

KUAMUT RAINFOREST CONSERVATION PROJECT

Kuamut
Rainforest



Conservation Project

Document Prepared by Permian Malaysia Sdn. Bhd.

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Project Lifetime	11 December 2015 – 1 December 2045.
GHG Accounting Period	11-12-2015 – 1-12-2045
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Gold Level Criteria	Not applicable
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1 SUMMARY OF PROJECT BENEFITS

1.1 Unique 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.

Outcome or Impact Estimated by the End of Project Lifetime	Section Reference
1) Protection and conservation of 83,381 ha of forest area	1
2) Conservation of critical biodiversity corridor between protected areas	5
3) Increased sustainable job opportunities for local community groups.	4
4) Habitat protection for three species of fauna that have a significant threat category.	5
5) Improved conditions for communities by improving health services, education, job creation and entrepreneurship opportunities supported.	2, 4

1.2 Standardized Benefit Metrics

Category	Metric	Estimated by the End of Project Lifetime	Section Reference
GHG emission reductions or removals	Net estimated emission removals in the project area, measured against the without-project scenario	Not applicable	
	Net estimated emission reductions in the project area, measured against the without-project scenario	16,291,488.57 t CO ₂ e in the period 2016-2045	3.2.4
Forest cover	For REDD projects: Estimated number of hectares of reduced forest loss in the project area measured against the without-project scenario	Not applicable	
	For ARR projects: Estimated number of hectares of forest cover increased in the project area measured against the without-project scenario	Not applicable	
Improved land management	Number of hectares of existing production forest land in which IFM practices are expected to occur as a result of project activities, measured against the without-project scenario	83,381 ha	2.1.5 3.1.5
	Number of hectares of non-forest land in which improved land management practices are expected to occur as a result of project activities, measured against the without-project scenario	Data not available	
Training	Total number of community members who are expected to have improved skills and/or knowledge resulting from training provided as part of project activities	500 (5-year estimate)	4.2.3, 2.1.11
	Number of female community members who are expected to have improved skills and/or knowledge resulting from training as part of project activities	300 (5-year estimate)	4.2.3, 2.1.11

Category	Metric	Estimated by the End of Project Lifetime	Section Reference
Employment	Total number of people expected to be employed in project activities, expressed as number of full-time employees	At least 40 people	2.1.11
	Number of women expected to be employed as a result of project activities, expressed as number of full-time employees	At least 20 women	2.1.11
Livelihoods	Total number of people expected to have improved livelihoods or income generated as a result of project activities	900 people from the communities on the Kuamut river	4.2.3
	Number of women expected to have improved livelihoods or income generated as a result of project activities	450	4.2.3
Health	Total number of people for whom health services are expected to improve as a result of project activities, measured against the without-project scenario	900 people from the communities on the Kuamut river	4.2.3
	Number of women for whom health services are expected to improve as a result of project activities, measured against the without-project scenario	457	4.2.3
Education	Total number of people for whom access to, or quality of, education is expected to improve as result of project activities, measured against the without-project scenario	At least 100	4.2.3
	Number of women and girls for whom access to, or quality of, education is expected to improve as result of project activities, measured against the without-project scenario	At least 50 women	4.2.3
Water	Total number of people who are expected to experience increased water quality and/or improved access to drinking water as a result of project	900 people from the communities	4.2.3, 5.1.3

Category	Metric	Estimated by the End of Project Lifetime	Section Reference
	activities, measured against the without-project scenario	on the Kuamut river	
	Number of women who are expected to experience increased water quality and/or improved access to drinking water as a result of project activities, measured against the without-project scenario	457	4.1.1, 5.1.3
Well-being	Total number of community members whose well-being is expected to improve as a result of project activities	1500	4.2.3
	Number of women whose well-being is expected to improve as a result of project activities	800	4.2.3
Biodiversity conservation	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	2.1.5
	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	29 mammal and 12 bird species in the project areas are considered as Rare, Threatened or Endangered [RTE] species .	5.1.1, Tables 36 & 37

2 GENERAL

2.1 Project Goals, Design and Long-Term Viability

2.1.1 Summary Description of the Project (G1.2)

The Kuamut Rainforest Conservation Project ('Kuamut Project') aims to protect and restore 83,381 ha of tropical forest in Sabah, Malaysia. The project is located in the Tongod and Kinabatangan Districts of Sabah, Malaysia. The project area is part of a long-term approximately 1-million-hectare concession granted to Yayasan Sabah on a 99-year lease arrangement with the Sabah Forestry Department (acting on behalf of the State Government of Sabah). Yayasan Sabah is a State-owned para-governmental charitable foundation that was formed in 1966 with the aim of 'improving the lives of Malaysians living in Sabah'.

Prior to the start of the project, the project area was designated as production forest (Class II). The area had been repeatedly logged in the past and was designated for further commercial exploitation. Project additionality is explicitly demonstrated by preventing continued commercial logging and instead manage the area for protection. Had the project not intervened, the resulting carbon emissions over this period would have contributed 16,291,488.57 tonnes of carbon dioxide equivalent (tCO₂e) to the atmosphere in the period 2016 – 2045, equivalent to an annual average of 543,049 tonnes of carbon dioxide equivalent (tCO₂e).

In addition to its contribution to preventing the release of greenhouse gas (GHG) emissions, the project is protecting an important biodiverse habitat. Despite its ex-logged state, the area is known to support very high populations of elephants, banteng and orangutan, and endangered bird species including Helmeted Hornbill, Bornean Peacock Pheasant and Storms Stork. The project will also improve the conditions for communities by improving access to water quality through the restoration of riparian reserves, generation of direct employment in project activities such as forest restoration, patrolling, etc. The project also aims to improve health services and reduce conflicts with outsiders working in logging concessions who would have arrived in the absence of the project. Furthermore, the project will provide training to community members to improve their skills in tourism, handicraft elaboration and improved agricultural practices as well as facilitate access to markets as well as formal and informal education packages, including for children.

Due to the history of repeated logging, the area is now a complex mosaic of forest in conditions ranging from intact to highly degraded. The most likely land use scenario without the project would therefore have been a combination of different forest management practices. Parts of the area would have been subjected to continued selective logging. The rest of the area would have been managed using a practice that is known locally as the Mosaic Planting Approach. The concept of Mosaic Planting Approach involved retaining small patches of natural forest areas containing young commercial tree species during harvesting, and planting of fast-growing species in the more open areas. The small patches of natural forests left standing comprise commercially forest species with a diameter below the prescribed cutting limit. The more open areas left are cleaned and planted with selected forest plantation species.

The project will avoid both the continued logging and the Mosaic Planting and instead manage the area for protection and carbon emission reductions. Emission reductions will be generated by the project through the avoided logging (AFOLU project category Improved Forest Management). These actions are expected to generate 16,291,488.57 t CO₂e in the period 2016 - 2045.

The project is operated by the Malaysian-based company Permian Malaysia Sdn. Bhd. (part of the Permian Global group), working in close collaboration with the Sabah Forestry Department, Yayasan Sabah, and Yayasan Sabah's wholly-owned forest management company Rakyat Berjaya Sdn. Bhd. together with other local partners, including the South East Asia Rainforest Research Partnership (SEARRP - a leading research organisation, established by the UK's Royal Society in 1985).

2.1.2 Project Scale

Project Scale	
Project	
Large project	Emission reductions are estimated to average 543,049 per year in the period 2016 -2045

2.1.3 Project Proponent (G1.1)

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2.1.5 Physical Parameters (G1.3)

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.

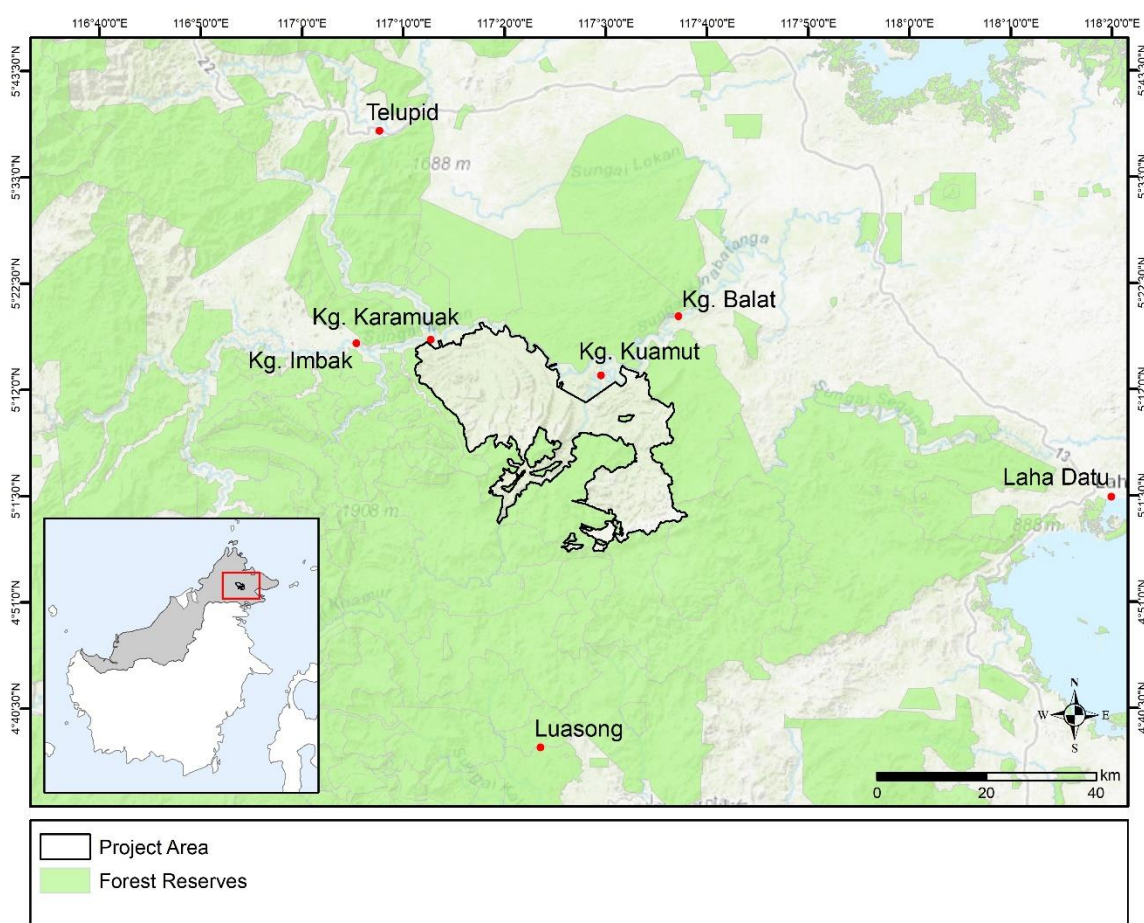


Figure 1: Project Location

Topography: The project area is generally very heterogeneous, with about 10% of the area lying above 500m above sea level. The lowest point in the area is about 16m above sea level, whilst the highest point is about 1,172m above sea level. The lowest lying area is concentrated in the northeast of the project area. About 60% of the area has slopes below 15°, while 29% of the area is between 15° and 25° and an estimated 10% of the area has slopes >25°. See Figure 2.

Soil & Geology: As in many parts of the tropics, the dense vegetation and deeply weathered soils restrict the occurrence of rock outcrops and only the general geology of the area has been mapped. The main geological formations found within this area are Kuamut, Crystalline Basement and Chert-Spillite. There is no detailed soil survey for the Kuamut area, but given its relatively complex geology, the soils are likely to be locally heterogeneous, with mentapok soils dominating in the more rugged area over the basic and igneous rocks of the Crystalline Basement and Bang soils developing over rocks of the Kuamut formation. These soils are classified in the USDA system as Ultisols (equivalent to the Acrisol-Alisol groups, in the FAO-UNESCO system).

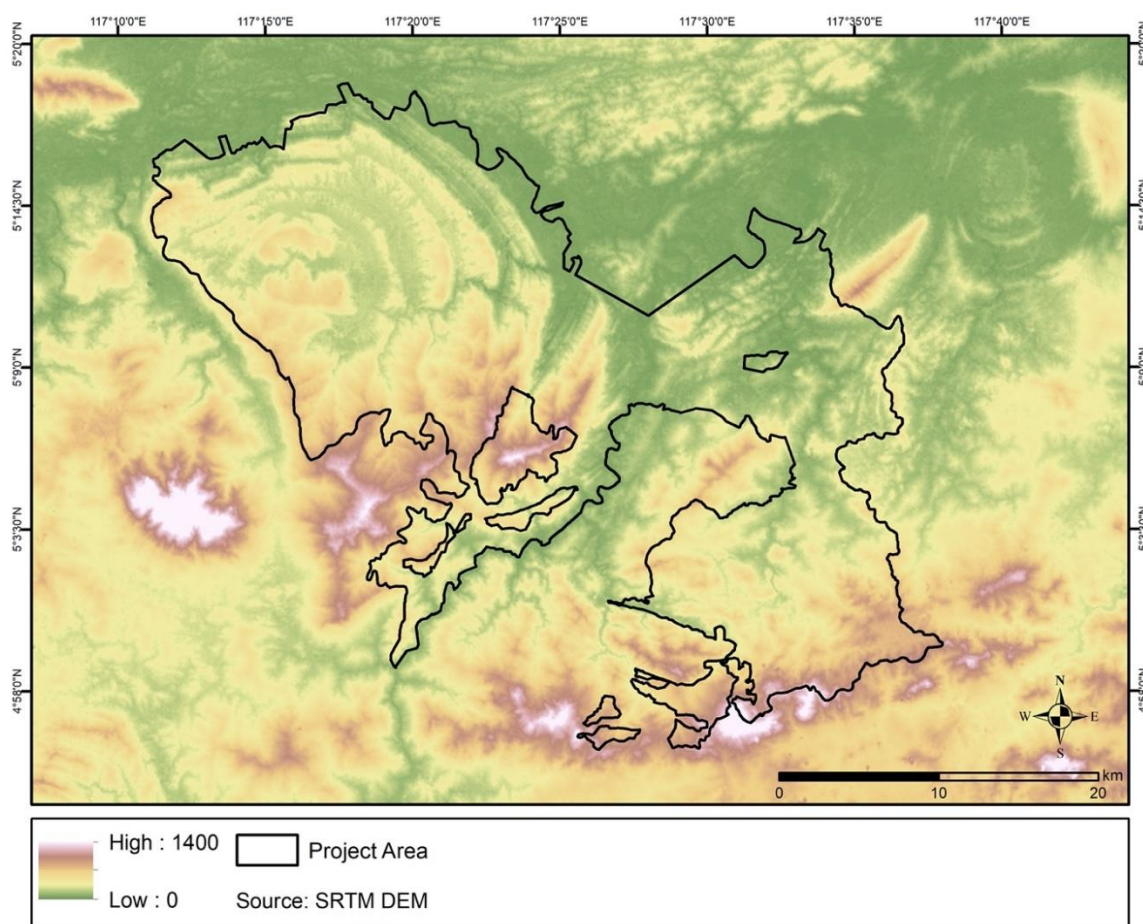


Figure 2: Topography of Kuamut Project area showing elevation of throughout the Project Area. Elevation, derived from LiDAR data, and using SRTM for areas where LiDAR data is absent, presented at 30meter pixel resolution. Slope is represented using a hillshade.

Climate: Mean annual rainfall for the period 2004-2017 recorded at the nearest weather station located at the Malua Field Station is 3,401 mm. Although all months' average >200 mm of rainfall, March to July is relatively dry (average 235 mm/month), while November to February are the wettest months (average 326 mm/month). The mean daily minimum temperature is about 23°C and the mean daily maximum 28°C.

Hydrology: There is an extensive network of streams within the project area, most of them unnamed. Generally, these streams all drain into the Kuamut River, which flows through the centre of the project area.

Vegetation: The natural forests of central-eastern Sabah are dominated by dipterocarps, particularly *Parashorea malaanonan* and *P. tomentella* together with *Shorea johorensis* and other *Shorea* species of the *Rubroshorea* group. Between 80 and 90% of large canopy trees belong to the *Depterocarpaceae* with the balance being accounted for mainly by *Koompassia*, *Diospyros* and *Durio* species. Although dipterocarps dominate the upper canopy, understory species from families such as *Euphorbiaceae* and *Rubiaceae* can make up over 85% of small stems. There are clear riverine and streamside associations comprising smaller trees of genera including *Saraca*, *Eugenia*, *Dillenia* and *Octomeles*. Relatively few large palms are found in the forests of this part of Sabah. At higher elevations (above approximately 700 m) the canopy seldom exceeds 25m and includes the gymnosperms *Agathis*, *Phylocladus* and *Podocarpus* spp. In terms of dynamics, the forests of central Sabah are thought to be in the late stages of recovery from an exceptionally severe drought disturbance at the end of the 19th century. Moderate to severe droughts, occurring irregularly at intervals of 1-2 events every 20 years, are an important feature of the forest environment of this part of Borneo. Tree species, particularly those in the understory, are well adapted to temporary water stress, the intensity of which changes along the local topographic gradient from low slopes to ridge tops; such stochastic variations doubtless play an important role in shorter-term forest dynamics and the maintenance of tree species richness. Prior to this project, research on the forests of Kuamut has been limited, but given their broadly similar topography, elevation, underlying geology and soils, much information can be derived from the adjacent and much better described Danum Valley Conservation Area (DVCA), the western and north-western flanks of which are fully contiguous with the Kuamut Forest Reserve. The knowledge of the flora of DVCA is based on general botanical collecting in the vicinity of the Danum Valley Field Centre including a number of WWF expeditions during the 1970s and subsequent much more detailed but localised enumeration studies. The higher-plant checklist compiled to date comprises more than 1,300 species in 562 genera of 139 families. Although this list is far from complete, it already represents close to 15% of the approximately 10,000 species of higher plants recorded for Sabah. There is no reason to assume that floral composition of the Kuamut Forest Reserve would differ substantively from the DVCA.

2.1.6 Social Parameters (G1.3)

The project area has no permanent human settlements, while the region surrounding it is only sparsely populated. At the outset of the project a radius of 20km was defined to undertake an initial survey of project stakeholders, and this survey identified only eight principal communities distributed along the banks of the Kinabatangan River, to the north of the Project Area. These communities form two principal groupings: four communities to the north-west of the project area and a further four to the north-east. These groupings will hereafter be referred to as the "Karamuak cluster" and "Kuamut cluster", respectively (see Figure 3). These

villages support 2,826 people (average per village is 350 people, min 10, max 750) living in 381 households (average per village is 48 people, min 4, max 84).

Residents of all communities belong chiefly to the indigenous ethnic group known as Orang Sungai – one of the chief Dusunic ethnic groups in Sabah. Each community is typically composed of a mixture of varying subgroupings of Orang Sungai, including the Sinabu, Kelabuan, Makiang, Kuamut and Sukang peoples. This reflects the diverse historical migratory patterns of each group, many of whom have transitioned from their traditionally nomadic lifestyles to more sedentary modes of agricultural production in permanent settlements at various stages since the early 20th century (some even date the founding of their current villages back to the 19th century). The Orang Sungai traditionally derive the majority of their subsistence from river resources (indeed, the name can be translated as “river people”, although this was coined by British Administrators and is not a self-ascribed appellation) supplemented by forest plants and animals. Nowadays, almost all community members rely heavily on agricultural smallholdings for economic contributions to livelihoods (principally cash crops such as oil palm, rubber and cocoa), although river and forest resources remain extremely important for subsistence.

The two community clusters are broadly similar in terms of cultural history and traditional livelihood practices, but at present exhibit some marked differences in terms of accessibility. Whilst Karamuak is relatively accessible, there is currently no reliable road access to the Kuamut cluster, which constitutes a sizeable constraint on contemporary livelihood opportunities since residents of this area are generally unable to sell produce to outside markets. Both clusters face similar challenges in terms of the availability of lands for future agricultural production, and the tenurial insecurity of lands currently used for production.

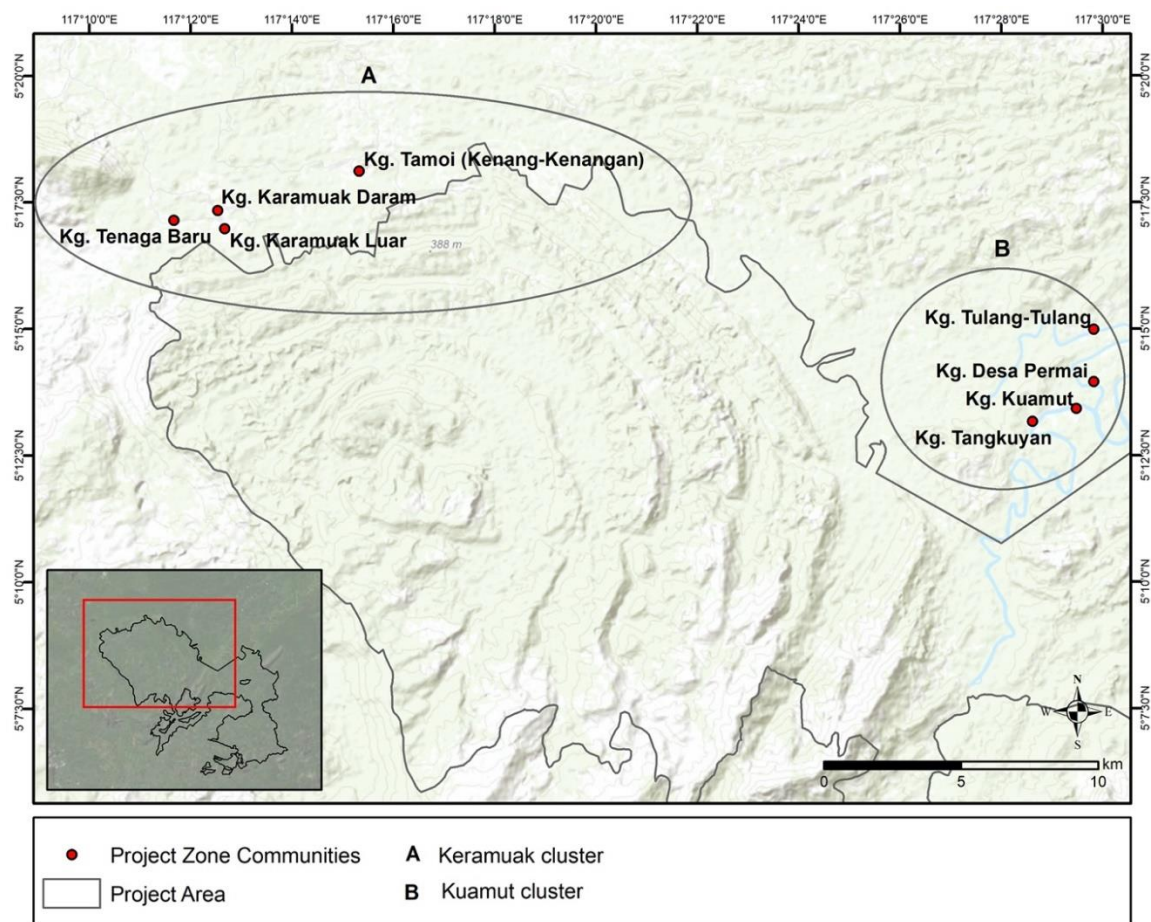


Figure 3: Project Zone communities

In terms of socio-cultural information, a Social Baseline Assessment was carried out between 2016 and 2019. Data was collected through numerous means such as household surveys in all Project Zone communities, community workshop discussions, site observations and informal gatherings.

Table 1 gives a general overview of population size, basic infrastructure, agriculture, education and healthcare for each of the current project zone communities. These data were gathered during discussion and presentation sessions in community workshops.

Table 1 Basic data on project zone villages obtained during community workshops

Community	Est. pop.	Est. Hse.	<>10Yr	Sources of water	Main agriculture	Education	Healthcare
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Tamoi	400	45	Same	River & rain	Oil palm, rubber, fruits & vegetables	Primary school in village	None
Keramuak Dalam	750	84	>	Gravity feed system	Oil palm, rubber, fruits & vegetables	None (primary school in Keramuak Luar)	None (clinic in Keramuak Luar)
Keramuak Luar	502	63	>	Gravity feed system	Oil palm, rubber, fruits & vegetables	Primary school in village	Clinic in village
Tenaga Baru	190	45	Same	Gravity feed system	Oil palm, rubber, fruits & vegetables	None (primary school in Keramuak Luar)	None (clinic in Keramuak Luar)
Kuamut	300	50	Same	River & rain	Cocoa, fruits & vegetables	Primary school in village	Clinic in village
Tangkuyan	614	60	>	River & rain	Cocoa, fruits & vegetables	None (primary school in Kuamut)	None (clinic in Kuamut)
Desa Permai	10	4	<	River & rain	Cocoa, fruits & vegetables	None (primary school in Tulang-Tulang)	None (clinic in Kuamut)
Tulang Tulang	60	30	<	River & rain	Cocoa, fruits & vegetables	Primary school	None (clinic in Kuamut)

(Notes: "Community" = Name of village. "Est. pop" = Estimated population size. "Est. Hse." = Estimated number of houses. "<>10Yr" = whether current population size is more, less or the same as 10 years ago. "Sources of water" = Principle sources of drinking water. "Main agriculture" = Main types of commercial and subsistence crops. "Education" = Location of primary school used by community. "Healthcare" = Location of closest healthcare provider.)

Population size is highly variable between communities, with the largest centres being the contiguous settlements of Keramuak Dalam and Keramuak Luar in the Keramuak cluster, and Tangkuyan and Kuamut in the Kuamut cluster (it should be noted however that the estimates given in the table above are generally inclusive of recent diaspora and are likely higher than the number of current permanent residents). Survey data reveal that the average number of inhabitants per household is similar between the Keramuak and Kuamut clusters (means = 5.25 and 6 respectively), but that there is also high variability in both cases (standard deviations = 2.26 and 1.87 respectively). It is common for several generations of the same family to occupy one household (including in-laws), and in some cases two separate families cohabit. Figure 4 indicates that gender ratios are well balanced across all age classes, and that there are significantly higher numbers of youths (birth to 20 years) than any other age class. Indeed, 65% of the surveyed population were under 30 years old, indicating a growing population. This may corroborate two claims which have frequently been made during community workshops and dialogues; firstly, that populations are increasing in the larger communities, and secondly that many younger people move out of communities after school

age due to lack of employment opportunities (it is assumed that the decline in age classes 21-40 are more likely associated with outmigration than mortality). It is however difficult to disaggregate the impacts of increased birth rates, outward migration and differential mortality among age classes; this could perhaps be a focus of more detailed studies of community demography in future.

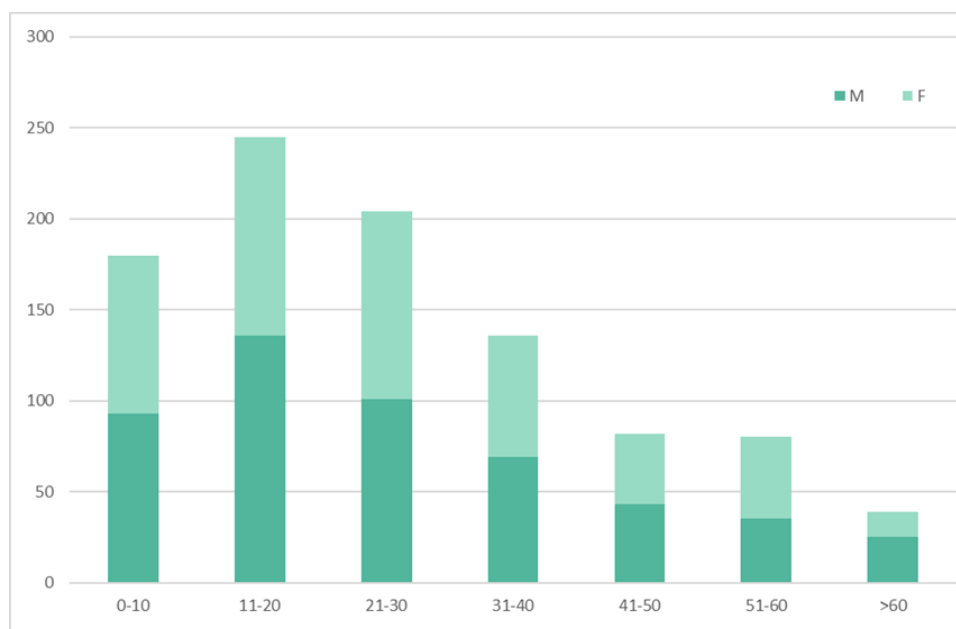


Figure 4. Distribution of population by gender and age class. Incorporates data from all communities combined since no major differences were found between clusters.

Several community clinics are available, although these are generally 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.

All communities have relatively easy access to primary school education, but secondary school students are forced to board at outside schools; usually in the closest urban centre of Tongod. Figure 5 shows the

educational attainment of all school leavers in the sampled population (those still in education or of pre-school age at the time of the surveys have been omitted from the analysis).

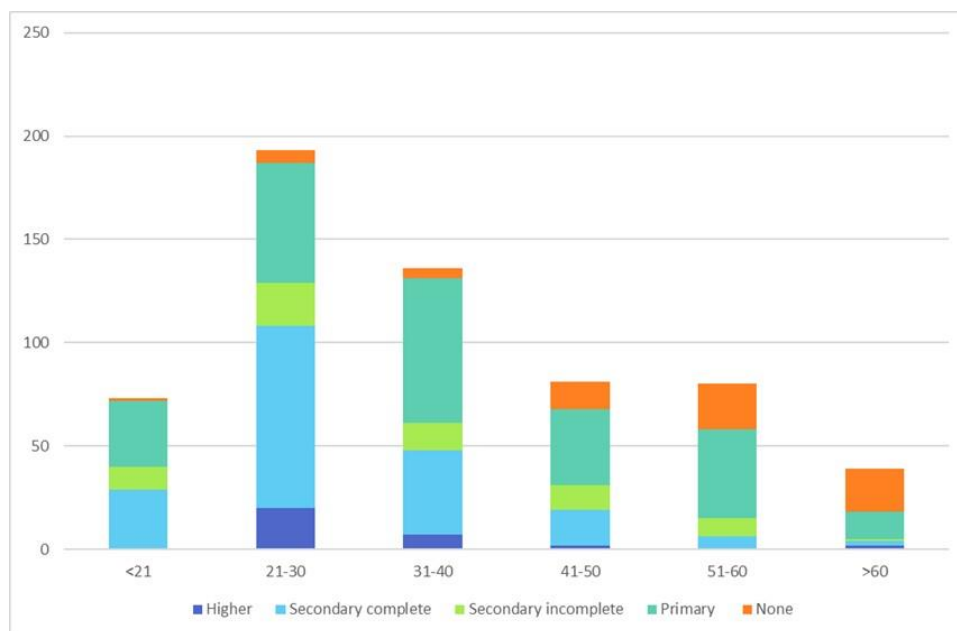


Figure 5 Educational attainment across age classes. "Higher" = University degree, college or higher-level diploma, "Secondary complete" = Completed STPM (UK A-Level equivalent) or SPM (UK GCSE equivalent), "Secondary incomplete" = Entered secondary school but did not graduate, "Primary" = Did not proceed beyond primary school, "None" = No formal education.

In most communities across Sabah, it is historically not uncommon for children to leave formal education upon the completion of primary school. This is frequently due to the distance from secondary schools (and the associated costs of supporting children at boarding schools) and the need for additional inputs in the family's agricultural production. Whilst this trend is noticeable in Keramuak and Kuamut, Figure 5 also indicates that rates of education are improving dramatically, with a large proportion of under 30s having completed secondary school and even tertiary education. This is in marked contrast with cohorts over 40, and the survey data indicate that the current rate of school dropouts (i.e. those who do not complete secondary education) is only 13.7%.

These trends are not consistent between the Keramuak and Kuamut clusters however, with a much lower overall proportion of adults in Kuamut having completed secondary school (13.3%) compared to adults in Keramuak (36.1%). This is likely to result from the more isolated location of the Kuamut villages and the difficulties in physical access to secondary schools, and possibly also due to lower general levels of income in Kuamut.

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 (and the few with specialized professions

such as clinic workers or local government officials), 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 350 (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 879 per month, although again there is very high variability), but many remain below the poverty line..

In the household surveys, respondents were asked to rate the relative importance of various subsistence and economic activities in terms of their overall contribution to livelihoods. Figure 6 indicates that commercial agriculture was considered a very important economic activity (slightly less so in the Kuamut cluster than the Keramuak cluster, perhaps for the reasons outlined above), whilst trade and paid work were considered rather less important. All communities indicated that they retain a high degree of dependence on various subsistence activities, including subsistence agriculture, gathering of river resources (fishing), and gathering of forest resources (hunting and collection of non-timber forest products). This subjective valuation of the relative importance of various livelihood activities corresponds well with the overall implications of the survey data presented in this and other sections.

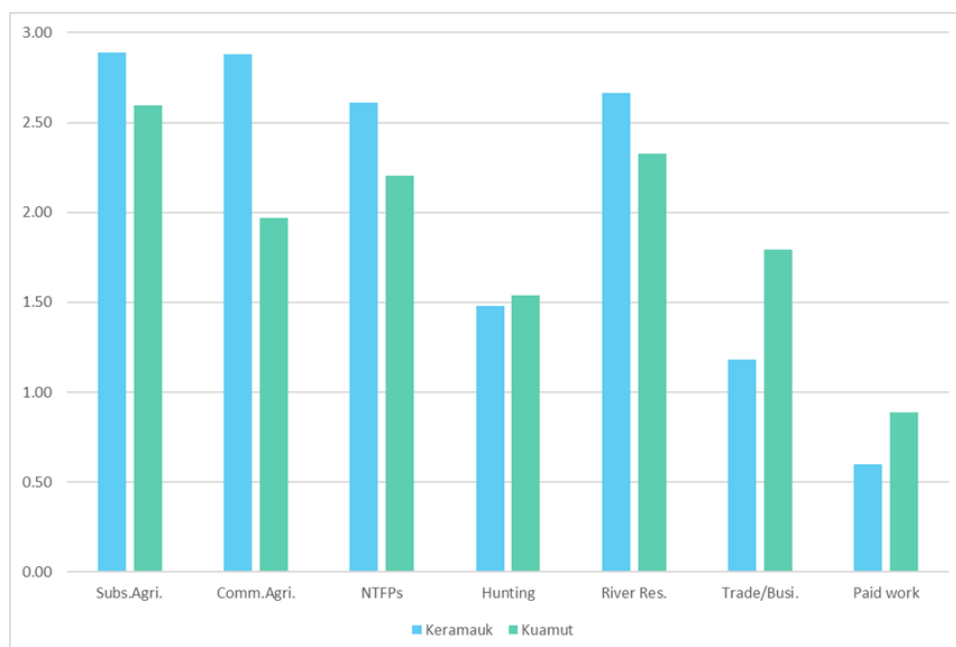


Figure 6. Subjective valuations of the relative importance of economic and subsistence livelihood activities. “Subs.Agri.” = subsistence agriculture, “Comm.Agri.” = commercial agriculture, “NTFPs” = non-timber forest products, “River Res.” = River resources, “Trade/busi” = Trade and local small business enterprises. Y-axis represents means of Likert values across all respondents for each category.

2.1.7 Project Zone Map (G1.4-7, G1.13, CM1.2, B1.2)

The project activities will include activities that are aimed at community livelihood improvement (see 2.1.11). The boundaries of the project zone therefore include the community areas and is shown in Figure 7.

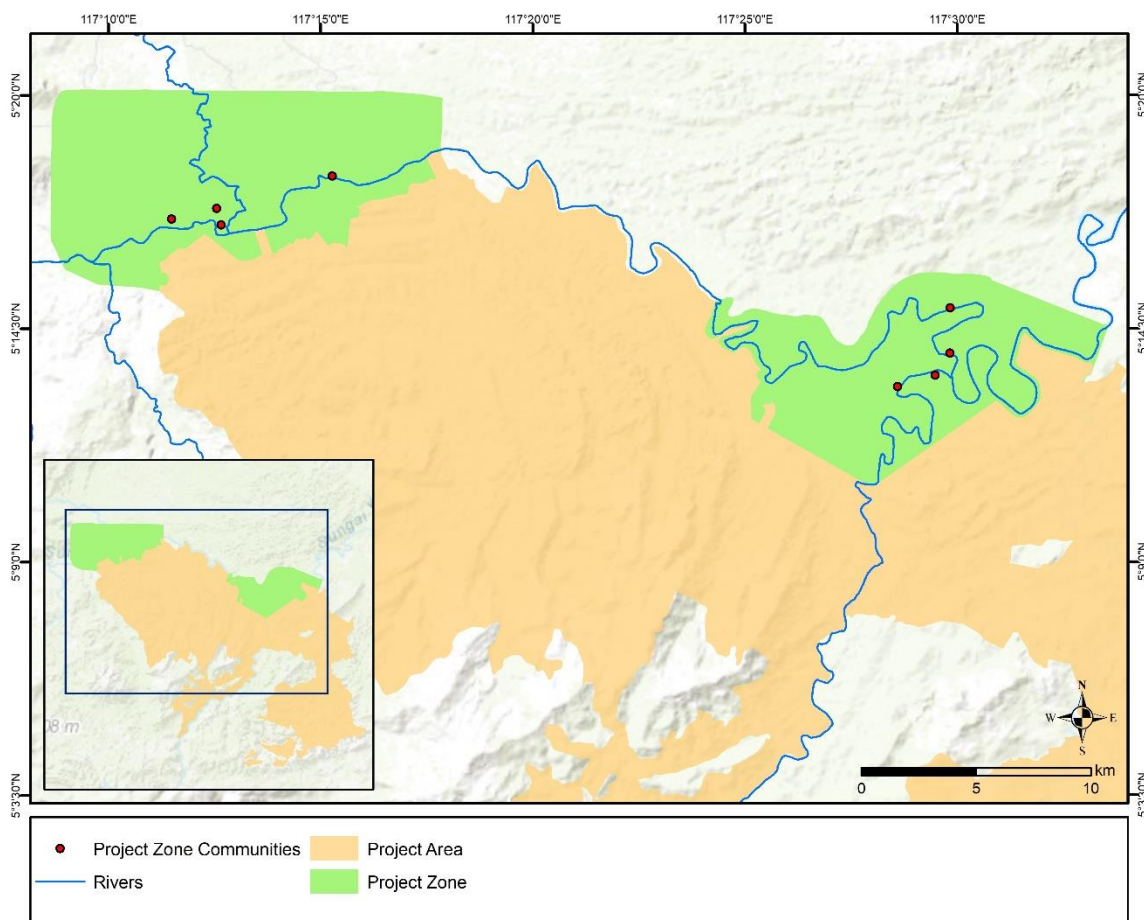


Figure 7: Project Zone

Although the community development activities are not expected to be negatively impacted by the activities, 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. Figure 8 - Figure 11 below show the HCV and agricultural areas identified by communities to date. 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.

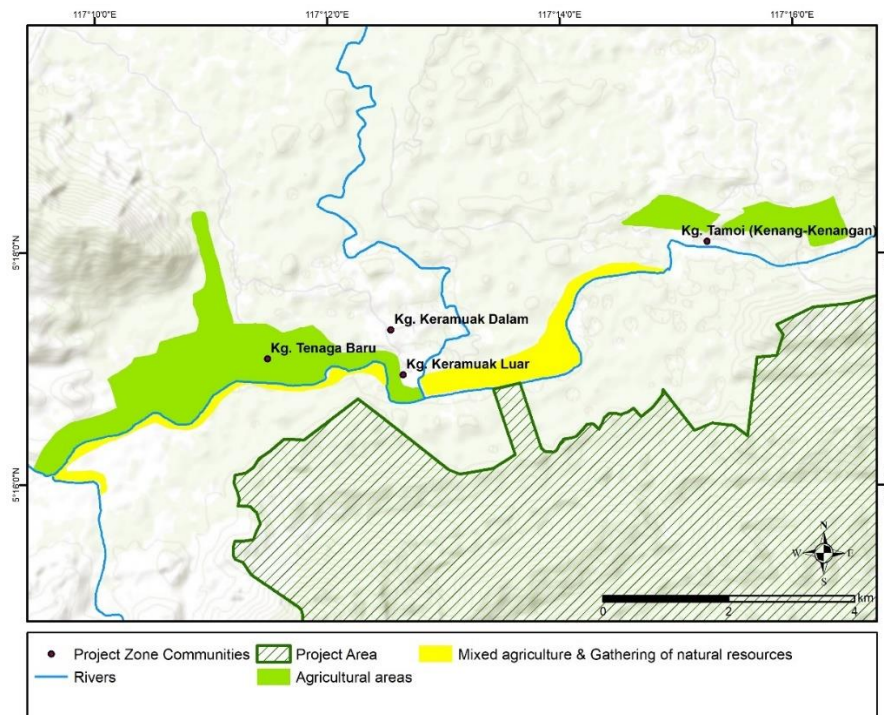


Figure 8: Current agricultural sites in the Karamuak cluster.

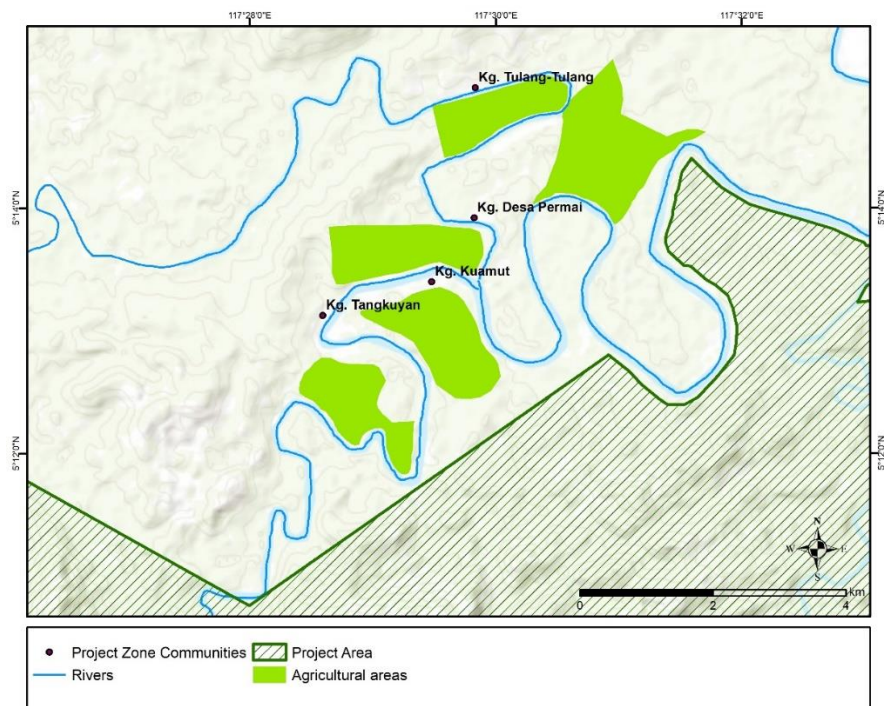


Figure 9: Current agricultural areas in the Kuamut cluster.

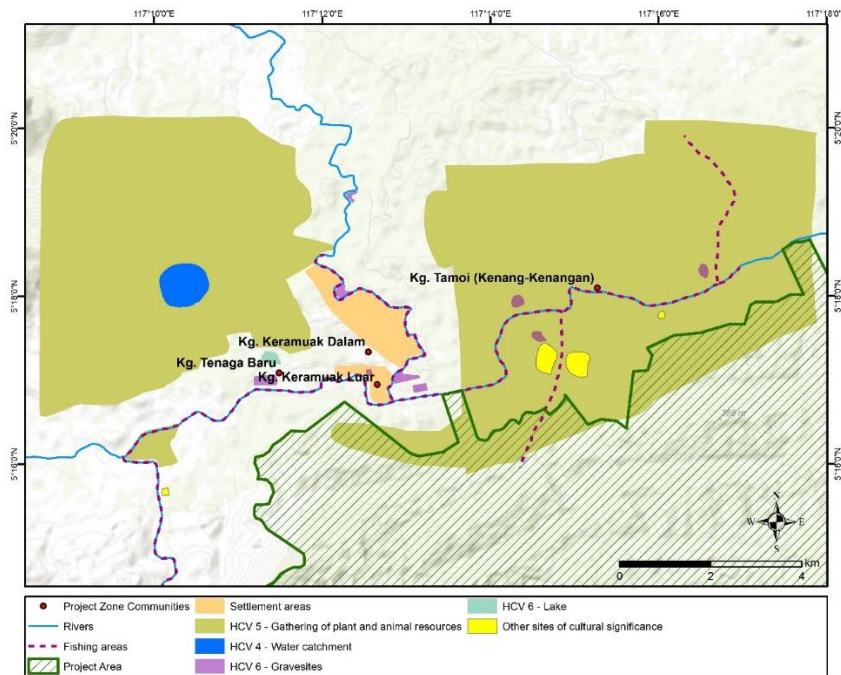


Figure 10: HCV areas in the Karamuak cluster.

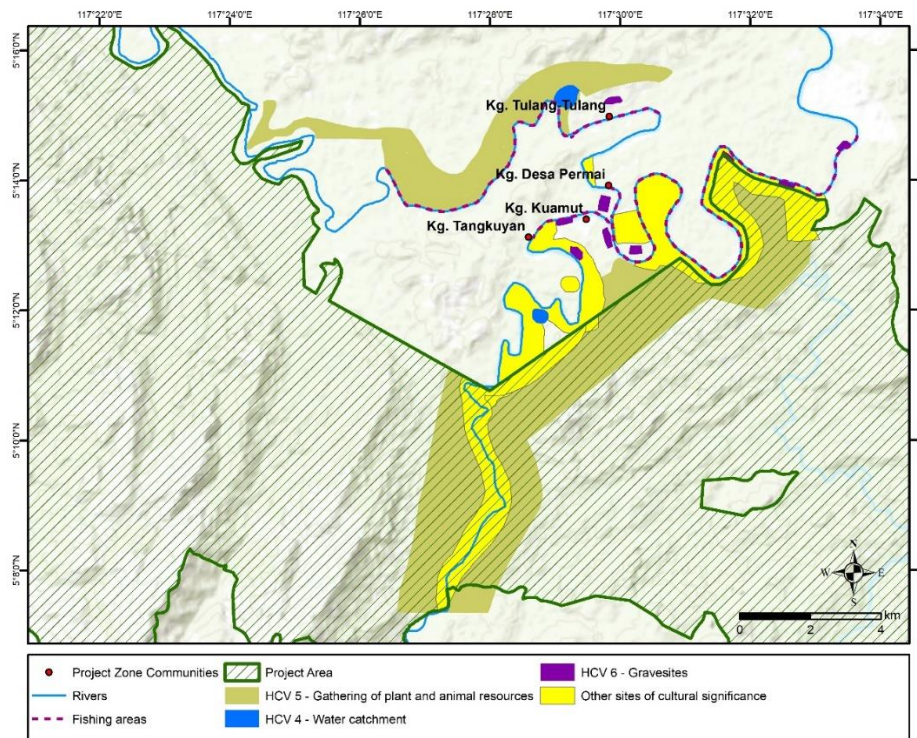


Figure 11: HCV areas in the Kuamut cluster.

In terms of offsite climate impacts, the only offsite climate impacts would occur in the areas considered in the leakage analysis. The leakage analysis considers all active logging concessions within the State of Sabah as indicated in Figure 12 below.

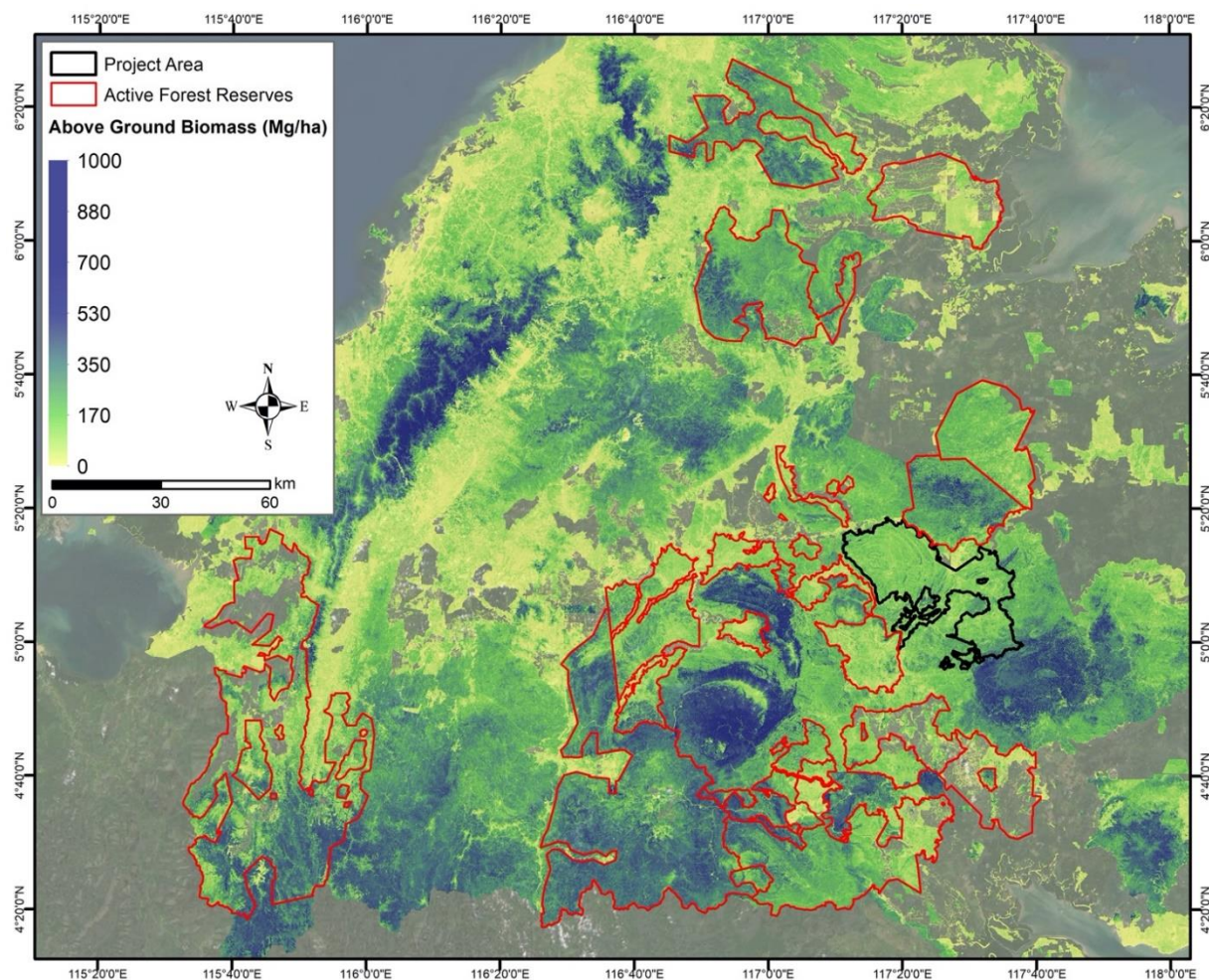


Figure 12: Active concessions in the state from 2010 to 2019, overlaid on Above Ground Biomass (in Mg ha⁻¹).

As discussed in section 4.3, no other stakeholders are impacted by the project and therefore there is no indication of other stakeholders impacted by the project on the maps provided here.

2.1.8 Stakeholder Identification (G1.5)

The project has sought to identify all stakeholders with a relationship to the project and to undertake an assessment of their rights, interests and relevance to the project itself. This assessment has included both institutional/non-community stakeholders (i.e. those with a relationship that is not simply based on proximity and/or use) and community stakeholders (those with a relationship based on proximity, tradition and/or current use).

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

Local community stakeholders were identified through two main approaches: 1) through consultation with the institutional stakeholders (as above) to elicit information on communities with close linkages to the project area, and 2) by a spatial identification of all communities within an initial search radius of 20km from the project area boundary. This initial search identified a number of villages, and once 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). The workshops were also used as a means to assess general community interactions with/dependence on the project area, discuss the principal threats and challenges faced by communities, and seek further consent to proceed with project activities aimed at establishing social baseline conditions. This process resulted in the identification of eight communities as direct project stakeholders, all lying in close proximity to the norther boundary of the project area. A further two villages that lay on the periphery of the initial 20km search radius were not identified as stakeholders after further investigation. In one such village (Kg. Imbak) initial meetings with community representatives indicated clearly that the community identified no stake in the project area. In the other (Kg. Balat), the distance from the project area by boat (the only means of transport available) is almost 40km (despite the village lying on the edge of the 20km radius), and testimony from other project zone communities suggested that residents of this area seldom access the project area. Both villages will be contacted again as the project proceeds to re-evaluate their potential involvement. No other villages lay within the 20km initial search radius (including to the eastern, southern and western borders). As a result, the project zone, as defined by those communities identified as stakeholders, was identified as the area including only those eight villages living to the north along the banks of the Kinabatangan River.

2.1.9 Stakeholder Descriptions (G1.6, G1.13)

Based on the stakeholder identification process described above, the stakeholder and their relevance to the project activities are listed in Table 2 below.

Table 2: Key project stakeholders and the rights, interest and relevance to the project

Stakeholder	Rights, Interest and Overall Relevance to the Project
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Confirmed project zone communities in Karamuak cluster and Kuamut cluster (Kg. Kuamut, Kg. Keramuak Luar, Kg. Keramuak Dalam, Kg. Tamoi, Kg. Tangkuyan, Kg. Tulang-Tulang, Kg. Desa Permai, Kg. Tenaga Baru).	Historical and current use of project area for subsistence natural resources, dependence on ecological provisioning services supplied by project area, potentially impacted by project activities. These communities were identified due to their proximity to the project area – within 20km radius - as shown in Figure 3 (section 2.1.6) The project activities will initially target the communities located in the Kuamut cluster in the first 1-3 years after project validation. Though project implementation, members from the communities of the Karamuak cluster will also be involved in activities related to patrolling and trainings to improve their capacities in agricultural practices, tourism and handicraft making, See section 2.1.11 and section 4 for detailed description of impacts to the communities.
Communities which may potentially satisfy the relevant criteria to be considered community stakeholders, but which are not currently involved in the project (Kg. Imbak and Kg. Balat).	Potentially the same as above, though this is currently considered unlikely to due physical distance from the project area. These communities were identified due to their proximity to the project area. These communities were not selected as they are located much further to the project area.
Sabah Forestry Department	Main project partner. Landowner, rights-holder and currently de facto manager of project area.
Rakyat Berjaya	Main project partner. Historically manager of commercial logging activities in the project area, current manager of substantial lands adjacent to the project area in the south and west.

Tongod District Office.	Has a stake in all matters pertaining to land and community development in the District of Tongod.
NGO Sector	Few local NGOs work in the project zone and area, however one group – PACOS Trust – which has a history of involvement in community issues within the wider region was identified as a potential stakeholder and supporter for the implementation of project activities with the communities.

2.1.10 Sectoral Scope and Project 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.

2.1.11 Project Activities and Theory of Change (G1.8)

The Kuamut Rainforest Conservation Project aims to conserve 83,381 ha of previously logged forest, which would have been subject to further timber harvesting in the absence of the project. The project is not located within a jurisdiction covered by a jurisdictional REDD+ program.

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. The project is designed to achieve this through a series of objectives, considered in turn below:

A) Climate objectives

- To deliver credible GHG emission reductions through avoided deforestation and forest degradation.
- To enhance ecological values at the landscape scale.
- To conduct research and development (R&D) activities as to implement the latest science, research and management practices.

B) Community objectives

- To enhance the quality of life and reduce poverty of the project-zone communities by creating sustainable livelihoods options and economic opportunities and generate new employment opportunities during the project implementation.

- To maintain and enhance ecosystem services for the overall well-being of the project-zone communities through ecosystem restoration.
- To conduct research and development (R&D) activities as to implement the latest science, research and management practices.
- To improve health services and education of community members.

C) Biodiversity objectives

- To eliminate drivers of deforestation and forest degradation and to stabilize and maintain healthy populations of faunal and floral species in the project zone through biodiversity conservation and protection.
- To maintain natural habitats and ecological integrity through ecosystem restoration.
- To conduct research and development (R&D) activities as to implement the latest science, research and management practices.

The objectives of the project will be achieved through a range of activities.

Forest protection

In order to protect the project area forests from fire, illegal logging, and illegal hunting, guard posts will be established at major access points, and supplemented by routine patrolling combined with on-going biodiversity and carbon monitoring (see sections below). Specifically, this will include:

Guard posts: Guard posts will be established progressively over the first 1-3 years of the project and will be positioned at the main access points to the project area. Each post will be manned by 2-4 staff working on rotation and will be equipped with all required facilities and satellite phone/radio as required. It is expected to establish at least 5 posts in the first years which will require 10 to 20 full time staff. All observations will be recorded, and access will be limited to those permitted to enter the project area legitimately. In addition to these guard posts, project offices will be opened in each of the two main village groups (Kuamut and Karamuak) to facilitate the community development program (see below) and to encourage community participation, collaboration and employment in the site protection work and patrolling.

Patrolling and monitoring: In addition to static guard posts, the project will undertake routine monitoring along major road and river access routes by car/motorbike and boat as required. Staff will also undertake periodic foot patrols, particularly along remote access points in the north where the project area borders state land. Patrol teams will be teams of 2-3 staff, supported by locally hired community team members. In total, it is expected to employ 20 to 30 staff for patrolling activities. Each will be equipped with GPS, camera and sat phone/radio as required. Initially the number of permanent patrol staff will be kept low, but the number will be progressively increased as the project develops. Permanent teams will also be supplemented by temporary additional staff as required. Where possible, routine or periodic patrolling will be combined with biodiversity and carbon survey work for cost-effectiveness.

Remote surveillance: The project will make extensive use of remote surveillance technology to enhance protection measures. This will include daily access to high resolution satellite imagery, capable of detecting disturbances such as illegal logging or clearance within 1-2 days of its occurrence. The project will also utilise remote camera trap technology to monitor access points, both overtly and covertly.

Natural Forest regeneration

By protecting degraded forests, the project will support natural regeneration within the project area. Currently the project area is a very complex mosaic of forest in a variety of conditions; ranging from almost entirely intact, to almost completely deforested. In between these extremes can be found a complete gradation of intermediate conditions, including areas dominated by pioneer tree species, climbers, scrub and grasses. Further, in some areas there appears to still exist a high density of tree seedlings of key species, whereas in other areas these appear to be lacking.

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. We will monitor natural regeneration using a combination of forest plots (within which we will assess a range of parameters including forest structure and the natural recruitment of tree seedlings) and high-resolution remotely sensed data. In areas where natural regeneration is incomplete, we will evaluate the possible benefits of supplementing natural regrowth with active restoration measures, including climber cutting and, if necessary, targeted enrichment planting in the most highly degraded sites.

Biodiversity conservation & monitoring

The project is committed to protecting and enhancing the biodiversity value of the project area. Currently this is very high, with regionally significant populations of a number of important and threatened species, including orangutan, banteng, elephant, clouded leopard, sun bear, and bird species including Helmeted Hornbill, Storms Stork, Bornean Peacock Pheasant. Measures to monitor and enhance biodiversity value will centre around forest protection and control of hunting threats. Considerable effort will also be focused on monitoring, conducted by the project staff itself and coordinated by SEARRP, either routinely in conjunction with other activities, or on a periodic basis making use of temporary staff and local community members as required. In addition, the project will seek collaboration with other interested parties, including local academic institutions and research centres.

Community livelihood improvement

A fundamental objective of the project is to instigate activities which deliver long-term net benefits to project zone communities. These benefits may be economic, developmental, associated with the safeguarding of traditional knowledge and cultural practices, or any combination of the above. Potential community activities have been identified in a participatory manner, by eliciting feedback from the communities themselves (in the form of multiple discussions during workshops and data from household surveys) with respect to the types of activities they are interested in pursuing and feel would be appropriate. Of approximately 10 types of activities proposed by communities to date, three are distinct in terms of their

high frequency of mention by respondents in surveys and their predominance in workshop discussions. These are:

Tourism: Principally river-based tourism activities focussing on sites of biocultural significance (mentioned by 42.9% of survey respondents).

Handicrafts: Commercial production of traditional products made from non-timber forest products such as rattans and bamboos, potentially cross-cutting with tourism activities (34.3% of respondents).

Agriculture: Technical and infrastructure assistance with developing various forms of sustainable subsistence and commercial agriculture (11.4% of respondents).

The proposed project activities will provide support for the implementation of the three activities mentioned above through:

- Training and capacity building in specific areas for developing eco-tourism in their communities, elaboration of handicrafts with value added and smart agriculture techniques.
- Identification of access to markets and marketing of their products
- Facilitate small processing facilities for the elaboration and value adding of handicrafts.

More specifically, for supporting agricultural activities, the project will promote sustainable palm oil cultivation practices within farmers dedicated to the production of palm oil, mostly in the Keramuak villages, while improvement of agricultural practices through smart agriculture techniques (e.g. shade cocoa, tillage, organic fertilizers, etc) will be promoted with the villages dedicated to rubber, cocoa and subsistence agriculture. Acknowledging the importance of road infrastructure to improve the accessibility to markets for the Kuamut villages, the project will coordinate closely with the local and regional authorities to identify the possibilities to improve the access to these villages and connect them to markets, in addition to the microfinance program described above and provision of small processing plants to add value to their products.

The above activities will be supported with a micro finance program to assist sustainable local development by supporting the development of small to medium sized businesses. A variety of mechanisms will be used, including the direct provision of microfinance to facilitating access to government-backed financing schemes and grants. When implemented directly by the project microfinance will typically be channelled through local community groups.

The microfinance development program will bring about community benefits by empowering women, encouraging effective and transparent financial management, and nourishing entrepreneurship among the project-zone communities.

The Kuamut project will also employ at least 40 people from the communities nearby, particularly from the Kuamut cluster aiming to include at least 50% women. The project activities that would require local hire

include the restoration of riparian reserves to improve water quality, patrolling activities and nursery maintenance and management.

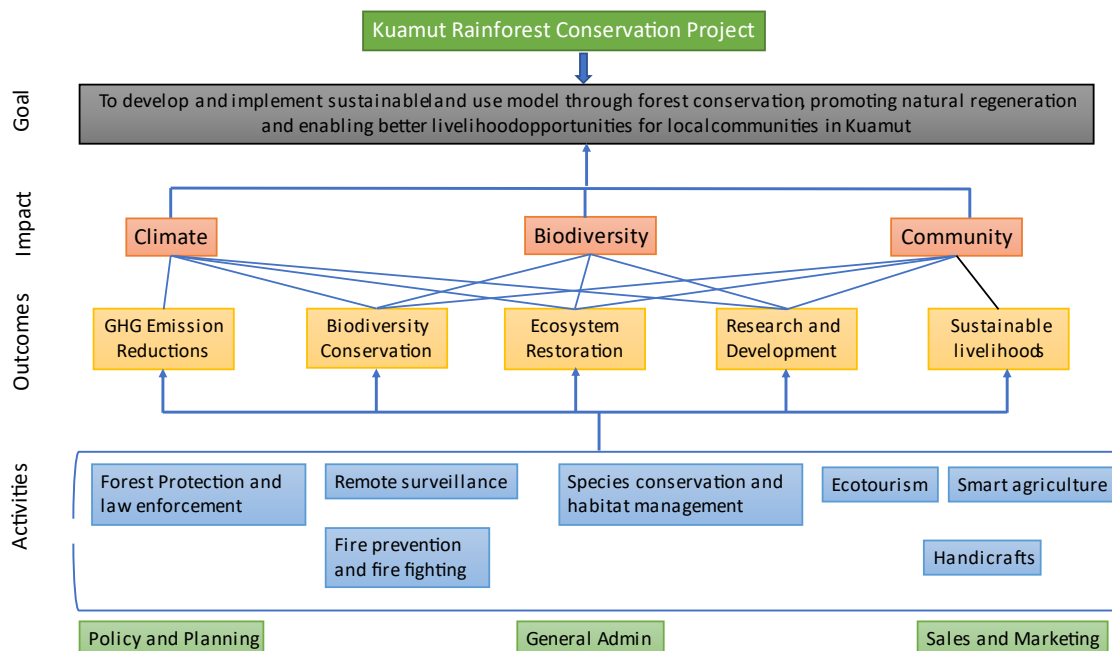
As described above, the project-zone communities only have close access to very basic health care. The Kuamut Project will seek to improve this by working closely with local government to improve access to public services and to assist local government in providing health education at the village level. Through project implementation, community members will be allowed to access to the health services established for the project team onsite. The Kuamut Project will also seek to improve local sanitation practices, including the common practice of discharge of all waste into local rivers, which are in turn used for cooking, drinking and bathing. The Kuamut Project will work with the villages together with local government agencies to bring awareness about and improve sanitation in each village, increase access to clean drinking water, and develop waste treatment facilities in each village. A more detailed analysis will be conducted through project implementation to potentially support the installation of piped water for the communities in the Kuamut cluster.

In regard to improving education, the Kuamut Project aims to support the local government's efforts to improve the quality of basic education and the number of enrolment and encourage the youth to pursue higher education. The project will implement an open competitive scholarship program to provide funding to selected students and will assist to develop facilities at local schools. Capacity building and educational workshops for teachers will be conducted as well through various training programs.

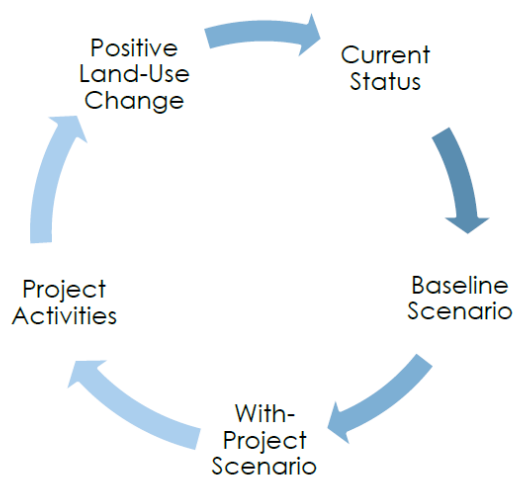
The basic education program will benefit the project-zone communities as they will have increased access to quality education.

It is important to highlight that further consultations will be conducted to update community needs and benefits through participatory and iterative process prior to the implementation of any community development activities in the project zone.

Theory of change



Causal relationship of project activities



2.1.12 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 3. All project data is available to support monitoring efforts at the provincial and national levels.

Table 3: 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 8: Decent work and economic growth	Direct employment of local people, and support for local enterprises
SDG 12: Responsible consumption and production	Commitment and extensive activities to promote sustainable agriculture and agroforestry in villages in the project area
SDG 13: Climate Action	Central objective. Anticipated average avoided emissions of 543,049 tonnes of CO ₂ equivalent annually
SDG 15: Life on Land	Protection and regeneration of natural forests, supporting biodiversity

2.1.13 Implementation Schedule (G1.9)

Date	Milestone(s) in the project's development and implementation
20-Mar-2012	Permian first meeting with Sabah Forestry Department to discuss carbon project development in Sabah
11-Nov-2013	MoU between Permian and Sabah Forestry signed and announced (including Kuamut)
July 2014	Presentation to Sabah Forestry Department concerning Kuamut
Feb-2014	First field work

08-Aug-2014	Formal proposal for Kuamut Project sent to Sabah Forestry Department and Yayasan Sabah
16-Mar-2015	Project area options maps produced by RBJ and submitted to Sabah Forestry Department
27-Mar-2015	Final project area clarified by Sabah Forestry Department to RBJ and Permian (meeting + emailed meeting note, maps shared at meeting)
11th Dec 2015-	Sabah Forestry Department converted the first 69,454 ha into a Class 1 Forest Reserve which sets the start date of the project.
8 th Dec 2016	Sabah Forestry Department added an additional 13,927 ha to the Class 1 Forest Reserve
2016-2017	Community survey and social baseline
2022	Project validation
2022	Community re-engagement (assuming that COVID restrictions and safety measures are in place)
2022-onwards	Implementation of Community livelihoods improvement activities
2022-2023	Establishment of guard posts, recruitment and training of rangers
2022-2023	VCS/CCB monitoring events and reports generated
2023	Project VCS/CCB Verification
2023	Project Verification Report dissemination
2023	Nursery establishment
2028	Project VCS/CCB Verification
2028	Project Verification Report dissemination
2029	Baseline renewal
2030	Project VCS/CCB Verification
2030	Project Verification Report dissemination
2035	Project VCS/CCB Verification

2035	Project Verification Report dissemination
2040	Project VCS/CCB Verification
2040	Project Verification Report dissemination
2045	Project VCS/CCB Verification
2045	Project Verification Report dissemination

2.1.14 Project Start Date

Following the VCS definition, the project start date is the date on which activities that lead to the generation of GHG emission reductions or removals are implemented. 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.

The project start date is therefore December 11th, 2015, which is the date the first 69,454 ha were converted into a Forest Reserve, and therefore this date will be used as the calculation base for the historical reference period required for setting a baseline scenario, and for the project crediting period as required by the methodological standards of the VCS guidelines.

2.1.15 Benefits Assessment and 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 1st December 2045. The project crediting period is renewable.

2.1.16 Differences in Assessment/Project Crediting Periods (G1.9)

There is no difference between the GHG emissions accounting and the community, and/or biodiversity assessment and periods.

2.1.17 Estimated GHG Emission Reductions or Removals

Year	Estimated GHG emission reductions or removals (tCO ₂ e)
2016	571,929.05
2017	616,953.10

2018	621,917.21
2019	721,571.60
2020	753,289.67
2021	773,559.90
2022	725,057.74
2023	725,057.75
2024	775,985.22
2025	874,703.62
2026	798,784.91
2027	742,268.34
2028	776,318.41
<u>2029</u>	<u>575,302.07</u>
<u>2030</u>	<u>475,793.57</u>
<u>2031</u>	<u>411,779.22</u>
<u>2032</u>	<u>450,636.03</u>
<u>2033</u>	<u>469,360.06</u>
<u>2034</u>	<u>449,039.77</u>
<u>2035</u>	<u>375,255.76</u>
<u>2036</u>	<u>328,577.32</u>
<u>2037</u>	<u>277,338.68</u>
<u>2038</u>	<u>193,301.15</u>
<u>2039</u>	<u>254,059.20</u>

<u>2040</u>	<u>364,522.39</u>
<u>2041</u>	<u>390,382.61</u>
<u>2042</u>	<u>424,573.60</u>
<u>2043</u>	<u>519,369.51</u>
<u>2044</u>	<u>434,568.52</u>
<u>2045</u>	<u>420,232.59</u>
Total estimated ERs	<u>9,477,396.52</u> <u>16,291,488.57</u>
Total number of crediting years	<u>13 (out of 30 total)</u> <u>30</u>
Average annual ERs for 2016-2028	<u>729,030.54</u> <u>543,049</u>

2.1.18 Risks to the Project (G1.10)

Identify Risk	Potential impact of risk on climate, community and/or biodiversity benefits	Actions needed and designed to mitigate the risk
Natural Risks	Natural risks to the climate change benefits of the 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. 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. Natural risks to the biodiversity benefits of the project are	The overarching objectives of the project include the conservation and restoration of forest ecosystems which would enable reducing the natural risks. Furthermore, the project activities will also include early detection of fires through real-time monitoring system, although there are no records of fire occurrence in the project area neither the project zone.

	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	Potential human-induced threats to the project's climate benefits are considered likely, both in the short and medium term. Potential risks include anthropogenic fire, encroachment and illegal logging (loss of above ground biomass). 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 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. 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.	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. 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 health services and access to clean water (see 2.1.11 and section 4) 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 monitoring of hunting impacts 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.

Political risk	A possible risk could also include changes in the decision by the government of Sabah to revert the concession to logging activities which would prevent the project to take place.	The government of Sabah acknowledges the importance of biodiversity conservation as confirmed by the implementation of the Sabah Biodiversity Strategy 2012-2022 ¹ , which is a 10-year strategy that charts Sabah's commitment and contributions to fulfil the pledge made by Malaysia to implement the CBD. There is little risk that the concession is reverted due to changes in policy as the proposed project contributes to the continuation of the implementation of the Sabah Biodiversity Strategy 2012-2022. <i>To mitigate any possible risk, a management agreement was signed between The State Government of Sabah, Permian Malaysia SDN. BHD and Rakya F Berjaya SDN BHD on August 6th 2021 which stipulates the conditions to grant the rights to Permian Malaysia to implement a forest carbon project in the project area</i>
Financial risk	The possibility of a lack of financial resources for the project implementation is low.	The start of project activities and monitoring will be undertaken with the financial contribution from Permian Global Research which will later be covered entirely by the revenues generated by the project through Permian Malaysia Sdn. At the time of the validation, the PP has secured commitments for forward purchases of carbon offsets from the Kuamut project which secures the budget availability for the implementation and monitoring of the project.

2.1.19 Benefit Permanence (G1.11)

The 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 effective protection status of the forest is anticipated to be maintained and extended, either through further licenses or

¹ <https://sabc.sabah.gov.my/sites/default/files/uploads/attachments/2020-05/Sabah-Biodiversity-Conservation-Strategy.pdf>

enhanced legal protection from the state as the global importance of the stored carbon stocks and biodiversity are fully recognised as a result of the project. In parallel the actions of the project to restore degraded areas 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. In this way the Kuamut Rainforest Conservation Project will contribute to wider region managed more sustainably with respect to carbon emissions, biodiversity conservation and equitable development of local communities.

2.1.20 Financial Sustainability (G1.12)

To evaluate the financing requirements for carrying out the activities proposed in the project and guaranteeing its execution and sustainability, this analysis identifies the initial investment required by the project, the continuing expenditures and human resources and the relevant sources of financing. This information is consolidated in a flow of funds which will allow to identify relevant project economic information. For the construction of the flow of funds, several steps were followed:

- **STEP 1. Parameters for estimating projections and establishing the project time horizon:** the project time horizon is the period during which the cash flow will be projected, which is determined by the characteristics of the project and which for the specific case is 20 years, starting in base year 2022 (date of validation and first verification) and culminating in 2041. Projections of income and expenditure were made year by year in accordance with the long-term inflation target of Malaysia, which is currently set at 2%. On the other hand, the exchange rate projection was adjusted according to the expected devaluation.
- **STEP 2. Estimation of income:** income corresponds to the resources obtained from the projection of the sale of carbon credits annually, subject to a sale price, which is established in accordance with the supply and demand conditions of the market. In addition, revenues can be obtained through external financing or sources of financing from private actors, local and regional governments. Income from sales has been estimated in US Dollars.
- **STEP 3. Estimation of capital investment:** this is the capital required for the implementation of the project. This item is classified into depreciable fixed assets and non-depreciable fixed assets. Depreciable fixed assets are subject to a loss in value over time and for the project include a base camp, field equipment, computers and software, vehicles, office equipment and fittings. This loss in value of the asset or depreciation was calculated using the method known as the straight line which, given its simplicity, allows the calculation of a fixed annual depreciation quota and consists of dividing the value of the asset by its useful life. Non-depreciable fixed assets such as land do not lose their value, but the purchase of land is not considered for the project. Ongoing and replacement capital expenditure is considered throughout the life of the project.
- **STEP 4. Estimation of costs:** this corresponds to the calculation of expenditures necessary to develop the planned activities of the project. The costs were classified into fixed costs and variable costs. Fixed costs are those that are generated regardless of the number of carbon credits issued by the project: professionals who carry out the project and technical activities (directors, biologists,

environmental technicians, community workers and agronomists). In the case of variable costs include items such as travelling costs, insurance, office supplies, repairs and maintenance.

- **STEP 5. Calculation and projection of the flow of funds:** once the previous calculations were made the flow of funds was constructed in which the expenses of the income of the project were subtracted from the concept of investments, costs, expenses and depreciation. The result obtained was the profit before taxes, which after subtracting the income tax at the expected standard rate resulted in the net flow of funds after taxes. This result indicates the needs or resource requirements for the project.

STEP 1. Parameters for estimating projections and establishing the project time horizon

The economic analysis of the project was estimated considering parameters such as the discount rate (rate at which future flows are discounted or brought to present value), devaluation (decrease in the value of the national currency with respect to a foreign currency), social benefits, and the useful life of machinery and equipment.

Description of parameters used for financial analysis.

Parameters	Value
Net Present Value	Positive
Loan interest rate	10%
Discount rate	15%
Inflation rate	2%
Depreciation method	Straight line
Useful life of base camp, field equipment, office equipment and fittings	10 years
Useful life of vehicles, computers and software	5 years

STEP 2. Estimation of income

The source of income is projected from the sale of carbon credits.

Source of Income 2022 - 2041

Sources of annual income	Cumulated 2022-2041 (USD)	Share of total income (%)
Sales of carbon credits	140,000,000	100%

STEP 3. Estimation of capital investment

Investment in the project is mainly represented by field equipment (3%), infrastructure and equipment (79%), the construction of base camp (cabin office/guard post) (5%), vehicles (11%), computers and software (2%), purchase of office equipment and fittings (<1%). These assets are not intended for sale and are intended for the development of the administrative activities of the Project. These will be appropriately secured, maintained and monitored throughout the life of the project.

Investment budget 2022 - 2041.

Depreciable fixed assets	Cumulated 2022-2041 (USD)	Share of total fixed assets (%)
Field equipment	117,000	3%
Infrastructure and equipment	3,175,000	79%
Base camp (cabin office/guard post)	209,000	5%
Vehicles	426,000	11%
Computers and software	84,000	2%
Office equipment and fittings	14,000	0%
Total fixed depreciable assets	4,025,000	100%

These fixed assets were depreciated at a fixed annual rate using the straight-line method. The useful life of the assets was estimated 10 years for infrastructure and equipment, field equipment, base camp, office equipment and fittings and 5 years for vehicles and computers and software. Depreciation per asset was estimated using the following equation:

$$\text{Depreciation (annual)} = \frac{\text{Asset value}}{\text{Useful life in years}}$$

STEP 4. Estimation of costs

The main costs are associated with the salaries of the professionals in charge of the implementation of the project activities. The salary structure calculated in the project corresponded to the estimated expenditure for salaries, social security and benefit charges established by law. The annual projection was based on the inflation target of Malaysia.

Costs projection 2022 - 2041.

Description	Cumulated 2022-2041 (USD)	Share of total costs (%)
Protection and Enforcement	5,600,000	12%
Policy and Technical Planning - MRV	8,700,000	19%
Ecosystem Restoration & Carbon and Biodiversity	4,800,000	10%
Community Development	6,000,000	13%
Training, Research and Development	1,300,000	3%
Communication	3,000,000	6%
Project Management	6,200,000	14%
Operation & Logistic	5,600,000	12%
General Administration	4,500,000	10%
Total	45,700,000	100%

STEP 5. Calculation and projection of cash flow

The Net Cash Flow (NFF) is the report that allows us to show in a clearer way the requirements of financing and investment in the project, since it visualises the incoming and outgoing money reported by the project during a period of 20 years. The main source of income for the project comes from sales of credits, which will be used to cover the costs and expenses associated with the implementation of project activities.

The results of the net flow of funds show that the project can cover the implementation costs of the project and, therefore, for all the years of the analysis period, the NPV is positive.

The information presented here is evidence of the financial position that the project presents for its correct implementation. Regular analysis of the financial performance of the project is planned, including comparison to budget to ensure that spending levels are maintained in line with projections. A summary analysis of the cash flow is presented below.

Cashflow	Cumulated 2022-2041 (USD)
Cash from Operating Activities	117,000,000
Working Capital Requirement (Opex)	(42,000,000)
Working Capital Requirement (Capex)	(4,000,000)
Corporation Tax Payment	(17,000,000)
Net Cash Flow After Tax Before Financing	54,000,000

Debt Financing	5,000,000
Loan Repayment	(5,000,000)
Loan Interest	(1,000,000)
Cash from Financing Activities	(1,000,000)
Net Cash Flow After Financing	53,000,000

2.1.21 Grouped Projects

Not applicable, not a grouped project

2.2 Without-project Land Use Scenario and Additionality

2.2.1 Land Use Scenarios without the Project (G2.1)

Prior to the start of the project, the project area was designated as production forest (Class II). The area had been repeatedly logged since the mid-1990s and as a result the area is now a complex mosaic of forest in conditions ranging from intact to highly degraded. The most likely land use scenario without the project would have been a combination of different forest management practices. This scenario and other possible scenarios are further discussed in sections 3.1.4 and 3.1.5.

Because of the project, the area has been converted from a Class II production forest to a Class I protected area. This shows that the project has not been implemented to generate GHG emissions for the purpose of their subsequent reduction, removal or destruction.

2.2.2 Most-Likely Scenario Justification (G2.1)

Please refer to section 3.1.4 and 3.1.5 for a justification of the land use scenario without the Projects and the other land use scenarios considered.

2.2.3 Community and Biodiversity Additionality (G2.2)

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.²

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.³ 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,

With respect to the potential community activities described in section 2.1.11, some of the major obstacles to the implementation of these activities identified by communities themselves (during workshop discussions and in household surveys) are 1) a lack of expertise, technical knowledge and skills, 2) lack of access to external markets and potential partner organisations, and 3) a lack of start-up capital and options for microfinancing. The project will seek to either provide these services directly or leverage them from elsewhere, as appropriate. There are not known to be any alternative mechanisms by which project zone communities could receive similar assistance at the present time.

The without-project scenario entails the continuation of commercial logging and mosaic planting operations within the project area, with concomitant negative impacts on native biodiversity. By uplifting the legal designation of the project area to a Class I Forest Reserve, forest habitats and natural ecosystems enjoy full legal protection under the Sabah Forest Enactment (1968). The protection of the project area from future disturbances, together with potential rehabilitation activities under the project, can be expected to generate positive impacts for faunal and floral diversity which would not have occurred under the without-project scenario.

2.2.4 Benefits to be used as Offsets (G2.2)

None of the expected community and biodiversity benefits are intended to be used as offsets. Only the climate benefits derived by the project will be use as offsets. Stakeholder Engagement

² Sabah's unrelenting exclusionary and inclusionary politics Vilashini Somiah & Jose Ricardo Sto. Domingo s. Rajaratnam School of International Studies Singapore 5 May 2021. <https://www.rsis.edu.sg/wp-content/uploads/2021/05/WP334.pdf>

³ Ibrahim, Zawawi. "The new economic policy and the identity question of the indigenous peoples of Sabah and Sarawak." The New Economic Policy in Malaysia—Affirmative Action, Ethnic Inequalities and Social Justice (2013): 293–313.

2.3 Stakeholder Engagement

2.3.1 Stakeholder Access to Project Documents (G3.1)

The Kuamut project has held a series of community engagements during which the project objectives and structure were explained and discussed. 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 as biodiversity, carbon sequestration, global warming and the principles of FPIC. These brochures have been given to community leaders who were 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.

2.3.2 Dissemination of Summary Project Documents (G3.1)

As mentioned in section 2.3.1, the project start date, the project description and background information on underlying key concepts has been prepared in the Malay language and disseminated among communities in the form of brochures. In future, summary information of key project documents will be prepared in the Malay language and disseminated among communities in printed format. These will include, *inter alia*, summary findings of the social baseline assessment, the project PD, monitoring reports, a schematic for the project's grievance and redress mechanism, and any other appropriate documentation which may be requested by communities.

2.3.3 Informational Meetings with Stakeholders (G3.1)

Since the inception of community engagements in late 2017, the project has 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. Engagement sessions of this type are generally organised together with community leaders, who then publicise the engagements in their respective communities and encourage participation.

Furthermore, the project has conducted an extensive series of household surveys to provide data on the community socio-economic baseline. At the beginning of each individual interview conducted as part of these surveys, respondents are again given a brief overview of the project structure and objectives, and are asked for their consent before the interview proper is initiated.

Table 4 below gives an overview of all engagement activities which have been undertaken to date. Further information on informational meetings with community stakeholders is given in a community process report. In future, records of all engagements (workshop reports, attendance sheets, etc) will be made available in the project's database.

Table 4: Project community engagement and data collection activities.

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.	Kg. Tamoi
1/12/18	Field observations	Field observations of sites of community importance in Project Area near the Kuamut cluster, including	Kg. Kuamut, Kg. Tangkuyan

		abandoned villages (Kg. Tangkong & Kg. Pagar), and disused road	
2/12/18	Community workshop	Third workshop with the four communities in the Kuamut cluster. 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. 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
February 2019	Household interview surveys	Household surveys conducted in Kg. Tamoi. Consent was obtained from interview subjects individually before commencing each interview.	Kg. Tamoi

It should be noted that engagements between the project and project zone communities have largely halted since the end of 2018, with the exception of household interview surveys which were conducted in early 2019. This occurred initially due to federal and state elections held in 2018, which led to a widespread political upheaval across Malaysia as government ministries were dissolved and reformed, departmental policies altered or replaced, and leadership positions reassigned across all levels of government. These sweeping changes impacted governmental and government-affiliated project partners such as the Sabah Forestry Department and Yayasan Sabah, as well as local administrative bodies such as the Tongod District Office (under whose purview the project zone is located). Moreover, these changes had direct ramifications for community leadership, since all Village Heads (Malay: *Ketua Kampung*) and Chairmen of Village Safety & Development Committees were rescinded (these positions are both appointed by governmental committees in Sabah). There ensued a lengthy period throughout most of 2019 during which the project zone communities had no officially sanctioned leadership at all, and communities themselves requested that the project refrain from further community-level engagements until this situation had been resolved.

Since early 2020, inter-district travel has been largely prohibited in Sabah owing to Covid-19 restrictions, and most communities have isolated themselves and disallowed entry to non-community members. There are thus additional ethical considerations at the present time with respect to minimizing risks of community exposure to Coronavirus.

For the above reasons, by the time of validation the project will need to re-establish engagements with communities, whilst mitigating risks of Covid transmission and re-evaluating the relationship between the project and communities in light of new leadership structures.

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

The project considers transparency in all aspects of its design and implementation to be of paramount importance, and considerable efforts have been made to ensure that information is communicated with communities in a form that is both comprehensive and culturally appropriate. Communities have been made aware that whilst the project will strive to deliver net benefits in the form of support for community activities (Section 2.1.11), there may be attendant risks inherent in committing to such activities (e.g. opportunity costs, etc).

The project is yet to implement any major activities with communities, but in due course will ensure that appropriate diligence is taken to identify any potential negative impacts through participatory processes and to develop appropriate measures to mitigate against those impacts.

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

Communities have been informed about the process of CCB validation and verification during multiple community workshops and in the form of informational materials such as brochures. Further information will be provided in similar forms once the validation stage has been reached.

When future verification events take place, communities will be informed of the timing of external audit visits well in advance and provided copies of the relevant documents (including translations in Malay).

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

Future visits to communities by external validation and verification auditors will be organised jointly with community representatives, who will assist with coordinating travel logistics, meeting venues, and informing the wider community about the visits. They will be encouraged to speak directly to the auditors, and to freely voice any opinions they hold regarding the project. They will also be informed as to how they can provide written comments via the grievance process (see below) or via the CCB website and public comment period. During the field visit, project staff will work with the communities and auditors to schedule time for the two to interact without project staff present.

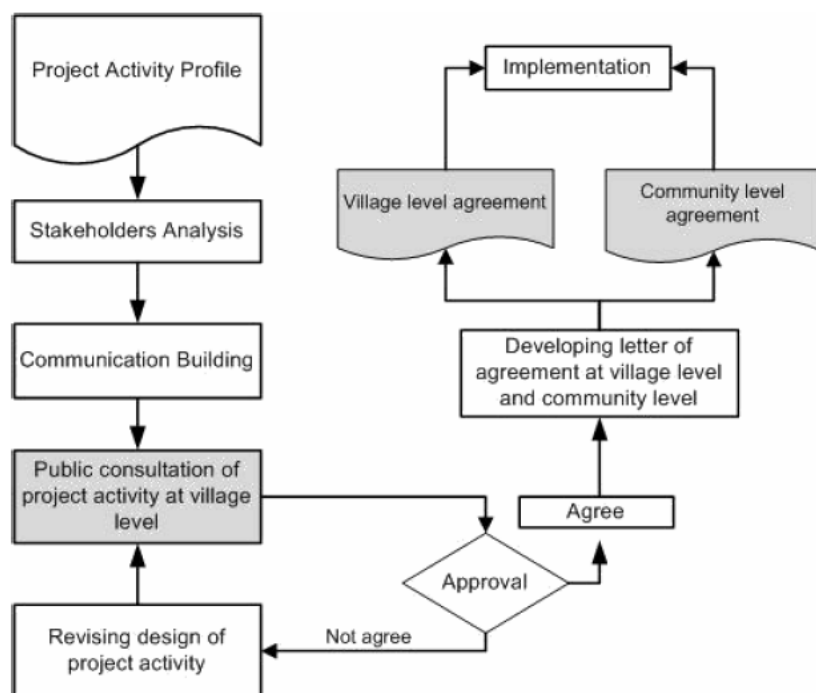
2.3.7 Stakeholder Consultations (G3.4)

As described in Section 2.3.3, the project has conducted 11 separate workshops and other meetings with village community stakeholders, reaching over 488 participants. A full list of such meetings is provided in Table 4 in Section 2.3.3. During these engagement events, frequent discussion sessions are held in which community members are asked to give input concerning the most appropriate forms of assistance the project could potentially offer – indeed all the activities mentioned in Section 2.1.11 are derived from discussions with (and data provided by) the communities themselves and are not imposed by the project. Moreover, the project seeks to ensure that all potential activities are designed specifically for each individual community; recognising inter-community diversity in terms of aspirations and the suitability of different interventions.

2.3.8 Continued Consultation and Adaptive Management (G3.4)

As above, the project community engagement process focuses on regular workshops and meetings during which community participants are encouraged to shape how engagements should be conducted in the future - establishing an iterative process in which the structure of engagements is predicated both on project needs and community preferences. The project will continue to conduct community interactions in a flexible and responsive manner, responding to changing community circumstances by adapting project activities and modes of engagement.

Following the FPIC principles, the project will ensure continuous dialogues with the communities around the project area through an iterative process as presented in the diagram below:



The following steps will be undertaken to implement such process in line with the internal FPIC protocol after identification of the relevant stakeholders around the project:

ENGAGEMENT WITH THE COMMUNITIES

1. Ensure that all materials used for public engagement are translated into local languages and understandable by non-technical experts.
2. Document the process of engagement with indigenous peoples' and local communities' representatives. Documentation should include:

- a. a timeline showing, at a minimum, when the process of engagement began relative to initial project planning and design; the process of engagement with non-indigenous government authorities; and the process of application for and acquisition of permits; and,
 - b. a record of correspondence and meetings that took place between the project developer and indigenous communities and their representatives.
3. Document the process of engagement with informal leadership and the broader public. Documentation should include:
 - a. a record of correspondence and meetings that took place between Permian's project team and informal leadership;
 - b. the dates, locations, and attendance of meetings that were open to the public;
 - c. the mechanisms through which the meetings were made known to the public; and,
 - d. any other opportunities for input from the broader public (i.e. comment processes or government-led consultations).
4. Specify how the process of engagement addresses marginalized groups within the community such as elders, women and youth.
 - a. Address to what extent the developer's process was inclusive of the entire community's needs while seeking consent.
 - b. Specify through which mechanisms the developer creates space for public participation via meetings, comment periods, or other mechanisms.
5. Provide materials about the project that have been distributed to the indigenous peoples', local communities, government(s), informal leadership, and the broader public.
6. Disclose any financial or nonfinancial compensation provided to community members as part of the engagement process.
 - a. Disclose any conflicts of interest that have arisen or may arise.
7. Disclose a summary of feedback from impacted indigenous peoples and local communities in response to the process of engagement. The summary should include:
 - a. the indigenous peoples' or local communities' representative's position on the project;
 - b. feedback received from informal leadership and the broader public;
 - c. indicators of divisiveness within the community; and,

- d. indicators of opposition such as negative media attention, legal actions, or protests.

AGREEMENT AND POST-AGREEMENT RELATIONSHIP MANAGEMENT

1. Provide agreements in which impacted indigenous peoples give consent to the project.
2. Disclose whether there is a project-level grievance mechanism, or by what means grievances are managed.
3. Relative to the project-level grievance mechanism, provide specific information as to the following:
 - a. how the grievance mechanism has been described to impacted communities; and,
 - b. whether impacted communities can access this mechanism from their community.
4. Disclose whether grievances have been filed and, if so, disclose the quantity, reason and outcomes of grievances filed.
5. If there is no project-level grievance mechanism, describe other feedback loops that have been implemented to ensure that the project maintains broad community support.

CONDUCT PARTICIPATORY MONITORING AND EVALUATION OF THE AGREEMENT

Key aspects that ensure an effective monitoring process throughout the lifespan of a project that involves Indigenous Peoples and local communities are:

- Use of independent monitors acceptable to all parties.
- Inclusion of diverse voices across the spectrum of rights-holders and other stakeholders, including marginalized groups such as women, the poor, the landless and youth i.e., to ensure their rights are equally respected.
- Offering respondents anonymity and maintaining anonymity of inputs where requested.
- Soliciting feedback on findings. Public sessions can be held to share and discuss the findings of the verification process. This gives community members an opportunity to confirm or contest the findings and to request that a different team repeat the process, if necessary
- Specificity about how problems will be addressed, and at what stage grievance processes will be triggered, should problems emerge during monitoring.
- Establishment of the conditions under which the consent process can be reinitiated, and the agreement renegotiated.
- Having a written record of all related activities

DOCUMENTING LESSONS LEARNED

During the FPIC process, and after it has been completed, it is important to document any lessons learned that can improve future actions. This can better guide the actions of the organization in future projects and diminish future risks and challenges.

For the indigenous community, this documentation underscores the commitment of the organization to respect Indigenous Peoples' rights and reinforces the trust-based relationship. For this reason, the team should work together with the community to document what was learned throughout each stage of the FPIC process, including both strengths and weaknesses.

This stage also helps to bring a sense of closure and can even facilitate possible future collaborations.

A community engagement plan will be developed and implemented prior first verification to continue communication and consultation between the project proponent(s) and communities and other stakeholders about the project.

2.3.9 Stakeholder Consultation Channels (G3.5)

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. The Kuamut project continues to hold regular community engagements during which the project objectives and structure are explained and discussed. 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. 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.

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

Meeting types, structure and locations are always designed to enable the target audience to participate freely and to contribute openly. Importantly, all engagements are conducted in the communities themselves at venues considered appropriate by community leaders. Community members are never asked to travel outside of their villages in order to participate in project engagements.

Although organising attendance of community members at workshops is left to the discretion of community leaders, they are encouraged to ensure that a broad cross-section of the community is represented – in particular women and youth groups which may be under-represented otherwise. They are also encouraged to make sure that as many people as possible attend workshops in order to maximise the direct outreach between the project and individual community members.

As the project progresses and community groups become more clearly defined, additional efforts will be made to hold dialogues specifically tailored to each group in order to facilitate candid (or even anonymous) communication with project staff.

2.3.11 Anti-Discrimination Assurance (G3.7)

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. 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). 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, colour, 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 Feedback and Grievance Redress Procedure (G3.8)

The project is currently in the process of formalising redress mechanisms for any potential grievances arising from project zone communities or other stakeholders. In the community context, procedures are being developed in a participatory manner through dialogues during community engagement activities. Whilst they are yet to be finalised and formally adopted by all parties, and draft procedures to redress grievances consist of the following steps:

The grievance is reported by the affected community member(s) to a designated representative (to be appointed by the communities themselves) for verification.

If the issue is considered by the community representative to constitute a legitimate grievance with respect to any aspect of project implementation or staff conduct, the representative will submit written details to the project staff member responsible for the implementation of field activities (field manager or equivalent).

The field manager (or equivalent) is responsible for resolving the issue directly and amicably within a period of 7 days.

If no amicable resolution can be reached, the matter is referred to the highest managerial levels of the project for appropriate intervention (the precise nature of which being contingent on the nature of the grievance); the matter to be resolved within a further 14 days.

If no amicable resolution can be found, the matter will be referred to an independent third party for formal mediation and arbitration. This mediator is to be agreed upon by all parties prior to the commencement of arbitration.

If the matter is still not resolved to the satisfaction of the parties originally submitting the grievance, the final recourse is legal arbitration pursuant to all relevant Malaysian laws and statutes.

These draft procedures will be discussed further with communities before being finalised, and are also subject to alterations and the project grows and its organisational structure develops.

Once the procedure has been fully negotiated with communities and formally adopted, it will be provided in print form in the Malay language to community leaders for dissemination. It will also be available on the project database, along with records of any grievances received and details of their resolution.

2.3.13 Accessibility of the Feedback and Grievance Redress Procedure (G3.8)

Once the procedure has been fully negotiated with communities and formally adopted, it will be provided in print form in the Malay language to community leaders for dissemination. It will also be available on the project database, along with records of any grievances received and details of their resolution.

2.3.14 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. Table 5 below summarizes some of the main aspects of the project's training and capacity building program, focusing on those aspects that incorporate local communities.

Table 5: Capacity building and training

Topic	Target	Description	Outcomes
Carbon MRV	Project-zone communities, employees	Field and classroom based Provide training and equipment for the monitoring of biomass and regrowth.	MRV team formed and necessary equipment and facilities provided
Fire prevention and suppression	Project-zone communities, local governments, employees	Field and classroom based training on organizational management, strategy, equipment use, resource mobilization, risk assessment and communication.	Firefighting team formed, monitoring facility and firefighting equipment in place with proper resources and communication network
Silviculture / reforestation	Project-zone communities, employees	Field based training on nursery establishment and operation, planting and maintenance	Nursery facilities developed and operational, tree planting underway

Topic	Target	Description	Outcomes
Participatory planning	Project-zone communities, local/village governments, employees	Training on participatory land-use mapping and village planning	Community maps digitalized and village plans endorsed by the local governments and communities
Basic skills	Project-zone communities, employees	Classroom and on-the-job training on administration, finance, project management, leadership and foreign languages	Management team established, and project activities properly and effectively managed
Conflict mediation	Project-zone communities, local governments, employees	Classroom and on-the-job training provide training on formal conflict mitigation and resolution processes	Conflict resolution mechanism in place and understood by community stakeholders
Biodiversity survey methods	Employees and project-zone communities	Field based training on flora and fauna survey, phenology, identification and data recording.	Biodiversity survey team established and activities run effectively
Data and information management	Employees	Provide training on data collection, storage and analysis	Data and information properly managed and easily accessed

In order to retain local capacities in cases of staff turn-over, the above training activities will be conducted with the support of local partner organizations with long term presence in the region such as SEARP and PACOS. In addition, Permian Global Research will provide continuous training support to local staff following its onboarding process for new employees and associates.

2.3.15 Community Employment Opportunities (G3.10)

The project seeks to invest in people; in particular those who are living within the project zone, the wider region, and Sabah as a whole. The project currently employs two part-time staff from the project zone communities (one from the Karamuak cluster and one from the Kuamut cluster), and it is envisioned that this number will increase substantially as implementation of project activities begins in earnest. The project aims to provide employment opportunities irrespective of gender, age, social class or ethnicity and other factors, with priority going to the project-zone communities. Staff or contractors, whether employed on a

long-term or short-term basis, will be entitled to employment terms based on similar types of work and working conditions in the area of employment.

Open positions will be advertised in a variety of ways to reach a broad array of potential applicants. This includes online posting on job boards, announcements and postings in villages and local educational institutions, and through social media. Project field staff will communicate with community leaders (or other appropriate representatives) to announce any upcoming employment positions, giving communities an opportunity to discuss the position's requirements and qualifications. After this consultation process, villagers who fit the job description and meet the minimum requirements will be recommended to the project team.

2.3.16 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.

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.

In addition to requirements under the body of employment law, Permian Malaysia Sdn. Bhd. is also fully compliant with Social Security Law (Laws 3/1992, 40/2004 and 4/2011). These laws require PT RMU to register all employees for Social Security (known as BPJS Ketenagakerjaan and BPJS Kesehatan) and to make payments on their behalf. All staff are issued membership cards to the scheme.

2.3.17 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:

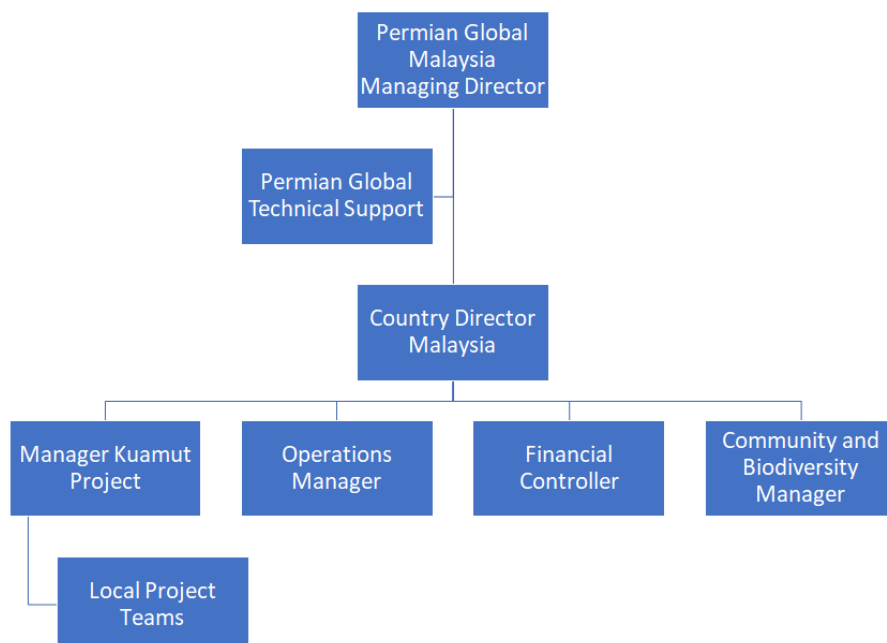
- Providing workers with a first aid kit including anti-venom cream and insect repellent;
- Providing navigation and communication equipment such as GPS, compass and handheld transceivers;
- Enforcing a buddy system (minimum two persons in a group) for all field activities;
- Providing standard safety 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 Project Governance Structures (G4.1)

The project will be managed by Permian Malaysia Sdn. Bhd using the governance structure outlined below. This team is based in headquarters in Kota Kinabalu, Sabah, and regional facilities throughout the project zone. 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.



2.4.2 Required Technical Skills (G4.2)

The project activities will be 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 6 below summarizes some of the main project activity themes and some of the range of skills required for their implementation.

Table 6: 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,

2.4.3 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. Resumes of involved staff are available for the auditors' review as requested.

As shown in the CVs available for audit purposes, the team of Permian Global (<https://permianglobal.com/>) 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.

Furthermore, the project is implemented jointly with the South East Asia Rainforest Research Partnership (SEARRP) based in Sabah, with more than 30 years of experience developing research as well as conservation, restoration and sustainable management of tropical rainforests (<https://www.searrp.org/>). The community work is implemented jointly with PACOS Trust (<https://pacostrust.com/>), a community-based organization dedicated to supporting indigenous communities in Sabah for more than 25 years. PACOS Trust supports community organizations in 14 districts (an increase of 4 from 2000/1) involving 23 geographical areas (including 7 new areas from last year), with each organization determining and implementing its own area plan and work programme.

2.4.4 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 Yayasan Sabah and Rakyat Berjaya Sdn. Bhd, Sabah Forestry Department, and a range of other partners that assist the project on an issue-based such as SEARP (South East Asia Rainforest Research Partnership) supporting

with the operations on the ground mostly on biodiversity aspects and logistics, as well as PACOS Trust, a community-based organization supporting indigenous communities in Sabah.

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.

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

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 validators on request.

2.4.6 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.

2.4.7 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 Statutory and Customary Property Rights (G5.1)

The project area is legally owned by the Sabah State Government which excludes any territory from indigenous or local communities. The necessary rights to implement the Kuamut Conservation Project were provided to the project proponent through an agreement between Permian Malaysia, the State Government of Sabah and Rakyat Berjaya SDN, BHD. Copy of this agreement is available for the review of the auditors.

The project has generated an initial overview of community lands and resource use areas outside the project area through the process of participatory mapping. Tenurial insecurity is one of the most significant challenges faced by members of the project zone communities; as is the case for most rural indigenous peoples in Sabah. Land in the state is alienated to indigenous peoples under the Sabah Land Ordinance in the form of a documentary title referred to as Native Title (NT). The process of applying for lands via the designated State authority (the Department of Lands and Survey) is historically fraught with difficulty, and many community members continue to await the issuance of formal land titles for long periods of time – sometimes decades. Moreover, official cadastral maps of land titles are not publicly available in Sabah and are considered confidential government documents. These issues constitute an obvious impediment to the production of spatially accurate maps of land tenure in the project zone. Nonetheless, approximate maps of community settlement areas, agricultural lands, areas accessed for harvesting natural resources and culturally significant sites have been produced through participatory mapping processes with communities. Moreover, communities have been made aware repeatedly during engagements that the project area corresponds to the boundaries of the Northern Kuamut forest reserve and that project activities relating to the maintenance and enhancement of climate and biodiversity benefits will take place solely within the project area. Any customary rights of the local communities will be respected through the project implementation which can be confirmed at each verification period.

2.5.2 Recognition of Property Rights (G5.1)

As described in the previous section, the project is implemented respecting all property rights which were transferred to Permian Malaysia through an agreement signed with the Sabah State Government.

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. Many community members feel that their rights to access and use natural resources have been circumscribed by the gazettement of the Kuamut forest reserve – and indeed these activities are not considered lawful under the Sabah Forestry Department's legislation. These are issues concerning which the project will endeavour to facilitate agreements between government and community stakeholders which are congruent with biodiversity conservation, climate change mitigation, community livelihoods and State law. As the project matures and grows, it will adopt formal Standard Operating Procedures governing staff conduct with

respect to community engagement founded on FPIC principles. The project will also negotiate written agreements with communities which will serve as guiding documents for future project-community collaborations.

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

The Kuamut project views Free, Prior and Informed Consent (FPIC) 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 2010⁴; Anderson 2011⁵; FAO 2014⁶).

All forms of community-project interactions are informed and governed by FPIC principles. Open and transparent discussions are held during all engagement activities, during which communities are encouraged to voice any concerns they may have over the project without fear of censure. Any and all activities proposed by the project are discussed with communities far in advance of any potential implementation, and communities are given opportunities to discuss among themselves and raise objections as they feel appropriate. Consent is considered to be fluid and multi-faceted, and is repeatedly sought at multiple stages (e.g. before commencing social entry, before conducting community workshops, before commencing data gathering activities such as household surveys). Moreover, the concept of FPIC as adopted by the project is explained in project documentation such as brochures, in order to ensure that the communities themselves are aware of their rights to receive clear and transparent information on the project, and to withhold consent if they feel it appropriate to do so.

2.5.4 Property Rights 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

⁴ 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.

⁵ 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

⁶ 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

from forest protection and regeneration (and potentially assisted regeneration) and prevent any other organization from applying for concessions in the project area.

2.5.5 Illegal Activity Identification (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 incentive, including strengthening tenure rights and providing sustainable livelihood options and employment opportunities.

2.5.6 Ongoing Disputes (G5.5)

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. Many community members feel that their rights to access and use natural resources have been circumscribed by the gazettment of the Kuamut forest reserve – and indeed these activities are not considered lawful under the Sabah Forestry Department’s legislation. These are issues concerning which the project will endeavour to facilitate agreements between government and community stakeholders which are congruent with biodiversity conservation, climate change mitigation, community livelihoods and State law.

However, although community access rights to traditional lands and resources remains a contentious issue (and one which will require considerable future efforts from all parties to ameliorate), it does not at present constitute a source of disputes per se. At the time of writing, the project is 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. This situation will constantly be monitored as part of the implementation of the community engagement plan to be developed prior to first verification of the project.

2.5.7 National and Local Laws (G5.6)

The Kuamut Rainforest Conservation Project is designed and implemented in full compliance with both state (Sabah), national (Malaysia) and international law. Relevant laws and regulations on land use, forestry, REDD+ and climate include:

- State Laws:
- Forest Enactment, 1968;
- Forest Rules, 1969;
- Environmental Protection Enactment, 2002;
- Environmental Protection Enactment (Prescribed Activities), 2005;
- Wildlife Conservation Enactment, 1997;
- Land Ordinance, 1930 (Sabah Cap. 68);
- Water Resources Enactment, 1998;
- Cultural Heritage (Conservation) Enactment, 1997;

- Biodiversity Enactment, 2000;
- Labour Ordinance (Sabah) Cap. 67;
- Native Court Rules (Native Customary Laws), 1995;
- National Laws:
- Environmental Quality Act, 1974;
- Pesticides Act, 1974;
- Occupational Safety and Health Act 1994;
- Workmen's Compensation Act, 1952;
- Factories and Machineries Act, 1967;
- Employees' Social Security Act 1969;
- Plant Quarantine act, 1976
- International Agreements:
- Convention on Wetlands of International Importance, 1971;
- Convention on the International Trade in Endangered Species of Wild
- Flora and Fauna, 1973;
- Cartagena Protocol on Biosafety to the Convention on Biological
- Diversity, 2000;
- International Tropical Timber Agreement, 1994;
- United Nations Convention on Biological Diversity, 1992;
- United Nations Framework Convention on Climate Change, 1992;
- United Nations Declaration of the Rights of indigenous Peoples, 2007;
- The Kyoto Protocol to the Convention on Climate Change, 1997.

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.

The Management Agreement between Permian Malaysia, the State Government of Sabah and RBJ (confidentially provided to the auditors) states the compliance with all the laws and regulations for the implementation of the project.

2.5.8 Approvals (G5.7)

Pursuant to a Management Agreement dated 6th August 2021 (the "Management Agreement") made between (1) Permian Malaysia SDN. BHD. (the "Company") (2) The State Government of Sabah (the "Government") and (3) Rakyat Berjaya SDN.BHD. (the "Service Provider") the Company was appointed by the Government and the Service Provider to manage the area and to implement the Project (as therein defined). The term of the Management Agreement is thirty years with the option, in certain circumstances, to extend such term for a further period of thirty years.

2.5.9 Project Ownership (G5.8)

Yayasan Sabah is a State-owned para-governmental charitable foundation that was formed in 1966 with the aim of 'improving the lives of Malaysians living in Sabah'.

The project area is part of a long-term approximately 1-million-hectare concession granted to Yayasan Sabah on a 99-year lease arrangement with the Sabah Forestry Department (acting on behalf of the State Government of Sabah). The Sabah Forestry Department is the landowner and rights-holder of project area.

The right of use of the entire project area was conferred by Yayasan Sabah to Permian Malaysia Sdn. Bhd. This right of use includes the right to generate and sell carbon offset credits derived from forest protection and regeneration. Through this contract Permian has project ownership as defined in the VCS Standard as "arising by virtue of a statutory, property or contractual right in the land, vegetation or conservational or management process that generates GHG emission reductions and/or removals (where the project proponent has not been divested of such project ownership)".

2.5.10 Management of Double Counting Risk (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 will not claim credit for the same GHG emission reduction under another program.

2.5.11 Emissions 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

2.5.12 Other Forms of Environmental Credit

The project will not claim other Forms of Environmental Credit under another program.

2.5.13 Participation under Other GHG Programs

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

2.5.14 Projects Rejected by Other GHG Programs

The Kuamut Rainforest Conservation Project has not applied for or been rejected by any other GHG programs.

2.5.15 Double Counting (G5.9)

Not applicable. There is no double counting since the project is not part of any Emissions Trading Programs and is not subject to Other Binding Limits or compliance mechanism.

3 CLIMATE

3.1 Application of Methodology

3.1.1 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

3.1.2 Applicability of Methodology

The following tables demonstrate and justify how the project activities meet each of the applicability and eligibility conditions of the methodology and tools applied.

Table 7: Applicability conditions from VM0010

No.	Applicability Condition	Demonstration and justification how the project activities meet this applicability condition
1	Forest management in the baseline scenario must be planned timber harvest	Condition met. Under the baseline scenario, the project area would have been managed as a production forest (Class II). Parts of the area would have been subjected to continued selective logging. The rest of the area would have been managed using a practice that is known locally as the Mosaic Planting Approach. The concept of Mosaic Planting Approach involves timber harvesting (while retaining small patches of natural forest areas containing young commercial tree species) and planting of fast-growing species in the more open areas. The small patches of natural forests left standing, usually on steeper slopes comprise commercially forest species with a diameter below the prescribed cutting limit. The more open and flatter areas left are harvested, cleaned and planted with selected fast-growing species.
2	Under the project scenario, forest use is limited to activities that do not result in commercial timber harvest or forest degradation	Condition met. Because of the project scenario, the area is gazetted as a Class I protection forest by the State of Sabah in the Forest Enactment no 7 of 2015 and no 13 of 2016 respectively. As a Class I protection forest, the area is fully protected and no longer subject to commercial timber harvest.
3	Planned timber harvest must be estimated using forest inventory methods	Condition met. The merchantable volume of timber per unit area that is potentially available for harvest and the resulting allowable offtake has been estimated using field plot data, and a published

	that determine allowable offtake as volume of timber ($\text{m}^3 \text{ ha}^{-1}$)	high-resolution Top of Canopy Height (TCH) Map obtained using LiDAR. These data were combined to produce a high-resolution merchantable timber volume map for the project area.
4	The boundaries of the forest land must be clearly defined and documented	Condition met. The project boundaries are clearly defined and documented when the area was designated as a forest reserve. It was reconfirmed through the Top- Of-Canopy height (TCH) Lidar imagery that the project area is indeed forest land
5	Baseline condition cannot include conversion to managed plantations	Condition met. Under the baseline scenario, the project area would have been managed as a production forest (Class II). Parts of the area would have been subjected to continued selective logging. The rest of the area would have been managed using a practice that is known locally as the Mosaic Planting Approach. The concept of Mosaic Planting Approach involves timber harvesting (while retaining small patches of natural forest areas containing young commercial tree species) and planting of fast-growing species in the more open areas. The small patches of natural forests left standing, usually on steeper slopes comprise commercially forest species with a diameter below the prescribed cutting limit. The more open and flatter areas left are harvested, cleaned and planted with selected fast-growing species.
6	Baseline scenario, project scenario and project case cannot include wetland or peatland	Condition met. There are no peatlands or wetlands in the project area. The soils in the project area are classified in the USDA system as Ultisols (equivalent to the Acrisol-Alisol groups, in the FAO-UNESCO system).

Table 8: Applicability conditions from VT0001 Tool for the Demonstration and Assessment of Additionality in VCS Agriculture, Forestry and Other Land Use (AFOLU)

No.	Applicability Condition	Demonstration and justification how the project activities meet this applicability condition
1	AFOLU activities the same or similar to the proposed project activity on the land within the proposed project boundary performed with or without being registered as the VCS AFOLU project shall not lead to violation of any applicable law even if the law is not enforced	Condition met. The AFOLU activities that took place before the project start and the planned project activities (see 1.11) do not lead to violation of any applicable law in Malaysia (see section 2.5.7)

2	The use of this tool to determine additionality requires the baseline methodology to provide for a stepwise approach justifying the determination of the most plausible baseline scenario.	Condition met. VM0010 refers to this tool to determine the most plausible baseline scenario
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In addition to the applicability conditions, VM0010 also defines a number of eligibility conditions:

Legal Right to Harvest

Yayasan Sabah is a State-owned para-governmental charitable foundation that was formed in 1966 with the aim of 'improving the lives of Malaysians living in Sabah'. The project area is part of a long-term approximately 1-million-hectare concession granted to Yayasan Sabah on a 99-year lease arrangement with the Sabah Forestry Department (acting on behalf of the State Government of Sabah). The concession is known at the 'Yayasan Sabah Forest Management Area' ⁷ (YSFMA) and comprises extensive areas harvested under a regime of natural forest management, mosaic plantings, agricultural (mostly oil palm) and timber plantations and a network protected areas, including the project area (see Figure 13 from Reynolds et al (2011)⁸).

Timber harvesting and plantation agriculture within the YSFMA (which provide the main revenue streams to Yayasan Sabah) and the Foundation's other profit generating activities are collectively managed through Yayasan Sabah's commercial holding company Innoprise Corporation Sdn. Bhd. Timber harvesting in the natural forests of the YSFMA are managed by Rakyat Berjaya Sdn. Bhd. – a wholly-owned subsidiary of Innoprise Corporation.

Licences to harvest, through annual coupe permits issued by the Sabah Forestry Department, are granted to Rakyat Berjaya Sdn Bhd – with detailed conditions (e.g. cutting diameter limits, harvesting methods, slope restrictions, buffer requirements and so on) outlined in these permits. Rakyat Berjaya Sdn Bhd engages specialist contractors to conduct harvesting activities on its behalf – but retains overall responsibility for compliance with conditions outlined in coupe permits and wider Sabah Forestry Department regulations, including monitoring, recording and reporting timber harvesting volumes.

Intent to Harvest

⁷ <http://www.yayasansabahgroup.org.my/forestry.cfm>

⁸ G. Reynolds, J. Payne, W. Sinun, G. Mosigil and R. P. D Walsh; 2011. Changes in forest land use and management in Sabah, Malaysian Borneo, 1990–2010, with a focus on the Danum Valley region. Philosophical Transactions of the Royal Society. B. 2011, Vol 366, pp. 3168–3176
<https://royalsocietypublishing.org/doi/pdf/10.1098/rstb.2011.0154>

The approximately 1 million ha YSFMA is, by some margin, the largest forest concession under single management in Sabah – and one of the largest of its kind in Malaysia. It covers ~13% of the entire land area of Sabah and its commercial and protected forest reserves comprises close to a third of the State's total forested area.

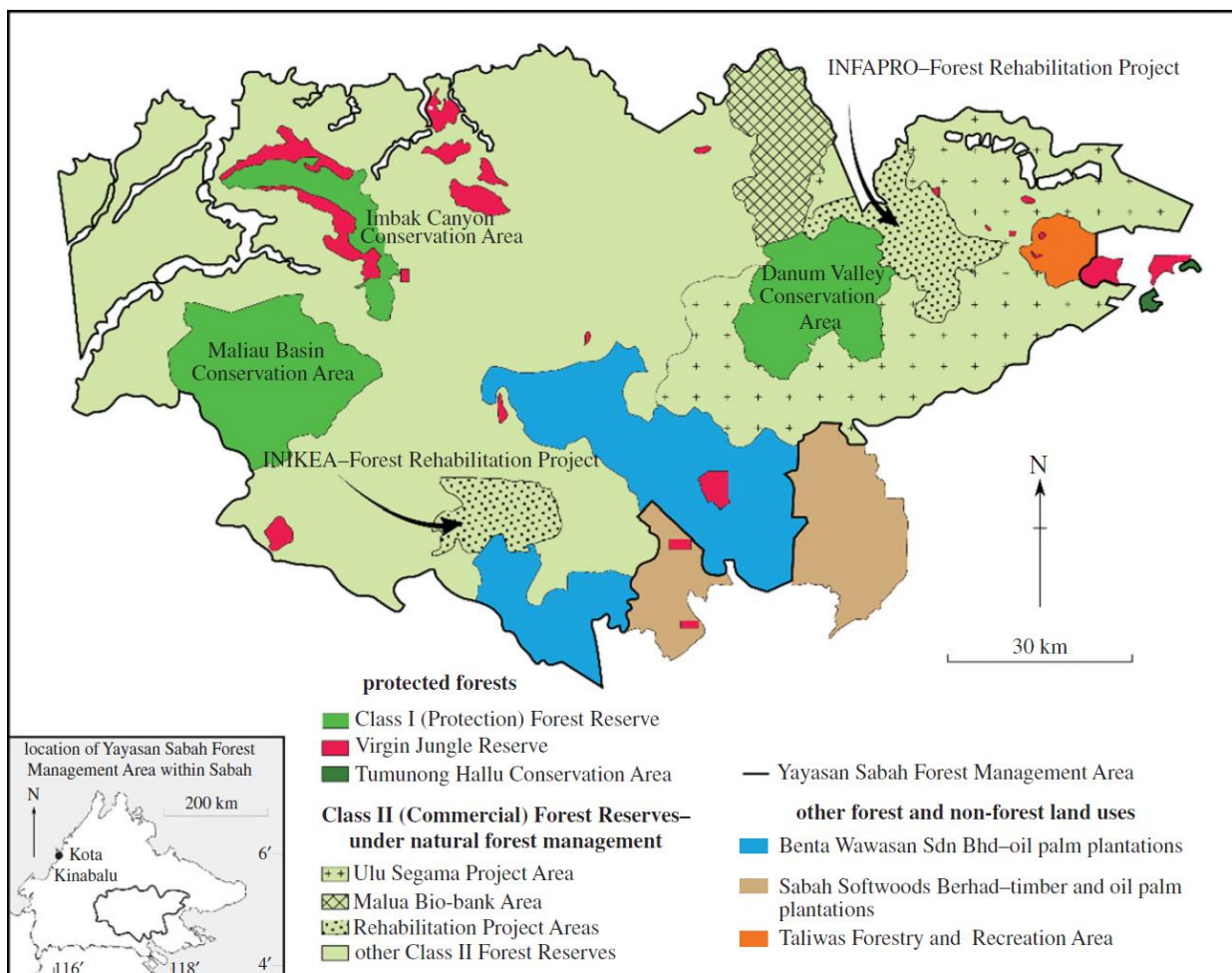


Figure 13: Forest status within the YSFMA in 2010 (from G. Reynolds et al (2011). Sabah forest land-use change 1990–2010)

The project area is representative of other forestlands harvested within the YSFMA and it has been managed as an integral component of YSFMA since its consolidation in 1985 – broadly in accordance with a long-term, concession-wide management plan - with timber harvested from the Kuamut Forest Reserve, under license to Rakyat Berjaya, processed and/or marketed through other of Innoprise

Corporation's subsidiary companies which shows the project site is within commercially viable distance to existing transport networks and a mill for timber processing.

3.1.3 Project Boundary

A map of the project boundary is provided above in Figure 1. It must be noted that 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 84,800 ha while the gazetted area is 83,381 ha). When the shapefile has been used in the calculations, the areas have been adjusted so the project area in the calculations matches the gazetted area.

The project will consider the following pools and sources:

Carbon pool		Included?	Justification/Explanation
Above ground biomass	Trees	Included	Mandatory and significant pool
	Non-tree	Excluded	Exclusion is always conservative when forests remains as forest since the stocks of non-tree aboveground biomass are expected to be greater in the project scenario (protected natural forest) than in the baseline scenario
Below ground biomass		Excluded	Excluded in the methodology since this is unlikely to change significantly in forests remaining as forests and is difficult to measure-omission is conservative
Deadwood	Logging slash	Included in the baseline	The dead wood (logging slash) carbon pool is expected to be larger in the baseline than in the project scenario, and therefore this pool must be included
	Naturally accumulated	Excluded	Conservatively omitted since this pool is expected to be larger in the project scenario than the baseline scenario
Litter		Excluded	Conservatively omitted since this pool is expected to be larger in the project scenario than the baseline scenario
Soil organic carbon		Excluded	Conservatively omitted since this pool is pool is unlikely to change significantly in forests remaining as forests

Carbon pool	Included?	Justification/Explanation
Harvested wood products	Included	Will be greater in baseline than project scenario since the baseline includes timber harvesting for commercial markets

Source		Gas	Included?	Justification/Explanation
Baseline	Biomass burning	CH4	Included	Included as required by the methodology
		N2O	Excluded	Potential emissions are negligible
	Fossil fuel combustion	CO2	Excluded	This is deemed conservative, as emissions will be greater in the baseline scenario than in the project scenario
		CH4	Excluded	This is deemed conservative, as emissions will be greater in the baseline scenario than in the project scenario
		N2O	Excluded	This is deemed conservative, as emissions will be greater in the baseline scenario than in the project scenario
	Removal of herbaceous vegetation	CO2	Excluded	Excluded by the methodology
Project	Biomass burning	CH4	Included	Included as required by the methodology
		N2O	Excluded	Potential emissions are negligible
	Fossil fuel combustion	CO2	Excluded	This is deemed conservative, as emissions will be greater in the baseline scenario than in the project scenario
		CH4	Excluded	This is deemed conservative, as emissions will be greater in the baseline scenario than in the project scenario

Source		Gas	Included?	Justification/Explanation
		N2O	Excluded	This is deemed conservative, as emissions will be greater in the baseline scenario than in the project scenario

In addition, a reference area representative of local common practice for timber harvest was defined in order to model the baseline (see section 3.2.1). As shown in section 3.1.4 and 3.1.5, the most likely land use scenario without the project would have been a combination of different forest management practices where parts of the area would have been subjected to continued selective logging (referred to as Natural Forest Management) and the rest of the area would have been managed using a practice that is known locally as the Mosaic Planting Approach. The reference area of local common practice for timber harvest was therefore split to represent both the management practices.

For the Mosaic Planting Approach, the reference area consists of 3 areas within the greater Yayasan Sabah Forest Management Area which each have their own management plan:

- An area of 20,000 ha within the SG Pinangah Forest Reserve
- An additional area of 5,000 ha within the SG Pinangah Forest Reserve (with a separate management plan)
- An area of 28,000 ha in the Gunung Rara forest reserve.

The location of the reference areas for the Mosaic Planting Approach is indicated in Figure 14 below.

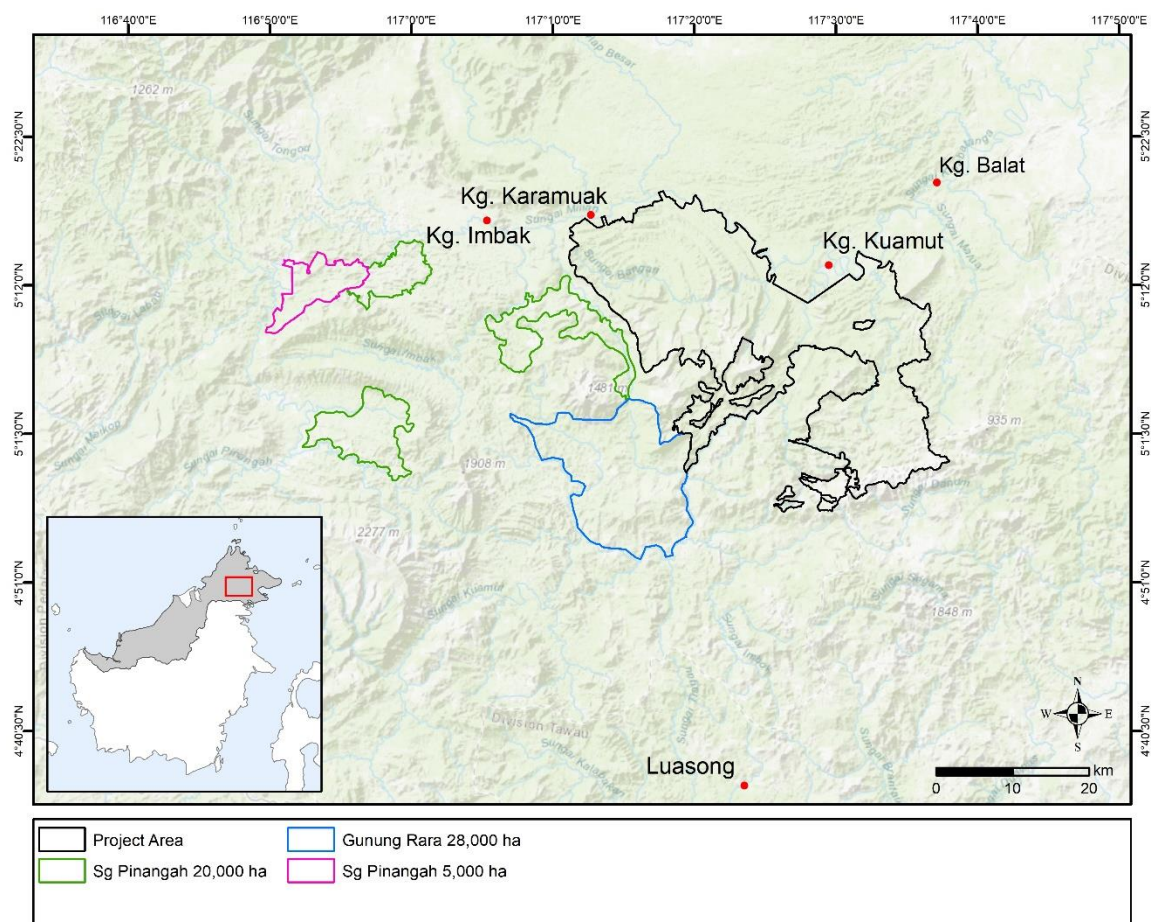


Figure 14: Location of reference areas for Mosaic Planting Approach

For the Natural Forest Management, the reference area consists of the Ulu Segama Forest Reserve. This area encompasses approximately 1272.68 km² within the Yayasan Sabah Forest Management Area. The location of the Ulu Segama Forest Reserve is indicated in Figure 15 below.

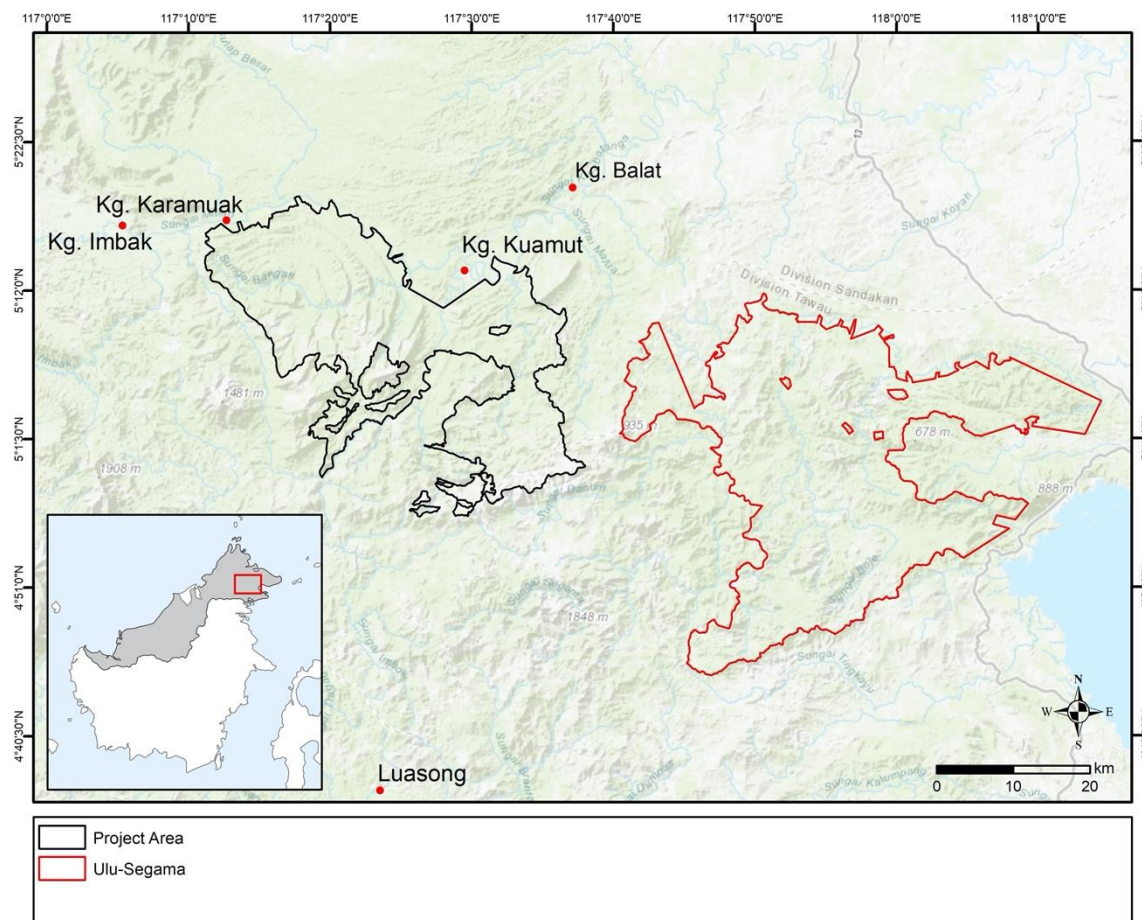


Figure 15: Location reference area for Natural Forest Management

Following the methodology, the temporal boundaries of the project are defined by the project start date and length of the project crediting period. The temporal boundaries of the project are therefore December 11th, 2015 (refer to section 2.1.14) and 1st December 2045 (refer to section 2.1.15).

The geographical boundaries for leakage are all forest concession within the following coordinates:

7° 21' 35.73"N 115° 22' 28.41"E

7° 21' 35.73"N 119° 16' 9.33"E

4° 6' 54.28"N 119° 16' 9.33"E

4° 6' 54.28"N 115° 22' 28.41"E

3.1.4 Baseline Scenario

Selection of baseline

VM0010 refers to VCS tool VT0001 to assess which of the baseline alternatives must be excluded from further consideration. Therefore, the baseline scenario has been selected using the steps contained in VT0001: Tool for the Demonstration and Assessment of Additionality in VCS Agriculture, Forestry and Other Land Use (AFOLU) Project Activities; Version 3.0,

Step 1 of VT0001: Identification of alternative land use scenarios to the proposed VCS AFOLU project activity

Sub-step 1a. Identify credible alternative land use scenarios to the proposed VCS AFOLU project activity

- a) At the time of the project start, the project area was designated as production forest (Class II) and designated for further commercial exploitation. Considering this status, the following realistic and credible land-use scenarios could occur on the land within the proposed project boundary in the absence of the AFOLU project activity:
 - i. Continuation of the pre-project land use: under this scenario, the whole project area is subject to Natural Forest Management practice which involves continued commercial logging. The whole area would continue to be designated as production forest (Class II) for commercial exploitation and would be subject to continued periodic logging under the Natural Forest Management approach in Sabah
 - ii. Project activity on the land within the project boundary performed without being registered as the VCS AFOLU project: under this scenario, the project areas would have been converted to a protected forest without being registered as the VCS AFOLU project
 - iii. Activities similar to the proposed project activity on at least part of the land within the project boundary based on legal requirements or extrapolation of observed similar activities in the geographical area with similar socio-economic and ecological conditions. Considering the current practices in Sabah, this could include the following:
 - o The project area is converted to an oil palm plantation. Conversion to oil palm is a common practice in Sabah
 - o The whole project area is subject to the Mosaic Planting Approach. This is a variation on the commercial logging scenario. Under this scenario the commercial exploitation of the area would continue but the whole area would be subjected to the Mosaic Planting Approach.
 - o Combination of commercial logging and Mosaic Planting Approach. This is a combination of the two scenarios above. Under this scenario, part of the area will be managed with the Mosaic Planting Approach. The remaining area would continue to be managed under the Natural Forest Management approach
- b) All the identified land use scenarios above are credible. As shown in figure 9 and figure 10, the scenarios described above all currently exist within the YSFMA area.
- c) Therefore, the outcome of Sub-step 1a is the following list of credible alternative land use scenarios that could have occurred on the land within the project boundary of the VCS AFOLU project.

Scenario		Description
i.	Conversion to palm oil	Under this scenario, the project area is converted to an oil palm plantation
ii.	Whole project area is subject to Natural Forest Management practice which involves continued commercial logging	This is the continuation of the pre-project land use. The whole area is designated as production forest (Class II) for commercial exploitation and would be subject to continued periodic logging under the Natural Forest Management approach in Sabah
iii.	Whole project area is subject to the Mosaic Planting Approach	This is a variation on the commercial logging scenario. Under this scenario the commercial exploitation of the area would continue but the whole area would be subjected to the Mosaic Planting Approach.
iv.	Combination of commercial logging and Mosaic Planting Approach	This is a combination of the two scenarios above. Under this scenario, part of the area will be managed with the Mosaic Planting Approach. The remaining area would continue to be managed under the Natural Forest Management approach
v.	Protected forest (project activity)	This is a scenario where the project activity would be performed without being registered as the VCS AFOLU project;

Sub-step 1b. Consistency of credible land use scenarios with enforced mandatory applicable laws and regulations

Since the project area was a production forest (Class II) before the start of the project, scenarios ii, iii and iv identified above are legally permissible under the current laws and regulations governing forest areas. Scenario i (conversion to palm oil) requires changing the status of the land from forest to agricultural land. Yayasan Sabah as the licence holder of the land has been granted permission before to convert forest land into oil palm. This conversion is justified by Yayasan Sabah's status as a state sanctioned organisation that was developed to promote economic opportunities for the people of Sabah. Scenario v (protected forest) requires changing the status of the area to legal protected (Class I Protection Forest) and requires a change in the law and cabinet approval.

Therefore, based on this analysis the outcome of this sub-step 1.b includes all the scenarios identified in the table above.

Sub-step 1c. Selection of the baseline scenario:

In accordance with the methodology, the steps in VCS tool VT0001 were considered as a stepwise approach for justifying the selection and determination of the most plausible baseline scenario. In order to determine the most likely baseline scenario a barrier analysis (step 3 in VT0001) was applied to determine which of the scenarios from step 1 is the most likely baseline scenario.

Step 3 of VT0001. Barrier analysis

Sub-step 3a. Identification of barriers

For scenario i. (palm oil), barriers exist consisting of barriers related to local ecological conditions and technological barriers. The barriers related to the local ecological conditions have to do with the fact that the conditions in the project area, especially when it comes to soils and topography (slopes), are sub-optimal for establishing large scale industrial palm oil plantations. Although this hasn't always stopped the establishment of palm oil plantations in other areas, in the case of the project area there are additional technological barriers since the area is relatively far removed from suitable roads and milling facilities, making it unattractive to develop palm oil plantations in the project area. The combination of these barriers would have prevented scenario i. from occurring.

Scenario ii. would be a continuation of the current land use. The main barriers for this scenario to apply to the whole project area are technological and local ecological conditions. More specifically, due to the history of repeated logging, the area is now a complex mosaic of forest in conditions ranging from intact to highly degraded. Especially the areas with highly degraded forest are commercially not very attractive due to low levels of merchantable volume stocking and their potential for commercial regeneration. Current standards in Sabah for natural forest management expect a minimum of about 9 harvestable trees with a DBH > 60 cm per hectare for an economic attractive cut. Due to the past harvesting, parts of the project area are unlikely to meet this criterion, meaning the area would not produce an economic harvest without some form of silvicultural intervention.

The barriers that have been identified for scenario ii. have led to the development of an integrated mosaic planting approach (scenario iii) that is being applied in other areas controlled by Yayasan Sabah. This approach combines the cultivation of fast-growing trees in small blocks that are scattered among patches of natural forest, thereby forming a forest mosaic. Ecological conditions again are a barrier for preventing this scenario being rolled out in the whole project area. The mosaic planting approach is mostly applied in areas with slopes < 20 degrees. The topography of the project area is such that the mosaic planting approach cannot be applied in the whole project area, therefore preventing the implementation of scenario iii.

Scenario v is a scenario where the project activity of converting the area to a protected forest would be performed without being registered as the VCS AFOLU project. This scenario faces financial barriers. Yayasan Sabah's objective is to promote economic opportunities for the people of Sabah and converting the area to a protected forest would generate no income, therefore making it economically and financially less attractive than the other land use scenarios without the revenue from the sale of GHG credits is.

Sub-step 3b. Show that the identified barriers would not prevent the implementation of at least one of the alternative land use scenarios

Scenario iv. is a mix of scenario ii. and iii. It would allow to overcome the barriers associated with scenarios ii. and iii. In this scenario, Natural Forest Management and the Mosaic Planting Approach would be combined to allow for optimal commercial use of the forest in the project area. There are no barriers preventing this scenario from occurring and therefore scenario iv. (combination of Natural Forest Management and the Mosaic Planting Approach) is considered as the most likely baseline scenario for this project. In accordance with the applicability conditions of the methodology, this is a baseline scenario of planned timber harvest.

Modelling the baseline scenario

As shown in the previous step, the baseline scenario is one of planned timber harvest combination of selective logging (Natural Forest Management) and the relatively new Mosaic Planting Approach. The methodology requires that the project proponent must determine how to model the baseline management scenario with a choice between two options: a Historical Baseline Scenario or a Common Practice Baseline Scenario. As explained earlier, timber harvesting in the natural forests of the YSFMA is managed by Rakyat Berjaya Sdn. Bhd while annual coupe permits are issued by the Sabah Forestry Department. Because of this system, there are no long-term harvest plans for the area that are being implemented and the implementation of the project is preventing the issuance of new coupe permits. In addition, the most likely baseline scenario includes the relatively new Mosaic Planting Approach. Because of the absence of the long-term management plan for Natural Forest Management and the fact that the Mosaic Planting Approach has not been applied yet in the project area, a Common Practice Baseline Scenario was applied to model the baseline scenario.

In accordance with the methodology, common practice is defined as timber harvest under the legal requirements for forest management and have been determined from a timber harvest plan developed from:

- Scenario modeling of the project area subject to continued logging as through the different management practices were implemented in the project area; and
- Reference areas already under timber harvest management that comply with legal requirements for forest management and have been selected to be representative of local common practice for timber harvest.

To develop the timber harvest plan based on common practice, the following steps were followed:

- Identification of the reference areas
- Initial stratification of the project area
- Forest inventory to determine the biomass per hectare potentially available for harvest:
- Division of the harvestable forest into annual operating areas in the different strata based on common practice
- Design of the forestry infrastructure needed to harvest, skid/haul, store and move harvested timber products from the land parcels to downstream processing or market entry points.

Identification of the reference areas

To ensure that the reference area includes the combination of the different forest management practices in the baseline scenario, the reference area of local common practice for timber harvest was split to represent both the management practices.

For the Mosaic Planting Approach, the reference area consists of 3 areas within the greater YSFMA which each have their own management plan. These areas have been identified in section 3.1.3, Figure 14. This reference area is in the same region as the project area and matches the project area in terms of forest types, climate and elevation as shown in the figures and tables below.

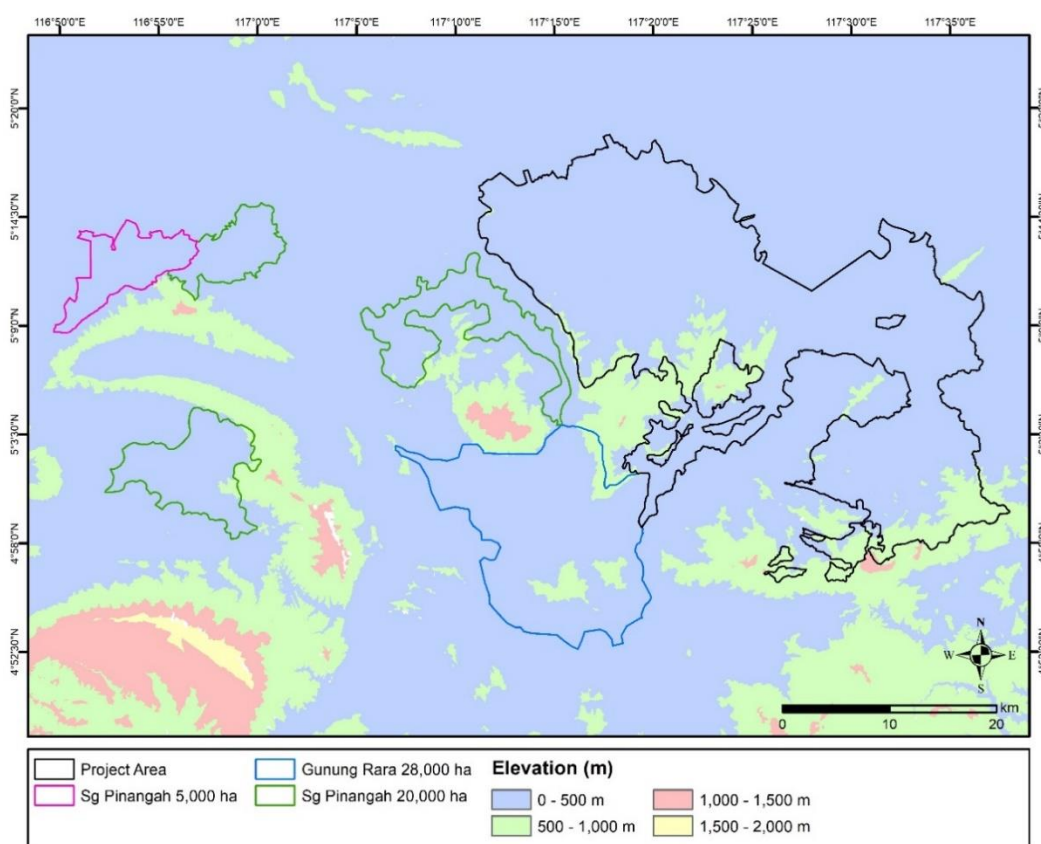


Figure 16: Elevation in the project area and the reference areas for the Mosaic Planting Approach (data from STRM ([Shuttle Radar Topography Mission 1 Arc-Second Global \(Digital Object Identifier \(DOI\) number: /10.5066/F7PR7TFT](#)))

Table 9: Elevation in the project area and the reference areas for the Mosaic Planting Approach

	CLASS 1	CLASS 2	CLASS 3
	0 – 500 m	500 – 1000 m	1000 – 1500 m

Project Area	93.77%	6.16%	0.07%
Sg Pinangah 20,000 ha	97.49%	2.51%	0%
Gunung Rara 28,000 ha	92.19%	7.81%	0%
Sg Pinangah 5,000 ha	100%	0%	0%

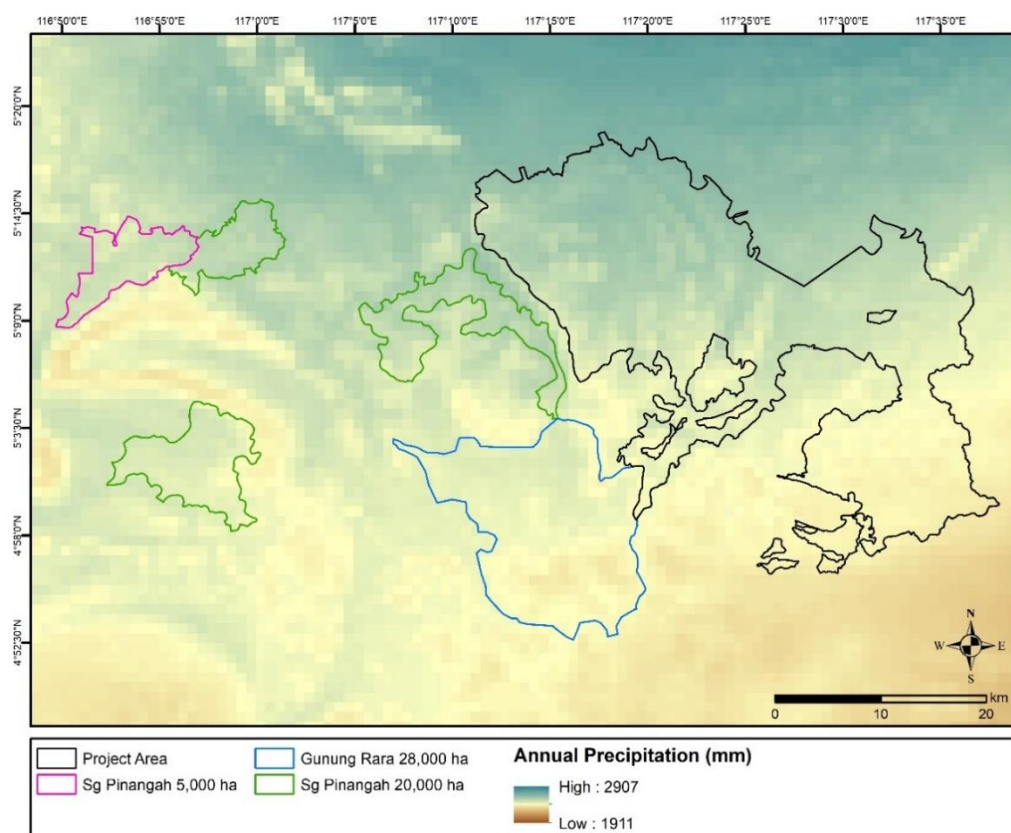


Figure 17: Annual precipitation in the project area and the reference areas for the Mosaic Planting Approach (source: Fick, S.E. and R.J. Hijmans, 2017. WorldClim 2: new 1km spatial resolution climate surfaces for global land areas. International Journal of Climatology 37 (12): 4302-4315)

Table 10: Annual precipitation in the project area and the reference areas for the Mosaic Planting Approach

	Average Annual precipitation (mm)
Project Area	2456
Sg Pinangah 20,000 ha	2461
Gunung Rara 28,000 ha	2382
Sg Pinangah 5,000 ha	2452

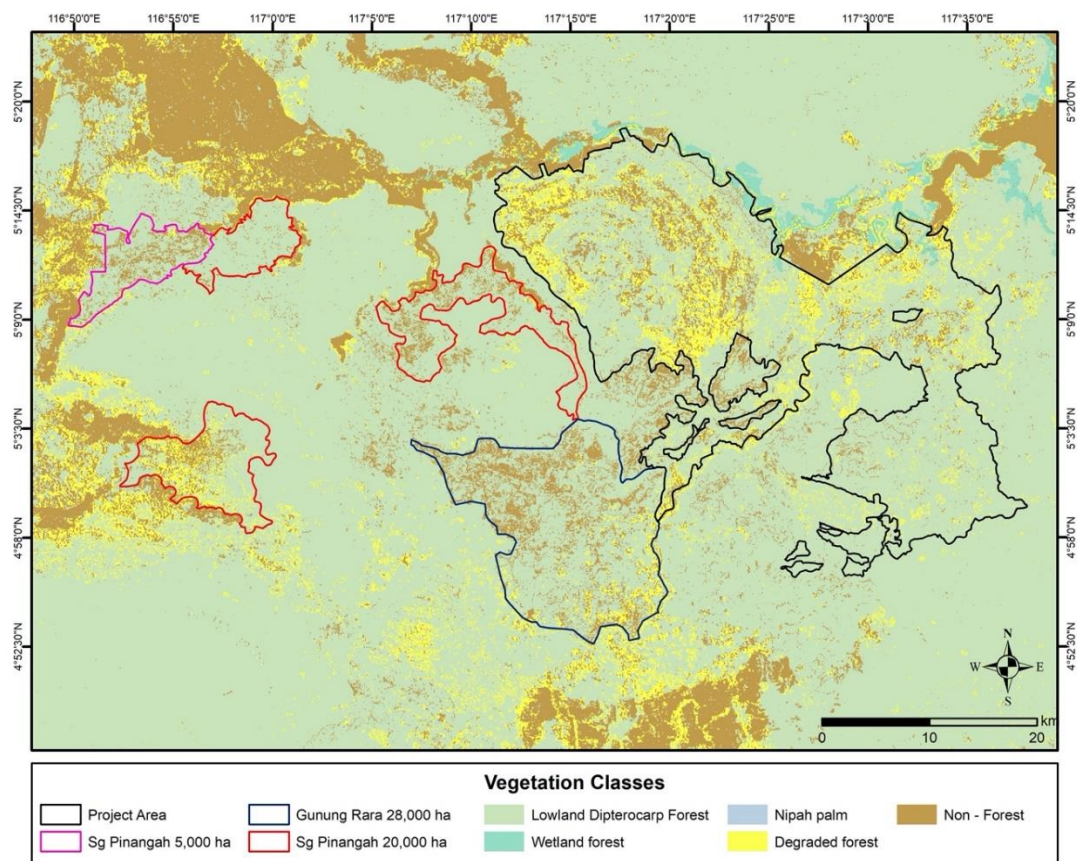


Figure 18: Vegetation classes in the project area and the reference areas for the Mosaic Planting Approach

Table 11: Vegetation classes in the project area and the reference areas for the Mosaic Planting Approach

	Lowland Dipterocarp Forest	Wetland Forest	Nipah Palm	Degraded Forest	Non-forest
Project Area	71.70%	0.55%	0.002%	16.28%	11.47%
Sg Pinangah 20,000 ha	74.41%	0%	0%	9.47%	16.12%
Gunung Rara 28,000 ha	68.23%	0%	0.006%	5.45%	26.31%
Sg Pinangah 5,000 ha	71.12%	0%	0%	2.20%	26.68%

Vegetation classes were based on Whitmore (1984)⁹ and Wyatt-Smith (1963)¹⁰.

For the common practice in Natural Forest Management (NFM), the reference area consists of the Ulu Segama Forest Reserve. This area encompasses 1272 km² within the YSFMA. The location of the reference area for NFM is shown in section 3.1.3, Figure 15. This reference area is in the same region as the project area and matches the project area in terms of forest types, climate and elevation as shown in the figures and tables below.

⁹ Whitmore, T.C. 1984. Tropical Rain Forests of the Far East (2nd Edition). Clarendon Press, Oxford.

¹⁰ Wyatt-Smith, J. 1963. Manual of Malayan Silviculture for Inland Forests. Malayan Forest Record No. 23. Forest Research Institute, Kepong

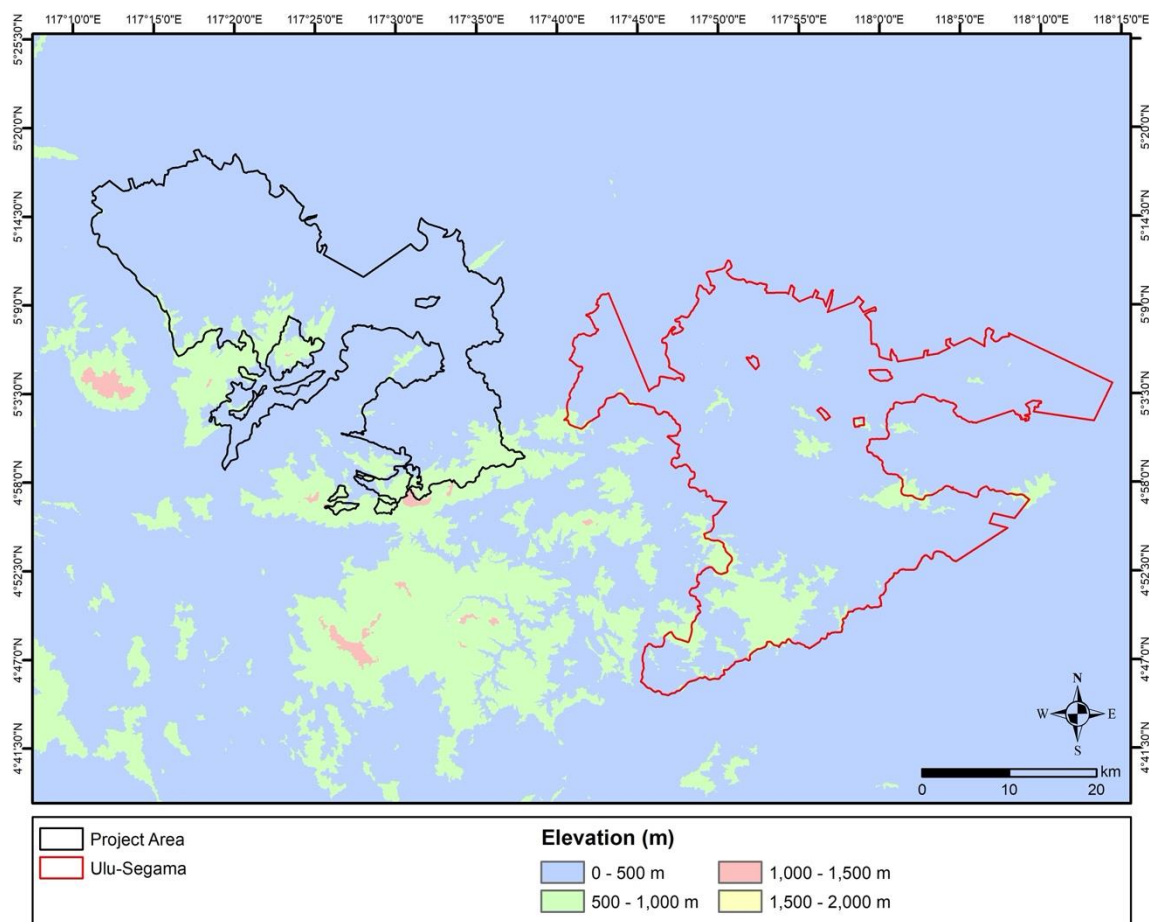


Figure 19: Elevation in the project area and the reference areas for NFM

Table 12: Elevation in the project area and the reference areas for NFM

	CLASS 1	CLASS 2	CLASS 3
	0 – 500 m	500 – 1000 m	1000 – 1500 m
Project Area	82.93%	17.04%	0.029%
Ulu-Segama	91.51%	8.49%	0

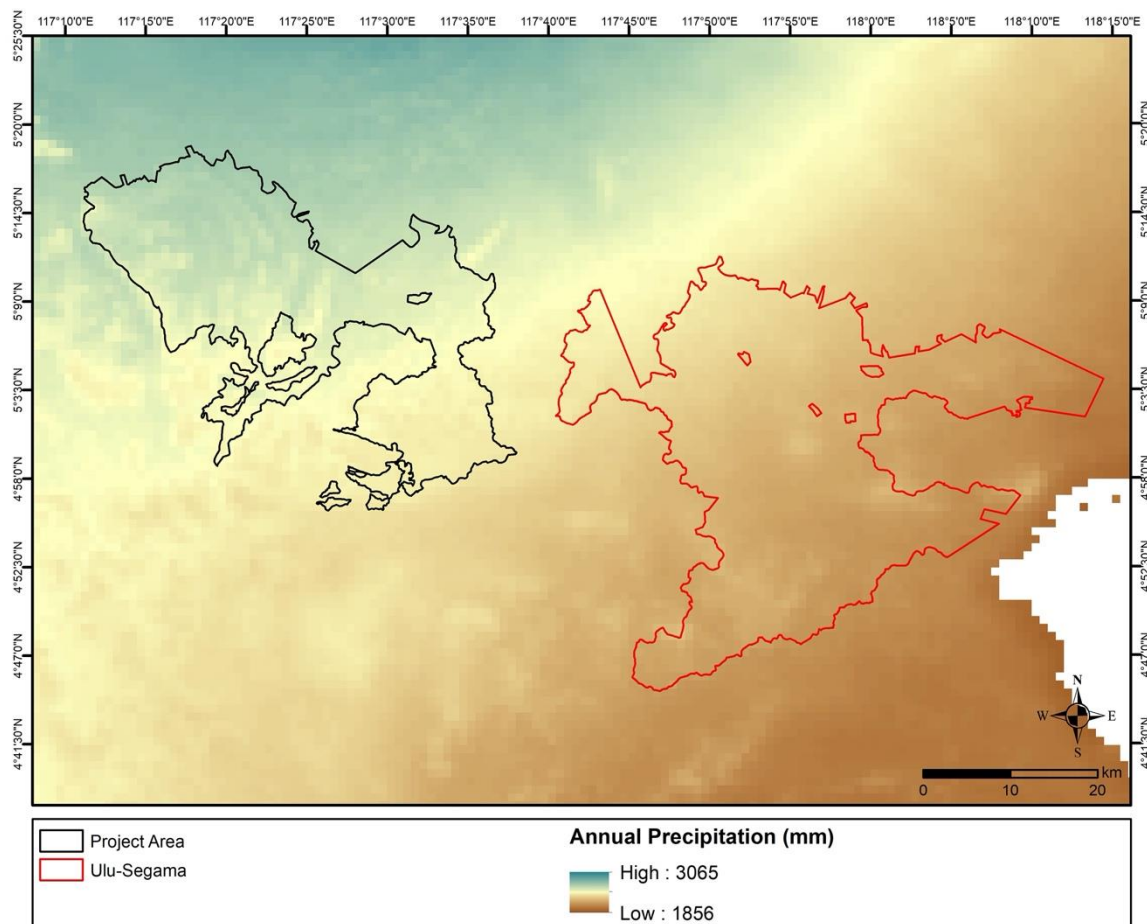


Figure 20: Annual Precipitation (mm) in the project area and the reference areas for NFM

Table 13: Annual Precipitation (mm) in the project area and the reference areas for NFM

	Average Annual Precipitation (mm)
Project Area	2461.49
Ulu-Segama	2170.47

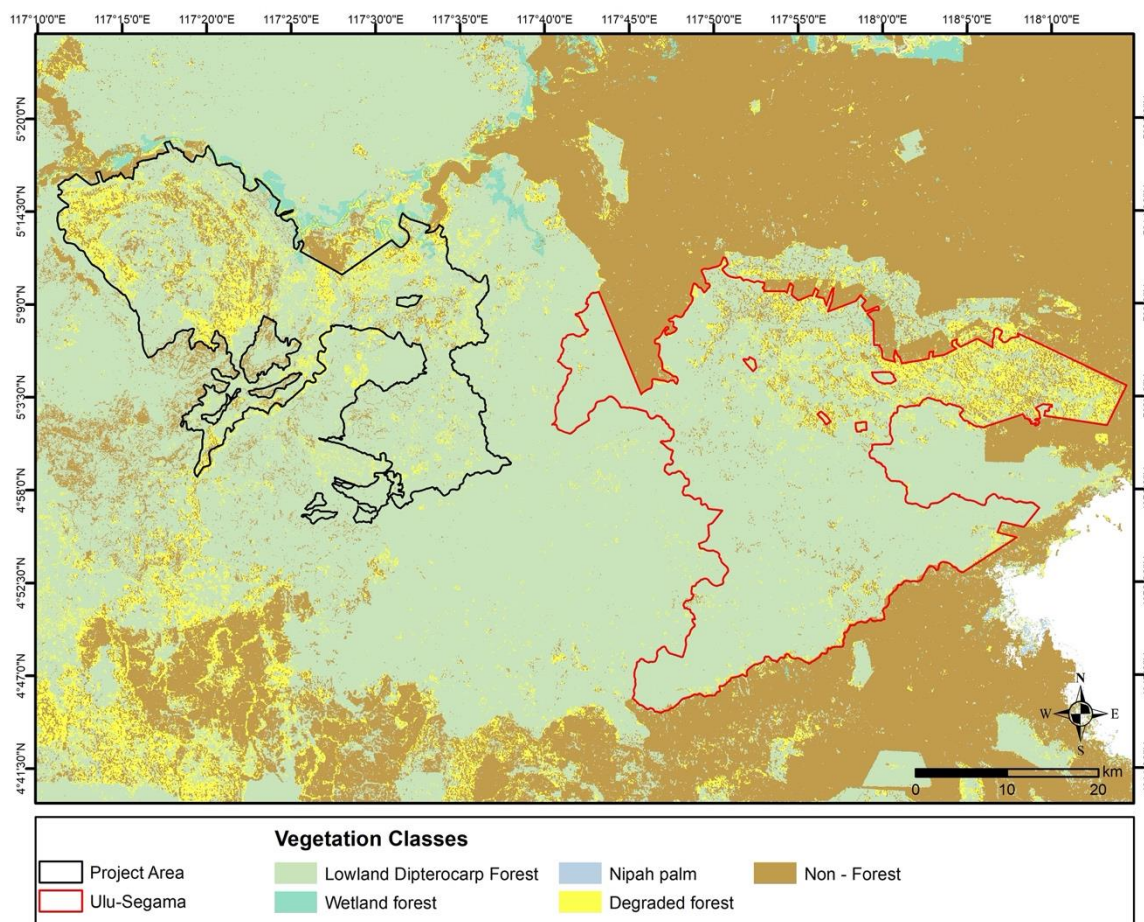


Figure 21: Vegetation classes in the project area and the reference areas for NFM

Table 14: Vegetation classes in the project area and the reference areas for NFM

	Lowland Dipterocarp Forest	Wetland Forest	Nipah Palm	Degraded Forest	Non-forest
Project Area	67.30%	1.27%	0%	19.22%	12.21%
Ulu-Segama	81.78%	0.12%	0.0008%	10.19%	7.90%

Initial stratification of the project area

The most likely baseline scenario is a combination of selective logging (Natural Forest Management) and the Mosaic Planting Approach. The concept of Mosaic Planting Approach involves timber harvesting while retaining small patches of natural forest areas containing young commercial tree species, and planting of fast-growing species in the more open areas. The small patches of natural forests left standing, usually on steeper slopes comprise commercially forest species with a diameter below the prescribed cutting limit. The more open and flatter areas left are harvested, cleaned and planted with selected forest plantation species.

Independent of the forest management, some parts of the project area would not have been subjected to management practices according to common practice within the YSFMA. This involves:

- Roads Buffers: 10m from roads
- Riverine Buffers: 30m from rivers
- Large riverine Buffers: 100m from major waterways (Kuamut River)
- Protected Area Buffers: 50m from protected areas
- Steep Slopes: Above 25°

The project area has therefore been divided in different baseline strata to reflect the different management practices under the baseline and the differences in existing vegetation. The following strata have been defined:

Stratum 1 - Inoperable: this stratum includes the area that would not have been subjected to any type of harvesting including Riverine Buffers, Protected Area Buffers and steep slopes

Stratum 2 – Natural Forest Management concessions: this stratum includes the areas that would have been subjected to continued selective logging (Natural Forest Management)

Stratum 3: Natural Forest Management within the Mosaic Planting areas: this includes the areas within the Mosaic Planting areas where patches of natural forest are left that are then subject to selective logging. These patches are usually located on steeper slopes. This stratum is different from stratum 2 because the cutting limit differs between the Natural Forest management and Mosaic Planting practices.

Stratum 4: Area within the Mosaic Planting areas subject to timber harvesting and planting: this stratum includes the parts of the Mosaic Planting areas that would have been subject to timber harvesting and clearing, followed by planting of fast-growing species.

The geographic extent of these strata has been defined.

To define stratum 1, all rivers, roads, protected area and buffers were demarcated (see Figure 22).

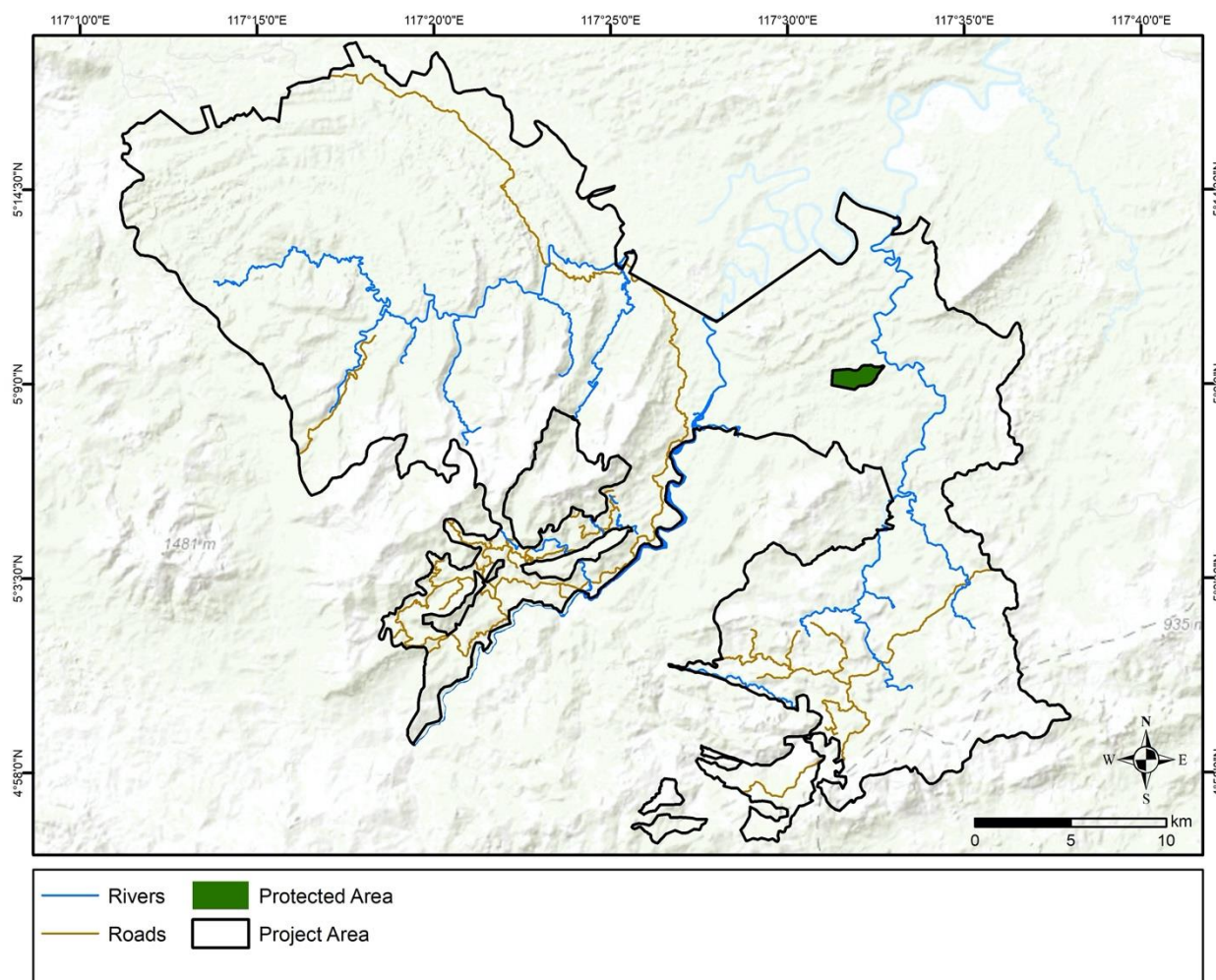


Figure 22: Rivers, roads, protected area and buffers in the project area.

To define the other strata, the first step has been to distinguish between the areas that would have been managed through the Natural Forest Management regime and the areas that would have been managed through the Mosaic Planting Approach.

The most important criteria to distinguish between these two management approaches is slope. Areas that are flatter (below 20 degrees) are deemed suitable for the Mosaic Planting Approach. This is in accordance with the local requirements for defining mosaic planting concessions. A high-resolution slope map (see Figure 23) was averaged to create 100-meter pixels (units of one hectares). A statistical technique of clustering was performed on the one-hectare resolution slope map to identify flat areas that would be managed using the Mosaic Planting approach, and the area for continued selective logging.

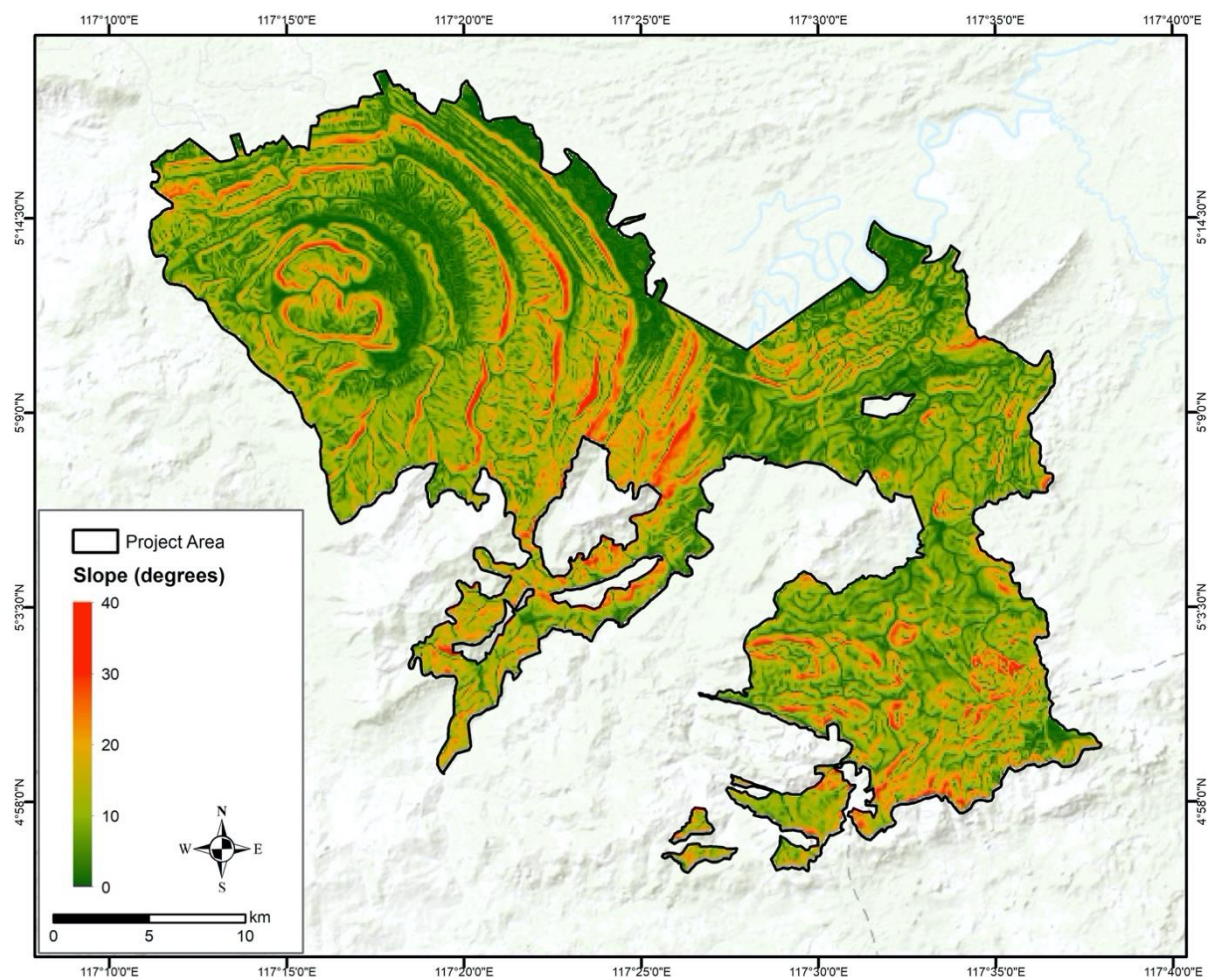


Figure 23: Map of Slope variation across project area. (Slope, derived from LiDAR data, and using SRTM for areas where LiDAR data is absent. Values are presented at 100 meter pixel resolution)

The cluster analysis identified two large contiguous ‘flat’ areas that would be suitable for the Mosaic Planting Approach.

In the second step, the flatter areas identified in the cluster analysis as more suitable to mosaic planting were overlaid with the boundaries of previous logging coupes (Figure 24).

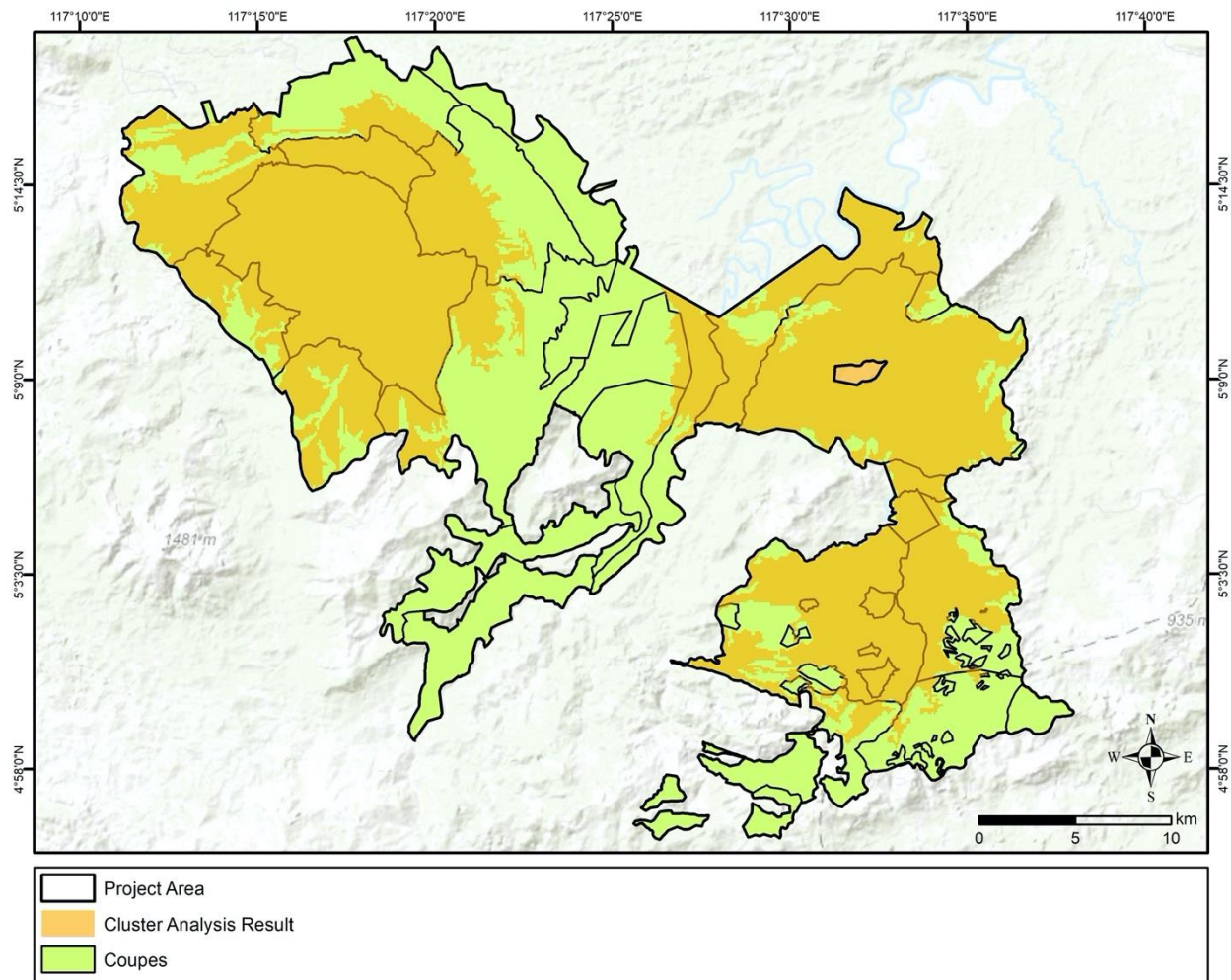


Figure 24: Map of Cluster Analysis showing ‘flatter areas’ overlaid on the boundaries of previous logging coupes.

It is normal practice in Sabah to use the rough boundaries of previous logging coupes to allocate permits. The boundaries of manually selected logging coupes were therefore used, resulting in a slightly adjusted boundary for the Mosaic Planting Approach area (see Figure 25). The remaining areas were allocated to stratum 2, for continued selective logging.

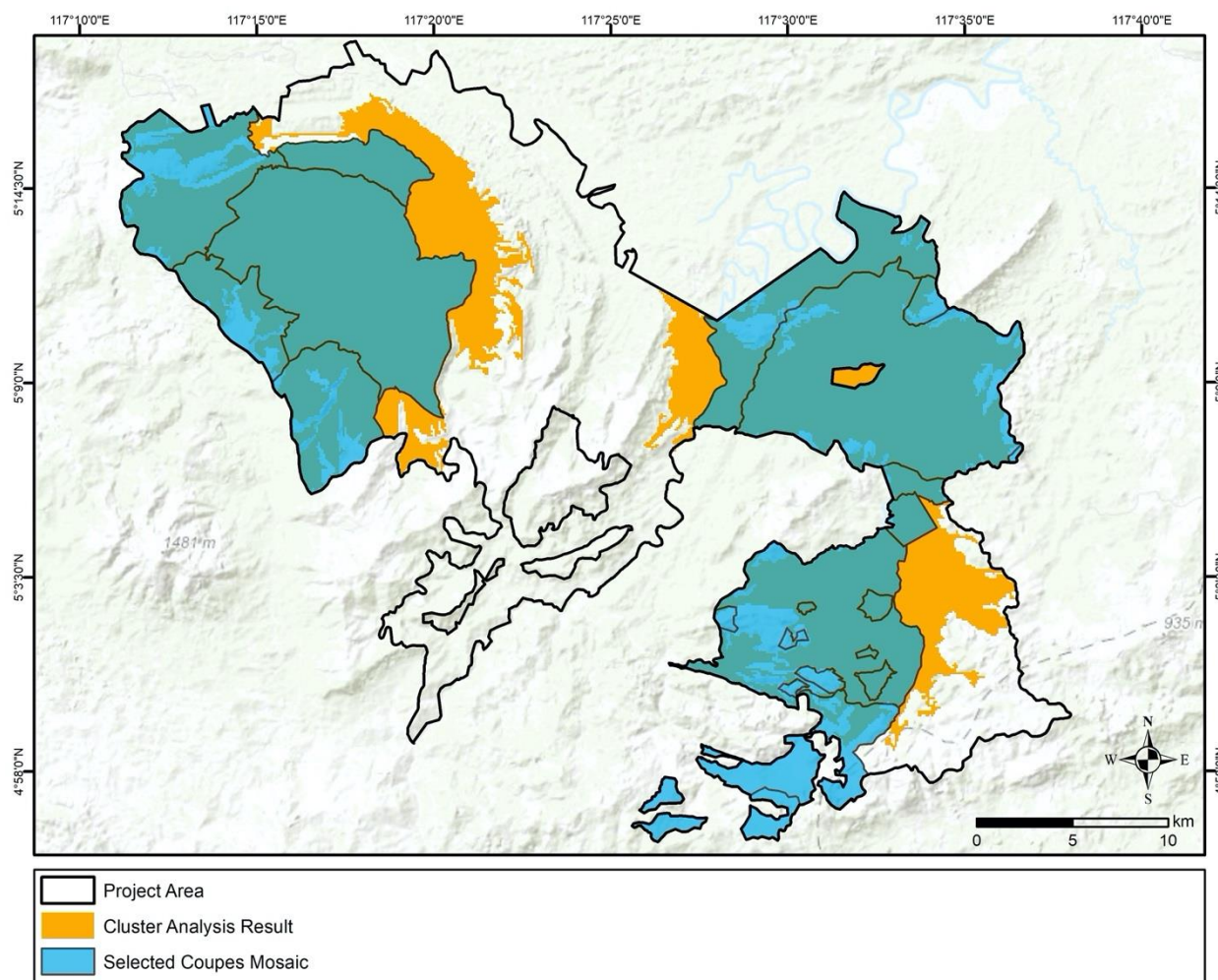


Figure 25: Selected logging coupes for allocation of Mosaic Planting Approach areas

In the third step, the larger areas suitable for the Mosaic Planting Approach have been further divided. The area of stratum 3 comprises the areas within the larger areas suitable for the Mosaic Planting Approach, that have a slope of more than 20 degrees. This stratum would have been subject to continuous selective logging as part of the Mosaic Planting Approach. Areas with a slope of less than 20 degrees were assigned to stratum 4 and these areas would have been subject to timber harvesting and clearing, followed by planting of fast-growing species. The result showing all strata is shown in Figure 26 below.

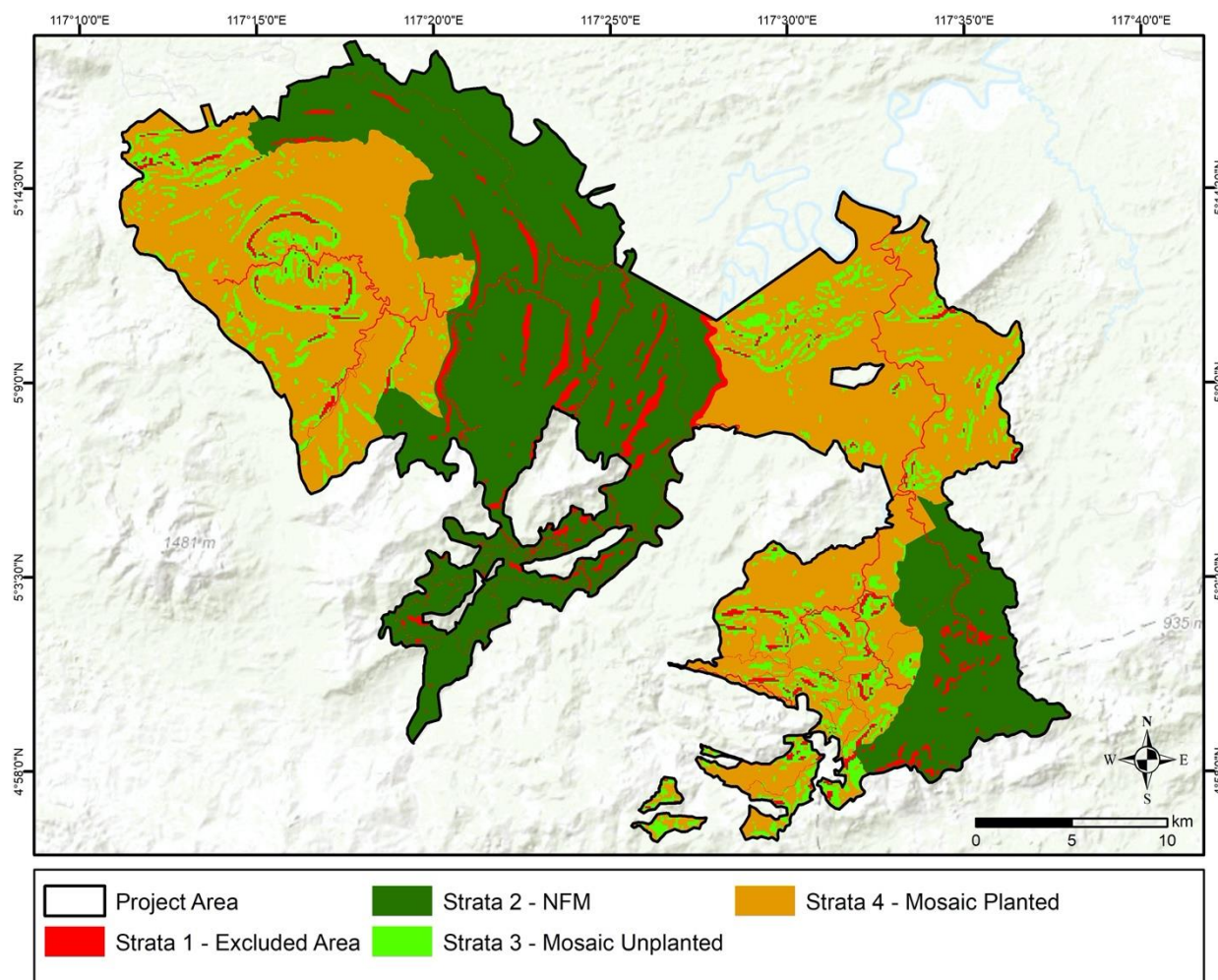


Figure 26: Map of the project area showing the different strata

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 15 below.

Table 15: Area of each stratum

	Area (ha)	Proportion Of Project Area
Stratum 1 (Inoperable)	4671	0.0560

Stratum 2 (Natural Forest Management)	34654	0.4156
Stratum 3 (selective logging within Mosaic Planting)	6866	0.0823
Stratum 4 (planting areas within Mosaic Planting)	37190	0.4460

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

The timber harvest plans for both the Mosaic Planting and NFM areas are based on 1) a detailed forest inventory using field plots and 2) airborne LiDAR data.

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 where 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)¹¹. Using these values, we then calculated a plot-level basal area weighted average and assigned it to any individuals lacking botanical information.

¹¹ 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

Biomass was calculated according to equation 4 from Chave et al. (2014)¹² 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).

Airborne LiDAR survey

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 27).

¹² 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.

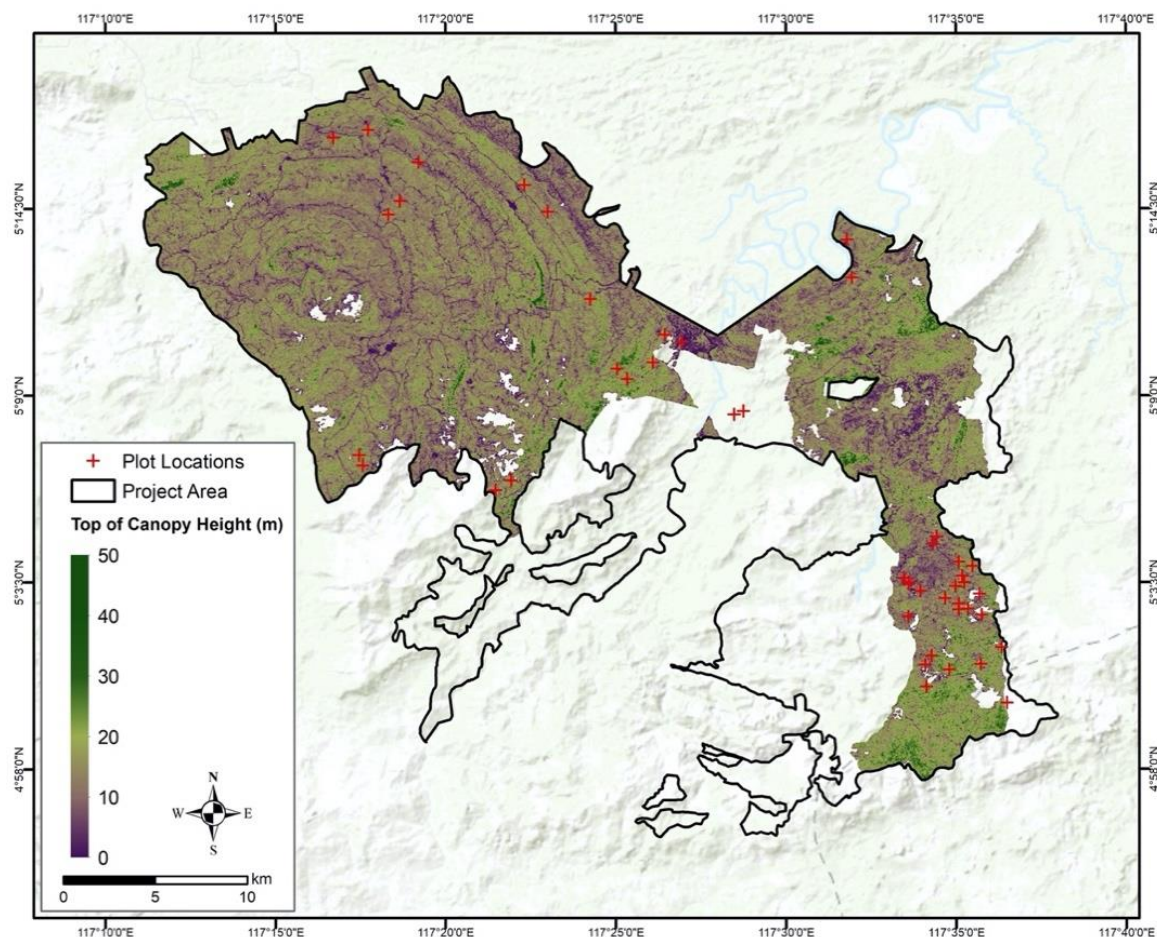


Figure 27: LiDAR coverage directly obtained for the project.

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.

The CAO State carbon mapping project originally published a 2016 map Above-ground Carbon Density (ACD) at a spatial resolution of 30 m (Asner et al. 2018)¹³. for the entire state of Sabah. The ACD data were derived from the LiDAR data using a combination of auxiliary remote sensing data and field data. To

¹³ Asner, G.P., P.G. Brodrick, C. Philipson, N.R. Vaughn, R.E. Martin, D.E. Knapp, J. Heckler, L.J. Evans, T. Jucker, B. Goossens, D.J. Stark, G. Reynolds, R. Ong, N. Renneboog, F. Kugan, and D.A. Coomes. 2018. Mapped aboveground carbon stocks to advance forest conservation and recovery in Malaysian Borneo. *Biological Conservation* 217:289-310

obtain the ACD, Asner et al. (2018) used a suite of GIS data to develop a multilayer artificial neural network, or deep learning model. Details of the networks remain proprietary to CAO (now GAO), but the methodology is described in see Asner et al. (2018)

In 2021, Asner et al. published a high-resolution Top of Canopy Height (TCH) map¹⁴ which was an intermediate step from their 2016 carbon map. This freely available data layer enabled us to parameterise the entire area of Kuamut and fill in the gaps in areas where LiDAR coverage was not directly obtained for the project (ie the blank areas in Figure 27). In summary, in areas where LiDAR point clouds were not directly available to the project (e.g due to clouds or areas not flown), these gaps were filled using the Sabah state-wide TCH map (Asner et al. 2018, Asner et al. 2021). This results in a high-resolution wall-to-wall TCH map (see Figure 28).

¹⁴ Asner, G.P., P.G. Brodrick, and J. Heckler. 2021. Global Airborne Observatory: Forest Canopy Height and Carbon Stocks for Sabah, Borneo Malaysia (Version 1.0) [Data set]. Zenodo. <http://doi.org/10.5281/zenodo.4549461>

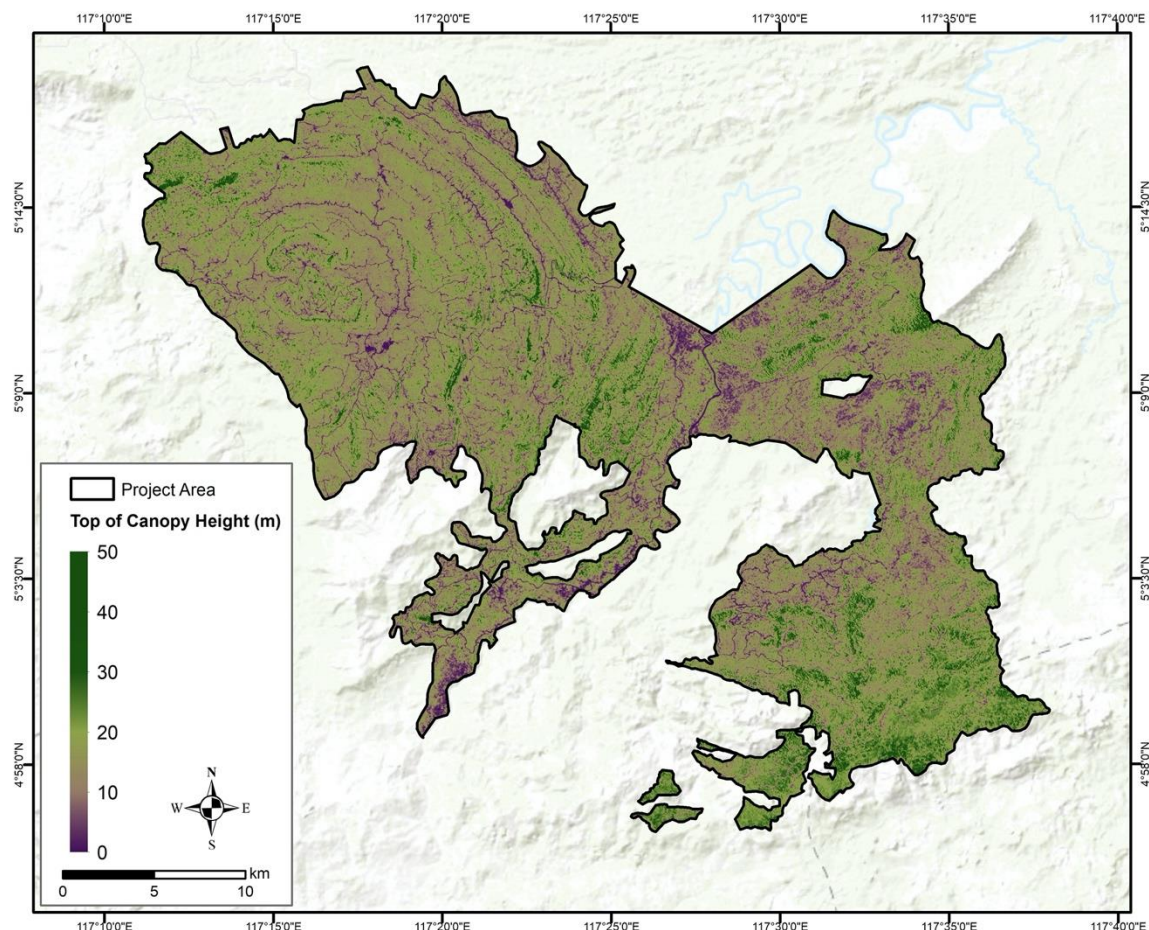


Figure 28: Top- Of-Canopy height (TCH) derived from LiDAR directly obtained for the project with gaps filled with a published TCH map.

General approach of combining plot data and airborne lidar.

The field plot data were combined with the high-resolution TCH map. Each field plot was geolocated in the TCH map (Figure 28) where the slope of each plot was used to cosine correct the area of the plot. The average TCH was determined for the cosine corrected area of each plot from the TCH map. The relationship between the merchantable volume from field plots and the TCH was modelled using a non-linear model. Since there are different defined cutting limits depending on the baseline land management, this was done separately for the NFM (Figure 29) and the Mosaic Planting Approach areas (Figure 30). We therefore separately describe the model and timber harvest plan for the NFM areas and the Mosaic Planting Approach areas.

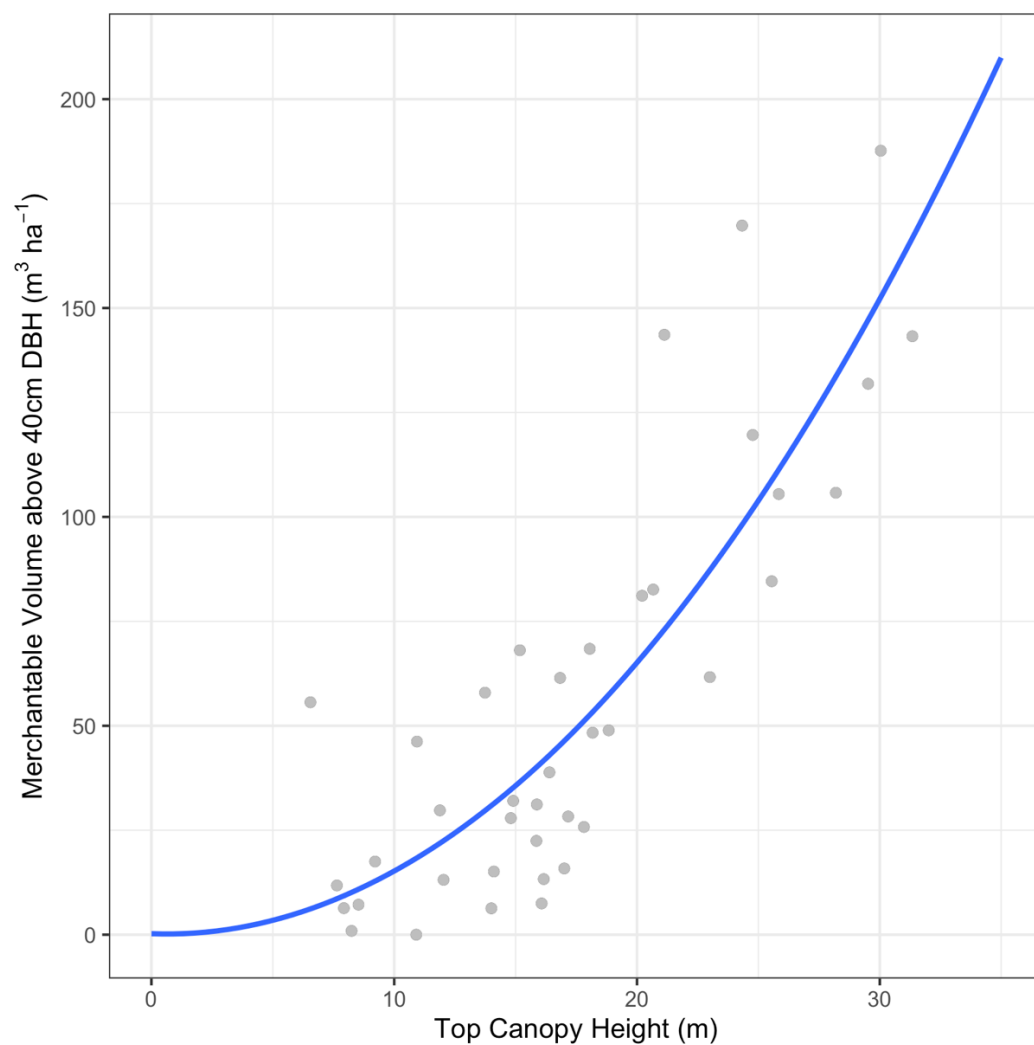


Figure 29: The relationship between field plot merchantable timber volume (above 40cm DBH) and LiDAR based Top of Canopy Height.

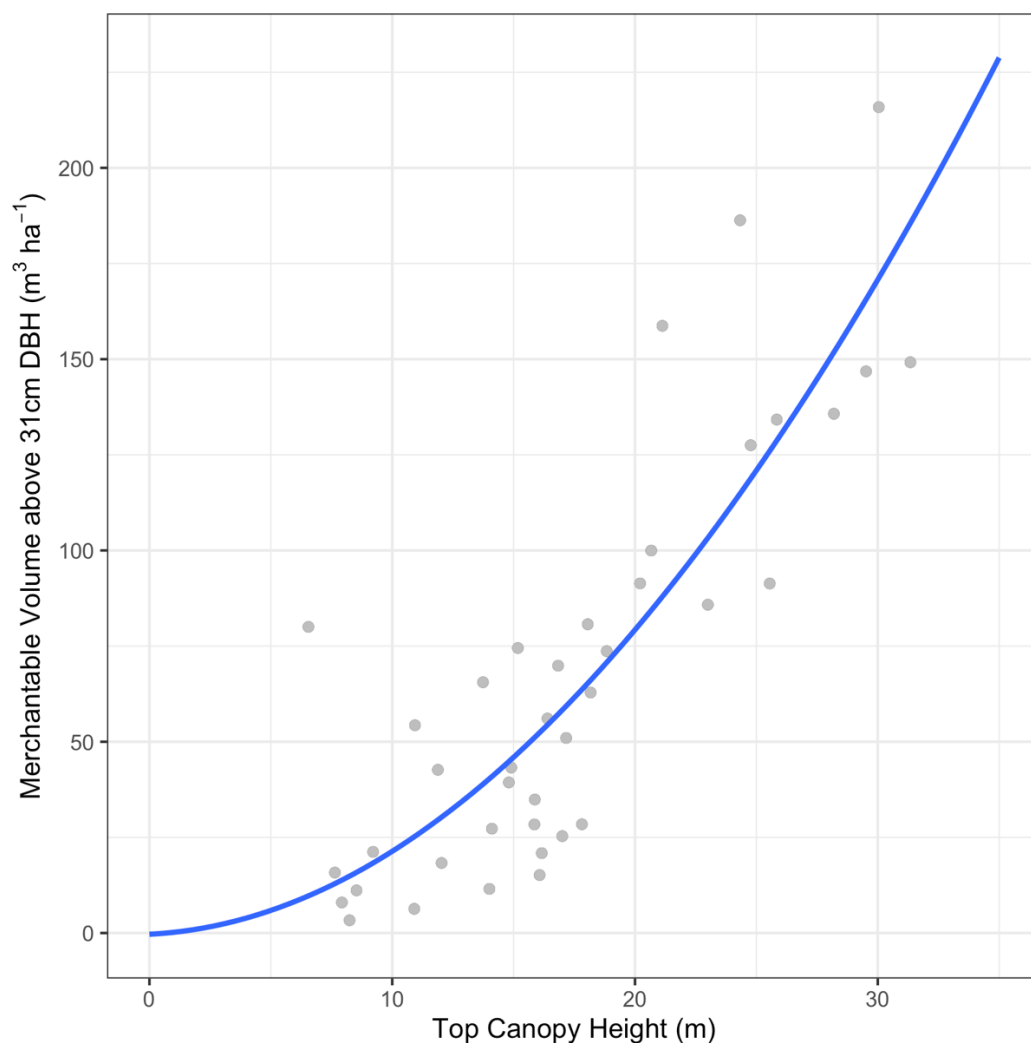


Figure 30: The relationship between field plot merchantable timber volume (above 31cm DBH) and LiDAR based Top of Canopy Height.

Using these models, a high-resolution merchantable timber volume map at a 30-meter pixel resolution was produced. Again, this was done separately for the NFM areas (Figure 31) and the Mosaic Planting areas (Figure 32).

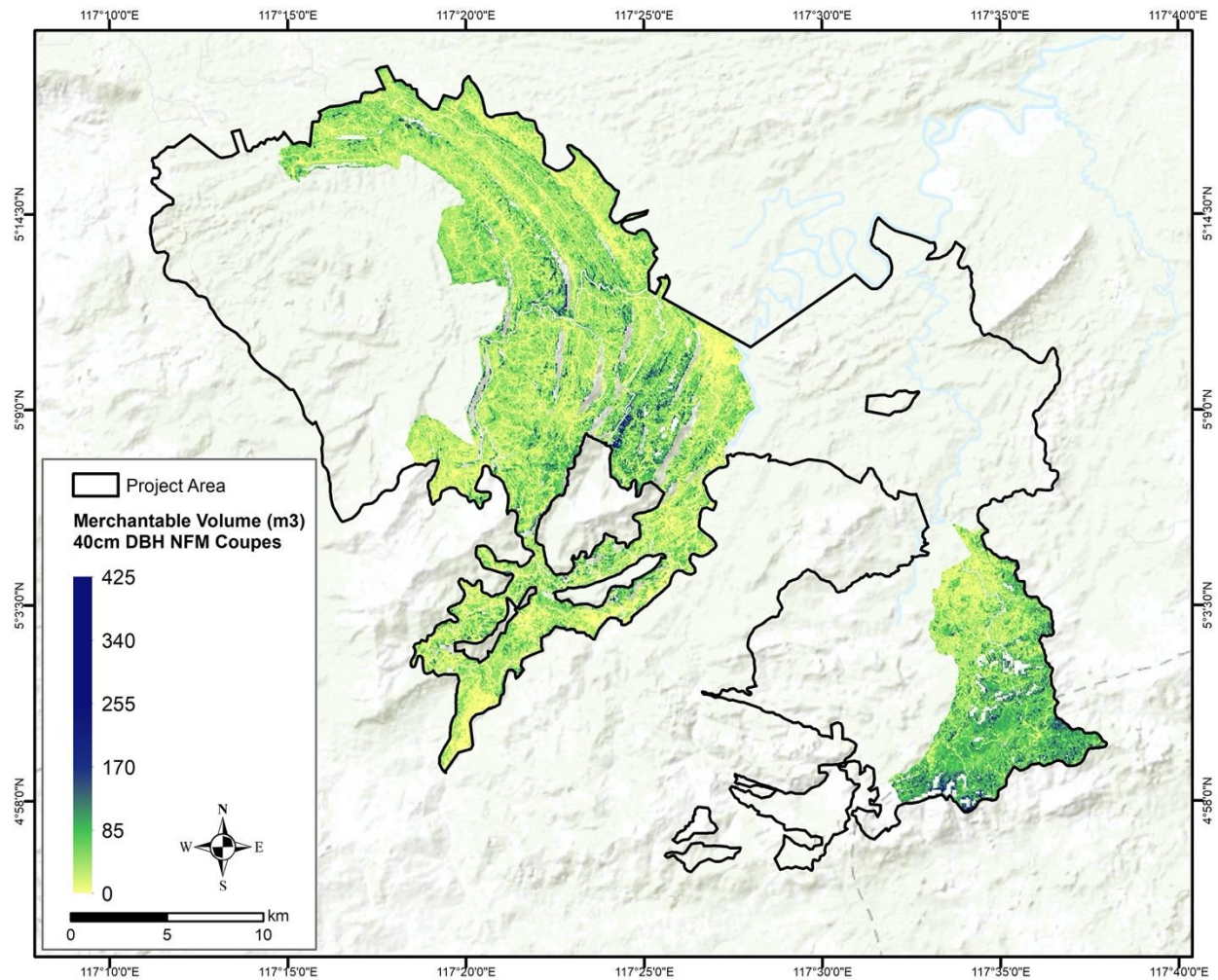


Figure 31: High Resolution Merchantable Timber Volume map derived from field plot data, airborne LiDAR and published TCH map using a DBH limit of 40 cm for Natural Forest Management areas

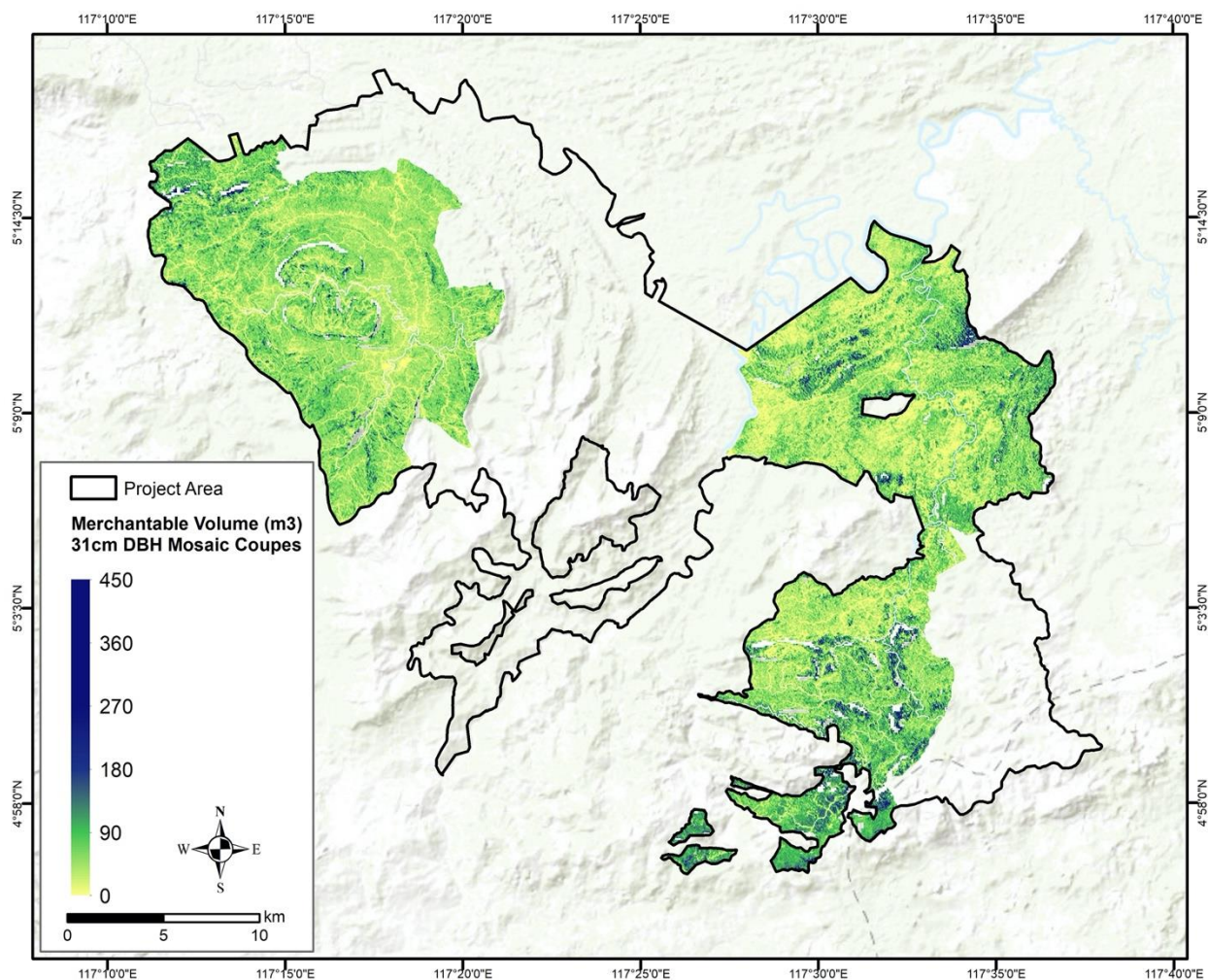


Figure 32: High Resolution Merchantable Timber Volume map derived from field plot data using a DBH limit of 31cm for Mosaic Planting Approach areas

Division of the harvestable forest into annual operating areas in the different strata based on common practice:

To divide the harvestable forest into annual operating areas, it is common practice in Sabah that new permits are based on the logging coupes of previous logging operations. Therefore, the scenario modelling started by collating historical data including the geographic boundaries of the historic logging coupes, and the last year that each logging coupe was logged. Each logging coupe was further subdivided into 31 hectare 'set-ups'. In Sabah setups are small units traditionally harvested by an individual logging team. The reference areas mentioned before, were used to determine when the different coupes and 'set-ups' would have been revised.

For the NFM areas, the timber harvesting plan foresees that NFM areas would experience re-entry logging 10 years after the last logging within the Kuamut reserve which took place in 2014. The analysis of the common practice from the Ulu Segama reference area shows that re-entry usually takes place once there is sufficient timber volume for an economic cut. Once re-entry logging is started, it is relatively efficient as some roads and access already exist from previously. In Ulu Segama around 20 000 ha was relogged per annum during the re-logging operation (Reynolds 2011). The harvest plan conservatively foresees that the re-entry logging would be complete in 5 years (circa 7 000 ha per annum for the 35 000 ha area). To determine the annual operating areas, the areas from the original logging coupes were used as a guide, where the most easily accessible areas would be logged first. This resulted in the annual operating areas as shown in Figure 33, showing for each coupe when the next harvesting is expected in the Timber Harvest Plan. The total area logged each year (here shown in different colour's) form the 'parcels' of the Timber Harvest Plan.

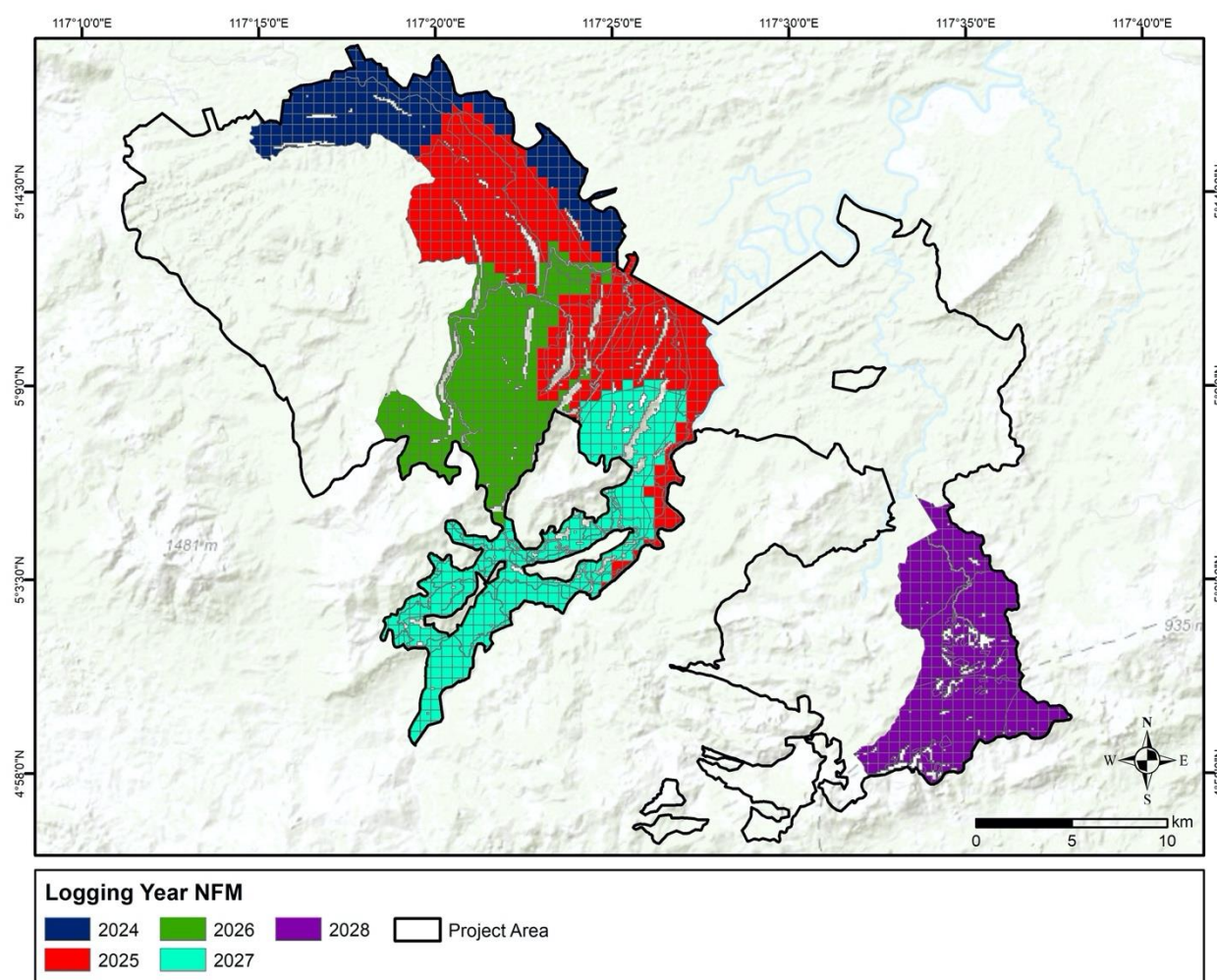


Figure 33: Annual operating areas for NFM area. Map indicating planned next harvesting for each NFM coupe under the baseline. Grid squares are 31 ha set-ups.

For the Mosaic areas, based on the reference areas, the timber harvesting plan assumes that the logging in the areas that will be replanted (often referred to as 'salvage logging') would take 6 years. This is based on the average rate of salvage logging in the management plans of the three reference mosaic areas. This resulted in the annual operating areas as shown in Figure 34, showing for each coupe when the next harvesting is expected in the Timber Harvest Plan.

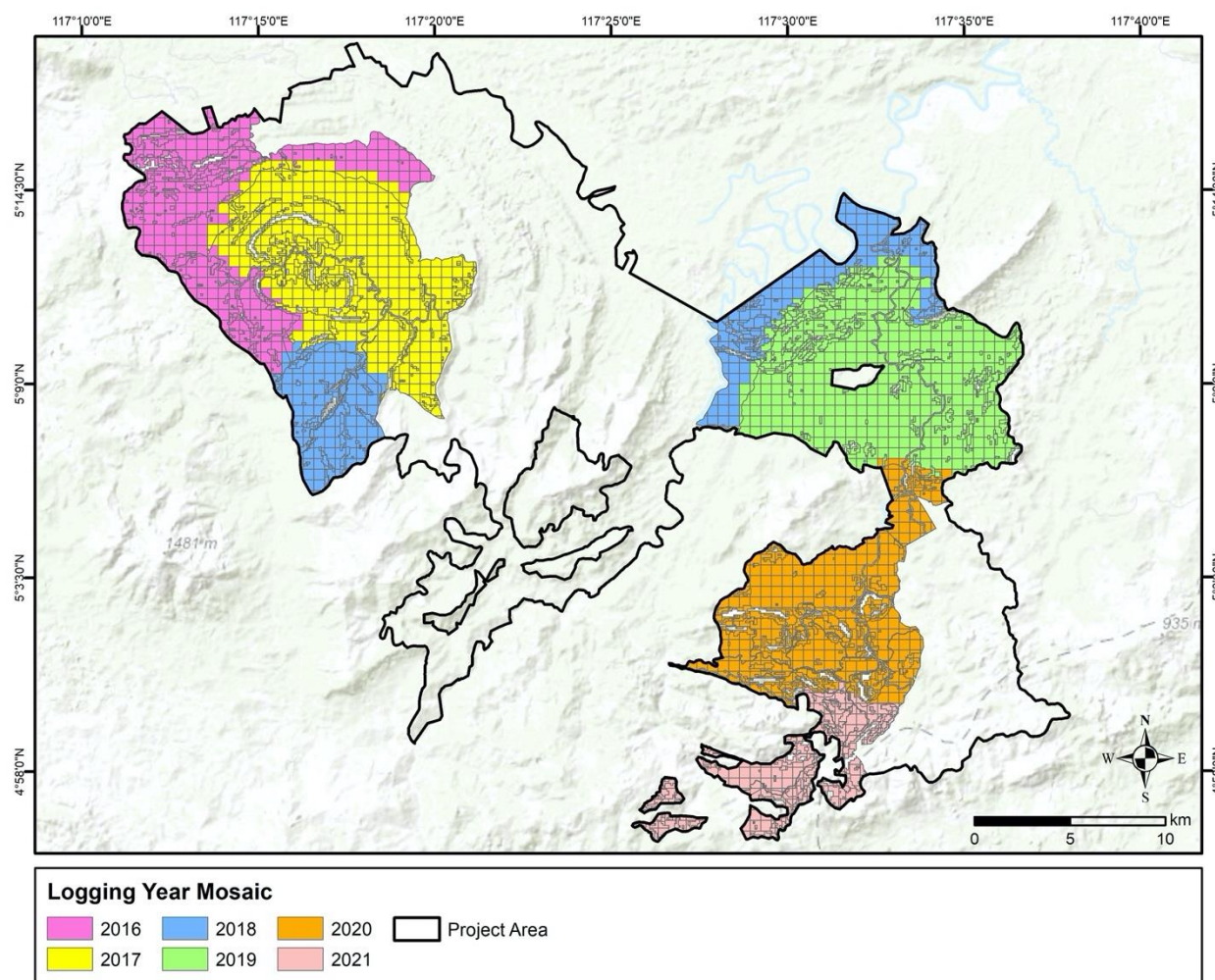


Figure 34: Annual operating areas for Mosaic Planting Approach area. Map indicating planned harvesting for each parcel within the Mosaic Planting Approach area under the baseline. Grid squares are 31 ha set-ups. The total area logged each year (here shown in different colour's) form the 'parcels' of the Timber Harvest Plan

Design of the forestry infrastructure needed to harvest, skid/haul, store and move harvested timber products from the land parcels to downstream processing or market entry points.

The project will not account for the forestry infrastructure and therefore the project will not estimate the mean volume of merchantable timber extracted for wood processing that is harvested during the process of forestry infrastructure establishment ($V_{EX,INF,j,i|BSL}$) and the mean volume of merchantable timber that is cleared during the process of forestry infrastructure establishment and NOT extracted for wood processing ($V_{notEX,INF,j,i|BSL}$).

Stratification

As explained in the step above on the modelling of the baseline and the development of the timber harvest plan, a wall-to-wall high resolution Merchantable Timber Volume map was developed by combining field data and LiDAR Top of Canopy Height data. The availability of wall-to-wall data excludes the need for further stratification beyond the initial strata defined during the modelling of the baseline scenario.

3.1.5 Additionality

In accordance with the requirements of the methodology, the additionality of the project is demonstrated using the most recent version of VCS tool, VT0001 VCS Tool for the Demonstration and Assessment of Additionality in AFOLU Project Activities.

Step 1: Identification of alternative land use scenarios to the proposed VCS AFOLU project activity

Sub-step 1a. Identify credible alternative land use scenarios to the proposed VCS AFOLU project activity

- a) As stated earlier, at the time of the project start, the project area was designated as production forest (Class II) and designated for further commercial exploitation. Considering this status, the following realistic and credible land-use scenarios could occur on the land within the proposed project boundary in the absence of the AFOLU project activity:
 - i. Continuation of the pre-project land use: under this scenario, the whole project area is subject to Natural Forest Management practice which involves continued commercial logging. The whole area would continue to be designated as production forest (Class II) for commercial exploitation and would be subject to continued periodic logging under the Natural Forest Management approach in Sabah
 - ii. Project activity on the land within the project boundary performed without being registered as the VCS AFOLU project: under this scenario, the project areas would have been converted to a protected forest without being registered as the VCS AFOLU project
 - iii. Activities similar to the proposed project activity on at least part of the land within the project boundary based on legal requirements or extrapolation of observed similar activities in the

geographical area with similar socio-economic and ecological conditions. Considering the current practices in Sabah, this could include the following:

- The project area is converted to an oil palm plantation. Conversion to oil palm is a common practice in Sabah
 - The whole project area is subject to the Mosaic Planting Approach. This is a variation on the commercial logging scenario. Under this scenario the commercial exploitation of the area would continue but the whole area would be subjected to the Mosaic Planting Approach.
 - Combination of commercial logging and Mosaic Planting Approach. This is a combination of the two scenarios above. Under this scenario, part of the area will be managed with the Mosaic Planting Approach. The remaining area would continue to be managed under the Natural Forest Management approach
- b) All the identified land use scenarios above are credible. As shown in figure 9 and figure 10, the scenarios described above all currently exist within the YSFMA area.
- c) Therefore the outcome of Sub-step 1a is the following list of credible alternative land use scenarios that could have occurred on the land within the project boundary of the VCS AFOLU project.

Scenario		Description
i.	Conversion to palm oil	Under this scenario, the project area is converted to an oil palm plantation
ii.	Whole project area is subject to Natural Forest Management practice which involves continued commercial logging	This is the continuation of the pre-project land use. The whole area is designated as production forest (Class II) for commercial exploitation and would be subject to continued periodic logging under the Natural Forest Management approach in Sabah
iii.	Whole project area is subject to the Mosaic Planting Approach	This is a variation on the commercial logging scenario. Under this scenario the commercial exploitation of the area would continue but the whole area would be subjected to the Mosaic Planting Approach.
iv.	Combination of commercial logging and Mosaic Planting Approach	This is a combination of the two scenarios above. Under this scenario, part of the area will be managed with the Mosaic Planting Approach. The remaining area would continue to be managed under the Natural Forest Management approach
v.	Protected forest (project activity)	This is a scenario where the project activity would be performed without being registered as the VCS AFOLU project;

Sub-step 1b. Consistency of credible land use scenarios with enforced mandatory applicable laws and regulations

Since the project area was a production forest (Class II) before the start of the project, scenarios ii, iii and iv identified above are legally permissible under the current laws and regulations governing forest areas. Scenario i (conversion to palm oil) requires changing the status of the land from forest to agricultural land. Yayasan Sabah as the licence holder of the land has been granted permission before to convert forest land into oil palm. This conversion is justified by Yayasan Sabah's status as a state sanctioned organisation that was developed to promote economic opportunities for the people of Sabah. Scenario v (protected forest) requires changing the status of the area to legal protected (Class I Protection Forest) and requires a change in the law and cabinet approval.

Therefore, based on this analysis the outcome of this sub-step 1.b includes all the scenarios identified in the table above and the outcome of Sub-step 1b is the following list of plausible alternative land use scenarios to the VCS AFOLU project activity that are in compliance with mandatory legislation and regulations taking into account their enforcement in the region or country and EB decisions on national and/or sectoral policies and regulations. The relevant regulations applicable to the plausible land use scenarios can be found in the Sabah Forestry Department official website (<https://forest.sabah.gov.my/index.php/discover/sustainable-forest-management.html>)

Scenario		Description
i.	Conversion to palm oil	Under this scenario, the project area is converted to an oil palm plantation
ii.	Whole project area is subject to Natural Forest Management practice which involves continued commercial logging	This is the continuation of the pre-project land use. The whole area is designated as production forest (Class II) for commercial exploitation and would be subject to continued periodic logging under the Natural Forest Management approach in Sabah
iii.	Whole project area is subject to the Mosaic Planting Approach	This is a variation on the commercial logging scenario. Under this scenario the commercial exploitation of the area would continue but the whole area would be subjected to the Mosaic Planting Approach.
iv.	Combination of commercial logging and Mosaic Planting Approach	This is a combination of the two scenarios above. Under this scenario, part of the area will be managed with the Mosaic Planting Approach. The remaining area would continue to be managed under the Natural Forest Management approach

v.	Protected forest (project activity)	This is a scenario where the project activity would be performed without being registered as the VCS AFOLU project;
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Sub-step 1c. Selection of the baseline scenario:

Please refer to section 3.1.4

Step 2. Investment analysis

The purpose of this step is to determine whether the proposed project activity (scenario v.), without the revenue from the sale of GHG credits is economically or financially less attractive than at least one of the other land use scenarios.

Sub-step 2a. Determine appropriate analysis method

In accordance with the tool, it must be determined whether to apply simple cost analysis, investment comparison analysis or benchmark analysis in sub-step 2b. These options are mutually exclusive hence, only one of them can be applied.

In accordance with the tool, if the VCS AFOLU project generates no financial or economic benefits other than VCS related income, then the simple cost analysis (Option I) should be applied. The project activities as described in section 2.1.11 do not generate financial or economic benefits for the project proponents, other than VCS related income. Therefore, the simple cost analysis (Option I) was applied.

Sub-step 2b. – Option I. Apply simple cost analysis

The costs associated with the VCS AFOLU project are documented and are available to the validator. The outcome of this Sub-step is that project activities produce no financial benefits for the project proponents other than VCS related income.

Step 4. Common practice analysis

Before the project was implemented, the project area was a Class II (Production) Forest Reserve. The normal practice within the YSFMA is for Class II forests to be harvested on a regular basis, through multiple rounds of re-entry, or multiple entry logging, and the establishment of mosaic planting areas.

The activities under the project involve the conversion of the project area from a Class II production area to a Class I (Protection) Forest Reserve. Class I designation confers total protection and prohibits all

extractive activities including timber harvesting and hunting. The publication by Reynolds et al (2011)¹⁵ was used to analyse to what extent similar activities to the one proposed had been implemented previously or were underway at the time the project was initiated in early 2012 (also see Figure 13 showing the YSFMA including the Class I Forest Reserves).

When the YSFMA was established, almost the entire area was classified as Class II production reserves - with the only exception being Virgin Jungle Reserves. The analysis by Reynolds et al (2011) estimated that in 1990, approximately 220,000 ha of the forests within the YSFMA remained unlogged. These included the (at that time) voluntarily set-aside Danum Valley and Maliau Basin Conservation Areas, even though they formally remained under Class II classification. Also included in the 220,00 ha was ca 100,000 ha of areas excised as unworkable, i.e. areas too steep to log using conventional harvesting methods. Most of the areas considered unworkable in 1990 have subsequently been licenced for harvesting, including through the use of helicopter yarding. The analysis therefore suggested that by 2010, the fully protected forests embedded within the borders of the YSFMA covered over 150,000 ha consisting of the already mentioned Danum Valley (which was gazetted as a Class I Forest Reserve in 1995) and Maliau Basin Conservation Areas (which was Class I gazetted in 1997), the Virgin Jungle Reserves, and some water catchments and riparian reserves.

With reference to Figure 13, there are areas classified as Class I (Protection) Forest Reserves in 2010, that were earlier classified as Class II production forest, in particular the Danum Valley and Maliau Basin Conservation Areas. When comparing the Kuamut Forest Reserve with these areas, the essential distinction is that the existing protected areas comprised almost entirely pristine forest and had not been logged when gazetted as a Class I Forest Reserves. The protection of the Danum Valley and Maliau Basin Conservation Areas was therefore driven by conservation and research interests based on their undisturbed status. Although the Project Area is part of an ecologically important and highly biodiverse habitat, within which minimally disturbed pockets of forest remain, the previous and repeated logging of the Kuamut Forest Reserve has resulted in significant disturbance and degradation. Given this, the impetus for protection which applied in the case of Danum and Maliau is largely absent in the case of the Kuamut Forest Reserve. This is further evidenced by the fact that after the Danum Valley and Maliau Basin were protected, the only other former Class II forests that have been protected (the Ulu Segama and Malua Forest Reserves) are part of a carbon financing project (the Innoprise-FACE Foundation Rainforest Restoration Project (INFAPRO) – within the Ulu Segama reserve) and a major bio-banking project (the Malua BioBank).

In conclusion, the outcome of the common practice within the YSFMA shows that, in the absence of external financial incentives, only pristine forests were re-gazetted from Class II (Production) to Class I (Protection) Forest Reserves. Further, and without financial incentives, the protection of these forests (i.e.

¹⁵ Glen Reynolds, Junaidi Payne, Waidi Sinun, Gregory Mosigil, Rory P D Walsh, 2011. Changes in forest land use and management in Sabah, Malaysian Borneo, 1990-2010, with focus on the Danum Valley region. Philos Trans R Soc Lond B Biol Sci <https://pubmed.ncbi.nlm.nih.gov/22006960/>

Danum and Maliau) took place almost 20 years before the start of the Project. Other formerly Class II Forest Reserves (e.g. Ulu Segama and Malua) have primarily been protected because of external financial incentives; Therefore the outcome of the common practice analysis is that the project activity, without the prospect of the sale of GHG credits, is not common practice.

Conclusion

Following the steps above, it is concluded that the proposed VCS AFOLU project activity is not the baseline scenario and, hence, it is additional

3.1.6 Methodology Deviations

The project does not have any methodology deviations.

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 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 field plot data were combined with the high-resolution Top- Of-Canopy height (TCH) map derived from LiDAR. Each field plot was geolocated in the TCH map where the slope of each plot was used to cosine correct the area of the plot. The average TCH was determined for the cosine corrected area of each plot from the TCH map. The relationship between the merchantable volume from field plots and the TCH was modelled using a non-linear model. Since there are different defined cutting limits depending on the baseline land management, this was done separately for the NFM and the Mosaic Planting Approach areas. Using these models, a high-resolution merchantable timber volume map was produced 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 ($V_{EX,j,ijBSL}$) was estimated as indicated in Table 16.

Table 16: 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		62.00	42.32
2017		50.00	35.04
2018		55.28	36.96
2019		54.24	39.76
2020		65.44	41.68
2021		80.64	68.48
2022			
2023			
2024	28.3		
2025	33.6		

2026	33.0		
2027	33.0		
2028	50.7		
2029			
2030			
2031			
2032			76.0
2033			76.0
2034			76.0
2035			76.0
2036			76.0
2037			76.0
2038			76.0
2039	28.3		76.0
2040	33.6		76.0
2041	33.0		76.0
2042	33.0		76.0
2043	50.7		76.0
2044			76.0
2045			76.0

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

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

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 , $m^3 \cdot ha^{-1}$;
$BCEFR$	Biomass conversion and expansion factor applicable to wood removals in the project area, $t.d.m \ m^{-3}$
CF_j	Carbon fraction of biomass for species j , $tC \ t \ d.m^{-1}$
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 LiDAR based Top of Canopy Height. 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 $BCEFR$ 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 $0.47 \ tC \cdot td.m^{-1}$ was used (Martin and Thomas 2011)¹⁶. The resulting values for the mean carbon stock of harvested biomass per hectare ($C_{HB,j,i|BSL}$) is provided in Table 17.

Table 17: 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 ($tC \ ha^{-1}$)		
	Stratum 2 (Natural Forest Management)	Stratum 3 (selective logging within Mosaic Planting)	Stratum 4 (planting areas within Mosaic Planting)

¹⁶ Martin, Adam & Thomas, Sean. (2011). A Reassessment of Carbon Content in Tropical Trees. PloS one. 6. e23533. 10.1371/journal.pone.0023533.

2016		55.07	37.59
2017		44.42	31.13
2018		49.11	32.83
2019		48.18	35.32
2020		58.13	37.02
2021		71.63	60.83
2022			
2023			
2024	25.14		
2025	29.85		
2026	29.31		
2027	29.31		
2028	45.04		
2029			
2030			
2031			
2032			67.51

2033			67.51
2034			67.51
2035			67.51
2036			67.51
2037			67.51
2038			67.51
2039	25.14		67.51
2040	29.85		67.51
2041	29.31		67.51
2042	29.31		67.51
2043	45.04		67.51
2044			67.51
2045			67.51

Following the methodology, it is assumed that not all of the harvested biomass leaves the forest and the timber harvested is 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·ha ⁻¹
$V_{EX,j,i BSL}$	Mean volume of extracted timber per unit area for species j in stratum i , m ³ ·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 ·ha ⁻¹ ;
D_j	Basic wood density of species j ; t d.m. m ⁻³
CF_j	Carbon fraction of biomass for species j , tC t 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 tC·td.m⁻¹ was used. The resulting values for the mean carbon stock of extracted timber per hectare is provided in Table 18.

Table 18: 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 ha ⁻¹)		
	Stratum 2 (Natural Forest Management)	Stratum 3 (selective logging within Mosaic Planting)	Stratum 4 (planting areas within Mosaic Planting)
2016		14.86	10.14
2017		11.98	8.40
2018		13.25	8.86
2019		13.00	9.53

2020		15.69	9.99
2021		19.33	16.41
2022			
2023			
2024	6.78		
2025	8.05		
2026	7.91		
2027	7.91		
2028	12.15		
2029			
2030			
2031			
2032			18.22
2033			18.22
2034			18.22
2035			18.22
2036			18.22

2037			18.22
2038			18.22
2039	6.78		18.22
2040	8.05		18.22
2041	7.91		18.22
2042	7.91		18.22
2043	12.15		18.22
2044			18.22
2045			18.22

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 value of 1.8 was used. This was calculated based on Pinard and Putz (1996)¹⁷ who found that within the Ulu Segama area 41% of unharvested trees were severely damaged (uprooted and crushed) in conventional logging. We applied this 41% to the extraction rate in the NFM areas. On average this gave a F_{RSD} of 1.8. The same F_{RSD} has been used for stratum 3.

Applying this value leads to the values for mean carbon stock in timber from residual stand damage in each stratum as provide in Table 19.

Table 19: Mean carbon stock in timber from residual stand damage in each stratum (years in bold indicate the years included in the first baseline period)

¹⁷ Pinard, M., & Putz, F. (1996). Retaining Forest Biomass by Reducing Logging Damage. Biotropica, 28(3), 278-295. doi:10.2307/2389193

Year that logging would occur according to the timber harvesting plan	Mean carbon stock in timber from residual stand damage 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		26.75	18.26
2017		21.57	15.12
2018		23.85	15.95
2019		23.4	17.15
2020		28.23	17.98
2021		34.79	29.55
2022			
2023			
2024	12.21		
2025	14.5		
2026	14.24		
2027	14.24		
2028	21.88		
2029			

2030			
2031			
2032			32.79
2033			32.79
2034			32.79
2035			32.79
2036			32.79
2037			32.79
2038			32.79
2039	12.21		32.79
2040	14.5		32.79
2041	14.24		32.79
2042	14.24		32.79
2043	21.88		32.79
2044			32.79
2045			32.79

As indicated earlier, the calculations have conservatively assumed that the mean volume of extracted timber for forestry infrastructure ($V_{EX,INF,j,i|BSL}$) 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 ($C_{notHB,inf,l,j,i|BSL}$ 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 20.

Table 20: 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 (tC ha ⁻¹)		
	Stratum 2 (Natural Forest Management)	Stratum 3 (selective logging within Mosaic Planting)	Stratum 4 (planting areas within Mosaic Planting)
2016		66.96	45.71
2017		54.00	37.85
2018		59.71	39.92
2019		58.58	42.94
2020		70.68	45.02
2021		87.10	73.96
2022			
2023			
2024	30.57		

2025	36.29		
2026	35.64		
2027	35.64		
2028	54.76		
2029			
2030			
2031			
2032			82.08
2033			82.08
2034			82.08
2035			82.08
2036			82.08
2037			82.08
2038			82.08
2039	30.57		82.08
2040	36.29		82.08
2041	35.64		82.08

2042	35.64		82.08
2043	54.76		82.08
2044			82.08
2045			82.08

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 these data the shares of likely wood products to be produced from the harvested wood have been determined as shown in Table 21.

Table 21: 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 18.

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 22.

Table 22: 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					1.02	2.50	1.56	5.07	0.69	1.70	1.07	3.46
2017					0.82	2.01	1.26	4.09	0.57	1.41	0.88	2.87
2018					0.91	2.23	1.39	4.52	0.61	1.49	0.93	3.02
2019					0.89	2.18	1.37	4.44	0.65	1.60	1.00	3.25
2020					1.07	2.64	1.65	5.36	0.68	1.68	1.05	3.41
2021					1.32	3.25	2.03	6.60	1.12	2.76	1.72	5.60
2022												
2023												
2024	0.46	1.14	0.71	2.32								
2025	0.55	1.35	0.85	2.75								

2026	0.54	1.33	0.83	2.70								
2027	0.54	1.33	0.83	2.70								
2028	0.83	2.04	1.28	4.15								
2029												
2030												
2031												
2032									1.25	3.06	1.91	6.22
2033									1.25	3.06	1.91	6.22
2034									1.25	3.06	1.91	6.22
2035									1.25	3.06	1.91	6.22
2036									1.25	3.06	1.91	6.22
2037									1.25	3.06	1.91	6.22
2038									1.25	3.06	1.91	6.22
2039	0.46	1.14	0.71	2.32					1.25	3.06	1.91	6.22
2040	0.55	1.35	0.85	2.75					1.25	3.06	1.91	6.22

2041	0.54	1.33	0.83	2.70					1.25	3.06	1.91	6.22
2042	0.54	1.33	0.83	2.70					1.25	3.06	1.91	6.22
2043	0.83	2.04	1.28	4.15					1.25	3.06	1.91	6.22
2044									1.25	3.06	1.91	6.22
2045									1.25	3.06	1.91	6.22

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 ;
$C_{EX,i BSL}$	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

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

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
$C_{WP BSL}$	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 23: 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 24.

Table 24: 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					1.60	5.37	2.42	9.39	1.09	3.67	1.65	6.41
2017					1.29	4.33	1.95	7.58	0.90	3.04	1.37	5.31
2018					1.43	4.79	2.16	8.38	0.95	3.20	1.44	5.60
2019					1.40	4.70	2.12	8.22	1.03	3.44	1.55	6.02
2020					1.69	5.67	2.56	9.91	1.08	3.61	1.63	6.31
2021					2.08	6.99	3.15	12.22	1.77	5.93	2.68	10.38
2022												
2023												
2024	0.73	2.45	1.11	4.29								
2025	0.87	2.91	1.31	5.09								
2026	0.85	2.86	1.29	5.00								

2027	0.85	2.86	1.29	5.00								
2028	1.31	4.39	1.98	7.68								
2029												
2030												
2031												
2032									1.96	6.58	2.97	11.51
2033									1.96	6.58	2.97	11.51
2034									1.96	6.58	2.97	11.51
2035									1.96	6.58	2.97	11.51
2036									1.96	6.58	2.97	11.51
2037									1.96	6.58	2.97	11.51
2038									1.96	6.58	2.97	11.51
2039	0.73	2.45	1.11	4.29					1.96	6.58	2.97	11.51
2040	0.87	2.91	1.31	5.09					1.96	6.58	2.97	11.51
2041	0.85	2.86	1.29	5.00					1.96	6.58	2.97	11.51

2042	0.85	2.86	1.29	5.00					1.96	6.58	2.97	11.51
2043	1.31	4.39	1.98	7.68					1.96	6.58	2.97	11.51
2044									1.96	6.58	2.97	11.51
2045									1.96	6.58	2.97	11.51

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 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)¹⁸ which gives 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 (2015)¹⁹ 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 2009²⁰). To our knowledge *Neolamarckia* was not in the database

¹⁸ Suarez *et al*, 2019. [Estimating aboveground net biomass change for tropical and subtropical forests: Refinement of IPCC default rates using forest plot data](#)

¹⁹ Ahmad Zuhaidi Yahya & Albert Ikau A.G. (2015) 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)

²⁰ 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

and we used a value of 0.362 from Mahmud *et al.* (2017)²¹. 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 (2015), 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 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)

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)

²¹ 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 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:

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

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

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

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:

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

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;
$\Delta C_{RG,i,p BSL}$	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:

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

(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 25.

Table 25: 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	42,196.95	154,722.15	154,722.15

2017	59,443.14	217,958.17	372,680.32
2018	61,344.61	224,930.24	597,610.57
2019	99,516.62	364,894.26	962,504.82
2020	111,666.03	409,442.12	1,371,946.94
2021	119,430.42	437,911.54	1,809,858.49
2022	100,851.97	369,790.54	2,179,649.02
2023	100,851.97	369,790.54	2,549,439.56
2024	120,359.43	441,317.90	2,990,757.47
2025	158,172.91	579,967.32	3,570,724.79
2026	129,092.71	473,339.93	4,044,064.72
2027	107,444.38	393,962.73	4,438,027.45
2028	120,487.05	441,785.86	4,879,813.31
2029	43,488.96	159,459.53	5,039,272.84
2030	5,372.84	19,700.41	5,058,973.25
2031	-19,147.47	-70,207.39	4,988,765.86
2032	-4,263.61	-15,633.23	4,973,132.63
2033	2,908.52	10,664.58	4,983,797.21
2034	-4,875.04	-17,875.14	4,965,922.06
2035	-33,137.56	-121,504.39	4,844,417.68
2036	-51,017.45	-187,063.99	4,657,353.69
2037	-70,644.10	-259,028.38	4,398,325.31
2038	-102,834.16	-377,058.60	4,021,266.71
2039	-79,561.17	-291,724.27	3,729,542.44
2040	-37,248.91	-136,579.34	3,592,963.09
2041	-27,343.31	-100,258.81	3,492,704.29
2042	-14,246.66	-52,237.75	3,440,466.53

2043	22,064.34	80,902.57	3,521,369.10
2044	-10,418.17	-38,199.95	3,483,169.15
2045	-15,909.46	-58,334.67	3,424,834.48

3.2.2 Project Emissions

The net greenhouse gas emissions in the project scenario 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)

The annual carbon stock change in aboveground biomass of trees in the project scenario ($\Delta C_{AB,IPRJ}$), will be estimated using a similar approach that was used for the baseline. The approach will involve remeasuring of field plots in combination with remote sensing (LiDAR (airborne and/or satellite), supported with optical and RADAR remote sensing data). The field data and remote sensing data will be combined to estimate the carbon stock per strata, and in turn determine the stock changes between sampling events.

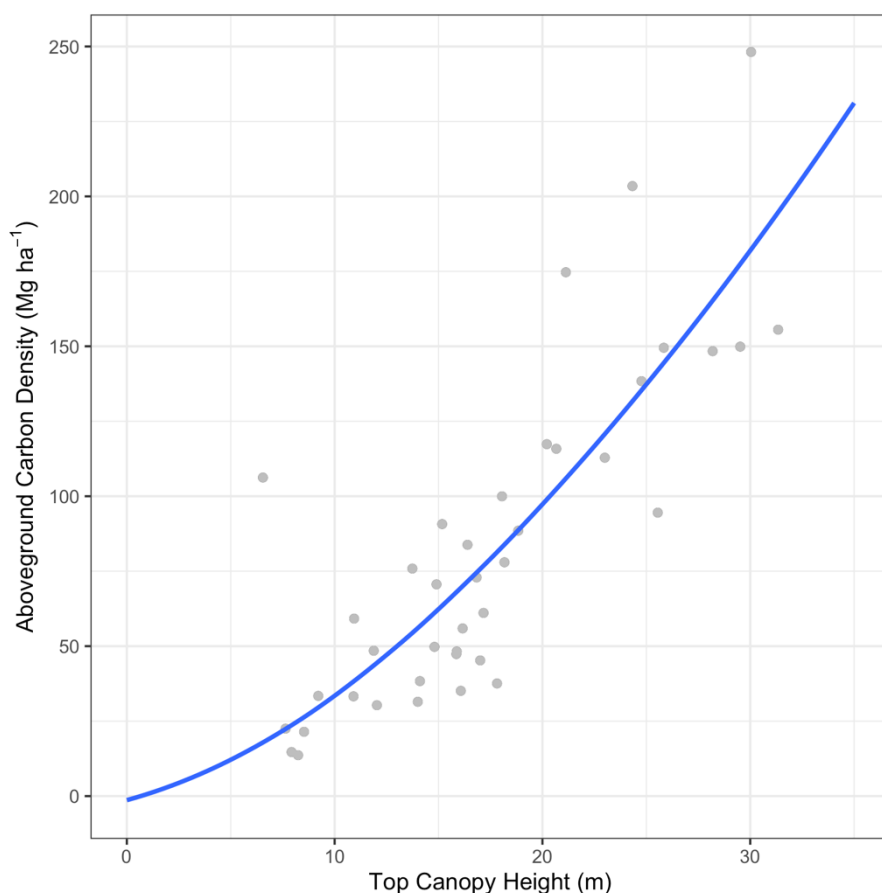
For the *ex-ante* estimations of the project emissions, a value of $1.6 \text{ t C ha}^{-1}\text{yr}^{-1}$ was used. This value is based on table 1 of Suarez (2019)²² which gives an average growth rate of $3.4 \text{ Mg d.m. ha}^{-1} \text{ year}^{-1}$ for tropical rainforest in Asia. This was multiplied by the default carbon fraction of 0.47 to provide the value of $1.6 \text{ t C ha}^{-1}\text{yr}^{-1}$.

Allometry:

For the allometry, a non-linear model has been developed to establish the relationship between Aboveground Carbon Density (above 40cm DBH) and LiDAR based Top of Canopy Height. This model was developed from the baseline data using the same approach as employed earlier for merchantable volume. This means that the baseline field plot data was used to calculate biomass

²² Suarez *et al*, 2019. [Estimating aboveground net biomass change for tropical and subtropical forests: Refinement of IPCC default rates using forest plot data](#)

per plot using equation 4 from Chave et al. (2014)²³. The resulting tree biomass was converted to carbon assuming a carbon fraction of 0.47 (Martin and Thomas 2011)²⁴. The plot level Aboveground Carbon Density (ACD) per hectare was derived by summing the ACD of all trees in the dataset (10 cm DBH). The field plot data were combined with the high-resolution Top of Canopy Height (TCH) Map. Each field plot was geolocated in the TCH Map where the slope of each plot was used to cosine correct the area of the plot. The average TCH was determined for the cosine corrected area of each plot from the TCH map. The relationship between the Aboveground Carbon Density from field plots and the TCH was modelled using a non-linear model (Figure 35). During the monitoring of the project emissions, the model will be re-assessed and updated if necessary.



²³ 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.

²⁴ Martin, Adam & Thomas, Sean. (2011). A Reassessment of Carbon Content in Tropical Trees. *PloS one*. 6. e23533. 10.1371/journal.pone.0023533.

Figure 35: The relationship between field plot Aboveground Carbon Density (above 40cm DBH) and LiDAR based Top of Canopy Height.

Measurements

Measurements will involve measurements in field plots and repeat remote sensing. The same SOPs will be used so any minimum values employed in inventories are held constant for the duration of the project

Determining Sample Plot Carbon Stocks

Field plots. The project will remeasure as many field plots as feasible, but it is expected that there may be access difficulties due to physical access on the ground (eg. Roads and bridges). It is therefore expected that subsequent monitoring of ongoing growth may rely on measurements from a subset of the plots. It is anticipated that this will be supplemented with measurements from other related or new plots that are in more accessible areas.

Determining Stratum Carbon Stocks and Mean Carbon Stocks

For the project emissions, the same approach is used as for the baseline emissions to determine Stratum Carbon Stocks and Mean Carbon Stocks. The wall-to-wall LiDAR campaign at the start of the project resulted in a high-resolution Digital Elevation Model (DEM) and Digital Surface Model (DSM) that together were used to produce the TCH map. The DEM, DSM and TCH map will be used to calibrate future remote sensing data. To determine ongoing forest growth, targeted LiDAR data will be collected in specific areas or using satellite LiDAR using a sampling approach. This will be complemented by other remote sensing data where necessary. This will result in an updated high resolution volume and carbon map that will be used to determine the Stratum Carbon Stocks and the Mean Carbon Stocks.

Determining Carbon Stock Changes

From the high resolution maps, the annual carbon stock change in aboveground biomass of trees will be calculated as:

$$\Delta C_{AB,t|PRJ} = \left(\sum_{i=1}^M \left(A_i * \frac{C_{AB,i,t2|PRJ} - C_{AB,i,t1|PRJ}}{T} \right) \right) * \frac{44}{12} \quad \text{(equation 32 from VM0010)}$$

Where:

$\Delta C_{AB,t PRJ}$	Annual carbon stock change in aboveground biomass of trees in year t, tCO ₂ e yr ⁻¹
$C_{AB,i,t PRJ}$	Mean aboveground biomass carbon stock of trees in stratum <i>i</i> at time t, tC ha ⁻¹
A_i	Area covered by stratum <i>i</i> , ha

T	Number of years between monitoring time $t1$ and $t2$ ($T = t2 - t1$); years
i	1,2,3 ... M strata
t	1,2,3 ... t^* years elapsed since the start of the project activity.
44/12	Ratio of molecular weights of carbon dioxide and carbon, tCO_2e tC^{-1} .

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.

Option A: Natural Disturbance - Fire

The net greenhouse gas emissions resulting from fire disturbance calculated as

$$\Delta C_{DIST-FR,t|PRJ} = \sum_{i=1}^M A_{Burn,i,t} * B_{i,t|PRJ} * COMF_i * G_{g,i} * 10^{-3} * GWP_{CH4} \quad \text{(equation 33 from VM0010)}$$

Where:

$\Delta C_{DIST-FR,t PRJ}$	Net greenhouse gas emissions resulting from fire disturbance in year t , tCO_2e
$A_{burn,i,t}$	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_{CH4}	Global warming potential for CH_4 (IPCC default: 21), tCO_2e tCH_4^{-1} ;
i	1,2,3 ... M strata
t	1,2,3 ... t^* years elapsed since the start of the project activity.

For fire damage it is assumed that a fire burning in the project scenario would also have burned in the baseline scenario. $B_{i,t|PRJ}$ is therefore equal to the fire damage to biomass absent in the baseline scenario (harvested and removed) but present in the project scenario. 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 high-resolution map and the Aboveground Carbon Density model (see Figure 35) by applying the following equation:

$$B_{i,t|PRJ} = \sum_{j=1}^J \{V_{EX,j,i|BSL} * BCEF_R\} \quad \text{(equation 34 from VM0010)}$$

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 ;
$V_{EX,j,i BSL}$	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.

For the ex-ante estimation, it is assumed that the area burned is zero as a consequence of the project but this will be monitored during project implementation. NASA FIRMS alerts²⁵ will be used to monitor any possible fires. Any hotspot inside or surrounding the project area will be checked. The emails alerts from NASA will be converted into text messages with the coordinates of the hotspots that determined field team members with receive on their phones. Remote sensing imagery as close to the fire event as possible will be used to map the burn scars.

Option B: Natural Disturbance - Non-Fire

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:

$$\Delta C_{DIST,t|PRJ} = \sum_{i=1}^M (A_{dist,i,t} * \sum_{j=1}^J \{C_{AB,j,i|BSL}\}) * \frac{44}{12} \quad \text{(equation 35 from VM0010)}$$

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
$C_{AB,j,i BSL}$	Carbon stock in aboveground biomass per unit area in stratum i , tC·ha ⁻¹

²⁵ <https://earthdata.nasa.gov/earth-observation-data/near-real-time/firms>

44/12	Ratio of molecular weights of carbon dioxide and carbon, $\text{tCO}_2\text{e tC}^{-1}$
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.

Similar to disturbances by fire, if any area is removed we will use the carbon value for that specific area based on the high resolution map. The area does not have a history of major disturbance events in the area, therefore for the ex-ante estimation it is assumed that the area disturbed is zero.

Option B: Sampling

Data on the occurrence of disturbances and illegal logging 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, we will also use the Global Forest Watch GLAD deforestation alerts²⁶. These alerts will be used as a guide for the field team to check specific locations where illegal logging may be happening. They will also be used as a guide to monitor the areas using remote sensing. This will be complemented with an analysis of optical data products (Landsat & Sentinel-2) and Synthetic Aperture Radar (SAR) data that have a proven capability for deforestation detection and some capacity for degradation detection²⁷. These technologies have developed since the time of methodology approval and will be used instead of the PRA approach suggested in the methodology (for example see Schultz (2018)²⁸, Shimizu et al (2017)²⁹, Bullock et

²⁶ <https://www.globalforestwatch.org/blog/data-and-research/glad-deforestation-alerts/>

²⁷ Prudente (2020). "IEEE International Geoscience and Remote Sensing Symposium 2020", SAR Data for Land Use Land Cover Classification in a Tropical Region with Frequent Cloud Cover

²⁸ Schultz, Michael. 'Tropical Deforestation Monitoring Using Landsat Time Series and Breakpoint Detection'. Wageningen University, 2018. <https://doi.org/10.18174/454885>.

²⁹ Shimizu, Katsuto, Raul Ponce-Hernandez, Oumer S. Ahmed, Tetsuji Ota, Zar Chi Win, Nobuya Mizoue, and Shigejiro Yoshida. 'Using Landsat Time Series Imagery to Detect Forest Disturbance in Selectively Logged Tropical Forests in Myanmar'. Canadian Journal of Forest Research 47, no. 3 (1 March 2017): 289–96. <https://doi.org/10.1139/cjfr-2016-0244>.

al (2020)³⁰ and Ganivet and Bloomberg (2019)³¹. To optimize the use of these optical data products, we will use LiDAR data (from surveys undertaken in 2016 and any subsequent monitoring) and the optical products to evaluate the sensitivity of freely available satellite radar products (Sentinal-1 C-band SAR, available globally from 2014-5) to structural changes associated with deforestation, degradation, and regrowth. We will investigate correspondence between Lidar-derived canopy metrics and the backscatter of VV and VH polarizations and the intensity ratio (VV/VH).

The proposed project activities are expected to completely prevent illegal logging and therefore for the *ex-ante* estimation, the area potentially impacted by illegal logging is assumed to be zero.

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:

$$\Delta C_{NET,t|PRJ} = (\Delta C_{DIST-FR,t|PRJ} + \Delta C_{DIST,t,PRJ} + \Delta C_{DIST-IL,t|PRJ}) - \Delta C_{AB,t|PRJ} \quad \text{(equation 38 from VM0010)}$$

and

$$GHG_{Net|PRJ} = \sum_{t=1}^{t^*} \Delta C_{Net,t|PRJ} \quad \text{(equation 39 from VM0010)}$$

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 , tCO ₂ e;
$\Delta C_{DIST-FR,t PRJ}$	Net greenhouse gas emissions resulting from fire disturbance in year t , tCO ₂ e

³⁰ Bullock, Eric L., Curtis E. Woodcock, and Pontus Olofsson. 'Monitoring Tropical Forest Degradation Using Spectral Unmixing and Landsat Time Series Analysis'. Remote Sensing of Environment, Time Series Analysis with High Spatial Resolution Imagery, 238 (1 March 2020): 110968. <https://doi.org/10.1016/j.rse.2018.11.011>.

³¹ Ganivet, Elias, and Mark Bloomberg. 'Towards Rapid Assessments of Tree Species Diversity and Structure in Fragmented Tropical Forests: A Review of Perspectives Offered by Remotely-Sensed and Field-Based Data'. Forest Ecology and Management 432 (15 January 2019): 40–53. <https://doi.org/10.1016/j.foreco.2018.09.003>.

$\Delta C_{DIST,t|PRJ}$ Net greenhouse gas emissions resulting from non-fire natural disturbance in year t , tCO₂e

$\Delta C_{DIST_IL,t|PRJ}$ Net carbon stock changes as a result of illegal logging at time t , tCO₂e

$\Delta C_{AB,t|PRJ}$ Annual carbon stock change in aboveground biomass of trees in year t , tCO₂e yr⁻¹

t 1,2,3 ... t^* years elapsed since the start of the project activity.

The net carbon stock change in the baseline scenario has been converted to net greenhouse gas emissions resulting in Table 26.

Table 26: Net greenhouse gas emissions in the project scenario.

Year that logging would occur according to the timber harvesting plan	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	-461,766.88	-461,766.88
2017	-461,766.88	-923,533.76
2018	-461,766.88	-1,385,300.64
2019	-461,766.88	-1,847,067.52
2020	-461,766.88	-2,308,834.40
2021	-461,766.88	-2,770,601.28
2022	-461,766.89	-3,232,368.17
2023	-461,766.88	-3,694,135.05
2024	-461,766.88	-4,155,901.93
2025	-461,766.88	-4,617,668.81
2026	-461,766.88	-5,079,435.69
2027	-461,766.88	-5,541,202.57
2028	-461,766.88	-6,002,969.45
2029	-461,766.88	-6,464,736.33
2030	-461,766.88	-6,926,503.21

2031	-461,766.88	-7,388,270.09
2032	-461,766.88	-7,850,036.97
2033	-461,766.88	-8,311,803.85
2034	-461,766.88	-8,773,570.73
2035	-461,766.88	-9,235,337.61
2036	-461,766.88	-9,697,104.50
2037	-461,766.88	-10,158,871.38
2038	-461,766.88	-10,620,638.26
2039	-461,766.88	-11,082,405.14
2040	-461,766.88	-11,544,172.02
2041	-461,766.88	-12,005,938.90
2042	-461,766.88	-12,467,705.78
2043	-461,766.88	-12,929,472.66
2044	-461,766.88	-13,391,239.54
2045	-461,766.88	-13,853,006.42

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)

For activity leakage, as described earlier 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 planned 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 this, historical timber harvest data was collated from the Sabah Forestry Department for each year since 2010, for each active concession in Sabah during this time. 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 36. 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 detailed data summarized by year and Forest reserve will be made available to the validator.

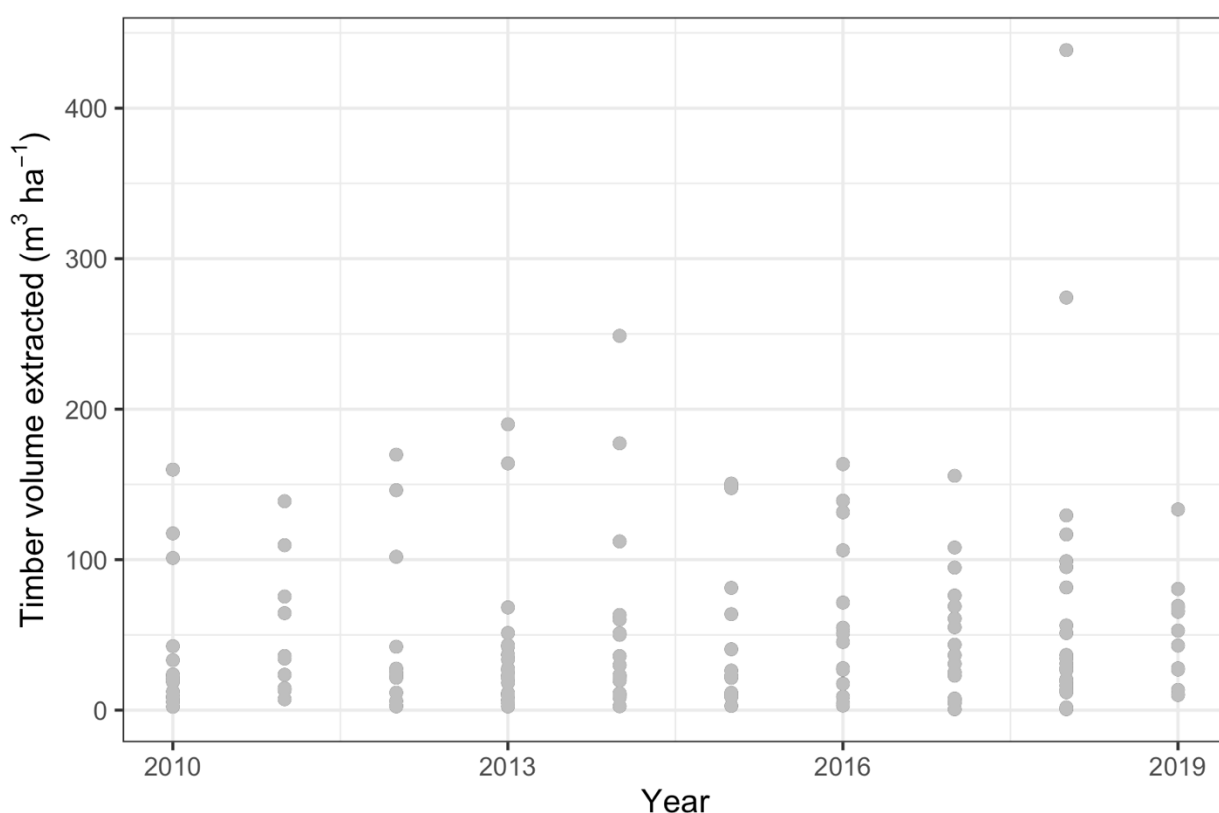


Figure 36: Historical timber harvest volume data through time in cubic meters per hectare. Data was collated by Sabah Forestry Department for all active concessions in the state from 2010 to 2019.

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:

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

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 ₂ e
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 ₂ e

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 37).

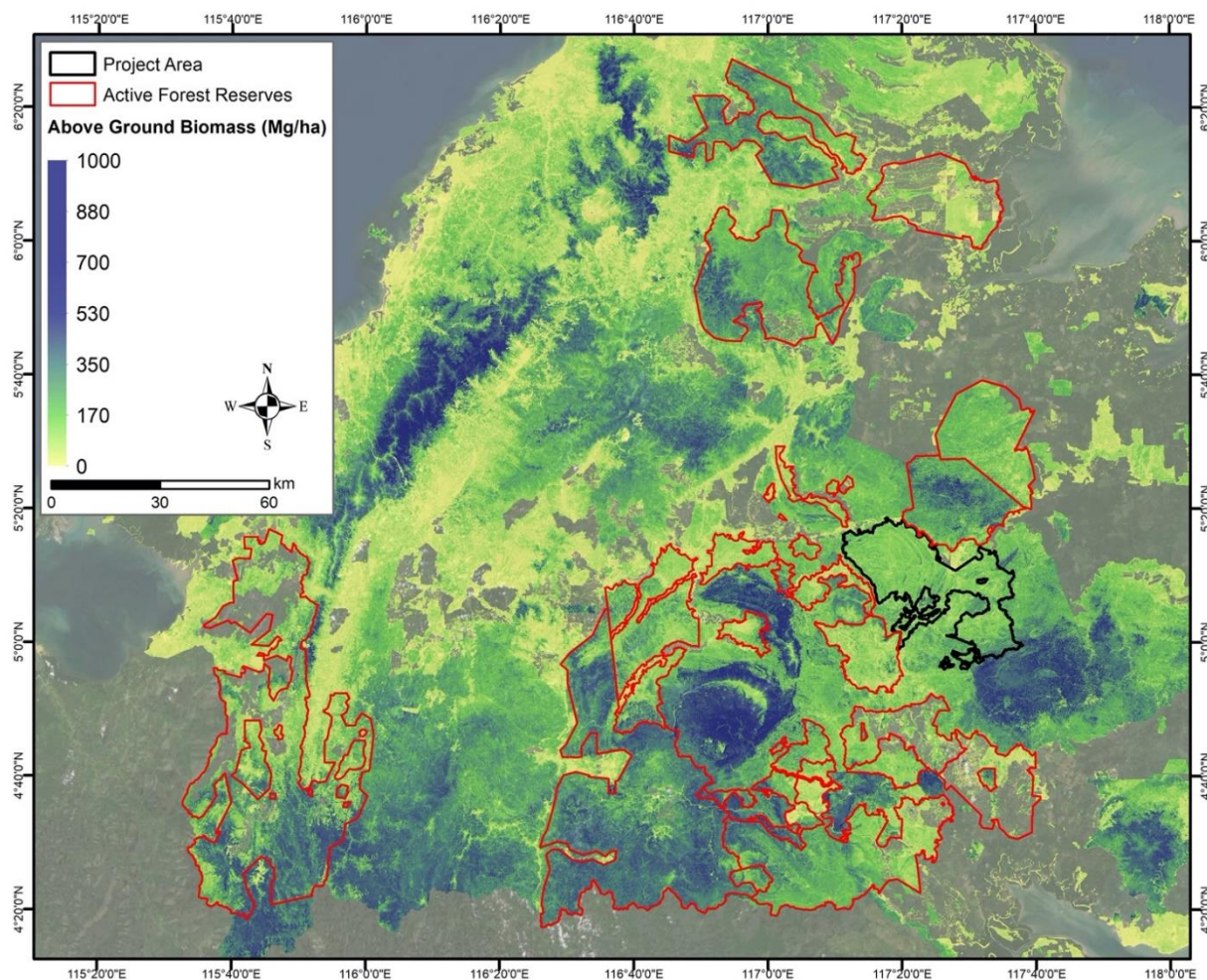


Figure 37: Active concessions in the state from 2010 to 2019, overlaid on Above Ground Biomass (in Mg ha⁻¹). AGB was calculated from a published Carbon map from the state and dividing by a carbon fraction of 0.47 (Asner 2017).

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. We removed one forest reserve (Bengkoka FR.), that had no remaining biomass per hectare. 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 BCEFR of 1.89 and a Carbon fraction of 0.47 (see Table 27). Here PML is calculated individually for each Forest Reserve Logging Type combination.

Table 27: 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>
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 (PMPi). Using the Merchantable Biomass and total biomass values in the above Table 27 (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 (PMLFT). The results are shown in the tables below.

Table 28: Ratio of merchantable biomass to total biomass for each forest type (PML_{FT})

Logging Type	PMP_FT	Merchantable Biomass	AGB (mg/ha)
Salvage Logging	0.65	115.63	177.69
NFM	0.36	79.31	220.74

Table 29: Ratio of merchantable biomass to total biomass (PMP_i)

Stratum	PMP_I	Merchantable Biomass	AGB (mg/ha)	Area (ha)
Mosaic	0.5558	88.6884	159.5553	44804
NFM	0.3970	67.5108	170.0578	35242

The difference between these two ratios (expressed as a percentage) was used to estimate the leakage factor (LF_{ME}). The results of the calculations are provided in Table 30 below

Table 30: 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	-9.5	0.4
Stratum 3 and Stratum 4	Salvage logging	17.1%	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 31.

Table 31: 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	44,559.98	44,559.98
2017	0	62,771.95	107,331.93
2018	0	64,779.91	172,111.84
2019	0	105,089.55	277,201.39
2020	0	117,919.33	395,120.72
2021	0	126,118.52	521,239.24
2022	0	106,499.68	627,738.92
2023	0	106,499.67	734,238.59
2024	0	127,099.56	861,338.15
2025	0	167,030.59	1,028,368.74
2026	0	136,321.90	1,164,690.64
2027	0	113,461.27	1,278,151.91
2028	0	127,234.32	1,405,386.23
2029	0	45,924.35	1,451,310.58
2030	0	5,673.72	1,456,984.30
2031	0	-20,219.73	1,436,764.57
2032	0	-4,502.37	1,432,262.20
2033	0	3,071.40	1,435,333.60
2034	0	-5,148.05	1,430,185.55
2035	0	-34,993.26	1,395,192.29
2036	0	-53,874.43	1,341,317.86
2037	0	-74,600.17	1,266,717.69
2038	0	-108,592.88	1,158,124.81

2039	0	-84,016.59	1,074,108.22
2040	0	-39,334.85	1,034,773.37
2041	0	-28,874.54	1,005,898.83
2042	0	-15,044.47	990,854.36
2043	0	23,299.94	1,014,154.30
2044	0	-11,001.58	1,003,152.72
2045	0	-16,800.39	986,352.33

3.2.4 Net GHG Emission Reductions and Removals

In accordance with the methodology, the Net GHG emission reductions have been calculated as:

$$GHG_{Credits|LtPF,t} = GHG_{Net|BSL,t^*} - GHG_{NET|PRJ,t^*} - GHG_{LK|LtPF,t} \quad (\text{equation 41 from VM0010})$$

Where:

$GHG_{Credits LtPF,t}$	Project greenhouse gas credits associated with the implementation of improved forest management (IFM) activities in the year t^* since the start of the project activity, in the project scenario, t CO ₂ e
$GHG_{NET BSL,t^*}$	Net greenhouse gas emissions in the baseline scenario in the year t^* since the start of the project activity, tCO ₂ e
$GHG_{NET PRJ,t^*}$	Net greenhouse gas emissions in the project scenario in the year t^* since the start of the project activity, tCO ₂ e
$GHG_{LK LtPF,t^*}$	Total greenhouse gas emissions due to leakage arising outside the project boundary as a result of the implementation of improved forest management (IFM) activities in the year t^* since the start of the project activity, in the project scenario, tCO ₂ e

The result of this calculation is shown in Table 32.

Table 32: Project greenhouse gas credits associated with the implementation of improved forest management (IFM) activities

Year that logging would occur according to the timber harvesting plan	Cumulative net greenhouse gas emissions in the baseline scenario in year t^* since the start of the project activity	Cumulative net greenhouse gas emissions in the project scenario in year t^* since the start of the project activity	Total cumulative leakage in year t^* since the start of the project activity (tCO ₂ e)	Estimated cumulative net GHG emission reductions (tCO ₂ e)
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	(tCO ₂ e)	(tCO ₂ e)		
2016	154,722.15	-461,766.88	44,559.98	571,929.05
2017	372,680.32	-923,533.76	107,331.93	1,188,882.15
2018	597,610.57	-1,385,300.64	172,111.84	1,810,799.36
2019	962,504.82	-1,847,067.52	277,201.39	2,532,370.96
2020	1,371,946.94	-2,308,834.40	395,120.72	3,285,660.63
2021	1,809,858.49	-2,770,601.28	521,239.24	4,059,220.53
2022	2,179,649.02	-3,232,368.17	627,738.92	4,784,278.27
2023	2,549,439.56	-3,694,135.05	734,238.59	5,509,336.02
2024	2,990,757.47	-4,155,901.93	861,338.15	6,285,321.24
2025	3,570,724.79	-4,617,668.81	1,028,368.74	7,160,024.86
2026	4,044,064.72	-5,079,435.69	1,164,690.64	7,958,809.77
2027	4,438,027.45	-5,541,202.57	1,278,151.91	8,701,078.11
2028	4,879,813.31	-6,002,969.45	1,405,386.23	9,477,396.52
2029	5,039,272.84	-6,464,736.33	1,451,310.58	10,052,698.59
2030	5,058,973.25	-6,926,503.21	1,456,984.30	10,528,492.16
2031	4,988,765.86	-7,388,270.09	1,436,764.57	10,940,271.38
2032	4,973,132.63	-7,850,036.97	1,432,262.20	11,390,907.41
2033	4,983,797.21	-8,311,803.85	1,435,333.60	11,860,267.47
2034	4,965,922.06	-8,773,570.73	1,430,185.55	12,309,307.24
2035	4,844,417.68	-9,235,337.61	1,395,192.29	12,684,563.00
2036	4,657,353.69	-9,697,104.50	1,341,317.86	13,013,140.32
2037	4,398,325.31	-10,158,871.38	1,266,717.69	13,290,479.00
2038	4,021,266.71	-10,620,638.26	1,158,124.81	13,483,780.15
2039	3,729,542.44	-11,082,405.14	1,074,108.22	13,737,839.35

2040	3,592,963.09	-11,544,172.02	1,034,773.37	14,102,361.74
2041	3,492,704.29	-12,005,938.90	1,005,898.83	14,492,744.35
2042	3,440,466.53	-12,467,705.78	990,854.36	14,917,317.95
2043	3,521,369.10	-12,929,472.66	1,014,154.30	15,436,687.46
2044	3,483,169.15	-13,391,239.54	1,003,152.72	15,871,255.98
2045	3,424,834.48	-13,853,006.42	986,352.33	16,291,488.57

Project Verified Carbon Units (section 8.4.1 of the methodology)

Adjustment for Uncertainty

In accordance with the requirements of the methodology, the uncertainties associated with parameters and coefficients have been estimated to determine if an adjustment for uncertainty is required.

All the activity data come from the modeled harvesting plan and the uncertainty associated with those parameters is considered zero since they are not based on measured data. In term of emission factors, the following categories of errors have been identified in relation to the LiDAR-assisted mapping of aboveground carbon: 1) measurements of trees, 2) allometric models 3) LiDAR measurements, 4) errors in predictions outside of field plots to LiDAR-scale and 5) prediction errors outside of LiDAR data and the data used for these outside LiDAR predictions (see Asner et al 2013³² for an in-depth discussion).

For the errors relate to the measurement of trees in the field, Asner et al (2013) consider that these only make a small contribution to plot level errors. Moreover, during the initiating of the field campaign, our field teams measured the first few plots more than once, until measurement errors where negligible. For the allometric models, the field plot data included height measurements of every single tree above 10cm DBH which, in combination with detailed taxonomic information, greatly reduces the error associated with allometric models. Similar to Asner et al (2013), Saatchi et

³² Asner, G., Mascaro, J., Anderson, C., Knapp, D., Martin, R., Kennedy-Bowdoin, T., van Breugel, M., Davies, S., Hall, J., Muller-Landau, H., Potvin, C., Sousa, W., Wright, J., Bermingham, E., 2013. High-fidelity national carbon mapping for resource management and REDD+. Carbon Balance Manag. 8, 7

al (2011)³³, Baccini et al (2012)³⁴, the error of the allometric model was therefore not considered further.

LiDAR is in general considered a precision approach. The average Root Mean Squared Error (RMSE, predicted versus observed) of point position errors in the refined point clouds of this sampling was 9.4 cm (Asner et al. 2018). The VCS tool for measuring aboveground live forest biomass using remote sensing (VT0005) notes that 'The use RS (LiDAR, RADAR, hyperspectral/hyperspatial imagery) in combination with a relatively small number field plots and can be used to achieve a statistically valid sample applying this tool. VT0005 highlights that 'statistically, reduced uncertainty is achieved with greater sampling intensity' and for our project area we have near wall-to-wall mapping with high resolution remote sensing data (Asner et al 2018 and 2021). We have not specifically considered the prediction errors outside of LiDAR data (and associated scaling data) as we have very high LiDAR coverage for our project area, however this is examined in greater detail in Jucker et al. (2018)³⁵ and Asner et al. (2018).

The uncertainty analysis therefore focuses on the remaining error, which is associated with the non-linear model used for calibrating the LiDAR to merchantable timber volume (and enables the high-resolution mapping). One approach for assessing the uncertainty of the model is sometimes referred to as Calibration. It involves separate datasets for developing the models for with a separate dataset for validating, or checking the model makes sensible predictions. The difficulty with this method, is that reducing the size of the dataset for developing the model makes little sense for relatively small datasets. We therefore used leave-one-out (or n-1) cross validation, following an approach based on Jucker et al (2018) and Asner et al. (2018). This involves repeating the non-linear multiple times, and in each iteration of the model, we left out one field plot. Therefore, in our case, rather than separating the dataset into two (for calibration and validation, or separating the data into 'K' number of folds), we have 40 iterations of our non-linear model, each with a

³³ Saatchi SS, Harris NL, Brown S, Lefsky M, Mitchard ETA, Salas W, Zutta BR, Buermann W, Lewis SL, Hagen S, et al: Benchmark map of forest carbon stocks in tropical regions across three continents. *Proc Natl Acad Sci* 2011, 108:9899–9904.

³⁴ Baccini A, Goetz SJ, Walker WS, Laporte NT, Sun M, Sulla-Menashe D, Hackler J, Beck PSA, Dubayah R, Friedl, S. Samanta & R. A. Houghton: Estimated carbon dioxide emissions from tropical deforestation improved by carbon- density maps. *Nature Clim Change* 2012, 2:182–185.

³⁵ T, Jucker, G.P. Asner, M. Dalponte, P.G. Brodrick, C.D. Philipson, N.R. Vaughn, Y. Arn Teh, C. Brelsford, D. F. R. P. Burslem, N. J. Deere, R. M. Ewers, J. Kvasnica, S. L. Lewis, Y. Malhi, S. Milne, R. Nilus, M. Pfeifer, O. L. Phillips, L. Qie, N. Renneboog, G. Reynolds, T. Riutta, M. J. Struebig, M. Svátek, E. C. Turner, and D. A. Coomes. Estimating aboveground carbon density and its uncertainty in Borneo's structurally complex tropical forests using airborne laser scanning. *Biogeosciences*, 15, 3811–3830, 2018

corresponding RMSE. We are able to estimate the RMSE for each of these models. From this cross-validation process we report the mean and standard deviation of these RMSE values

The error from the non-linear models needs to be propagated to the entire carbon stock (for the project scenario) and for the entire merchantable volume (for the baseline scenario). We therefore performed a Monte Carlo simulation where we resampled the non-linear model using a non-parametric bootstrap (each for ACD, 31cm Merchantable volume, and 40cm Merchantable volume). We performed the bootstrapping using the nlsBoot() function withing the R package nlstools. We performed 10,000 iterations, to generate 10,000 versions of the coefficients. Using each of set of coefficients, we predicted the stock for the entire area using the high resolution TCH map. For each of these 10,000 stock maps, we summed the entire stock, and using all of these total stock values we calculated the 95% confidence intervals. Using the 95% confidence intervals we calculated the uncertainty for each of the stock maps (ACD for the project scenario, and both merchantable volume stock maps (31cm and 40 cm DBH Merchantable Volume).

Table 33 shows the result with for each stock map the mean of the RMSE for n-1 cross validation (along with the corresponding SD of RMSE); the value of the total stock (mean of 10,000 bootstrap iterations), the upper and lower 95% CI from these iterations and the corresponding uncertainty values.

Table 33: Outcome of Monte Carlo simulation for the different stock maps.

Stock map	RMS E (SD)	Low 95% CI (Total stock)	Bootstrapped Mean (Total Stock)	High 95% CI (Total stock)	Uncertainty Value Lower	Uncertainty Value Upper
Merchantable Volume for dbh > 31 cm (m ³)	27.90 (0.65)	4745229	4752443	4759657	0.15	0.15
Merchantable Volume for dbh > 40 cm (m ³)	25.61 (0.61)	3853621	3860086	3866552	0.17	0.17
Above- ground Carbon Density (Mg)	30.21 (0.79)	5999739	6007676	6015614	0.13	0.13

These errors were propagated using the IPCC simple equation for error propagation

$$U_{Total} = \sqrt{U_1^2 + U_2^2 + \dots U_n^2}$$

Applying the numbers from Table 33:

$$U_{BSL} = \sqrt{0.15^2 + 0.17^2} = 0.227$$

$$U_{Total|LtPF} = \sqrt{U_{BSL}^2 + U_{Prj}^2}$$

$$U_{Total|LtPF} = \sqrt{0.227^2 + 0.13^2} = 0.262\%$$

The resulting uncertainty of 0.262% is smaller than the 15% threshold indicated in the methodology, therefore no deduction for uncertainty is required.

Calculation of verified carbon units

As per the VCS requirement, the amount of greenhouse gas emission reductions estimated must be adjusted to account for risk, following application of the most recent version of the VCS AFOLU Non-Permanence Risk Tool. The adjustment will take place at the time of verification when the VCU will be estimated as:

$$VCU_{net|LtPF} = (Credits_{total,t2|LtPF} - Credits_{total,t1|LtPF}) - Bu_{IFM-VCS} \quad \text{(equation 44 from VM0010)}$$

Where:

$VCU_{net LtPF}$	Number of verified carbon units; dimensionless
$Credits_{total,t1 LtPF}$	Net anthropogenic greenhouse gas removals by sinks, as estimated for $t^*=t1$ in tCO ₂ e
$Credits_{total,t2 LtPF}$	Net anthropogenic greenhouse gas removals by sinks, as estimated for $t^*=t2$ in tCO ₂ e
$Bu_{IFM-VCS}$	Total number of credits withheld in VCS AFOLU pooled buffer account

An ex-ante estimation of the risks has been performed 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 10 which is the minimum risks rating to be applied according to the tool.

Applying this to the numbers in Table 32 gives the following ex-ante estimates of the number of credits to be withheld in VCS AFOLU pooled buffer account

Table 34: Project greenhouse gas credits associated with the implementation of improved forest management (IFM) activities

Year that logging would occur according to the timber harvesting plan	Estimated net GHG emission reductions (tCO ₂ e)	Total number of credits withheld in VCS AFOLU pooled buffer account	Number of verified carbon units
2016	571,929	57,193	514,736
2017	616,953	61,695	555,258
2018	621,917	62,192	559,725
2019	721,572	72,157	649,414
2020	753,290	75,329	677,961
2021	773,560	77,356	696,204
2022	725,058	72,506	652,552
2023	725,058	72,506	652,552
2024	775,985	77,599	698,387
2025	874,704	87,470	787,233
2026	798,785	79,878	718,906
2027	742,268	74,227	668,042
2028	776,318	77,632	698,687
2029	575,302	57,530	517,772
2030	475,794	47,579	428,214
2031	411,779	41,178	370,601
2032	450,636	45,064	405,572
2033	469,360	46,936	422,424
2034	449,040	44,904	404,136
2035	375,256	37,526	337,730
2036	328,577	32,858	295,720
2037	277,339	27,734	249,605
2038	193,301	19,330	173,971
2039	254,059	25,406	228,653
2040	364,522	36,452	328,070
2041	390,383	39,038	351,344
2042	424,574	42,457	382,116
2043	519,370	51,937	467,433
2044	434,569	43,457	391,112
2045	420,233	42,023	378,209
Total	16,291,489	1,629,149	14,662,340

3.3 Monitoring

3.3.1 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	See Figure 35
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	During monitoring, this model will be re-assed and updated if necessary

Data / Parameter	$BCEF_R$
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 table 4.5 of the IPCC 2006 Guidelines for National Greenhouse Gas Inventories, Volume 4, Chapter 4
Value applied	1.89

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

Note: The PP conservatively excluded the emissions from the establishment of the forest infrastructure (parameter in the equations from section 8.1.1) and the emissions from use of logging equipment (section 8.1.5). So the parameters in 9.1 that are related to those emissions are not applicable and are therefore not listed.

3.3.2 Data and Parameters Monitored

Data / Parameter	$A_{burn,i,t}$
Data unit	ha
Description	Area burnt in stratum i at time t
Source of data	LiDAR, Landsat & 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 & Sentinel-2) that have a proven capability for deforestation detection and some capacity for degradation detection.
Frequency of monitoring/recording	At each monitoring event
Value applied	0
Monitoring equipment	LiDAR, Landsat & Sentinel-2 remote sensing data, NASA FIRMS alerts
QA/QC procedures to be applied	Standard procedures for analysis of remote sensing data. To optimize the use of these optical data products, we will use

	LiDAR data (from surveys undertaken in 2016 and any subsequent monitoring) and the optical products to evaluate the sensitivity of freely available satellite radar products (Sentinal-1 C-band SAR, available globally from 2014-5) to 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 data	Estimation of forest disturbance in the project scenario
Calculation method	
Comments	

Data / Parameter	$A_{dist,i,t}$
Data unit	ha
Description	Area disturbed in stratum i at time t
Source of data	LiDAR, Landsat & Sentinal-2 remote sensing data in combination with ground truthing
Description of measurement methods and procedures to be applied	Data on the area disturbed 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 & Sentinal-2) that have a proven capability for deforestation detection and some capacity for degradation detection.
Frequency of monitoring/recording	At each monitoring event
Value applied	0

Monitoring equipment	LiDAR, Landsat & Sentinel-2 remote sensing data
QA/QC procedures to be applied	Standard procedures for analysis of remote sensing data. To optimize the use of these optical data products, we will use LiDAR data (from surveys undertaken in 2016 and any subsequent monitoring) and the optical products to evaluate the sensitivity of freely available satellite radar products (Sentinel-1 C-band SAR, available globally from 2014-5) to 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 data	Estimation of forest disturbance in the project scenario
Calculation method	
Comments	

Data / Parameter	$A_{DIST_IL,i}$
Data unit	ha
Description	Area impacted by illegal logging in stratum i
Source of data	LiDAR, 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 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 & Sentinel-2) that have a proven capability for deforestation detection and some capacity for degradation detection.

Frequency of monitoring/recording	At each monitoring event
Value applied	0
Monitoring equipment	LiDAR, Landsat & Sentinel-2 remote sensing data, GFW GLAD deforestation alerts
QA/QC procedures to be applied	Standard procedures for analysis of remote sensing data. To optimize the use of these optical data products, we will use LiDAR data (from surveys undertaken in 2016 and any subsequent monitoring) and the optical products to evaluate the sensitivity of freely available satellite radar products (Sentinel-1 C-band SAR, available globally from 2014-5) to 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 data	Estimation of forest disturbance in the project scenario
Calculation method	
Comments	

Data / Parameter	$\Delta C_{AB, [PR, J]}$
Data unit	tCO ₂ e
Description	Annual carbon stock change in aboveground biomass of trees in the project scenario
Source of data	Remeasuring of field plots in combination with remote sensing (LiDAR (airborne and/or satellite), supported with optical and RADAR remote sensing data).

Description of measurement methods and procedures to be applied	The field data and remote sensing data will be combined to estimate the carbon stock per strata, and in turn determine the stock changes between sampling events. For this a non-linear model has been developed to establish the relationship between Aboveground Carbon Density and LiDAR based Top of Canopy Height. The project will remeasure as many field plots as feasible, but it is expected that there may be access difficulties due to physical access on the ground (eg. roads and bridges) and also due to travel restrictions due to Covid. It is therefore expected that subsequent monitoring of ongoing growth may rely on measurements from a subset of the plots. It is anticipated that this will be supplemented with measurements from other related or new plots that are in more accessible areas. To determine ongoing forest growth, targeted LiDAR data will be collected in specific areas or using satellite LiDAR using a sampling approach. This will be complemented by other remote sensing data where necessary.
Frequency of monitoring/recording	At each monitoring event
Value applied	the annual carbon stock change in aboveground biomass of trees is assumed to be $1.6 \text{ t C ha}^{-1}\text{yr}^{-1}$. This is based on table 1 of Suarez (2019) ³⁶ which gives an average growth rate of $3.4 \text{ Mg d.m. ha}^{-1} \text{ year}^{-1}$ for tropical rainforest in Asia. This is combined with a carbon fraction of 0.47 to give the value of $1.6 \text{ t C ha}^{-1}\text{yr}^{-1}$.
Monitoring equipment	
QA/QC procedures to be applied	Standard operating procedures for field measurements and analysis of remote sensing data

³⁶ Suarez *et al*, 2019. [Estimating aboveground net biomass change for tropical and subtropical forests: Refinement of IPCC default rates using forest plot data](#)

Purpose of data	Determine regrowth in the project scenario
Calculation method	
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 present in the project scenario but absent in the baseline scenario before burning will be determined using the high resolution maps and the model that determines the relation between the Aboveground Carbon Density and the TCH
Frequency of monitoring/recording	At each monitoring event
Value applied	
Monitoring equipment	
QA/QC procedures to be applied	
Purpose of data	Estimation of forest disturbance in the project scenario
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	
Description of measurement methods and procedures to be applied	If it is determined that an area has been burned (so $A_{dist,i,t} > 0$) the aboveground biomass stock will be determined using the high resolution maps and the model that determines the relation between the Aboveground Carbon Density and the TCH
Frequency of monitoring/recording	At each monitoring event
Value applied	
Monitoring equipment	
QA/QC procedures to be applied	
Purpose of data	Estimation of forest disturbance in the project scenario
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	High resolution TCH map in combination with model that determines the relation between the Aboveground Carbon Density and the TCH
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 and the model that determines the relation between the Aboveground Carbon Density and the THC
Frequency of monitoring/recording	At each monitoring event
Value applied	
Monitoring equipment	
QA/QC procedures to be applied	
Purpose of data	Estimation of forest disturbance in the project scenario
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						
Value applied	<table> <tr> <td>Stratum</td><td>PMP_I</td></tr> <tr> <td>Mosaic</td><td>0.5558</td></tr> <tr> <td>NFM</td><td>0.3970</td></tr> </table>	Stratum	PMP_I	Mosaic	0.5558	NFM	0.3970
Stratum	PMP_I						
Mosaic	0.5558						
NFM	0.3970						
Monitoring equipment							
QA/QC procedures to be applied							
Purpose of data	Estimation of forest disturbance in the project scenario						
Calculation method							
Comments							

3.3.3 Monitoring Plan

Methods for measuring, recording, storing, aggregating, collating and reporting data and parameters

Ongoing forest growth in the project scenario will be monitored using an approach involving remeasuring of field plots in combination with remote sensing (LiDAR (airborne and/or satellite), supported with optical and RADAR remote sensing data). This combination of remote-sensing data sources will be used to produce an updated wall-to-wall Top of Canopy Height (TCH) map – similar to the process described for the baseline where the TCH map was produced predominantly with LiDAR.

The field data and TCH map (produced from remote sensing data) will be combined to produce high resolution carbon and volume maps, to estimate the carbon stock per strata, and in turn determine the stock changes between sampling events. To monitor forest disturbances (fire, non-fire forest disturbances plus illegal logging), the data on forest regrowth will be complemented with an

analysis of optical data products (Landsat & Sentinel-2) that have a proven capability for deforestation detection and some capacity for degradation detection.

In addition, for 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. We will also use the Global Forest Watch GLAD deforestation alerts (<https://www.globalforestwatch.org/blog/data-and-research/glad-deforestation-alerts/>). These alerts will be used as a guide for the field team to check specific locations where illegal logging may be happening. They will also be used as a guide to monitor the areas using remote sensing; imagery from the closest dates possible to the logging event will be used to accurately map the extent of it.

For fires, the field team will also monitor the presence of any fire within or just outside project area and evaluate best course of action to avoid its spread. NASA FIRMS alerts (<https://earthdata.nasa.gov/earth-observation-data/near-real-time/firms>) will be used to monitor any possible fires. Any hotspot inside or surrounding the project area will be checked. The emails alerts from NASA will be converted into text messages with the coordinates of the hotspots that determined field team members will receive on their phones. Remote sensing imagery as close to the fire event as possible will be used to map the burn scars.

All climate, community and biodiversity data generated by the project is centrally managed on the Permian server **Error! Reference source not found.** – 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.

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.

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 project-zone communities, employees. These employees have received field and classroom based training for the monitoring of biomass and regrowth and teams have been formed that have been provided with the necessary equipment and facilities.

Policies for oversight and accountability of monitoring activities

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 38). A copy of the SOPs are available to validators on request. In order to ensure the security and traceability of data entry and QA/QC procedures, all users are allocated unique user IDs and passwords in order to access the database, and in turn their access and roles can be restricted as appropriate.

Procedures for internal auditing and QA/QC and for handling non-conformances with the validated monitoring plan

The data management process and responsibilities for internal auditing and QA/QC, including detecting and correcting non-conformances with the validated monitoring plan, are described in Figure 38 and the SOPs.

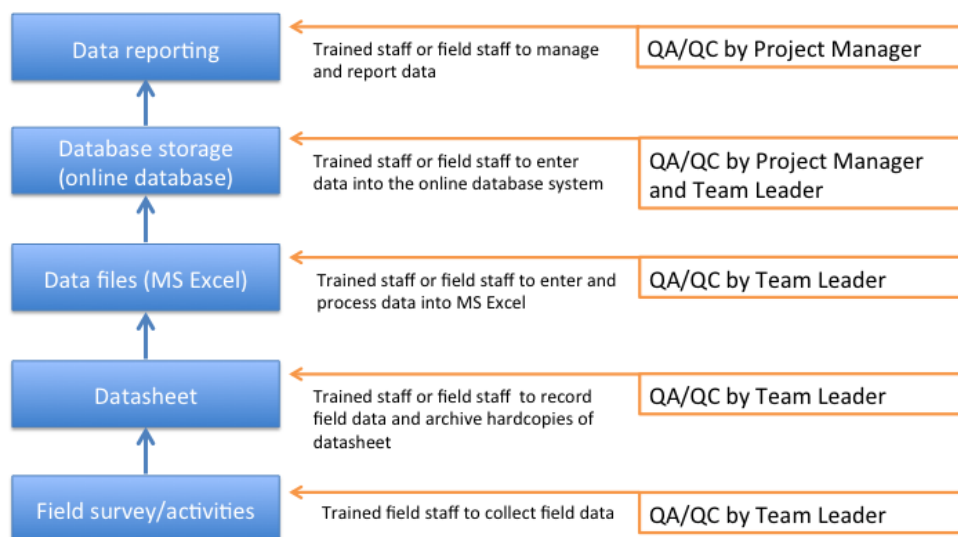


Figure 38: Data management QA/QC procedures

Sampling approaches used

The monitoring of the annual carbon stock change in aboveground biomass of trees in the project scenario will involve remeasuring of field plots in combination with remote sensing.

To the extent possible, the same 46 circular 30-meter radius permanent sample plots (PSPs) plots that were set up within the Kuamut area for the baseline will be remeasured at each monitoring event. Some PSPs might become inaccessible over time due to physical access on the ground (eg. roads and bridges). Where plots prove to be inaccessible, it is anticipated that this will be

supplemented with measurements from other related or new plots that are in more accessible areas. As noted in the VCS tool for measuring aboveground live forest biomass using remote sensing (VT0005): 'The use RS (LiDAR, RADAR, hyperspectral/hyperspatial imagery) in combination with a relatively small number field plots and can be used to achieve a statistically valid sample applying this tool. VT0005 highlights that 'statistically, reduced uncertainty is achieved with greater sampling intensity' and for our project area we have near wall-to-wall mapping with high resolution remote sensing data. Therefore no separate target precision level has been set for the sampling approach.

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

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 (including monitoring), global warming and the principles of FPIC.

Going forward, summary information of key project documents will be prepared in the Malay language and disseminated among communities in printed format. These will include the project PD (including the monitoring plan), monitoring reports, a schematic for the project's grievance and redress mechanism, and any other appropriate documentation which may be requested by communities. The complete PD and the verified Monitoring Reports will be disseminated and made publicly available on the internet and this will be communicated to the communities and other stakeholders through other means such as community notice boards as appropriate.

3.4 Optional Criterion: Climate Change Adaptation Benefits

The project-zone communities are vulnerable to the potential climate change impacts (described in the section above) 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.

3.4.1 Regional Climate Change Scenarios (GL1.1)

3.4.1.1 Climate variability scenarios for the project zone

Regional climate change at the Sabah scale was modeled using the CostingNature Policy support system³⁷. CostingNature is a spatial eco-hydrological model designed to assess ecosystem services

³⁷ <http://www.policysupport.org/costingnature>

under scenarios of land use and climate change. The model is capable of simulating the change in water availability and stress with implications for climate adaptation solutions. Variables are modelled at a spatial resolution of 1 km, 90 m and 30 m. The model generates the baseline hydrology of the area of interest and allows the creation of climate change scenarios. It is particularly suitable to better understand the role of ecosystems in the provision of climate adaptation benefits for people and biodiversity.

For the Sabah district application, we used the CMIP 5 IPCC climate models with the RCP2.6 emission and concentration pathway. We used this pathway as representative of the literature on mitigation scenarios aiming to limit the increase of global mean temperature to 2°C. We applied the model with downscaled IPCC GCM scenarios from WorldClim³⁸ and simulated the change in climate between 2041 and 2060, which was considered relevant in terms of the climate adaptation benefits of the proposed project Kuamut.

The change in climate was simulated using projected data for temperature and rainfall and results were obtained in terms of changes in water balance, water availability, water stress, erosion, water quality, and runoff as an indicator of vulnerability to droughts or flooding hazards. Results are also summarized in terms of likely impacts to the environment, the regional economy, people and biodiversity.

- **Temperature**

The future will see climate change intensifying. The simulations pointed to a projected temperature rise of less than 4 °C till the end of the 21st century for east Malaysia. Particularly, the Sabah district will see an increase in temperature of around 6.1% on annual average for the end of the prediction period (1.5°C), with more pronounced changes towards the west in the highest parts of the district and to the south and far east, where currently lower temperatures will see shaper increases (up to 24%) (more than 4°C) (Figure 1b). In contrast, the Kuamut project area which currently shows an average annual temperature of 26.5 °C, could only see close to a 6% increase between the 2041 – 2060 period (1.5°C). However, the Kuamut project will rank amongst the areas across the district with medium to low temperature increases.

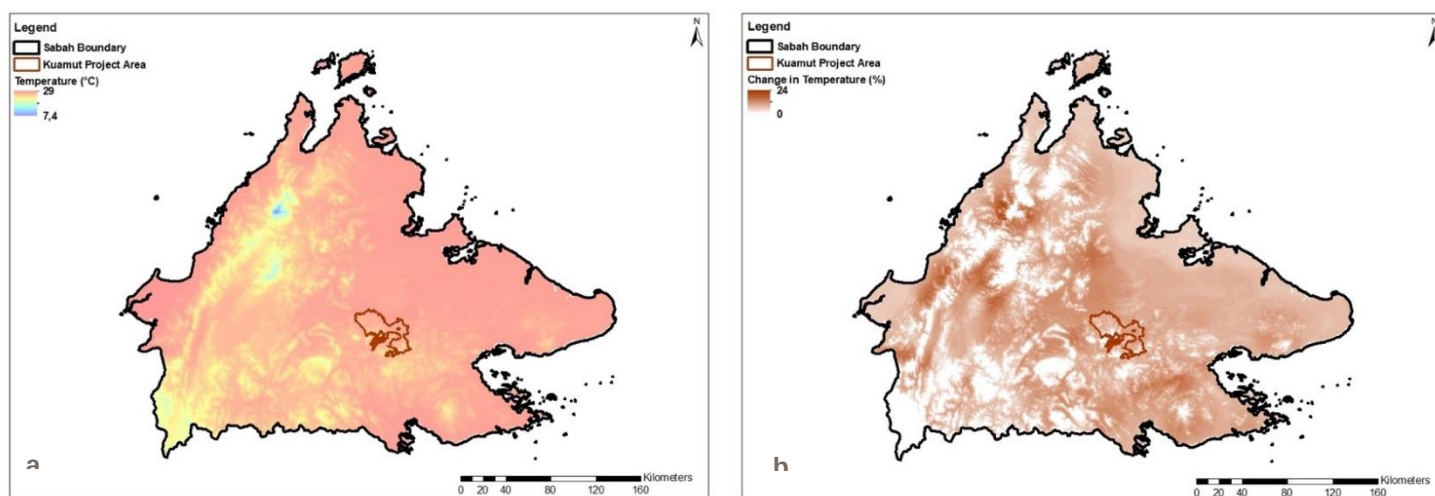


Figure 39. Temperature changes in the Sabah district. a. Baseline Temperature °C. b. Change in temperature as percentage of baseline. The Kuamut project area ranks among the areas with medium to low changes.

- **Precipitation**

Results for Malaysia show a lack of definite trend for rainfall with increasing rainfall towards the end of the 21st century. However, despite the variability of average precipitation, [Mayowa et al. \(2015\)](#) has reported significant increase in northeast monsoon rainfall over the period of 1971–2010. Similarly, results for Sabah show that the district has a highly variable rainfall distribution ranging from around 1600 mm year-1 in the highest parts to close to 3900 mm year-1 in coastal areas to the north and the far west. The district has an annual average rainfall of around 2468 mm year-1 indicating a relatively high precipitation.

Climate change can result in pronounced rainfall changes in exposed slopes of the highest parts either increasing or decreasing depending on the exposure to winds and the tradeoff between higher temperatures and the resulting changes in cloud condensing conditions. In the lowlands though there is a tendency for rainfall to slightly increase. On average, the Sabah district can see a 2.7% increase in precipitation annually (Figure 40b).

Similarly, the Kuamut project area, can also see a 1.8 % increase in annual precipitation, up from a baseline annual average precipitation of 2535 mm year-1 (higher than the average for the Sabah district). This result indicates that rainfall changes will not be as drastic in the Kuamut project area, when compared with the whole of the district while still showing higher annual rainfall than the district average (Figure 40b).

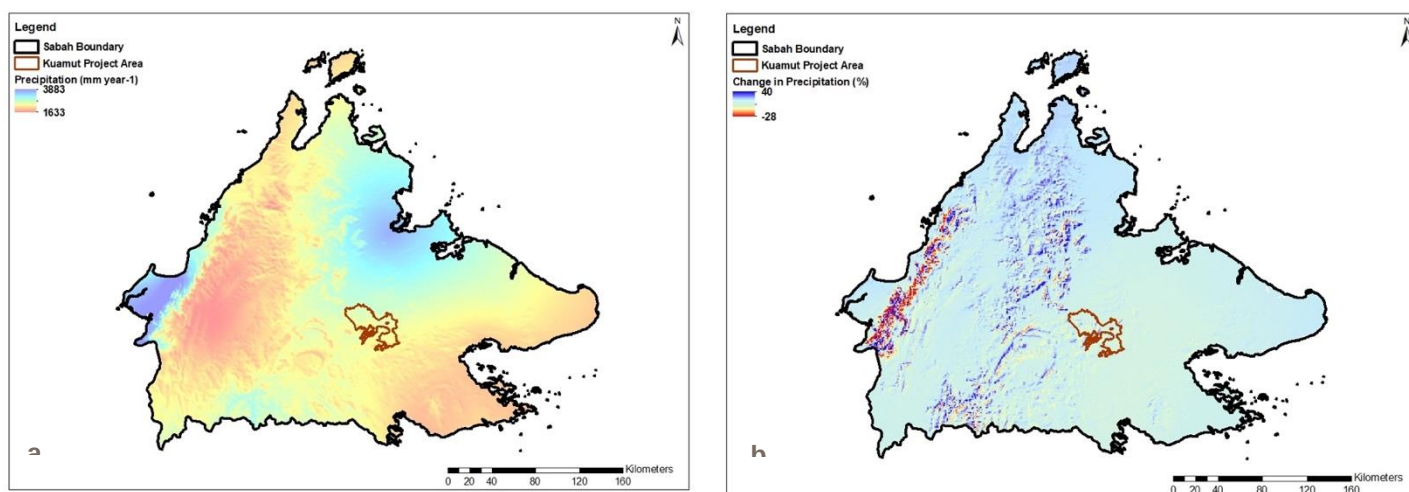


Figure 2. Precipitation changes in the Sabah district. a. Baseline precipitation mm year⁻¹. b. Change in precipitation as percentage of baseline. The Kuamut project area shows a lower mean annual precipitation increase compared with the Sabah district.

- **Extreme Weather**

In terms of seasonality, climate variability is expected to be greater, which suggests a substantial increase in rainfall and its intensity for the wet season (November to April), and warmer and longer dry months during the dry season (May to October) (Tang, et al. 2019). Different authors also coincide in predicting an increase in extreme weather events during the 21st century in Malaysia, continuously rising since the 80s. The latter trend in Malaysia is analogous to the global increment of extreme weather, especially floods and storms.

3.4.2 Climate Change Impacts (GL1.2)

3.4.2.1 Water Availability and Stress

Climate change will affect water availability (water balance mm year⁻¹) particularly in the higher parts of the Sabah district, towards the east and south (Figure 3b), and these changes will result in greater water stress towards the north east coast (Figure 3d)³⁹. This impact is explained by the fact that higher temperatures will bring greater water losses through evapotranspiration resulting in lower water availability altogether, even when slight rainfall increases can occur.

Therefore, existing plantations and urban areas towards the north east coast of Sabah will likely see greater water stress, resulting in reduced potable water supplies and declines in the productivity of plantations and cultivated land. The impacts of climate change particularly related to rice production and palm oil plantations have been reported in the past (Singh et al., 1996; Al-Amin and Siwar, 2008), and negative impacts are likely to continue into the future. Therefore, climate change can impact food security for people living below the poverty line in the Sabah district, coinciding with earlier reports for the whole of Malaysia (Alam, et al. 2016).

In terms of runoff, the Trusan Kinabatangan river basin where the Kuamut project is located, and a large basin feeding the north east coast of Sabah, could likely see a decline in mean annual river flow of up to 4%, during the projected period (Figure 3f). This result warns about the likelihood of greater drought risks and implications for water supplies and land irrigation in the lower parts of this

³⁹ Water stress index is typically defined as the relationship between total water use and water availability. The closer water use is to water supply, the more likely stress will occur in natural and human systems

river basin. Freshwater and coastal biodiversity will also likely be negatively impacted by changes in water regulation and river discharge and a more accentuated seasonality. In terms of fisheries, [Shaffril et al. \(2013\)](#) reasoned that unstable climate could also reduce the days of fishing, and thus, poses a greater risk to fishery activities.

The Kuamut project area in contrast, will not experience significant changes in water availability (just a 1.3% decline on annual average), and therefore its forests are likely to play a climate adaptation role regulating water supplies downstream the Trusan Kinabatangan river. If the forest in Kuamut was not protected, droughts downstream the Kinabatangan river could likely be more pronounced and flooding events even larger due to the loss of flow regulation provided by the forest. Therefore, the Kuamut project can help buffer against the likely impact of climate change in terms of water flow, regulation and water stress mitigation.

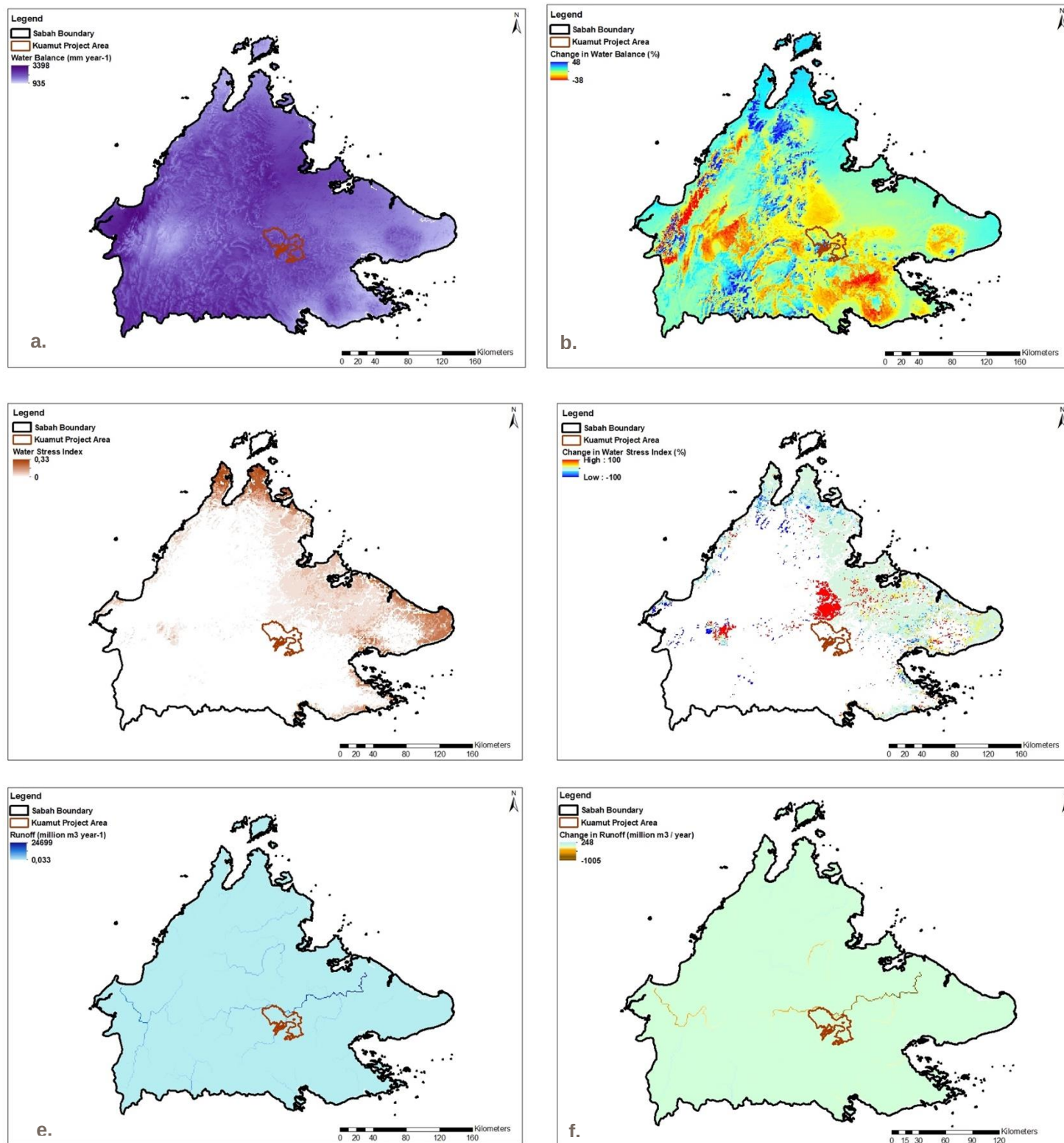


Figure 3. Water availability and stress changes in the Sabah district. a. Baseline water balance mm year⁻¹. b. Change in water balance as percentage of baseline. c. baseline water stress index. d. Change in water stress index as percentage of baseline. e. Baseline Runoff in million m³ year⁻¹. F. Change in runoff in million m³ / year.

Change in Runoff in million m³ year⁻¹. The Kuamut project can help making less pronounced any changes in water flows and stress downstream.

3.4.2.2 Soil Erosion and Water Quality

Climate change will likely result in increased hillslope soil erosion in Sabah due to slightly greater rainfall, but also due to more intense and concentrated rainfall events during the northeast monsoon, leading to greater and more powerful runoffs immediately after, especially in steep hillslopes (Figure 4). The highest parts of the district in the municipalities of Kota Marudu, Kundasang, Ranau and Pensiangan, among others, will see greater soil erosion especially those that have and will continue to face strong land use changes. Forest areas though are likely to see lower increases in erosion due to the soil protection provided by the forest biomass, whereas coastal areas towards the northeast will also likely see a consistent increase in soil erosion due to the much lower soil protection. This impact of climate change will likely result in lower water quality and thus higher treatment costs downstream of those areas.

Forest areas of Kuamut in contrast will see only small increases in soil erosion, which means that the water quality flowing downstream from Kuamut would be cleaner compared to water flowing from other areas, therefore resulting in better water quality downstream for water consumption, irrigation and the local biodiversity.

A summary of the likely impacts of climate change in the Sabah district is presented in Table 1.

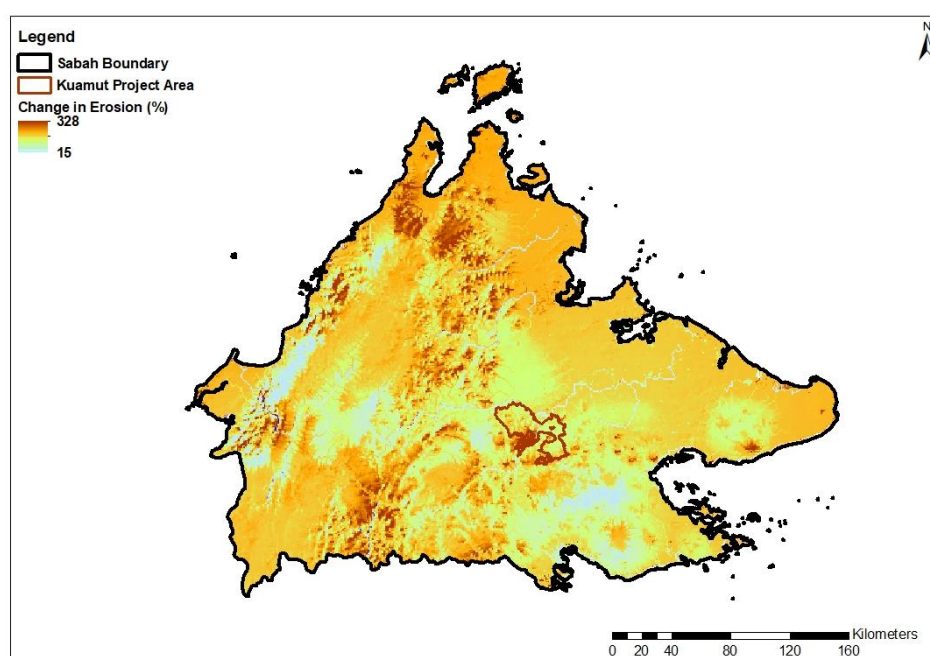


Figure 4. Change in soil erosion as percentage of baseline. The Kuamut project area shows amongst the lowest changes in soil erosion across the Sabah district and therefore it is likely to help maintain better water quality downstream.

Table 1. Likely impacts of climate change in the Sabah district

Sector	Likely impacts
Environmental	Decreased quality for biodiversity, especially freshwater
	Greater river sedimentation
	Greater risk of plant water stress during prolonged droughts
	Increased fire risks in natural and logged forests
Economic	Loss of rural productivity and infrastructure
	Loss of crop productivity and yields
	Increased burden from disaster management
	Increased water treatment and sanitation costs
	Increased dredging costs in rivers
Social	Reduced quantity and quality of potable drinking water
	Reduced food security and loss of incomes
	Spread of water and vector borne infectious diseases
	Increased number of human injuries and deaths

3.4.3 Measures Needed and Designed for Adaptation (GL1.3)

The project-zone communities are vulnerable to the potential climate change impacts (described in the section above) because their livelihoods and well-being are dependent on the healthy ecosystem of the surrounding forests 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 most relevant to climate change adaptation, and the causal relationship between the activity and the adaptation benefit, are summarized below in Table 2.

Table 2. Description of adaptation benefits

Activity	Components	Adaptation Benefits
Ecosystem protection and forest regeneration.	Avoided degradation due to logging	Kuamut forests also play a critical role buffering against the hydrological impacts of climate change downstream for people, biodiversity and the local economies. Protection and forest restoration will ensure that the impacts of climate with the project area itself are mitigated, with sound benefits for the local biodiversity and surrounding communities. Reducing hunting pressures will increase the resilience of endangered species. Reduced soil erosion and improved water quality will help to maintain or improve the availability of potable water and reduce the prevalence of gastrointestinal and vector diseases
	Avoided Deforestation	
	Reforestation	
	Fire prevention	
	Habitat and species protection	
	Reduction of hunting pressures	
Participatory Planning	Short and long-term community planning	The project's activities related to village, district and regional planning create a basis to integrate climate change predictions into the long-term planning process. This includes the potential need for climate change risks to be reflected in infrastructure development plans, and the creation of management and monitoring systems to evaluate the need to implement Climate Change adaptation measures.
	Community-level plans integrated into formal district and regional level plans	
Community-based business development & Microfinance development	Small-business development advice and support	The project implements a comprehensive program of support for enhancing and developing diversified alternative livelihoods. This includes support for improved agricultural, agroforestry and NTFP based business development, as well as diversification away from a traditional natural resources-based economy. These business development activities incorporate planning based on potential long-term climate change impacts (such as in crop/species selection, timing, etc.) so as to ensure both resilience and the availability of alternative revenue sources in the case of affected industries.
	Access to microfinance	
	technical assistance	
	implement sustainable livelihoods as well as a scholarship program to improve access to education	
	Agriculture, agroforestry, fisheries and non-timber forest product management advice and support for diversification	
Sustainable energy development	Development of renewable and sustainable energy sources	The project works with local communities to develop a greater reliance on local renewable and sustainable energy sources. These activities develop resilience to potential climate change impacts which may affect the provision of energy from traditional sources.
Improved public health and sanitation services	Improved access to clean water and sanitation facilities	The project works with local communities to improve the provision of basic services and access to health care. In improving access to water in particular, the role ecosystem protection plays in ensuring resilience to potential climate change impacts is key (as above). By improving access to basic health care provision communities also generate greater resilience to climate change impacts such as changing or increased patterns of disease.
	Improved access to public health care services	

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4 COMMUNITY

4.1 Without-Project Community Scenario

4.1.1 Descriptions of Communities at Project Start (CM1.1)

As already described in section 2.1.6, a Social Baseline Assessment was carried out between 2016 and 2019. Data was collected through numerous means such as household surveys in all Project Zone communities, community workshop discussions, site observations and informal gatherings. Refer to Section 2.1.6 for a general overview of the Project Zone communities, and to the separate Technical Report for further details of the Social Baseline Assessment.

Section 2.1.6 already provides the overview of population size, basic infrastructure, agriculture, education and healthcare for each of the current project zone communities, as well as population by gender and age class. In addition, data was collected on the agricultural practices. In addition, Figure 39 shows the total acreage of planted crops in the survey sample, divided between the Kuamut and Keramuak clusters. The dominant agricultural land use is oil palm, which is planted exclusively by community members in the Keramuak cluster. The Keramuak communities also have a higher total planted area than Kuamut (which is to be assumed given the total populations of each cluster; approximately 2000 and 1000 individuals respectively). It is also clear that the Kuamut cluster places a greater emphasis on planting hill rice, fruit trees and vegetables, which lends support to the idea that subsistence farming is of greater importance in this cluster due to the difficulty of transporting cash crops to a place of sale (with the exception of cocoa).

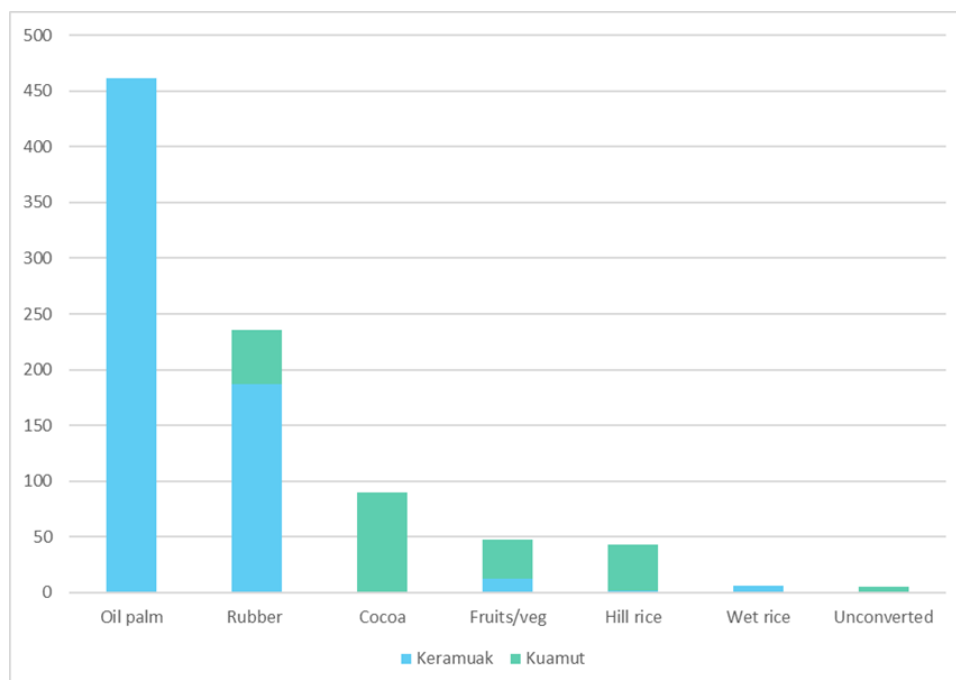


Figure 39 Crops planted in the survey sample for each cluster. Y-axis represents estimated total acres.

Agricultural planting in the Project Zone is constrained not only by accessibility of local markets, but also the availability of land. The Project Zone communities are surrounded by privately-owned land (state government managed forest reserves and privately-owned commercial agricultural operations). In addition, tenure of existing agricultural lands is not always secure. The process of alienation of state land in Sabah is governed by the Sabah Land Ordinance and administered by the Department of Lands and Survey. Indigenous communities can apply for lands by demonstrating customary rights (which in the case of agriculture is indicated by the continuous cultivation of an area for a minimum of three years) and after the processing of this application are awarded documentary title over a given area of land; usually in a document conferring individual ownership referred to as a Native Title. However, in practice the administrative demands of processing thousands of claims across the state (and establishing the veracity of customary rights claims in each case) means that the issuance of titles can be extremely slow. The period between the submission of claims and the award of Native Title is known as LA (Land Application) and can continue for years, or in some cases even decades. Community members continue to farm and exhibit *de facto* ownership of LA lands, but they remain state land in the eyes of the law, and thus open to competing claims from external sources. Project zone communities thus face the dual pressures of tenurial insecurity over much of their existing lands, and a shortage of additional lands to expand into if their populations continue to rise. Figure 40 shows the total planted areas in the survey data for the major crops by land ownership status.

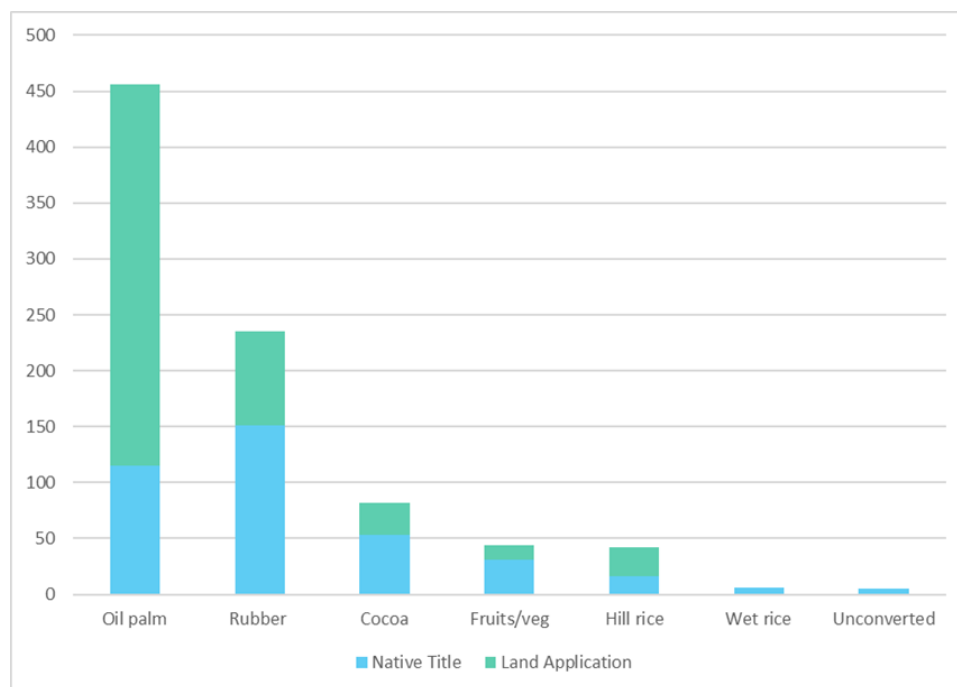


Figure 40. Crops planted in lands under Native Title and Land Application. Y-axis represents acres of land in the survey for the Keramuak and Kuamut clusters combined.

In the household surveys, respondents were asked to rate the relative importance of various subsistence and economic activities in terms of their overall contribution to livelihoods. Figure 41 indicates that commercial agriculture was considered a very important economic activity (slightly less so in the Kuamut cluster than the Keramauk cluster, perhaps for the reasons outlined above), whilst trade and paid work were considered rather less important. All communities indicated that they retain a high degree of dependence on various subsistence activities, including subsistence agriculture, gathering of river resources (fishing), and gathering of forest resources (hunting and collection of non-timber forest products). This subjective valuation of the relative importance of various livelihood activities corresponds well with the overall implications of the survey data presented in this and other sections.

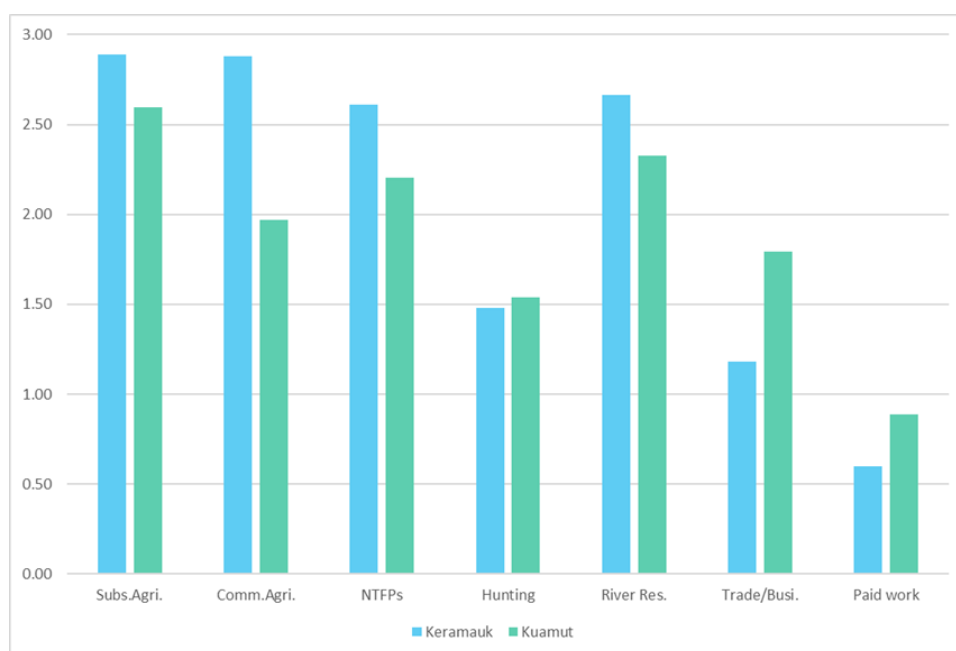


Figure 41. Subjective valuations of the relative importance of economic and subsistence livelihood activities. “Subs.Agri.” = subsistence agriculture, “Comm.Agri.” = commercial agriculture, “NTFPs” = non-timber forest products, “River Res.” = River resources, “Trade/busi” = Trade and local small business enterprises. Y-axis represents means of Likert values across all respondents for each category.

Survey respondents were asked to list the main types of animal and plant resources gathered by members of their households from rivers and forests. A total of 94 types were listed (66 plants and 28 animals; in most cases each type corresponds with a single biological species, but some refer to multiple species) which are gathered for a variety of uses; most commonly fish, mammals and forest plants used as sources of food (Table 35 and Figure 42).

Table 35. The ten wild plants and animals most commonly listed by survey respondents, and their principle uses. “Frequency” denotes the percentage of total survey respondents who mentioned each item.

Name (Malay)	Lifeform	Description	Frequency	Uses
Pakis	Plant	Various species of wild ferns	68	Food
ikan Patin	Animal	Species of freshwater fish	54	Food
Babi Hutan	Animal	Bearded pig (<i>Sus barbatus</i>)	44	Food
Rebung	Plant	Wild bamboo shoots	44	Food
Dabur	Plant	Shoots of a species of rattan	38	Food
ikan Baung	Animal	Species of freshwater fish	32	Food
ikan Putih	Animal	Species of freshwater fish	30	Food
Payau	Animal	Sambar deer (<i>Cervus unicolor</i>)	26	Food
ikan Lontong	Animal	Species of freshwater fish	26	Food
Pagil	Plant	Pioneer tree species	18	Firewood

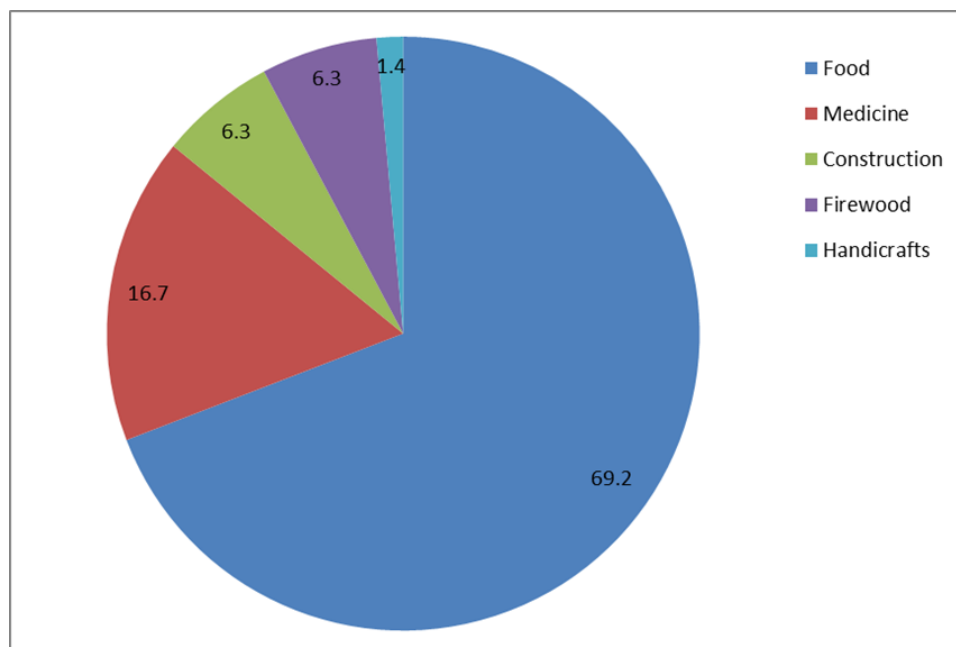


Figure 42. Percentages of total wild plants and animals by type of use.

These figures indicate that community members from both clusters remain partially dependent on subsistence uses of wild plants and animals; particularly as a supplementary source of nutrition. It is noteworthy that the high frequency of mention of animal species such as bearded pigs and sambar deer does not correspond well with the relatively low valuation given to hunting indicated in Figure 41– this may be because respondents attenuated their stated valuations during this part of the survey due to an awareness of the illegality of this practice. General observations and personal communications from community members indicate that hunting is a widespread activity throughout the project zone, and that at least a proportion of these hunting activities occur within the project area.

Areas important for the gathering of plants and animals were spatially delineated by communities during participatory mapping exercises, along with water catchment areas and sites of local cultural significance (see figures in Section 2.1.7). These provide a strong indication of the distribution of High Conservation Value areas in the project zone pertinent to communities (HCV 4-6).

During the household surveys, respondents were asked to list several of the most prominent issues which they felt represented significant challenges in daily life. Each respondent was asked to name three issues at minimum, but were able to add as many as they wished. Many of the most commonly cited issues differed between the Keramuak and Kuamut clusters, although the most frequently mentioned issue was accessibility in both cases (mentioned by 88.2% and 89.1% of respondents respectively). This is interesting given the large disparities between accessibility in each cluster; the Keramuak villages have road access and relatively short travel times to the urban centres of Tongod and Telupid, whilst those in Kuamut have no road access at all. Respondents' comments indicated that although a road network exists in Keramuak, it is very poorly maintained (roads in the area are unsealed and require regular maintenance) and occasionally impassable during heavy rains.

The issue of clean water is of particular import in Kuamut (mentioned by 73.4% of respondents), and reasonably significant in Keramuak (45.5% of respondents), likely reflecting the fact that most Keramuak villages have access to gravity-feed water supply, whilst Kenang-Kenangan (Tamoi) and all of the Kuamut villages rely on stored rainwater, resorting to river water in times of drought. There is another disparity between the clusters around the issue of human-wildlife conflict, which was mentioned by 74.5% of respondents in Keramuak but only 6.3% in Kuamut. The reasons for this likely centre around the prevalence of oil palm in Keramuak, which is frequently disturbed by small mammals and primates, and occasionally elephants. Other issues frequently mentioned by both clusters include access to electricity, healthcare, and lack of employment opportunities.

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). Many community members feel that their rights to access and use natural resources have been circumscribed by the gazettement of the Kuamut forest reserve – and indeed these activities are not considered lawful under the Sabah Forestry Department's legislation. However, although community access rights to traditional lands and resources remains a contentious issue (and one which will require considerable future efforts from all parties to ameliorate), it does not at present constitute a source of disputes *per se*, and there do not appear to be any significant ongoing disputes over lands or resources which have involved legal arbitration, protest, or any form of physical or verbal conflict.

4.1.2 Interactions between Communities and Community Groups (CM1.1)

The individual communities within each cluster are geographically close to one another; indeed some (such as Keramuak Dalam and Keramuak Luar) are spatially contiguous and only distinguished by a separation of administrative structures and community leadership. Whilst there are some general religious differences (e.g. Tangkuyan is principally Christian and Kuamut principally Muslim), communities retain a shared history and broader cultural institutions, and there does not appear to be any indication of division or discord between communities. This is also the case between the two clusters, which share similar cultural histories and in many cases are linked by blood relations and inter-marriage.

With respect to defining community groups; there are many potential dimensions across which individuals could be ascribed to groups (along the lines of age, gender, sources of income, marital status, household size, reliance on natural resources, etc), though not all of these groupings would necessarily be recognized by the communities themselves. Among the less arbitrary groups which have been highlighted by communities themselves during workshop discussions are younger people who have completed secondary (and in some cases tertiary) education but have returned to live in their communities and find themselves with limited employment opportunities (this group will be referred to as "youth" hereafter). A second group includes those who hold and practice certain forms of traditional knowledge related to the production of cultural handicrafts from forest resources such as rattans and bamboos (these are almost exclusively women and will be referred to hereafter as "female artisans"). A third includes those who are engaged principally in agriculture – whether of a commercial or subsistence nature, or a combination thereof (hereafter referred to as "smallholders").

It is currently envisaged that targeting these three community groups as the main focus of livelihood enhancement interventions will be an effective means of generating net positive benefits for communities as a whole. It should of course be remembered that all project activities involving communities will be instigated fully within the principles of FPIC, and communities themselves will decide which individuals interact with project activities and in what capacity.

To date there has been no observable tension or friction between the abovementioned community groups.

4.1.3 High Conservation Values (CM1.2)

The spatial distribution of HCVs related to communities is shown in Figures 7 and 8 in Section 2.1.7. Since there are many discrete individual sites, this section will describe them as generalized categories.

High Conservation Value	HCV 4 – Ecosystem services
Qualifying Attribute	Water catchments in higher elevation hill forests which provide clean water supply
Focal Area	Principally concerns the Keramuak cluster, e.g. water catchment in Gunung Tingkar, which is inside a protected forest reserve

High Conservation Value	HCV 6 – Cultural values
Qualifying Attribute	Ancestral gravesites
Focal Area	Multiple areas in both clusters, largely on state-land in and adjacent to community settlements

High Conservation Value	HCV 5 – Community needs
Qualifying Attribute	Sites for the gathering of plant and animal resources for community subsistence
Focal Area	Forested areas adjacent to each cluster, frequently including northern parts of the Project Area.

High Conservation Value	HCV 5 – Community needs
Qualifying Attribute	Fishing grounds
Focal Area	Stretches of the Kinabatangan and Kuamut rivers used for fishing activities, usually extending around 2-5 km up and downriver from settlement areas.

4.1.4 Without-Project Scenario: Community (CM1.3)

The most likely without-project scenario would involve a continuation of current conditions in the Project Zone, including those which constitute significant challenges for communities and community groups: such as limited access to clean water (especially in Kuamut), no or poor road access, limited access to markets for agricultural and other produce (again especially in Kuamut), and limited options for employment and career development amongst youths.

These issues would likely be ramified by increasing populations in communities. Additional lands are not likely to become available, meaning that sufficient agricultural land may not be available for future generations under current agricultural practices.

In the Project Area, the without-project scenario involves the continuation of commercial logging operations, with significant land clearance for mosaic planting. This would likely have negative impacts on

water quality; with particular significance for the Kuamut river which flows through the centre of the Project Area. Community members from Kuamut use this water for washing and at times of low rainfall even drinking, so this has obvious health implications. Continued operations may also have impacted fish stocks upon which communities are partially reliant.

Another likely outcome of the without-project scenario would be the exacerbation of human-wildlife conflicts (which is already a serious issue for communities; especially in Keramuak), as wildlife is increasingly displaced by mosaic clearance. Other likely outcomes include negative impacts on local climate, air quality, fire and flood risks, encroachment by outsiders working in logging concessions, and the overburdening of poorly-maintained roads in Keramuak.

4.2 Net Positive Community Impacts

4.2.1 Expected Community Impacts (CM2.1)

A full description of the proposed activities that the project aims to instigate in provision of enhanced livelihood opportunities for communities and community groups is given in section 4.2.3 below, together with the anticipated outputs, outcomes and positive impacts of those activities. The tables in this section will focus on potential negative impacts and risks associated with project activities.

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.

Community Group	Karamuak cluster and Kuamut cluster
Impact(s)	COVID pandemic
Type of Benefit/Cost/Risk	Risk, direct, predicted
Change in Well-being	COVID pandemic continues for longer than predicted, leading to longer-term difficulties in implementing project activities. Potentially high magnitude.

4.2.2 Negative Community Impact Mitigation (CM2.2)

The Community Monitoring Plan will incorporate multiple indicators to capture and assess the magnitude of potential negative impacts. This method will be used in conjunction with other means such as community workshops, smaller group dialogues, the project grievance mechanism and general project-to-community lines of communication to both identify negative impacts as they arise and to formulate means of resolution in a participatory manner.

With respect to the specific risks outlined in Section 4.2.1, a number of measures will be 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 actualizable 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 be reasonably prevalent, 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 technically a new restriction placed on communities as a result of the project. However, the relevant laws have historically been only infrequently enforced in rural areas of Sabah and many community members are not even aware of them, which may create the impression that hunting restrictions are a novel development arising as a consequence of the project. Furthermore, the project proponents do not have the authority to enforce state laws in any case, and acting as an informant to the relevant state authorities would likely cause enormous harm to the project-community relationship. This is thus a complex and delicate issue, and one which project should consider with especial tact and care when discussing hunting with communities during ongoing dialogues; seeking 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.

Certain institutions in the state are reasonably fragile (in the sense of fragility adopted by the World Bank in its conception of FCV), and may be subject to sweeping changes which are difficult to anticipate. This was demonstrated in 2018, when a change in federal government for the first time in Malaysia's history led to widespread revamping of ministerial and departmental structures, policies and membership of key civil service positions. Unforeseeable changes of this type could clearly have major implications for the project, and can only really be ameliorated by retaining a flexible project structure and close relationships with governmental stakeholders and project partners.

With regard to the ongoing Coronavirus pandemic, all project implementation and monitoring activities will adhere to contemporary Malaysian and Sabah state health and safety protocols, and will retain flexibility in adapting to changing future scenarios.

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

A fundamental objective of the project is to instigate activities which deliver long-term net benefits to Project Zone communities. These benefits may be economic, developmental, associated with the safeguarding of traditional knowledge and cultural practices, or any combination of the above. Whilst the project remains in an exploratory phase and is yet to begin implementation of community activities on the ground, a number of possible trajectories have been identified whereby the project could provide meaningful assistance to communities in developing livelihoods whilst safeguarding the integrity of the project area, and the climate and biodiversity values derived therefrom.

Potential community activities have been identified from discussions held during workshops and data from household surveys with respect to the types of activities that community members are interested in pursuing and feel would be appropriate. Figure 43 and Figure 44 show the percentage of respondents who suggested various types of activities during the household survey interviews, divided into each cluster.

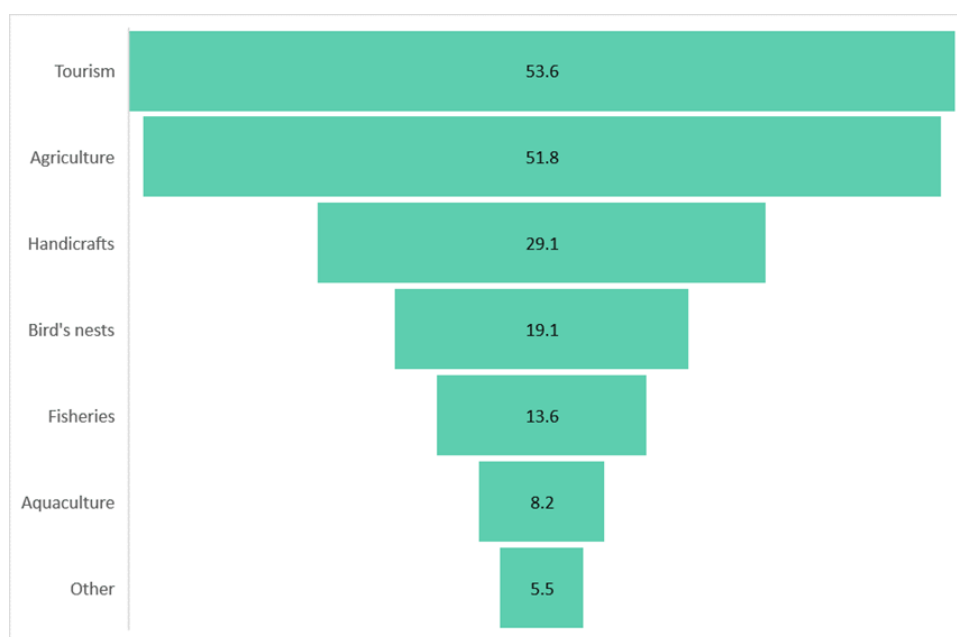


Figure 43. Potential community livelihood activities by percentage of mention during household surveys by members of the Keramuak cluster.

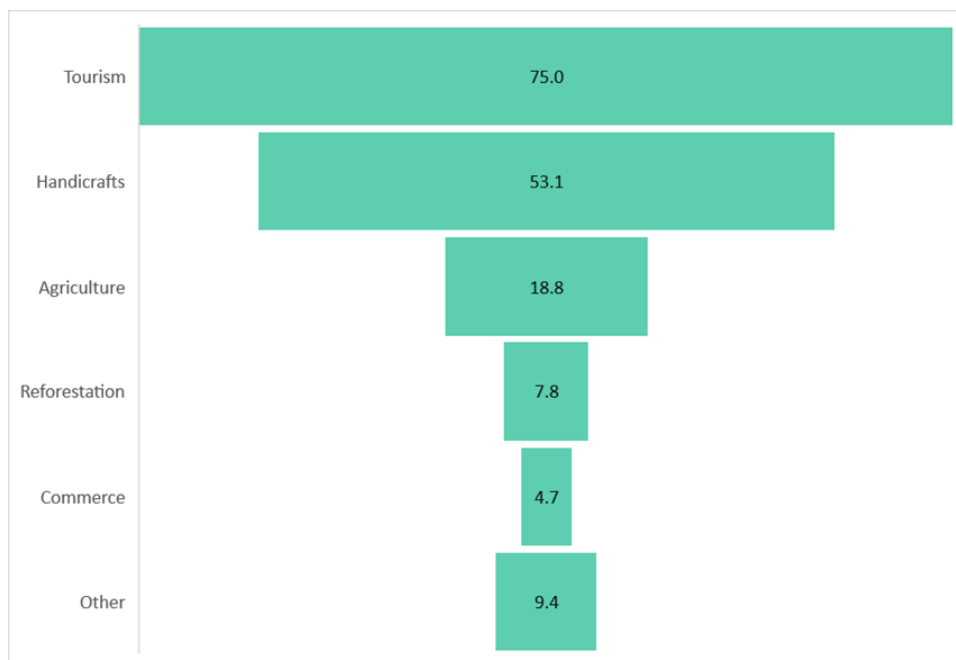


Figure 44. Potential community livelihood activities by percentage of mention during household surveys by members of the Kuamut cluster.

Three types of activities are notable in terms of their high frequency of mention by respondents in the household surveys and their predominance in workshop discussions. These are:

- **Tourism:** Principally river-based tourism activities focusing on sites of biocultural significance (mentioned by 53.6% of survey respondents in Keramuak and 75% in Kuamut).
- **Handicrafts:** Commercial production of traditional products made from non-timber forest products such as rattans and bamboos, potentially cross-cutting with tourism activities (29.1% of respondents in Keramuak and 53.1% in Kuamut).
- **Agriculture:** Technical and infrastructural assistance with developing various forms of sustainable subsistence and commercial agriculture (51.8% of respondents in Keramuak and 18.8% in Kuamut).

Whilst the activities detailed here remain subject to further discussion with Project Zone communities and other stakeholders, it is envisaged that future activities will be developed largely along the lines of these thematic groupings, or subsets thereof. Table 36 presents further details of potential outcomes and impacts associated with each of the three main activities.

Table 36. Predicted outputs, outcomes and impacts of livelihood enhancement activities proposed by communities (and target community groups).

Activity description (and principal community group)	Expected climate, community, and/or biodiversity			Relevance to project's objectives
	Outputs (short term)	Outcomes (medium term)	Impacts (long term)	
Tourism (youth group)	Skills development for particular community groups; especially youth	Increasing community autonomy over process	Stable revenue generation for communities	Generation of net-positive community benefits, non-consumptive use of project area
Handicrafts (female artisan group)	Skills development for particular community groups; especially women	Linkages with tourism activities, access to external markets	Stable revenue generation for communities	Generation of net-positive community benefits, sustainable use of project area NTFPs
Agriculture (smallholder group)	Influx of knowledge and infrastructural support	Reduces pressure from unsustainable agricultural practices	Stable revenue generation for communities	Generation of net-positive community benefits

Community respondents were also asked to identify the major obstacles to the implementation of these activities. The most frequently mentioned obstacles were:

- i. Lack of expertise, technical knowledge and skills
- ii. Lack of access to external markets and potential partner organisations
- iii. Lack of start-up capital and options for microfinancing

These and other foreseeable obstacles will be taken into account in the design and implementation of future community activities.

Initially the following activities will be developed to target the communities on located in the Kuamut river covering the three groups mentioned in table 36 above:

- Formal and informal education programs to children and youth at school age through a scholarship program provided by the project.
- Training programs to improve skills to develop tourism, elaboration of handicrafts and improved agricultural practices.
- Improve access to water by restoring riparian water reserves

As described in Section 2.1.11, The Kuamut project will further assist with a micro finance program to support the development of small to medium sized businesses. A variety of mechanisms will be used, including the direct provision of microfinance to facilitating access to government-backed financing schemes and grants. When implemented directly by the project microfinance will typically be channelled through local community groups.

The microfinance development program will bring about community benefits by empowering women, encouraging effective and transparent financial management, and nourishing entrepreneurship among the project-zone communities.

More specifically, for supporting agricultural activities, the project will promote sustainable palm oil cultivation practices within farmers dedicated to the production of palm oil, mostly in the Keramuak villages, while improvement of agricultural practices through smart agriculture techniques (e.g. shade cocoa, tillage, organic fertilizers, etc) will be promoted with the villages dedicated to rubber, cocoa and subsistence agriculture. Acknowledging the importance of road infrastructure to improve the accessibility to markets for the Kuamut villages, the project will coordinate closely with the local and regional authorities to identify the possibilities to improve the access to these villages and connect them to markets, in addition to the microfinance program described above and provision of small processing plants to add value to their products.

The Kuamut project will also employ at least 40 people from the communities nearby, particularly from the Kuamut cluster aiming to include at least 50% women. The project activities that would require local hire include the restoration of riparian reserves to improve water quality, patrolling activities and nursery maintenance and management.

As described above, the project-zone communities only have close access to very basic health care. The Kuamut Project will seek to improve this by working closely with local government to improve access to public services and to assist local government in providing health education at the village level. Through project implementation, community members will be allowed to access to the health services established for the project team onsite, initially offered to the communities to the Kuamut river, involving 914 people from which at least 50% are women. The Kuamut Project will also seek to improve local sanitation practices, including the common practice of discharge of all waste into local rivers, which are in turn used for cooking, drinking and bathing. The Kuamut Project will work with the villages together with local government agencies to bring awareness about and improve sanitation in each village, increase access to clean drinking water, and develop waste treatment facilities in each village. A more detailed analysis will be conducted through project implementation to potentially support the installation of piped water for the communities in the Kuamut cluster.

In regard to improving education, the Kuamut Project aims to support the local government's efforts to improve the quality of basic education and the number of enrolment and encourage the youth to pursue higher education to at least 100 students from which 50% should be women. The project will implement an open competitive scholarship program to provide funding to selected students and will assist to develop facilities at local schools. Capacity building and educational workshops for teachers will be conducted as well through various training programs.

The basic education program will benefit the project-zone communities as they will have increased access to quality education.

4.2.4 High Conservation Values Protected (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.

4.3 Other Stakeholder Impacts

4.3.1 Impacts on Other Stakeholders (CM3.1)

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.

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

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.

4.3.3 Net Impacts on Other Stakeholders (CM3.3)

The without-project scenario would entail the continuation of subcontracted logging operations in an already resource-depleted area, and mosaic planting operations which generally offer short-term incomes at considerable environmental costs. If the project is successful, the non-community stakeholders stand to both receive long-term financial gains and enjoy the reputational benefits described in Section 4.3.1. These would constitute significant net-positive impacts for these stakeholders, and may facilitate the adoption of similar carbon financing mechanisms elsewhere in Sabah and Malaysia.

4.4 Community Impact Monitoring

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

Monitoring of the impacts of project activities will be comprised of several mutually reinforcing methods which will be conducted over differing timescales. It is envisaged that a project Community Engagement Team will work with Project Zone communities over the long term in the implementation of project activities, and will also be responsible for the collection, collation and reporting of monitoring data. Methods to assess project impacts will include periodic household surveys, community-level engagements to assess project progress, smaller engagements targeting specific community groups, and communications via the grievance mechanism and other channels. Monitoring will thus constitute an ongoing aspect of project implementation, the results of which will be collated into regular (annual or biennial) monitoring reports.

Household surveys will be conducted among a randomly-selected sample of Project Zone community households every two years. These will aim to update the demographic and income baseline data reported in Section 4.1.1, and to record information related to impact indicators. Selected indicators will follow the

principle of SMARS (Specific, Measurable, Achievable, Relevant & Reliable, Sensitive) as per the SBIA Manual⁴⁰. Selected monitoring indicators will include, but not be limited to:

- i. Positive impacts associated with the implementation of project activities, such as increased household incomes, and improvements associated with the project in terms of opportunities, capacity, infrastructure, and other changes to livelihood and well-being;
- ii. Potential negative impacts associated with the project, including the impacts of the cessation of hunting, resentments arising due to unequal distributions of project benefits, and any unanticipated negative impacts arising from project activities;
- iii. The impacts of changes which are not directly associated with the project, such as future changes in government and local administration, unpredictable climatic conditions, long term impacts of the Covid pandemic, and;
- iv. Positive and negative impacts on community HCVs; both those associated with project activities (e.g. gathering of natural resources for handicraft production, management of local pollution related to tourism activities) and those not directly associated with the project (e.g. impacts of climatic changes and upstream agricultural pollution on fish stocks).

In addition to periodic household surveys, other forms of community engagements will be conducted with greater frequency. Community-level workshops will provide opportunities for the Community Engagement Team to provide updates on project developments, for both positive and negative aspects of project implementation to be discussed in an open and transparent manner, and for agreements pertinent to FPIC to be evaluated and any objections raised to be recorded in a public forum. These engagements will also provide an opportunity for the discussion of the monitoring indicators described above, and a community-based self-evaluation of project impacts (as per Richards and Panfil, 2011: p44)

Smaller and more targeted focus-group discussions will be held regularly with the community groups directly involved with the implementation of project activities to record indicator data related to specific activity outputs, outcomes and impacts as described in Table 35 (Section 4.2.3). These discussions will facilitate the assessment of differentiated impacts of project activities on the various community groups, and will also provide a channel for community groups to voice any concerns or issues which they may not have felt comfortable raising during the broader community-level engagements. In the event of unforeseen impacts arising (whether positive or negative), these focus-group discussions will also provide an effective forum for identifying potential causal factors.

⁴⁰ Richards, M. and Panfil, S.N. (2011). Social and Biodiversity Impact Assessment (SBIA) Manual for REDD+ Projects: Part 1 – Core Guidance for Project Proponents. Climate, Community & Biodiversity Alliance, Forest Trends, Flora & Fauna International and Rainforest Alliance. Washington, DC (available at <http://www.v-c-s.org/project/ccb-program/guidance/>).

Information produced during the abovementioned monitoring activities will be collated and compiled into regular (annual or biennial) monitoring reports, which will contain the outputs of all monitoring activities (including potential negative impacts identified via the grievance mechanism), a synthesis of the data to assess to overall adherence of project activities and impacts to the Theory of Change, and revised activity plans for the mitigation of negative impacts and enhancement of positive impacts. Versions of the reports will be prepared in the Malay language and disseminated among Project Zone communities for validation.

The full monitoring plan (inclusive of timeframe, specific indicators, implementing personnel, reporting framework, budget etc.) will be prepared together with the implementation plan for project activities, and will be completed within 12 months of project validation (as specified in Richards and Panfil, 2011: p48).

4.4.2 Monitoring Plan Dissemination (CM4.3)

Prior to the implementation of project activities, an Activity Implementation plan and the Community Monitoring Plan will be disseminated among the Project Zone communities in print form and in the Malay language. After an appropriate period of time for communities to read the documents and discuss them internally, the Community Engagement Team will hold dialogue sessions in communities to present the plans, discuss and receive feedback from community participants, and consequently make revisions to the plans as necessary.

The plans will be disseminated among other project stakeholders for inputs and proposed revisions. Once all stakeholders are satisfied with the plans, the finalized versions will be made publicly available on the project's website.

4.5 Optional Criterion: Exceptional Community Benefits

4.5.1 Exceptional Community Criteria (GL2.1)

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.⁴¹

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.

⁴¹ Sabah's unrelenting exclusionary and inclusionary politics Vilashini Somiah & Jose Ricardo Sto. Domingo s. Rajaratnam School of International Studies Singapore 5 May 2021. <https://www.rsis.edu.sg/wp-content/uploads/2021/05/WP334.pdf>

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.⁴² Furthermore, as stated above, the long history of governance arrangements in Sabah, generate development inequalities for indigenous rural communities. In this context, the most likely scenario in the absence of the project would be the continuation of underdevelopment and limited opportunities of livelihood improvement for project zone communities.

Because of a strictly enforced movement control order imposed by the Sabah Government during the pandemic, recent data on household incomes from project zone communities is not available. However, and based on consultations with the Sabah-based, community livelihood-focussed NGO PACOS, which has a long-standing engagement with project zone communities, more than 50% of households are below the national poverty line (of approximately US\$ 4.00 (2011 PPP) per person per day, and has not increased in real terms since 1977)⁴³,) – a situation that has likely be exacerbated by the pandemic. At the time of the social survey, it was found that cash-poor, average monthly income is around MYR 350 (around one-third of Malaysian minimum wage) in the Kuamut cluster and MYR 879 per month in the Keramuak cluster. PACOS has been commissioned to collect new income data for project zone communities – an exercise which will be completed by the end of June 2022.

As previously mentioned, 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 generally 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. Access to clean water is a pressing development issue for the project zone communities – especially those in the Kuamut cluster

⁴² Ibrahim, Zawawi. "The new economic policy and the identity question of the indigenous peoples of Sabah and Sarawak." *The New Economic Policy in Malaysia—Affirmative Action, Ethnic Inequalities and Social Justice* (2013): 293–313.

⁴³ World Bank 2020. Malaysia Poverty and Equity Brief – East Asia and Pacific. Available in https://databank.worldbank.org/data/download/poverty/33EF03BB-9722-4AE2-ABC7-AA2972D68AFE/Global_POVEQ_MYS.pdf

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

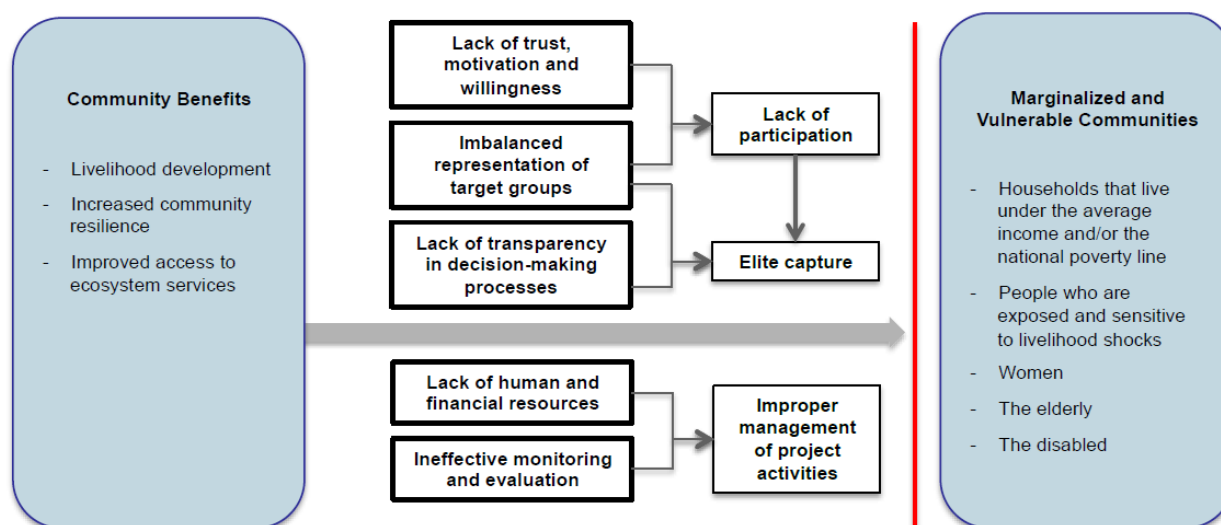
Following the findings of the social survey, and in advance of further consultations with project zone communities, the following short-term and long-term community benefits are foreseen:

- 1) Provision of piped, clean water: Communities in the 'Kuamut Cluster' do not, at present, have access to clean, piped water. As a priority, and within 18 months of starting the community development activities, the project will install either a gravity fed or pumped water system. Piped water in the 'Karamuak Cluster' will be checked for quality and reliability and any improvements or repairs deemed necessary will be carried-out within the same time period.
- 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, suggest that there are 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). Project support could include purchase of high-quality crop seeds and planting material, establishing processing facilities and support with marketing and distribution – particularly of processed products
- 3) Direct community engagement on the project: It is expected that the project will generate significant employment opportunities – particularly through the production of tree seedlings for restoration purposes (as and when forest restoration is initiated in the project area) and tourism related activities (particularly through the provision of specialist guides with local knowledge of the area).
- 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).
- 5) Installation of solar power systems: At present, the main sources of electrical power in project zone communities (all of which are off-grid) are diesel generators. Although some solar arrays have been installed, these presently account for only a minimal fraction of power generation. Through the first five years of the project, it is our intention to phase-out diesel power generation and to replace this with solar power – leaving diesel generators for back-up and emergency use only. We will also explore the potential to supplement solar power with other low-carbon power generation methods, including micro-hydro systems and solid-waste gasifiers.

While the above benefits can be inferred from previous community consultations as priorities, it is important to highlight that due to pandemic-related access restrictions imposed in the villages surrounding the project area, these activities will need to be consulted again, in partnership with PACOS, and in accordance with accepted FPIC principles and practices.

4.5.3 Community Participation Risks (GL2.3)

The success of community programs are largely dependent on participation, transparent decision-making processes based on mutual trust, and proper management of project activities. Three main potential barriers to community benefits in reaching the marginalized and/or vulnerable communities were identified during the social survey, and mitigation measures are presented in the diagram and discussed below.



Lack of participation: The marginalized poor communities tend to live remotely away from village centres, and often lack the means or time required to attend community meetings, due to distance and other constraints. Also, it is common for the project-zone communities that the marginalized feel discouraged to voice their opinions in front of dominant groups. This can trigger mistrust toward other community members and leads to lack of motivation and willingness to participate. Also, unbalanced or misrepresented target groups for certain project activities could entail non-participation of the poorer and marginalized community members. The Kuamut Project will encourage all community stakeholders, particularly the poorer and marginalized, to participate in project activities through differentiated approaches. The participatory planning processes enables all project-zone communities to be involved in decision-makings. Understanding barriers to meaningful participation to the project, socialization, information dissemination and community meetings take place at various locations and times by considering the needs of the marginalized. For example, some meetings will be facilitated only for women, and take place at their houses in the evening when they usually have spare time. Community message boards, booklets, flyers and videos, and local radio programs could also be used to reach target audience effectively.

Elite captures: A lack of participation and transparency in decision-making processes generally creates an opportunity for elite captures in which dominant groups can steer decisions to their favour, while hindering the flow of benefits to the marginalized households. When making decisions regarding an infrastructural development project such as road construction, for example, community board members may choose a location based on their personal benefits, rather than communal benefits as a whole. Without transparent decision-making systems and well-represented board of communities in place, community programs may be manipulated to satisfy the personal interests of certain individuals and may not produce overall positive impacts on the marginalized households. In order to address the risk of elite captures, the Kuamut Project will encourage the poorer and marginalized communities to participate (see above) and aim to enhance the balance of community representation. To increase transparency in decision-making processes of the activities to be undertaken with the communities, meeting records and decisions will be maintained and made publicly available. A mixed representation of community members, including the marginalized groups, will reinforce more equitable and democratic distribution of benefits, thereby placing checks and balances on decision-making processes and safeguarding the interest of communities as a whole.

Improper management of project activities: Another potential barrier to anticipated project benefits reaching target community members is improper management of project activities due to the lack of human and financial resources and effective monitoring and evaluation systems. The implementation and progress of project activities with the communities should be regularly monitored in order to assess the impacts of these activities on the marginalized households, to ensure appropriate allocation and use of community funds, and to enforce rules. Without a stringent system of checks and balances, the risk of the elite capture of benefits, ineffective performance and misappropriation of funds remains high. Proper training will also be provided to build the capacity of local people. Community-based adaptive management plan will reinforce checks and balances on decision-making processes and lead to a form of democratic natural resources governance.

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

Community Group	<i>Women from the Karamuak cluster and the Kuamut cluster.</i>
Net positive impacts	<i>The project is aiming to benefit around 500 women from the communities surrounding the project area. The community program includes improving health services, education, access to water and improve their livelihoods. A process to ensure participation of marginalized groups is described in section 4.5.3, aiming to ensure women participation.</i>
Benefit access	<i>Several barriers are described in section 4.5.3 above. Traditionally, women do not necessarily participate in the decision-making process, therefore, the project will implement targeted consultation processes with women to collect their views and feedback to project implementation, respecting the</i>

	<i>community processes and mechanisms for engaging with women.</i>
Negative impacts	<i>No negative impacts are expected to occur because of the project implementation. Furthermore, the iterative consultation and engagement with the communities and with the most vulnerable groups process will allow identifying any potential impact that may occur in advance and make any corrective actions following adaptive management models.</i>

4.5.5 Net Impacts on Women (GL2.5)

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.

Project implementation will help empower women to a higher extent through the scholarship program to be developed in which at least 50% women participation will be encouraged. Furthermore, employment opportunities will also be promoted to women involving at least 20 women to be hired as full-time employees in project activities in addition to generating improved livelihoods and increased income to at least 457 women from the communities in the project zone when implementing the community development activities. In addition, the improved access to health services also aims to benefit at least 50% of the women from the communities in the Kuamut river as well as improved access to water quality as a result of project activities.

4.5.6 Benefit Sharing Mechanisms (GL2.6)

Through the socio-economic survey, the project team was able to identify the priorities that members of the communities in the Karamuak and Kuamut clusters which will be supported by the project activities. These could include providing training and capacity building for developing potential ecotourism community enterprises, support in identification of access to markets and facilitating small processing facilities for adding value to handicrafts. More specific activities will be developed for supporting improving agricultural practices, such as promoting sustainable palm oil cultivation protocols within farmers dedicated to oil palm production and promotion of smart agriculture techniques among other project interventions aimed to improve livelihoods of agriculture-dependent communities in the project zone.

It is important to highlight that due to the mobilization restrictions over the last two years prior validation of the project including community imposed restrictions on the entry to villages of non-community members, additional consultation process with the community members has been extremely difficult. Nonetheless, the project is committed to conduct additional consultations following

the FPIC protocol to ensure effective participation of community members in defining the decision-making process and any other additional mechanisms for benefit sharing in a transparent manner.

4.5.7 Benefits, Costs, and Risks Communication (GL2.7)

The social engagement process included a series of workshops with community members during which the project objectives and structure were explained and discussed. A number 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 as biodiversity, carbon sequestration, global warming and the principles of FPIC.

Although the project start date was in December 2015 and the early engagements with the communities started on November 2017, the community livelihood activities identified during this period are yet to be implemented, thus the project will undertake additional consultation process with community members once the restrictions are lifted and safety measures are in place to enable engagement with the communities.

4.5.8 Governance and Implementation Structures (GL2.8)

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.

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 involvement of the communities in the project activities implemented with the communities themselves, is based on an inclusive approach to ensure effective participation of all community members. As previously described, the project aims to conduct extensive consultations once the restrictions for mobilizing project team members are lifted, with the purpose of updating earlier engagements and revise any other potential need to strengthening the engagement and implementation structures with the communities.

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

The project foresees several interventions to improve the capacities of community members, these include:

Scholarship program for students with emphasis of involving at least 50% women

Training and capacity building for developing potential eco-tourism activities in their communities

Training and capacity building for the elaboration of handicrafts and facilitate access to markets

Training in improved agricultural techniques, with a particular focus on sustainable oil palm cultivation and climate smart agriculture techniques.

It is important that throughout project implementation, and in consultation with communities, that a detailed evaluation and prioritisation of these activities take place, including an assessment of the impact of these trainings in the communities with adaptation according to their capacity needs and requests.

5 BIODIVERSITY

5.1 Without-Project Biodiversity Scenario

5.1.1 Existing Conditions (B1.1)

The Project Area is situated within the global terrestrial ecoregion "Borneo lowland rain forests" (Olson *et al.* 2001)⁴⁴ and borders, to the south and east, the world-renowned primary forests of the Danum Valley Conservation Area (Hazebrook *et al.* 2012⁴⁵, Reynolds *et al.* 2012). In a state-wide vegetation classification produced by the Forest Research Centre of the Sabah Forestry Department, the Project Area is delineated as a mixture of mostly lowland and upland mixed dipterocarp forest with areas of small crown and kerangas forest at higher elevations (*kerangas* is the Malaysian term for Sundaland heath forest). Forests in this area are typically dominated by dipterocarp trees of the genera *Parashorea* and *Shorea* in the upper canopy, with the understory comprised largely of members of the families Euphorbiaceae and Rubiaceae (refer to section 2.1.5 for further details).

Very little systematic inventory work has been conducted in the Project Area, but reasonable inferences of probable species presence can be derived from surveys and field research in the adjacent landscape, which is of broadly similar elevation, climatic conditions, soil, underlying geology, major vegetation types and, for logged forest areas, management history (Wright 1975⁴⁶ (summarized in March & Greer 1992⁴⁷),

⁴⁴ Olson, D.M., Dinerstein, E., Wikramanayake, E.D., Burgess, N.D., Powell, G.V.N., Underwood, E.C., D'amico, J.A., Itoua, I., Strand, H.E., Morrison, J.C., Loucks, C.J., Allnutt, T.F., Ricketts, T.H., Kura, Y., Lamoreux, J.F., Wettengel, W., Hedao, P. and Kassem, K.R. (2001). Terrestrial Ecoregions of the World: A New Map of Life on Earth. *Bioscience* 51 (11), 933-938.

⁴⁵ Hazebrook, H.P., Adlin, T.Z., Sinun, W., Reynolds, G. 2012. Danum Valley: The Rainforest. Natural History Publications,

⁴⁶ Wright, P.S. 1975. *The Soils of Sabah Vol 3: Western Parts of Tawau and Lahad Datu Districts*. Land Resource Study 10. London: Land Resources Division, Ministry of Overseas Development.

⁴⁷ Marsh, C.W., Greer, A.G. 1992. *Forest land-use in Sabah, Malaysia: an introduction to Danum Valley*. Philosophical Transactions of the Royal Society Series B, 335, 331-339.

Walsh 1996⁴⁸, Walsh & Newbery 1999⁴⁹, Tongkul 2005⁵⁰, Reynolds et al 2012). No prominent geophysical barriers to dispersal exist from these landscapes into the Project Area.

In terms of floral diversity, the Sabah Forestry Department's herbarium records for Kalabakan (a forest reserve to the south of the Project Area) list a total of 892 plant species, of which 44 are classified as Critically Endangered, Endangered or Vulnerable in the IUCN Red List (species listed under these three designations will be considered here Rare, Threatened or Endangered [RTE] species, whose presence in an area invokes HCV 1 status), and 18 are endemic to Borneo. A recent High Conservation Values (HCV) assessment in this area recorded 26 RTE species in the family Dipterocarpaceae alone (Daemeter, 2017)⁵¹. A permanent vegetation plot in the Danum Valley Conservation Area, including a 50 ha plot which operates as part of the Smithsonian Institution's global network of large plots that involves the enumeration all tree species greater than 1cm DBH, has recorded (to date) a total of 687 species, 243 genera and 73 families (see: <https://forestgeo.si.edu/sites/asia/danum-valley>, also Newbery 1999⁵², de Kok & Utteridge⁵³ 2010, Hazebrook 2012).

Faunal diversity in the Project Area can be inferred by wildlife survey work conducted in the Malua Forest Reserve (which is circa 35,000 ha swathe of forest contiguous with the eastern border of the Project Area) and the Imbak Canyon Conservation Area (a circa 30,000 ha Class I Forest Reserve approximately 25km west of the Project Area). Combined records from these areas list 82 mammal species, 245 bird

⁴⁸ Walsh, R.P.D. 1996. Drought frequency changes in Sabah (Borneo) since the late nineteenth century and possible implications for tropical rain forest dynamics. *Journal of Tropical Ecology* 12: 385-407.

⁴⁹ Walsh, R.P.D., Newbery, D.M. 1999. The ecoclimatology of the Danum, Sabah, in the context of the world's rain forest regions, with particular reference to dry periods and their impact. *Philosophical Transactions of the Royal Society Series B*, 354, 1582, 1869-1883.

⁵⁰ Tongkul, F. 2002. Structural Geology of the Danum Valley area, Lahad Datu, Sabah. Preliminary report, Geology Programme, School of Science and Technology, Universiti Malaysia Sabah.

⁵¹ Daemeter (2017). *High Conservation Value Full Assessment and High Carbon Stock Preliminary Assessment*. Report under the UNDP-GEF project Biodiversity Conservation in Multiple-use Forest Landscapes in Sabah, Malaysia.

⁵² Newbery, D.M., Kennedy, D.N., Pettol, G.H., Madani, L., Ridsdale, C.R. 1999. Primary forest dynamics in lowland dipterocarp forest at Danum Valley, Sabah, Malaysia. *Philosophical Transactions of the Royal Society Series B*, 354, 1763-1782.

⁵³ De Kok, R., Utteridge, T. 2010. Field Guide to the Plants of East Sabah. Royal Botanic Gardens, Kew.

species, 38 amphibians, 33 reptiles and 22 fishes (Sabah Forestry Department, 2011⁵⁴; Yayasan Sabah, 2014⁵⁵; York *et al.*, 2013⁵⁶).

The fauna of Danum Valley, which directly abuts the Project Area to the south and east, has been the subject of many scientific research projects and is especially recognised for its rich diversity of mammals (121 species, about a fifth of which are Borneo endemics) and birds – with 317 species recorded to date, including 15 endemics. Danum records also show 73 species of reptile (12 endemic), 56 frog species (with almost half of these (26) being endemic) and 47 species of fish. Invertebrates form the most diverse group with – conservatively – in excess of 2,000 species of moth, over 200 species of butterfly, 300+ species of ant and the highest diversity of termites (93) ever sampled at a single site in SE Asia (summarized in Hazebrook 2012). The diversity of beetles would likely number into the high tens of thousands, with the flies, wasps, dragonflies and phasmids also being extremely speciose (numerous studies summarized in Hazebrook *et al* 2012). Given the broadly similar forest type, elevational range and underlying soil types, and although Danum comprises only pristine forest, it would be reasonable to assume a high degree of congruence with the faunal diversity of the Project Area.

Based on all this research. Table 37 and Table 38 below show the 29 mammal and 12 bird species considered RTE (the other taxa have largely not been assessed in the Red List).

Table 37. RTE mammal species recorded in local landscape.

Common name	Scientific name	Order	Red list status
Clouded leopard	<i>Neofelis diardi</i>	Carnivora	VU
Marbled cat	<i>Pardofelis marmorata</i>	Carnivora	VU
Borneo bay cat	<i>Catopuma badia</i>	Carnivora	EN
Otter civet	<i>Cynogale bennettii</i>	Carnivora	EN

⁵⁴ Sabah Forestry Department. (2011). *Malua Forest Reserve – Conservation Management Plan 2008-2014*. (Revised 2011). Sabah Forestry Department, Sandakan, Sabah, Malaysia.

⁵⁵ Yayasan Sabah. (2014). *Imbak Canyon Conservation Area Sabah, Malaysia. Strategic Management Plan 2014-2023*. Conservation and Environmental Management Division, Yayasan Sabah, Kota Kinabalu, Sabah, Malaysia.

⁵⁶ York, O.K., Kunai, J.G., Pamin, D., Matsubayashi, H., Bernard, H. and Ahmad, A.H. (2013). Notes on mammal fauna in and around Gunung Kuli Research Station, in Imbak Canyon Conservation Area, Sabah, Malaysia. *Journal of Tropical Biology and Conservation* 10, 1-9.

Hose's civet	<i>Diplogale hosei</i>	Carnivora	VU
Masked palm civet	<i>Paguma larvata</i>	Carnivora	VU
Banded civet	<i>Hemigalus derbyanus</i>	Carnivora	VU
Binturong	<i>Arctitis binturong</i>	Carnivora	VU
Sun bear	<i>Helarctos malayanus</i>	Carnivora	VU
Smooth-coated otter	<i>Lutra perspicillata</i>	Carnivora	VU
Oriental small-clawed otter	<i>Aonyx cinerea</i>	Carnivora	VU
Brown spiny rat	<i>Maxomys rajah</i>	Rodentia	VU
Whitehead's rat	<i>Maxomys whiteheadi</i>	Rodentia	VU
Dark tailed rat	<i>Niviventer cremoriventer</i>	Rodentia	VU
Ear spot squirrel	<i>Callosciurus adamsi</i>	Rodentia	VU
Tufted ground squirrel	<i>Rheithrosciurus macrotis</i>	Rodentia	VU
Hollow-faced bat	<i>Nycteris javanica</i>	Chiroptera	VU
Orangutan	<i>Pongo pygmaeus</i>	Primates	EN
Bornean gibbon	<i>Hylobates muelleri</i>	Primates	EN
Pig-tailed macaque	<i>Macaca nemestrina</i>	Primates	VU
Hose's langur	<i>Presbytis hosei</i>	Primates	VU
Horsfield's tarsier	<i>Cephalopachus bancanus</i>	Primates	VU
Philippine slow loris	<i>Nycticebus menagensis</i>	Primates	VU
Proboscis monkey	<i>Nasalis larvatus</i>	Primates	EN
Pangolin	<i>Manis javanica</i>	Pholidota	EN
Bornean elephant	<i>Elephas maximus borneensis</i>	Proboscidea	EN
Bearded pig	<i>Sus barbatus</i>	Artiodactyla	VU
Sambar deer	<i>Cervus unicolor</i>	Artiodactyla	VU

Tembadau	<i>Bos javanicus</i>	Artiodactyla	EN
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Table 38. RTE bird species recorded in local landscape.

Common name	Scientific name	Family	Red list status
Helmeted hornbill	<i>Rhinoplax vigil</i>	Bucerotidae	CR
Kinabalu serpent eagle	<i>Spilornis kinabaluensis</i>	Accipitridae	VU
Wallace's hawk eagle	<i>Nisaetus nanus</i>	Accipitridae	VU
Large green pigeon	<i>Treron capellei</i>	Columbidae	VU
Short-toed coucal	<i>Centropus rectunguis</i>	Cuculidae	VU
Blue-banded kingfisher	<i>Alcedo euryzona</i>	Alcedinidae	VU
Great slaty woodpecker	<i>Mulleripicus pulverulentus</i>	Picidae	VU
Blue-headed pitta	<i>Pitta baudi</i>	Pittidae	VU
Straw-headed bulbul	<i>Pycnonotus zeylanicus</i>	Pycnonotidae	VU
Bornean wren babbler	<i>Ptilocichla leucogrammica</i>	Pellorneidae	VU
Brown chested flycatcher	<i>Rynomyias brunneatus</i>	Muscicapidae	VU
Large-billed blue flycatcher	<i>Cyornis caerulatus</i>	Muscicapidae	VU

Whilst the listed species all have historical ranges within the Project Area, those which are more sensitive to habitat disturbance may be currently restricted to the relatively undisturbed south-eastern areas, which are contiguous with larger areas of undisturbed forest extending into the Danum Valley and Mount Louisa Forest Reserve. In addition to forest condition, the presence and dispersal of animal populations is likely mediated by the legal protection of forest areas and restrictions on hunting activities. Again, the fully protected Class I Forest Reserves to the south and east of the Project Area constitute important primary source areas for RTE species. Figure 45 shows the biomass (which can be considered a proxy measure of forest condition or quality) of forests in the Project Area and surrounding landscape. Figure 46 shows the designations and protection status of forest reserves in the landscape.

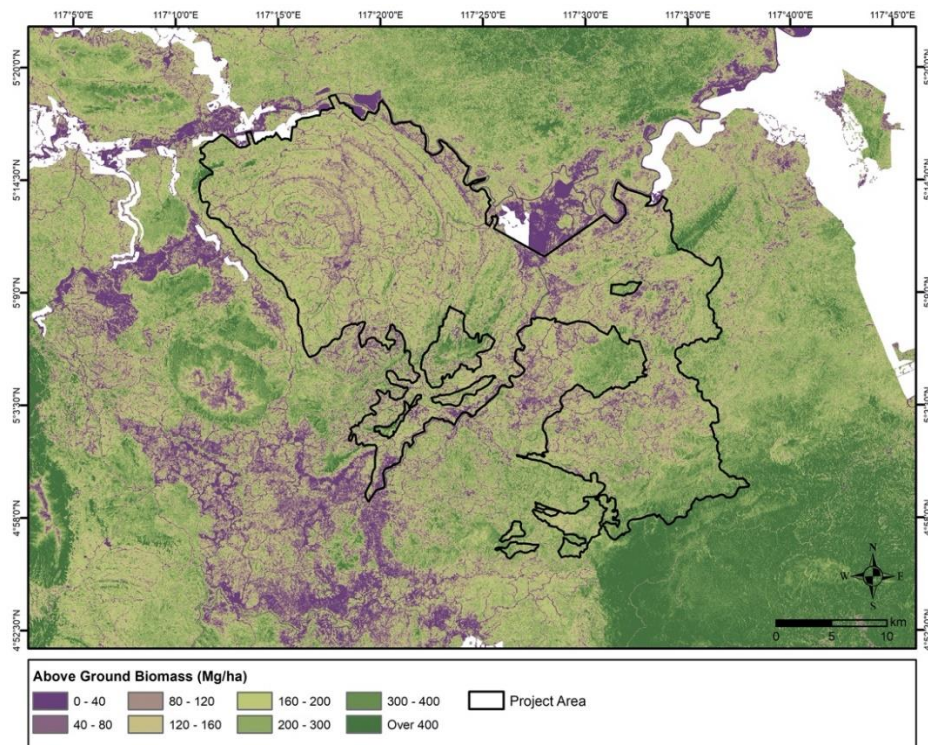


Figure 45. Above ground biomass in the Project Area and surrounding landscape, derived from LiDAR data. White areas indicate agricultural monocultures which were excluded from the dataset.

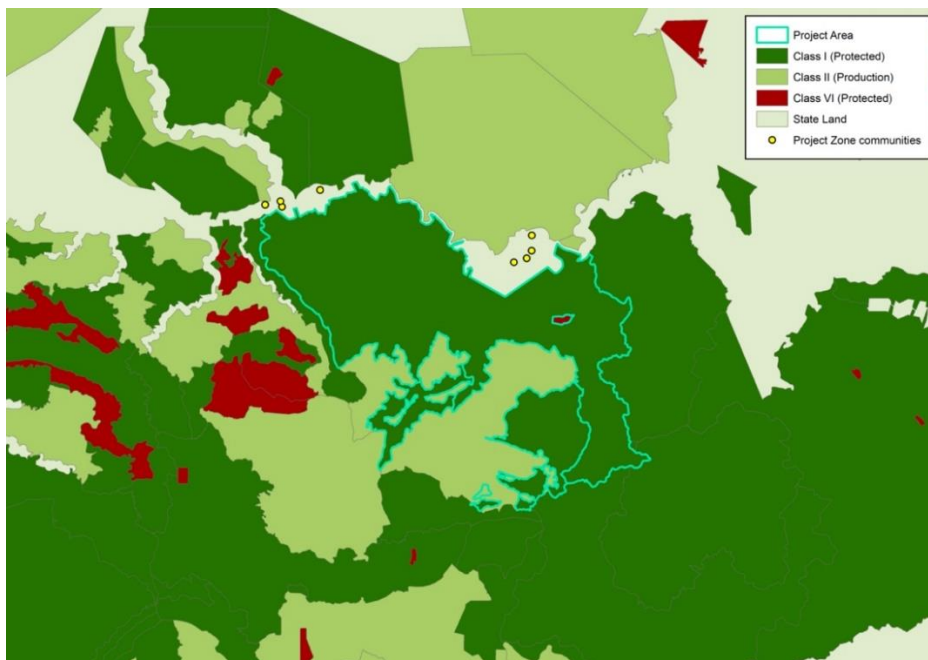


Figure 46. Designations of forest reserves in the surrounding landscape. Classes I and VI are considered fully protected and no land conversion or extractive activities are permitted by law.

5.1.2 High Conservation Values (B1.2)

High Conservation Value	HCV 1 – Species diversity
Qualifying Attribute	RTE floral and faunal species dependent on mature undisturbed forest habitats; for example felids, mustelids and certain primates
Focal Area	Southern and eastern parts of the Project Area

High Conservation Value	HCV 1 – Species diversity
Qualifying Attribute	RTE species more tolerant of forest disturbance, such as ungulates, some primates and bird species and the Bornean elephant
Focal Area	Entire Project Area

High Conservation Value	HCV 2 – Landscape level ecosystems
Qualifying Attribute	Mature and undisturbed mixed dipterocarp forests which are contiguous with the larger forest landscape in protected areas to the east and south of the Project Area (see Figure 42)
Focal Area	Southern part of the Project Area

5.1.3 Without-project Scenario: Biodiversity (B1.3)

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 wholesale land clearance and the planting of a small number of fast-growing timber species (refer to sections 2.2.1, 3.1.4 and 3.1.5 for a full justification of the without-project land use scenario).

Selective logging may not have particularly deleterious impacts on generalist and disturbance tolerant RTE species such as ungulates, or migratory species with large ranges, e.g., the Bornean pygmy elephant (e.g.

Johns 1992,1996⁵⁷). This practice does however result in structural changes to the forest through the felling of trees and the clearance of skid trails for timber removal (Marsh & Greer 1992, Reynolds *et al* 2012). It is likely therefore to be more detrimental to those species highly dependent on undisturbed forests, including canopy and understory specialists (e.g Lambert 1990, 1992⁵⁸, Johns 1992, Brühl 2003⁵⁹, Dumbrell & Hill 2005⁶⁰ and other studies summarized in Hazebroek 2012). Moreover, the ongoing presence of logging concession workers may encourage opportunistic hunting, and several of the RTE ungulates are widely targeted as game 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 involve the complete removal of natural vegetation and thus of natural habitats for all species and sources of food for herbivorous and frugivorous species. 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, the mosaic landscape as a whole will be severely compromised in its complement of local biodiversity, ecological integrity (including recovery and recruitment in embedded forest patches) and capacity for the maintenance of ecosystem functions including pollination and microbial cycling of soil nutrients. In addition to on-site impacts on biodiversity, mosaic planting in the Project Area may have downstream impacts through the increased erosion of exposed topsoils and the sedimentation of the Kuamut River (which flows northwards through the centre of the Project Area and empties into the major Kinabatangan River at the village of Kuamut), potentially negatively impacting water quality and aquatic HCV 5 resources utilized by communities (see section 4.1.1).

⁵⁷ Johns, A.D. 1992. *Vertebrate responses to selective logging: Implications for the design of logging systems*. Philosophical Transactions of the Royal Society Series B, 335, 437-442.

Johns, A.D. 1996. *Bird population persistence in Sabahan logging concessions*. Biological Conservation 75: 3-10.

⁵⁸ Lambert, F.R. 1990. *Avifaunal changes following selective logging of a north Bornean rain forest; report for the Royal Society*. Institute of Tropical Biology, University of Aberdeen. 59 pp.

Lambert, F.R. 1992. *The consequences of selective logging for Bornean lowland forest birds*. Philosophical Transactions of the Royal Society Series B, 335, 443-457.

⁵⁹ Brühl, C.A., Eltz, T., Linsenmair, K.E. 2003. *Size does matter: Effects of tropical rainforest fragmentation on the leaf litter ant community in Sabah, Malaysia*. Biodiversity Conservation 12: 1371-1389.

⁶⁰ Dumbrell, A.J., Hill, J.K. 2005. *Impacts of selective logging on canopy and ground assemblages of tropical forest butterflies: Implications for sampling*. Biological Conservation 125: 123-131.

Given the 'without project' likelihood of increased mosaic planting in the Project Area, conditions for biodiversity could reasonably be expected to worsen, by a significant margin, in comparison to initial baseline conditions under this scenario.

5.2 Net Positive Biodiversity Impacts

5.2.1 Expected Biodiversity Changes (B2.1)

Biodiversity Element	RTE floral and faunal species
Estimated Change	Gradual dispersal of RTE species throughout the Project Area
Justification of Change	Curbing of deforestation and hunting activities leads to increasing dispersal of RTE species through the Project Area, detected through implementation of biodiversity monitoring activities.

Biodiversity Element	Mature forests and habitat complexity
Estimated Change	Natural forest regeneration leads to increase in mature forest habitats
Justification of Change	Cessation of logging and prevention of mosaic planting results in natural forest regeneration through the Project Area, detected through implementation of biodiversity monitoring activities.

5.2.2 Mitigation Measures (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 which would almost certainly result from the without-project scenario.

The additional project activities outlined in section 2.1.11 will further safeguard biodiversity in the with-project scenario through the prevention of illegal logging and control of hunting activities.

The forest of the Project Area will be protected from further degradation and allowed to regenerate naturally on the assumption that the HCV 1 species documented in the surrounding landscape have a high probability of being present in the Project Area 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.

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

The project will confer immediate biodiversity benefits via protection of key habitats and functioning ecosystems and, by extension, the protection of floral and faunal species themselves. 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.

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

Given the baseline conditions at the start of the project and the likely worsening conditions under the without-project scenario, the project has an extremely high probability of providing net positive biodiversity impacts in comparison to both initial conditions and the without-project scenario.

5.2.4 High Conservation Values Protected (B2.4)

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.

5.2.5 Species Used (B2.5)

The degraded parts of the Project Area have the capacity to regenerate naturally under the condition of full protection, and no planting activities are currently envisioned. Any activities with communities aimed at the enhancement of agriculture in the Project Zone will focus on methods for the improvement of yields from currently planted crops, rather than the introduction of new crop species.

5.2.6 Invasive Species (B2.5)

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

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

No non-native species will be used in the Project Zone.

5.2.8 GMO Exclusion (B2.7)

The project will not utilize GMOs in any form.

5.2.9 Inputs Justification (B2.8)

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

5.2.10 Waste Products (B2.9)

Project activities will not generate significant waste products.

5.3 Offsite Biodiversity Impacts

5.3.1 Negative Offsite Biodiversity Impacts (B3.1) and Mitigation Measures (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 (section 4.2.3) and education activities

5.3.2 Net Offsite Biodiversity Benefits (B3.3)

There is a possibility that hunting activities will be refocused in other forest reserves outside of the Project Zone; for example the Deramakot Forest Reserve to the north of the Kuamut village cluster. The project will seek to mitigate these potential offsite effects through efforts to reduce community reliance on hunting over time via the livelihood enhancement activities outlined in section 4.2.3.

Although hunting activities are carried out by Project Zone communities, it does not appear to be a primary contributor to subsistence and hunting pressure is unlikely to be high. The principal threats to biodiversity in the without-project scenario would be land clearance for mosaic plantings and forest degradation due to selective logging and these activities will be entirely obviated by the existence of the project. It is therefore entirely reasonable to assume that the net positive biodiversity impacts accruing under the with-project scenario will greatly outweigh any effects of displaced hunting.

5.4 Biodiversity Impact Monitoring

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

Biodiversity monitoring activities are envisioned to be conducted together with the climate monitoring activities described in section 3.3.3, with collaboration from the Community Engagement team's monitoring activities described in section 4.4.1. All data collected, recorded, stored and reported will be subject to review and approval by team leaders and/or project managers with reference to written SOPs covering each level of data management. Local professional biologists and/or ecologists will also be consulted in the precise formulation of biodiversity monitoring methods and the evaluation of resultant data.

Indicators will include the pressure, state and response variables most relevant to biodiversity such as vegetation quality, presence of HCV 1 species, signs of anthropogenic disturbance, and the status of hunting activities. The project will explore the use of a recently developed smartphone-enabled tool for monitoring forest quality – the Forest Integrity Assessment (Suggit et al 2021)⁶¹.

The indicators used for carbon monitoring (through the monitoring of field plots and analysis of remotely-sensed imagery) will track natural forest regeneration throughout the project's lifetime, which will provide a proxy measure for habitat health and suitability for RTE species. Signs of RTE species (direct sightings, tracks and/or scats) will be documented opportunistically by the field team during monthly surveillance and monitoring activities (see section 3.3.3), and recorded via data sheets, photographs, and GPS waypoints. Whilst these methods will not allow robust estimations of population densities, they are relatively cost-effective and feasible within the overall project framework and will allow the determination of species presence and abundance indices for certain species. Signs of anthropogenic disturbance (such as vegetation cutting and used shotgun cartridges) will be similarly documented. The Community Engagement team will also address ongoing hunting as part of their monitoring activities.

All biodiversity monitoring data will be collated and analysed to produce annual reports which will track the efficacy of project interventions in safeguarding biodiversity and enhancing HCV 1 and HCV 2 values, and will include recommendations for more thorough research and potentially the adaptation of project activities should any negative trends be identified.

5.4.2 Biodiversity Monitoring Plan Dissemination (B4.3)

The biodiversity monitoring plan will be disseminated among project stakeholders for inputs and proposed revisions. Once all stakeholders are satisfied with the plan, finalized versions will be made publicly available on the project's website together with periodic updates on monitoring outputs.

⁶¹ Suggit, A.J., Yeong, K.L., Lindhe, A., Agama, A.L., Hamer, K.C., Reynolds, G., Hill, J.K., Lucey, J.M. 2021. Testing the effectiveness of the forest integrity assessment: A field - based tool for estimating the condition of tropical forest. Ecological Solutions and Evidence 2, 2.

The biodiversity monitoring plan and monitoring results will be communicated with Project Zone communities concomitantly with discussions on community monitoring results, as discussed in section 4.4.2.

5.5 Optional Criterion: Exceptional Biodiversity Benefits

5.5.1 High Biodiversity Conservation Priority Status (GL3.1)

The Bornean orangutan (*Pongo pygmeus morio*) is Critically Endangered according to the IUCN red list of endangered species (Ancrenaz *et al* 2016)⁶². Recent studies indicate that the species is in rapid decline (Utami-Atmoko *et al* 2017, Santika *et al* 2017), with more than 100,000 individuals estimated to have died since the early 2000s – largely as a consequence of habitat loss, agricultural expansion, fires and hunting (Voigt *et al* 2018). The most recent estimates for population of orangutan in Sabah, based on empirical surveys conducted in 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).

The estimated number of orangutan present in the Kuamut Forest Reserve was 313 (129 – 855) in 2002 (Ancrenaz *et al* 2005) and 630 (422 – 942) in 2017 (Simon, Davies & Ancrenaz 2019). The Project Area of 83,381 ha covers approximately 70% of the Kuamut Forest Reserve (116,471 ha) and comprises most of the lower elevation forests of Kuamut – habitat types which are known to be favoured by orangutan (Ancrenaz *et al* 2010, Ancrenaz *et al* 2016, Milne *et al* 2021). Based on the 2017 survey, we estimate that the Project Area currently supports, and is regularly used by, at least 500 orangutan; a population that has likely been stable from the early 2000s to the present day (Ancrenaz *pers. com.*). 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* 2005, Ancrenaz *et al* 2010, Simon, Davies & Ancrenaz 2019).

Estimates for the total current population of Bornean orangutan are unclear. In 2012 Wich *et al* estimated a population of 104,700 individuals (declining from 288,500 in the early 1970s). Using modelling approaches, the same authors suggest that total Borneo populations of orangutans would decline to 47,000 by 2025 (Wich *et al* 2012). More recent studies indicate that the species remains in rapid decline (Voigt *et al* 2018). On this basis, it would be reasonable to assume that the Project Area currently supports approximately 1% of the total population of Bornean orangutan (Ancrenaz *pers. com.*).

⁶² <https://www.iucnredlist.org/species/17975/123809220>

5.5.2 Trigger Species Population Trends (GL3.2, GL3.3)

Trigger Species	Bornean orangutan (<i>Pongo pygmeus morio</i>)
Population Trend at Start of Project	Based on empirical surveys conducted in 2002 and 2017 (Ancrenaz <i>et al</i> 2005, Simon, Davies & Ancrenaz 2019) we estimate that the population of orangutan in the Project Area is approximately 500 and that this number remained stable between the two surveys (Simon, Davies & Ancrenaz 2019, Ancrenaz <i>pers. com.</i>) with the latter taking place soon after the project start date in 2016.
Without-project Scenario	The major impact of the without project scenario would be habitat clearance associated with the development of mosaic plantings. This change in land-use would result in population fragmentation and hence compaction in remaining natural forests. While some animals may survive in mosaic areas it is reasonable to assume that the majority of range-restricted resident females would show high mortality, probably in the order of 80% (Goosens <i>et al</i> 2006, Ancrenaz <i>pers. com.</i>). Assuming a total of 500 orangutans exist in the Project Area (adults and adolescents – approximately half (250) being females) the clearance of approximately 40% of low-lying forests in the Project Area to establish mosaic plantings would likely result in the loss of ~80 female orangutan (250 individuals x 0.4 (habitat loss) x 0.8 (mortality) = 80) (Goosens <i>et al</i> 2006, Ancrenaz <i>pers. com.</i>). While less impacted by land-use change within the Project Area, given larger home ranges, male orangutan numbers would also likely decline. Assuming a mortality rate of 20%, the without project scenario would result in the loss of approximately 20 male orangutan (250 males x 0.4 habitat loss x 0.2 mortality rate). Further, the long-term viability of orangutan living in the more fragmented forest under the without project scenario would lead to further losses, likely amounting to 20% mortality of the remaining population (Goosens <i>et al</i> 2006, Ancrenaz <i>pers. com.</i>).

	– 80 individuals (400 individuals x 0.2 mortality). Total losses of orangutan under the without project scenario would likely amount to 180 individuals, equivalent to 36% of the population supported by the Project Area (Ancrenaz <i>pers. com.</i>).
With-project Scenario	Survey data indicates that the orangutan population supported by the Project Area remained stable between the early 2000s and the project start date in 2015/16 at approximately 500 individuals (Simon, Davies & Ancrenaz 2019). Based on surveys from the Malua and Ulu Segama Forest Reserves in Sabah (which are adjacent to the Kuamut Forest Reserve and have been subject to a similar regime of logging), it is known that recovering, logged-over forest provides a suitable habitat for the maintenance of orangutan populations in Sabah (Ancrenaz <i>et al</i> 2010). As a result of the Project, active measures will be taken to secure the boundaries in order to minimise losses to hunting, prevent illegal timber harvesting or agricultural development, and we therefore expect the current orangutan population supported by the Project Area to remain stable. The Project will collaborate with the Sabah-based, orangutan focussed NGO 'HUTAN' (see: www.hutan.org.my) to monitor the Kuamut orangutan population. This will involve a combined approach including 5-yearly aerial nest surveys (by helicopter or drone), twice-yearly ground-based monitoring using a network of line transects across the Project Area and continual camera trapping at key locations.

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