil covered by vegetation, reduces erosion within the project area, and therefore downstream sediment transport. According to the modelling carried out at a regional scale, sheet erosion within the project area has been likely reduced by around 2,500 tons per year, in 2021 compared to that modelled in 2016, at project start. This reduction has mainly reduced sediment transport through the Kinabatangan river, with benefits for water quality for human populations and their agricultural activities in the Kinabatangan district. As indicated earlier, higher spatial scale modelling efforts would be required to more precisely evaluate avoided erosion benefits by the project, because at the present 1km scale of analysis soil erosion processes are likely to be underestimated due to smoother slopes represented by a 1km DEM. Therefore, the potential of soil erosion prevention already achieved by the project is likely higher, but assessing it in more detail would require more complex hydrological and soil erosion modelling, which escapes the scope of the present general and regional appraisal of adaptation benefits generated by the project.

Water Quality

The benefits of forest conservation and regrowth in the Kuamut project area in terms of improved water quality were assessed using the Human Footprint on Water Quality Index. In the case of this analysis, the main variable that affects water quality is the reduction of sediments, as described above. According to the modelling, the human footprint on water quality is reduced by about 2 percent downstream of the project area, as a result of reduced sedimentation. This adaptation service is of great value for the supply of drinking water, the reduction of treatment costs and the improvement of human health, in the communities located downstream of the project area. On the other hand, the reduction of sedimentation improves the quality of water supplied to productive lands within the influence of the Kinabatangan river. However, as the

river passes through unprotected areas further downstream, the pollution that results from these areas dilutes the effect of having cleaner water draining from the Kuamut project area. Therefore, better soil and land cover management in the project zone and further downstream would be very important to amplify the adaptation benefits of the project in terms of reduced pollution. Despite this, it is expected that as the project continues to reduce deforestation and increase biomass, erosion and sedimentation generated from within the project area will continue to reduce ensuring better water quality immediately downstream.

Figure 10 presents the reducing effect of the Human Footprint on Water Quality (HFWQ) thanks to the reduction of sedimentation that occurred in the project area. The HFWQ is the percent of runoff at any point that fell as rainfall on potentially contaminating land uses upstream. It is calculated as cumulated downstream runoff from polluting (e.g. agriculture) and non-polluting (e.g. natural land) land uses, with the polluted runoff then expressed as the proportion of total runoff. For application in the Kuamut project, the HFWQ represents the decrease in the percentage of water contaminated by sediments as a result of decreased erosion due to increased AGB in the project area.

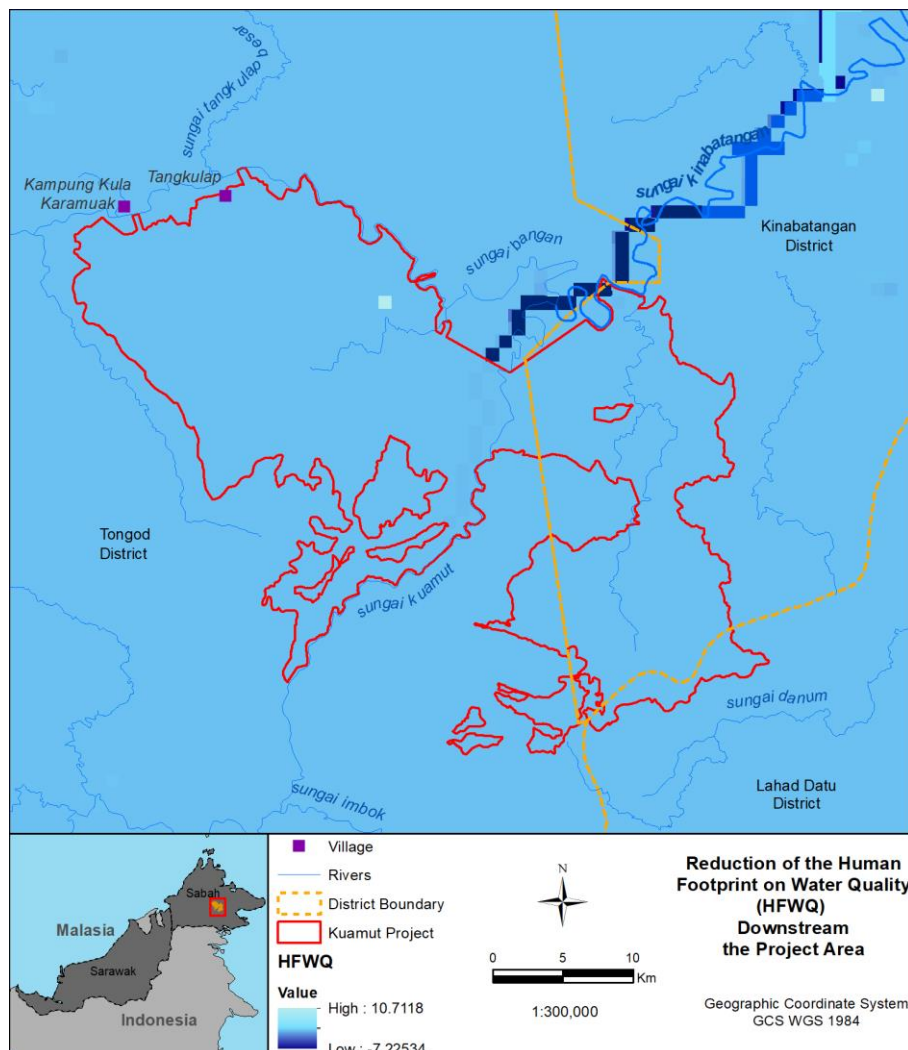


Figure 10: Reduction of the Human Footprint on Water Quality (HFWQ) Downstream the Project Area.

Water stress

Since the surface water balance and surface runoff do not change significantly, water stress in water quantities remain relatively constant in the year 2021, especially downstream of the Kinabatangan River. However, water stress is reduced because of better water quality, as elaborated in the section on human footprint on water quality. As previously indicated, a more detailed hydrological analysis with a model calibrated and adjusted to the project area and the Kinabatangan river basin, could allow a more detailed quantification of these aspects. However, such detail is beyond the scope of this overall assessment of the provision of adaptation services generated by the project.

In conclusion, the Project is already contributing to tackle some of the potential impacts of climate change, described in the validation report, and thus has started to provide some clear adaptation benefits. In terms of environmental benefits, the project has already reduced the supply of sediments from the project area to important rivers such as the Kinabatangan, with positive implications for communities and agricultural activities along the river and within the important Kinabatangan district. Furthermore, water stress problems, which may result from the early impacts of climate change, have not increased immediately downstream the project area, since a more vigorous forest cover has started to provide a better water flow regulation and soil water storage.

In terms of economic benefits, the project is potentially already contributing to lower water treatment and sanitation costs downstream, as well as reduced dredging costs of rivers such as the Kinabatangan, which is likely seeing less transport of sediments from the project area. Socially, the project is clearly contributing to the provision of a better quality of potable drinking water, and water for agricultural activities, with positive implications for human health and their economic activities.

The table below shows a summary of the potential adaptation benefits already provided by the project according to the modeling presented above.

Table 12 adaptation benefits already provided by the project according to the modelling

Activity	Components	Adaptation Benefits
Ecosystem protection and forest regeneration	- Avoided Degradation due to logging - Avoided deforestation - Reforestation - Fire prevention - Habitat and species protection - Reduction in hunting pressures	Forest regrowth and increased biomass of forests in the Kuamut project, have already resulted in important adaptation benefits such as reduced soil erosion and sedimentation downstream. Thus, ensuring a better water quality downstream to help maintain or improve the availability of potable water, reduce water filtration costs and potentially reduce the

		prevalence of gastrointestinal and vector diseases.
Improved Public health and sanitation services	- Improved access to clean water and sanitation facilities - Improved access to public health care services	Reduced soil erosion and sedimentation is helping to improve the water quality downstream the project area, along the Kinabatangan River, both for human communities and their agricultural activities.

4 COMMUNITY

4.1 Net Positive Community Impacts

4.1.1 Community Impacts (CM2.1)

The project area contains no human settlements. Outside the project area, the project zone includes eight villages in two clusters, within 20 km of the Project Area, as stipulated in VCS guidance. The tables below provide a description of the net positive impacts for all community groups.

Karamuak Cluster - Community Building (rest houses, hostel and community hall) Repairs – implemented by RBJ, stand-alone activity.

Community Group	Karamuak Cluster
Impact	Enhanced living conditions through repaired community buildings that are used for community gatherings, training and accommodation, contributing to the broader goals of community infrastructure improvement, and fostering a sense of pride and security. Given these are community buildings, the repairs impacted up to 30-50 people according to the capacity of the community hall, rest houses and hostel available.
Type of Benefit/Cost/Risk	Benefit, Direct
Change in Well-being	The repaired community buildings significantly strengthened social bonds among residents, leading to more communal gatherings and enhanced relationships. Residents experienced a marked improvement in psychological health due to the pride and security associated with living in well-maintained environments. A heightened sense of belonging emerged among community members, fostering a shared identity and attachment to the community. The project's alignment with broader infrastructure goals ensured long-term sustainability, promising lasting benefits for future generations.

	Cultural heritage was preserved and celebrated through the maintenance of traditional buildings and structures, integral to the community's identity. Environmental health improved, thanks to better waste management, efficient resource use, and possibly the incorporation of sustainable materials in the housing repairs.
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Karamuak Cluster – Construction of Community Hall Toilet – implemented by RBJ, stand-alone activity.

Community Group	Karamuak Cluster
Impact	Improved community health standards with the construction of a community hall toilet, representing a proactive approach to health and hygiene. Health improvements, such as reduced disease prevalence, are expected outcomes, contributing to the overall wellness of the community.
Type of Benefit/Cost/Risk	Benefit, Direct
Change in Well-being	The construction of the community hall toilet directly led to improved community health standards, demonstrating a proactive approach to health and hygiene. There was a noticeable reduction in the prevalence of diseases, particularly those associated with poor sanitation and hygiene, contributing to the overall wellness of the community. The new facility had a direct and positive impact on public health, enhancing the daily lives of community members and reducing health risks. The initiative promoted greater awareness and education about hygiene and sanitation practices, fostering a culture of health consciousness within the community. The improved sanitation facilities indirectly contributed to increased community participation in public events and gatherings, owing to the enhanced comfort and hygiene standards. The project also positively impacted the environment by reducing contamination and pollution, which are often associated with inadequate sanitation facilities. This development in sanitation infrastructure is expected to have long-term benefits, including sustained improvement in public health and continued adherence to higher standards of hygiene and cleanliness.

Karamuak Cluster - Tree Felling for Safety – implemented by RBJ, stand-alone activity.

Community Group	Karamuak Cluster
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Impact	Increased safety through strategic tree felling near the community center, addressing an unforeseen safety hazard. This initiative is part of the general safety and well-being improvements within the project's scope.
Type of Benefit/Cost/Risk	Benefit, Direct
Change in Well-being	The strategic tree felling near the community center significantly enhanced physical safety, addressing a previously unforeseen safety hazard. This initiative led to a noticeable reduction in the risk of accidents, such as falling branches or trees, especially during adverse weather conditions. Residents experienced an increased sense of security in their living environment, knowing that proactive measures were taken to ensure their safety. The project contributed to the overall aesthetic improvement of the area, making the community center surroundings more appealing and accessible. The tree felling was part of a broader initiative to improve general safety and well-being, indicating a comprehensive approach to community development. This action also increased awareness and understanding among community members about the importance of environmental management and safety. By addressing this specific hazard, the community demonstrated its ability to identify and respond to safety concerns effectively, fostering trust and confidence in local leadership.

Karamuak Cluster - Construction of Protective Fence – implemented by RBJ, stand-alone activity.

Community Group	Karamuak Cluster
Impact	Enhanced safety around the SESB power station with the construction of a protective fence, directly responding to community requests. This project contributes to the general improvement in community safety.
Type of Benefit/Cost/Risk	Benefit, Direct
Change in Well-being	The construction of the protective fence around the SESB power station directly enhanced the safety of the surrounding area, responding effectively to the concerns raised by the community. Residents, especially those living near the power station, experienced a heightened sense of security, knowing that a physical barrier was in place to prevent accidents.

	This safety measure significantly reduced the risk of potential hazards associated with the power station, such as electrical accidents or unauthorized access. The initiative demonstrated the community leadership's responsiveness to resident concerns, thereby strengthening trust and communication between the community members and local authorities. The fence not only served as a safety feature but also as a symbol of the community's commitment to proactive safety measures and infrastructure improvements. This project contributed to the overall sense of well-being in the community, as residents felt that their safety and concerns were being prioritized. The aesthetic aspect of the fence, if designed considerately, could also enhance the visual appeal of the area around the power station, contributing to the community's pride in their environment.
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Karamuak Cluster - Provision of Polypipes for Water System – implemented by RBJ, stand-alone activity.

Community Group	Karamuak Cluster
Impact	Improved access to clean water with the provision of polypipes, directly addressing a critical need. This project enhances health and hygiene, aligning with the overall improvements in community conditions, including health services and infrastructure development. 98 households received access to this clean water supply.
Type of Benefit/Cost/Risk	Benefit, Direct
Change in Well-being	Prior to the social baseline survey, the Karamuak villages (with the exception of Tamoi) had piped water supplied by a gravity feed system, however as was highlighted by many community members during the social baseline survey, the supply was insufficient and they frequently relied on stored rainwater. The new polypipe installations have provided a marked improvement in health and hygiene, with a notable reduction in time and effort spent on water collection.

Tongod Communities - Youth Day Event – implemented by RBJ, stand-alone activity.

Community Group	Tongod Communities
Impact	Enhanced engagement and capacity building of youth through the Youth Day event, fostering community spirit and youth involvement. This event is part of the broader goal of community

	engagement, as evidenced by the training of 111 individuals in various skills during the monitoring period.
Type of Benefit/Cost/Risk	Benefit, Direct
Change in Well-being	The Youth Day event significantly enhanced engagement and capacity building among the youth, fostering a strong sense of community spirit and involvement. This event led to strengthened community bonds, as young people actively participated and connected with others in the community, bridging generational gaps. Youth empowerment was a key outcome, with young members of the community gaining confidence and skills that are essential for personal and professional development. The training of 111 individuals in various skills during the monitoring period contributed to an increase in the overall skill set within the community, enhancing employability and self-reliance. Increased participation of youth in community decision-making processes was observed, bringing fresh perspectives and ideas to the table and ensuring a more inclusive community governance. The event and the associated training programs promoted a sense of ownership and responsibility among the youth, encouraging them to contribute positively to their community. The initiative also laid the groundwork for future community projects and events, with the youth now more equipped and motivated to lead and participate.

Karamuak and Kuamut Clusters - Community Learning Centre Training – implemented by PACOS, stand-alone activity in 2017.

Community Group	Karamuak and Kuamut Clusters
Impact	Empowerment of women through Accounts and Management Training at the Community Learning Centre, enhancing autonomy and decision-making power. Specifically, 15 individuals were trained, promoting gender equality and financial literacy.
Type of Benefit/Cost/Risk	Benefit, Direct
Change in Well-being	The Accounts and Management Training at the Community Learning Centre empowered women by enhancing their autonomy and decision-making power. A total of 15 individuals received training, which significantly contributed to promoting gender equality and financial literacy within the community.

	This empowerment led to increased confidence among women, allowing them to actively participate in financial and management roles that were previously less accessible. The training facilitated a shift in community perceptions regarding gender roles, fostering a more inclusive and equitable environment. Women's enhanced financial literacy and management skills contributed to better financial planning and decision-making within households and community projects. The initiative also inspired other women and girls in the community, serving as a powerful model for what can be achieved through education and training. The overall impact of the training was not just limited to the individuals who attended but extended to the broader community, as these women applied their new skills in various community activities and businesses..
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Karamuak and Kuamut Clusters - Environmentally-Friendly Farming Training – implemented by PACOS, stand-alone activity in 2020.

Community Group	Karamuak and Kuamut Clusters
Impact	Sustainable agriculture practices introduced through training, with 15 individuals trained in organic agricultural skills. This initiative enhances food security and ecosystem health, leading to increased agricultural productivity and environmental stewardship.
Type of Benefit/Cost/Risk	Benefit, Direct
Change in Well-being	Sustainable agriculture practices were successfully introduced through training, directly impacting the way farming is conducted in the community. A total of 15 individuals received training in organic agricultural skills, equipping them with knowledge and techniques for environmentally friendly farming. This initiative significantly enhanced food security in the community, as these sustainable practices led to increased agricultural productivity. The training also fostered a deeper understanding and implementation of environmental stewardship among the participants, contributing to better ecosystem health. Participants applied their new skills to improve soil health, pest management, and crop diversity, which are critical components of sustainable agriculture.

	The adoption of organic practices reduced dependence on chemical fertilizers and pesticides, benefiting both the environment and the health of the community members. The success of this initiative encouraged other community members to adopt similar practices, creating a ripple effect of sustainable agriculture throughout the Karamuak and Kuamut Clusters.
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Karamuak and Kuamut Clusters - Food Processing and Entrepreneurship Training – implemented by PACOS, stand-alone activity in 2020.

Community Group	Karamuak and Kuamut Clusters
Impact	Economic diversification through training in food processing and entrepreneurship, with 18 individuals receiving training. This initiative supports economic growth and increased self-sufficiency among participants.
Type of Benefit/Cost/Risk	Benefit, Direct
Change in Well-being	Economic diversification was achieved through targeted training in food processing and entrepreneurship, addressing a crucial area of community development. A total of 18 individuals received this training, equipping them with valuable skills in both food processing techniques and business management. This initiative significantly supported economic growth within the community by fostering new business opportunities and expanding the local market. Participants experienced increased self-sufficiency as they were able to start or enhance their own businesses, reducing reliance on external employment. The training in entrepreneurship empowered participants with knowledge in business planning, financial management, and market analysis, crucial for successful ventures. The development of food processing skills not only added value to local agricultural products but also opened up new avenues for trade and income generation. This diversification of economic activities enhanced community resilience, as it reduced dependence on a single income source and spread economic risk. The success of the participants served as an inspiration and model for other community members, potentially leading to a broader cultural shift towards entrepreneurship and innovation.

Karamuak and Kuamut Clusters - Handicraft and Ecotourism Training – implemented by PACOS, stand-alone activity in 2021.

Community Group	Karamuak and Kuamut Clusters
Impact	Promotion of local culture and sustainable tourism through training, with 35 individuals trained in handicraft making and community-based ecotourism. This fosters pride and economic stability, creating new income streams from tourism.
Type of Benefit/Cost/Risk	Benefit, Direct
Change in Well-being	The training program successfully promoted local culture and sustainable tourism, directly impacting the community's cultural and economic landscape. A total of 35 individuals were trained in handicraft making and community-based ecotourism, skills that are deeply rooted in the community's cultural heritage. This initiative led to a strengthened cultural identity, as residents gained a deeper appreciation and understanding of their traditional crafts and practices. The introduction of new income streams from tourism provided an economic boost to the community, reducing reliance on traditional income sources and enhancing economic stability. Handicraft making allowed for the preservation and celebration of local crafts, providing a tangible connection to the community's cultural heritage. The development of community-based ecotourism ensured that tourism activities were environmentally sustainable and respectful of local culture. Participants became ambassadors of their culture, sharing their knowledge and skills with tourists, which further fostered community pride and cultural exchange. The economic benefits from tourism were not limited to the trained individuals but extended to the wider community, as increased visitor numbers boosted demand for local services and products.

Karamuak and Kuamut Clusters – Annual Joint Tactics – implemented by PACOS (2018, 2020 & 2021)

Community Group	Karamuak cluster and Kuamut cluster
Impact(s)	Annual joint tactic sessions (2018 – 2021) for community activity planning and knowledge sharing, including 6 people in total (3 female). The joint tactic session is a centralised activity where representatives of the community gather to report their activities and do a yearly planning of activities that they want to implement to benefit the communities. Each village can send 2 representatives to this session (Kuamut 2 people x 3 sessions = 6 people)

Type of Benefit/Cost/Risk	Benefit, direct
Change in Well-being	Opportunity for community members and leaders to share knowledge of successes and learnings from monitoring of project related activities.

Karamuak and Kuamut Clusters – Annual Paralegal Training – implemented by PACOS (2016, 2017, 2018, 2019 & 2021)

Community Group	Karamuak cluster and Kuamut cluster
Impact(s)	Annual paralegal training (2016, 2017, 2018, 2019 & 2021) for 20 people in total A yearly activity where representatives from the communities in the PACOS network areas will gather to learn about laws that are affecting them. The training ends with the International Human Rights Day celebration on the 10th December. Each gathering communities send 4 representatives from their village. (Kuamut 4 x 5 gatherings = 20 people)
Type of Benefit/Cost/Risk	Benefit, direct
Change in Well-being	The training program successfully introduced alternative livelihood opportunities and raised awareness. The introduction of new income streams from legal practices provides an economic boost to the community, reducing reliance on traditional income sources and enhancing economic stability. This diversification of economic activities enhanced community resilience, as it reduced dependence on a single income source and spread economic risk. The success of the participants served as an inspiration and model for other community members, potentially leading to a broader cultural shift towards entrepreneurship and innovation.

Additional Community Impact Considerations

Community Group	Youth from the Karamuak cluster and Kuamut cluster
Impact(s)	Unequal benefits from project.
Type of Benefit/Cost/Risk	Predicted, direct, risk.
Change in Well-being	Given that the youth group is relatively large, activities instigated with project support are unlikely to have the capacity to support everyone. Moderate magnitude risk.
Community Group	Hunters from the Karamuak cluster and Kuamut cluster
Impact(s)	Establishment of Project Area leads to cessation in hunting.
Type of Benefit/Cost/Risk	Potential cost, indirect, predicted.

Change in Well-being	Reduced sources of nutrition following cessation of hunting in Project Area. Low to moderate impact.
Community Group	Community groups not directly benefiting from project activities located further away from the 20km radius used to identify the communities participating in the project activities
Impact(s)	Differential incomes from project
Type of Benefit/Cost/Risk	Risk, direct, predicted.
Change in Well-being	Success of project activities leads to greater incomes among particular community groups, which may foster unanticipated animosity among other groups or between communities. Various potential levels of magnitude.
Community Group	Karamuak cluster and Kuamut cluster
Impact(s)	Change in federal and/or state government
Type of Benefit/Cost/Risk	Risk, indirect, potential
Change in Well-being	External political interference such as alienation of community lands or reneging on project agreements, for example following future changes in government. Various potential levels of magnitude, including total project failure.

4.1.2 Negative Community Impact Mitigation (CM2.2)

The Community Monitoring Plan incorporates multiple indicators to capture and assess the magnitude of potential negative impacts. With respect to the specific risks outlined in Section 4.1.1, a number of measures have been employed from the beginning of implementation to minimize the probability of their manifestation. For the youth community group, it will be important to ensure that opportunities are presented for all interested group members to participate; within actual limits which are clearly established with communities from the outset. Activities are likely to begin relatively small, but scale-up and diversify as the project progresses. Regular dialogues will be held between affected community groups and project proponents to ensure that benefits are being distributed equitably, and to address any actual or nascent grievances.

Whilst hunting within the Project Area may continue at low levels, the Social Baseline Assessment does not indicate that it constitutes a critical component of subsistence (Figure 41). Moreover, whilst hunting may be considered a traditional activity, it is also an illegal one in the eyes of state law (under both the Sabah Wildlife Enactment 1997 and the Sabah Forest Enactment 1964). Hunting without a permit is illegal in all instances, as is hunting in any forest reserve. This was therefore already an illegal activity in the without-project scenario and is not a new restriction placed on communities by the project. There is no evidence of commercial hunting for endangered species, which is why significant numbers of individuals of endangered species are evident in the project area. The project proponents do not have the authority to enforce state laws but much of the patrolling is undertaken by the staff of the Sabah Forest Department who do have enforcement authority. For the project team, the better approach is to encourage development of eco-

tourism, with the opportunity for local people to become guides and then to provide education in both biodiversity conservation and the relevant state legislation.

Ongoing dialogues will also present opportunities for community members to express any negative issues arising as a consequence of project activities, as will the project's grievance mechanism. Whilst the project will generally tailor livelihood activities towards specified community groups, these need not be exclusive; the communities themselves will be instrumental in selecting the most suitable and committed participants for activities.

4.1.3 Net Positive Community Well-Being (CM2.3, GL1.4)

In accordance with the Climate, Community, & Biodiversity (CCB) Standards of VERRA, the project's impacts on community well-being and its alignment with climate change adaptation can be articulated as follows:

1. **Community Well-Being and Social Impacts:** The project has significantly enhanced community well-being across multiple dimensions. Key improvements include:
 - **Infrastructure Enhancement:** Repair and construction of community buildings and facilities (like toilets and protective fences) have directly improved living conditions and safety, fostering community pride and security. This aligns with CCB standards emphasizing improved infrastructure for enhanced community well-being.
 - **Health and Sanitation:** Initiatives like the construction of sanitation facilities and provision of clean water systems have directly addressed health and hygiene needs, leading to a probable reduction in disease prevalence and improved overall wellness. These initiatives are in line with CCB standards focusing on health and sanitation improvements.
 - **Economic Empowerment and Livelihood Diversification:** Training in food processing, entrepreneurship, handicrafts, and ecotourism have diversified economic opportunities, fostering economic resilience and self-reliance. This aligns with CCB's focus on sustainable economic development and livelihood security.
 - **Social Cohesion:** Activities such as Youth Day events and Community Learning Centre training have strengthened community bonds, empowered marginalized groups, and promoted gender equality. These initiatives reflect CCB's emphasis on social cohesion and inclusive community development.
2. **Climate Change Adaptation and Environmental Stewardship:** The project has effectively integrated climate change adaptation measures, aligning with the CCB's Gold Level criteria for climate change adaptation benefits:
 - **Sustainable Agricultural Practices:** Training in environmentally-friendly farming practices enhances the community's adaptive capacity to climate change, ensuring food security and

ecosystem health. This is a direct response to CCB's criteria for sustainable natural resource management and climate resilience.

- **Water Resource Management:** The provision of polypipes for a gravity water system has improved access to water, a critical factor in adapting to climate variability and ensuring sustainable water resources, as highlighted in CCB standards.
 - **Biodiversity Conservation and Environmental Health:** Measures like strategic tree felling near community centers have been implemented considering both safety and ecological balance. This reflects CCB's emphasis on integrating community safety with environmental stewardship.
3. **Cultural Preservation and Sustainable Tourism:** The integration of cultural preservation with economic development through handicraft and ecotourism training aligns with CCB's criteria for maintaining cultural values and promoting sustainable tourism.

Gold Level for climate change adaptation benefits

Project activities have assisted communities to adapt to the probable impacts of climate change.

The project-zone communities are vulnerable to the potential climate change impacts because their livelihoods and well-being are dependent on the healthy ecosystem of the forest in the project area. Although some negative impacts of climate change are inevitable, and beyond the control of the Kuamut Project, we aim to strengthen community and biodiversity resilience by implementing adaptation options through a variety of project activities.

Those activities implemented through most relevant to climate change adaptation, and the causal relationship between the activity and the adaptation benefit, are summarized below.

- **Ecosystem-based adaptation:** The conservation of the Kuamut forest allows the maintenance of biodiversity and ecosystem services as part of a strategy to aid communities in adapting to adverse effects of climate change. Kuamut forests also play a critical role in buffering against the hydrological impacts of climate change and regulating local climate.
- **Water provision:** The conservation of the Kuamut forests also improve water infiltration and storage capacity of soils (i.e. more organic matter) and 'retention systems' such as storage streams.
- **Biodiversity conservation:** The conservation and restoration of natural habitats also improves the resilience of biodiversity to adapt to climate change, which in returns supports the maintenance of ecosystem services that benefit local communities, such as pollination and regulation of pests and other harmful impacts caused by the changes in climate and increased fish stocks dues to the reduced erosion into the rivers.
- **Diversification of income opportunities:** Through the provision of training opportunities during the monitoring period, some members of the community have improved their skills and would be able to diversify their income opportunities over time, through the continuous support of the project as well.

- It should also be noted that the without project scenario, which would have included continued logging and forest clearance/ fragmentation, would have further and severely damaged water quality and increased potential exposure to zoonotic diseases and exposure to malaria- with inevitable impacts on community wellbeing and reducing their resilience capacity to adapt to climate change.

4.1.4 Protection of High Conservation Values (CM2.4)

Since the Project Area has been designated as a Class I Forest Reserve under the 1968 Forest Enactment it now enjoys the status of Totally Protected Area under state law, meaning that all unauthorized access is prohibited together with all forms of land clearance or harvesting of natural resources. This lends full legal protection to all HCVs within the Project Area, including those of relevance to local communities such as ancestral settlements.

For other community-related HCVs in the Project Zone, it is not anticipated that project activities will engender risks of negative impacts. The formulation of project activities will incorporate safeguards to mitigate any such risks – for example activities related to sustainable agriculture would avoid the promotion of interventions heavily reliant on the use of pesticides which may impact aquatic HCVs through run-off.

The project will also aim to address the issue of illegal hunting through community capacity building (livelihood contributions through the development of community project activities) together with training and educational capacity building in wildlife conservation, the HCV concept, and prevailing state legislation.

4.2 Other Stakeholder Impacts

4.2.1 Mitigation of Negative Impacts on Other Stakeholders (CM3.2)

The primary non-community stakeholders are the Sabah Forestry Department and Yayasan Sabah (via its subsidiary body Rakyat Berjaya). By reclassifying the Kuamut forest reserve as a Class I Protection Forest, both entities are foregoing potential future revenues from continued logging operations and mosaic planting. They thus bear some opportunity costs by engaging with the project, and may stand to lose a portion of their incomes if the project is unsuccessful.

Conversely, with a successful project both the Sabah Forestry Department and Yayasan Sabah may make significant financial returns, and enjoy the reputational benefits of contributing to the conservation of the state's biodiversity and participating in a pioneering model of conservation management through the enhancement of ecosystem services whilst enhancing the livelihoods of indigenous communities.

4.2.2 Net Impacts on Other Stakeholders (CM3.3)

Beyond the opportunity costs described above, neither entity holds any additional financial liabilities and are not expected to commit significant staff or capital resources to the project. The project proponents continue to engage frequently with other stakeholders, to discuss the planned project implementation and ensure that these stakeholders are comfortable with their roles and responsibilities within the project.

4.3 Community Impact Monitoring

4.3.1 Community Monitoring Plan (CM4.1, CM4.2, GL1.4, GL2.2, GL2.3, GL2.5)

Monitoring Process:

- Sampling Methods:
 - Field Visits and Direct Observation: 2016: Yearly Paralegal Training (information gathering); Jan 2016 - Jan 2017: Field Visits and Direct Observation (information gathering); 2017: Yearly Paralegal Training, CLC Accounts and Management Training (14-17 Nov, Tawai Recreation Centre, information gathering); 2018: Yearly Paralegal Training (information gathering); 2019: Yearly Paralegal Training, Field Visits (2019-2021, information gathering); 2020: Training on Environmentally-Friendly Farming (29-31 Jan, Lomunu Training Centre, Penampang, information gathering), Training on Food Processing (19-21 Feb, Lomunu Training Centre, Penampang, information gathering).
 - Stakeholder Engagements: Engaging with a wide range of stakeholders, including both government and non-government entities, has been pivotal. Through numerous consultations, we have sought input from relevant experts and potential long-term project partners to guide our monitoring and implementation strategies.
 - Informal Interviews, Community Workshops, and Small Group Conversations: These interactions have facilitated deep dives into the nuances of community needs, aspirations, and concerns, ensuring that our project aligns with local priorities and enhances community well-being.
 - Centralized Joint Tactics Session (JTS) and Surveys: JTS sessions and structured surveys have provided a platform for gathering quantitative and qualitative data, enabling a robust analysis of project outcomes and stakeholder feedback.

Stakeholder Consultations:

Extensive consultations were carried out with a variety of stakeholders to enrich our monitoring process:

- Rakyat Berjaya and Rakyat Berjaya Karamuak (Social Forestry Centre): Engagements focused on understanding local land uses, logistical constraints, and integrating RBJ Social Forestry programs into our project framework.
- Sabah Forestry Department and Tongod District Office: These consultations aimed at acquiring community-level information and ensuring local administrative support.
- PACOS Trust and Borneo Conservancy Initiative: Discussions revolved around previous initiatives, land conflicts, and insights into Sabah state legislation relevant to customary land rights.

Data Collation and Analysis:

- The project's evidence base is constructed from verbal insights from experts, documentary evidence on community composition and land use patterns, and primary data collected through site visits. This comprehensive data collection effort is critical for understanding the project zone's socio-economic and environmental dynamics.

Monitoring Results and Evaluation:

Main Indicator	Specific Indicator	Aspects Measured	Results
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Positive impacts associated with the implementation of project activities	Training Programs	- Number of participants trained - Types of skills acquired - Gender distribution of participants	- 111 people trained in various programs, improving skills and knowledge. - Training in Accounts and Management, organic agricultural skills, food processing and entrepreneurship, handicraft making, community-based ecotourism, socio-economic training, joint tactics knowledge sharing, and annual paralegal training. - 74 women trained, highlighting gender inclusivity.
	Employment Opportunities	- Number of direct employment opportunities created - Types of roles filled - Duration of employment	- 24 people directly employed in management, implementation, and monitoring. - 8 employed for regular patrols to monitor illegal logging and poaching. - 7 women directly employed (plus 10 from RBJ), ensuring gender representation in employment. - The length of employment varies depending on the position, however there are several long-term positions.
	Infrastructure Improvements	- Types of infrastructure developed - Number of community members benefiting - Quality and sustainability of infrastructure	- Toilet construction, protective fences, and water system improvements directly benefitting the community. - Clean water access provided to 245 people (98 households), including a supply of drinking water to Kg Karamuak village and

			expansions to two further villages. - The infrastructure developed, including sanitation facilities, protective fences, and water systems, employed high-quality, durable materials and environmentally sustainable designs. Projects were community-centered, ensuring relevance and long-term utility, with a focus on maintenance and resilience to environmental changes.
Potential negative impacts associated with the project	Cessation of Hunting	- Changes in wildlife populations - Community perceptions on hunting restrictions - Alternatives provided for livelihoods	- The project area now significantly better managed for biodiversity conservation, with 83,381 ha protected. - The cessation of logging and effective patrols have nearly eliminated illegal logging and poaching, contributing to wildlife recovery. - The monitoring activities reveal that although hunting restrictions within the Kuamut forest reserve have affected community access to traditional practices, this has not led to disputes involving legal actions, protests, or conflicts. The cessation of hunting, while a concern, has not manifested as a significant negative impact in community dynamics or perceptions of conservation. - Community perceptions of hunting restrictions are largely

			positive, recognizing the benefits to local wildlife and ecosystem health. The project has proactively engaged with community members to address concerns and provide sustainable alternatives for livelihoods. These alternatives include training in ecotourism, organic agriculture, and handicraft production, aiming to offset the economic impact of hunting restrictions by creating diverse income opportunities. This approach not only supports conservation efforts but also enhances community resilience and economic stability.
Impacts of changes not directly associated with the project	Government and Administration Changes	- Impact on project continuity and support - Community's adaptation to policy changes - Engagement with new administrations	- Continued project engagement and adaptive strategies ensured project continuity and effectiveness amidst external changes.
Change in Community Perceptions	Perceptions on Hunting Restrictions	- Community understanding and acceptance of restrictions - Perceived impact on wildlife conservation - Contribution to sense of belonging and shared community identity	- Positive acceptance, with communities recognizing restrictions' conservation importance. Increased sense of belonging and strengthened community identity through collective conservation efforts.

	Alternatives Provided for Livelihoods	- Awareness and uptake of alternative livelihood programs - Satisfaction with provided alternatives - Impact on economic well-being - Enhancement of community security and attachment	- High engagement in alternative livelihood programs, leading to improved economic stability and reduced reliance on hunting. The diversity and quality of alternatives strengthen the community's sense of security, foster shared identity, and deepen attachment to community values and goals.
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4.3.2 Monitoring Plan Dissemination (CM4.3)

Whilst reduced activities were implemented during the COVID pandemic led restrictions and internal elections in the communities, sections 2.1.1 and 2.5.2 of this report demonstrate how the project proponents have communicated and disseminated relevant details about the project to stakeholders during this monitoring period, including a detailed methodology. The project proponents instigated a community scoping exercise in 2016, followed by a programme of community engagements from 2017-2019 to identify relevant communities, socialise the project and its associated costs, risks and benefits. Objectives included:

1. Enhancing and broadening community understanding of overall project goals and design;
2. Key informant interviews and informal discussions on community interactions with the Project Area;
3. Discussion of potential project activities which could contribute to community livelihoods and safeguarding of the Project Area;
4. Gathering of basic data on community demography, settlement history, and infrastructure;
5. Generation of spatial data on community settlements and HCV 4-HCV 6 areas in and around the project area;
6. Discussion of future mechanisms to enhance and safeguard community-project interactions such as communication channels and grievance procedures;
7. Creating opportunities for communities to offer feedback on the project and any other issues of concern;
8. Updating community representatives on project progress;
9. Receiving updates on community political and administrative developments, and;
10. Logistical planning and organisation of upcoming field activities

A full list of the community engagements conducted as part of the social baseline assessment are listed in Appendix 5.

Communities are unable to access the internet and so the most immediate way to communicate was through the workshops previously described.

Other means of communication that have been used throughout the monitoring period include SEARRP scientists, staff and appointed consultants who conducted forest monitoring surveys and consultations required for the certification of the Kuamut Rainforest Restoration Project. SEARRP undertook the surveys inside the forest reserve and with communities in the area, and these were coordinated with RBJ and the community leaders. Evidence of site access letters for these meetings have been provided to the VVB during the verification process.

4.4 Optional Criterion: Exceptional Community Benefits

According to data from the Malaysian Department of Statistics (DOSM), Sabah consistently had the highest incidences of poverty across all states of Malaysia between 2004 and 2016. In 2019, Sabah's poverty incidence was 19.5 per cent of total households, or about 615,000 people. Apart from underdevelopment, Sabah also has one of the highest unemployment rates in Malaysia.

Sabah's historical underdevelopment was affected by various national development policies, such as the New Economic Policy (NEP) that began in the 1970s, which failed to capture the indigeneity of Sabahans. For example, the NEP allowed development projects to be influenced by Peninsular Malaysian politicians, who were less concerned with the intricate identities of Sabahans. When these policies were applied to Sabah, those benefiting the most were Muslim Bumiputeras, with the majority non-Muslim Bumiputeras being left out. Furthermore, as stated above, the long history of governance arrangements in Sabah, generate development inequalities for indigenous communities such as those located close to the project area, thus, the most likely scenario in the absence of the project would be the continuation of underdevelopment and limited opportunities of livelihood improvement for indigenous communities

The socio-economic conditions of the communities are below the national poverty line, with limited access to energy, health services neither clean water. Several community clinics are available, although these are only equipped to deal with minor ailments – for serious injuries, sickness and childbirth community members must travel to hospitals in the distant urban centres of Telupid or Kota Kinabatangan. No communities are connected to mains power; instead, electricity is generally supplied by hybrid solar-diesel generators provided by the state government – although some communities are only able to run the generators for 6-12 hours per day.

One of the most striking infrastructural differences between the Keramuak and Kuamut clusters is access to clean water. The Keramuak villages (with the exception of Tamoi) have piped water supplied by a gravity-feed system from a catchment in Gunung Tingkar forest reserve to the north-east. Nonetheless, many community members claim that the supply from the gravity-feed system is insufficient, and they must frequently use stored rainwater. Communities in the Kuamut cluster have no form of piped water whatsoever, and when stored rainwater runs out they are forced to resort to water from the Kinabatangan river; which has a high sediment load and may contain toxins from upstream agricultural run-off. It is thus clear that access to clean water is a pressing development issue for the project zone communities – especially those in the Kuamut cluster.

This is the explanation of the level of incomes in the project area at the start of the project in 2016. The chief form of wage labour generally available locally is work in nearby oil palm estates. Aside from the few

community members who undertake this form of employment, most derive incomes primarily from cash-cropping and highly localised small-scale trade. Having transitioned from a migratory past to a sedentary agrarian lifestyle, most community members (especially adult men, although not exclusively) devote a significant proportion of their time to the maintenance of agricultural smallholdings, in which they grow a variety of cash-crops (chiefly oil palm, rubber and cocoa) and subsistence crops (hill rice, vegetables and fruit trees). Survey data on cash-cropping reveal a distinct asymmetry between the Keramuak and Kuamut clusters. In the Keramuak villages oil palm is the prevalent cash-crop, and most households maintain oil palm smallholdings. This is in large part due to the relatively easy access to these communities by road, and nearby mills which are prepared to purchase oil palm fruit bunches from villagers. By contrast, the Kuamut villages have no reliable road access, and thus no means of transporting palm bunches out for sale (other than by boat, which is prohibitively expensive). These communities plant some cocoa (which they receive assistance to export from the Sabah Cocoa Board), but this crop generates relatively minor revenues in comparison to oil palm. Kuamut communities are thus extremely cash-poor, and the average monthly income is around MYR 300 (around one-third of Malaysian minimum wage); although this is highly variable between individuals. Community members in the Keramuak cluster generate larger incomes (around MYR 600 per month, although again there is high variability), but many remain below the poverty line.

4.4.1 Short-term and Long-term Community Benefits (GL2.2)

The following short-term and long-term community benefits were implemented during the monitoring period:

1. Provision of piped, clean water: Communities in the 'Kuamut Cluster' did not have access to clean, piped water. During the monitoring period (June-July 2020, RBJ provided polypipes to the Kg. Karamuak community to support the maintenance of their gravity water system within the village, thus supporting 98 families residing in the village.
2. Agricultural advice & support: Project zone communities have identified agriculture as a potential driver of improved future incomes. Consultations with community representatives, and the PACOS team active in the area, suggested that there were opportunities for diversification (in terms of the range of fruit and vegetable crops grown), within-community processing (drying and powdering of chillies for example and fermentation of durian as the high-value product 'tempoyak', for example).

During the monitoring period, the project provided:

- Training on Environmentally Friendly Farming for 15 participants (11 females). Participants learned: Organic Agriculture, Smart farming methods such as fertigation and hydroponic as well as about natural fertilizer such as effective microorganism (EM) or Effective Microorganism Activated Solution (EMAS), indigenous microorganism (IMO) and organic insecticide.
 - Training on socioeconomic livelihood related activities e.g eco-friendly farming for 6 women. This annual gathering of villages where they participate in a one-day learning & exposure on livelihood related activities such as eco-friendly farming in Penampang & KK.
3. Direct community engagement on the project: During the monitoring period, the project provided training on food processing and entrepreneurship for 18 people from which were 14 females. Participants learned:

- Techniques how to process food such as how to make Tempoyak, candied papaya and vegetable-based noodles.
- Basics of business and entrepreneurship including how to start a business, basic financial management, and how to increase the value of their product such as by calculating cost, packaging and labelling as well as having a backstory or explanation about the product.
- Training on Handicraft Making & Community-Based Ecotourism for 31 people (31 females). Participants learned:
 - i. Importance of natural resource management for non-timber forest products and ecotourism.
 - ii. Modernizing handicrafts by introducing new elements in design, technique or material into old handicrafts and various ways in increasing the value of handicrafts, through pattern, durability, use and story.
 - iii. How to start their own ecotourism business and the opportunities for ecotourism available, including sessions with community businesses to share experiences in different types of ecotourism in Sabah.
 - iv. Basics of social enterprising such as working as a group and the SUKARIA model (Semangat, Untung, Komuniti, Alam, Rancang Impak Anda).
 - v. Types of packaging and their purpose, basic criteria or information to be included in product labelling and marketing platforms available to help in sales and marketing.

In addition to the above, the project employed staff from communities by the project, including through regular patrols.

4. Healthcare training & support (including emergency first aid): Discussions with PACOS suggest that the level of basic medical and healthcare knowledge among project zone communities is minimal. The project intends to support a healthcare-focussed education programme – with a particular emphasis on emergency first aid (e.g. diagnosis of conditions and infectious diseases that may require immediate evacuation and hospitalisation).

During the COVID pandemic provided, the project provided food-aid program to 97 families (245 people).

5. Other positive well-being impacts provided to communities:
 - Annual paralegal training (2016-2021) for 8 people in total. A yearly activity where representatives from the communities in the PACOS network areas will gather to learn about laws that are affecting them. The training ends with the International Human Rights Day celebration on the 10th December. Each gathering communities send 4 representatives from their village. (Kuamut 4 x 5 gatherings = 20 people)
 - Repairs on community buildings in Kg. Karamuak as part of community collaboration and assistance (March 2018, RBJ).
 - Construction of toilet for community hall at Kiliwong community (April 2018, RBJ).
 - Facilitate tree felling in the village areas, including around the Karamuak Community Centre, to enhance community safety by roadside (April 2018, RBJ).
 - Fund the construction of a protective fence surrounding the Sabah Electricity Sdn Bhd (SESB) power station at Karamuak village is completed, following a request made by the communities (Aug 2019, RBJ)

- Facilitated and hosts the State Ministry of Youth and Sports for a youth day event with communities in Tongod. This was held at the RBJ Milian Forestry Centre, near Imbak village (October 2021, RBJ).
- Community Learning Centre (CLC) Accounts and management Training for 15 people (all female). There were 15 participants (all women) from CLC Kuamut, Kinabatangan, CLC Tampasak, CLC Minunsuh, CLC Soguon and CLC Imusan, Tongod.

Furthermore, during the monitoring period, all members of the community had improved livelihoods but specifically those employed and those who benefitted from sales of fish. The project resulted in a complete cessation of logging activities. Any form of logging or land-use change has a clear and negative impact on fish communities. Previous industrial logging had caused increased turbidity in river water and a lack of oxygen (see scientific paper based on data collected within about 10 km of the site)³⁸. This will almost certainly have caused a reduction in fish populations. Project Zone communities primarily rely on catching fish for protein – and there is anecdotal evidence that fish catches during preceding decades have decreased substantially. Following protection of the Project Area, we anticipate a gradual increase in fish stocks and improvement to the livelihoods for all the people in the communities.

The malaria variant *Plasmodium knowlesi* is widespread in Macaque monkeys in Sabah and is easily transferred by mosquitoes to humans, in and around logged forest. It is the major source of concern regarding malaria in Sabah. Mosquitoes and therefore malaria will have been reduced by the recovery of the forest in the project area³⁹. Agricultural advice and training have been provided by both RBJ in Karamuak and PACOS in Kuamut during the monitoring period.

The prospect of increased fish stocks and reduced malaria and agricultural training will benefit all households in the community. It should also be noted that the without project scenario, which would have included continued logging and forest clearance/ fragmentation, would have further and severely damaged water quality and increased potential exposure to zoonotic diseases - with inevitable impacts on community wellbeing. All women in the community will benefit from the likely increase in fish stocks and reduction in exposure to Malaria and other zoonotic diseases.

4.4.2 Marginalized and/or Vulnerable Community Groups (GL2.4)

Community Group	Women from the Karamuak cluster and the Kuamut cluster.
Net positive impacts	The project is aiming to benefit around 500 women from the communities surrounding the project area. During the current monitoring period, the project supported 74 women through training activities, 7 women were employed for project activities, 78 women received food aid, 13 women and girls gained access to quality education, 102 women received access to water supply.

³⁸ <https://doi.org/10.1016/j.biocon.2018.04.004>

³⁹ <https://malariajournal.biomedcentral.com/articles/10.1186/s12936-016-1416-1> and <https://eprints.ums.edu.my/id/eprint/21602/>

Benefit access	Traditionally, women do not necessarily participate in the decision-making process, therefore, the project implemented targeted consultation processes with women to collect their views and feedback to project implementation, respecting the community processes and mechanisms for engaging with women.
Negative impacts	The iterative consultation and engagement with the communities and with the most vulnerable groups process allowed to identify any potential impact that may have occurred in advance a make any corrective actions following adaptive management models.

4.4.3 Net Impacts on Women (GL2.5)

Section 1.2 provides a breakdown of the number of women impacted by the projects activities during the monitoring period, including employment, training and wellbeing. The project aims to generate positive impacts on the livelihoods of women and ensuring that women participate in decision-making together with involvement in project implementation activities such as forest restoration and nurseries management, besides other activities that could be identified through the iterative consultation process during the project implementation. The project follows a strict protocol to ensure participation of women and marginalized groups. The following strategies are followed:

- I. A gender perspective is applied in all stages of programme and project development processes as follows:
 - a. Applying a gender analysis in the project cycle, in planning, implementation, monitoring, evaluation, impact assessment, and ensuring data disaggregation in preparing reports etc.
 - b. Where appropriate, formulating measurable gender indicators/sex-disaggregated social and economic indicators and targets and conversely, assessing opportunities to reduce gender inequalities/inequities.
 - c. Ensuring participation of indigenous women in project development.
 - d. Make special efforts to give women the possibility to express themselves and be heard directly in all the different activities and programmes of the organization.
- II. A culturally sensitive approach is applied in addressing gender issues. PACOS Trust respects the different roles, responsibilities, rights, obligations, knowledge and skills of men and women who are involved in or who are affected by PACOS Trust's programmes and projects. In this context, the specific needs and circumstances of indigenous women that affect their effective participation to PACOS Trust activities shall be addressed.
- III. Where appropriate, examine how relevant national, regional and global laws, policies, programmes, and institutions affect gender equity, and explore possibilities for promoting gender equity within these.
- IV. Strengthen the programme on indigenous women, which includes capacity building and other forms of support to strengthen indigenous women's organizations, groups and leaders.
- V. Conduct general gender awareness trainings for officers and staff and people organizations, as well as capacity building activities to address the issues and

- concerns of indigenous women.
- VI. Strengthen the advocacy and mainstreaming of indigenous women's rights and empowerment at all levels, in all the programmes of PACOS Trust.
 - VII. Promote and ensure involvement of men in gender and women's rights activities in all programmes of PACOS Trust.
 - VIII. Ensure that all data gathered in the context of activities undertaken by PACOS Trust, its people organisations and network organisations is sex-disaggregated and analysed and the situation of women is documented regularly.
 - IX. To provide support to people organizations on the implementation of this Gender Policy.

During the current monitoring period, the project supported 74 women through training activities, 7 women were employed for project activities, 78 women received food aid, 13 women and girls gained access to quality education.

4.4.4 Benefit Sharing Mechanisms (GL2.6)

Following an extensive consultation process in all the communities located in the project zone during the monitoring period 2016-2019, the Project introduced benefits as outlined in section 4.4.1 of this report.

From 2023 onwards, the project has defined an updated Benefit Sharing Mechanism framework as described in **Figure 11**. This has been developed based on the updated community development plan.

The Benefit Sharing Mechanism outlines a comprehensive framework for distributing the gains from emission reduction initiatives among the local community. This initiative is projected to expand to five additional villages over the subsequent three years. Concurrently, the project ensures improved healthcare access by supplying a dedicated boat for medical transportation needs in Kuamut village. Another fundamental component is the expansion of electricity to Desa Permai and Tulang Tulang by 2024, thereby enhancing the quality of life and economic opportunities for residents.

An integral part of the mechanism is the Village Development Fund, which will invest up to RM 400K annually per cluster (including Kuamut and Karamuak), supporting critical areas such as health, education, and infrastructure in alignment with SDGs and community consensus. Household direct support is also a key feature, providing a monthly cash benefit of RM 100 to 450 households, with increments planned each year.

Post the sale of carbon credits, the Benefit Sharing Mechanism will finance additional benefits from the proceeds. These will encompass a microfinance program to back local enterprises and eco-tourism initiatives, promote agricultural advancements through garden and nursery projects, and foster food security through regenerative and agro-ecological practices. These programs are selected in conjunction with community input to ensure relevance and alignment with both the project's objectives and SDGs.

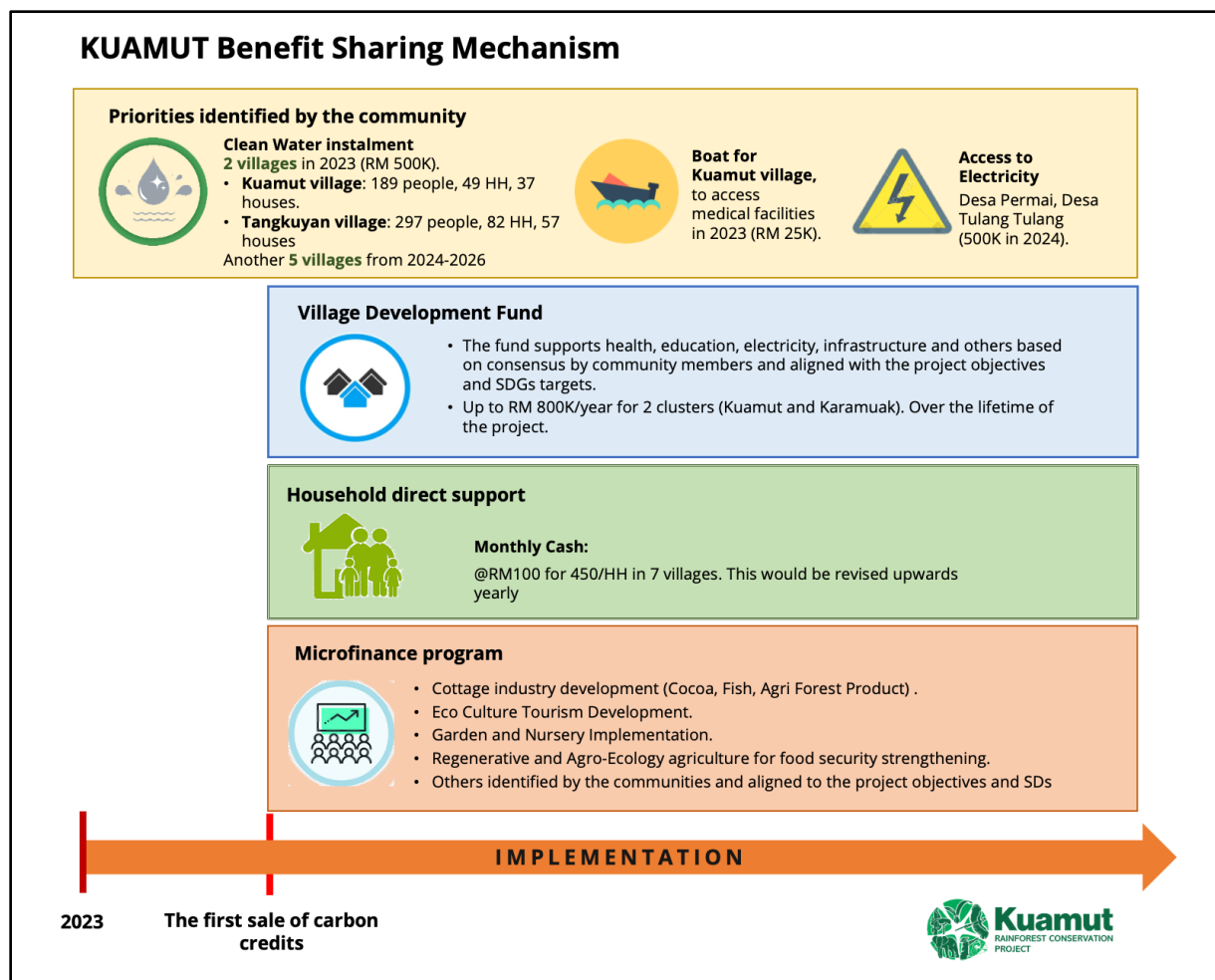


Figure 11 Kuamut Benefit Sharing Mechanism

4.4.5 Governance and Implementation Structures (GL2.8)

The project governance involves Yayasan Sabah (primarily via its forestry subsidiary Rakyat Berjaya Sdn Bhd – RBJ), the Sabah Forestry Department and Permian Malaysia and Permian Global. The project implementation is carried out by Permian Malaysia in coordination with RBJ and the Sabah Forestry Department with oversight from the North Kuamut Management Committee.

The governance and implementation structures of the community livelihood improvement activities in the project zone are guided by the existing self-governance of the communities defined by their cultural practices and land rights inside each community. As previously described, the project has set up a project structure for community work implementation, with PACOS Trust as main partner for community work. The community from 7 villages elected their representative as member of Community Executive Committee, to act and represent community voice towards the project implementation.

4.4.6 Smallholders/Community Members Capacity Development (GL2.9)

Previous activities, during the monitoring period, resulted in training with agricultural techniques and some education with regard to the production of handicrafts, food processing, smart agriculture and ecotourism. Section 4.4.1 provides details of the activities aimed at improving the capacities of community members during the reported monitoring period.

5 BIODIVERSITY

5.1 Net Positive Biodiversity Impacts

5.1.1 Biodiversity Changes (B2.1)

Change in Biodiversity	Gradual dispersal and population increases of RTE species throughout the Project Area
Monitored Change	Based on empirical surveys conducted in 2014-2017 presented in the Project Description Document, the population of orangutans in the Project Area is approximately 630 individuals (see Simon, Davies and Ancrenaz 2019⁴⁰, for detailed methodology of aerial nest surveys). Without-project intervention, the population of orangutan in the project area is expected to decline due to a reduction in lesser habitat extent, lower habitat quality, and more intense disturbance. Field visits and general observations by the project team during this monitoring period indicated a very low level, or barely any, human activities in the project area. Since the project inception, no evidence was found that the orangutans in the project area are threatened. Subsequent systematic census based on aerial nest counts is planned in the next monitoring period. Several studies and analyses conducted during this monitoring period both within and in the vicinity of the project area also showed that the project area supports the rich assemblages of Sabah's biodiversity, including rare, threatened, and endemic species, especially primates (such as orangutans, gibbons and langur), elephants, and banteng (see Appendix 7 for a summary of these studies).
Justification of Change	Due to project intervention, namely the upgrade from logging to Class I protection of the area, the orangutan population decline due to continued habitat disturbance and conversion did not happen. As demonstrated in the vegetation analysis, presented under the Climate section, this facilitated an improvement in

⁴⁰ Simon D, Davies G, Ancrenaz M (2019) Changes to Sabah's orangutan population in recent times: 2002–2017. PLoS ONE 14(7): e0218819. <https://doi.org/10.1371/journal.pone.0218819>

	habitat condition (i.e., an increase in aboveground biomass of trees and vegetation). The change in the management status is also associated with less human activities and hence a reduction in threats to biodiversity. With such a condition, it should be safe to assume that the number of orangutans has remained stable and is likely recovering in some areas. The condition of the project area in terms of being a suitable habitat for various species, especially RTE species, has been proven by a number of studies conducted directly within the area and analyses at the larger scale whose scope also included the project area (see Appendix 7 for a summary of these studies).
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Change in Biodiversity	Natural forest regeneration leads to increase in mature forest habitats
Monitored Change	The data provided in the Climate section showing that the forest in the project area is regenerating (e.g., an increase in the aboveground biomass of trees and vegetation). Various studies and analyses also conducted during this monitoring period within and in the vicinity of the project area showed that the project area is an important area for conservation that supports the rich assemblages of Sabah's biodiversity. This includes rare, threatened and endemic species, especially primates (such as orangutans, gibbons and langur), elephants, and banteng (see Appendix 7 for a summary of these studies). Many of these RTE species require mature, or relatively undisturbed, forest habitats to persists in the long-term.
Justification of Change	Methods used to monitor forest regeneration include remote sensing using satellite imagery technology (i.e., to estimate aboveground biomass) There were also border patrols using helicopters and ground observations in some areas, which are likely to prevent illegal logging activities. The the project area is a suitable habitat for various forest species, especially RTE species, and this has been shown by various studies conducted directly within the area and analyses at the larger scale, but where the scope also included the project area (see Appendix 7 for a summary of these studies).

5.1.2 Mitigation Actions (B2.3)

The reclassification of the Project Area from a Class II (Production) Forest Reserve to a Class I (Protection) Forest Reserve, and the concomitant cessation of logging operations and avoidance of mosaic planting,

provides an immediate and substantive mitigation of the negative impacts on biodiversity that would almost certainly result from the without-project scenario.

The forest within the Project Area will be protected from further degradation and allowed to regenerate naturally. We assume that the species documented in the surrounding landscape have a high probability of being present in the Project Area given the similar forest type, and that the area should therefore be protected even in the absence of full scientific certainty – this is consistent with the precautionary principle as elaborated in the 1992 Convention on Biological Diversity.

5.1.3 Net Positive Biodiversity Impacts (B2.2, GL1.4)

The project will confer immediate biodiversity benefits via protection of key habitats, ecosystems, ecosystem functions and, by extension, the protection of numerous floral and faunal species. Given that the forest in the Project Area is contiguous with much larger areas of protected primary forests to the south and east, the project will also provide a buffer area and ultimately an expansion – as forests recover – of suitable habitats for RTE species in central Sabah, hence improving landscape-level connectivity.

Throughout the lifetime of the project, natural regeneration of previously degraded forest areas will result in an increase in the total area of suitable habitat for forest specialist species and will enhance the complexity of community trophic interactions typical of lowland dipterocarp forests.

Section 5.2.2 provides more information on the net positive biodiversity impact of the project.

5.1.4 High Conservation Values Protected (B2.4)

The project has conducted a series of participatory mapping exercises with communities, using scaled base maps to record data on High Conservation Value (HCV) areas of importance to communities, agricultural sites, settlement areas and main infrastructure. Some HCV 5 (gathering of natural resources for subsistence) and HCV 6 (sites of cultural significance) are situated within the northern part of the project area near both the Kuamut and Karamuak clusters, though no agricultural areas were identified inside the project area. The project is committed to the protection of all HCV values present in the Project Area and Project Zone and will ensure that no negative impacts on biodiversity values result from the implementation of project activities.

5.1.5 Invasive Species (B2.5)

No project activities involved the risk of introducing novel or invasive species into either the Project Area or Project Zone.

5.1.6 Impacts of Non-native Species (B2.6)

No non-native species have been used in the Project Zone.

5.1.7 GMO Exclusion (B2.7)

The project has not and will not utilize GMOs in any form.

5.1.8 Inputs Justification (B2.8)

Project activities have not necessitated the additional use of chemical fertilizers, pesticides or biological control agents.

Name	Not Applicable. During this period the project did not use or promote the use of fertilizers, chemical pesticides, biological control agents or other inputs
Justification of Use	Not applicable
Adverse Effect	Not applicable

5.2 Offsite Biodiversity Impacts

5.2.1 Negative Offsite Biodiversity Impacts (B3.1) and Mitigation Actions (B3.2)

Negative Offsite Impact	Mitigation Measure(s)
Hunting activities refocused in other forest reserves outside of Project Zone	Reduction in overall hunting pressure through livelihood enhancement activities and education activities

5.2.2 Net Offsite Biodiversity Benefits (B3.3)

To evaluate the net effect of the project on biodiversity, we need to consider both the unmitigated negative impacts on biodiversity outside the project zone and the project's biodiversity benefits within the project zone. The goal is to demonstrate that the project has a positive net impact on biodiversity.

Unmitigated Negative Impacts on Biodiversity Outside the Project Zone:

- Historically, poaching activities were linked to staff from past logging contractors working in the Project Area, which could have had detrimental effects on wildlife populations outside the project zone. It is however worth noting that a number of studies that have taken place in Sabah (including within parts of the Kuamut FR) found that poaching pressure in Central Sabah is low. For example, Guharajan et al. (2021)⁴¹ found that two poaching-level covariates (accessibility and human settlement density; i.e., proxies for poaching pressure) had very minor effects on sun bear occupancy, suggesting that the sun bear population in the study area may not be subject to

41 Guharajan, R., Mohamed, A., Wong, S.T., Niedballa, J., Petrus, A., Jubili, J., Lietz, R., Clements, G.R., Wong, W.M., Kissing, J. and Lagan, P., 2021. Sustainable forest management is vital for the persistence of sun bear *Helarctos malayanus* populations in Sabah, Malaysian Borneo. *Forest Ecology and Management*, 493, p.119270. <https://doi.org/10.1016/j.foreco.2021.119270>

intense poaching pressure. Gardner & Goossens (2017a)⁴² also suggests that “the number of illegal activity events recorded using camera traps and direct observations were relatively low in Kuamut compared to other forests”. Whilst Brozovic et al. (2018)⁴³ “found some evidence of hunting during [their] surveys (such as illegal campsites and bullet cartridges) and camera traps recorded hunters in Tangkulap-Sungai Talibu and Northern Kuamut. However, these instances were rare, suggesting that hunting levels are low across the study areas”.

- There is a possibility that hunting activities may be refocused in other forest reserves outside the project zone. This could potentially lead to declines in wildlife populations in these areas; however, as per the studies referenced above, hunting levels are seen to be low in the Kuamut FR and its surrounding areas, and any relatively recent poaching pressure is thought to have had only minor effects on population figures.

Project's Biodiversity Benefits Within the Project Zone:

- The project has implemented anti-poaching patrols, with project staff members employed to deter illegal logging and poaching activities within the project zone. These patrols are monitored and reported on, with any discoveries and learnings shared. This proactive approach helps protect wildlife populations within the project area. Examples of the joint monitoring reports / presentation of findings from the anti-poaching and RBJ joint patrol works have been provided to the auditor during the verification.
- Data collected during this monitoring period by Simon, Davies & Ancrenaz (2019)⁴⁴ suggest that the population size of orangutans within the Kuamut Project Area is estimated to be approximately 630 individuals, which has remained stable since 2002-2003 (see Ancrenaz et al. 2005⁴⁵; Ancrenaz Pers. Coms.), and we expect that the population is likely recovering in some areas. Through the prevention of habitat conversion to mosaic plantings and the termination of logging activities, the orangutan population is predicted to increase within the Project Area as the forest recovers, and thus the project will contribute to the recovery and conservation of this trigger species. The project has provided training sessions on agriculture and organic farming to 15 community members within the project zone. By offering alternative livelihoods, the project aims to reduce community reliance on local resource use.
- The project area contains critical habitats and functioning ecosystems, and protects significant concentrations of floral and faunal species. It also serves as a buffer zone and provides connecting habitat for larger areas of protected primary forests to the south and east.
- Throughout the project's lifetime, degraded forest areas will undergo natural regeneration, increasing the total area of suitable habitat for forest specialist species and restoring trophic interactions typical of lowland dipterocarp forests.

42 Gardner, P.C., & B. Goossens. 2017. The Bornean Banteng Programme: Conservation and management of the endangered wild cattle *Bos javanicus lowi* in Sabah. Danau Girang Field Centre. Surveys of bantengs in Kuamut Forest Reserve. Available at:

https://deramakot.sabah.gov.my/images/pdf/pub/BantengSurveyReport_KuamutForestReserve.pdf

43 Brozovic R, Abrams J F, Mohamed A, Wong S T, Niedballa J, Bhagwat T, Sollmann R, Mannan S, Kissing J and Wilting A. 2018. Effects of forest degradation on the moonrat *Echinosorex gymnura* in Sabah, Malaysian Borneo. *Mammalian Biology*. 93 135-143. <https://doi.org/10.1016/j.mambio.2018.10.003>

44 Simon D, Davies G, Ancrenaz M (2019) Changes to Sabah's orangutan population in recent times: 2002–2017. *PLoS ONE* 14(7): e0218819. <https://doi.org/10.1371/journal.pone.0218819>

45 Ancrenaz, M., Gimenez, O., Ambu, L., Ancrenaz, K., Andau, P., Goossens, B., Payne, J., Sawang, A., Tuuga, A. and Lackman-Ancrenaz, I., 2005. Aerial surveys give new estimates for orangutans in Sabah, Malaysia. *PLoS Biology*, 3(1), p.e3.

Justification for Positive Net Effect on Biodiversity:

The potential negative impacts for biodiversity outside of the project zone from our project implementation are the displacement of poaching and hunting activities. However, as indicated in 5.2.1 above, we believe these will not result in any major negative offsite biodiversity impacts due to mitigation measures and substantial biodiversity benefits within the project zone. A number of relatively recent studies (e.g., Tilker et al. 2019⁴⁶, Gardner & Goossens 2017a⁴⁷, Brozovic et al. 2018⁴⁸ and Guharajan et al. 2021⁴⁹) also indicate that hunting levels are thought to be low in the Kuamut FR and its surrounding areas, and that any recent poaching pressure has only minor effects on RTE species populations in Central Sabah. However, in the case that any offsite negative impacts on biodiversity did occur, these impacts would be outweighed by the far more significant biodiversity benefits provided by the project. The project provides vital and secure wildlife habitat through anti-poaching and anti-logging patrols, and as a result the orangutan population is thought to be stable and likely recovering in the Kuamut Project Area since project implementation. Therefore, the project's biodiversity benefits are net positive and any negative offsite biodiversity impacts will be minimal.

5.3 Biodiversity Impact Monitoring

5.3.1 Biodiversity Monitoring Plan (B4.1, B4.2, GL1.4, GL3.4)

The Biodiversity Monitoring Plan has been developed by the project team (mainly SEARRP and Permian Global), in close consultation with key experts on various aspects of biodiversity and monitoring techniques. These experts were selected based on their experience in conducting tasks for similar target species and parameters, in conditions that are similar or close to the project area. Danum Valley is a key research site of SEARRP, established by the Royal Society in 1985, and Kuamut is linked to the Imbak Canyon and Danum Valley conservation areas. SEARRP carries out world-class scientific research that addresses the major environmental issues facing the tropics: plantation development, habitat restoration, and climate change. Kuamut Rainforest Conservation Project ensures the protection of the Project Area and helps facilitate the recovery of habitats for many species including some of the most threatened taxa

⁴⁶ Tilker, A., Abrams, J.F., Mohamed, A., Nguyen, A., Wong, S.T., Sollmann, R., Niedballa, J., Bhagwat, T., Gray, T.N., Rawson, B.M. and Guegan, F., 2019. Habitat degradation and indiscriminate hunting differentially impact faunal communities in the Southeast Asian tropical biodiversity hotspot. *Communications Biology*, 2(1), p.396. <https://doi.org/10.1038/s42003-019-0640-y>

⁴⁷ Gardner, P.C., & B. Goossens. 2017. The Bornean Banteng Programme: Conservation and management of the endangered wild cattle *Bos javanicus lowi* in Sabah. Danau Girang Field Centre. Surveys of bantengs in Kuamut Forest Reserve. Available at: https://deramakot.sabah.gov.my/images/pdf/pub/BantengSurveyReport_KuamutForestReserve.pdf

⁴⁸ [1] Brozovic R, Abrams J F, Mohamed A, Wong S T, Niedballa J, Bhagwat T, Sollmann R, Mannan S, Kissing J and Wilting A. 2018. Effects of forest degradation on the moonrat *Echinosorex gymnura* in Sabah, Malaysian Borneo. *Mammalian Biology*. 93 135-143. <https://doi.org/10.1016/j.mambio.2018.10.003>

⁴⁹ Guharajan, R., Mohamed, A., Wong, S.T., Niedballa, J., Petrus, A., Jubili, J., Lietz, R., Clements, G.R., Wong, W.M., Kissing, J. and Lagan, P., 2021. Sustainable forest management is vital for the persistence of sun bear *Helarctos malayanus* populations in Sabah, Malaysian Borneo. *Forest Ecology and Management*, 493, p.119270. <https://doi.org/10.1016/j.foreco.2021.119270>

such as Bornean orangutans, Bornean elephants, and helmeted hornbills. All RTE species listed in the PD are believed to exist within the project area, and many of the populations are likely to increase or become more resilient as the habitat recovers and as disturbances from logging and other associated activities are stopped.

The biodiversity monitoring and protection plan of the Kuamut Rainforest Conservation project has three key objectives: 1. Secure critical orangutan habitats and populations; 2. Fill knowledge gaps on the use of the project area by RTE and HCV species (e.g. elephants, gibbons, helmeted and other hornbill species, endemic trees and other plant species); and 3. Secure habitat for other wide-ranging species and buffer the western flank of the Danum Valley Conservation Area – the only significant area of lowland primary forest remaining in Sabah.

The project team have compiled and assessed information on biodiversity-related studies and management conducted during this (2016-2021) monitoring period both inside and adjacent to the project area conducted by various parties. Some of these activities have been conducted directly and specifically within the project area. Project team members, especially from SEARRP have contributed to the regional assessments of various aspects of biodiversity including prioritization of areas for increased protection that use biodiversity as one of the main indicators. We have provided the auditor Earthood with evidence of the site access requests between SEARRP, Sabah Forestry Department and RBJ for these studies. Some other studies, assessments, and management activities have also been conducted outside or in the immediate vicinity of the project area, or at the state-wide level, but have strong relevance to the project area. All these studies strongly indicate the extreme importance of the conservation of the project area for biodiversity conservation in the region and globally (Ross et al. 2016⁵⁰; Guharajan et al. 2021⁵¹; Mohamed,

⁵⁰Ross, J., Hearn, A., Macdonald, D.W., Semiadi, G., Alfred, R., Mohamed, A., Brodie, J.F., Giordano, A., Heydon, M., Hon, J. and Mathai, J., 2016. Predicted distribution of the banded civet *Hemigalus derbyanus* (Mammalia: Carnivora: Viverridae) on Borneo. *Raffles Bulletin of Zoology*. Available at: <https://sites.lsa.umich.edu/ajmarsha/wp-content/uploads/sites/162/2016/07/Ross-et-al.-2016-Banded-palm-civet-small.pdf>

⁵¹ Guharajan, R., Mohamed, A., Wong, S.T., Niedballa, J., Petrus, A., Jubili, J., Lietz, R., Clements, G.R., Wong, W.M., Kissing, J. and Lagan, P., 2021. Sustainable forest management is vital for the persistence of sun bear *Helarctos malayanus* populations in Sabah, Malaysian Borneo. *Forest Ecology and Management*, 493, p.119270. <https://doi.org/10.1016/j.foreco.2021.119270>

Brickle & Wilting 2017⁵², Mohamed et al. 2021⁵³; Ancrenaz et al. 2014⁵⁴; Ancrenaz et al. 2005⁵⁵; Ancrenaz et al. 2010⁵⁶; Gardner & Goossens, 2017a⁵⁷; Tilker et al. 2019⁵⁸, Evans et al. 2018⁵⁹, Evans et al. 2020⁶⁰, Gardner & Goossens 2017b⁶¹; Hearn et al. 2019⁶²; Simon, Davies & Ancrenaz, 2019⁶³; De la Torre et al.

⁵² Mohamed, A., Brickle, N. and Wilting, A., 2017. A new record of Bornean Peacock Pheasant Polyplectron schleiermacheri from Sabah, Malaysia. *FORKTAIL*, (33), pp.53-55.

⁵³ Mohamed, A., R. Sollmann, S. T. Wong, J. Niedballa, J. F. Abrams, J. Kissing, and A. Wilting. 2021. Counting Sunda clouded leopards with confidence: incorporating individual heterogeneity in density. *Oryx*, 2021, 55(1), 56–65.
<https://doi.org/10.1017/S0030605318001503>

⁵⁴ Ancrenaz, M., Sollmann, R., Meijaard, E., Hearn, A.J., Ross, J., Samejima, H., Loken, B., Cheyne, S.M., Stark, D.J., Gardner, P.C. and Goossens, B., 2014. Coming down from the trees: Is terrestrial activity in Bornean orangutans natural or disturbance driven?. *Scientific reports*, 4(1), p.4024.
<https://doi.org/10.1038/srep04024>

⁵⁵ Ancrenaz, M., Gimenez, O., Ambu, L., Ancrenaz, K., Andau, P., Goossens, B., Payne, J., Sawang, A., Tuuga, A. and Lackman-Ancrenaz, I., 2005. Aerial surveys give new estimates for orangutans in Sabah, Malaysia. *PLoS Biology*, 3(1), p.e3.
<https://journals.plos.org/plosbiology/article?id=10.1371/journal.pbio.0030003>

⁵⁶ Ancrenaz, M., Ambu, L., Sunjoto, I., Ahmad, E., Manokaran, K., Meijaard, E. and Lackman, I., 2010. Recent surveys in the forests of Ulu Segama Malua, Sabah, Malaysia, show that orang-utans (*P. p. morio*) can be maintained in slightly logged forests. *PLoS One*, 5(7), p.e11510. <https://doi.org/10.1371/journal.pone.0011510>

⁵⁷ Gardner, P.C., & B. Goossens. 2017. The Bornean Banteng Programme: Conservation and management of the endangered wild cattle *Bos javanicus lowi* in Sabah. Danau Girang Field Centre. Surveys of bantengs in Kuamut Forest Reserve. Available at:
https://deramakot.sabah.gov.my/images/pdf/pub/BantengSurveyReport_KuamutForestReserve.pdf

⁵⁸ Tilker, A., Abrams, J.F., Mohamed, A., Nguyen, A., Wong, S.T., Sollmann, R., Niedballa, J., Bhagwat, T., Gray, T.N., Rawson, B.M. and Guegan, F., 2019. Habitat degradation and indiscriminate hunting differentially impact faunal communities in the Southeast Asian tropical biodiversity hotspot. *Communications Biology*, 2(1), p.396. <https://doi.org/10.1038/s42003-019-0640-y>

⁵⁹ Evans, L. J., G. P. Asner, B. Goossens. 2018. Protected area management priorities crucial for the future of Bornean elephants. *Biological Conservation* 221:365–373
<https://doi.org/10.1016/j.biocon.2018.03.015>

⁶⁰ Evans, L. J., B. Goossens, A. B. Davies, G. Reynolds, G. P. Asner. 2020. Natural and anthropogenic drivers of Bornean elephant movement strategies. *Global Ecology and Conservation* 22: e00906.
<https://doi.org/10.1016/j.gecco.2020.e00906>

⁶¹ Gardner, P.C., & B. Goossens 2017. The Bornean Banteng Programme: Conservation and management of the endangered wild cattle *Bos javanicus lowi* in Sabah. Surveys of bentengs in Deramakot Forest Reserve. Danau Girang Field Centre. Available at:
https://deramakot.sabah.gov.my/images/pdf/pub/BantengSurveyReport_DeramakotForestReserve.pdf

⁶² Hearn, A.J., Cushman, S.A., Goossens, B., Macdonald, E., Ross, J., Hunter, L.T., Abram, N.K. and Macdonald, D.W., 2018. Evaluating scenarios of landscape change for Sunda clouded leopard connectivity in a human dominated landscape. *Biological Conservation*, 222, pp.232-240.
<https://doi.org/10.1016/j.biocon.2018.04.016>

⁶³ Simon, D., Davies, G., Ancrenaz, M. 2019. Changes to Sabah's orangutan population in recent times: 2002–2017. *PLoS ONE*, <https://doi.org/10.1371/journal.pone.0218819>

2022⁶⁴; Brozovic et al. 2018⁶⁵). For a detailed description of the methods and results of the above cited studies used for reporting the net impacts of biodiversity monitoring, please refer to Appendix 7.

During the first monitoring period, the project collaborated with external parties to conduct the following biodiversity monitoring activities:

Activity and Date	Description and Outcome
Aerial LiDAR surveys of the Kuamut project area (April 2016)	Permian Global funded the Carnegie Institution of Science ('Carnegie') for the purposes of conducting aerial LiDAR surveys of the Kuamut Project area of Sabah, Malaysia. This funded the costs of at least three additional days flying over the project area during April 2016 as part of the ongoing surveys that Carnegie was conducting in the region. This work directly contributed the Kuamut field plot data and resulted in the Jucker et al. (2018) peer-reviewed publication in the Journal Biogeosciences: 'Estimating aboveground carbon density and its uncertainty in Borneo's structurally complex tropical forests using airborne laser scanning', which includes Permian Global coauthors.
Exchange and analysis of LiDAR and hyperspectral imagery of Kuamut project area (Feb 2017)	Permian Global entered into a contract with the Carnegie Institution for Science for the acquisition of high resolution Kuamut-specific LiDAR and hyperspectral imagery. A series of workshops over a two-week period were also conducted between Permian Global, SEARRP and Carnegie to analyse the data. Aside from giving an overall picture of the diversity of canopy trees in the project area, which is closely linked to overall diversity, the hyperspectral data for the area was used when stratifying the area for the design of the current biodiversity monitoring programme. The data included geo-referenced point cloud data captured by Carnegie from the project area which could be analysed and interpreted using a range of processing software packages to achieve a degree of average positional accuracy of not less than 20 centimetres, including: a) Canopy height b) Ground layer (DTM) c) Canopy layer (DSM)

⁶⁴ de la Torre, J.A., Cheah, C., Lechner, A.M., Wong, E.P., Tuuga, A., Saaban, S., Goossens, B. and Campos-Arceiz, A., 2022. Sundaic elephants prefer habitats on the periphery of protected areas. *Journal of Applied Ecology*, 59(12), pp.2947-2958. <https://doi.org/10.1111/1365-2664.14286>

⁶⁵ Brozovic R, Abrams J F, Mohamed A, Wong S T, Niedballa J, Bhagwat T, Sollmann R, Mannan S, Kissing J and Wilting A. 2018. Effects of forest degradation on the moonrat *Echinosorex gymnura* in Sabah, Malaysian Borneo. *Mammalian Biology*. 93 135-143. <https://doi.org/10.1016/j.mambio.2018.10.003>

	A copy of this agreement was shared with the verifier of this monitoring report. This work directly contributed field plot data and funding, and resulted in the Asner et al. (2018) publication in Biological Conservation cited throughout this MR which includes Permian Global coauthors.
Camera trapping in 2016 by researchers Azlan Mohamed & Andreas Wilting (conducted between March 2016 and July 2016 in close collaboration with Permian / SEARRP carbon plot team)	This work and datasets from the Kuamut Project Area directly resulted in four published biodiversity research studies (Mohamed, Brickle & Wilting. 2017 ⁶⁶ , Brozovic <i>et al.</i> 2018 ⁶⁷ , Tilker <i>et al.</i> 2019 ⁶⁸ , Mohamed <i>et al.</i> 2021 ⁶⁹) see Appendix 7 for more details. This research includes papers on the Bornean peacock pheasant, Sunda-clouded-leopards, moonrats and importantly a paper describing how the defaunation index is low for the Kuamut FR – indicating low hunting during the monitoring period.
Orangutan Survey – Changes to Sabah’s orangutan population in recent times (conducted in 2014-2017, by Simon, Davies & Ancrenaz, and published in 2019)	Securing critical orangutan habitats and populations are a key biodiversity objective for the project. An orangutan survey (Simon, Davies & Ancrenaz 2019⁷⁰) was completed by HUTAN (SEE https://www.hutan.org.my/about-us/ - one of the project consultants) in the Project Area in 2014-2017 during the monitoring period with the support of the Sabah Forestry Department and RBJ, who provided access to the project site to the researchers. The survey compared the 2014-2017 findings with the findings of a previous study completed in 2002-2003 (Ancrenaz <i>et al.</i> 2005 ⁷⁰). The 2014-2017 survey found a total of approximately 630 individuals within the Kuamut Project Area during this time period. This value was calculated by summing the number of orangutans that were estimated across the: (1) Northern Kuamut (West): population size and 95% CIs = 193 (128-292), (2) Kuamut (West): population size and 95% CIs = 20 (13-31) and (3) Northern Kuamut (East): population size and 95% CIs = 417 (281-619). This corresponds to a density of 0.58 orangutans per km ² (see

⁶⁶ Mohamed, A., Brickle, N. and Wilting, A., 2017. A new record of Bornean Peacock Pheasant Polyplectron schleiermacheri from Sabah, Malaysia. *FORKTAIL*, (33), pp.53-55.

⁶⁷ Brozovic R, Abrams J F, Mohamed A, Wong S T, Niedballa J, Bhagwat T, Sollmann R, Mannan S, Kissing J and Wilting A. 2018. Effects of forest degradation on the moonrat *Echinosorex gymnura* in Sabah, Malaysian Borneo. *Mammalian Biology*. 93 135-143. <https://doi.org/10.1016/j.mambio.2018.10.003>

⁶⁸ Tilker, A., Abrams, J.F., Mohamed, A., Nguyen, A., Wong, S.T., Sollmann, R., Niedballa, J., Bhagwat, T., Gray, T.N., Rawson, B.M. and Guegan, F., 2019. Habitat degradation and indiscriminate hunting differentially impact faunal communities in the Southeast Asian tropical biodiversity hotspot. *Communications Biology*, 2(1), p.396. <https://doi.org/10.1038/s42003-019-0640-y>

⁶⁹ Mohamed, A., R. Sollmann, S. T. Wong, J. Niedballa, J. F. Abrams, J. Kissing, and A. Wilting. 2021. Counting Sunda clouded leopards with confidence: incorporating individual heterogeneity in density. *Oryx*, 2021, 55(1), 56–65. <https://doi.org/10.1017/S0030605318001503>

⁷⁰ Simon D, Davies G, Ancrenaz M (2019) Changes to Sabah’s orangutan population in recent times: 2002–2017. *PLoS ONE* 14(7): e0218819. <https://doi.org/10.1371/journal.pone.0218819>

	Appendix 11 for a map of the study area and Simon, Davies & Ancrenaz 2019 for more details). The 2014-2017 survey also showed an increase in orangutan population density and size from the 2002-2003 period within the much larger Imbak-Kalabakan region; this region included the western part of the Kuamut Project Area. A small proportion of this increase reflects immigration from adjacent land areas where there has been significant forest clearance adjacent to the eastern boundary of the Project Area, but the larger population located recently in the Imbak-Kalabakan region was identified as a result of the more intensive survey efforts in the 2014-2017 sampling (i.e., compared to the 2002-2003 surveys). The study also found that the orangutan population size had remained consistent in the larger Segama region, which encompasses the eastern side of the Kuamut Project Area. We estimate that across the whole Kuamut Project Area, the number of orangutans has remained stable and is likely recovering in some areas. This is a reassuring finding from the monitoring, suggesting that there is a healthy and significant population of orangutans that are regularly using and supported by the Project Area. The Project Area will also act as a long-term refuge for orangutans should continued forest clearance take place in the wider landscape A new survey of the orangutan population within the Project Area (and specific to it) was completed in November 2023. Analyses of the data obtained from this survey is currently underway, with preliminary results indicating continued population stability, with modest increases in certain parts of the Project Area. We are planning repeat orangutan surveys on a 3-to-5-year basis initiating in 2023.
Survey and monitoring of IUCN tree species, including red listed HCV dipterocarp species (2016 & 2020)	In 2016, Permian Malaysia conducted a survey to monitor the IUCN status' of all the tree species in a all 46 field plots (as used for the climate data), and these plots where remeasured (including new botanical work) starting in 2020. In total we found that there are 34 species of critically endangered (6), endangered (5), and vulnerable (23) tree species. See Table 15 for the species list and numbers of individuals. The survey results have been provided to the auditor during verification. Project intervention ensures the protection of the project area, which has resulted in the avoidance of logging and other forms of disturbances. Because of this, the RTE tree species in the project area are protected.

Four of the previously mentioned biodiversity research studies (Mohamed, Brickle & Wilting 2017⁷¹, Brozovic *et al.* 2018⁷²; Tilker *et al.* 2019⁷³, Mohamed *et al.* 2021⁷⁴) were conducted within the project area, during the monitoring period by independent researchers in collaboration with Permian Global staff who were implementing field plots at the same time. These studies also analysed wildlife distributions at the wider landscape scale, with contributions from project partner, SEARRP, and so in the context of the project implementation, are very relevant to the project area. One of the project partners, RBJ, has also contributed to these studies by providing the researchers with access to the project area. Following the project start, an extensive systematic camera trapping inventory was conducted in the 'Northern Kuamut Forest Reserve' by Azlan Mohamed which resulted in four scientific research papers studies and covered the majority of the project area. (Mohamed, Brickle & Wilting 2017 2017, Brozovic *et al.* 2018; Tilker *et al.* 2019., Mohamed *et al.* 2021) All studies used data from the camera trapping campaign that was conducted between March 2016 and July 2016, across 53 camera trapping stations. This totalled 3,522 camera trapping days for the Mohamed *et al.* (2021) study, and based on personal communication between the project team and the first author of the paper, this study documented 33 species from the study area, including 13 species categorized as threatened by IUCN (Critically Endangered, Endangered, and Vulnerable) as seen in Table 13. Of particular note, were the documentation of the Critically Endangered Pangolin (*Manis javanica*), and the records of the Sunda clouded leopard which were recorded a total of 17 times, with analysis indicating that this represents 8 individuals (Mohamed *et al.* 2021). Further results for these two studies are given below (with additional summaries in Appendix 7):

Table 13: List of threatened species with the IUCN Red List Status documented by independent researchers (Tilker *et al.* 2019; Mohamed *et al.* 2021) from the Project Area and its immediate vicinity during this reporting period

Common Name	Scientific Name	IUCN Status
Pangolin	<i>Manis javanica</i>	Critically endangered
Bay cat	<i>Catopuma badia</i>	Endangered
Elephant	<i>Elephas maximus</i>	Endangered
Banteng	<i>Bos javanicus</i>	Endangered
Sunda clouded leopard	<i>Neofelis diardi</i>	Vulnerable
Binturong	<i>Arctictis binturong</i>	Vulnerable
Small-clawed otter	<i>Aonyx cinereus</i>	Vulnerable

⁷¹ Mohamed, A., Brickle, N. and Wilting, A., 2017. A new record of Bornean Peacock Pheasant Polyplectron schleiermacheri from Sabah, Malaysia. *FORKTAIL*, (33), pp.53-55.

⁷² Brozovic R, Abrams J F, Mohamed A, Wong S T, Niedballa J, Bhagwat T, Sollmann R, Mannan S, Kissing J and Wilting A. 2018. Effects of forest degradation on the moonrat *Echinosorex gymnura* in Sabah, Malaysian Borneo. *Mammalian Biology*. 93 135-143. <https://doi.org/10.1016/j.mambio.2018.10.003>

⁷³ Tilker, A., Abrams, J.F., Mohamed, A., Nguyen, A., Wong, S.T., Sollmann, R., Niedballa, J., Bhagwat, T., Gray, T.N., Rawson, B.M. and Guegan, F., 2019. Habitat degradation and indiscriminate hunting differentially impact faunal communities in the Southeast Asian tropical biodiversity hotspot. *Communications Biology*, 2(1), p.396. <https://doi.org/10.1038/s42003-019-0640-y>

⁷⁴ Mohamed, A., R. Sollmann, S. T. Wong, J. Niedballa, J. F. Abrams, J. Kissing, and A. Wilting. 2021. Counting Sunda clouded leopards with confidence: incorporating individual heterogeneity in density. *Oryx*, 2021, 55(1), 56–65. <https://doi.org/10.1017/S0030605318001503>

Sun bear	<i>Helarctos malayanus</i>	Vulnerable
Sambar deer	<i>Rusa unicolor</i>	Vulnerable
Bearded pig	<i>Sus scrofa</i>	Vulnerable
Grey langur	<i>Presbytis hosei</i>	Vulnerable
Pig-tailed macaque	<i>Macaca nemestrina</i>	Vulnerable
Tufted ground squirrel	<i>Rheithrosciurus macrotis</i>	Vulnerable

The extensive nature of the camera trapping exercise has supported multiple analyses; Tilker et al. (2019)⁷⁵, reported a relatively high occupancy probability for the following species: Yellow-throated marten, Sun bear, Pig-tailed macaque, Pangolin, Malayan porcupine, Great argus, Bornean yellow muntjac, Bearded pig, Banded civet, Red muntjac, Common palm civet, Banded linsang, Short-tailed mongoose, Long-tailed porcupine and Leopard cat. Other important observations include Bornean Peacock Pheasant (*Polyplectron schleiermacheri*) (Mohamed, Brickle & Wilting 2017)⁷⁶. Moonrats (*Echinosorex gymnura*) were also detected within the reserve (Brozovic et al. 2018)⁷⁷. While the numbers of Moonrats recorded were comparatively low, analysis by Brozovic et al (2018), suggested that this species prefer closed canopy forest – hence, abundance may increase as the forest regenerates as a consequence of the project. The area also has a significant population of Bornean orangutans in Sabah (*Pongo pygmaeus morio*) and this species will be a specific focus of the monitoring programme (Ancrenaz et al 2005)⁷⁸. Other target species will be charismatic and threatened large mammals known to be present in the area, these include Bornean elephants (*Elephas maximus borneensis*), banteng (*Bos javanicus*), bay cat (*Catopuma badia*), and Sabah grey langur (*Presbytis sabana*). The project will also continue to monitor the conservation status of the large variety of threatened birds such as the Critically Endangered helmeted hornbills (*Rhinoplax vigil*) and the Endangered Bornean Peacock-Pheasant

⁷⁵ Tilker, A., Abrams, J.F., Mohamed, A., Nguyen, A., Wong, S.T., Sollmann, R., Niedballa, J., Bhagwat, T., Gray, T.N., Rawson, B.M. and Guegan, F., 2019. Habitat degradation and indiscriminate hunting differentially impact faunal communities in the Southeast Asian tropical biodiversity hotspot. *Communications Biology*, 2(1), p.396. <https://doi.org/10.1038/s42003-019-0640-y>

⁷⁶ Mohamed, A., Brickle, N. and Wilting, A., 2017. A new record of Bornean Peacock Pheasant *Polyplectron schleiermacheri* from Sabah, Malaysia. *FORKTAIL*, (33), pp.53-55.

⁷⁷ Brozovic R, Abrams J F, Mohamed A, Wong S T, Niedballa J, Bhagwat T, Sollmann R, Mannan S, Kissing J and Wilting A. 2018. Effects of forest degradation on the moonrat *Echinosorex gymnura* in Sabah, Malaysian Borneo. *Mammalian Biology*. 93 135-143. <https://doi.org/10.1016/j.mambio.2018.10.003>

⁷⁸ Ancrenaz, M., Gimenez, O., Ambu, L., Ancrenaz, K., Andau, P., Goossens, B., Payne, J., Sawang, A., Tuuga, A. and Lackman-Ancrenaz, I., 2005. Aerial surveys give new estimates for orangutans in Sabah, Malaysia. *PLoS Biology*, 3(1), p.e3. <https://journals.plos.org/plosbiology/article?id=10.1371/journal.pbio.0030003>

(*Polyplectron schleiermacheri*) (Tilker et al. 2019⁷⁹, Evans et al. 2018⁸⁰, Evans et al. 2020⁸¹, Gardner & Goossens 2017a⁸², Mohamed, Brickle & Wilting 2017).

In summary, the monitoring Process includes:

Aerial LiDAR surveys were conducted in April 2016 to assess canopy height, ground layer, and canopy layer in the Kuamut project area.

LiDAR and hyperspectral imagery of the project area were acquired in February 2017 and analyzed to stratify the area for the design of the biodiversity monitoring program.

An orangutan survey was completed in 2014-2017, estimating 0.58 orangutans per km² in the the Kuamut project area (Simon, Davies & Ancrenaz 2019⁸³), and there was a follow-up survey in November 2023.

A survey in 2016 monitored the IUCN status of all tree species in select plots, identifying 34 critically endangered, endangered, and vulnerable tree species.

Results and Evaluation of Monitoring:

Biodiversity Indicator	Baseline Scenario	Project Scenario	Monitoring Results
Vegetation Quality	The most likely without-project scenario would involve the continuation of annual selective logging on a rotational basis by coupe, and mosaic planting which requires almost	Under the project scenario, cessation of logging and prevention of mosaic planting results in natural forest regeneration through the Project Area.	Due to the project intervention, namely the protection of the area, habitat conversion to mosaic planting and continued logging activities did not happen. As demonstrated by the

⁷⁹ Tilker, A., Abrams, J.F., Mohamed, A., Nguyen, A., Wong, S.T., Sollmann, R., Niedballa, J., Bhagwat, T., Gray, T.N., Rawson, B.M. and Guegan, F., 2019. Habitat degradation and indiscriminate hunting differentially impact faunal communities in the Southeast Asian tropical biodiversity hotspot. *Communications Biology*, 2(1), p.396. <https://doi.org/10.1038/s42003-019-0640-y>

⁸⁰ Evans, L. J., G. P. Asner, B. Goossens. 2018. Protected area management priorities crucial for the future of Bornean elephants. *Biological Conservation* 221:365–373
<https://doi.org/10.1016/j.biocon.2018.03.015>

⁸¹ Evans, L. J., B. Goossens, A. B. Davies, G. Reynolds, G. P. Asner. 2020. Natural and anthropogenic drivers of Bornean elephant movement strategies. *Global Ecology and Conservation* 22: e00906.
<https://doi.org/10.1016/j.gecco.2020.e00906>

⁸² Gardner, P.C., & B. Goossens. 2017. The Bornean Banteng Programme: Conservation and management of the endangered wild cattle *Bos javanicus lowi* in Sabah. Danau Girang Field Centre. Surveys of bantengs in Kuamut Forest Reserve. Available at:
https://deramakot.sabah.gov.my/images/pdf/pub/BantengSurveyReport_KuamutForestReserve.pdf

⁸³ Simon, D., Davies, G., Ancrenaz, M. 2019. Changes to Sabah's orangutan population in recent times: 2002–2017. *PLoS ONE*, <https://doi.org/10.1371/journal.pone.0218819>

	wholesale land clearance and the planting of a small number of fast-growing timber species. Mosaic planting, as practiced at several locations in Sabah, is likely to have severe impacts on biodiversity at all levels, since the actively planted portion of the mosaic involves the complete removal of natural vegetation, and thus of natural habitats for all species. These natural habitats provide important sources of food for herbivorous and frugivorous species, along with other ecological resources. Mosaics retain pockets of natural forest (which are subject to selective logging as described above), and while these areas are likely to constitute refugia for a subset of the fauna and flora originally present (i.e., generalist, wide-ranging species), the mosaic landscape as a whole will be severely compromised in its complement of local biodiversity (i.e., many HCV 1 species), ecological integrity (including recovery and recruitment in		vegetation analysis, this has allowed improvement in habitat condition (Figure 4, presented under the Climate Section in 3.1.3, which shows yearly biomass maps between 2016-2021). See Appendix 9 for further details on the link between carbon density, vegetation quality & biodiversity.
Presence of HCV1 Species		Under the project scenario, deforestation and hunting activities will be prevented, which will lead to increased dispersal and population resilience of RTE species throughout the Project Area.	An orangutan survey (Simon, Davies & Ancrenaz 2019 ⁸⁴) was completed in the Kuamut Project Area in 2014-2017. The study compared the 2014-2017 findings with the findings of a previous study completed in 2002-2003 (Ancrenaz et al. 2005) ⁸⁵ . Within the Project Area the orangutan population size for 2014-2017 was estimated as 630 individuals. It is safe to assume that this has remained stable across this 2002-2003 and 2014-2017 time period and is likely recovering in some areas; a positive finding. Hence, following its designation as a Class I Forest Reserve in 2016, orangutan habitat with the Project Area has been conserved, which has

⁸⁴ Simon D, Davies G, Ancrenaz M (2019) Changes to Sabah's orangutan population in recent times: 2002–2017. PLoS ONE 14(7): e0218819. <https://doi.org/10.1371/journal.pone.0218819>

⁸⁵ Ancrenaz, M., Sollmann, R., Meijaard, E., Hearn, A.J., Ross, J., Samejima, H., Loken, B., Cheyne, S.M., Stark, D.J., Gardner, P.C. and Goossens, B., 2014. Coming down from the trees: Is terrestrial activity in Bornean orangutans natural or disturbance driven?. *Scientific reports*, 4(1), p.4024. <https://doi.org/10.1038/srep04024>

	embedded forest patches) and capacity for the maintenance of ecosystem functions including pollination and microbial cycling of soil nutrients.		resulted in a stable population as opposed to a decline (i.e., the without project scenario). We are planning repeat orangutan surveys on a 3-to-5-year basis initiating in 2023, following our most recent monitoring. Analyses from i collaborative studies (Mohamed, Brickle & Wilting 2017)⁸⁶, Brozovic et al. 2018⁸⁷, Tilker et al. 2019⁸⁸ and Mohamed et al. 2021⁸⁹ also detected various RTE species, including Bornean Peacock Pheasants, Pangolins and Sun bears, . Additionally, moonrats were detected within the reserve, suggesting that their abundance may increase as the forest regenerates due to the project implementation. See Appendix 7 for a detailed summary of these studies. Data was collected from camera trap monitoring at 53 sites
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⁸⁶ Mohamed, A., Brickle, N. and Wilting, A., 2017. A new record of Bornean Peacock Pheasant Polyplectron schleiermacheri from Sabah, Malaysia. *FORKTAIL*, (33), pp.53-55.

⁸⁷ Brozovic R, Abrams J F, Mohamed A, Wong S T, Niedballa J, Bhagwat T, Sollmann R, Mannan S, Kissing J and Wilting A. 2018. Effects of forest degradation on the moonrat *Echinosorex gymnura* in Sabah, Malaysian Borneo. *Mammalian Biology*. 93 135-143. <https://doi.org/10.1016/j.mambio.2018.10.003>

⁸⁸ Tilker, A., Abrams, J.F., Mohamed, A., Nguyen, A., Wong, S.T., Sollmann, R., Niedballa, J., Bhagwat, T., Gray, T.N., Rawson, B.M. and Guegan, F., 2019. Habitat degradation and indiscriminate hunting differentially impact faunal communities in the Southeast Asian tropical biodiversity hotspot. *Communications Biology*, 2(1), p.396. <https://doi.org/10.1038/s42003-019-0640-y>

⁸⁹ Mohamed, A., R. Sollmann, S. T. Wong, J. Niedballa, J. F. Abrams, J. Kissing, and A. Wilting. 2021. Counting Sunda clouded leopards with confidence: incorporating individual heterogeneity in density. *Oryx*, 2021, 55(1), 56–65. <https://doi.org/10.1017/S0030605318001503>

			within the project area during March – July 2016 in collaboration with Permian Global staff.
Signs of anthropogenic disturbance		Under the project scenario, logging will halt, mosaic planting will be prevented and further habitat loss and hunting activities will be curbed through the project activities listed in 2.1.1.	To monitor anthropogenic disturbance, routine outpost / security gate manning and/or monitoring by the field team in the form of surveillance occurred throughout the monitoring period at monthly intervals where logistically feasible (evidence documentation was provided to the VVB). Field visits and general observations by the project team during this monitoring period indicated very low levels of human activities in the project area. For example, since the project inception, no evidence has been found that the orangutans in the project area are threatened by poaching or hunting.
Status of hunting activities		Under the project scenario, hunting activities will decrease and be detected through implementation of biodiversity monitoring activities (e.g., patrols).	To monitor hunting activities, routine outpost / security gate manning and/or monitoring by the field team in the form of surveillance occurred throughout the monitoring period at monthly intervals where logistically feasible (evidence documentation was provided to the VVB). The project's proactive measures, including anti-poaching patrols, livelihood enhancement activities and the protection of key habitats, are in

			place to manage any anthropogenic threats and maintain low incidences of hunting activities within the project area, which will allow a safe refuge for populations of RTE species (e.g., orangutans, sun bears, elephants) that are threatened by human activity.
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5.3.2 Biodiversity Monitoring Plan Dissemination (B4.3)

The results of the monitoring plan are research documents that have been made publicly available as peer-reviewed scientific publications in journals on the internet. For example, the Orangutan survey that was conducted in the project area in 2014-2017 and referenced in section 5.3.1 was made available online in the PLOS ONE open access journal⁹⁰.

We engage experts from Hutan, an NGO in Sabah that have been working on orangutan monitoring and conservation, in the development of the methodology for the monitoring of orangutan population. The results of the monitoring activities conducted in coordination with Hutan are made available through the Hutan webpage⁹¹. The Biodiversity Monitoring Plan, its implementations and results have been and will continue to be disseminated to the key stakeholders, including the local communities. However, due to the sensitive nature of some findings, such as specific locations of rare species, we have been adjusting the messaging accordingly. The biodiversity team coordinates closely with the community team regarding information dissemination of the biodiversity monitoring plan, the implementation of the plan and the results produced. Further from dissemination, the project team seeks to explore the possibility of integrating the biodiversity and community development programs, such as by promoting ecotourism potential to be developed with local community members lead the activities such as for wildlife watching guides.

Other means of communication that have been used throughout the monitoring period include SEARRP scientists, staff and appointed consultants who conducted forest monitoring surveys and consultations required for the certification of the Kuamut Rainforest Restoration Project. SEARRP undertook the surveys inside the forest reserve and with communities in the area, and these were coordinated with RBJ and the community leaders. Evidence of site access letters for these meetings have been provided to the VVB during the verification process.

5.4 Optional Criterion: Exceptional Biodiversity Benefits

⁹⁰ Simon D, Davies G, Ancrenaz M (2019) Changes to Sabah's orangutan population in recent times: 2002–2017. PLoS ONE 14(7): e0218819. <https://doi.org/10.1371/journal.pone.0218819>

⁹¹ <https://www.hutan.org.my/partners/>

Metric of Project Biodiversity Benefits	Current estimate
Expected change in the number of hectares managed significantly better by the project for biodiversity conservation, measured against the without-project scenario	83,381 ha
Expected number of globally Critically Endangered or Endangered species benefiting from reduced threats as a result of project activities, measured against the without-project scenario	34 tree, 29 mammal and 12 bird species in the project areas are considered as Rare, Threatened or Endangered [RTE] species.

During this reporting period, the importance and significance of the project area for the survival and long-term viability of these RTE fauna species have been confirmed and recognized by the analysis conducted for Sabah's Protected Area Prioritization Project (Table 14 & Figure 12, Appendix 2). Most of these RTE species have a declining global population trend. All of them are threatened with status' ranging from Vulnerable (26 species), Endangered (13 species), to Critically Endangered (4 species, namely Sunda Pangolin, Bornean Orangutan, Straw-headed bulbul, and Helmeted Hornbill).

During this reporting period, the importance and significance of the project area for the survival and long-term viability of RTE flora has been confirmed using botanical surveys in the long-term climate field plots. In 2016, Permian Malaysia conducted a survey to monitor the IUCN red list status' of all the tree species in all 46 field plots (as used for the climate data), and these plots were remeasured (including new botanical work) starting in 2020. In total we found that there are 34 species of critically endangered (6), endangered (5), and vulnerable (23) tree species. The species list, including numbers of individuals is provided in Table 15. Project intervention ensures the protection of the project area, which has resulted in the avoidance of logging and other forms of disturbances. Because of this, the RTE tree species in the project area are protected.

Table 14 List of RTE species which distribution have been identified to include Kuamut Forest Reserve, based on analysis conducted for Sabah's Protected Area Prioritization Project

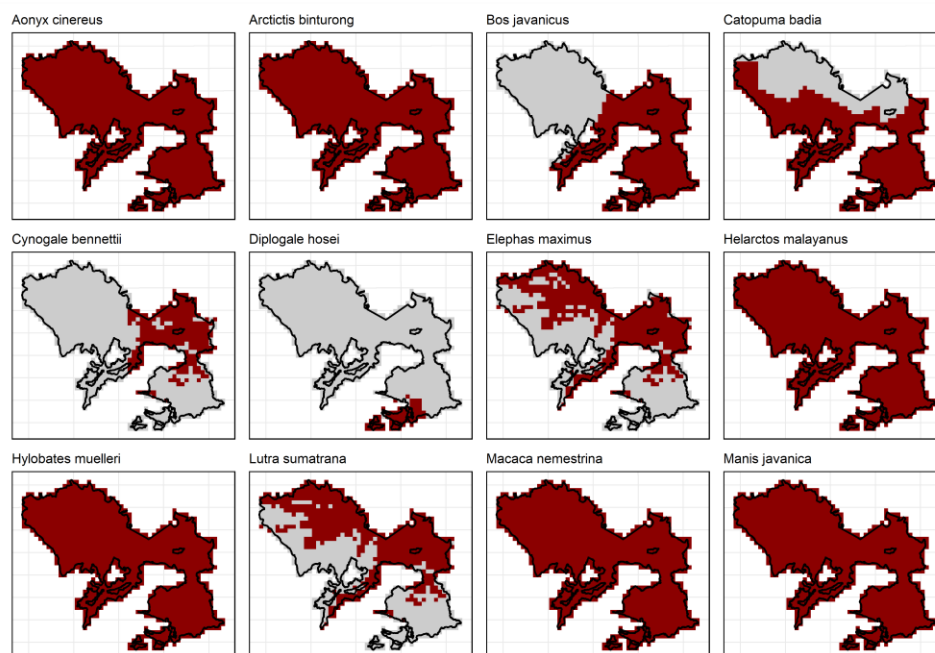
Class	Common English Name	Species	IUCN RL Status	Global Population Trend (as of 2021) ⁹²
Mammal	Asian Small-clawed Otter	<i>Aonyx cinereus</i>	VU	Decreasing
Mammal	Binturong	<i>Arctictis binturong</i>	VU	Decreasing
Mammal	Banteng	<i>Bos javanicus</i>	EN	Decreasing
Mammal	Borneo Bay Cat	<i>Catopuma badia</i>	EN	Decreasing
Mammal	Otter Civet	<i>Cynogale bennettii</i>	EN	Decreasing
Mammal	Hose's Civet	<i>Diplogale hosei</i>	VU	Decreasing

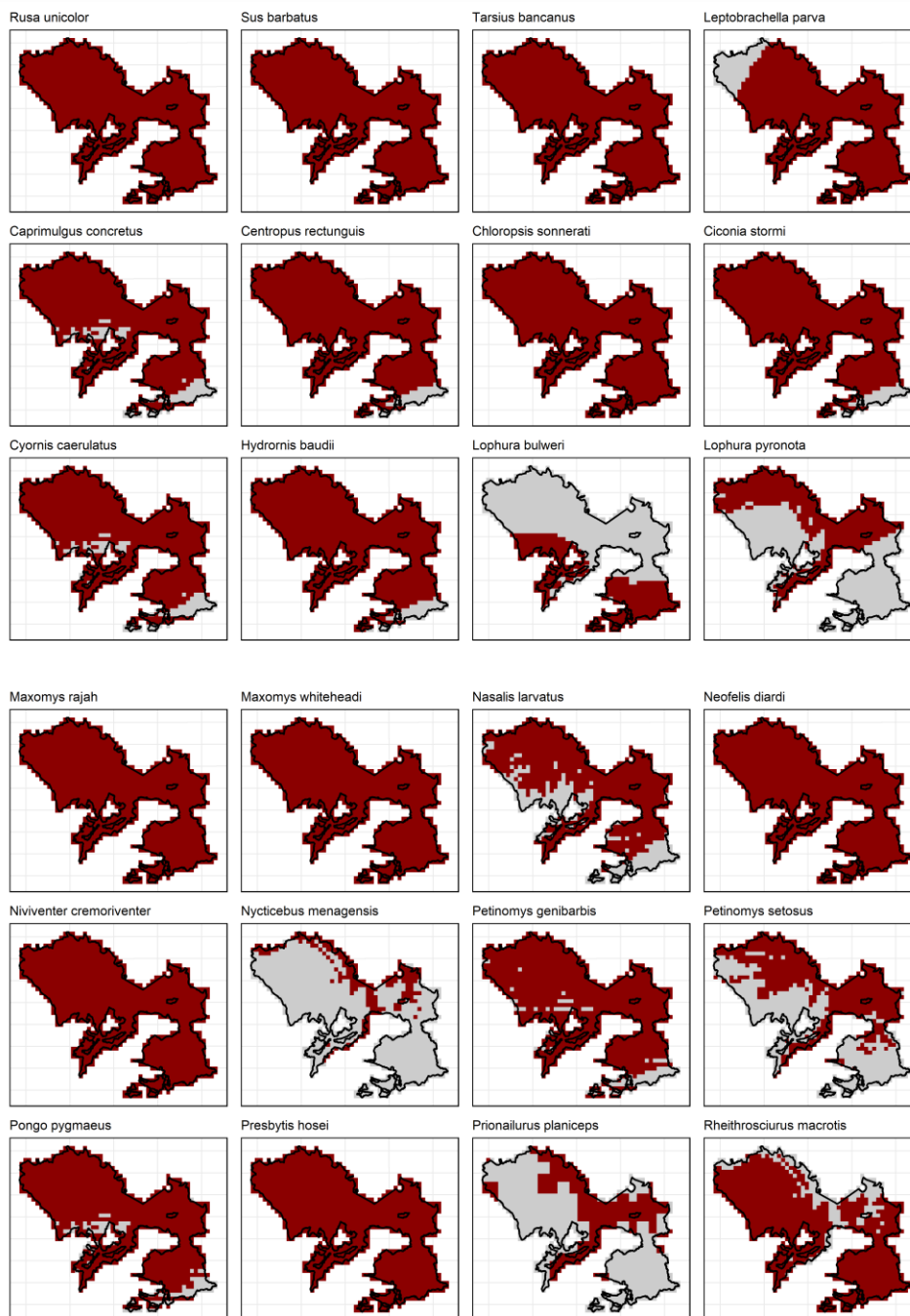
⁹² <https://www.iucnredlist.org/search/list?query=sabah&searchType=species>

Mammal	Asian Elephant	<i>Elephas maximus</i>	EN	Decreasing
Mammal	Sun Bear	<i>Helarctos malayanus</i>	VU	Decreasing
Mammal	Bornean Gibbon	<i>Hylobates muelleri</i>	EN	Decreasing
Mammal	Hairy-nosed Otter	<i>Lutra sumatrana</i>	EN	Decreasing
Mammal	Southern Pig-tailed Macaque	<i>Macaca nemestrina</i>	EN	Decreasing
Mammal	Sunda Pangolin	<i>Manis javanica</i>	CR	Decreasing
Mammal	Rajah Sundaic Maxomys	<i>Maxomys rajah</i>	VU	Decreasing
Mammal	Whitehead Sundaic Maxomys	<i>Maxomys whiteheadi</i>	VU	Decreasing
Mammal	Proboscis Monkey	<i>Nasalis larvatus</i>	EN	Decreasing
Mammal	Sunda Clouded Leopard	<i>Neofelis diardi</i>	VU	Decreasing
Mammal	Sundaic Arboreal Niviventer	<i>Niviventer cremoriventer</i>	LC	Unknown
Mammal	Philippine Slow Loris	<i>Nycticebus menagensis</i>	VU	Decreasing
Mammal	Whiskered Flying Squirrel	<i>Petinomys genibarbis</i>	VU	Decreasing
Mammal	Temminck's Flying Squirrel	<i>Petinomys setosus</i>	VU	Decreasing
Mammal	Bornean Orangutan	<i>Pongo pygmaeus</i>	CR	Decreasing
Mammal	Hose's Langur	<i>Presbytis hosei</i>	VU	Decreasing
Mammal	Flat-headed Cat	<i>Prionailurus planiceps</i>	EN	Decreasing
Mammal	Tufted Ground Squirrel	<i>Rheithrosciurus macrotis</i>	VU	Decreasing
Mammal	Sambar	<i>Rusa unicolor</i>	VU	Decreasing
Mammal	Bearded Pig	<i>Sus barbatus</i>	VU	Decreasing
Mammal	Horsefield's Tarsier	<i>Cephalopachus (Tarsius) bancanus</i>	VU	Decreasing
Amphibian	Undefined	<i>Leptobranchella parva</i>	LC	Stable
Bird	Bonaparte's Nightjar	<i>Caprimulgus concretus</i>	VU	Decreasing
Bird	Short-toed Coucal	<i>Centropus rectunguis</i>	VU	Decreasing
Bird	Greater Green Leafbird	<i>Chloropsis sonnerati</i>	EN	Decreasing
Bird	Storm's Stork	<i>Ciconia stormi</i>	EN	Decreasing
Bird	Large-billed Blue Flycatcher	<i>Cyornis caeruleatus</i>	VU	Decreasing
Bird	Blue-headed Pitta	<i>Hydrornis baudii</i>	VU	Decreasing
Bird	Bulwer's Pheasant	<i>Lophura bulweri</i>	VU	Decreasing
Bird	Bornean Crestless Fireback	<i>Lophura pyronota</i>	EN	Decreasing
Bird	Black Partridge	<i>Melanoperdix niger</i>	VU	Decreasing
Bird	Great Slaty Woodpecker	<i>Mulleripicus pulverulentus</i>	<u>VU</u>	Decreasing

Bird	Wallace's Hawk Eagle	<i>Nisaetus nanus</i>	VU	Decreasing
Bird	Bornean Peacock-pheasant	<i>Polyplectron schleiermacheri</i>	EN	Decreasing
Bird	Bornean Wren-babbler	<i>Ptilocichla leucogrammica</i>	VU	Decreasing
Bird	Straw-headed Bulbul	<i>Pycnonotus zeylanicus</i>	CR	Decreasing
Bird	Helmeted Hornbill	<i>Rhinoplax vigil</i>	CR	Decreasing
Bird	Hook-billed Bulbul	<i>Setornis criniger</i>	VU	Decreasing
Bird	Large Green Pigeon	<i>Treron capellei</i>	VU	Decreasing

Mammals





Birds

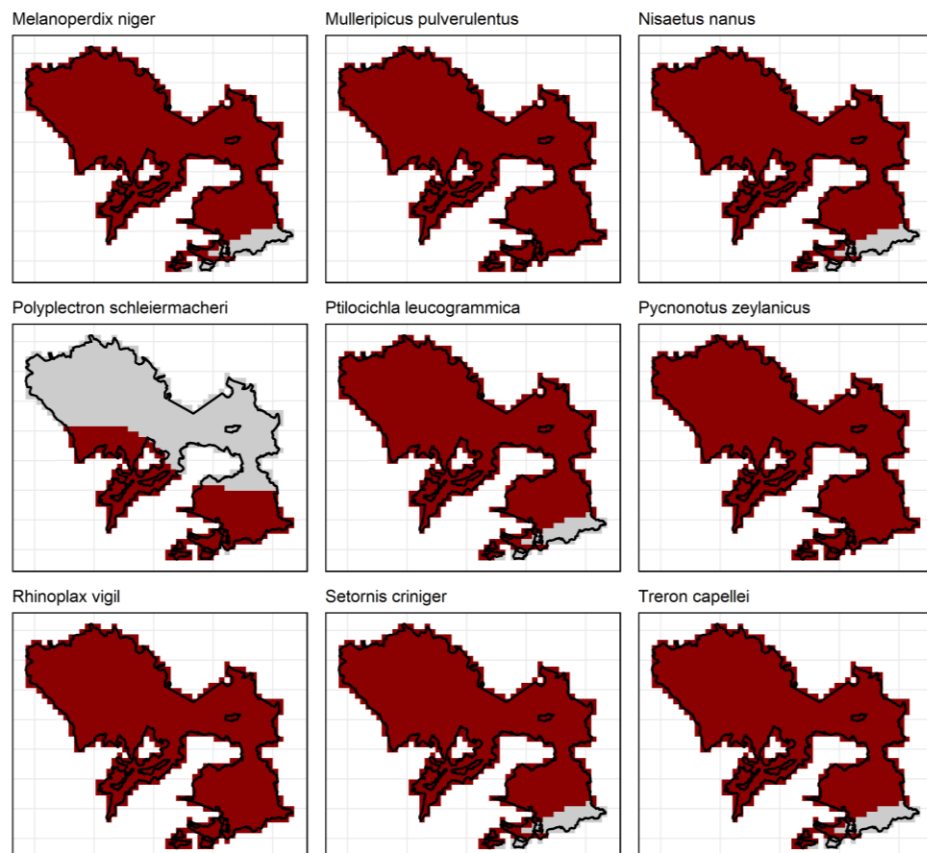


Figure 12. Distribution Maps of RTE species in Kuamut Forest Reserve. This was generated based on analysis conducted for Sabah-wide Protected Area Prioritization Project⁹³ by Dr Sara Williams, who was employed by SEARRP (under a sub-contract with the University of Montana), and funded by the Rainforest Trust. The source of the data comes from the IUCN list of RTE species.

Table 15 List of RTE tree species which have been identified withing the Kuamut Forest Reserve, based on botanical analysis of the forest field plots.

Scientific Name	Number Of Individuals	Red List Category
<i>Alangium havilandii</i>	7	Vulnerable
<i>Anisoptera laevis</i>	2	Vulnerable
<i>Aquilaria beccariana</i>	2	Vulnerable
<i>Artocarpus anisophyllus</i>	4	Vulnerable
<i>Artocarpus tamaran</i>	2	Vulnerable
<i>Chisocheton pauciflorus</i>	2	Vulnerable
<i>Dillenia borneensis</i>	2	Vulnerable
<i>Diospyros daemona</i>	1	Vulnerable
<i>Dipterocarpus conformis</i>	7	Endangered

⁹³ <https://www.rainforesttrust.org/urgent-projects/protecting-the-last-great-forests-of-northern-borneo/>

<i>Dryobalanops beccarii</i>	17	Endangered
<i>Durio grandiflorus</i>	1	Vulnerable
<i>Durio kutejensis</i>	5	Vulnerable
<i>Eusideroxylon zwageri</i>	8	Vulnerable
<i>Hopea beccariana</i>	1	Vulnerable
<i>Hopea ferruginea</i>	9	Critically Endangered
<i>Hopea nervosa</i>	8	Critically Endangered
<i>Hopea plagata</i>	24	Critically Endangered
<i>Hopea sangal</i>	9	Vulnerable
<i>Madhuca elmeri</i>	3	Endangered
<i>Palaquium maingayi</i>	1	Vulnerable
<i>Shorea acuminatissima</i>	2	Vulnerable
<i>Shorea atrinervosa</i>	8	Vulnerable
<i>Shorea faguetiana</i>	18	Endangered
<i>Shorea falciferoides</i>	5	Vulnerable
<i>Shorea ferruginea</i>	6	Vulnerable
<i>Shorea gibbosa</i>	9	Critically Endangered
<i>Shorea guiso</i>	2	Vulnerable
<i>Shorea johorensis</i>	22	Critically Endangered
<i>Shorea leptoderma</i>	3	Critically Endangered
<i>Shorea mecistopteryx</i>	21	Vulnerable
<i>Shorea pauciflora</i>	21	Endangered
<i>Shorea smithiana</i>	1	Vulnerable
<i>Shorea superba</i>	7	Vulnerable
<i>Shorea symingtonii</i>	3	Vulnerable

5.4.1 Trigger Species Population Trends (GL3.3)

Trigger Species	Bornean orangutan (<i>Pongo pygmaeus morio</i>)
With-project Scenario	- Improvement in protection status of the habitat - Habitat/forest/landcover and threat monitoring using satellite imageries, border patrol using helicopters, and on-the-ground monitoring visits to some accessible places by project team

The Bornean orangutan (*Pongo pygmaeus morio*) is Critically Endangered (Ancrenaz et al 2016). The most recent estimates for the population of orangutans in Sabah, based on empirical surveys conducted

in 2014-2017, indicate the presence of approximately 12,000 individuals with the bulk of the population concentrated in the lowland forests of central and eastern Sabah (Simon, Davies & Ancrenaz 2019)⁹⁴.

The Project Area is strategically located in the core habitat of the P.p. morio metapopulation and adjacent to the major population centres for this sub-species in the Ulu Segama and Malua Forest Reserves and the Danum Valley Conservation Area (Ancrenaz et al 2005⁹⁵, Ancrenaz et al 2010⁹⁶, Simon, Davies & Ancrenaz 2019⁹⁷). Based on empirical surveys conducted in 2014-2017 (Simon, Davies & Ancrenaz 2019) it is estimated that the population of orangutan in the Project Area is approximately 630 individuals, and that this number has remained stable since the last surveys were conducted in 2002-2003 before the project was initiated (Ancrenaz et al. 2005⁹⁸; Ancrenaz Pers. Coms).

Measures taken to mitigate the risk to the natural forest ecosystem, and the biodiversity it supports, are equivalent to those taken to protect the climate change benefits of the project, summarised above. Activities specifically aimed at reducing hunting pressure on key species include awareness programs, sign board placement about the protection status of the area and the biodiversity, and guard post and check point staffing by RBJ/Yayasan Sabah/the authority. Security personnel were stationed at two strategically placed security gates to monitor vehicle in/out from the Yayasan Sabah Concession Area, including Kuamut Forest Reserve. The gates are located at Km 11, Jalan Danum and Haranky. Future programs under the plan include monitoring of biodiversity use (including hunting and harvest) to enable sustainable use, creation of alternative livelihoods for those reliant on hunting incomes, and increased protection, patrolling and enforcement to reduce and prevent the exploitation of endangered and/or legally protected species.

Securing critical orangutan habitats and populations are a key biodiversity objective for the project. An orangutan survey was conducted in the project area in 2014-2017 during the monitoring period with the support of the Sabah Forestry Department and RBJ, who provided access to the project sight to the researchers.. It is estimated that across the whole Kuamut project area, there is a significant number of orangutans (approximately 630 individuals), and that the population is stable and possibly recovering in some areas. This is a reassuring finding from the monitoring, suggesting that there is a healthy population

⁹⁴ Simon, D., Davies, G., Ancrenaz, M. 2019. Changes to Sabah's orangutan population in recent times: 2002–2017. *PLoS ONE*, <https://doi.org/10.1371/journal.pone.0218819>

⁹⁵ Ancrenaz, M., Gimenez, O., Ambu, L., Ancrenaz, K., Andau, P., Goossens, B., Payne, J., Sawang, A., Tuuga, A. and Lackman-Ancrenaz, I., 2005. Aerial surveys give new estimates for orangutans in Sabah, Malaysia. *PLoS Biology*, 3(1), p.e3. <https://journals.plos.org/plosbiology/article?id=10.1371/journal.pbio.0030003>

⁹⁶ Ancrenaz, M., Ambu, L., Sunjoto, I., Ahmad, E., Manokaran, K., Meijaard, E. and Lackman, I., 2010. Recent surveys in the forests of Ulu Segama Malua, Sabah, Malaysia, show that orang-utans (*P. p. morio*) can be maintained in slightly logged forests. *PLoS One*, 5(7), p.e11510. <https://doi.org/10.1371/journal.pone.0011510>

⁹⁷ Simon D, Davies G, Ancrenaz M (2019) Changes to Sabah's orangutan population in recent times: 2002–2017. *PLoS ONE* 14(7): e0218819. <https://doi.org/10.1371/journal.pone.0218819>

⁹⁸ Ancrenaz, M., Gimenez, O., Ambu, L., Ancrenaz, K., Andau, P., Goossens, B., Payne, J., Sawang, A., Tuuga, A. and Lackman-Ancrenaz, I., 2005. Aerial surveys give new estimates for orangutans in Sabah, Malaysia. *PLoS Biology*, 3(1), p.e3. <https://journals.plos.org/plosbiology/article?id=10.1371/journal.pbio.0030003>

of orangutans that are regularly using and supported by the Project Area. For on-going monitoring, a new survey has been completed in November 2023, with data now to be analysed.

6 ADDITIONAL PROJECT IMPLEMENTATION INFORMATION

Document any additional information that explains how the project has been implemented in accordance with the validated project description for all indicators that require implementation of an activity or process. Criteria and indicators shall be referenced for each statement made in this section.

7 ADDITIONAL PROJECT IMPACT INFORMATION

Document any additional information that provides the results of monitoring and shows how the project meets all indicators that require demonstration of impacts. Criteria and indicators of the Climate, Community & Biodiversity Standards or requirements of the VCS Standard shall be referenced for each statement made in this section.

APPENDIX 1: CHANGES TO THE BASELINE DUE TO THE USE OF MORE ACCURATE AND UP-TO-DATE DATASETS (Differential GPS location of field plots & more accurate information on protected species)

As described in 2.2.4, the approach for biomass mapping has been updated with new more accurate and up-to-date datasets. These more accurate maps have been used to update the 2016 timber volume maps. As these volume maps are used to produce the timber harvest plan and estimate the Mean volume of extracted timber under the baseline ($V_{EX,j,i|BSL}$), this value and all subsequent calculations have changed slightly.

As described in detail in 'APPENDIX 8. Species conservation factor details' more detailed information was obtained on protected species. This affects the species conservation factor deduction from both merchantable timber and ongoing growth in the project scenario, and therefore all the tables have been updated and reported here.

This annex therefore updates and replaces part of section 3.1.4 (part of the section titled "Initial stratification of the project area" and the section titled "Forest inventory to determine the biomass per hectare potentially available for harvest") and the whole of section 3.2.1 of the PD.

In the methodology, the analysis for leakage due to market effects (section 8.3.2 of the methodology) depends on the net greenhouse gas emissions in the baseline scenario. Therefore, the market leakage section of section 3.2.3 of the PD has also been updated in this Annex.

>>>start of updated section 3.1.4 of the PD<<<<< **3.1.4 Baseline scenario**

Modelling the baseline scenario

Initial stratification of the project area (starting below figure 26)

As noted in 3.1.3, the size of the project area in the official shapefile is slightly larger than the area gazetted as the class I forest reserve (shapefile area is 84800 ha while the gazetted area is 83381 ha). For the purpose of the calculations, the areas of the different strata have therefore been adjusted (by reducing the area of each strata by 1.67%) so the project area in the calculations matches the gazetted area. The adjusted areas of the strata are indicated in Table 14 below.

Table 14: Area of each stratum

	Area (ha)	Corrected Area (ha)	Proportion Of Project Area
Stratum 1 (Inoperable)	5135	5049	0.06055
Stratum 2 (Natural Forest Management)	35029	34443	0.41308
Stratum 3 (selective logging within Mosaic Planting)	7176	7056	0.08462
Stratum 4 (planting areas within Mosaic Planting)	37460	36833	0.44174
Total	84800	83381	1

Forest inventory to determine the biomass per hectare potentially available for harvest:

The monitoring of the annual carbon stock change in aboveground biomass of trees involves remote sensing in combination with targeted remeasuring of field plots.

Field Inventory:

A total of 46 circular 30-meter radius (each 0.28 ha) permanent sample plots (PSPs) were set up within the Kuamut area between the 9th of October 2015 and the 3rd of August 2016 according to a modified field protocol from the Carnegie Airborne Observatory (a more detailed description is available for validation in a Standard Operational Procedure). We use 2 foot of rebar driven into the ground the mark the centre of the plot. In each of these sample plots, the tree height and DBH of all trees above 10 cm DBH were measured. When buttress roots prevent measuring the diameter at 1.3m, the diameter of the trunk was measured higher up, where the measurement reflects the trunk size. Lianas and dead trees were recorded and marked in the 'comments' column of the datasheet as "AL" or "DS" but are conservatively not included in the analysis. The trees are also marked with permanent metal numbered tags which are carefully nailed into each tree.

We recorded taxonomic information, taking leaf samples wherever possible. More than 75% of the individuals were identified to Genus, and more than 50% of the individuals have been identified to Species level. Average wood density values were estimated for each genus using the Global Wood Density Database (Chave et al. 2009) ⁹⁹. Using these values, we then calculated a plot-level basal area weighted average and assigned it to any individuals lacking botanical information.

Biomass was calculated according to equation 4 from Chave et al. (2014) ¹⁰⁰ utilising the measured diameter and heights, and the estimated wood density. This means that the taxonomic information is incorporated via the wood density, so while one equation is used – the estimated biomass will be quite different for different species of the same dimensions. The equations of Chave et al. (2014) are widely regarded as more accurate than species specific allometric (which also do not exist for the majority of species diverse tropical regions). We estimated timber volume from the calculated biomass using a BCEF-R of 1.89. The plot level timber volume was derived by summing the timber volume of all trees above the defined cutting limit (40 cm DBH for the NFM areas, and 31 cm DBH for the Mosaic Planting Approach areas).

The project started remeasuring the plots during 2021, but due to heavy movement control orders, and access difficulties, we did not complete the plot remeasure until March 2022. All 46 of the field plots were re-measured. Tree's height were originally measured in the field plots in 2016 as there was no local tree height model for Sabah. The tree height and DBH data from Kuamut in 2016 has now been combined with

⁹⁹ Chave, J., Coomes, D., Jansen, S., Lewis, S. L., Swenson, N. G. & Zanne, A. E. 2009. Towards a Worldwide Wood Economics Spectrum. *Ecology Letters* (12): 351-366

¹⁰⁰ Chave *et al* (2014). Improved allometric models to estimate the aboveground biomass of tropical trees. *Global Change Biology*. Volume 20, Issue 10, October 2014, Pages 3177-3190.

other datasets and used to produce a local height model for Sabah, and are published ([Philipson et al., 2020](#)). We therefore used tree height modelled from DBH. Plot photos were originally taken to show the existence of a plot, but do not add anything when repeated. Slope measurements were originally taken as a backup, but average slope from the LiDAR measurements proved more useful for slope correction. Due to access difficulties for the plot remeasure, time was limited at the plots, and minimising these three items of data collection allowed more careful data collection for the critical DBH measurements. These updates are described in v1.1 of the field measurements SOP. As all 46 of the field plots were re-measured, the field plot validation dataset therefore includes a total of 92 (two measurements of 46) field plots.

Biomass Mapping

When the field inventory was taking place in 2016, the Carnegie Airborne Observatory (CAO) and Sabah Forest Department undertook an ambitious project to map the Aboveground Carbon Density across the entire state of Sabah. The Kuamut project directly collaborated with this carbon mapping project, firstly by sharing the field inventory data and secondly by commissioning additional intensive LiDAR acquisition for the Kuamut project area (see Figure).

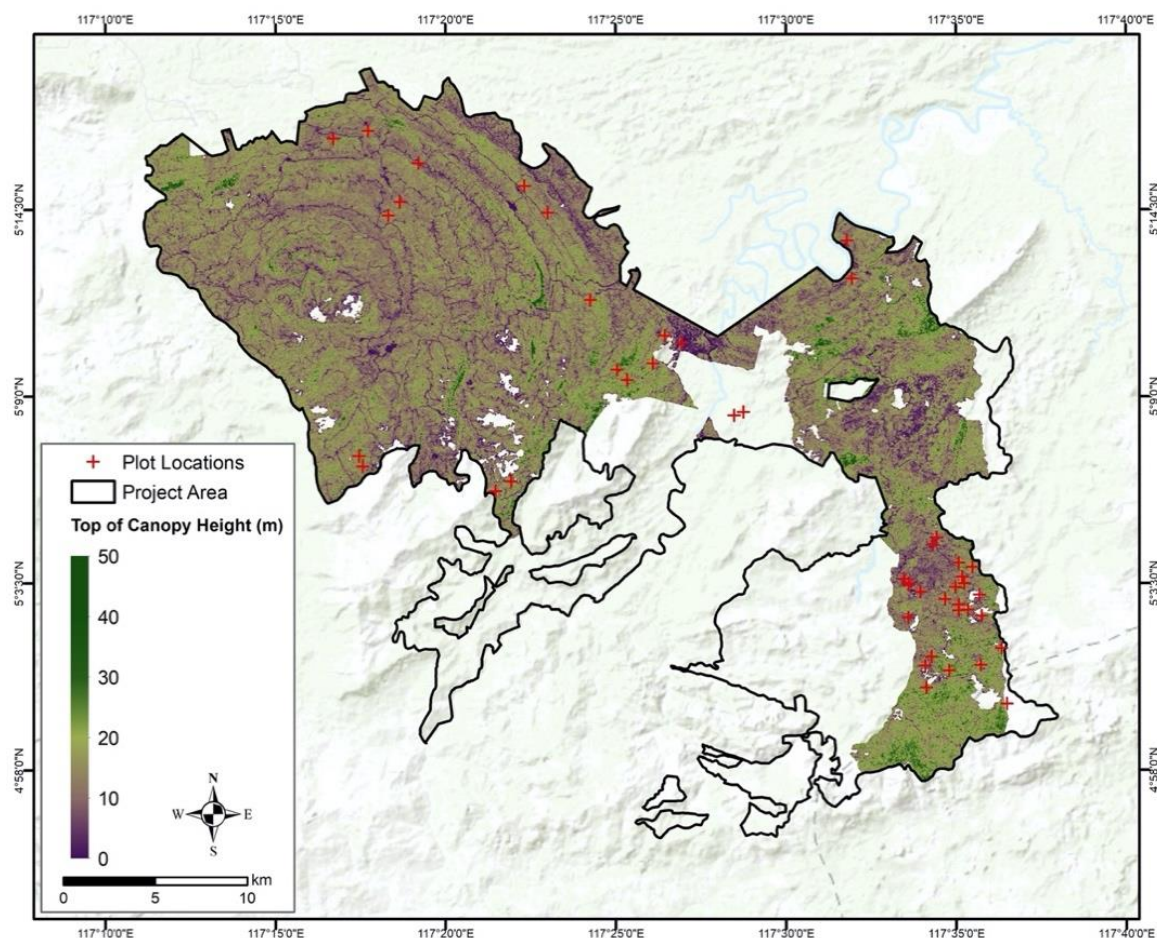


Figure 13: LiDAR coverage directly obtained for the project. In this figure, the Top-of-Canopy-Height is presented at a 30-meter pixel resolution derived from the LiDAR point clouds. Field plot locations are represented with red crosses. Areas where no LiDAR point cloud is available are empty, showing the DEM hillshade, and thus no TCH colour scale.

To accurately estimate any emissions from small amounts of deforestation or degradation, the project has developed a multi-temporal modelling approach to estimate the spatial variability and distribution of aboveground biomass. The modelling approach adopted a machine learning workflow that uses the following data sources: aerial LiDAR scan (ALS) data describing canopy height, optical (Landsat 8) and Synthetic Aperture Radar (SAR) satellite imagery and forest plot data, all datasets acquired on the same year (2016). The combination of remote-sensing data sources is used to produce an updated wall-to-wall Top of Canopy Height (TCH) map. This monitoring of forest growth using remote sensing imagery is conducted in combination with remeasuring of field plots. It is important to note that while the forest growth monitoring process utilises both remote sensing and field measurements, it is very much supported with the field plot measurements, and it is possible to accurately model the regrowth without measuring the field plots every monitoring period.

As part of the workflow, annual composites of Landsat 8 (L8) imagery were created for the project area using Google earth engine. For the SAR data, imagery from Sentinel 1 (S1) was used where all S1 images, for a given year, that intersected the area of interest, were collected. Each image was preprocessed using the steps described in Mullissa et al (2021).¹⁰¹ All S1 preprocessing was carried out using google earth engine and the {rgee} package. The Copernicus GLO 30 m global digital elevation model (DEM)¹⁰² was used to derive terrain data for the area of interest including: slope, aspect, minimal curvature, mean curvature. All the bands from the imagery discussed above were combined into a data cube, comprising a total of 41 bands. In order to harmonize the data between yearly composites, it was necessary to apply temporal smoothing across each band of the data cube for all years in the period 2015:2022.¹⁰³

The data cube was aligned with the tree Canopy Height Model (CHM) that was generated to produce figure 13. The coverage of the CHM is not complete due to some areas where LiDAR point clouds were not directly available to the project as a result of clouds or areas not flown. All regions that intersected the CHM were used to create a data frame comprising the measured canopy height values from the CHM and all of the environmental/ earth observation data contained within the data cube. Machine learning was applied to analyse the information in the data cube and develop a Canopy Height Model using the combination of environmental metrics that could produce a model with the lowest RMSE value. Spatial resampling was undertaken to evaluate the performance of the ensemble model as shown in figure 14. The model was then used to predict canopy height. The resulting predictions stored as spatial raster data.

¹⁰¹ <https://doi.org/10.3390/rs13101954>

¹⁰² <https://portal.opentopography.org/raster?opentopoID=OTSDEM.032021.4326.3>

¹⁰³ Although this Monitoring report focuses on the years 2016:2021, including years 2015 and 2022 improves the temporal smoothing estimation for those non-endpoint years.

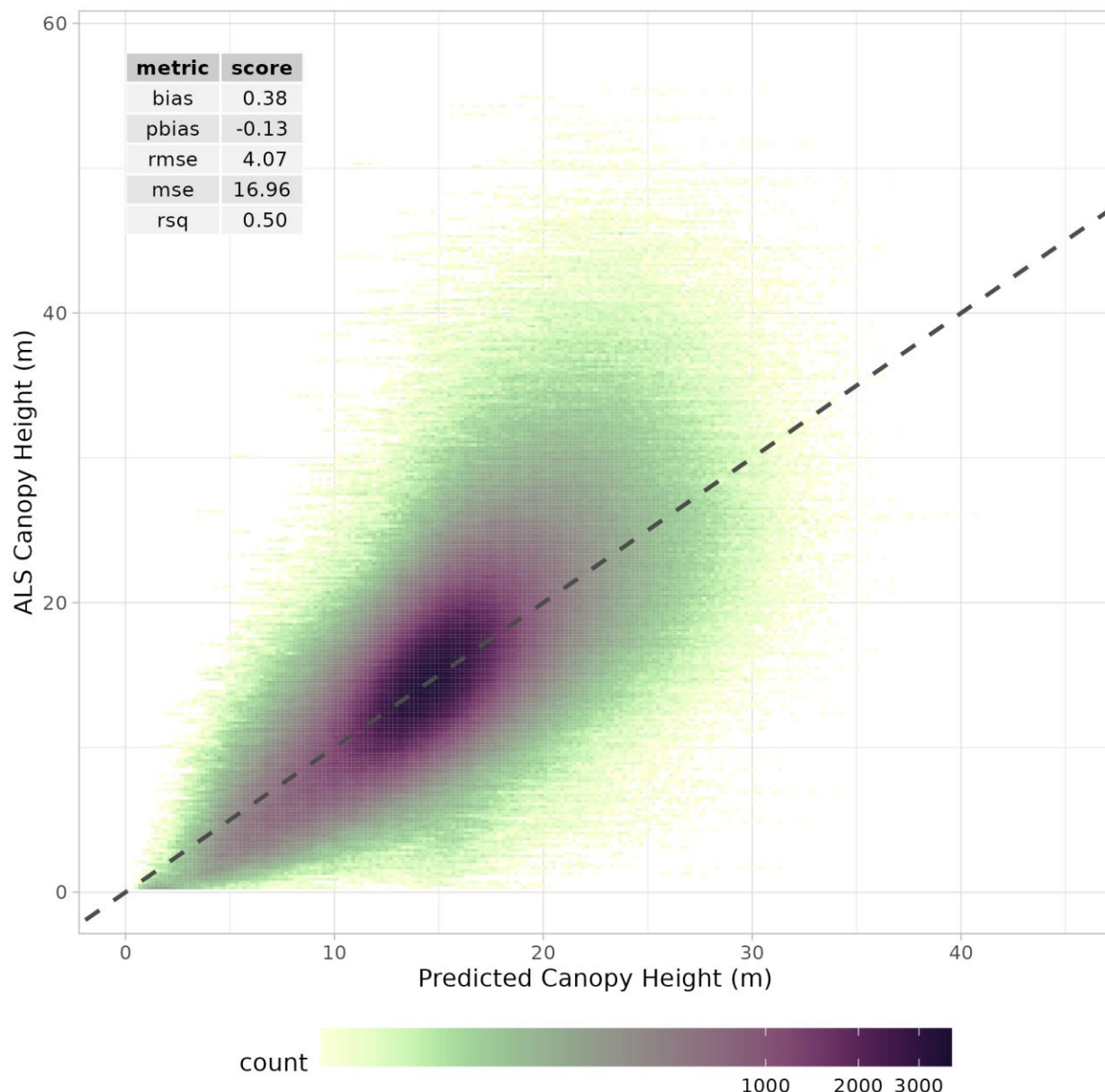


Figure 14: Evaluation of the performance of the developed Canopy Height Model against the Lidar generated canopy height data

To determine the Above Ground Biomass, the canopy height model predictions for all years were appended to their respective year's data cube as an additional band to form the input data cube for biomass model development. This was combined with the data from the field measurements that were undertaken in 2016 and 2020 in the Kuamut project area. Data cubes for the corresponding years were used to extract the earth observation data that intersected each plot area for each year it was surveyed. The total Above Ground Carbon (AGC) in the plot was converted to Aboveground Carbon density (ACD) by dividing the AGC by the planimetric area of the plot. The derived dataframe was used to train a model to

predict ACD. All variable combinations were tested that included between 6-10 control features, two of which were required to be modelled: canopy height and mean curvature¹⁰⁴ (because of their importance). The best performing model was selected. The model was trained on the full forest plot inventory and validated using spatial resampling (see figure 15).

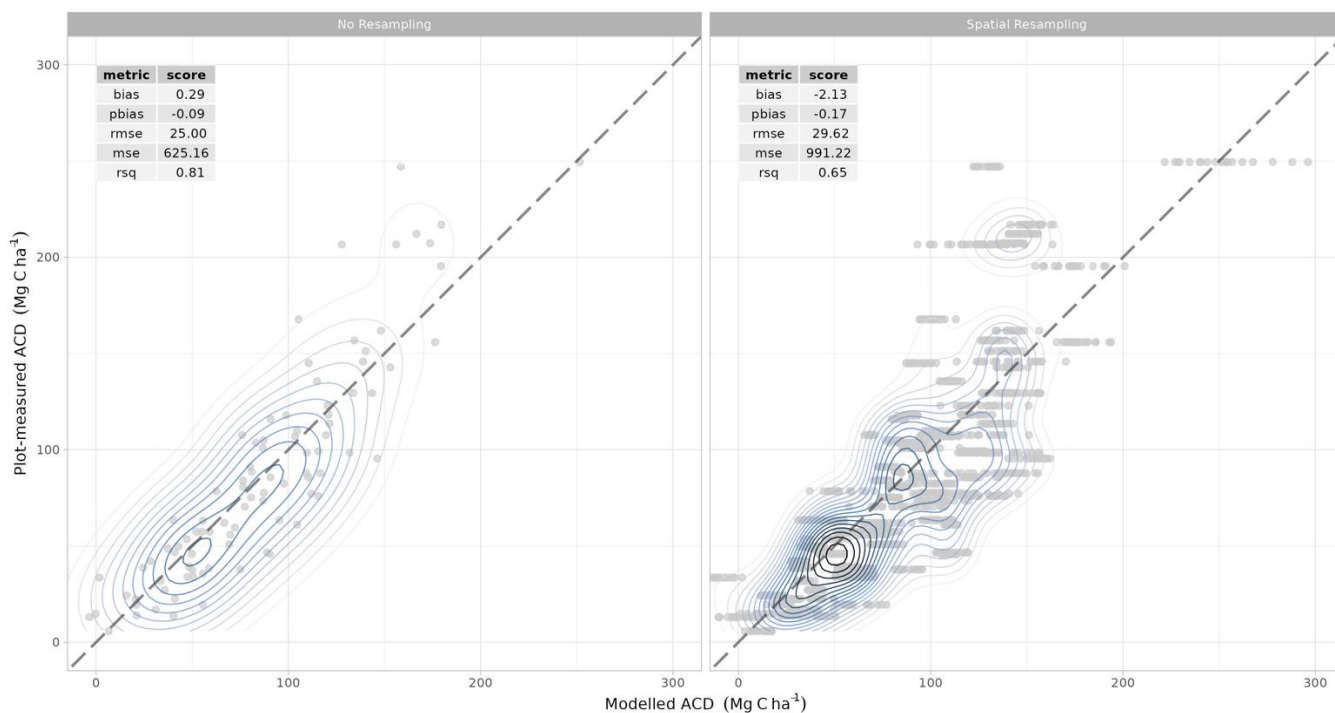


Figure 15: Model validation comparing plot-measured ACD against modelled ACD values, indicating extremely low bias and good model performance.

The best model was used to predict ACD across the entire Kuamut area. All steps related to the model were repeated for Merchantable Volume with cutting limits of 10 cm, 31 cm, and 40 cm. The combination of data sources was used to produce volume maps for 2016, as per the methodology.

Growth Rate calculation:

Growth rate was calculated across multiple years for the entire Kuamut project area to derive the most robust estimate possible. Predicted ACD maps for years 2016-2021 were used because the project commenced in 2016 and 2022 predictions require an additional annual prediction in 2023 to be confident in the stability of the time series. A linear mixed effects model, with fixed effect for strata, was fit across the entire dataset providing a distribution of predicted growth rates, and the fixed effect slopes are therefore the growth rates for each of the strata in the project area (as described in the monitoring part of this report above).

¹⁰⁴ Mean curvature identifies upland areas and ridgelines, which in the Kuamut project area are typically less effected by historical logging activity, due to their inaccessibility

>>>end of updated section 3.1.4 of the PD, original PD continues from section titled 'Division of the harvestable forest into annual operating areas in the different strata based on common practice that starts under original figure 32 in the PD:<<<<<

>>> start of updated section 3.2.1<<<<

3.2 Quantification of GHG Emission Reductions and Removals

3.2.1 Baseline Emissions

Calculation of carbon stocks in commercial timber volumes (section 8.1.1 of the methodology)

Section 3.1.4 above, in the step titled 'modelling of the baseline scenario' describes how the merchantable volume of timber per unit area ($V_{j,i|BSL}$) that is potentially available for harvest was estimated through an approach where a detailed forest inventory using field plots was combined with airborne LiDAR data.

In summary, a total of 46 circular 30-meter radius (each 0.28 ha) permanent sample plots (PSPs) plots were set up within the Kuamut area. We recorded taxonomic information, taking leaf samples wherever possible. More than 75% of the individuals were identified to Genus, and more than 50% of the individuals have been identified to Species level. Average wood density values were estimated for each genus using the Global Wood Density Database (Chave et al. 2009). Using these values, we then calculated a plot-level basal area weighted average and assigned it to any individuals lacking botanical information.

Biomass was calculated according to equation 4 from Chave et al. (2014) utilising the measured diameter and heights, and the estimated wood density. This means that the taxonomic information is incorporated via the wood density, so while one equation is used – the estimated biomass will be quite different for different species of the same dimensions. The equations of Chave et al. (2014) are widely regarded as more accurate than species specific allometric (which also do not exist for the majority of species diverse tropical regions). We estimated timber volume from the calculated biomass using a BCEF-R of 1.89. The plot level timber volume was derived by removing the species conservation factors from the total timber volume of all trees above the defined cutting limit (40 cm DBH for the NFM areas, and 31 cm DBH for the Mosaic Planting Approach areas). By estimating species conservation factors using our full plot data set, using these factors to reduce the timber volume of the trees above the cutting limit, we conservatively account for any species that would not be harvested without being reliant on perfect botanical information in each individual plot. See additional information describing how conservative this approach is in appendix 8, 'APPENDIX 8. Species conservation factor details.

A multi-temporal modelling approach was used to estimate the spatial variability and distribution of aboveground biomass. Different remote sensing imagery was combined into a data cube, comprising a total of 41 bands. Machine learning was applied to analyse the information in the data cube and develop a Canopy Height Model using the combination of environmental metrics that could produce a model with the lowest RMSE value. The model was then used to produce a high-resolution merchantable timber volume map that provides the merchantable timber volume at a 30-meter pixel resolution,

From this high resolution map, the mean volume of extracted merchantable timber per hectare ($V_{EX,j,i|BSL}$) was estimated as indicated in Table 15.

Table 15: Mean volume of extracted merchantable timber per hectare for each year (years in bold indicate the years included in the first baseline period)

Year that logging would occur according to the timber harvesting plan	Mean volume of extracted merchantable timber per hectare in stratum i ($m^3 ha^{-1}$)		
	Stratum 2 (Natural Forest Management)	Stratum 3 (selective logging within Mosaic Planting)	Stratum 4 (planting areas within Mosaic Planting)
2016		74.3	55.5
2017		62	45.1
2018		65.8	50.8
2019		74.3	53.6
2020		79.9	62
2021		80.8	76.1
2022			
2023			
2024	33.4		
2025	40.3		
2026	38.8		
2027	41.8		
2028	44.8		
2029			
2030			
2031			
2032			89.3
2033			89.3
2034			89.3
2035			89.3
2036			89.3
2037			89.3
2038			89.3
2039	33.4		89.3
2040	40.3		89.3
2041	38.8		89.3
2042	41.8		89.3
2043	44.8		89.3
2044			89.3
2045			89.3

The carbon stock of timber harvested per hectare was then calculated as:

$$C_{HB,j,i|BSL} = (V_{EX,j,i|BSL} + V_{EX,INF,j,i|BSL}) * BCEF_R * CF_j \quad (\text{equation 3 from VM0010})$$

Where:

$C_{HB,j,i|BSL}$

Mean carbon stock of harvested biomass per unit area for species j in stratum i , $tC \cdot ha^{-1}$

$V_{EX,j,i BSL}$	Mean volume of extracted timber per unit area for species j in stratum i , $m^3 \cdot ha^{-1}$
$V_{EX,INF,j,i BSL}$	Mean volume of extracted timber for forestry infrastructure per unit area for species j in stratum i , $m^3 \cdot ha^{-1}$;
$BCEF_R$	Biomass conversion and expansion factor applicable to wood removals in the project area, $t \cdot d \cdot m^{-3}$
CF_j	Carbon fraction of biomass for species j , $tC \cdot t \cdot d \cdot m^{-1}$
i	1,2,3 ... M strata
j	1,2,3 ... J tree species.

The model described in section 3.1.4 establishes the relationship between field plot merchantable timber volume ($V_{EX,j,i|BSL}$) and the Canopy Height Model. The model does not estimate the mean volume of extracted timber for forestry infrastructure ($V_{EX,INF,j,i|BSL}$). This parameter was therefore considered to be zero in the calculations. This is a conservative assumption since it underestimates the timber extracted, and therefore the carbon removed, in the baseline.

To estimate the carbon stock of timber harvested, a $BCEF_R$ of 1.89 was used which is the IPCC default value for natural forests in the humid tropics (table 4.5 of the IPCC 2006 Guidelines for National Greenhouse Gas Inventories, Volume 4, Chapter 4). For the carbon fraction, the value of $0.47 \text{ tC} \cdot \text{td} \cdot \text{m}^{-1}$ was used (Martin and Thomas 2011)¹⁰⁵. The resulting values for the mean carbon stock of harvested biomass per hectare ($C_{HB,j,i|BSL}$) is provided in Table 16.

Table 16: Mean carbon stock of harvested biomass per hectare for each year (years in bold indicate the years included in the first baseline period)

Year that logging would occur according to the timber harvesting plan	Mean carbon stock of harvested biomass in stratum i ($tC \text{ ha}^{-1}$)		
	Stratum 2 (Natural Forest Management)	Stratum 3 (selective logging within Mosaic Planting)	Stratum 4 (planting areas within Mosaic Planting)
2016		66	49.3
2017		55.07	40.06
2018		58.45	45.13
2019		66	47.61
2020		70.98	55.07
2021		71.77	67.6

¹⁰⁵ Martin, Adam & Thomas, Sean. (2011). A Reassessment of Carbon Content in Tropical Trees. PloS one. 6. e23533. 10.1371/journal.pone.0023533.

2022			
2023			
2024	29.67		
2025	35.8		
2026	34.47		
2027	37.13		
2028	39.8		
2029			
2030			
2031			
2032			79.33
2033			79.33
2034			79.33
2035			79.33
2036			79.33
2037			79.33
2038			79.33
2039	29.67		79.33

2040	35.8		79.33
2041	34.47		79.33
2042	37.13		79.33
2043	39.8		79.33
2044			79.33
2045			79.33

Following the methodology, it is assumed that not all of the harvested biomass leaves the forest and the timber harvested as divided in two components: 1) wood removed to market (extracted timber) and 2) wood remaining in the forest as a result of harvest.

The mean carbon stock of the wood removed to markets (extracted timber), is calculated as:

$$C_{EX,j,i|BSL} = (V_{EX,j,i|BSL} + V_{EX,INF,j,i|BSL}) * D_j * CF_j \quad \text{(equation 4 from VM0010)}$$

Where:

$C_{EX,j,i BSL}$	Mean carbon stock of extracted timber per unit area for species j in stratum i ; $tC \cdot ha^{-1}$
$V_{EX,j,i BSL}$	Mean volume of extracted timber per unit area for species j in stratum i , $m^3 \cdot ha^{-1}$
$V_{EX,INF,j,i BSL}$	Mean volume of extracted timber for forestry infrastructure per unit area for species j in stratum i , $m^3 \cdot ha^{-1}$;
D_j	Basic wood density of species j ; $t \cdot d.m. \cdot m^{-3}$
CF_j	Carbon fraction of biomass for species j , $tC \cdot t \cdot d.m.^{-1}$
i	1,2,3 ... M strata
j	1,2,3 ... J tree species.

For D_j the value of 0.51 was used which is the average value of the species found in the field plots. For the carbon fraction, the value of $0.47 \cdot tC \cdot td.m.^{-1}$ was used. The resulting values for the mean carbon stock of extracted timber per hectare is provided in Table 17.

Table 17: Mean carbon stock of extracted timber per hectare for each year (years in bold indicate the years included in the first baseline period)

Year that logging would occur according to the timber harvesting plan	Mean carbon stock of harvested biomass in stratum i ($tC \cdot ha^{-1}$)
---	--

	Stratum 2 (Natural Forest Management)	Stratum 3 (selective logging within Mosaic Planting)	Stratum 4 (planting areas within Mosaic Planting)
2016		17.71	13.23
2017		14.78	10.75
2018		15.68	12.11
2019		17.71	12.77
2020		19.04	14.78
2021		19.26	18.14
2022			
2023			
2024	7.96		
2025	9.6		
2026	9.25		
2027	9.96		
2028	10.68		
2029			
2030			
2031			

2032			21.28
2033			21.28
2034			21.28
2035			21.28
2036			21.28
2037			21.28
2038			21.28
2039	7.96		21.28
2040	9.6		21.28
2041	9.25		21.28
2042	9.96		21.28
2043	10.68		21.28
2044			21.28
2045			21.28

Calculation of dead wood (logging slash) generated in the process of timber harvest (section 8.1.2 of the methodology)

The change in carbon stock in the dead wood pool in stratum i has been calculated as the difference between the total carbon stock of the harvested biomass and the carbon stock of the extracted timber, plus the residual stand damage and biomass of trees left to decay as a result forestry infrastructure establishment:

$$\Delta C_{DWSLASH,i,p|BSL} = \left[\sum_{j=1}^J [(C_{HB,j,i|BSL} - C_{EX,j,i|BSL}) + C_{RSD,j,i|BSL} + C_{notHB,inf,j,i|BSL}] \right] \quad \text{(equation 5 from VM0010)}$$

Where:

$\Delta C_{DWSLASH,i,p BSL}$	Change in carbon stock of dead wood as logging slash resulting from timber harvest per unit area in stratum i in land parcel p , in $tC \cdot ha^{-1}$
$C_{HB,j,i BSL}$	Mean carbon stock of harvested biomass per unit area for species j in stratum i , $tC \cdot ha^{-1}$
$C_{EX,j,i BSL}$	Mean carbon stock of extracted timber per unit area for species j in stratum i , $tC \cdot ha^{-1}$;
$C_{RSD,j,i BSL}$	Mean carbon stock in timber from residual stand damage per unit area for species j in stratum i , $tC \cdot ha^{-1}$
$C_{notHB,inf,lj,i BSL}$	Mean carbon stock of biomass that is not harvested during the establishment of forestry infrastructure per unit area for species j in stratum i , $tC \cdot ha^{-1}$
i	1,2,3 ... M strata
j	1,2,3 ... J tree species.
P	1, 2, 3 ... P land parcels

The mean carbon stock in timber from residual stand damage was calculated as follows:

$$C_{RSD,j,i|BSL} = C_{EX,j,i|BSL} * F_{RSD|BSL} \quad \text{(equation 6 from VM0010)}$$

Where:

$C_{RSD,j,i BSL}$	Mean carbon stock in timber from residual stand damage per unit area for species j in stratum i , $tC \cdot ha^{-1}$
$C_{EX,j,i BSL}$	Mean carbon stock of extracted timber per unit area for species j in stratum i , $tC \cdot ha^{-1}$
$F_{RSD BSL}$	Factor for residual stand damage, dimensionless
i	1,2,3 ... M strata
j	1,2,3 ... J tree species.

For $F_{RSD|BSL}$ the methodology suggests a value of 2.3 based on Pinard and Putz (1996)¹⁰⁶ who found unharvested trees where severely damaged (uprooted and crushed) in conventional logging within the Ulu Segama area. We have used a more conservative value of 1.8. The F_{RSD} value of 1.8 was used for both NFM and Mosaic stratum.

Applying this value leads to the values for mean carbon stock in timber from residual stand damage in each stratum as provide in Table 18.

Table 18: Mean carbon stock in timber from residual stand damage in each stratum (years in bold indicate the years included in the first baseline period)

Year that logging would occur according to the timber harvesting plan	Mean carbon stock in timber from residual stand damage in stratum i ($tC \cdot ha^{-1}$)
---	--

¹⁰⁶ Pinard, M., & Putz, F. (1996). Retaining Forest Biomass by Reducing Logging Damage. Biotropica, 28(3), 278-295. doi:10.2307/2389193

	Stratum 2 (Natural Forest Management)	Stratum 3 (selective logging within Mosaic Planting)	Stratum 4 (planting areas within Mosaic Planting)
2016		31.87	23.81
2017		26.6	19.35
2018		28.23	21.79
2019		31.87	22.99
2020		34.28	26.6
2021		34.66	32.65
2022			
2023			
2024	14.33		
2025	17.29		
2026	16.64		
2027	17.93		
2028	19.22		
2029			
2030			
2031			

2032			38.31
2033			38.31
2034			38.31
2035			38.31
2036			38.31
2037			38.31
2038			38.31
2039	14.33		38.31
2040	17.29		38.31
2041	16.64		38.31
2042	17.93		38.31
2043	19.22		38.31
2044			38.31
2045			38.31

As indicated earlier, the calculations have conservatively assumed that the mean volume of extracted timber for forestry infrastructure ($V_{EX,INF,i,j|BSL}$) is zero. Based on that, it is also assumed that the mean carbon stock of biomass that is not harvested during the establishment of forestry infrastructure ($C_{notHB,inf,lj,i|BSL}$ in equation 5 of the methodology) is also zero.

The resulting total change in carbon stock of dead wood remaining in the forest as a result of harvest under the baseline ($\Delta C_{DWSLASH,i,p|BSL}$) is estimated in Table 19.

Table 19: Total change in carbon stock of dead wood remaining in the forest as a result of harvest under the baseline in each stratum (years in bold indicate the years included in the first baseline period)

Year that logging would occur according to the timber harvesting plan	Change in carbon stock of dead wood remaining in the forest as a result of harvest in stratum <i>i</i> (tC ha ⁻¹)		
	Stratum 2 (Natural Forest Management)	Stratum 3 (selective logging within Mosaic Planting)	Stratum 4 (planting areas within Mosaic Planting)
2016		80.17	59.88
2017		66.9	48.66
2018		71	54.81
2019		80.17	57.83
2020		86.21	66.9
2021		87.18	82.11
2022			
2023			
2024	36.04		
2025	43.48		
2026	41.86		
2027	45.1		
2028	48.34		
2029			
2030			

2031			
2032			96.35
2033			96.35
2034			96.35
2035			96.35
2036			96.35
2037			96.35
2038			96.35
2039	36.04		96.35
2040	43.48		96.35
2041	41.86		96.35
2042	45.1		96.35
2043	48.34		96.35
2044			96.35
2045			96.35

Calculation of baseline carbon sequestered in wood products (section 8.1.3 of the methodology)

Under the baseline, the harvested wood would have been harvested for conversion to wood products. Therefore, the carbon stock in the wood products pool have been included in the baseline.

The methodology makes the distinction between (i) wood products that would decay within 3 years after harvest (ie, the Wood Waste (WW) and the Short-Lived Fraction (SLF)), (ii) wood products that are retired between 3 and 100 years after harvest and (iii) other wood products that are considered to permanently store carbon.

The Sabah Forestry Department provided on the production of major wood products in Sabah for the period 2015-2020. Based on this data the shares of likely wood products to be produced from the harvested wood have been determined as shown in Table 20.

Table 20: Share of wood product k in the total wood products produced from the harvested wood

Wood product k	Share of wood product k in the total wood products produced from the harvested wood
Sawn Wood	0.19
Woodbase Panels	0.56
Other Industrial Roundwood	0.25

These fractions were applied to the mean carbon stock of harvested biomass in stratum i as estimated earlier in Table 17.

The carbon stock of extracted timber that is immediately emitted to the atmosphere at the time of harvest is calculated as

$$C_{WP0,i|BSL} = \sum_k C_{EX,i,k|BSL} * (WW_k + SLF_k) \quad \text{(equation 9 from VM0010)}$$

Where:

$C_{WP0,i BSL}$	Carbon stock of extracted timber from stratum i that is assumed to be emitted immediately at the time of harvest, in t C·ha ⁻¹
$C_{EX,i BSL}$	Mean carbon stock of extracted timber per unit area in stratum i , for wood product type k , tC·ha ⁻¹
WW_k	Fraction of biomass carbon from wood waste that is assumed to be emitted to the atmosphere immediately at the time of harvest for wood product k , dimensionless;
SLF_k	Fraction of biomass carbon from the shortlived wood product pool that is assumed to be emitted to the atmosphere immediately at the time of harvest for wood product k , dimensionless
i	1,2,3 ... M strata
k	Wood products

For WW and SLF, the default values given in the methodology were used which in turn are taken from Winjum *et al* (1998). This means that for WW, a value of 24% (suitable for developing countries) was used for all types of wood products. For SLF the following values were used

- Sawn wood: 0.12

- Woodbase panels: 0.06
- Other industrial roundwood: 0.18

The resulting carbon stock of extracted timber from each stratum that is assumed to be emitted immediately at the time of harvest is provided in Table 21.

Table 21: Carbon stock of extracted timber from each stratum that is assumed to be emitted immediately at the time of harvest (years in bold indicate the years included in the first baseline period)

Year that logging would occur according to the timber harvesting plan	Stratum 2 (Natural Forest Management)				Stratum 3 (selective logging within Mosaic Planting)				Stratum 4 (planting areas within Mosaic Planting)			
	Sawn. Wood	Panels	Other Industrial. Round-wood	total	Sawn. Wood	Panels	Other Industrial. Round-wood	total	Sawn. Wood	Panels	Other Industrial. Round- wood	total
2016					1.21	2.97	1.86	6.05	0.90	2.22	1.39	4.52
2017					1.01	2.48	1.55	5.04	0.74	1.81	1.13	3.67
2018					1.07	2.63	1.65	5.35	0.83	2.03	1.27	4.13
2019					1.21	2.97	1.86	6.05	0.87	2.15	1.34	4.36
2020					1.30	3.20	2.00	6.50	1.01	2.48	1.55	5.04
2021					1.32	3.24	2.02	6.57	1.24	3.05	1.90	6.19
2022												
2023												
2024	0.54	1.34	0.84	2.72								
2025	0.66	1.61	1.01	3.28								

2026	0.63	1.55	0.97	3.16								
2027	0.68	1.67	1.05	3.40								
2028	0.73	1.79	1.12	3.65								
2029												
2030												
2031												
2032									1.46	3.58	2.23	7.27
2033									1.46	3.58	2.23	7.27
2034									1.46	3.58	2.23	7.27
2035									1.46	3.58	2.23	7.27
2036									1.46	3.58	2.23	7.27
2037									1.46	3.58	2.23	7.27
2038									1.46	3.58	2.23	7.27
2039	0.54	1.34	0.84	2.72					1.46	3.58	2.23	7.27
2040	0.66	1.61	1.01	3.28					1.46	3.58	2.23	7.27
2041	0.63	1.55	0.97	3.16					1.46	3.58	2.23	7.27

2042	0.68	1.67	1.05	3.40					1.46	3.58	2.23	7.27
2043	0.73	1.79	1.12	3.65					1.46	3.58	2.23	7.27
2044									1.46	3.58	2.23	7.27
2045									1.46	3.58	2.23	7.27

The amount of extracted carbon stock that is assumed to enter the wood products pool that is not immediately emitted at harvest was calculated as

$$C_{WP,i|BSL} = \sum_k C_{EX,i,k|BSL} - C_{WP0,i|BSL} \quad \text{(equation 10 from VM0010)}$$

Where:

$C_{WP BSL}$	Carbon stock of extracted timber that is assumed to enter the wood products pool that is not immediately emitted at the time of harvest, in t C·ha ⁻¹ ;
$C_{EX,i,k BSL}$	Mean carbon stock of extracted timber per unit area for wood product type k , tC·ha ⁻¹
$C_{WP0,i BSL}$	Carbon stock of extracted timber that is assumed to be emitted immediately at the time of harvest, in t C·ha ⁻¹
k	Wood products

Of this amount, the carbon stock of wood products assumed to be retired between 3-100 years following harvest was calculated as

$$C_{WP100,i,p|BSL} = C_{WP,i,p|BSL} * OF_k \quad \text{(equation 11 from VM0010)}$$

Where:

$C_{WP100,i,p BSL}$	Carbon stored in wood products that are assumed to be retired between 3 - 100 years after harvest, t C ha ⁻¹
$C_{WP,i,p BSL}$	Carbon stock of extracted timber that is assumed to enter the wood products pool that is not immediately emitted at the time of harvest, in t C·ha ⁻¹
OF_k	Fraction of biomass carbon for wood product type k that is assumed to be emitted to the atmosphere between 3 and 100 years of timber harvest, dimensionless
i	1,2,3 ... M strata

For the fraction of biomass carbon for wood product that is assumed to be emitted to the atmosphere between 3 and 100 years of timber harvest, the default values for OF provided in the methodology were used, with the default values for the tropical forest region. These values for OF were estimated in the methodology using values from Winjum *et al* 1998 split by forest region.

Table 22: Fraction of biomass carbon for wood product type that is assumed to be emitted to the atmosphere between 3 and 100 years of timber (from Winjum *et al* 1998)

Wood Product Class	<i>OF</i>		
	Boreal	Temperate	Tropical
Sawnwood	0.39	0.62	0.86
Woodbase panels	0.62	0.86	0.98
Other industrial roundwood	0.86	0.98	0.99
Paper and paperboard	0.39	0.62	0.99

The resulting values for the carbon stored in wood products that are assumed to be retired between 3 - 100 years after harvest are provide in Table 23.

Table 23: Carbon stored in wood products that are assumed to be retired between 3 - 100 years after harvest

Year that logging would occur according to the timber harvesting plan	Stratum 2 (Natural Forest Management)				Stratum 3 (selective logging within Mosaic Planting)				Stratum 4 (planting areas within Mosaic Planting)			
	Sawn. Wood	Panels	Other Industrial Round-wood	total	Sawn. Wood	Panels	Other Industrial Round-wood	total	Sawn. Wood	Panels	Other Industrial Round-wood	total
2016					1.91	6.40	2.89	11.19	1.42	4.78	2.16	8.36
2017					1.59	5.34	2.41	9.34	1.16	3.88	1.75	6.79
2018					1.69	5.67	2.56	9.91	1.30	4.38	1.97	7.65
2019					1.91	6.40	2.89	11.19	1.37	4.62	2.08	8.07
2020					2.05	6.88	3.10	12.04	1.59	5.34	2.41	9.34
2021					2.07	6.96	3.14	12.17	1.95	6.56	2.96	11.46
2022												
2023												
2024	0.86	2.88	1.30	5.03								
2025	1.03	3.47	1.57	6.07								
2026	1.00	3.34	1.51	5.84								

2027	1.07	3.60	1.62	6.30								
2028	1.15	3.86	1.74	6.75								
2029												
2030												
2031												
2032									2.29	7.69	3.47	13.45
2033									2.29	7.69	3.47	13.45
2034									2.29	7.69	3.47	13.45
2035									2.29	7.69	3.47	13.45
2036									2.29	7.69	3.47	13.45
2037									2.29	7.69	3.47	13.45
2038									2.29	7.69	3.47	13.45
2039	0.86	2.88	1.30	5.03					2.29	7.69	3.47	13.45
2040	1.03	3.47	1.57	6.07					2.29	7.69	3.47	13.45
2041	1.00	3.34	1.51	5.84					2.29	7.69	3.47	13.45
2042	1.07	3.60	1.62	6.30					2.29	7.69	3.47	13.45

2043	1.15	3.86	1.74	6.75					2.29	7.69	3.47	13.45
2044									2.29	7.69	3.47	13.45
2045									2.29	7.69	3.47	13.45

Change in carbon stocks due to forest regrowth after harvest (section 8.1.4 of the methodology)

In accordance with the methodology, the carbon sequestration in the baseline scenario resulting from forest regrowth after timber harvest up to year t is considered equal to the estimated baseline forest regrowth rate of each stratum.

Therefore, carbon sequestration resulting from forest regrowth after timber harvest is calculated as:

$$C_{RG,i,p|BSL} = \sum_i RGR_i \quad \text{(equation 12 from VM0010)}$$

Where:

$C_{RG,i,p BSL}$	Carbon sequestration resulting from forest regrowth after timber harvest and establishment of forestry infrastructure in stratum i in land parcel p , t C ha ⁻¹ yr ⁻¹
RGR_i	Regrowth rate of forest post timber harvest post forestry infrastructure establishment for stratum i , t C ha ⁻¹ yr ⁻¹ ;
i	1,2,3 ... M strata

For stratum 2 and 3, RGR_i is assumed to be 1.6 t C ha⁻¹yr⁻¹ based on table 1 of Suarez (2019)¹⁰⁷ (which would be an average growth rate of 3.4 Mg d.m. ha⁻¹ year⁻¹ for tropical rainforest in Asia and a carbon fraction of 0.47). For stratum 4, RGR_i is estimated as 3.0 t C ha⁻¹yr⁻¹. For this estimation, data from Yahya and Ikau (2016)¹⁰⁸ on DBH, height, age, and planting density were used. In addition, we used 0.2955 Mg M⁻³ as the mean wood density for Paraserianthes from the global wood density database (Chave 2009, Zanne 2009¹⁰⁹). To our knowledge Neolamarckia was not in the database and we used a value of 0.362 from Mahmud *et al.* (2017)¹¹⁰. Using these values, Tree-level Above-Ground Biomass (in Mg) was calculated using Eq. 4 in Chave *et al.* (2014), and assuming an average age of planted individuals of 6.25 years.

The average regrowth rate was estimated from the tree-level above-ground biomass based on a feasible planting rate and harvesting 15 years after planting. For the planting rate it was assumed that the entire area would take 30 years to plant, or 1261 hectares per year. Based on the planting density in Yahya and Ikau (2016), this planting rate would require nursery facilities for almost a million seedlings per year. This is an ambitious planting rate and results in a conservative overall RGR for the planted areas. We will further analyse the reference areas in the coming years to see if this planting rate has been achieved.

In estimating the forest regrowth in stratum 4, it was further assumed that there would be no growth between the salvage logging and the planting within the mosaic areas due to the damaging nature of salvage logging. If there was any regrowth during this interlude, not only would it be negligible, but there would also be additional site preparation clearing immediately before planting. When we average the growth rate based on this planting rate, we estimate the overall average growth rate mentioned above for the area to be 3.0 t C ha⁻¹yr⁻¹.

Calculation of baseline emissions from the combustion of fossil fuels in forestry and wood processing machinery (section 8.1.5 of the methodology)

¹⁰⁷ Suarez *et al.*, 2019. [Estimating aboveground net biomass change for tropical and subtropical forests: Refinement of IPCC default rates using forest plot data](#)

¹⁰⁸ Ahmad Zuhaidi Yahya & Albert Ikau A.G. (2016) Reforestation with naturally regenerated trees and selected forest plantation species based on mosaic planting approach. International Journal of Agriculture, Forestry and Plantation, Vol. 1 (Dec 2015)

¹⁰⁹ Zanne, A., Lopez-Gonzalez, G., Coomes, D., Ilic, J., Jansen, S., Lewis, S., Miller, R., Swenson, N., Wiemann, M. & Chave, J. 2009. Global Wood Density Database. Dryad Digital Repository

¹¹⁰ Mahmud, Siti Zalifah & Hashim, Rokiah & Saleh, Abdul & Sulaiman, Othman & Saharudin, Nur & Lokmal, N. & Maseat, Khairul & Husain, Hamdan. (2017). Physical and mechanical properties of juvenile wood from Neolamarckia cadamba planted in West Malaysia. Maderas. Ciencia y tecnología. 19. 10.4067/S0718-221X2017005000020.

The implementation of the baseline activity (selective logging and/or clearcutting) entails the use of forestry and wood processing machinery, which leads to GHG emissions from fossil fuel combustion. In accordance with the methodology, the omission of any or all of the associated GHG emission sources is considered conservative. These emissions have therefore been excluded from the calculations and CFuel is considered zero in the baseline.

Calculation of baseline scenario greenhouse gas emissions from change in carbon stocks (section 8.1.6 of the methodology)

The net greenhouse gas emissions in the baseline scenario are estimated from the carbon stock change as a result of timber harvest plus the carbon stock change resulting from conversion and retirement of wood products minus carbon sequestration from forest regrowth after harvest.

In accordance with the methodology, annualized calculations have been performed that vary between years 1, 2-10; 11-20 using the following equations:

$$\Delta C_{NET|BSL1} = \sum_{i,p} A_{1,i,p} * \sum_{t=1}^M (C_{DWslash,i,p|BSL} / 10) + C_{WP0,i,p|BSL} + (C_{WP100,i,p|BSL} / 20) \quad \text{(equation 23 from VM0010)}$$

$$\Delta C_{NET|BSL(2-10)} = \sum_{i,p} A_{2-10,i,p} * \sum_{t=1}^M ((\Delta C_{DWslash,i,p|BSL} / 10) + (\Delta C_{WP100,i,p|BSL} / 20)) \quad \text{(equation 24 from VM0010)}$$

$$\Delta C_{NET|BSL(11-20)} = \sum_{i,p} A_{11-20,i,p} * \sum_{t=1}^M (C_{WP100,i,p|BSL} / 20) \quad \text{(equation 25 from VM0010)}$$

Where:

$\Delta C_{NET BSL(1)}$	Net change in carbon stock across all parcels in the baseline scenario in the first year since harvest in the baseline scenario, in t C
$\Delta C_{NET BSL(2-10)}$	Net change in carbon stock across all parcels in the baseline scenario in years 2 - 10 since harvest in the baseline scenario, in t C
$\Delta C_{NET BSL(11-20)}$	Net change in carbon stock across all parcels in the baseline scenario in years 11 - 20 since the start of the project activity, in t C;
$\Delta C_{Slash,i,p BSL}$	Change in carbon stock of dead wood as logging slash resulting from timber harvest per unit area in stratum i in land parcel p , in t C ha ⁻¹
$\Delta C_{WP0,i,p BSL}$	Change in carbon stock resulting from wood product conversion and retirement from stratum i in land parcel p , that is assumed to be emitted in the first year of harvest in the baseline t C ha ⁻¹
$\Delta C_{WP100,i,p BSL}$	Carbon stored in wood products that is assumed to be retired between 3 - 100 years after harvest from stratum i in land parcel p , t C ha ⁻¹ ;
$A_{1,i,p BSL}$	Area of stratum i in land parcel p that was harvested 1 year ago, ha
$A_{2-10,i,p BSL}$	Area of stratum i in land parcel p that was harvested between 2 and 10 year ago, ha
$A_{11-20,i,p BSL}$	Area of stratum i in land parcel p that was harvested between 11 and 20 year ago, ha
i	1,2,3 ... M strata
p	1, 2, 3 ... P land parcels harvested within the project crediting period

The net change (sequestration) in carbon stock due to forest regrowth across all parcels in all years since harvest in the baseline scenario are calculated as follows:

$$\Delta C_{NET|BSL(1+)} = \sum_{i,p} A_{t*} * \sum_{t=1}^M (-\Delta C_{RG,i,p|BSL}) \quad \text{(equation 26 from VM0010)}$$

Where:

$\Delta C_{NET BSL(1+)}$	Net change in carbon stock due to forest regrowth in all parcels that have been harvested in the baseline scenario, in t C;
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$\Delta C_{RG,i,p BSL}$	Carbon sequestration resulting from forest regrowth after timber harvest in stratum i in land parcel p , t C ha ⁻¹
A_{t^*}	Cumulative area harvested until time t^* , ha;
t^*	1, 2,...10, time elapsed since the start of the project, in years
i	1,2,3 ... M strata
p	1, 2, 3 ... P land parcels harvested within the project crediting period

Since the baseline emissions from the combustion of fossil fuels have been conservatively omitted, the net change in carbon stock over each year of the project crediting period in the baseline scenario since the start of the project activity is calculated as:

$$\Delta C_{NET|BSL,t^*} = \sum_{p=1}^P [\Delta C_{Net,p|BSL(1)} + \Delta C_{Net,p|BSL(2-10)} + \Delta C_{Net,p|BSL(11-20)} + \Delta C_{Net,p|BSL(+1)}] \text{ (equation 27 from VM0010)}$$

Where:

$\Delta C_{NET BSL,t}$	Net change in carbon stock across all parcels in the baseline scenario in the year t^* since the start of the project activity, in tC;
$\Delta C_{NET BSL(1)}$	Net change in carbon stock in the baseline scenario for all parcels p that are within 1 year of harvest in the baseline scenario, in tC;
$\Delta C_{NET BSL(2-10)}$	Net change in carbon stock in the baseline scenario for all parcels p , that were harvested between 2 – 10 years ago in the baseline scenario, in tC;
$\Delta C_{NET BSL(11-20)}$	Net change in carbon stock in the baseline scenario for all parcels p , that were harvested between 11 – 20 years ago in the baseline scenario, in tC
$\Delta C_{NET BSL(+1)}$	Net change in carbon stock due to forest regrowth in all parcels that have been harvested in the baseline scenario, in t C;
t^*	1, 2,...10, time elapsed since the start of the project, in years
p	1, 2, 3 ... P land parcels harvested within the project crediting period

The net carbon stock change in the baseline scenario has been converted to net greenhouse gas emissions resulting in Table 4.

Table 24: Net carbon stock change in the baseline scenario.

Year that logging would occur according to the timber harvesting plan	Net change in carbon stock across all parcels in the baseline scenario in year t^* (tC)	Net greenhouse gas emissions in the baseline scenario in year t^* (tCO ₂ e)	Cumulative net greenhouse gas emissions in the baseline scenario in year t^* since the start of the project activity
2016	62744.85	230064.47	230064.5
2017	89309.57	327468.44	557532.9
2018	103619.40	379937.79	937470.7
2019	160404.16	588148.59	1525619.3
2020	189483.06	694771.21	2220390.5
2021	187617.75	687931.75	2908322.2
2022	168602.81	618210.31	3526532.6
2023	168602.81	618210.31	4144742.9
2024	195705.26	717585.94	4862328.8

2025	241360.11	884987.07	5747315.9
2026	203960.51	747855.22	6495171.1
2027	175997.84	645325.42	7140496.5
2028	167161.55	612925.67	7753422.2
2029	79559.97	291719.89	8045142.1
2030	26617.45	97597.33	8142739.4
2031	1401.60	5139.20	8147878.6
2032	19299.20	70763.73	8218642.3
2033	28273.77	103670.49	8322312.8
2034	17607.54	64560.97	8386873.8
2035	-14948.75	-54812.09	8332061.7
2036	-36486.55	-133784.02	8198277.7
2037	-58208.38	-213430.73	7984847.0
2038	-84923.86	-311387.47	7673459.5
2039	-53221.18	-195144.32	7478315.2
2040	-2287.39	-8387.10	7469928.1
2041	13020.42	47741.55	7517669.6
2042	29766.63	109144.31	7626813.9
2043	55631.45	203981.98	7830795.9
2044	26465.80	97041.27	7927837.2
2045	20708.43	75930.90	8003768.1

>>> end of updated section 3.2.1<<<<

>>>start of updated section 3.2.3 of the PD<<<<

3.2.3 Leakage

Analysis for leakage due to market effects (section 8.3.2 of the methodology)

When it comes to leakage due to market effects, this was estimated as the net emissions from planned timber harvest activities in the baseline scenario multiplied by an appropriate leakage factor:

$$GHG_{LK|LtPF,t*} = LF_{ME} * GHG_{NET|BSL,t*} \quad \text{(equation 40 from VM0010)}$$

Where:

$GHG_{LK|LtPF,t^*}$

Total market leakage as a result of IFM LtPF activities, in the year t^* since the start of the project activity, tCO_2e

LF_{ME}

Leakage factor for market-effects calculations; dimensionless

$GHG_{NET|BS,t^*L}$

Net greenhouse gas emissions in the baseline scenario in the year t^* since the start of the project activity, tCO_2e

The leakage factor was determined by considering where logging will be increased as a result of the decreased supply of the timber caused by the project. This analysis assumes that the forest estate where harvesting would likely be displaced to, are all the known forest areas in Sabah where harvesting legally took place during the years 2016-2019 (the base year until the year of last archived data by SFD).

All harvested merchantable volume from the year 2016 (project baseline base year) until 2019 was collated by SFD for all active logging concessions within the State of Sabah. All SFD data was recorded as either 'NFM', 'Salvage logging' or 'Plantation Timber'. Data for Plantation Timber was not included in our analysis as it does not apply to our baseline scenario. We calculated the Volume per hectare (Harvest Volume / Harvest Area), for every individual record within the database. We then calculated the mean volume extracted per hectare (2016-2019), for each Forest Reserve and Logging Type ('NFM' or 'Salvage logging'). Using the mean volume extracted per hectare we estimate the biomass within the timber volume using the BCEFR of 1.89. We consider these records of timber that was harvested from the base year, the best estimate of merchantable timber biomass available.

For all of these active Forest Reserves the total biomass per hectare in the analysed forest estate was calculated a published carbon map for the base year of 2016 (Asner et al. 2017, & 2021). The carbon of all pixels was summed for each forest reserve using outlines provided by SFD (see Figure 12).

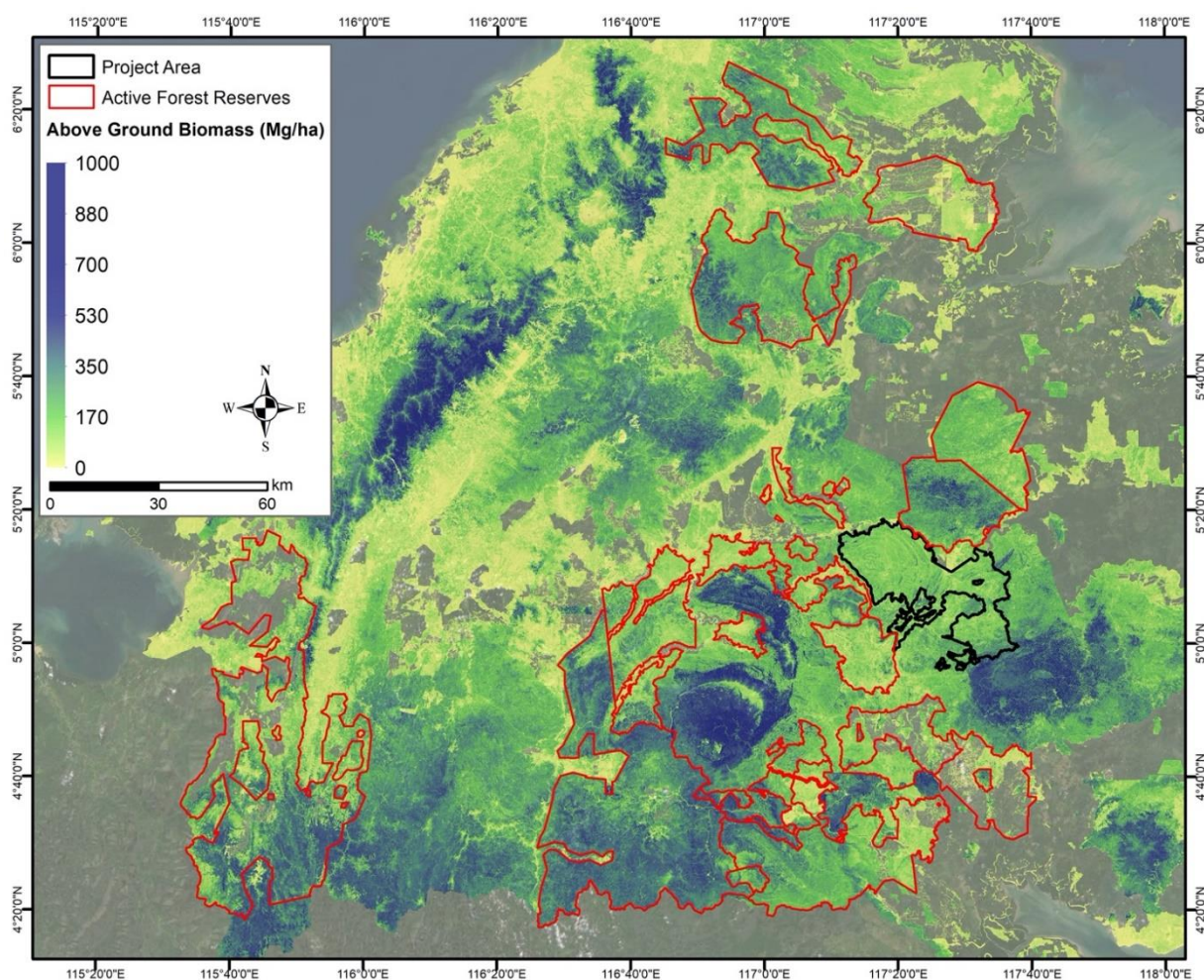


Figure 12: Active concessions in the state from 2010 to 2019, overlaid on Above Ground Biomass (in Mg ha⁻¹). AGB was calculated from a published Carbon map from the state and dividing by a carbon fraction of 0.47 (Asner 2017).

The carbon per hectare was calculated based on the total carbon for the forest reserve and the total area based on the SFD Forest Reserve boundaries. One forest reserve (Bengkoka FR.), had no remaining biomass per hectare, we therefore applied the ACD value of the lowest FR. Biomass data is summarised from data in 2016 Asner et al. (2017, & 2021), and merchantable biomass was collated from all records of timber that was harvested (merchant-ED) during 2016-2019. The biomass per hectare was calculated from the carbon per hectare using the BCEF_R of 1.89 and a Carbon fraction of 0.47 (see Table 25). Here PML is calculated individually for each Forest Reserve Logging Type combination.

Table 25: Above Ground Biomass and Merchantable biomass for all active logging concessions from the years 2016-2019 within the SFD Estate.

<i>Forest Reserve</i>	<i>AGB (mg/ha)</i>	<i>Logging Type</i>	<i>Merchantable Biomass</i>
BENGKOKA FR.	37.44681	SalvageLogging	124.52561
BONGGAYA FR.	37.4468	SalvageLogging	11.8043
DERAMAKOT FR.	286.8085	NFM	92.2929
GN. RARA FR.	141.4894	NFM	106.1330
GN. RARA FR.	141.4894	SalvageLogging	134.1513
KALABAKAN FR.	139.3617	SalvageLogging	30.8830
LINGKABAU FR.	262.5532	NFM	50.1192
LINGKABAU FR.	262.5532	SalvageLogging	108.5909
SAPULUT FR.	339.1489	NFM	65.1720
SAPULUT FR.	339.1489	SalvageLogging	99.4819
SEGALIUD LOKAN FR.	156.8085	NFM	15.7768
SEGALIUD LOKAN FR.	156.8085	SalvageLogging	105.0819
SG. PINANGAH FR.	158.7234	NFM	22.9497
SG. PINANGAH FR.	158.7234	SalvageLogging	163.5833
SIPITANG FR.	185.9574	NFM	263.0616
SIPITANG FR.	185.9574	SalvageLogging	271.4405
ULU TUNGUD FR.	234.4681	NFM	19.0139

In order to obtain comparable values of total biomass per hectare for the project area, we summarised the biomass data from Asner et al. (2018, & 2021) in the same way as for the active forest reserves above. We estimated the

total biomass per hectare for the main boundary of NFM and Mosaics within the project area (i.e not subtracting stratum 1, or separating mosaic strata) as this is the most comparable to the process for the other forest reserves.

To estimate the leakage factor, the ratio of merchantable biomass to total biomass was estimated for the NFM stratum (stratum 2) and the combined Mosaic strata (stratum 3 and 4) in the project area (PMP_i). Using the Merchantable Biomass and total biomass values in the above Table 25 (for each forest reserve), we calculated the mean merchantable and total biomass, and then the PML for each of the comparable forest types in the analysed forest estate (PML_{FT}). The results are shown in the tables below.

Table 26: Ratio of merchantable biomass to total biomass for each forest type (PML_{FT})

Logging Type	PMP _{FT}	Merchantable Biomass	AGB (mg/ha)
Salvage Logging	0.964	116.62	162.10
NFM	0.399	79.31	220.74

Table 27: Ratio of merchantable biomass to total biomass (PMP_i)

Stratum	PMP _i	Merchantable Biomass	AGB (mg/ha)	Area (ha)
Mosaic	0.7117	112.74	158.4134	44635.62
NFM	0.4454	75.26	168.9854	35028.57

The difference between these two ratios (expressed as a percentage) was used to estimate the leakage factor (LF_{ME}). The minor change in this value is a result of the slightly improved DEM input data since the PD. The results of the calculations are provided in Table 9 below

Table 28: Calculated deduction factors (LF_{ME})

Stratum in the project area	Corresponding forest type in the analysed forest estate	% difference between PMP _i and PML _{FT}	LF _{ME}
Stratum 2	Natural Forest Management	10.30%	0.4
Stratum 3 and Stratum 4	Salvage logging	35.48%	0.2

Based on the area of the NFM Strata (35241.45 ha), and the Mosaic Strata (44808.52 ha), we estimated an area weighted leakage for the entire project as 0.288.

Applying this value to equation 20- and using activity leakage of zero, this leads to the following results for the leakage calculation as shown in Table 10.

Table 29: Emission as a result of leakage.

Year that logging would occur according to the timber harvesting plan	Leakage due to activity shifting (tCO ₂ e)	Market leakage as a result of IFM LtPF activities in year t* (tCO ₂ e)	Total cumulative leakage in year t* since the start of the project activity
2016	0	66258.57	66258.57
2017	0	94310.91	160569.48
2018	0	109422.08	269991.56
2019	0	169386.80	439378.36
2020	0	200094.11	639472.47
2021	0	198124.34	837596.81
2022	0	178044.57	1015641.38
2023	0	178044.57	1193685.95
2024	0	206664.75	1400350.70
2025	0	254876.28	1655226.97
2026	0	215382.30	1870609.28
2027	0	185853.72	2056463.00
2028	0	176522.59	2232985.59
2029	0	84015.33	2317000.92
2030	0	28108.03	2345108.95
2031	0	1480.09	2346589.04
2032	0	20379.95	2366968.99
2033	0	29857.10	2396826.10
2034	0	18593.56	2415419.66
2035	0	-15785.88	2399633.77
2036	0	-38529.80	2361103.97
2037	0	-61468.05	2299635.92
2038	0	-89679.59	2209956.33
2039	0	-56201.56	2153754.77
2040	0	-2415.49	2151339.28
2041	0	13749.57	2165088.85
2042	0	31433.56	2196522.41
2043	0	58746.81	2255269.22
2044	0	27947.89	2283217.10
2045	0	21868.10	2305085.20

>>>end of updated section 3.2.3 of the PD<<<<

**APPENDIX 2. HIGH CONSERVATION VALUE (RARE, THREATENED, ENDEMIC) SPECIES
POSSIBLY FOUND IN KUAMUT RAINFOREST PROJECT AREA, WITH STATUS UPDATE
DURING THIS REPORTING PERIOD**

No	Species	Red List Category	Suggested Monitoring Scheme	Update for 1st MR
1	Sunda Pangolin	Critically Endangered	Camera-trapping	Project Area remains an important habitat for this species. According to analysis conducted by Sabah Protected Area Prioritization Project, the entire project area is deemed suitable habitat for this species. The continuing presence of this species in the project area has been confirmed from the study by independent researchers (Tilker et al. 2019; Mohamed et al. 2021). The population of this species in the area is likely to be recovering following the termination of logging and lower levels of human activities. Camera trapping to monitor this species is under plan for subsequent monitoring period.
2	Bornean Orangutan	Critically Endangered	Targeted census	Assessments conducted during this monitoring period (Sabah Protected Area Prioritization Project) indicate that the project area remains a key habitat for this great ape. Suitable habitats include almost the entire project area, except small patches in the southeast and southern part of the project area. Overall, habitat condition in the project area is believed to be improving following the termination of logging. There is no indication to suggest any hunting threat specifically targeting this species in the project area. A targeted census based on nest count using helicopter is being planned for subsequent monitoring period.
3	Helmeted Hornbill	Critically Endangered	Acoustic	While the population of this species has been seriously depleted in most of its entire global range (https://www.iucnredlist.org/species/22682464/184587039), the project area and the surrounding forest landscape continue to give hope for the survival and possible recovery of this magnificent hornbill species. This has been confirmed through the recent analysis conducted during this project reporting period by Sabah Protected Area Prioritization Project, showing that the entire project area is suitable habitat for this species. Meanwhile, the continuing presence of the bird species in the area has been confirmed during field visits to the project area.

4	Straw-headed Bulbul	Critically Endangered	Acoustic	This critically endangered songbird species has been seriously threatened and has almost entirely been extirpated in many parts of its global range. Persecution for the pet trade and habitat destruction continue to threaten populations across the species' range, and these factors are suspected to be driving a rapid and on-going decline that exceeds 80% in the previous three generations (IUCN Red List; https://www.iucnredlist.org/species/22712603/183176477). Although the actual recent presence in Kuamut Project Area is to be updated, the importance of the area as suitable habitat for this species has been reconfirmed by the analysis conducted recently for the Sabah Protected Area Prioritization Project. We plan to use acoustic recording as a tool to monitor this species and other relevant biodiversity in the project area to be implemented in the upcoming period.
5	Pigmy Elephant	Endangered	Camera-trapping; dung-beetle	Analysis conducted by Sabah Protected Area Prioritization Project during this reporting period found that the project area, especially the northern part, is deemed as suitable habitat of this largest land mammal species. The continuing presence of this species in the project area has been confirmed from the study by independent researchers (Tilker et al. 2019; Mohamed et al. 2021). Recent study (de la Torre et al. 2022) reveals that Sundaic elephants prefer habitats on the periphery of protected areas. The presence of this endangered species in the project zone, especially in areas that overlap with villages, poses a challenge for the project to help formulate solutions to promote human-elephant coexistence.
6	Sabah Grey Langur	Endangered	Acoustic	Analysis conducted by Sabah Protected Area Prioritization Project during this reporting period found that the entire project area is deemed as suitable habitat for this species. The continuing presence of this species in the project area has been confirmed from the study by independent researchers (Tilker et al. 2019; Mohamed et al. 2021).
7	Proboscis Monkey	Endangered	Acoustic	Analysis conducted by Sabah Protected Area Prioritization Project during this reporting period found that almost the entire project area is deemed as suitable habitat of for this species. However, the actual presence of this endemic primate that is typically restricted to riparian areas around and near coastal area, in

Kuamut project area is yet to be confirmed and updated.

8	North Borneo Gibbon	Endangered	Acoustic	Analysis conducted by Sabah Protected Area Prioritization Project during this reporting period found that the entire project area is deemed as suitable habitat for this species. We believe it is safe to assume that the habitat and population is likely improving with the protection of the project area that allows forest regrowth and likely benefiting highly arboreal species such as the gibbon. The presence and conservation status of this species will be monitored in the subsequent period using acoustic recording.
9	Bay Cat	Endangered	Camera-trapping	Analysis conducted by Sabah Protected Area Prioritization Project during this reporting period found that the southern part of the project area is deemed as suitable habitat for this species. The continuing presence of this species in the project area has been confirmed from the study by independent researchers (Tilker et al. 2019; Mohamed et al. 2021).
10	Flat-headed Cat	Endangered	Camera-trapping	This reporting period, we have no update with regards to the presence of this species in the project area. No records were reported from the camera trapping works conducted by independent researchers during this period.
11	Otter Civet	Endangered	Camera-trapping	Analysis conducted by Sabah Protected Area Prioritization Project during this reporting period found that the northeastern part of the project area is deemed as suitable habitat for this species.
12	Hairy-nosed Otter	Endangered	Camera-trapping	Analysis conducted by Sabah Protected Area Prioritization Project during this reporting period found that the northern and middle part of the project area, especially around Kuamut river, are deemed as suitable habitat for this species.

13	Banteng	Endangered	Camera-trapping	The significance of the project area for the global conservation of this species and continuing existence of this species in the project area has been confirmed by independent researchers' study (Journeaux et al. 2018, Tilker et al. 2019; Mohamed et al. 2021) published during this reporting period. The study demonstrated that, based on camera trap success rate, Kuamut Forest Reserve is one of good habitats with high activity of banteng in Sabah. In Kuamut Forest Reserve, the team deployed camera traps in 30 stations with a total effort of 3281 trap nights. Banteng was detected in a total of 259 independent events from 12 out of 30 stations. In total 38 individuals were identified from 3 herds. Demographically, the result of the study suggested that the population is quite healthy with the composition of 21 bulls, 9 cows, 3 juveniles and 5 calves.
14	Bornean Peacock-pheasant	Endangered	Camera-trapping	Analysis conducted by Sabah Protected Area Prioritization Project during this reporting period found that the southern part of the project area is deemed as suitable habitat for this species. The presence and conservation status of this species, along with other ground-dwelling birds and mammals, will be monitored using camera traps
15	Storm's Stork	Endangered	Targeted observations	Analysis conducted by Sabah Protected Area Prioritization Project during this reporting period identified the entire project area as suitable habitat for this species. We believe it is safe to assume that the habitat and population is likely improving with the protection of the project area compared to baseline scenario.
16	White-crowned Hornbill	Endangered	Acoustic	No specific update on the status of this species for this monitoring period. However, we believe it is safe to assume that the habitat and population is likely improving with the protection of the project area compared to baseline scenario. The presence and conservation status of this species will be monitored in the subsequent period using acoustic recorders.
17	Wrinkled Hornbill	Endangered	Acoustic	No specific update on the status of this species for this monitoring period. However, we believe it is safe to assume that the habitat and population is likely improving with the protection of the project area compared to baseline scenario. The presence and conservation status of this species will be monitored in the subsequent period using acoustic recorders.

18	Spiny Terrapin	Endangered	Targeted observation	No specific update on the status of this species for this monitoring period. However, we believe it is safe to assume that the habitat and population of this species is likely improving with the protection of the project area compared to baseline scenario. The presence of this species and other RTE in the project area will be recorded as part of the biodiversity monitoring in the project.
19	Asian Giant Tortoise	Endangered	Targeted observation	No specific update on the status of this species for this monitoring period. However, we believe it is safe to assume that the habitat and population of this species is likely improving with the protection of the project area compared to baseline scenario. The presence of this species and other RTE in the project area will be recorded as part of the biodiversity monitoring in the project.
20	Western Tarsier	Vulnerable	Targeted observation	No specific update on the status of this species for this monitoring period. However, we believe it is safe to assume that the habitat and population of this species is likely improving with the protection of the project area compared to baseline scenario. The presence of this species and other RTE in the project area will be recorded as part of the biodiversity monitoring in the project.
21	Kayan Slow Loris	Vulnerable	Targeted observation	No specific update on the status of this species for this monitoring period. However, we believe it is safe to assume that the habitat and population of this species is likely improving with the protection of the project area compared to baseline scenario. The presence of this species and other RTE in the project area will be recorded as part of the biodiversity monitoring in the project.
22	Sunda Pig-tailed Macaque	Vulnerable	Camera trapping	Analysis conducted by Sabah Protected Area Prioritization Project during this reporting period found that the entire project area is deemed as suitable habitat for this species. Continuing presence of this species in the project area during this reporting period has been confirmed from the study by independent researchers (Tilker et al. 2019; Mohamed et al. 2021).
23	Tufted Ground Squirrel	Vulnerable	Camera trapping	Analysis conducted by Sabah Protected Area Prioritization Project during this reporting period found that almost the entire project area, except areas near Milian river, are deemed as suitable habitat for this species. Continuing presence of this species in the project area during this reporting period has been confirmed from the study by independent

researchers (Tilker et al. 2019; Mohamed et al. 2021).

24	Sundaic Arboreal Niviventer	Vulnerable	Camera trapping	Analysis conducted by Sabah Protected Area Prioritization Project during this reporting period found that almost the entire project area is deemed as suitable habitat for this species. The presence and status of this species in the project area will be monitored using camera traps
25	Whitehead's Sundaic Maxomys	Vulnerable	Camera trapping	Analysis conducted by Sabah Protected Area Prioritization Project during this reporting period found that almost the entire project area is deemed as suitable habitat for this species. The presence and status of this species in the project area will be monitored using camera traps
26	Sunda Clouded Leopard	Vulnerable	Camera-trapping	Continuing presence of this species in the project area during this reporting period has been confirmed from the study by independent researchers (Tilker et al. 2019; Mohamed et al. 2021).
27	Binturong	Vulnerable	Camera-trapping	Continuing presence of this species in the project area during this reporting period has been confirmed from the study by independent researchers (Tilker et al. 2019; Mohamed et al. 2021).
28	Hose's Civet	Vulnerable	Camera-trapping	Analysis conducted by Sabah Protected Area Prioritization Project during this reporting period found that only relatively small areas in the southern part of the project area are deemed as suitable habitat for this species. The presence and status of this species in the project area will be monitored using camera traps
29	Sun Bear	Vulnerable	Camera-trapping	Continuing presence of this species in the project area during this reporting period has been confirmed from the study by independent researchers (Tilker et al. 2019; Mohamed et al. 2021).
30	Oriental Small-clawed Otter	Vulnerable	Camera-trapping	Continuing presence of this species in the project area during this reporting period has been confirmed from the study by independent researchers (Tilker et al. 2019; Mohamed et al. 2021).
31	Smooth Otter	Vulnerable	Camera-trapping	No specific update on the status of this species for this monitoring period. However, we believe it is safe to assume that the habitat and population is likely improving with the

protection of the project area compared to baseline scenario.

32	Bearded Pig	Vulnerable	Camera-trapping	The presence of this species in the project area during this reporting period has been confirmed from the study by independent researchers (Tilker et al. 2019; Mohamed et al. 2021). However, African Swine Flu outbreak reported from Sabah towards the end of the reporting period,
33	Sambar Deer	Vulnerable	Camera-trapping	Continuing presence of this species in the project area during this reporting period has been confirmed from the study by independent researchers (Tilker et al. 2019; Mohamed et al. 2021).
34	Chestnut-necklaced Partridge	Vulnerable	Camera-trapping	No specific update on the status of this species for this monitoring period. However, we believe it is safe to assume that the habitat and population is likely improving with the protection of the project area compared to baseline scenario. The presence and conservation status of this species, as well as other ground-dwelling birds and mammals, will be monitored in the subsequent period using camera traps and acoustics.
35	Bornean Crestless Fireback	Vulnerable	Camera-trapping	No specific update on the status of this species for this monitoring period. However, we believe it is safe to assume that the habitat and population is likely improving with the protection of the project area compared to baseline scenario.
36	Bulwer's Pheasant	Vulnerable	Camera-trapping	No specific update on the status of this species for this monitoring period. However, we believe it is safe to assume that the habitat and population is likely improving with the protection of the project area compared to baseline scenario.
37	Short-toed Coucal	Vulnerable	Acoustic	No specific update on the status of this species for this monitoring period. However, we believe it is safe to assume that the habitat and population is likely improving with the protection of the project area compared to baseline scenario.
38	Rhinoceros Hornbill	Vulnerable	Acoustic	No specific update on the status of this species for this monitoring period. However, we believe it is safe to assume that the habitat and population is likely improving with the protection of the project area compared to baseline scenario. The presence and conservation status of this species will be monitored in the subsequent period using acoustic recorders.

39	Black Hornbill	Vulnerable	Acoustic	No specific update on the status of this species for this monitoring period. However, we believe it is safe to assume that the habitat and population is likely improving with the protection of the project area compared to baseline scenario. The presence and conservation status of this species will be monitored in the subsequent period using acoustic recorders.
40	Wreathed Hornbill	Vulnerable	Acoustic	No specific update on the status of this species for this monitoring period. However, we believe it is safe to assume that the habitat and population is likely improving with the protection of the project area compared to baseline scenario. The presence and conservation status of this species will be monitored in the subsequent period using acoustic recorders.
41	Wallace's Hawk-Eagle	Vulnerable	Acoustic	No specific update on the status of this species for this monitoring period. However, we believe it is safe to assume that the habitat and population is likely improving with the protection of the project area compared to baseline scenario. The presence and conservation status of this species will be monitored in the subsequent period using acoustic recorders.
42	Great Slaty Woodpecker	Vulnerable	Acoustic	No specific update on the status of this species for this monitoring period. However, we believe it is safe to assume that the habitat and population is likely improving with the protection of the project area compared to baseline scenario. The presence and conservation status of this species will be monitored in the subsequent period using acoustic recorders.
43	Blue-headed Pitta	Vulnerable	Camera trapping	No specific update on the status of this species for this monitoring period. However, we believe it is safe to assume that the habitat and population is likely improving with the protection of the project area compared to baseline scenario. The presence and conservation status of this species, as well as other ground-dwelling birds and mammals, will be monitored in the subsequent period using camera traps and acoustics.
44	Fairy Pitta	Vulnerable	Camera trapping	No specific update on the status of this species for this monitoring period. However, we believe it is safe to assume that the habitat and population is likely improving with the protection of the project area compared to baseline scenario. The presence and conservation status of this species, as well as

other ground-dwelling birds and mammals, will be monitored in the subsequent period using camera traps and acoustics.

45	Hook-billed Bulbul	Vulnerable	Acoustic	No specific update on the status of this species for this monitoring period. However, we believe it is safe to assume that the habitat and population is likely improving with the protection of the project area compared to baseline scenario. The presence and conservation status of this species will be monitored in the subsequent period using acoustic recorders.
46	Bornean Ground-babbler	Vulnerable	Camera trapping	No specific update on the status of this species for this monitoring period. However, we believe it is safe to assume that the habitat and population is likely improving with the protection of the project area compared to baseline scenario. The presence and conservation status of this species will be monitored in the subsequent period using camera traps and acoustic recorders.
47	Large-billed Blue-flycatcher	Vulnerable	Acoustic	No specific update on the status of this species for this monitoring period. However, we believe it is safe to assume that the habitat and population is likely improving with the protection of the project area compared to baseline scenario. The presence and conservation status of this species will be monitored in the subsequent period using acoustic recorders.
48	Java Sparrow	Vulnerable	Acoustic	No specific update on the status of this species for this monitoring period. However, we believe it is safe to assume that the habitat and population is likely improving with the protection of the project area compared to baseline scenario. The presence and conservation status of this species will be monitored in the subsequent period using acoustic recorders.
49	King Cobra	Vulnerable	Targeted observation	No specific update on the status of this species for this monitoring period. However, we believe it is safe to assume that the habitat and population of this species is likely improving with the protection of the project area compared to baseline scenario. The presence of this species and other RTE in the project area will be recorded as part of the biodiversity monitoring in the project.

50	Malayan Flat-shelled Turtle	Vulnerable	Targeted observation	No specific update on the status of this species for this monitoring period. However, we believe it is safe to assume that the habitat and population of this species is likely improving with the protection of the project area compared to baseline scenario. The presence of this species and other RTE in the project area will be recorded as part of the biodiversity monitoring in the project.
51	South Asian Box Turtle	Vulnerable	Targeted observation	No specific update on the status of this species for this monitoring period. However, we believe it is safe to assume that the habitat and population of this species is likely improving with the protection of the project area compared to baseline scenario. The presence of this species and other RTE in the project area will be recorded as part of the biodiversity monitoring in the project.

APPENDIX 3: FIELD PLOT GPS LOCATIONS, IN UTM'S.

Plot number	Horizontal Accuracy	X_Coord	Y_Coord
1	0.919	564814.68	557649.05
2	0.638	562730.05	558660.66
3	1.656	565132.34	559137.35
4	0.948	562111.4	559041.45
5	0.583	562087.37	557270.26
6	0.337	565542.37	560010.95
7	1.985	564632.32	558917.15
8	1.498	564804.57	560241.52
9	1.075	564999.42	559477.09
10	0.508	565923.15	558502.72
11	0.49	564067.87	558261.15
12	0.407	564816.26	557977
13	5	563396.11	561197.63
14	5	563611.3	561597.01
15	0.946	561860.97	559355.34
16	1.062	562105.73	559139.92

17	0.64	565316.3	557702.23
18	0.715	566047.56	557366.8
19	1.243	563339.85	555146.5
20	0.922	562994.91	554656.08
21	1.94	564304.96	554385.9
22	1.216	563060.27	553459.69
23	5	567127.02	555606.22
24	0.511	567421.37	552599.94
25	5	544818.04	574488.55
26	5	541215.7	580676.67
27	5	542478.63	579221.96
28	5	535492.83	581910.95
29	0.807	548864.9	572566.15
30	0.633	548211.82	571041.85
31	5	532752.52	583650.61
32	5	546270.46	570712.64
33	5	546815.75	570141.86
34	0.33	566002.49	554698.64
35	5	530850.51	583247.49
36	0.638	549779.06	572148.79
37	5	533859.76	579079.05
38	5	534490.42	579810.16
39	0.781	552617.44	568223
40	1.041	553106.46	568399.47
41	5	540510.81	564647.75
42	5	539667.51	564109.93
43	5	559005.63	575656.7
44	5	558754.55	577710.76
45	0.454	532259.51	566027.49
46	0.477	532452.55	565446.88

APPENDIX 4: SPECTRAL INDICES FOR LANDSAT 8 IMAGERY USED IN BIOMASS MAPPING – CALCULATED IN GOOGLE EARTH ENGINE USING THE R PACKAGE.

Spectral Index	Full Name
NDVI	Normalized Difference Vegetation Index
RDVI	Renormalized Difference Vegetation Index
SAVI	Soil-Adjusted Vegetation Index
EVI	Enhanced Vegetation Index

EVI2	<u>Two-Band Enhanced Vegetation Index</u>
RGBVI	<u>Red Green Blue Vegetation Index</u>
AVI	<u>Advanced Vegetation Index</u>
BNDVI	<u>Blue Normalized Difference Vegetation Index</u>
CVI	<u>Chlorophyll Vegetation Index</u>
GBNDVI	<u>Green-Blue Normalized Difference Vegetation Index</u>
IAVI	<u>New Atmospherically Resistant Vegetation Index</u>
MNLI	<u>Modified Non-Linear Vegetation Index</u>
GEMI	<u>Global Environment Monitoring Index</u>
GLI	<u>Green Leaf Index</u>
MCARI2	<u>Modified Chlorophyll Absorption in Reflectance Index 2</u>
kEVI	<u>Kernel Enhanced Vegetation Index</u>
kIPVI	<u>Kernel Infrared Percentage Vegetation Index</u>
kNDVI	<u>Kernel Normalized Difference Vegetation Index</u>
kRVI	<u>Kernel Ratio Vegetation Index</u>
kVARI	<u>Kernel Visible Atmospherically Resistant Index</u>

APPENDIX 5: COMMUNITY ENGAGEMENTS CONDUCTED AS PART OF THE SOCIAL BASELINE ASSESSMENT

Community Engagements conducted as part of the Social Baseline Assessment

Date	Type of engagement	Description	Communities present
11/4/17	Introductory meeting	First contact with community leaders to introduce project.	Kg. Kuamut, Kg. Tangkuyan
4/5/17	Introductory meeting	First contact with community leaders to introduce project.	Kg. Keramuak Luar, Kg. Tenaga Baru
13/9/17	Introductory meeting	Meeting with leaders of four communities to describe project and seek FPIC for the instigation of project activities.	Kg. Kuamut, Kg. Tangkuyan, Kg. Desa Permai, Kg. Tulang-Tulang
14/9/17	Opportunistic community discussions	Reiteration of topics discussed above with community members who were not present the previous day.	Kg. Kuamut, Kg. Tangkuyan
13/10/17	Community workshop	First workshop with four communities in the Kuamut cluster. Workshop included a detailed description of project structure and objectives, gathering basic data on community composition & infrastructure, open discussions & feedback from communities and seeking FPIC to conduct household surveys and other follow-up activities.	Kg. Kuamut, Kg. Tangkuyan, Kg. Desa Permai, Kg. Tulang-Tulang
November 2017	Household interview surveys	Household surveys conducted in Kg. Kuamut. Consent was obtained from interview subjects individually before commencing each interview.	Kg. Kuamut
November 2017	Household interview surveys	Household surveys conducted in Kg. Tangkuyan. Consent was obtained from interview subjects individually before commencing each interview.	Kg. Tangkuyan
November 2017	Household interview surveys	Household surveys conducted in Kg. Desa Permai. Consent was obtained from interview subjects individually before commencing each interview.	Kg. Desa Permai
November 2017	Household interview surveys	Household surveys conducted in Kg. Tulang-Tulang. Consent was obtained from interview subjects individually before commencing each interview.	Kg. Tulang-Tulang
25/11/2017	Community workshop	First workshop with three communities in the Keramuak cluster. Workshop included a detailed description of project structure and objectives, gathering basic data on community composition & infrastructure, open discussions & feedback from communities, and seeking FPIC to conduct household surveys and other follow-up activities.	Kg. Keramuak Luar, Kg. Keramuak Dalam, Kg. Tenaga Baru
27/11/2017	Community workshop	Second workshop with four communities in the Kuamut cluster. Workshop included participatory mapping of community lands & resource use areas, discussion of potential project grievance procedures, discussion of potential livelihood activities to which the project could contribute, and open discussion & feedback sessions.	Kg. Kuamut, Kg. Tangkuyan, Kg. Desa Permai
10/4/2018	Interim update meeting	Meeting with community leaders to communicate project updates and provide an opportunity for community representatives to ask questions and voice concerns.	Kg. Kuamut, Kg. Tangkuyan, Kg. Desa Permai

June 2018	Household interview surveys	Household surveys conducted in Kg. Keramuak Luar. Consent was obtained from interview subjects individually before commencing each interview.	Kg. Keramuak Luar
July-August 2018	Household interview surveys	Household surveys conducted in Kg. Keramuak Dalam. Consent was obtained from interview subjects individually before commencing each interview.	Kg. Keramuak Dalam
August 2018	Household interview surveys	Household surveys conducted in Kg. Keramuak Dalam & Kg. Tenaga Baru. Consent was obtained from interview subjects individually before commencing each interview.	Kg. Keramuak Dalam, Kg. Tenaga Baru
14/8/18	Introductory meeting	Meeting with community leaders from Kg Tamoi to discuss involvement in the project and future community engagements	Kg. Tamoi
28/11/18	Community workshop	First workshop with the community of Kg. Tamoi. Workshop included a detailed description of project structure and objectives, gathering basic data on community composition & infrastructure, participatory mapping, open discussions & feedback from communities, and seeking FPIC to conduct household surveys and other follow-up activities. Field observations of sites of community importance in	Kg. Tamoi
1/12/18	Field observations	Project Area near the Kuamut cluster, including abandoned villages (Kg. Tangkong & Kg. Pagar), and disused road	Kg. Kuamut, Kg. Tangkuyan
2/12/18	Community workshop	Third workshop with the four communities in the Kuamut cluster. The workshop included project update sessions, discussion of potential project activities for 2019, final selection of livelihood activities to which the project could contribute, and open discussion & feedback sessions.	Kg. Kuamut, Kg. Tangkuyan, Kg. Desa Permai, Kg. Tulang-Tulang
3/12/18	Community workshop	Second workshop with three communities in the Keramuak cluster. The workshop included participatory mapping of community lands & resource use areas, discussion of potential livelihood activities to which the project could contribute, and open discussion & feedback sessions.	Kg. Keramuak Luar, Kg. Keramuak Dalam, Kg. Tenaga Baru
Jan-March 2019	Household interview surveys	Household surveys conducted in Kg. Tamoi. Consent was obtained from interview subjects individually before commencing each interview.	Kg. Tamoi

APPENDIX 6: SAMPLE PROGRAMME FOR COMMUNITY WORKSHOP (SOURCES: KUAMUT SOCIAL BASELINE ASSESSMENT)

Kuamut Rainforest Restoration Project – Introductory Community Workshop Kuamut Village, Mukim Kuamut, Tongod
13th October 2017

WORKSHOP PROGRAMME

Time	Session	Responsible
08.30am – 09.00am	Arrival of workshop participants & registration	All
09.00am – 09.15am	Opening speech by community leaders	Community representatives
09.15am – 09.45am	Introductions by project representatives & community participants	All
09.45am – 10.30am	Lecture: Forest conservation & global warming	Adam
10.30am – 12.00pm	Lecture: Introduction to project – objectives & methods for community engagement	Adam
12.00pm – 12.30pm	Q & A session	Adam, Philip
12.30pm – 1.30pm	Lunch	
1.30pm – 2.30pm	Sharing session: Community history & culture	Adam, Philip
2.30pm – 4.00pm	Sharing session: Community administration, basic infrastructure and use of natural resources	Adam, Philip
4.00pm – 4.30pm	Q & A session	Adam, Philip
4.30pm – 4.45pm	Next steps for the project	Adam
4.45pm – 5.00pm	Closing by community leaders & group photo session	Community representatives

Confidential

APPENDIX 7 – external publications relating to biodiversity monitoring

Previous biodiversity monitoring studies conducted in or adjacent to the Kuamut project area that highlight the importance of the area for conserving biodiversity (i.e., a large variety of HCV 1 species). Not all studies conducted monitoring activities within the specific project monitoring period (2016-2021) or collected data from within the project area; however, monitoring activities that were conducted during the monitoring period were done in collaboration with project partners SEARRP and/or RBJ (e.g. for requesting access to the project area and for logistical support). We have also summarised how the findings of each of these studies is relevant to the project and how the with-project scenario will lead to biodiversity benefits (where relevant).

Study and publication date	Date monitoring was conducted	Location	Habitat type	Brief methodology (with specific reference to Kuamut sites where relevant)	Findings in relation to the importance of the project area for biodiversity
Ancrenaz et al. (2005)	2002-2003	Across Sabah, including within the Kuamut project area	Dry lowland dipterocarp forest (<500 m a s l) and hill dipterocarp forest (500-1000 m a s l) within exploitation and protection forests	- Conducted orangutan nest counts across Sabah using ground and helicopter surveys - Estimated the current distribution and size of orangutan populations throughout the state	- The Kuamut forest block (which incorporated the eastern side of the Kuamut project area) was estimated to have a population size of 313 (129-855) individuals - In dry lowland dipterocarp production forests, orangutan abundance is directly related to the degree of logging and associated damage (when hunting pressure is low) Findings suggest that if logging and mosaic planting in the project area is prevented then orangutan abundance is likely to increase (HCV 1 species)
Ancrenaz et al. (2010)	2007	Within the Malua and Ulu Segama FRs (adjacent to the Kuamut project area)	Lowland mixed dipterocarp forest (<500 m a s l), upland mixed dipterocarp forest (<500 m a s l) and ultramafic forest within commercial forest reserves	- Conducted aerial and ground surveys of orangutan nests - Compared with previous estimates obtained in 2002 survey	- Orangutan populations can persist in lightly and sustainably logged forests - Forests that are heavily logged or that follow conventional extraction methods, show a decline in orangutan numbers, resulting in localized extinction - Orangutans leave areas undergoing active disturbance (e.g., logging), but will eventually recolonize regenerating areas Findings suggest that if active disturbance in the project area is halted,

					more orangutans will return to the area (HCV 1 species)
Ancrenaz et al. (2014)	2006-2013	Across Borneo, including within the Kuamut project area	Six forest classes that differed in their current and past management history, from primary forest to recent heavily logged forest	Conducted a large-scale analysis of ground-based camera trapping data to evaluate terrestrial activity in orangutans	- The degree of forest disturbance and canopy gap size influenced orangutan terrestriality - Orangutan density was estimated as 0.1-1.42 in/km² in the Kuamut FR Findings support previous results of orangutan presence in the Kuamut FR and that degraded forests should be incorporated into orangutan conservation strategies (HCV 1 species)
Brozovic et al. (2018)	March–July 2016 (within the Kuamut project area)	In the Deramakot, Tangkulap-Sungai Talibu and Northern Kuamut FRs in central Sabah	Forest of varying quality within the three reserves under different forest management strategies	- Conducted a large-scale camera trap survey for moonrats, including 53 camera trap stations with Northern Kuamut FR across 3,522 camera trap days - Analysed moonrat habitat associations using occupancy modelling and 9 environmental covariates	- Canopy closure and forest quality were positively associated with occurrence of moonrats - Occupancy was highest in sustainably managed forest reserves (i.e. Deramakot FR); hence, moonrats responded better to reduced-impact logging compared to conventional techniques Findings suggest that if logging and mosaic planting in the project area is halted, moonrat occupancy will likely increase as the forest regenerates (HCV 1 species)
Evans et al. (2018)	GPS tracking data collected between 2010-2017, LiDAR data collected in 2016	Used GPS tracking data from across Sabah, including within the Kuamut project area	- Forest of varying quality (e.g. primary forest to severely degraded forest and scrub) within Totally Protected Areas (TPAs) and commercial forest reserves - Some areas of other land uses, including agriculture	Modelled elephant distributions using species distribution models incorporating GPS tracking data and airborne three-dimensional forest mapping to examine the importance of intact to heavily logged forests for elephants in Sabah	- Degraded forest in commercial FRs was found to be highly suitable for elephants - Degraded habitats need to be conserved as the loss of these landscapes to large-scale agriculture would be detrimental for elephants Findings suggest that the project area provides important habitat for elephant populations (HCV 1 species)
Evans et al. (2020)	GPS collars were fitted between 2010-2017, and arial	Across Sabah, including Central Sabah and the	Forest of varying quality (e.g., primary forest to severely degraded forest and scrub) within TPAs and	Combined remote sensing (e.g. top of canopy height, AGC density) and GPS telemetry data were used to identify broad habitat utilization	- Degraded forests are important for elephants, which actively avoid urbanized areas, roads and villages - Agriculture impacts the movement patterns of elephants

	mapping was conducted in 2016	Kuamut project area	commercial forest reserves • Some areas of other land uses, including agriculture	and key movement areas for elephants to help management and reduce conflict	• Findings suggest that the project area provides important habitat for elephant populations (HCV 1 species)
Gardner & Goossens (2017a)	Field survey work started in 2012 and camera trapping took place during 2014-2015	Within the Kuamut project area	Lowland mixed dipterocarp forest surrounding the Kuamut river and to the east of the Kuamut project area; this also included open areas, abandoned logging roads and along forest trails	• 31 paired camera trap stations were placed within the project area between 2014-2015 to capture bantengs • Surveys were conducted to look for tracks and faecal deposits • 11 faecal samples were collected for DNA analysis	• Bantengs were captured at 23 (39%) of the 31 camera trap stations within the Kuamut FR • Evidence of breeding and survival of calves was observed in the Kuamut FR • Findings suggest that the project area is of high importance for banteng populations (HCV 1 species)
Gardner & Goossens (2017b)	Field survey work started in 2012 and camera trapping took place during 2015	In Deramakot FR (which borders the Kuamut project area in the North)	Logged lowland mixed dipterocarp forest within the Deramakot FR, including open areas, abandoned logging roads and along forest trails	• 30 paired camera trap stations were placed within the project area during 2015 to capture bantengs • Surveys were conducted to look for tracks and faecal deposits • 25 faecal samples were collected for DNA analysis	• Bantengs were captured at 14 (47%) of the 30 camera trap stations within the Deramakot FR • It is estimated that a total of 22 individuals may inhabit the Deramakot FR including: 6 bulls and bullocks, 12 cows and 4 calves • Findings suggest that the Deramakot FR, which is adjacent to the kuamut project area, provides important habitat for banteng populations (HCV 1 species)
Guharajan et al. (2021)^a	2014-2018	In the Tangkulap and Deramakot FRs, that border the Northern part of the Kuamut project area	Previously logged forest within Tangkulap FR (that used conventional selective logging) and current production forest within the Deramakot FR (which used reduced impact logging techniques)	• 127 camera trap stations were placed in the two adjacent forest blocks to determine the presence of sun bears • Single-season occupancy models were run to understand habitat use by sun bears and project their distributions	• Sun bear habitat selection was most strongly influenced by habitat quality • Sun bear occupancy slightly increased between the sampling period (although this result wasn't significant), and was likely due to forest regeneration • Sun bear distributions were higher in areas that had been subject to reduced impact logging compared to areas that had been logged conventionally • Findings suggest that if logging and mosaic planting in the project area is halted, sun bear occupancy will increase due to forest regeneration (HCV 1 species and vegetation quality)
		Models were developed from			

Hearn et al. (2019)	Used data from another paper collected in Hearn et al. (2018) ¹¹	GPS tracking data collected in the Lower Kinabatangan Wildlife Sanctuary (in Sabah) and a resistance layer was then developed from this data		Used simulation modelling to predict patterns in Sunda clouded leopard population connectivity, population density, distribution and genetic diversity	- Sabah's central forest regions (which include the Kuamut project area) are predicted to be important for the population connectivity of clouded leopards - Findings suggest that the project area is important for the population connectivity of clouded leopards (HCV 1 species and landscape level ecosystems)
Mohamed, Bikle & Wilting. (2017)	March-July 2016	In the North Kuamut Forest Reserve in Central Sabah (i.e. within the project area)	Degraded lowland mixed dipterocarp forest south of the Kinabatangan River and to the north-west of the Danum Valley Conservation Area	53 stations, each consisting of two camera-traps and set at a height of approximately 30 to 45 cm above the ground were placed within the North Kuamut forest reserve in the project area - The camera-traps were in place for a minimum of 60 days, and for as long as three months. - One camera trap, which was active for 82 days (26 April to 17 July 2016) and placed on an old logging skid-trail, recorded images of the Bornean Peacock Pheasant. The precise location of the trap is withheld as a precautionary measure due to the scarcity of this endangered species.	- Three Bornean Peacock Pheasants were recorded (on three separate days) including an adult female and one apparent juvenile – for which the plumage has not yet been described. - The birds were found in an area of heavily degraded forest around 200 m a s l, and this is the first time the species has been recorded in this location. - These records suggest that there is evidence of breeding and that the species is residing in heavily degraded forest. - Several other HCV 1 species (e.g., sun bears and pig-tailed macaques) were also recorded by the camera traps. - Findings suggest that the project area provides important habitat for the Bornean Peacock Pheasant, which is also a new location record for this species (HCV 1 species)
Mohamed et al. (2021)	March–July 2016 (within the Kuamut project area)	In the Deramakot, Tangkulap-Sungai Talibu and Northern Kuamut FRs in central Sabah	Logged forest with different management histories consisting of predominantly mixed lowland dipterocarp forest, with Northern Kuamut having a higher proportion of upland dipterocarp forest	53 camera trap stations were placed within the Kuamut FR (over 3,522 camera trap days) to monitor Sunda clouded leopards - The study also investigated ways to improve density estimates of clouded leopard populations	- There were 8 individual clouded leopards from 17 independent records in the Kuamut FR - Previous population density estimates for clouded leopards may have been underestimated - There were similar densities of clouded leopards in well-managed forest and in recently selectively logged forest

					Findings suggest that the project area provides important habitat for clouded leopards (HCV 1 species)
Ross et al. (2016)	Occurrence records were collected from 2001-2011	Across Borneo, including within Central Sabah within/ surrounding the Kuamut project area	A variety of landcover classes across Borneo ranging from primary forest and forest mosaics to plantations	Occurrence records were analysed to predict habitat suitability of the banded civet across Borneo	- Lowland and upland forest together with lower montane forest are considered to be suitable habitat for banded civets - Central Sabah, including the project area, was predicted to have a high habitat Suitability Index - Findings suggest that the project area is of high habitat suitability for banded civet populations (HCV 1 species)
Simon, Davies & Ancrenaz (2019)	2014-2017	Across Sabah, including within the Kuamut project area	Dry lowland dipterocarp forest (<500 m a s l) and Hill dipterocarp forest (500-1000 m a s l) within exploitation and protection forests	Ariel nest surveys were conducted for orangutans across Sabah during 2014-2017 and compared with baseline data collected in 2002-2003 (see Ancrenaz et al. 2005 above)	- Total orangutan population size in Northern Kuamut (West), Kuamut (West) and Kuamut (East) FRs was 630 individuals; these three FRs comprise the current Kuamut project area - There are large orangutan populations within Sabah's interior/central forests, occupying sustainably managed logged and unlogged forests, which have been stable for >15 years - Fragmented populations in Eastern Sabah that are surrounded by oil palm monocultures have declined at varying rates - Findings suggest that orangutan populations within and surrounding the project area have remained stable since 2002-2003 (Ancrenaz et al. 2005) (HCV 1 species)
Tilker et al. (2019)	2014-2016: sampling took place within the Project Area during March – July 2016	In the Deramakot, Tangkulap-Sungai Talibu and Northern Kuamut FRs in Central Sabah (note that hunted)	Wet evergreen lowland and upland dipterocarp tropical rainforest within logging concessions that have varying levels of habitat degradation from current and past logging	- Conducted large-scale camera trap surveys to assess how moderate degradation and hunting impact ground-dwelling mammals and birds 53 camera trap stations were placed within the Kuamut FR	- Functional extinction rates were higher in hunted compared to degraded sites and species had lower occupancy in hunted sites - Logged secondary forests can retain substantial components of their original faunal assemblage

		sites were in Vietnam and Laos)		Sites with high hunting intensity were in Vietnam and Laos and degraded forest sites were in Sabah	- Habitat degradation at the degraded sites in Sabah negatively impacts the faunal community as a whole - Findings suggest that if logging and mosaic planting in the project area is halted, there will be positive impacts on the faunal community as the forest regenerates (HCV 1 species)
de la Torre et al. (2022)	GPS tracking data for Sabah were from between 2010-2020	GPS locations were from across Peninsular Malaysia and Sabah, including within and around the edges of the Kuamut project area	GPS locations were from a variety of different habitats ranging from lowland dipterocarp forest (at varying levels of degradation) to other land uses such as oil palm and rubber monocultures	- Conducted analyses of Asian elephant space and habitat use through home range estimation and step selection function analysis - Used >600,000 GPS locations from 102 elephants across Peninsular Malaysia and Borneo, which included 55 elephants from Sabah	- In Sabah, secondary forest, forest gaps, forest edges, areas of regrowth and new plantations were frequently used by elephants - Over half of existing elephant ranges were outside of protected Areas (PAs) - However, large PAs with core areas are still needed to provide safe refuges for elephant populations in the long term - Findings suggest that the project area provides important habitat for elephants and if human activities are halted, any human-elephant conflicts may be reduced (HCV 1 species)

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APPENDIX 8. Species conservation factor details

Under the Sabah Wildlife Conservation Enactment 1997 four tree species are listed as protected, along with a series of non-tree species including palms, herbaceous plants and understory shrubs (see Sabah Wildlife Conservation Enactment 1997 and also <https://forest.sabah.gov.my/usm/Pages/HCV/HCV1.html> 'A: BIOLOGICAL DIVERSITY; (I) FLORA; protected species'). The protected tree species, all of which occur in the project area, are *Aquilaria beccariana*, *Eusideroxylon zwageri*, *Durio acutifolius* and *Aquilaria malaccensis*.

We remove these species from the avoided deforestation baseline and ongoing project scenario growth estimates for both the Mosaic or NFM strata as these trees would have not have been harvested as part of the baseline or project scenarios.

The Sabah Forestry Department also prohibits the harvesting (in NFM areas) of a further series of tree species which are considered of particular ecological importance or as food sources for wildlife (see: <https://mtc.com.my/resources-CommitmentSustainability.php>). We additionally remove these prohibited species from both the baseline and project scenario growth in the NFM strata.

Estimating carbon in protected trees

We used our 46 field plots to sample for protected and prohibited tree species in the Project Area. The estimate of carbon in these species is obtained using plots in the NFM and Mosaic strata (to include the four fully protected tree species for the Mosaic strata, and both protected and prohibited species in NFM areas). See Table 2 for the combined list and corresponding strata.

In order to estimate the carbon in these protected and prohibited tree species, we calculate the Tree-level Above-Ground Carbon (in Mg) for all trees using tree allometric Eq. 4 in Chave *et al.* (2014) (i.e. following identical methods to all other tree calculations in the PD and MR). We estimate the total AGC (in Mg) in all surveyed trees above the appropriate cutting limit (31 cm for Mosaic and 40 cm for NFM) and determine the % of carbon in all protected and prohibited species in each strata. This equates to 6% for Mosaic and 24% for NFM (Table 1.). We have conservatively based our calculations on botanical information to the genus rather than species level to reduce potential identification errors (individual species in the genera involved can be difficult to distinguish). In summary, we remove 24% (NFM) and 6% (Mosaic) from both the merchantable timber, and ongoing forest growth under the project scenario, to account for unharvested protected and prohibited species.

APPENDIX 8-Table 1: Species Conservation factor Estimate

Above Ground Carbon (AGC) in protected vs all tree species

Strata	Harvestable Tree AGC (Mg)	Protected Tree AGC (Mg)	protected AGC (%) ¹
NFM	643	154	24
Mosaic	68	4	6

¹The protected taxa list for the Mosaic areas comprises at least 18 species from 17 genera; the protected and NFM-prohibited taxa list for the NFM areas comprises 246 species and 30 genera. Note that we have conservatively based our calculations on botanical information to the genus rather than species level to reduce potential identification errors (individual species in the genera involved can be difficult to distinguish).

APPENDIX 8-Table 2: Full combined list of Species protected and prohibited from harvesting and their corresponding strata.

Genus	Species	Full Name	Management Strata
<i>Aquilaria</i>	<i>beccariana</i>	<i>Aquilaria beccariana</i>	Mosaic & NFM
<i>Eusideroxylon</i>	<i>zwageri</i>	<i>Eusideroxylon zwageri</i>	Mosaic & NFM
<i>Durio</i>	<i>acutifolius</i>	<i>Durio acutifolius</i>	Mosaic & NFM
<i>Aquilaria</i>	<i>malaccensis</i>	<i>Aquilaria malaccensis</i>	Mosaic & NFM
<i>Podocarpus</i>	<i>sp</i>	<i>Podocarpus sp</i>	Mosaic & NFM
<i>Gonystylus</i>	<i>sp</i>	<i>Gonystylus sp</i>	Mosaic & NFM
<i>Caryota</i>	<i>sp</i>	<i>Caryota sp</i>	Mosaic & NFM
<i>Ceratolobus</i>	<i>sp</i>	<i>Ceratolobus sp</i>	Mosaic & NFM
<i>Corypha</i>	<i>sp</i>	<i>Corypha sp</i>	Mosaic & NFM
<i>Cycadaceae</i>	<i>sp</i>	<i>Cycadaceae sp</i>	Mosaic & NFM
<i>Cytoceae</i>	<i>sp</i>	<i>Cytoceae sp</i>	Mosaic & NFM
<i>Zingiberaceae</i>	<i>sp</i>	<i>Zingiberaceae sp</i>	Mosaic & NFM
<i>Nenga</i>	<i>sp</i>	<i>Nenga sp</i>	Mosaic & NFM
<i>Nepenthaceae</i>	<i>sp</i>	<i>Nepenthaceae sp</i>	Mosaic & NFM
<i>Orchidaceae</i>	<i>sp</i>	<i>Orchidaceae sp</i>	Mosaic & NFM
<i>Podocarpus</i>	<i>sp</i>	<i>Podocarpus sp</i>	Mosaic & NFM
<i>Rhododendron</i>	<i>sp</i>	<i>Rhododendron sp</i>	Mosaic & NFM
<i>Livistonia</i>	<i>sp</i>	<i>Livistonia sp</i>	Mosaic & NFM
<i>Arenga</i>	<i>sp</i>	<i>Arenga sp</i>	Mosaic & NFM
<i>Aquilaria</i>	<i>beccariana</i>	<i>Aquilaria beccariana</i>	NFM
<i>Eusideroxylon</i>	<i>zwageri</i>	<i>Eusideroxylon zwageri</i>	NFM
<i>Durio</i>	<i>acutifolius</i>	<i>Durio acutifolius</i>	NFM
<i>Aquilaria</i>	<i>malaccensis</i>	<i>Aquilaria malaccensis</i>	NFM
<i>Podocarpus</i>	<i>sp</i>	<i>Podocarpus sp</i>	NFM
<i>Gonystylus</i>	<i>sp</i>	<i>Gonystylus sp</i>	NFM
<i>Aquilaria</i>	<i>beccariana</i>	<i>Aquilaria beccariana</i>	NFM
<i>Aquilaria</i>	<i>malaccensis</i>	<i>Aquilaria malaccensis</i>	NFM
<i>Aquilaria</i>	<i>microcarpa</i>	<i>Aquilaria microcarpa</i>	NFM
<i>Artocarpus</i>	<i>altilis</i>	<i>Artocarpus altilis</i>	NFM
<i>Artocarpus</i>	<i>anisophyllus</i>	<i>Artocarpus anisophyllus</i>	NFM
<i>Artocarpus</i>	<i>chaplasha</i>	<i>Artocarpus chaplasha</i>	NFM
<i>Artocarpus</i>	<i>dadah</i>	<i>Artocarpus dadah</i>	NFM
<i>Artocarpus</i>	<i>elasticus</i>	<i>Artocarpus elasticus</i>	NFM
<i>Artocarpus</i>	<i>excelsus</i>	<i>Artocarpus excelsus</i>	NFM
<i>Artocarpus</i>	<i>glaucus</i>	<i>Artocarpus glaucus</i>	NFM
<i>Artocarpus</i>	<i>heterophyllus</i>	<i>Artocarpus heterophyllus</i>	NFM
<i>Artocarpus</i>	<i>integer</i>	<i>Artocarpus integer</i>	NFM

<i>Artocarpus jarrettiae</i>	<i>Artocarpus jarrettiae</i>	NFM
<i>Artocarpus kemando</i>	<i>Artocarpus kemando</i>	NFM
<i>Artocarpus lanceifolius</i>	<i>Artocarpus lanceifolius</i>	NFM
<i>Artocarpus longifolius</i>	<i>Artocarpus longifolius</i>	NFM
<i>Artocarpus nitidus</i>	<i>Artocarpus nitidus</i>	NFM
<i>Artocarpus obtusus</i>	<i>Artocarpus obtusus</i>	NFM
<i>Artocarpus odoratissimus</i>	<i>Artocarpus odoratissimus</i>	NFM
<i>Artocarpus primackiana</i>	<i>Artocarpus primackiana</i>	NFM
<i>Artocarpus rigidus</i>	<i>Artocarpus rigidus</i>	NFM
<i>Artocarpus tamaran</i>	<i>Artocarpus tamaran</i>	NFM
<i>Artocarpus teysmannii</i>	<i>Artocarpus teysmannii</i>	NFM
<i>Artocarpus tomentosulus</i>	<i>Artocarpus tomentosulus</i>	NFM
<i>Avicennia marina</i>	<i>Avicennia marina</i>	NFM
<i>Baccaurea angulata</i>	<i>Baccaurea angulata</i>	NFM
<i>Baccaurea bracteata</i>	<i>Baccaurea bracteata</i>	NFM
<i>Baccaurea brevipes</i>	<i>Baccaurea brevipes</i>	NFM
<i>Baccaurea costulata</i>	<i>Baccaurea costulata</i>	NFM
<i>Baccaurea deflexa</i>	<i>Baccaurea deflexa</i>	NFM
<i>Baccaurea edulis</i>	<i>Baccaurea edulis</i>	NFM
<i>Baccaurea javanica</i>	<i>Baccaurea javanica</i>	NFM
<i>Baccaurea lanceolata</i>	<i>Baccaurea lanceolata</i>	NFM
<i>Baccaurea macrocarpa</i>	<i>Baccaurea macrocarpa</i>	NFM
<i>Baccaurea macrophylla</i>	<i>Baccaurea macrophylla</i>	NFM
<i>Baccaurea maingayi</i>	<i>Baccaurea maingayi</i>	NFM
<i>Baccaurea minor</i>	<i>Baccaurea minor</i>	NFM
<i>Baccaurea mollis</i>	<i>Baccaurea mollis</i>	NFM
<i>Baccaurea motleyana</i>	<i>Baccaurea motleyana</i>	NFM
<i>Baccaurea nanihua</i>	<i>Baccaurea nanihua</i>	NFM
<i>Baccaurea odoratissima</i>	<i>Baccaurea odoratissima</i>	NFM
<i>Baccaurea parviflora</i>	<i>Baccaurea parviflora</i>	NFM
<i>Baccaurea philippinensis</i>	<i>Baccaurea philippinensis</i>	NFM
<i>Baccaurea polyneura</i>	<i>Baccaurea polyneura</i>	NFM
<i>Baccaurea pubera</i>	<i>Baccaurea pubera</i>	NFM
<i>Baccaurea pyriformis</i>	<i>Baccaurea pyriformis</i>	NFM
<i>Baccaurea racemosa</i>	<i>Baccaurea racemosa</i>	NFM
<i>Baccaurea sarawakensis</i>	<i>Baccaurea sarawakensis</i>	NFM
<i>Baccaurea sumatrana</i>	<i>Baccaurea sumatrana</i>	NFM
<i>Baccaurea tetrandra</i>	<i>Baccaurea tetrandra</i>	NFM
<i>Baccaurea trigonocarpa</i>	<i>Baccaurea trigonocarpa</i>	NFM
<i>Bruguiera cylindrica</i>	<i>Bruguiera cylindrica</i>	NFM

<i>Bruguiera</i>	<i>gymnorhiza</i>	<i>Bruguiera gymnorhiza</i>	NFM
<i>Bruguiera</i>	<i>hainesii</i>	<i>Bruguiera hainesii</i>	NFM
<i>Bruguiera</i>	<i>parviflora</i>	<i>Bruguiera parviflora</i>	NFM
<i>Bruguiera</i>	<i>sexangula</i>	<i>Bruguiera sexangula</i>	NFM
<i>Castanopsis</i>	<i>acuminatissima</i>	<i>Castanopsis acuminatissima</i>	NFM
<i>Castanopsis</i>	<i>borneensis</i>	<i>Castanopsis borneensis</i>	NFM
<i>Castanopsis</i>	<i>buruana</i>	<i>Castanopsis buruana</i>	NFM
<i>Castanopsis</i>	<i>clemensii</i>	<i>Castanopsis clemensii</i>	NFM
<i>Castanopsis</i>	<i>costata</i>	<i>Castanopsis costata</i>	NFM
<i>Castanopsis</i>	<i>densinervia</i>	<i>Castanopsis densinervia</i>	NFM
<i>Castanopsis</i>	<i>endertii</i>	<i>Castanopsis endertii</i>	NFM
<i>Castanopsis</i>	<i>evansii</i>	<i>Castanopsis evansii</i>	NFM
<i>Castanopsis</i>	<i>foxworthyi</i>	<i>Castanopsis foxworthyi</i>	NFM
<i>Castanopsis</i>	<i>fulva</i>	<i>Castanopsis fulva</i>	NFM
<i>Castanopsis</i>	<i>hypophoenicea</i>	<i>Castanopsis hypophoenicea</i>	NFM
<i>Castanopsis</i>	<i>javanica</i>	<i>Castanopsis javanica</i>	NFM
<i>Castanopsis</i>	<i>megacarpa</i>	<i>Castanopsis megacarpa</i>	NFM
<i>Castanopsis</i>	<i>microphylla</i>	<i>Castanopsis microphylla</i>	NFM
<i>Castanopsis</i>	<i>motleyana</i>	<i>Castanopsis motleyana</i>	NFM
<i>Castanopsis</i>	<i>oligoneura</i>	<i>Castanopsis oligoneura</i>	NFM
<i>Castanopsis</i>	<i>oviformis</i>	<i>Castanopsis oviformis</i>	NFM
<i>Castanopsis</i>	<i>paucispina</i>	<i>Castanopsis paucispina</i>	NFM
<i>Castanopsis</i>	<i>pedunculata</i>	<i>Castanopsis pedunculata</i>	NFM
<i>Castanopsis</i>	<i>psilophylla</i>	<i>Castanopsis psilophylla</i>	NFM
<i>Ceriops</i>	<i>decandra</i>	<i>Ceriops decandra</i>	NFM
<i>Ceriops</i>	<i>tagal</i>	<i>Ceriops tagal</i>	NFM
<i>Dacryodes</i>	<i>costata</i>	<i>Dacryodes costata</i>	NFM
<i>Dacryodes</i>	<i>elmeri</i>	<i>Dacryodes elmeri</i>	NFM
<i>Dacryodes</i>	<i>incurvata</i>	<i>Dacryodes incurvata</i>	NFM
<i>Dacryodes</i>	<i>laxa</i>	<i>Dacryodes laxa</i>	NFM
<i>Dacryodes</i>	<i>longifolia</i>	<i>Dacryodes longifolia</i>	NFM
<i>Dacryodes</i>	<i>macrocarpa</i>	<i>Dacryodes macrocarpa</i>	NFM
<i>Dacryodes</i>	<i>rostrata</i>	<i>Dacryodes rostrata</i>	NFM
<i>Dacryodes</i>	<i>rubiginosa</i>	<i>Dacryodes rubiginosa</i>	NFM
<i>Dacryodes</i>	<i>rugosa</i>	<i>Dacryodes rugosa</i>	NFM
<i>Dracontomelon</i>	<i>costatum</i>	<i>Dracontomelon costatum</i>	NFM
<i>Dracontomelon</i>	<i>dao</i>	<i>Dracontomelon dao</i>	NFM
<i>Durio</i>	<i>acutifolius</i>	<i>Durio acutifolius</i>	NFM
<i>Durio</i>	<i>affinis</i>	<i>Durio affinis</i>	NFM
<i>Durio</i>	<i>dulcis</i>	<i>Durio dulcis</i>	NFM

<i>Durio</i>	<i>grandiflorus</i>	<i>Durio grandiflorus</i>	NFM
<i>Durio</i>	<i>graveolens</i>	<i>Durio graveolens</i>	NFM
<i>Durio</i>	<i>griffithii</i>	<i>Durio griffithii</i>	NFM
<i>Durio</i>	<i>kinabaluensis</i>	<i>Durio kinabaluensis</i>	NFM
<i>Durio</i>	<i>kutejensis</i>	<i>Durio kutejensis</i>	NFM
<i>Durio</i>	<i>lanceolatus</i>	<i>Durio lanceolatus</i>	NFM
<i>Durio</i>	<i>oxleyanus</i>	<i>Durio oxleyanus</i>	NFM
<i>Durio</i>	<i>purpureus</i>	<i>Durio purpureus</i>	NFM
<i>Durio</i>	<i>testudinarius</i>	<i>Durio testudinarius</i>	NFM
<i>Durio</i>	<i>zibethinus</i>	<i>Durio zibethinus</i>	NFM
<i>Eusideroxylon</i>	<i>zwageri</i>	<i>Eusideroxylon zwageri</i>	NFM
<i>Gonystylus</i>	<i>affinis</i>	<i>Gonystylus affinis</i>	NFM
<i>Gonystylus</i>	<i>bancanus</i>	<i>Gonystylus bancanus</i>	NFM
<i>Gonystylus</i>	<i>borneensis</i>	<i>Gonystylus borneensis</i>	NFM
<i>Gonystylus</i>	<i>brunnescens</i>	<i>Gonystylus brunnescens</i>	NFM
<i>Gonystylus</i>	<i>consanguineus</i>	<i>Gonystylus consanguineus</i>	NFM
<i>Gonystylus</i>	<i>forbesii</i>	<i>Gonystylus forbesii</i>	NFM
<i>Gonystylus</i>	<i>keithii</i>	<i>Gonystylus keithii</i>	NFM
<i>Gonystylus</i>	<i>macrophyllus</i>	<i>Gonystylus macrophyllus</i>	NFM
<i>Gonystylus</i>	<i>maingayi</i>	<i>Gonystylus maingayi</i>	NFM
<i>Gonystylus</i>	<i>micranthus</i>	<i>Gonystylus micranthus</i>	NFM
<i>Gonystylus</i>	<i>stenosepalus</i>	<i>Gonystylus stenosepalus</i>	NFM
<i>Gonystylus</i>	<i>velutinus</i>	<i>Gonystylus velutinus</i>	NFM
<i>Intsia</i>	<i>bijuga</i>	<i>Intsia bijuga</i>	NFM
<i>Intsia</i>	<i>palembanica</i>	<i>Intsia palembanica</i>	NFM
<i>Kandelia</i>	<i>candel</i>	<i>Kandelia candel</i>	NFM
<i>Koompassia</i>	<i>excelsa</i>	<i>Koompassia excelsa</i>	NFM
<i>Koompassia</i>	<i>malaccensis</i>	<i>Koompassia malaccensis</i>	NFM
<i>Lansium</i>	<i>domesticum</i>	<i>Lansium domesticum</i>	NFM
<i>Lithocarpus</i>	<i>bancanus</i>	<i>Lithocarpus bancanus</i>	NFM
<i>Lithocarpus</i>	<i>beccarianus</i>	<i>Lithocarpus beccarianus</i>	NFM
<i>Lithocarpus</i>	<i>bennetti</i>	<i>Lithocarpus bennetti</i>	NFM
<i>Lithocarpus</i>	<i>blumeanus</i>	<i>Lithocarpus blumeanus</i>	NFM
<i>Lithocarpus</i>	<i>brochidodromus</i>	<i>Lithocarpus brochidodromus</i>	NFM
<i>Lithocarpus</i>	<i>bullatus</i>	<i>Lithocarpus bullatus</i>	NFM
<i>Lithocarpus</i>	<i>cantleyanus</i>	<i>Lithocarpus cantleyanus</i>	NFM
<i>Lithocarpus</i>	<i>caudatifolius</i>	<i>Lithocarpus caudatifolius</i>	NFM
<i>Lithocarpus</i>	<i>clementianus</i>	<i>Lithocarpus clementianus</i>	NFM
<i>Lithocarpus</i>	<i>confertus</i>	<i>Lithocarpus confertus</i>	NFM
<i>Lithocarpus</i>	<i>confragosus</i>	<i>Lithocarpus confragosus</i>	NFM

<i>Lithocarpus</i>	<i>conocarpus</i>	<i>Lithocarpus conocarpus</i>	NFM
<i>Lithocarpus</i>	<i>coopertus</i>	<i>Lithocarpus coopertus</i>	NFM
<i>Lithocarpus</i>	<i>corneri</i>	<i>Lithocarpus corneri</i>	NFM
<i>Lithocarpus</i>	<i>daphnoideus</i>	<i>Lithocarpus daphnoideus</i>	NFM
<i>Lithocarpus</i>	<i>dasystachyus</i>	<i>Lithocarpus dasystachyus</i>	NFM
<i>Lithocarpus</i>	<i>echinifer</i>	<i>Lithocarpus echinifer</i>	NFM
<i>Lithocarpus</i>	<i>echinulatus</i>	<i>Lithocarpus echinulatus</i>	NFM
<i>Lithocarpus</i>	<i>elegans</i>	<i>Lithocarpus elegans</i>	NFM
<i>Lithocarpus</i>	<i>encleisocarpus</i>	<i>Lithocarpus encleisocarpus</i>	NFM
<i>Lithocarpus</i>	<i>ewyckii</i>	<i>Lithocarpus ewyckii</i>	NFM
<i>Lithocarpus</i>	<i>ferrugineus</i>	<i>Lithocarpus ferrugineus</i>	NFM
<i>Lithocarpus</i>	<i>gracilis</i>	<i>Lithocarpus gracilis</i>	NFM
<i>Lithocarpus</i>	<i>hallieri</i>	<i>Lithocarpus hallieri</i>	NFM
<i>Lithocarpus</i>	<i>hatusimae</i>	<i>Lithocarpus hatusimae</i>	NFM
<i>Lithocarpus</i>	<i>havilandii</i>	<i>Lithocarpus havilandii</i>	NFM
<i>Lithocarpus</i>	<i>jacobsii</i>	<i>Lithocarpus jacobsii</i>	NFM
<i>Lithocarpus</i>	<i>kalkmanii</i>	<i>Lithocarpus kalkmanii</i>	NFM
<i>Lithocarpus</i>	<i>keningauensis</i>	<i>Lithocarpus keningauensis</i>	NFM
<i>Lithocarpus</i>	<i>lampadarius</i>	<i>Lithocarpus lampadarius</i>	NFM
<i>Lithocarpus</i>	<i>leptogyne</i>	<i>Lithocarpus leptogyne</i>	NFM
<i>Lithocarpus</i>	<i>lucidus</i>	<i>Lithocarpus lucidus</i>	NFM
<i>Lithocarpus</i>	<i>luteus</i>	<i>Lithocarpus luteus</i>	NFM
<i>Lithocarpus</i>	<i>mariae</i>	<i>Lithocarpus mariae</i>	NFM
<i>Lithocarpus</i>	<i>meijeri</i>	<i>Lithocarpus meijeri</i>	NFM
<i>Lithocarpus</i>	<i>nieuwenhuisii</i>	<i>Lithocarpus nieuwenhuisii</i>	NFM
<i>Lithocarpus</i>	<i>nodosus</i>	<i>Lithocarpus nodosus</i>	NFM
<i>Lithocarpus</i>	<i>oblancifolius</i>	<i>Lithocarpus oblancifolius</i>	NFM
<i>Lithocarpus</i>	<i>papillifer</i>	<i>Lithocarpus papillifer</i>	NFM
<i>Lithocarpus</i>	<i>porcatus</i>	<i>Lithocarpus porcatus</i>	NFM
<i>Lithocarpus</i>	<i>pseudokunstleri</i>	<i>Lithocarpus pseudokunstleri</i>	NFM
<i>Lithocarpus</i>	<i>pulcher</i>	<i>Lithocarpus pulcher</i>	NFM
<i>Lithocarpus</i>	<i>pusillus</i>	<i>Lithocarpus pusillus</i>	NFM
<i>Lithocarpus</i>	<i>rassa</i>	<i>Lithocarpus rassa</i>	NFM
<i>Lithocarpus</i>	<i>revolutus</i>	<i>Lithocarpus revolutus</i>	NFM
<i>Lithocarpus</i>	<i>rigidus</i>	<i>Lithocarpus rigidus</i>	NFM
<i>Lithocarpus</i>	<i>rotundatus</i>	<i>Lithocarpus rotundatus</i>	NFM
<i>Lithocarpus</i>	<i>ruminatus</i>	<i>Lithocarpus ruminatus</i>	NFM
<i>Lithocarpus</i>	<i>sandakanensis</i>	<i>Lithocarpus sandakanensis</i>	NFM
<i>Lithocarpus</i>	<i>sericobalanos</i>	<i>Lithocarpus sericobalanos</i>	NFM
<i>Lithocarpus</i>	<i>stonei</i>	<i>Lithocarpus stonei</i>	NFM

<i>Lithocarpus</i>	<i>sundaicus</i>	<i>Lithocarpus sunaicus</i>	NFM
<i>Lithocarpus</i>	<i>tawaiensis</i>	<i>Lithocarpus tawaiensis</i>	NFM
<i>Lithocarpus</i>	<i>turbinatus</i>	<i>Lithocarpus turbinatus</i>	NFM
<i>Lithocarpus</i>	<i>urceolaris</i>	<i>Lithocarpus urceolaris</i>	NFM
<i>Lithocarpus</i>	<i>wallichianus</i>	<i>Lithocarpus wallichianus</i>	NFM
<i>Mangifera</i>	<i>bloomesteinii</i>	<i>Mangifera bloomesteinii</i>	NFM
<i>Mangifera</i>	<i>caesia</i>	<i>Mangifera caesia</i>	NFM
<i>Mangifera</i>	<i>decandra</i>	<i>Mangifera decandra</i>	NFM
<i>Mangifera</i>	<i>foetida</i>	<i>Mangifera foetida</i>	NFM
<i>Mangifera</i>	<i>griffithii</i>	<i>Mangifera griffithii</i>	NFM
<i>Mangifera</i>	<i>indica</i>	<i>Mangifera indica</i>	NFM
<i>Mangifera</i>	<i>macrocarpa</i>	<i>Mangifera macrocarpa</i>	NFM
<i>Mangifera</i>	<i>magnifica</i>	<i>Mangifera magnifica</i>	NFM
<i>Mangifera</i>	<i>odorata</i>	<i>Mangifera odorata</i>	NFM
<i>Mangifera</i>	<i>pajang</i>	<i>Mangifera pajang</i>	NFM
<i>Mangifera</i>	<i>parvifolia</i>	<i>Mangifera parvifolia</i>	NFM
<i>Mangifera</i>	<i>pentandra</i>	<i>Mangifera pentandra</i>	NFM
<i>Mangifera</i>	<i>quadrifida</i>	<i>Mangifera quadrifida</i>	NFM
<i>Mangifera</i>	<i>rufocostata</i>	<i>Mangifera rufocostata</i>	NFM
<i>Mangifera</i>	<i>subsessilifolia</i>	<i>Mangifera subsessilifolia</i>	NFM
<i>Mangifera</i>	<i>swintonioides</i>	<i>Mangifera swintonioides</i>	NFM
<i>Mangifera</i>	<i>torquenda</i>	<i>Mangifera torquenda</i>	NFM
<i>Nephelium</i>	<i>aculeatum</i>	<i>Nephelium aculeatum</i>	NFM
<i>Nephelium</i>	<i>cuspidatum</i>	<i>Nephelium cuspidatum</i>	NFM
<i>Nephelium</i>	<i>daedaleum</i>	<i>Nephelium daedaleum</i>	NFM
<i>Nephelium</i>	<i>lappaceum</i>	<i>Nephelium lappaceum</i>	NFM
<i>Nephelium</i>	<i>maingayi</i>	<i>Nephelium maingayi</i>	NFM
<i>Nephelium</i>	<i>melanomiscum</i>	<i>Nephelium melanomiscum</i>	NFM
<i>Nephelium</i>	<i>papillatum</i>	<i>Nephelium papillatum</i>	NFM
<i>Nephelium</i>	<i>ramboutan-ake</i>	<i>Nephelium ramboutan-ake</i>	NFM
<i>Nephelium</i>	<i>reticulatum</i>	<i>Nephelium reticulatum</i>	NFM
<i>Nephelium</i>	<i>subfalcatum</i>	<i>Nephelium subfalcatum</i>	NFM
<i>Nephelium</i>	<i>uncinatum</i>	<i>Nephelium uncinatum</i>	NFM
<i>Paranephelium</i>	<i>joannis</i>	<i>Paranephelium joannis</i>	NFM
<i>Paranephelium</i>	<i>xestophyllum</i>	<i>Paranephelium xestophyllum</i>	NFM
<i>Rhizophora</i>	<i>apiculata</i>	<i>Rhizophora apiculata</i>	NFM
<i>Rhizophora</i>	<i>mucronata</i>	<i>Rhizophora mucronata</i>	NFM
<i>Rhizophora</i>	<i>stylosa</i>	<i>Rhizophora stylosa</i>	NFM
<i>Santiria</i>	<i>apiculata</i>	<i>Santiria apiculata</i>	NFM
<i>Santiria</i>	<i>conferta</i>	<i>Santiria conferta</i>	NFM

<i>Santiria</i>	<i>grandiflora</i>	<i>Santiria grandiflora</i>	NFM
<i>Santiria</i>	<i>griffithii</i>	<i>Santiria griffithii</i>	NFM
<i>Santiria</i>	<i>kalkmaniana</i>	<i>Santiria kalkmaniana</i>	NFM
<i>Santiria</i>	<i>laevigata</i>	<i>Santiria laevigata</i>	NFM
<i>Santiria</i>	<i>megaphylla</i>	<i>Santiria megaphylla</i>	NFM
<i>Santiria</i>	<i>mollis</i>	<i>Santiria mollis</i>	NFM
<i>Santiria</i>	<i>oblongifolia</i>	<i>Santiria oblongifolia</i>	NFM
<i>Santiria</i>	<i>rubiginosa</i>	<i>Santiria rubiginosa</i>	NFM
<i>Santiria</i>	<i>tomentosa</i>	<i>Santiria tomentosa</i>	NFM
<i>Shorea</i>	<i>amplexicaulis</i>	<i>Shorea amplexicaulis</i>	NFM
<i>Shorea</i>	<i>macrophylla</i>	<i>Shorea macrophylla</i>	NFM
<i>Shorea</i>	<i>mecistopteryx</i>	<i>Shorea mecistopteryx</i>	NFM
<i>Shorea</i>	<i>palembanica</i>	<i>Shorea palembanica</i>	NFM
<i>Shorea</i>	<i>pilosa</i>	<i>Shorea pilosa</i>	NFM
<i>Shorea</i>	<i>pinanga</i>	<i>Shorea pinanga</i>	NFM
<i>Sympetalandra</i>	<i>unijuga</i>	<i>Sympetalandra unijuga</i>	NFM
<i>Triomma</i>	<i>malaccensis</i>	<i>Triomma malaccensis</i>	NFM
<i>Mangifera</i>	<i>sp</i>	<i>Mangifera sp</i>	NFM
<i>Durio</i>	<i>sp</i>	<i>Durio sp</i>	NFM
<i>Triomma</i>	<i>sp</i>	<i>Triomma sp</i>	NFM
<i>Dacryodes</i>	<i>sp</i>	<i>Dacryodes sp</i>	NFM
<i>Canarium</i>	<i>sp</i>	<i>Canarium sp</i>	NFM
<i>Shorea</i>	<i>pinanga</i>	<i>Shorea pinanga</i>	NFM
<i>Shorea</i>	<i>amplexicaulis</i>	<i>Shorea amplexicaulis</i>	NFM
<i>Shorea</i>	<i>pilosa</i>	<i>Shorea pilosa</i>	NFM
<i>Shorea</i>	<i>mecistopteryx</i>	<i>Shorea mecistopteryx</i>	NFM
<i>Shorea</i>	<i>cristata</i>	<i>Shorea cristata</i>	NFM
<i>Shorea</i>	<i>macrophylla</i>	<i>Shorea macrophylla</i>	NFM
<i>Dracontomelon</i>	<i>sp</i>	<i>Dracontomelon sp</i>	NFM
<i>Lansium</i>	<i>sp</i>	<i>Lansium sp</i>	NFM
<i>Baccaurea</i>	<i>sp</i>	<i>Baccaurea sp</i>	NFM
<i>Parartocarpus</i>	<i>sp</i>	<i>Parartocarpus sp</i>	NFM
<i>Artocarpus</i>	<i>dadah</i>	<i>Artocarpus dadah</i>	NFM
<i>Artocarpus</i>	<i>integar</i>	<i>Artocarpus integar</i>	NFM
<i>Nephelium</i>	<i>sp</i>	<i>Nephelium sp</i>	NFM
<i>Paranephelium</i>	<i>nitidum</i>	<i>Paranephelium nitidum</i>	NFM
<i>Aquileia</i>	<i>malaccensis</i>	<i>Aquileia malaccensis</i>	NFM
<i>Euphoria</i>	<i>malaiensis</i>	<i>Euphoria malaiensis</i>	NFM

Appendix 9: Carbon Density, Vegetation Health & Biodiversity

Carbon and vegetation health/quality:

The concept that multiple ecosystem functions are intercorrelated has been well established by biodiversity ecosystem function research and in particular work on ecosystem multi-functionality (Gamfeldt *et al.* 2013). There is currently a large body of research focusing on biomass and carbon, and it is now widely accepted that many other ecosystem functions crucial to ecosystem and vegetation health are strongly correlated with biomass and carbon (Gamfeldt *et al.* 2013; Ruiz-Jaen & Potvin 2010; Shen *et al.* 2016; Mo *et al.* 2023). We have chosen aboveground biomass as a functional measure to assess overall vegetation health, which we refer to as vegetation 'quality'. We define vegetation quality as a biodiversity indicator that incorporates overall forest structure and composition. This includes the height, size, composition and diversity of trees, the canopy cover, the diversity of the forest strata (i.e., tree layers; see Zakaria *et al.* 2005), along with other structural and ecological aspects of the vegetation. If the vegetation quality is high (i.e. as found within pristine or primary forest habitats), it reflects good overall habitat condition and the ability of a forest habitat to support ecosystem processes and functions, as well as population persistence.

In degraded tropical forest habitats, levels of aboveground carbon are often relatively low, and have resulted from habitat disturbance through anthropogenic activities such as logging (Saner *et al.* 2012). Such disturbance involves the removal of large trees and frequently results in the death and damage of smaller trees during harvesting (Rozak *et al.* 2018). This leads to detrimental changes in canopy height and structure (Okuda *et al.*, 2019), as well as compromised ecosystem functioning (Slade, Mann & Lewis, 2011; also see review by López-Bedoya *et al.* 2021). Intensively logged forests have been found to contain less aboveground carbon compared to unlogged forests (e.g. across Sabah; Asner *et al.* 2018) and carbon stocks generally decrease when logging intensity increases (Rozak *et al.*, 2018). Degraded forests in Sabah that contain lower levels of aboveground carbon compared to unlogged forests contain fewer large trees (i.e., with a larger basal area), particularly dipterocarps that are selectively removed during logging cycles. Dipterocarps are the dominant structural component of SE Asian forests and the target of logging activities due to their commercial value (Saner *et al.* 2012). Dipterocarp trees are important for forest health and essential for the structure and function of SE Asian forests (see review by Brearley, Banin & Saner, 2016). They are amongst the tallest trees in the forest (Shenkin *et al.* 2019) and hence are important stores of aboveground carbon (Slik *et al.*, 2013). Hence, aboveground carbon density is an excellent measure to assess overall vegetation quality as higher aboveground biomass levels relate to forests with a greater number of large trees, and thus more intact dipterocarp trees, which are the dominant structural component of forests in Sabah.

In the context of the Project Area, much of the forest has been very heavily degraded by previous disturbance (e.g., by high-intensity logging), and so higher levels of aboveground carbon will reflect better

quality forest habitat, with larger trees and structural attributes more similar to primary or undisturbed forests. Within this disturbed forest habitat, carbon will accumulate over time as the forest regenerates (Philipson et al., 2020) and so any increases in aboveground carbon will also reflect forest recovery and improvements to vegetation quality following the termination of logging activities. Hence, carbon density is an excellent proxy for vegetation quality within the previously logged forest of the Kuamut FR.

Vegetation health/quality and biodiversity:

Degraded forest habitats of lower vegetation quality generally contain fewer species compared to primary or pristine forests and this is well established in the scientific literature (e.g. see extensive review by Meijaard et al., 2005). Forest disturbance significantly alters habitat structure (i.e. by removing large trees) and this often results in a decline in both forest species' abundance and diversity, particularly for species that are restricted in range such as endemics (Morris, 2010). Forest disturbance is particularly detrimental for forest specialists that depend on undisturbed forest habitats, and this has been documented for taxa such as butterflies (e.g. Dumbrell & Hill, 2005) and birds (e.g., Edwards et al., 2009). Mammal populations are also widely affected by changes in vegetation cover due to the direct impact on the richness of food resources and the habitat preferences of these species (Kinnaird et al., 2003). Similarly, primate densities have been shown to decline following logging (Meijaard et al., 2005) and species that require large trees (e.g., Hornbills; Kuar et al. 2020) may be directly affected by the decrease in nesting site availability. Orangutans are more likely to move in directions of increased canopy closure and avoid canopy gaps (Davies et al. 2017), and so vegetation quality and carbon density are likely to correlate with the occurrence of our trigger species. Areas of high carbon have been found to support high faunal biodiversity (Imai et al., 2009; Deere et al., 2018, Williams et al., 2020), and aboveground carbon has been shown to correlate with plant diversity within forest habitats in Sabah (Fleiss et al., 2020). Hence, there is a clear link between vegetation quality (i.e. inferred by measuring aboveground carbon) and biodiversity in degraded forest habitats. Given that biodiversity positively correlates with multiple different ecosystem functions and services on many trophic levels (see Figure 1 reproduced from Slade et al. 2019), and aboveground carbon is the ecosystem function that can be mostly accurately measured, we have chosen aboveground biomass as a functional measure of vegetation quality and health. Using aboveground biomass as an accurate proxy for vegetation health, we can explore relationships among environmental conditions, ecosystem multifunctionality and biodiversity from our monitoring.

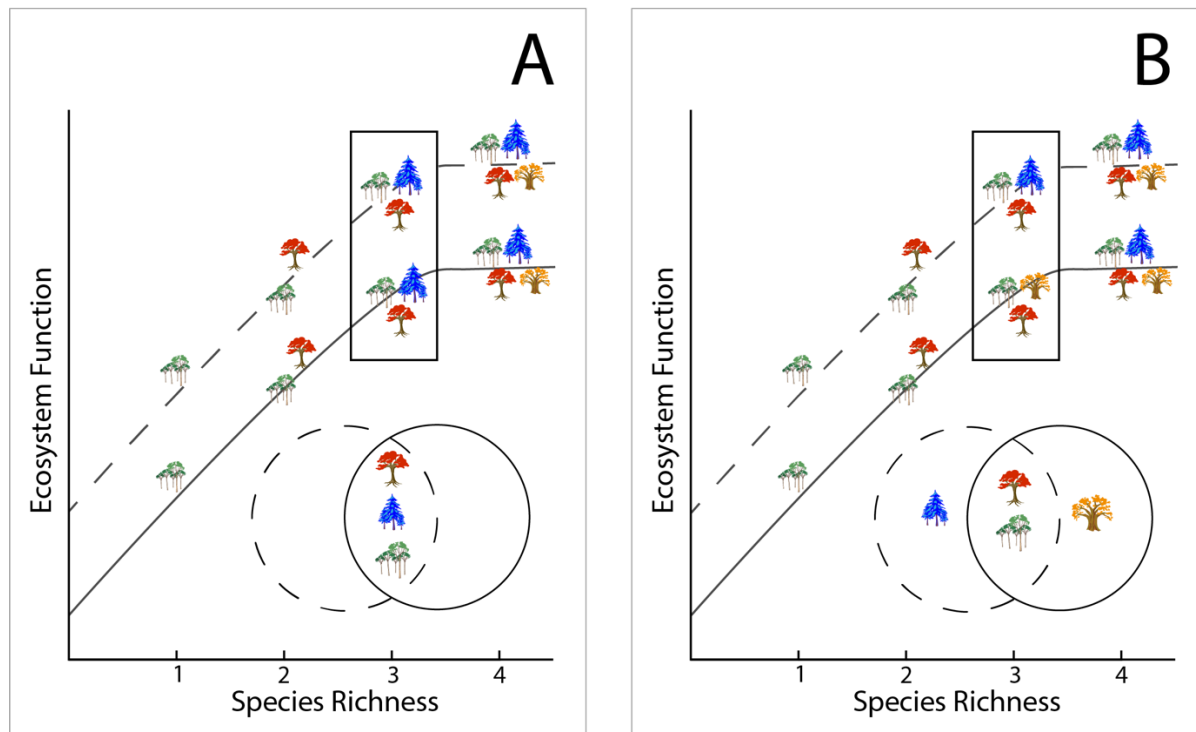


Figure 1: This figure is reproduced from Slade et al. (2019). Many different ecosystem functions and services have been shown to correlate with biodiversity. This concept has been mostly well established in many different biomes of the world, including for biomass and species richness.

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Appendix 11.

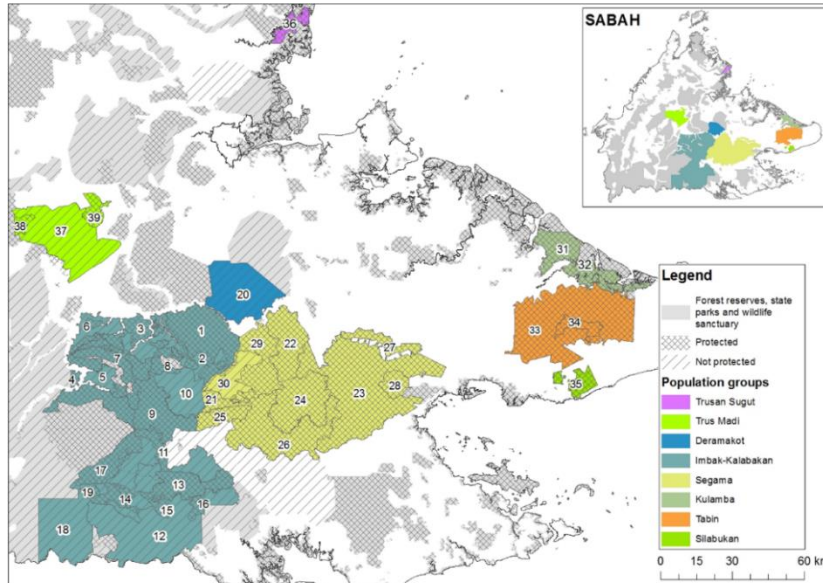


Figure 1. Map taken directly from Simon, Davies & Ancrenaz (2019)¹¹¹ showing the forest reserves for which orangutan population density and size were estimated in the 2014-2017 surveys. The Project Area comprises the forest reserves labeled as 1 - Northern Kuamut (West), 2 - Kuamut (West) and 29 - Northern Kuamut (East). In total, it is estimated that there are 630 orangutans in the Project Area in 2014-2017.

¹¹¹ Simon, D., Davies, G., Ancrenaz, M. 2019. Changes to Sabah's orangutan population in recent times: 2002–2017. *PLoS ONE*, <https://doi.org/10.1371/journal.pone.0218819>