Verified Carbon Standard
Project Description Template

19 November 2007

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INFAPRO Rehabilitation of logged-over dipterocarp forest in Sabah, Malaysia

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1 Description of Project:

1.1 Project title

INFAPRO Rehabilitation of logged-over dipterocarp forest in Sabah, Malaysia

1.2 Type/Category of the project

IFM - LtHP
AFOLU Improved Forest Management. Conversion of Low Productive to High Productive Forest by climber cutting and enrichment planting and prevention of unsustainable logging.

1.3 Estimated amount of emission reductions over the crediting period including project size:

It is estimated that project results into a net emission reduction benefit of 4,140,409 tCO_2-e within a Crediting Period of 30 years in a rehabilitated area of 25,000 hectares. This value is not corrected for a non-permanence buffer.

1.4 A brief description of the project:

The project rehabilitates 25,000 ha of severely logged-over mixed dipterocarp rainforest in Sabah, Malaysia and prevents relogging of the forest in this area. In the absence of the project activity, the forest would be re-logged and would only slowly recuperate due to the high quantities of vines and climbing bamboos suppressing the remnant trees and the natural regeneration process.

The project is called INFAPRO which is an acronym for Innoprise-Face Foundation Rainforest Rehabilitation Project. INFAPRO is the collaborative project between Rakyat Berjaya and Face the Future. Rakyat Berjaya is responsible for the field project, which contains implementation and management of the forest rehabilitation activities. Face the Future holds the carbon sequestration rights and is responsible for the carbon development aspect of the project.

In 1992 Rakyat Berjaya and the Face Foundation (the predecessor of Face the Future) signed a contract with the objective of carbon sequestration through the joint implementation of an enrichment planting forestry project on Yayasan Sabah's now largely logged-over concession, in direct vicinity of the Danum Valley Conservation Area. The resulting INFAPRO project is a large-scale rainforest rehabilitation project aimed at the rehabilitation of 25,000 ha of heavily degraded logged-over rainforest. In doing so, the project enables the sequestration of large volumes of carbon dioxide from the atmosphere, thus combating climate change. INFAPRO is supported by the Government of Sabah in a Memorandum of Understanding between the State of Sabah and Face.

The INFAPRO project is divided into two phases. The first is the implementation phase which covers the first three years of each contract and is under the shared financial responsibility of Face the Future and Rakyat Berjaya. Activities within this phase are implemented by Rakyat Berjaya. The second phase is the subsequent management phase, which covers the following 96 years, which is under responsibility of Rakyat Berjaya. As a whole, the project results in the prevention of short-term re-logging and rehabilation of a severely degraded logged-over rainforest.

Background and objectives to the project

The logging of dipterocarp forests has traditionally accounted for ca. 50 to 70% of Sabah's state revenue (Sabah Forestry Department, 1989). In order to maintain the economic returns derived from this sector, forest regeneration must be managed for sustainable yields. The high densities of natural dipterocarp stands in Sabah (Newbery et al., 1992) lead to extraction rates of up to 120 m^3 ha^{-1}. However, this level of extraction results in substantial disturbance to the residual stand (Nussbaum et al., 1993; Appanah and Weinland, 1990). In some areas the residual stocking and seedling bank of timber species is much reduced and natural regeneration does not occur. Therefore, to maintain the species composition and commercial value of these forests, artificial regeneration needs to be employed (Primack et al., 1987; Appanah and Weinland, 1990) or, as this project is employing, a combination of: climber cutting, liberation thinning and enrichment planting.

Image 1.4.1 Typical logging site, some 10 yrs after logging: no recovery of the forest cover.

Enrichment planting of dipterocarp species forms the core of INFAPRO's project activities. These techniques have been refined through applied research and experimentation. Additional project activities include liberation, climber cutting and intensive management to enhance the growth of the residual forest matrix. Through liberation and climber cutting INFAPRO promotes the natural regeneration of dipterocarp seedlings and ecologically important fruit species within logged-over rainforest. Silvicultural treatments are then used to encourage the growth and survival of these seedlings. The inclusion of indigenous fruit tree species within planting and liberation activities serves to increase the biodiversity of the planting compartments and to attract wildlife.

The core project activities and objectives of INFAPRO include:

- Conduct forest restoration and rehabilitation in suitable logged forests for the purpose of compensating CO_2 emissions;
- Identify appropriate indigenous tree species for use in the rehabilitation of degraded tropical forests;
- Achieve the above objectives on a cost efficient basis and under circumstances that are sociably acceptable; and

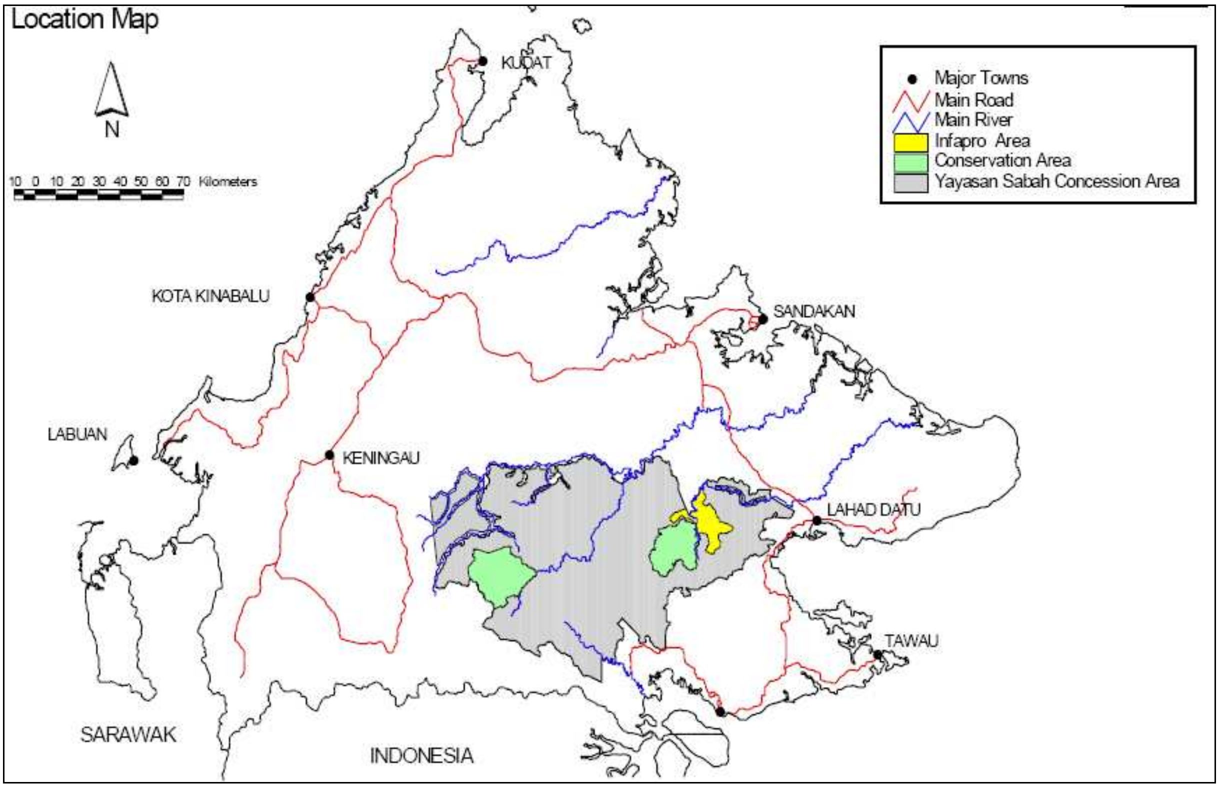
- Conduct and refine forest restoration and rehabilitation as a strategy to sustain timber and non timber values in perpetuity under regimes that are in accordance with sustainable forest management.

1.5 Project location including geographic and physical information allowing the unique identification and delineation of the specific extent of the project:

INFAPRO is located in the Malaysian state of Sabah on the island Borneo, about 71 kilometres from the town Lahad Datu. It is situated to the eastern part of the Yayasan Sabah Concession in the Ulu Segama Forest Reserve in the Lahad Datu District (see map 1.5.1). The Project Area is adjacent to Danum Valley Field Centre, about 11 km from the INFAPRO nursery. The coordinates of the INFAPRO nursery and camp are 4°58'55"N and 117°51'25"E. The following coordinates represent the most Northern, Western, Southern and Eastern extremes of the Project Area boundary:

North: 5°11'15"N & 117°49'50"E
South: 4°53'30"N & 117°52'55"E
East: 5°00'20"N & 117°58'10"E
West: 5°01'50"N & 117°41'50"E

Map 1.5.1 Location of INAPRO Project Area within the Yayasan Sabah Concession Area and the State Sabah.



Climate

The climate is weakly influenced by two annual monsoons. Annual rainfall in the area has been recorded (by the Danum Valley Field Centre) to averages 2,699 mm (station records, 1986 – 1992). The wettest period occurs in January and the driest period in April. Mean daily temperature at the field station is 26.7 ºC (1992 – 2001), with a minimum of 25.7 ºC and a maximum of 27.7 ºC.

Topography and hydrology

The project site consists of largely rugged terrain with some flat areas, with elevations ranging up to 610 m. The Segama Valley is mostly low-lying and covered by wide patches of alluvium while the higher lands are composed of tuffaceous ridges.

About 65% of the area comprises slopes of 0˚ - 15˚ and about 25% of slopes between 15˚ - 25˚. The remaining slopes are above 25˚.

Only the Segama River drains the area. The drainage pattern is roughly rectangular with the rivers flowing to the east. The Segama River drains into the Sulu Sea and is fed by numerous tributaries of which among the major ones are Bole, Kawag and Bilong.

Geology and soils

The underlying geology of the Project Area is dominated by Cretaceous to Tertiary sedimentary formations. The dominant rock types are chert, spilite and greywacke. Other rocks that occur in varying proportions include granodiorite, diorite and gabbro. These rock types represent the oldest in Sabah.

Orthic and Chromic Luvisols, Eutric and Chromic Cambisols are the dominant soil types, which are derived mainly from basic igneous rocks of the Mentapok association. Also occurring in significant proportions within the area are orthic Acrisols and Dystric Cambisols of the Gumpal association. These soil units are derived from parent materials comprised of sandstone, shale and assorted rock associated with mountains and very high hills. Other soil associations found within the area include Bang (on high hills, slopes 15˚ - 25˚), Tabin (high hills, slopes above 25˚), Rumidi (low hills and minor falts, slopes below 15˚), Kretam (moderate hills, slopes 10˚ - 20˚) Malubok (mountains, above 25˚) and Bidu-bidu (mountains and hills, slopes generally 25˚).

Vegetation

The Project Area supports mixed dipterocarp forest, with high species diversity. The main tree species are *Dipterocarpus* spp. (keruing), *Dryobalanops* spp. (kapur), *Hopea nutans* (giam), *Hopea* spp. (selangan), *Hopea nervosa* (selangan jangkang), *Hopea sangal* (gagil), *Parashorea* spp. (white seraya), *Shorea* spp. (red and yellow seraya, selangan batu), *Vatica* spp. (resak), *Anisoptera* spp. (pengiran), *Agathis dammara* (mengilan), *Aquilaria malaccensis* (gaharu), *Azadirachta excelsa* (limpaga/bawang-bawang), *Dialium* spp (keranji), *Diospyros* spp. (kayu malam), *Eusideoxylon zwageri* (belian), *Intsia palembanica* (merbau), *Koompassia excelsa* (mengaris), *Koordersiodendron pinnatum* (ranggu), *Payena* spp. and *Palaquium* spp. (nyatoh), *Scorodocarpus borneensis* (bawang hutan), *Sindora* spp. (sepetir), *Sympetalandra borneesis* (merbau lalat).

Under natural conditions, (i.e. without logging), the canopy has an average height of 40 m, with emergents reaching up to 70 m. Stand densities for trees greater than 60 cm diameter vary between 15-20 trees per ha.

There does not appear to be any correlation between species distribution and soil characteristics for most of the dipterocarps of the region. Floristic variations are probably rather linked to biological factors such as fruiting, fruit dispersal, seed predation, regeneration processes, and growth requirements during development, forest structure and dynamics.

Faunal diversity

Studies conducted on faunal diversity in Danum Valley revealed that the area has a high density and diversity of fauna in comparison with other parts of Malaysian Borneo.

Primal diversity is relatively rich, comprising of Orang utan (*Pongo pygmaeus*), Borneo gibbon (*Hylobates muellen*), red langurs, long-tailed and pig-tailed macaques. Borneo Pygmy elephants (Elephas maximum) are common as well as a population of Sumatran rhino (*Dicerorhinus sumatrensis*). Tembadau (*Bos javanicus*) occur in the flatter areas together with large populations of sambar deer (*Cervus unicolor*), barking deer (*Muntiacus muntjac* and *Muntiacus atherodes*), mouse deer (*Tragulus javanicu*s and *Tragulus napu*), common porcupine (*Hystix brachyuran*) and bearded pig (*Sus barbatus*). The most common large omnivore is the Malayan sun bear (*Helarctos malayanus*).

Carnivore diversity includes the rare clouded leopard, bay cat and flat-headed cat; the leopard cat, marbled cat, bear cat, Malay badger, yellow throated marten, banded Linsang and several species of civet, small clawed and smooth otters.

Eight of the nine species of hornbill found in Borneo occur within the area, the most common being the Rhinoceros hornbill (*Buceros rhinoceros*). Others include the helmeted hornbill (*Buceros vigil*), the bushy crested hornbill (*Anorrhinus galeritus*) and the white-crowned hornbill (*Aceros comatus*).

Monitor lizards (Varanus spp.) are common, as are a variety of snake species, including cobras, pythons and vipers.

1.6 Duration of the project activity/crediting period:

The Project Start Date is 29 June 1992. The rehabilitation activities are carried out in several subsequent rehabilitation contracts, each phase consisting of a specific number of hectares. The duration of the contract is 99 years, calculated from the start date of the first rehabilitation contract. The end date of all the contracts is the same as for the first contract (i.e. 28 June 2091).

Monitoring of the project has been undertaken since the project's start and validation and verification has been previously achieved under the Carbon Offset Verification Standard of SGS. In the absence of broad internationally agreed rules and other voluntary standards, SGS was the most robust AFOLU accounting and crediting programme available at the time. Carbon credits were issued periodically under the SGS standard until the 31st of December, 2006. Since the introduction of the VCS AFOLU standard in 2007, our aim has been to convert the INFAPRO project to a VCS compliant activity and to generate VCUs from hence forth. The project is not pursuing certification or registration with any other GHG programme.

The Project Crediting Period Start Date is 1 January 2007.

The Crediting Period is 30 years: from 1 January 2007 to 31 December 2036.

1.7 Conditions prior to project initiation:

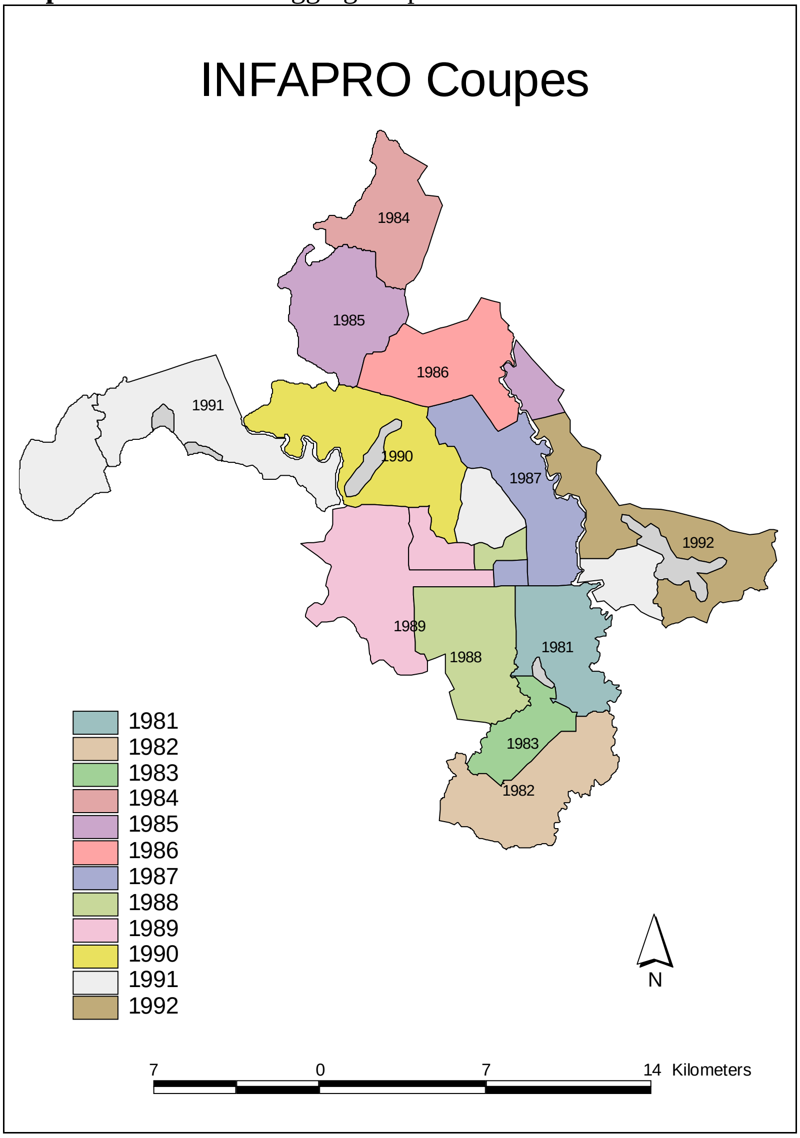
The Project Area supports mixed dipterocarp forest, with a high species diversity. Under natural conditions, i.e. without logging, the canopy has an average height of up to 40 m, with emergers reaching up to 70 m. Stand densities for trees beyond 60 cm vary between 15 – 20 trees per ha (INFAPRO, 2001; Pinard, 1996). An inventory exercise conducted in 2000 and

2001 by INFAPRO, indicated that the majority of the area is in a relatively degraded condition and in need of silvicultural intervention (INFAPRO, 2001).

Since 1981 the Project Area has been logged under a modified Malaysian Uniform System on an annual coupe basis (Moura-Costa et al., 1996), until 1992. Map 1.7.1 below shows the logging coupes in INFAPRO. The conventional harvesting system was based on a minimum harvesting diameter of 60 cm dbh (Chai, 1997 and Sabah Forestry Department, 1989, in Pinard and Cropper, 2000). Two yarding systems were used for logging within the Project Area, i.e. high lead (cable yarding) and tractor yarding. These methods resulted in very different degrees and patterns of damage (INFAPRO, 2001, Moura-Costa et al., 1996). The use of high lead machines resulted in severe damage to the residual stand along the yarding corridor, with the intervened areas being less disturbed. High lead yarding is generally confined to terrain where tractors cannot work satisfactorily. Tractor yarding led to a complex mosaic of damage comprising severely degraded areas such as skid trails and log landings and less disturbed remnant patches. As a result, at present the area consists of patches of secondary forests at different stages and types of recovery. All INFAPRO areas have been logged only once and were old-growth forest at the time of logging.

According to Moura Costa (1993) the high densities of natural stands in Sabah (Newbery et al., 1992) allowed extraction rates of up to 120 m3/ha (data extracted from the original logging records of Pacific Hardwoods (Silam Forest Products) and Kennedy Bay Forest Products, compiled by Moura Costa, Karolus and Ahmad, 1995). Based on the timber extraction data (Moura Costa, 1995) in the Ulu Segama Forest Reserve for the period 1970 – 1991 in total more than 6 million m3 wood has been extracted from an area of about 53,000 hectares. The average extracted volume (“felled and bucked”) is 117 m3/ha.

Map 1.7.1 INFAPRO logging coupes.



The development of the logged-over areas depend on the intensity of logging. In the Project Area, three strata are identified: open canopy areas, pioneer dominated areas and a mixture of pioneers and remnant trees (remnant/pioneer type). There is no straight boundary between these different forest types but a gradual transition. The ecological characteristics of each of the forest types are described here below.

<u>Open canopy area</u>

In Sabah, after conventional logging, residual stands become dominated by vines, climbing bamboos, grasses, sedges and pioneer trees (Fox, 1976 and Chai et al., 1977 in Pinard et al., 2000). In the open areas the vines, climbers and weeds are the dominating colonisers. The establishment of pioneer trees may have been limited by seed availability or unfavourable site conditions (Pinard, Howlett and Davidson, 1996a). Pioneer tree species of East Malaysia have been found to be poorly represented in soil seed banks of primary dipterocarps forest (Putz and Appanah, 1987 and Kennedy, 1991 in Pinard et al., 1996a) as seed dispersal is dependent on small scattered groups of mature pioneers within the former primary dipterocarp forest. The high light levels in the large canopy openings created by logging, promote the rapid growth of light-demanding vines and climbing bamboos, which can outcompete the pioneers (Nussbaum, Anderson and Spencer 1995).

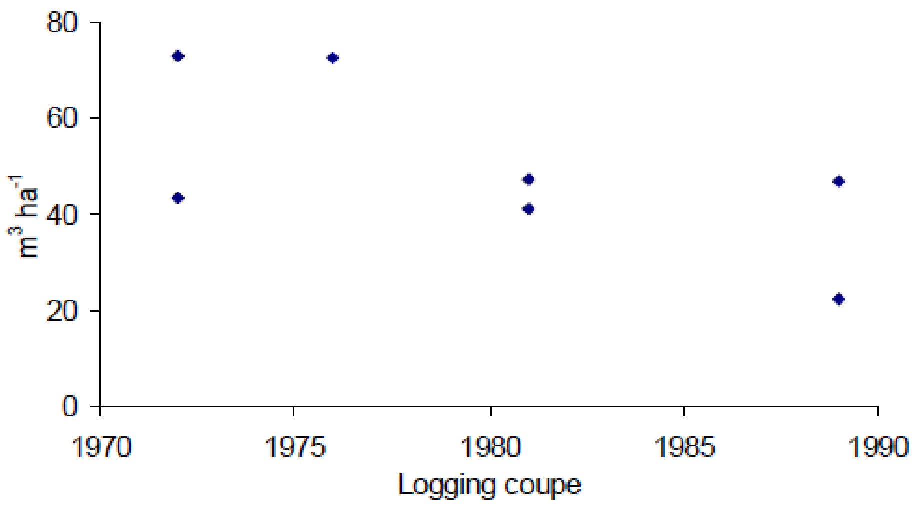
The presence of vines and climbers slows the recovery of the logged, degraded forest. Residual trees infested with vines experience reduced growth rates (Lowe and Walker, 1977 and Putz, 1983 in Pinard, 1995). Nussbaum et al. (1995) found that in areas where less than 50% of the original canopy remained, 73% of the seedlings were overgrown by vines. Kuper (1997) observed slow natural regeneration in the INFAPRO area for this reason. Yap (unpublished results, Infapro, 2000) observed that such forest may not even recover in areas that have been logged as early as 1960s in her natural forest recovery study in Ulu Segama Forest Reserve. Without restoration activities like enrichment planting, recovery of degraded logged forest is not likely to occur (Nussbaum et al., 1995).

Part of the Project Area consists of skid trails and log landings. The soil on skid trails and log landings generally is compacted and nutrient-poor with accelerated rates of erosion; few or no living plants remain (Nussbaum et al., 1995, Pinard et al., 1996). Pioneer recruitment increases with some soil disturbance (Putz, 1983 and Kennedy, 1991, in Pinard et al., 2000) but on compacted soils and subsoils typical of skid trails and log landings in Sabah, pioneer recruitment is sparse (Pinard et al., 1996a). Decades after logging operations are completed, such areas show very poor recovery of soil properties and vegetation (Malmer and Grip, 1990 in Nussbaum et al., 1995) and may take up to a thousand years to recover their original biomass (Uhl et al., 1982 in Nussbaum et al., 1995).

Heavily damaged residual forests yield little timber and thus are at high risk of conversion to other types of land use (Pinard and Putz, 1996). Open canopies and heavy vine loads typical for many heavily logged forests, increase vulnerability to fire and further degradation (Uhl and Buschbacher, 1985 in Pinard et al., 1996).

Analysis of a pseudo timeseries of forest recovering after logging within the INFAPRO area indicates that recovery of the open canopy forest has not occurred within 28 years after logging (see figure 1.7.1). Extraction volumes may have differed somewhat for the different investigated blocks. Therefore the standing volumes cannot be compared directly. However, it can be seen that the current standing volume of forest logged in 1972 is still very low at present. For comparison, Huth et al. (1997) reported a standing volume of 500 m3/ha for primary lowland dipterocarp forest.

Figure 1.7.1 Standing volume (as measured in 2000) for the 'open canopy' sites logged in 1972, 1976, 1981 and 1989.



Pioneer dominated area

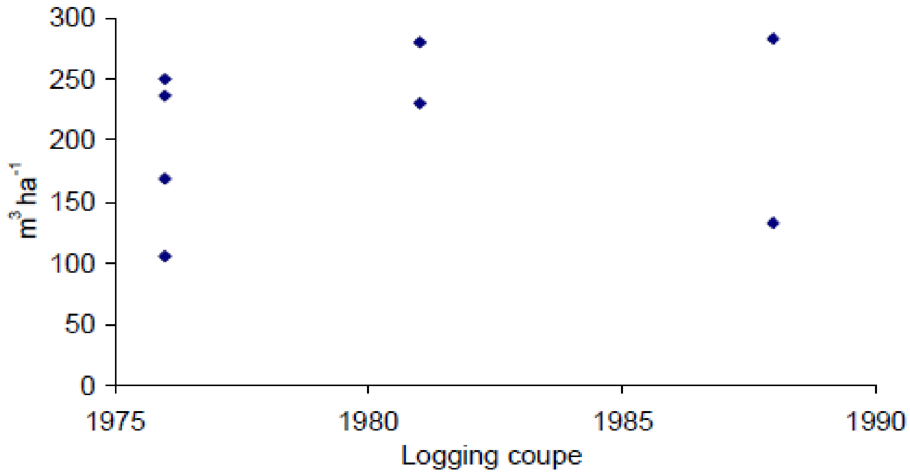
As discussed above, infestations of twining vines, grasses and sedges can be extensive after logging. In some places however, these infestations are suppressed by stands of colonising pioneer tree species that establish amid the weeds and shade out the heliophilic weedy plants (Pinard et al., 1996a). In recently logged forest in Sabah, the establishment of pioneer trees is often patchy, with small and generally monodominant stands of pioneer trees dispersed among both residual stands and climber/weed infested areas. This pattern depends on particular combinations of site conditions (soil properties, light conditions, etc.) and regeneration requirements of individual species (seed availability).

Generally, fruits of dipterocarp trees do not disperse far from parent trees (Ashton, 1982, in Pinard et al., 2000) so both density and distribution of mature residual trees are important for seedling establishment under pioneers. In addition, logging reduces the seedling and sapling population of persistent species and thus limits the opportunities for rapid regeneration (Burgess, 1989, Tang, 1990 and Wyatt-Smith, 1990 in Howlett and Davidson, 1996). Pinard et al. (2000) simulated that the establishment of persistent tree species under pioneers is limited by a lack of seedlings when damage exceeds 40%, which is the case with conventional logging. The invading pioneers compete with surviving seedlings and saplings of primary forest species and their germination is reduced. However, dipterocarp seedling and sapling populations may increase about 10 years post-logging in pioneer forest (Primack et al., 1987 and Kuusipalo et al., 1996, in Howlett et al., 1996). By recreating understorey conditions under which primary forest species are adapted to establish, the short-lived pioneers may facilitate recolonisation of disturbed sites (Howlett et al., 1996). Still, light levels under these pioneers are low, whereas also the primary forest species show faster growth under more open conditions after their initial establishment. Moreover, climbers and vines limit regeneration and reduce growth after establishment.

The standing volume of pioneer species such as Macaranga spp. culminate 15 years after logging and then rapidly decreases (Huth et al., 1997). The presence of pioneers may last 50 to 100 years according to Huth et al. (1997). Pinard (2000) estimates the maximum life span of Macaranga to be close to 30 (Fox, 1968 in Pinard et al., 2000) and simulates that the presence of pioneer trees lasts approximately 35 years. In the course of succession, the pioneers disappear and the population of climax Dipterocarp species establishes again. Huth et al. (1997) simulated that recovery of secondary stands to the approximate original primary forest structure takes at least 150 years and up to 300 years at heavily damaged sites. Pinard (2000) estimated that 120 years after conventional logging time cycling resembled that of an undisturbed forest. However, ecosystem carbon storage did not reach pre-logging levels within 500 years after logging. Logging may influence a site’s productivity to such an extent that ecosystem carbon storage may never reach pre-logging levels again (Gillman et al., 1985 and Zabowski et al., 1994, in Pinard et al., 2000).

Analysis of a pseudo timeseries of pioneer forest recovering after logging within the INFAPRO area indicates that recovery has not occurred within 24 years after logging, although the majority (86 %) of the stands did show regeneration. The standing volume of the forest logged in 1976 is even lower than those logged during later periods, although the recovery time was larger. However, standing volumes cannot be compared directly as logging volumes may have differed.

Figure 1.7.2 Standing volume (as measured in 2000) for the 'pioneer dominated' sites logged in 1976, 1981 and 1988.



<u>Mixture of remnant forest and pioneers</u>

Some patches in the primary forest were either not not logged or less intensive logged due to the lower commercial yield present (related to inferior site conditions) or because the sites were not easily accessible. The forest structure is still partly intact, but there is an abundance of climbers and vines that have colonised the patches, coming from the surrounding 'pioneer' and 'open canopy' vegetation types. The average amount of climbers, 1.1 t ha^{-1} present is comparable to that in the other vegetation types (as measured by INFAPRO, 2000), even though light levels are presumably lower. Because of these climbers, mature trees experience reduced growth rates (Lowe and Walker, 1977 and Putz et al., 1984, in Pinard and Putz, 1996). Natural regeneration, already at a low level in primary forests, is not able to outgrow the climber/vine layer and therefore, the normal succession of the forest is disrupted. It is very likely that succession will resemble that of the pioneer or even open canopy vegetation types, after the mature trees have died.

<u>Regrowth</u>

In 2008 Lincoln (2008) completed her research on the influence of logging damage on dynamics of logged-over lowland dipterocarp forest in Sabah, Malaysia. The study site is close to the INFAPRO Project Area and respresents similar forest conditions and logging history. It builds on the work done by Pinard (e.g. Pinard, 1995) and compares the response of forests that are conventionally logged and logged based on RIL guidelines. Repeated measurements were taken in a period of 12 years after logging in 1993. In contrast to RIL areas, the conventionally logged forest did not show recovery in stem density, basal area and above-ground carbon stocks. Biomass increment in conventionally logged areas were 7.5 t/ha in the period 1993-1996 and 9.3 t/ha in the period 1996-2005. This is lower than in old-growth forest. No net increase of above-ground carbon stock was recorded, due to the high mortality. In the research by Lincoln growth and mortality were in balance during the 12 year period after logging. Mortality is however likely to reduce after a longer period, as the number of damaged trees decreases, resulting in net growth of logged-over forest. This is mainly to be expected in Pioneer dominated and Remnant/Pioneer sites, as these forests are less affected than the Open Canopy areas.

1.8 A description of how the project will achieve GHG emission reductions and/or removal enhancements:

The objective of the project activity is to rehabilitate 25,000 ha of degraded rainforest with indigenous dipterocarps, fast growing pioneers and forest fruit trees by enrichment planting and climber cutting. Enrichment planting is a technique for promoting artificial regeneration of forests in which seedlings of preferred trees are planted in the understorey of existing logged forest and then given preferential treatment to encourage their growth. The development concept and management techniques have evolved from 100% enrichment planting to a combination of enrichment planting and tending of existing natural regeneration. All compartments are managed and maintained for at least three years after planting by climber cutting, liberation thinning, row slashing and ring weeding. Enrichment planting is required for the forest restoration because the high logging intensity has reduced the number of dipterocarp seed trees. The damage to the remaining forest stand has resulted in an abundant growth of climbers, vines, herbs and shrubs, impeding the growth of natural regeneration and remnant trees. The use of heavy machinery for harvesting and transport has degraded the soil, which has a negative impact on the rate of forest recovery (Nussbaum, 1993, 1995).

One of the objectives of the project activity is to conduct and refine forest restoration and rehabilitation as a strategy to sustain timber and non timber values in perpetuity under regimes that are in accordance with sustainable forest management. The implication is that the logging cycle is set at 60 years, which is based on the capacity of the forest to provide a sufficient level of timber without affecting its recovering capacity. In similar forests around the Project Area, harvesting takes place at a much shorter interval. Through the establishment of the project a second logging round on the short term (i.e. about 20 years) is being avoided. The project activity avoids the emissions from a second logging round, i.e. reductions in forest carbon stocks due to harvesting of trees and the associated damage to the forest stand and emissions of GHG from the use of machinery and logging trucks.

1.9 Project technologies, products, services and the expected level of activity:

The enrichment planting in INFAPRO, which is achieved exclusively with indigenous species, aims to rehabilitate the natural diversity of Sabah’s rainforests. The main species chosen for the project are indigenous dipterocarps mainly of the *Shorea, Parashorea, Dipterocarpus, Vatica, Hopea* and *Dryobalanops* genus. These species were chosen due their extensive natural occurrence (hence ease of establishment), good timber properties and their ability to be vegetatively propagated. In addition to the dipterocarps, forest fruit trees are planted. These not only act as suitable pioneer species for the more open and severely degraded areas but in addition provide food for bird and animal species, increasing biodiversity and restoring the natural composition of the forests structure.

Table 1.9.1 Species selected for project activities and enhancement of biodiversity.

Dipterocarps / hardwoods		Fruits	Other species
Azadirachta excelsa	*Shorea beccariana*	*Aglaia squamulosa*	*Agathis borneensis*
Diptercarpus applanatus	*Shorea faguetiana*	*Alangium ebenaceum*	*Aqualaria malaccensis*
Dipterocarpu caudiferus	*Shorea falciferoides*	*Artocarpus integer*	*Duabanga moluccana*
Dipterocarpus acutangulus	*Shorea fallax*	*Baccaure angulata*	*Koompassia excelsa*
Dipterocarpus confertous	*Shorea flaviflora*	*Baccaurea latifolia*	*Neolamarckia cadamba*
Dipterocarpus conformis	*Shorea gibbosa*	*Democarpus longan*	*Octomelis sumatrana*
Dipterocarpus gracilis	*Shorea guiso*	*Diospyrus spp*	*Palaquium spp*
Dipterocarpus lowii	*Shorea johorensis*	*Durio spp*	*Scaphium macropodum*
Dryobalanops beccarii	*Shorea laevis*	*Garcinia parvifolia*	
Dryobalanops keithii	*Shorea leprosula*	*Lansium domesticum*	
Dryobalanops lanceolata	*Shorea leptoderma*	*Nephelium lappaceum*	
Eusideroxylon zwagerii	*Shorea macroptera*	*Nephelium mutabile*	
Hopea beccariana	*Shorea macropyhilla*	*Parartocarpus spp*	
Hopea dryobalanoidea	*Shorea mecistopteryx*	*Pometia pinnata*	
Hopea ferruginea	*Shorea ovali*	*Walsura pinnata*	
Hopea nervosa	*Shorea parvifolia*		
Hopea nutan	*Shorea parvistipulata*		
Hopea pentanevia	*Shorea pauciflora*		
Hopea sangal	*Shorea pilosa*		
Hopia spp	*Shorea pinanga*		
Instia palembanica	*Shorea seminis*		
Parashorea malaanonan	*Shorea smithiana*		
Parashorea smythiesii	*Shorea superba*		
Parashorea tomentella	*Shorea symingtonii*		
Shorea acuminatissima	*Vatica albiramis*		
Shorea agami	*Vatica dulitensis*		
Shorea argentifolia			

The INFAPRO activities involve enrichment line planting (EP) of the existing degraded forest matrix (i.e. the remnant trees), using indigenous tree species such as dipterocarps, fast growing pioneers and forest fruit trees as listed in table 1.9.1. Site preparation for EP at INFAPRO initially involved the removal of 100% of vines and climbers through cutting and manual clearing. A 2 meter wide line was cleared as a planting line for dipterocarps and other species, and pioneers occurring within this line were girdled to allow for successful growth of the planted species. Seedlings were planted along the line at 3 meter intervals. Rock phosphate fertiliser is applied in each planting hole (100 g per plant), since results of a soil analysis showed very low fertility in the logged areas to be planted (Yap, 2000). Weeding is carried out when necessary, up to 4 rounds a year during the initial 3 years after planting. Silvicultural treatments are continued throughout the project's life in order to maintain steady growth rates. Because the initial phases of the project were aimed at testing different strategies and systems, planting during the initial phases was organised in the form of large trial plots using variations of the system described above.

The results of these trial plots, and the techniques were analysed, and since 1995 the techniques utilised have differed slightly. Reduced impact site preparation (RISP) was introduced, reducing slashing to a 1 meter wide line. Assessment of natural regeneration occurs, as a favourable alternative to planting, and enrichment planting of seedlings is only conducted where natural regeneration is lacking. Pioneer girdling is only limited to cases where the growth of artificial or natural regeneration is directly impeded and only on pioneers which have less than 20 cm dbh (Mosigil, unpublished data). Since 2004, pioneer girdling is not practiced anymore based on recommendations from an external auditor (Kuper, 2004).

Rehabilitation occurs not only within the logged-over forest, but also within severely degraded areas such as log landings and skid trails. These areas can account for up to 30% of the logged areas (Nussbaum et al. 1993, Sabah Forestry Department 1989), and little natural regeneration is observed in these areas even many years after logging. A second system with specific techniques for the rehabilitation of these areas is utilised. This began on an experimental basis and resulted into an approach where fast growing indigenous pioneer trees and light demanding dipterocarps are planted and mulched. These seedlings are raised in planting bags that are much bigger than usual to allow for a better developed root system, which enhances its abilities to survive in the less favourable soil conditions of log landings. The techniques are aimed at promoting the initial colonization of these areas, preventing the spreading of vines, climbers and weeds that commonly invade such areas and arresting the process of forest recovery. Survival seems to be promising (Jaludin and Yap, pers.comm.)

Nursery facilities, plant production and propagation techniques

To achieve the planting targets for successful forest rehabilitation, a large number of seedlings is required. Initially an amount of 333,000 seedlings was required to rehabilitate an area of 1,000 hectares. Due to improvements of the rehabilitation approach this is reduced to 200,000 seedlings, of which 5 to 10% consists of fruit and pioneer seedlings. However, an inherent difficulty related to the large scale planting of dipterocarps and rehabilitation of tropical forests is the poor availability of planting material. Dipterocarps exhibit mast fruiting, with 1 to 10 years between seeding years (Ashton et al. 1988); furthermore seeds have brief viability preventing long term storage. To attempt to overcome these difficulties in the early years of the project, a research nursery was established in 1993 within Danum Valley Field Centre (DVFC). This centre‘s facilities provides a space to research improved nursery techniques and the development of alternative methods of plant propagation which aim to guarantee a steady supply of planting material for the project. In 1996, the research nursery has been moved to Infapro base camp to be near the operation nurseries so that application of the research findings can be immediately incorporated. Since the completion of the PhD study by Glen Reynolds in 2009 on vegetative propagation, the research nursery is used as operation nursery when needed.

A large scale operational nursery was established for the project with an area of 3,600 m2, in 1993 and the capacity to produce 600,000 plants per year. Since 1994, this nursery has expanded to 8 large nurseries covering 5,000 m2 to accommodate 1 million plants per year. The nursery is centrally located within the Project Area, and is strategically placed just 11 km from DVFC with hosts researchers attached to the project. Recently, a temporary nursery that can accommodate 100,000 plants was established at a former log landing along Sg Lumpadas area nearer to the current development area to capitalise on the last year mast fruiting and to reduce transportation period as well as the evapotranspiration and mortality of the transplanted seedlings.

During the initial two years of the project, 500,000 dipterocarp seedlings were successfully produced using different propagation systems. A total of 250,000 seedlings were grown from seeds, 240,000 by cultivation of wild forest seedlings and 10,000 by vegetative propagation by cuttings. Research on hedge orchards of dipterocarps has being conducted in order to improve and simulate more materials for cutting production (Moura-Costa, 1994 and 1995). The planting of ramets (cuttings) in the field and its field studies were done in 1994 and 1995 and its survival and growth as well as root development have been published (Reynolds, 2009).

Research, training and development

INFAPRO's success to date has been based on its research-led approach. In addition to the multiple-faceted research efforts carried out as part of the project, an intensive training programme for all project staff is maintained and implemented. Such trainings and applied research has allowed INFAPRO to implement research findings directly and efficiently and leads to successful rehabilitation of logged-over tropical forest. Rather than being rigid, project activities have evolved to ensure the maximum success as well as the transfer of technologies both locally and internationally and adaptive management based on results and findings.

The research and training component during the first contract of operation was focused on better training staff for the next phase of the project. This included the training of staff at Officer Level, as well as rangers and forest labourers. Training of officers was in the form of further degrees, with a focus on site-species matching and vegetative propagation. Research projects were structured in order to generate results with practical application. Initial research topics undertaken in the first contract period included the effects of fertilizers on dipterocarps, site-species matching and silviculture of enrichment planted dipterocarps and vegetative propagation of dipterocarps, all of which directly relate to the activities of the INFAPRO project.

As a result of applied research and additional training undertaken by INFAPRO's staff, the project concept and the technologies utilised during the Implementation Phase have evolved from 100% enrichment planting to a combination of enrichment planting, liberation thinning and tending of existing natural regeneration (since 1995).

Guidelines for forest operations have been prepared in two languages (English and Bahasa Malaysia). INFAPRO monitors the survival and growth according to the census guidelines. In terms of seedling survival, INFAPRO aims to achieve 95% survival of tended seedlings three months after establishment and 80% after 3 years. These objectives have been largely achieved through continued evaluation and modification of the operational guidelines.

An intensive training program is also continuously undertaken, to enhance the skills and experiences of project staff at all levels. This program covers the core aspects of INFAPRO's activities such as tree identification, survey and mapping, fire fighting, GIS and other field operations. Furthermore, staff are encouraged to attend regional and overseas conferences, seminars and workshops in order to be well informed and update of any new development related to similar work elsewhere, allowing for adaptive management as the field moves forward.

There are two types of research undertaken in INFAPRO: short-term and long-term research. Short-term research priorities are designed to pursue particular investigations for large-scale rehabilitation and are often informed of any problems arising during project implementation, as described above. Thus, it is supporting the nursery and field operation activities to improve rehabilitation techniques and silvicultural treatments to the forest to obtain a higher survival rate and to maximise growth of treated plants.

Long-term research involves more specialised investigations such as the carbon offset monitoring, production of planting material by vegetative propagation techniques, manipulation of the canopy for light, plant nutrition, association of dipterocarps with mycorrhizae, soil dynamics, and natural recovery of logged-over forest, the ecophysiology of dipterocarps, pests and diseases. These subjects are either directly pursued by the research team or in collaboration with other scientists at DVFC or other institutions such as Forest

Research Institute Malaysia (FRIM), Kuala Lumpur and Forest Research Centre (FRC), Sepilok, Sabah.

The proximity to the Danum Valley Field Centre allows for close collaboration and synergy with an extensive network of local and international scientists. With its specialisation in research relating to the effects of forest disturbance through timber harvesting, conversion to plantation and rainforest rehabilitation, this association with the Danum Valley Field Centre has been particularly important both for gathering and disseminating information.

The project has maintained close links and collaborations with other institutions working directly or indirectly with forest rehabilitation. These include the FRC, FRIM, University Putra Malaysia (UPM), Wanariset Research Station (Samarinda, Indonesia) and the ASEAN-Canada Forest Tree Seed Centre (Thailand), Oxford Forestry Institute (United Kingdom), University of Aberdeen and University of London (United Kingdom). Another source of expertise and scientific advice comes from the researchers linked to other institutions that have been or are currently attached to Danum Valley Field Centre.

Table 1.9.2 Research studies by the INFAPRO research team.

Research studies	Year
Carbon Monitoring Campaign in Infapro Development Area	2007, 2010
Carbon study in Malua Forest Reserve	2010
Carbon offset verification study	2000 – 2010
Growth and yield plots	2000 – 2010
Phenology study	2000 – 2010
Application of GIS in forest rehabilitation	2005 – 2010
Bare root planting	1998 – 2001
Shade manipulation study	1997 – 2002
Natural recovery of logged forest study	1994 – 1998, 2000 – 2010
Fertiliser trials in nursery and field	1993 – 1998
Planting material trials	1993 – 2010
Mycorrhizae study	1993 – 1994
Species trials	1992 – 2010
Vegetative propagation studies	1992 – 2009
Rehabilitation of log landings and skid trails	1992 – 1994
Hedge orchard management	1992 – 1994
Genetic improvement study	1992 – 1993
Seedling sizes for out planting	1992
Planting width experiment	1992

INFAPRO has carried out one workshop in 2000, focused on knowledge dissemination, and has participated in several workshops. The proceedings of these workshops are published and are made available. In addition many papers have been produced based on INFAPRO's findings. A list of over 80 publications, related to INFAPRO's research findings and project activities that were published between 1992 and 2005 is available upon request.

1.10 Compliance with relevant local laws and regulations related to the project:

The following laws and regulations apply to INFAPRO:

- Sustainable Forest Management License Agreement 1997
- Sabah Forest Enactment 1968, Forest Rules 1969 (to support the implementation of the Enactment)
- Environment Protection Enactment 2002 and Prescribed activities 2005
- Wildlife Conservation Enactment 1997

- Land Ordinance, 1930
- Environmental Quality Act 1985
- Labour Ordinance (Sabah cap 67)
- Water Resources Enactment 1998 (Sabah)
- Biodiversity Enactment 2000 (Sabah)

Table 1.10.1 Laws and regulations' applicability to the Project Area.

Law / Regulation	Specific issues	Application to project
Sabah Forest Enactment 1968, Forest Rules 1969	Section 28a (1992) requires the application of management plans. The Forest Enactment also governs harvesting logs for commercial use or for internal use like making bridges & culverts, any structures/infrastructures developed within Forest Reserves etc.	INFAPRO is part of the larger Forest Management Unit Ulu Segama - Malua. Forest Management Plans are in place for this FMU. The current FMP is written by the Sabah Forest Department in cooperation with the licensee and local stakeholders. There is also a specific FMP for the INFAPRO Project Area. If future commercial logging in INFAPRO will take place, it will be sustainable and based on RIL techniques. This is not part of the project activity. The use of wood for internal infrastructures in INFAPRO is in line with this enactment.
Environment Protection Enactment 2002 and Prescribed activities 2005	No structures are allowed within the limits of 30m on both sides of perennial rivers Part VI and PART II - The Enactment governs the protection and enhancement of the environment/natural resources or prevention and control of such activities that would have adverse impact to environment/natural resources/cause pollution be it vegetation, soil, water, etc in a conservation area or any other land. The Enactment also includes regulations on waste management. Under Prescribed Activities 2005 First Schedule, any felling or extraction of timber covering an area of 100 ha or more but less than 500 ha or development of forest plantation or reforestation covering an area of 100 ha or more but less than 500 ha requires proposal for mitigation measures. Under Prescribed Activities 2005 Second Schedule, any felling or extraction of timber covering an area of 500 ha or more, or	INFAPRO does not built any permanent structures within the limits of 30m of both sides of perennial rivers. All waste is taken care of without polluting the environment. Engine oil is being re-used, etc. A Car Wash was built with a sediment trap. See also table 5a and b in the INFAPRO Forest Management Plan. These activities are not implemented in INFAPRO. An EIA has been carried out for the project activity and the results are reflected in the INFAPRO Forest Management Plan. See also section 5 of this Project Document.

	development of forest plantation or reforestation covering an area of 500 ha or more shall requires a Environmental Impact Assessment (EIA) Report.	
Wildlife Conservation Enactment 1997	Forbids or restricts in part IV hunting of protected animals or requires a permit to hunt animals. Forbids or restricts in part V the possession or trading in animals. Forbids or restricts in part VI harvesting of protected plant species or requires a permit to harvest protected plant species.	Keeping, trading or hunting of proctected animals in all Forest Reserves In Sabah is not allowed. However certain animals like wild boars and deers, can be hunted with permit/license issued by the Sabah Wildlife Department. These hunting permits are only issued for certain areas and INFAPRO is not one of these areas for hunting ground. For plant species: the indigenous Agarwood or Gaharu (*Aquilaria malaccensis*), forest fruit tree species especially the keystone species such as Ara and Kayu malam, durians, kawang jantung and other wild fruit tree species listed by the Sabah Forest Department, are also not permitted for harvesting.
Land Ordinance, 1930	The Ordinance is governing all issues of land boundaries and the penalty of encroachment.	The Land & Survey Dept holds all information of the land boundaries and they issue land titles and temporary occupation to owners adjacent to INFAPRO boundary, not within the Yayasan Sabah Concession Area (which includes the INFAPRO area). Should there be any need for further surveying and laying on the ground of the boundaries of the Licensed area it shall be done under the supervision of a registered survey and submitted to Director of SFD for approval. In case of any disputes, the case can be referred to the Director of Lands and Surveys.
Environmental Quality Act 1974 and 1985	In section 34a (1985) it requires the implementation of an Environmental Impact Assessment (EIA) for prescribed activities. This is required for logging operations on areas exceeding 500 hectares or clear felling exceeding 50 hectares.	For forest rehabilitation no EIA is required. Nevertheless, an EIA has been carried out for the project activity and the results are reflected in the INFAPRO Forest Management Plan. See also section 5 of this Project Document.
Labour Ordinance (Sabah cap 67)	The Ordinance contains rules related to employment terms & conditions, complaints & inquiries, recruitment of workers, employment of women, provisions related to employment etc.	INFAPRO complies with all the regulated employment terms and conditions. For example, if a female employee just gives birth, she is given a 60 days maternity leave with pay. Salary rates and employment conditions are specified within the ICSB employment terms and conditions and compliant with the Labour Ordinance.

Water Resources Enactment 1998 (Sabah)	The enactment governs water quality. In Article 40 and 41 the Enactment declares river reserves for all rivers with a width that is not smaller than 3 meters. Within the river reserves approval is required for the removal of natural vegetation or the disposition of material and for the erection of structures or buildings.	Similar to the Environment Protection Enactment and Environmental Quality Act, INFAPRO Project Area is located on the upper stream of the second largest river in Sabah, Sg Segama. Any adverse development upstream can have substantial impacts to downstream activities. Although INFAPRO Project Area is not a gazetted Water catchment area, we take any necessary precautions to avoid any adverse downstream effects such as not polluting the river streams, no car washing in rivers, maintain riparian reserves, not developing any infrastructures within 30 m of any sides streams or rivers, maintain water crossings to forest along road access so as to reduce erosions and sediments etc. The Sg Segama is also where the Drainage and Irrigation Dept sets up monitoring of flood and sediments and the location of one of the two water treatment plants for Lahad Datu town in its downstream area.
Biodiversity Enactment 2000 (Sabah)	Following Article 15 Collectors who intend to obtain access to biological resources shall apply to the Sabah Biodiversity Council for an access license.	Under Section 9, INFAPRO is obliged to assist the Sabah Biodiversity Centre's functions where necessary as well as observing Article 15.
Sustainable Forest Management License Agreement 1997	In the SFMLA it describes the followings amongst others: A strip of 30 m in width of all perennial streams and rivers shall be maintained as riparian reserve. All possible precautions shall be taken to protect the areas from encroachment/ poaching. Subjects related to harvesting with RIL techniques, royalty matters, penalties and other contractual provisions. List of prohibited species and commercial species for logging.	INFAPRO observes these regulations. With respect to protection against encroachment and poaching: surveillance and patrolling is carried out by INFAPRO. This is reflected in the quarterly and annual INFAPRO reports, which are shared with Sabah Forest Department (SFD). SFD is also member of the INFAPRO steering committee. Logging does not take place in INFAPRO.

1.11 Identification of risks that may substantially affect the project's GHG emission reductions or removal enhancements:

Using version 3 of the VCS's tool for AFOLU Non-Permanence Risk Assessment and Buffer Determination, it is estimated that the project's risk rating is 9.25 %. Since 10% is the lowest risk classification for IFM projects, the project's buffer pool requirement is therefore estimated to be 10% of the project's carbon stock changes.

1.12 Demonstration to confirm that the project was not implemented to create GHG emissions primarily for the purpose of its subsequent removal or destruction.

The project was established for the purpose of carbon sequestration through forest rehabilitation of forests that were already degraded in the decade before the start of the project activity.

1.13 Demonstration that the project has not created another form of environmental credit (for example renewable energy certificates).

Not applicable.

1.14 Project rejected under other GHG programs (if applicable):

Not applicable.

1.15 Project proponents roles and responsibilities, including contact information of the project proponent, other project participants:

The Innoprise Corporation Sdn. Bhd (Innoprise) is the investment arm and the holding and management company of Yayasan Sabah (YS/Sabah Foundation), which is a statutory body established in 1966 with a mission to improve the quality of life of Malaysians in Sabah though charitable activities, mainly in the fields of education and welfare. To fund these activities, Yayasan Sabah was granted a forest concession of almost 1 million hectares. Management of these lands is the responsibility of Rakyat Berjaya Sdn Bhd (RBJ) under the supervision of the Sabah Forestry Department. Rakyat Berjaya is a wholly-owned company of Innoprise. Within Rakyat Berjaya the Conservation & Environmental Management Division is responsible for managing INFAPRO. Figure 1.15.1 below show the organizational structure.

Face the Future is a company that was set up with the mission to mitigate climate change by rehabilitating and conserving forests and other ecosystems. Its predecessor is Face Foundation (FACE: Forests Absorbing Carbon-dioxide Emissions), a Dutch Foundation that was established with the objective to develop afforestation and reforestation projects in order to combat climate change. The projects that Face Foundation had established are located in Malaysia, Ecuador, Uganda, the Czech Republic and the Netherlands. In 2009 Face Foundation transferred her projects to Face the Future. This document refers to Face the Future's project activity in the Malaysian state of Sabah.

Figure 1.15.1 Organizational chart of INFAPRO within the Yayasan Sabah Group management structure.

Steering committee

A Steering committee was established in order to provide guidance to the project. The Terms of Reference for the Steering Committee includes the following tasks:

- Evaluate and recommend technical and scientific progress of the project and contents of Plan of Operation and Annual Work Plan.
- Provide direction for activities of subsequent Plan of Operation and Annual Work Plan.
- Identify and provide general guidelines pertaining to research, training and publication under the research component of the project.
- Ensure that the project activities conform to the current Forest Enactment of the State of Sabah.

The Steering committee intents to meet yearly and constitutes of the following members:

- Face the Future
- Yayasan Sabah Group (Chair)
- Sabah Forestry Department
- Forest Research Institute Malaysia (FRIM)

The Steering committee allows for other stakeholders to attend as observers. Examples of those are the Danum Valley Management Committee, The Royal Society (UK) and the INIKEA project.

Field project

The project operates within the hierarchy of the Conservation and Environmental Management Division (CEMD) of Yayasan Sabah Group. Coordination and monitoring functions rest with the Senior Manager Rehabilitation and Plant Improvement (R&PI) based in Kota Kinabalu, while implementation is carried out by the INFAPRO Project Team based in Faceville Km 58, Main Line West road (MLW), Ulu Segama Forest Reserve of Lahad Datu, East coast of Sabah.

Coordination between INFAPRO ground staff and the Group Manager of CEMD is via a Senior Manager (Rehabilitation and Plant Improvement), with practical implementation by the manager of INFAPRO who reports to the Senior Manager.

INFAPRO within the YS Group management hierarchy:

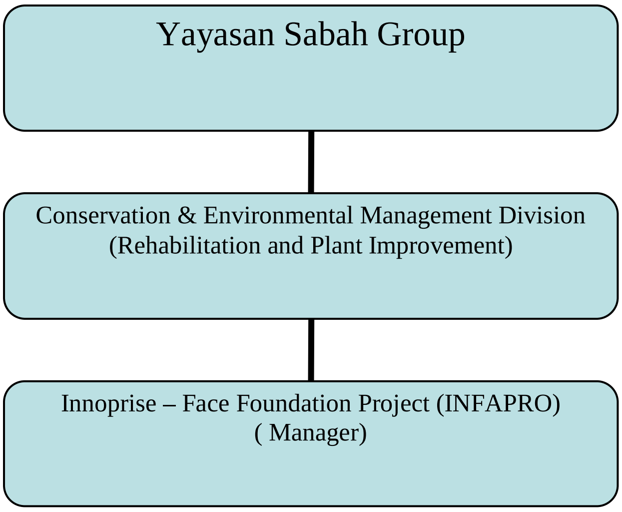
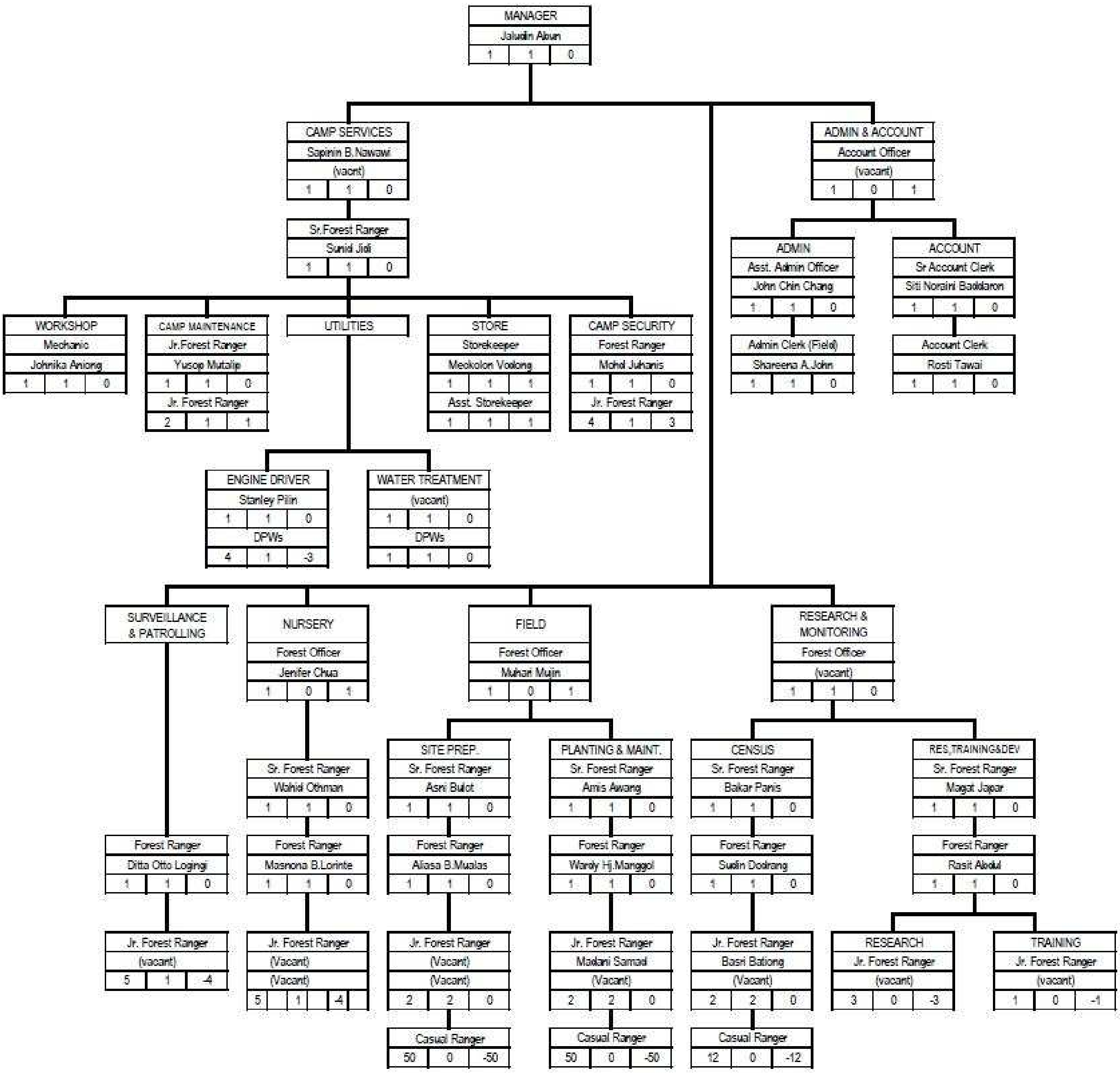


Figure 1.15.2 Internal organisational structure of INFAPRO.



The INFAPRO Manager resides on site in INFAPRO's base camp "Faceville" at Km 58, Mainline west, Ulu Segama Forest Reserve. The Manager is assisted by a group of officers and forest rangers, assigned as Heads of Unit (HoU). These act as supervisors of day-to-day operations in the nursery, field, research and development, and the administration and finance areas.

Project administration and accounting is based in the INFAPRO office in Lahad Datu.

During the implementation phases of INFAPRO project activity, the Manager is assisted by the project's four HoUs:

1. Nursery unit
2. Operations unit
3. Management Information System (MIS)/Census Unit
4. Research, Training and Development Unit

These units are supported by the Accounts and Administration Section which is based in Lahad Datu.

The activities of INFAPRO are co-ordinated and monitored though regular meetings at different levels.

- Project Forest Rangers and Key-Casual Rangers Meeting – a monthly meeting with Head of Units, Forest Rangers and Key-Casual Rangers
- Project Team Meeting – a monthly meeting with the three Head of Units
- Conservation & Environmental Management Meeting – at least once per three months with headquarter staff, senior project staff and invited guests from relevant zone managers
- Steering Committee Meeting – once a year with Steering Committee members (representatives from Face the Future, YS, Sabah Forest Department and the Forest Research Institute of Malaysia)

When the implementation phase for the total Project Area is completed, the organizational structure will be adapted to the requirements in the Management Phase of INFAPRO.

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<u>Carbon development project</u>

The project proponent Face the Future holds responsibility for the carbon development aspect of the project and is entitled to the carbon sequestration rights of the project.

Contact information Face the Future:
Face the Future

Managing Director
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1.16 Any information relevant for the eligibility of the project and quantification of emission reductions or removal enhancements, including legislative, technical, economic, sectoral, social, environmental, geographic, site-specific and temporal information.):

The eligibility of the project and quantification of emission reductions and removal enhancements is discussed in the section 2.2 and 2.5 of this Project Description. Section 2.2 describes how the project satisfies the applicability conditions laid out in the selected VCS methodology for Improved Forest Management projects. Section 2.5 describes the additionality of the project, including the preliminary screening on the starting date of the project.

1.17 List of commercially sensitive information (if applicable):

Not applicable.

2 VCS Methodology:

2.1 Title and reference of the VCS methodology applied to the project activity and explanation of methodology choices:

The VCS methodology applied to the project activity is titled: *Methodology for Improved Forest Management: Conversion of Low Productive to High Productive Forest, VCS Methodology VM0005, version 1.0*. The methodology has been developed for this project activity. It is intended for project activities that enhance forest carbon stocks by enrichment planting and silvicultural treatment of degraded forest and / or avoid emissions from further forest degradation from logging. The project activity aims at both avoiding short-term relogging and rehabilitation of the forest stand.

2.2 Justification of the choice of the methodology and why it is applicable to the project activity:

The project activity is an improved forest management activity and is implemented on forest lands managed for wood products. The Project Area belongs to the Ulu Segama – Malua Forest Reserve, which is a Class II Commercial Forest Reserve. These reserves are defined by the Forest Enactment (1968; in article 5) as forests for supply of timber and other produce to meet the general demand of trade. The Ulu Segama - Malua Forest Reserve (USM) is part of the logging concession that is granted to Yayasan Sabah by the State Government of Sabah (Yayasan Sabah Enactment). The project activity aims at the rehabilitation of forest that has been logged in the 1980s and the avoidance of further degradation from relogging. Forest rehabilitation is achieved by enrichment planting and silvicultural treatment of the degraded forest stand through climber cutting.

The project is situated in an area of lowland dipterocarp forest, which is in line with the FAO definition of Evergreen Tropical Rainforest: 'Evergreen Tropical Rainforests occur where the annual rainfall is greater than 2,500 mm, where forests grow mostly at low elevations, are evergreen, luxuriant, predominantly of hardwood species, have a complex structure and are rich in both plants and animals. Soils tend to be shallow and poor in nutrients, features having a marked effect on forest management practices.' The highest elevation in the Project Area is 610 meter, the majority of the tree species are evergreen and there is a dominance of hardwood species – 60% of the basal area and 30% of the tree density consists of trees that belong to the dipterocarp family, which are considered as hardwood species (SFD, 2008). The main canopy layer consists of trees with a dbh larger than 50 centimetres. The middle storey is composed of trees with a dbh between 20 and 50 centimetres, while the understorey is formed by trees smaller than 20 centimetres (SFD, 2008). Before logging, the average height of the canopy layer is about 45 m, but emergent trees can reach heights of up to 70 m (Pinard, 1996). The average annual rainfall, as measured in the nearby Danum Valley Research Centre, is around 2,700 mm (SFD, 2008, Danum Valley Field Centre Climatology and Hydrology Records since 1985).

The project activity fulfils the applicability conditions listed in the table 2.2.1 below.

Table 2.2.1 Applicability conditions of the methodology VM0005.

Applicability conditions VCS methodology VM0005	Project Activity
Project activities aim at the avoidance of relogging of logged-over, degraded natural Evergreen Tropical Rainforest, or the rehabilitation of logged-over natural Evergreen Tropical Rainforest through direct human intervention such as cutting of climbers and vines, liberation thinning and/or enrichment planting, or a combination of these activities;	The project activity aims at both avoidance of relogging and the rehabilitation of degraded Evergreen Tropical Rainforest through direct human intervention.
Land within the Project Area must have qualified as forest;	The vegetation in the Project Area amply exceeds the minimum thresholds in the Malaysian definition of forests and therefore qualifies as forest. This is a minimum canopy crown cover of 30%, a minimum height of 5 m of vegetation at maturity and a minimum forested land area of 0.5 ha.
In the baseline, the logged-over forest in the Project Area is unlikely to revert to normal regrowth patterns due to vines and climbers, which may include climbing bamboos, resulting from high-intensity logging operations in the past. In such cases, and subject to appropriate substantiation, regrowth of tree biomass before and following relogging in the baseline can be assumed to be zero. Where this is not the case, ex-ante estimates of regrowth must be made and monitoring of the baseline for ex-post confirmation of regrowth rates must be conducted;	Growth in untreated logged forest in the Project Area is suppressed by climbers and vine. Especially in the first years after logging the carbon sequestration that takes place in the remaining trees is neutralized by a high mortality due to damage caused by intensive logging. However forest regrowth does take place and therefore ex-ante estimations of regrowth are made and regrowth in the baseline is monitored, in line with the requirements of the methodology – see section 4.3.5 on Forest Regrowth.
The soil carbon pool within the project boundary is either in a steady state at project commencement, or, if not, the soil carbon pool is only expected to	The project activity results into a quicker recovery of the forest ecosystem than in the baseline scenario. In the baseline the soil within

increase more or decrease less in the with-project scenario in comparison to the baseline, and may therefore, conservatively be omitted	the Project Area suffers from the impact of logging activities. By rehabilitating the forest the soil stabilizes quicker, which enhances its capacity to keep the soil carbon pool intact or to increase the soil carbon pool. This especially applies to rehabilitation of former log landings.
Site preparation is carried out so as to avoid levels of soil disturbance or soil erosion sufficient to significantly reduce the soil carbon pool over the project lifetime;	Site preparation is carefully implemented. Cutting of ground vegetation is restricted to the planting lines and is only carried out with the aim to increase the competitiveness of the planted seedlings and favored natural regeneration. No machines are used in the forest off the roads, avoiding soil compaction. For road construction the impact on the soil is minimized by making use of existing roads and by constructing and maintaining side and cross drains and culverts.
The use of nitrogen fertilizer in the project activities is prohibited;	No nitrogen fertilizer is being applied in the project activity, except for a negligible amount in the nursery that is equivalent to GHG emissions of less than 0.01 tCO_2-e per year.
During the Crediting Period, harvesting shall not occur in the with-project scenario.	No harvesting takes place during the Crediting Period. In the Forest Management Plan for INFAPRO it is stated that the Project Area will not be harvested within a period of 60 years, which means that logging does not happen within the Crediting Period.
Biomass burning, fuel gathering, removal of litter, or removal of dead wood do not occur in the baseline scenario and in the with-project scenario within the project boundary;	These activities do not take place within the Project Area and unless explicit authorization has been given, it is forbidden to remove any forest produce from the Forest Reserve (Forest Enactment 1968).
A Reference Area may be used to derive relevant parameter values for the baseline scenario. This area shall be of similar size as the Project Area, or larger (i.e. 75% of the Project Area or more), for which similarity with the Project Area can be demonstrated using criteria outlined in this methodology, and for which it can be demonstrated that the management is not affected by its selection as a Reference Area; and,	For the use of the Reference Area: see Part 4 GHG Emission Reductions of this PD.
Flood irrigation or drainage of primarily saturated soils are not permitted as part of the project activity, so associated non-CO2 greenhouse gas emissions can be neglected.	There is no flood irrigation or drainage within the Project Area.
There is no peatland within the Project Area or emissions associated with peatland are not significant.	There is no peatland in the Project Area. The most common soil associations are Mentapok (on basic igneous rocks), Gumpal (soil formed on slump deposits consisting of sandstone, mudstone and tuffaceous rocks) and Bang (mostly acrisols developed on sandstone and

	mudstone. Together these associations cover 89% of the Project Area.
The methodology is not applicable to grouped projects.	This is not a grouped project.

2.3 Identifying GHG sources, sinks and reservoirs for the baseline scenario and for the project:

The carbon pools that are selected for the project activity are listed in the table 2.3.1 below.

Table 2.3.1 Selected carbon pools.

Carbon pools	Selected	Justification/Explanation of choice
Above-ground tree biomass	Yes	Major carbon pool decreasing significantly in the baseline and increasing in the project.
Above-ground non-tree biomass	No	Pool need not to be measured because it is not subject to significant changes and potential changes are transient in nature.
Below-ground biomass	Yes	Major carbon pool assumed to significantly decrease in the baseline due to relogging and increase in the project due to forest rehabilitation.
Dead wood	Yes	In the with-project scenario the dead wood carbon pool is conservatively accounted as zero. The approach used for quantification of avoided emissions from relogging does not require accounting for dead wood. The baseline emissions are calculated based on a combination of the spatial and a-spatial approach, as described in section 4.3.2 in the methodology (pre-relogging a-spatial data for $\Delta C_{REL,i,t}$): the levels of forest degradation are obtained from a Reference Area. For this project activity carbon losses in the baseline scenario due to damage to the forest stand is conservatively not accounted for and therefore the dead wood carbon pool can be neglected – see equation (3) of the methodology.
Litter	No	Conservative approach - unlikely to decrease as a result of the project activity, or increase in the baseline
Soil organic carbon	No	Conservative approach - unlikely to decrease as a result of the project activity, or increase in the baseline
Wood products	Yes	The wood products carbon pool is accounted for in the baseline scenario. In the with-project scenario wood products are accounted as zero, as no harvesting is taking place and accounting as zero in the with-project scenario is conservative.

The Greenhouse gases that are included in and excluded from the project boundary are shown in table 2.3.2 below.

Table 2.3.2 Selected Greenhouse gases.

Gas	Sources	Selected	Justification/explanation of choice
Carbon dioxide (CO_2)	Combustion of fossil fuel in vehicles / machinery	Yes	Relogging is included as the baseline activity. Emissions resulting from combustion of fossil fuels due to the use of machinery for harvesting, infrastructure and transport take place in the baseline scenario.

	Removal of herbaceous vegetation	No	Excluded based on VCS guidance.
Methane (CH_4)	Combustion of fossil fuel in vehicles / machinery	Yes	Included as CO_2 equivalent emission. Relogging is included as the baseline activity. Emissions resulting from combustion of fossil fuels due to the use of machinery for harvesting, infrastructure and transport take place in the baseline scenario.
	Burning of biomass	No	Not included – no burning allowed; not accounting for methane emissions in the baseline scenario is conservative
Nitrous oxide (N_2O)	Combustion of fossil fuel in vehicles / machinery	Yes	Included as CO_2 equivalent emission. Relogging is included as the baseline activity. Emissions resulting from combustion of fossil fuels due to the use of machinery for harvesting, infrastructure and transport take place in the baseline scenario.
	Nitrogen based fertilizer	No	Not included – no use of fertilizer allowed.
	Burning of biomass	No	Not included – no burning allowed; not accounting for N_2O emissions in the baseline scenario is conservative.

2.4 Description of how the baseline scenario is identified and description of the identified baseline scenario:

The selected Project Area has been severely logged in the 1980s, while the implementation of the project started in 1992. The most likely baseline scenario is that the area would be maintained as part of the Ulu Segama Forest Reserve, without investing in the rehabilitation of the forest. Within a few decades there would be a second round of logging, caused by the need for revenues and the fact that the number of marketable species has increased. The commercial Forest Reserves in Sabah have been intensively logged in the past and high revenues from large-scale logging that took place in the 1970s and 1980s have strongly decreased. During the times of high revenues no forest rehabilitation took place, and with the reduced income from timber it is even less likely that rehabilitation is implemented. To maintain a positive cash-flow from timber, operators have re-entered the commercial reserves for a second round of logging. In the baseline scenario for INFAPRO, the relogging would take place before the moratorium on logging in the Forest Reserve becomes effective. In the baseline scenario the concept of Sustainable Forest Management (SFM), including forest rehabilitation, is more and more accepted and incorporated into forest management plans. The rate and intensity at which rehabilitation takes place is insufficient to recover the Forest Reserve within the crediting period. The increased acceptance of SFM principles does lead to the adoption of Reduced Impact Logging (RIL) techniques for relogging in the baseline.

Regrowth of the existing trees in the baseline scenario is slow, due to extensive logging damage to the existing trees, competition from and suppression by climbers, vines and shrubs, and less availability of seeds from superior mother trees for natural regeneration. See also section 1.7 of this Project Document on the initial conditions before the start of the project activity. After a few decades the regrowth of the forest in the baseline is expected to increase, because the mortality that resulted from relogging normalizes and a part of the remaining trees are able to outgrow the climbers and vines. However, especially on the long term, growth is much less than in the with-project scenario because a complete generation of trees that are introduced with enrichment planting is lacking in the baseline scenario. See section 4.2.6 for a more detailed description of carbon stock changes in the baseline scenario.

The methodology requires in section 4.1.1 to provide information to prove that the project proponent meets the minimum acceptable standards outlined for the baseline scenario. The following information is required:

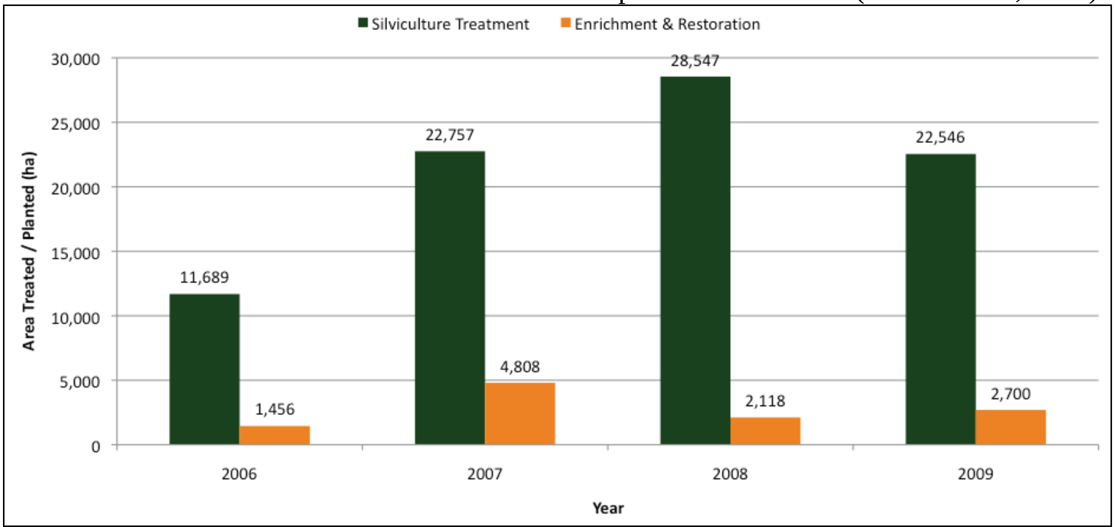
1. A documented history of the operator (operator must have at least 5 years of management records to show logging intensities and normal historical practices). Common records would include data on timber cruise volumes, inventory levels, harvest levels, etc. on the property that demonstrate what the normal practice in the area is. The documented history must also indicate the periodicity in logging operations in the area and in management planning (e.g. interval between two subsequent logging coupes according to management plans (past or current) and in reality); and
2. The legal requirements for forest management and land use in the area; however if these are not enforced then this requirement does not have to be met; and
3. Proof that their environmental practices equal or exceed those commonly considered a minimum standard among similar landowners in the area.

Below follows a description of the management history of the operator and the Forest Management Unit Ulu Segama that comprises the INFAPRO Project Area. It addresses the periodicity in logging and the achievements in forest rehabilitation. The legal requirements and the content of forest management plans with respect to logging and rehabilitation are also presented. The position of the operator in comparison with other licensees in terms of environmental standards is described in order to show that its environmental practices are at least equal to other licensees, for as far as it concerns the baseline for INFAPRO.

<u>History of forest management</u>
Forest management in Sabah has been focusing on timber production until recently. Since 1997 there is a change towards sustainable forest management, focused on multiple resource use management and the long-term health of forest ecosystems. In 1999 Yayasan Sabah decided to assign the lower part of the Ulu Segama Forest Reserve as a Industrial Timber Plantation, to be managed by Benta Wawasan Sdn Bhd, which is a wholly owned subsidiary of Innoprise Corporation Sdn Bhd. Prior to establishing the timber plantation, the area would be cleared of all existing trees. Following concerns on the impact it would have on Orang utan populations in the reserve, the area was reverted back to a natural forest management status in 2003. On 15 March 2006 the Sabah State Government decided to create one single Forest Management Unit of about 250,000 hectares to be managed under sustainable forest management principles. This Ulu Segama - Malua Forest Management Unit (USM FMU) consists of the reserves Ulu Segama and Malua (both Class II Commercial Forest Reserves) and Merisuli, Kawang Gibong and Sepagaya (all three Class VI Virgin Jungle Reserves). The Forest Reserves Ulu Segama and Malua together comprise 98% of the land area within the FMU. The FMU is part of the Yayasan Sabah Concession Area. A forest management plan on sustainable forest management has been adopted for covering the period 2008 – 2017. USM is the second model for sustainable forest management in Sabah. In 1995 the Deramakot Forest Rerserve was selected as a model for sustainable forest management, based on principles formulated by the Sabah Forestry Department and GTZ in 1989.

The 2008 forest management plan for USM targets the silvicultural treatment and rehabilitation of the degraded forests. These activities mainly started since 2007. In the planning period of the plan an area of 35,000 hectares is selected for timber stand improvement (TSI – i.e. silvicultural treatment) and 12,700 hectares for rehabilitation. The total area identified in USM for TSI is over 80,000 hectares and for rehabilitation 70,000 hectares. TSI involves one round of climber cutting in the planning period of the current forest management plan (i.e. for 2008 – 2017) and forest rehabilitation involves enrichment planting in severely degraded forests. As forest rehabilitation is more intensive than TSI, it is more expensive: the costs for rehabilitation per hectare are estimated at more than 3,500 Malaysian Ringit (RM), while TSI costs are more than 350 RM. The implementation of TSI in USM is ahead of schedule, but due to high costs and challenges to secure funding rehabilitation is behind schedule. In the State of Sabah as a whole, treatment of degraded forest as part of SFM policy started since 1997. The areas silviculturally treated and enriched in the period 2006 – 2009 are presented in chart 2.4.1. The areas include all the work that is done in Ulu Segama - Malua and INFAPRO in the respective years. In the period 1997 – 2006 an area of about 60,000 hectares has been treated (SFD, 2007). The total area treated over a period of 13 years (1997 – 2009) is about 143,000 hectares of degraded forest. This includes externally funded projects like INFAPRO and INIKEA. Gradual progress is being made in improving the degraded forests in Sabah. At the current rate it will take a couple of decades before all degraded forests are treated.Treatment of forest is expensive, especially forest rehabilitation as it is occurring in INFAPRO. The Sabah State Government avails over limited funds to restore the large areas of degraded forest and additional investments are important to get these forests back in shape. An initiative to raise external funds for SFM is the Malua Wildlife Habitat Conservation Bank (or Malua BioBank). Part of the initiative is to rehabilitate the forest for the conservation of the unique biodiversity in the area. Although the Malua BioBank started in 2007 and is actively pursuing the generation of external investments, no sufficient funds have become available to start the interventions in the Malua Forest Reserve.

Chart 2.4.1 Forest areas treated and enriched in the period 2006 – 2009 (Source: SFD, 2009).



The majority of the forest within the unit has undergone large-scale multiple logging cycles. Ulu Segama and Malua were gazetted as Forest Reserves in 1962 and 1961 respectively, and were regazetted as Class II Commercial Forest Reserves in 1984. All logging has been done with conventional techniques and resulted in high extraction volumes, except for the second logging round in Malua in 2006 and 2007, which was based on RIL techniques. The first logging year in Ulu Segama was in 1957, when a concession of about 22,000 hectares was granted. According to available records of licensees in the Ulu Segama - Malua areas, logging licenses were given in the period 1957 – 1982 for Ulu Segama for a total area of 264,000 hectares amounting to a total production of about 23 million m^3 of wood (i.e. 87 m^3/ha on average). In the period 1963 – 1981 an area of 38,000 hectares was under logging licenses in Malua, with a total production of 2.5 million m^3 of wood (i.e. 65 m^3/ha on average). Yayasan

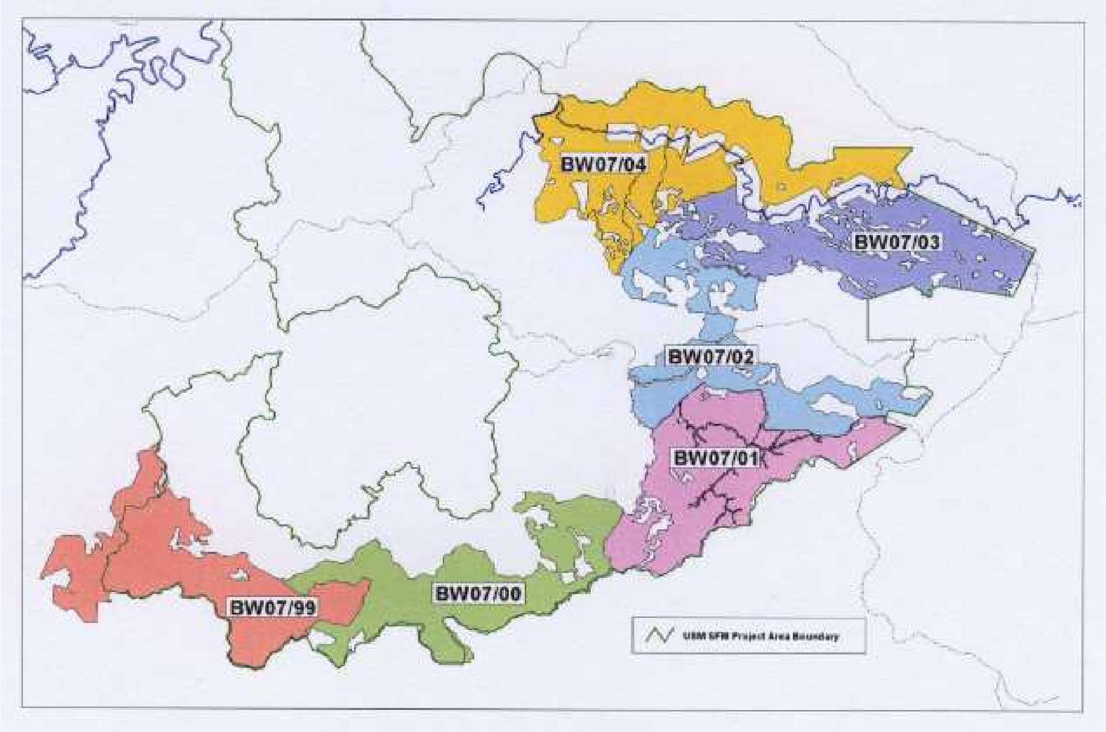
Sabah is the biggest licensee: a 103,000 hectare license was received in 1970 in Ulu Segama and a 17,000 hectare license was received in 1976 in Malua. In these periods, in total 63 licenses were granted in Ulu Segama and 17 in Malua. Extraction volumes in the first logging round in Ulu Segama can be quite high. Timber harvesting records for a part of Ulu Segama in the period 1970 – 1991, covering an area of about 54,000 hectares, show an average harvesting volume of 117 m^3/ha (Moura Costa, 1995). The Yayasan Sabah Forest Management Plan for 1984 – 2032 includes a table that shows the logged and unlogged areas by that time in Ulu Segama: already 153,000 hectares are logged and 98,000 are not logged (this includes the Danum Valley Conservation Area). In the period 1971 – 1982 the average yield in Ulu Segama is 103 m^3/ha in the Lahad Datu region and 70 m^3/ha in the Sandakan region (Ulu Segama was divided into two parts managed under two different regions at that time).

In the period 1999-2007 relogging took place in the USM. According to an estimate in March 2006 a total production of 4.2 million m^3 was obtained from an area of 122,000 hectares. The average production in Ulu Segama forests was 46.5 m^3/ha and 33 m^3/ha in Malua. The relogging with RIL techniques in Malua was not included in the assessment. Map 2.4.1 show the areas in Ulu Segama that were relogged in the period 1999-2004. The area in the East (East of coupe BW07/02 and South of BW07/03) is the Taliwas area that is assigned for forestry research and recreation as well as education purposes, and is therefore not relogged. Another reason for not relogging this area, is that it is partly converted to tree plantations for research purposes. The area South of Danum Valley Conservation Area (DVCA) and North of the logging coupes BW07/99 and BW07/00 and the area to the East of DVCA and to the West of logging coupes BW07/01 and part of BW07/02 are not logged because of the high altitude and the corresponding ultramafic forest type. The trees are relatively small and there are less commercial species. The steep slopes increase the costs for establishing logging infrastructure. In 2005 and 2006 about 3,600 hectares of forest was harvested through helicopter logging in the Ulu Segama area (not visible on map 2.4.1), resulting in a total relogged area of about 126,000 hectares (SFD, 2008). In 2006 and 2007 relogging took place in the Malua Forest Reserve in an area of 28,000 hectares. The extracted volume is 0.4 milion m^3 of wood in total and 15.2 m^3/ha on average (GFS, 2008). The total relogged area in USM in the period 1999 – 2007 is 154,000 hectares.

The historical logging cycle by Yayasan Sabah in USM is estimated at about 20 years. The main part of the first logging round took place in the period 1970 – 1990, which makes 1980 the average harvesting year of the first logging round. The second logging round took place in the period 1999 – 2004 (Ulu Segama) and 2007 (Malua). Half of the relogged area in USM was harvested by 2002, resulting into an average cycle of 22 years. However, the second round of logging in Ulu Segama – Malua was not based on a fixed logging cycle or rotation. The logging coupes in Ulu Segama between 1999 and 2004 were planned irrespective of the year of the first logging cycle. Therfore, the actual period between the first and the second round of logging is very variable. Because of a lack of data on which specific area was logged for the first time in a particular year, it is not possible to determine a precise historical logging cycle.

A moratorium on logging in Ulu Segama - Malua was announced by the Sabah State Government on 15 March 2006. As per 1 January 2008 no logging activities are allowed in this Forest Management Unit.

Map 2.4.1 Logging coupes in Ulu Segama in the period 1999-2004 (Source: SFD, 2008).



Legal requirements for rehabilitation

The Forest Enactment 1968 requires licensees to carry out a reforestation plan for harvesting areas larger than 1,000 hectares. Alternatively, a forest rehabilitation fee has to be paid to the forest rehabilitation fund (see section 4B and 4E of the Forest Enactment). The forest rehabilitation fund is intended for, amongst others, the implementation of reforestation plans.

In the Sabah Licence Timber Agreement 1970, which is the license granted to Yayasan Sabah, there is no mentioning of reforestation fees or plans. The agreement does however state that it shall be in accordance with any law that is in force in the State of Sabah, and that would include the Forest Enactment 1968.

The Yayasan Sabah Forest Management Plan (1984-2032) states that Yayasan Sabah is not required to carry out silvicultural work in the Concession Area according to the License Agreement 1970. However, the Forest Department has indicated in the FMP that Yayasan Sabah should develop a programme for silvicultural treatment. In the FMP a decision is made to start a silvicultural programme, with intensive (i.e. including planting) and extensive treatment (i.e. minimum silvicultural treatment). The program applies to all areas that are not converted to plantations.

The Sustainable Forest Management Licence Agreement (SFMLA) 1997 replaces the License of 1970. The SFMLA 1997 states that forest management planning must include planting, regenerating and silvicultural treatments of residual stands and forest protection. It also requires the preparation of forest management plans that include designation of areas for silvicultural treatment and enrichment planting. Further, a timber harvesting plan has to contain a silvicultural treatment plan and an enrichment planting plan. The area for silvicultural treatment and enrichment planting each year shall comprise an area at least equal to that proposed for timber harvest.

Despite the legal requirement since 1968 for replanting after harvesting and the resolutions in the licenses and FMP's, the first restoration and rehabilitation activities started slowly since 1997. The situation when Infapro started in 1992 was that forest rehabilitation was unique and not a common practice. Although it does take place since 1997, it will take decades before the entire FMU is silviculturally treated or rehabilitated.

Legal requirements for logging

Conventional timber harvesting in Sabah is based on a logging cycle of 60 years (Pinard and Cropper, 2000; SFD, 1989). The logging cycle of 60 years is not a requirement by law – it is based on a minimum diameter cut of 60 centimetres that is prescribed for most of the commercial species (Forest Rules 1969, Rule 11, Schedule 1). Assuming an average growth of 1 centimetre per year, it takes 60 years for a tree to reach the dimensions that allow for cutting. The maximum diameter for cutting is 120 centimetres. These diameter thresholds are included in the 1997 Sustainable Forest Management License Agreement between the State Government of Sabah and Yayasan Sabah (article 62). The SFMLA 1997 is a 100 year license to Yayasan Sabah for an area of about 800,000 hectares, including USM (i.e. FMU's number 21 and 20A).

Previously a rotation period of 80 years was used by the Sabah Forestry Department. In the Yayasan Sabah Forest Management Plan for the period 1984 – 2032 it is proposed to reduce the 80 year cycle to a 60 year cycle, amongst others by lowering the minimum diameter cut to 50 centimetres. Also a shorter rotation period of 30 or 40 years are being discussed in the FMP. No resolution is made in the FMP as to which rotation period is selected.

The SFMLA 1997 for Yayasan Sabah includes provisions on sustainable forest management for forestry operations in natural forests. Areas with slopes steeper than 25 degrees are excluded from harvesting. An Environmental Impact Assessment has to be implemented for harvesting areas of equal and/or more than 500 ha and a monitoring report has to be submitted to the Environment Protection Department (EPD) on a quarterly basis. Timber harvesting and extraction have to be implemented in line with provisions for Reduced Impact Logging (RIL). RIL applies to three stages in harvesting operations: 1) pre-operational planning and layout of the harvest area, 2) Reduced Impact Logging and extraction of logs, and 3) post-harvest operations. RIL is aimed at reducing the impact of harvesting on soil, trees, seedlings and streams. All trees to be felled have to be marked in the forest and mapped beforehand. The trees have to be within the diameter range that is allowed for cutting (i.e. the 60 – 120 centimetres dbh range) and have to belong to species that are not protected. No felling is allowed within reach of 30 metres at each side of perennial streams. Roads and skid trails are designed to minimize impact on soils and therefore limits are set to the way these roads are constructed. Directional felling is applied in order to minimize the impact on potential crop trees and natural regeneration. After harvesting measures are taken to minimize soil erosion, including the removal of obstructions to natural drainage channels and the creation of cross drains on skid trails.

Common environmental practices in Sabah

Yayasan Sabah has made progress in the past decade on prioritizing sustainable forest management. It is operating under a Sustainable Forest Management License Agreement (SFMLA) since 1997, which is a long-term contract for 100 years. The introduction of the SFMLA's followed the adoption of a Sustainable Forest Management (SFM) policy by the Sabah Foretry Department in 1997, based on experiences with SFM in the Deramakot Forest Reserve in Sabah. The privatization of the Forest Reserves allows the State of Sabah to reduce its budget deficits (Su Mei Toh, 2006). Yayasan Sabah was among the 10 SFM partners that signed a SFMLA or a Long Term License in 1997. The Sabah Forestry Department and the 10 SFM partners commit themselves to sustainable management of the commercial forests (like Ulu Segama - Malua) by achieving a responsible balance of competing uses, and putting in place new practices to better manage the multiple roles of forests (SFD, 2007). For Ulu Segama - Malua a decision was made in March 2006 by the Sabah State Government to have it placed under SFM. Following the introduction of the SFMLA's, Forest Management Plans have been developed for Forest Management Units in close collaboration with forest stakeholders. The Forest Management Plan for the Ulu Segama – Malua Forest Management Unit was completed by 2007. The process of going from short term to long term licenses for Forest Reserves has continued since 1997. In its Annual Report for 2009, Sabah Forestry Department reports that it wants to phase out short term logging licenses by the first half of 2011.

Relogging in natural forest within a short interval has been common practice in Sabah (pers. com. Sunjoto). Ong (2005) indicates in his description of the management history of the Deramakot Forest Reserve that it had been logged for the first time in the period 1962 – 1968, with an average extraction rate of 110 m^3/ha. A second round of logging occurred between 1975 and 1985. Following the introduction of sustainable forest management in the Forest Reserve, harvesting is based on an annual allowable cut and in the planning period of the first Forest Management Plan (1995 – 2004), regulating a yield of 135,000 m^3 for the whole period.

One of the main goals of the Sabah Forestry Department in 2009 was to have RIL implemented for all natural forest management areas by the 1st January 2010 (SFD, 2009). Although all the relogged areas in Ulu Segama were conventionally logged in 1999-2004, Yayasan Sabah was one of the first to introduce RIL at a large scale, in Malua in 2006 and 2007 and in the Kalabakan and Gunung Rara Forest Reserves. Yayasan Sabah first pioneered with RIL techniques in 1992 under collaboration with New England Power (NEP), USA. The recent RIL operations were subjected to a Environment Audit Committee (EAC) which comprised Forest Research Institute Malasyia, Rainforest Alliance and CIFOR. The RIL operation in Malua was subject to third-party auditing, to verify the compliance with the RIL requirements (GFS, 2008; SFD, 2007). The Sabah State Government had decided in 1998 that Yayasan Sabah would lead the other FMU holders in RIL implementation (SFD, 2007b). The selected baseline scenario for INFAPRO is relogging of the Project Area based on RIL techniques in 2007. By that time RIL is not a common practice in forestry in Sabah and it exceeds what is being considered the minimum standard for environmental practices.

2.5 Description of how the emissions of GHG by source in baseline scenario are reduced below those that would have occurred in the absence of the project activity (assessment and demonstration of additionality):

Assessment and demonstration of additionality is based on the tool VT0002 version 1.0 ‘Tool for the Demonstration and Assessment of Additionality in IFM Project Activities’. This tool is to be used exclusively under the VCS methodology VM0005. The table 2.5.1 below shows the applicability conditions of the tool and how the project fulfils these conditions.

Table 2.5.1 Applicability conditions of the additionality assessment tool VT0002.

Applicability condition	Project activity
The IFM project activity is eligible under the current VCS IFM types (see VCS Tool for AFOLU Methodological Issues).	The project activity falls within the IFM category Low Productive to High Productive Forest.
Activities within the proposed project boundary performed with or without being registered as IFM project activity shall not lead to violation of any applicable law even if the law is not enforced.	The IFM project activity does not lead to the violation of any applicable law – see section 1.10 of this Project Document.
The use of this tool to determine additionality requires the baseline methodology to provide for an approach justifying the determination of the most plausible baseline scenario. Project	The baseline methodology in the VCS approved methodology VM0005 requires to identify the most likely baseline scenario. The identification of the most likely baseline scenario in section 2.4 of this Project

proponents proposing new baseline methodologies shall ensure consistency between the determination of a baseline scenario and the determination of additionality of a project activity.	Document and in the current section 2.5 is consistent (see step 1c of this section).

Step 0: preliminary screening based on the starting date of the IFM project activity

The project start date is 25 June 1992. The additionality tool requires for projects with a start data before 1 January 2002 that the following conditions are met:

1. Project validation and verification against the VCS has been completed by 1 October 2011;
2. The project proponent can verifiably demonstrate that the project was designed and implemented as a climate change mitigation project from its inception. This evidence (as well as the evidence for additionality) shall be based on (preferably official, legal and/or other corporate) documentation that was available to third parties at, or prior to, the start of the project activity; and
3. Prior to 1 January 2002, the project applied an externally reviewed methodology and engaged independent carbon monitoring experts to assess and quantify the project's baseline scenario and net emissions reductions or removals.

<u>Validation and verification before 1 October 2011</u>
In order to achieve validation under the VCS, the project proponent aims for validation and verification of the project activity before 1 October 2011.

<u>Project design as a climate mitigation project</u>
The project has been explicitly designed and implemented as a carbon sequestration project. It was identified by Face as a suitable carbon forest project. The most important reason for Face to fund the project, was the capacity to additionally sequester carbon from the atmosphere into the forest biomass. Face was established in 1990 with the specific goal to plant, rehabilitate or conserve forests in order to reduce GHG concentrations in the atmosphere and help mitigate climate change.

On 29 June 1992 the State Government of Sabah and Face signed a Memorandum of Understanding, confirming the statutory purpose of Face to rehabilitate forests for absorbing carbondioxide emissions and that Face is prepared to fund and develop forest plantation projects in Sabah, Malaysia.

<u>Externally reviewed methodology and engagement of independent carbon monitoring experts</u>
In 2000 the project was reviewed by EcoSecurities in order to assess and quantify the baseline scenario and the net emissions reductions from the project. The results are published in the report "Estimation of carbon stocks and flows for the Infapro project in Sabah, Malaysia. A report written for the Face Foundation, April – June 2000." EcoSecurities applied its own methods and model (ECO_2 Model ™) to quantify the carbon budget of forest ecosystems on stand level.

In 2001 Face contracted the certification company SGS to validate and verify INFAPRO, based on SGS' GHG Validation and Verification programma. In the absence of an international standard defined or accepted by the UNFCCC Secretariat, SGS had prepared a set of criteria based on Decision 17/C.P7 of the Marrakech accords. These criteria act as a standard and INFAPRO was validated against it. In April 2001 SGS carried out a pre-assessment. The main assessment report was published on 17 April 2002.

Step 1 Identification of alternative land use scenarios to the proposed IFM project activity

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

Land use scenario A: Continued forest degradation
After being logged the forest is abandoned and no silvicultural treatment to the remaining forest matrix takes place. As a result the area is colonized by pioneer trees, vines, herbs and climbers, hampering the recovery of the forest. In the first decades after the intensive first round of conventional logging, the net increase in biomass is close to zero, due to increased mortality rates that are caused by the logging damage to the residual forest stand, combined with suppressed growth of the remaining trees. After around 20 years there is a second round of logging. This is induced by several factors. The timber stock in the concession is largely reduced after decades of harvesting (harvesting by the operator started in 1968) and there is not much timber left. The concession holder is in need of revenues from the sale of timber. At the same time the market for tropical tree timber species has expanded and new species in the forest have become marketable. The harvesting volumes are limited, especially compared to the first logging round. This is partly due to the degraded state of the forest and partly due to the application of RIL techniques for harvesting. Rehabilitation of the forest in the Project Area does not take place, because the costs for rehabilitation are high and a major part of the concession is degraded forest, limiting the timber revenues. Rehabilitation does take place in the concession with help from external sponsors, but the area to be rehabilitated is large and it will take several decades before all forest has been recovered.

Land use scenario B: Avoided forest degradation
As in land use scenario A the forest is abandoned after logging and no silvicultural treatment is applied, because of the high costs that cannot be provided for by the concession holder. The recovery of the forest is very slow. The concession holder can afford to avoid logging on the short term and applies a logging cycle of 60 years, in line with the conventional length of a sustainable logging round. Although the forest remains in a degraded state after the first round of logging, further degradation by a second logging round on the short term is being avoided.

Land use scenario C: Forest management with IFM activities
After the first round of logging the forest is partly being restored. The licensee has sufficient financial means to implement forest rehabilitation in the concession and decides to make the investment in order enhance the commercial timber values in the forest and fulfilling the requirements in the Sustainable Forest Management License Agreement to make and implement a plan for rehabilitation and silvicultural treatment of the logged forest. Such activities have not been implemented in the 10 years prior to the project start date in other similar areas in Sabah. In the Deramakot Forest Reserve, which is generally considered as the model for sustainable forest management in Sabah, implementation of SFM started in 1995 and 1996, including forest rehabilitation activities (Mannan et al., 2002). About 60 years after the first round of logging, the operator enters the Forest Management Unit for a second round of logging, based on RIL techniques.

Land use scenario D: Conversion to oil palm plantation or industrial timber plantation
The forest area has lost a lot of its commercial value following the first logging round and it will take very long before the forest is productive again. In the years directly after logging, there is no revenue from the area, only costs. At the same time there is an increasing demand for oil palm and the areas of oil palm plantations are rapidly expanding in Sabah. The logging of the remaining forest stand provides some additional income. In the period 1995 – 2003 the area with oil-palm plantation in Sabah increased from 630,000 hectares to 1,077,000 hectares, which is an increase of 71%. The perspective of low timber revenues from the poorly stocked forests has prompted licensees to request the SFD for conversion of parts of the Forest

Reserves into oil-palm plantations (Su Mei Toh, 2006). Only Yayasan Sabah (through its subsidiary Benta Wawasan Sdn. Bhd.) is allowed to convert parts of the Forest Reserves into oil palm plantations, but only for one rotation. Once the rotation cycle is completed, the area is supposed to be turned back to natural forest management. A Special Environmental Impact Assessment is to be implemented prior to the conversion of the area. Alternatively, applicable to all licensees, the natural forest within the commercial Forest Reserves can partly be converted to an Industrial Timber Plantation. This requires the operator to submit an Environmental Impact Assessment and a Plantation Development Plan.

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

Land use scenario A: Continued forest degradation
Silvicultural treatment and forest rehabilitation are a requirement in the Sustainable Forest Management License Agreement 1997. The stipulation is that the annual area for silvicultural treatment and enrichment planting is equal to the area that is harvested each year. In the period that relogging took place in Ulu Segama (which is the Forest Reserve to which INFAPRO belongs), no forest restoration took place within the Forest Reserve. Since 2006 restoration activities are being carried out. In the forest management planning period of 10 years on 44% of all the area that is in need of silvicultural treatment and on 18% of the land that is in need of rehabilitation (enrichment planting). With respect to the logging cycle, there is no prescription in laws or regulations about the length. The legal requirements (Forest Enactment 1968) and regulations requirement (SFMLA 1997) are that most of the commercial trees can only be cut in the diameter range of 60 cm – 120 cm.

Land use scenario B: Avoided forest degradation
See description under Land use scenario A for the laws and regulations concerning forest restoration and logging cycles. Land use scenario is in line with enforced mandatory applicable laws and regulations.

Land use scenario C: Forest management with IFM activities
The rehabilitation that is taking place within this scenario is in line with the Forest Enactment 1968 and the SFMLA 1997. The same applies to the logging cycle of 60 years. See also the description under Land use scenario A.

Land use scenario D: Conversion to oil palm plantation or industrial timber plantation
Conversion of natural forest to industrial tree plantations is possible with consent from the SFD. The SFMLA contains a provision for plantation development on a maximum of 15% of the licensed area with slopes less than 15 degrees (Su Mei Toh, 2006). Conversion of natural forest into oil palm plantation is formally not allowed, since it is not a forest produce. Conversion to oil palm or industrial timber plantation is not very likely. The plans for the conversion of a large part of Ulu Segama into an industrial timber plantation in 1999 were withdrawn 4 years later because of concerns on the impact it would have on biodiversity (especially Orang utans because of their high density in Ulu Segama – Malua).

Sub-step 1c. Selection of the baseline scenario

Land use scenario A ‘continued forest degradation’ is selected as the most likely land use scenario. The description of the management history in Sabah and in the concession of the licensee in section 2.4 shows that silvicultural treatment and forest rehabilitation starts gradually since 1997. Especially forest rehabilitation (that is comparable to the activities in INFAPRO) is happening below the scale and rate required to restore the degraded forests in the concession and in the Forest Management Unit where INFAPRO belongs to. In addition, records for the same Forest Management Unit show that relogging in about 20 years is a common practice that took place in the majority of the area.

Step 2 Investment analysis

No investment analysis is carried out.

Step 3 Barrier analysis

Sub-step 3a. Identify barriers that would prevent the implementation of the type of proposed project activity

The implementation of the project activity faces several barriers: an investment barrier, a technological barrier and a barrier due to prevailing practice. The barriers are described below.

Investment barrier

The costs per hectare for timber stand improvement as budgeted in the USM Forest Management Plan 2008 – 2017 is RM 350, while the average historical costs per hectare in INFAPRO are RM 2,600. This figure is calculated based on budgets since 1992 and prices have increased in the meantime. The current costs per hectare for INFAPRO are about RM 7,000. The approach in INFAPRO is similar to rehabilitation activities that are taking place in the North of Ulu Segama – at an initially budgeted cost of about RM 3,500 per hectare. During implementation the costs appear to be higher, which will probably lead to the reduction of planted seedlings per hectare in order to cut costs. The rate at which rehabilation is happening in Ulu Segama is about 1,200 hectares per year since 2007 (SFD, 2008). In all the Forest Reserves in the whole of Sabah on average 2,800 hectares have been rehabilitated in the period 2006-2009 and this is less in the years before 2006. Rehabilitation of degraded forests is a very costly operation. The introduction of SFMLA’s (long-term agreements between the Sabah State Government and private entities) is amongst others aimed at reducing the State budget deficit. At the same time the licensees are confronted with high costs for meeting the requirements for SFM at included in the SFMLA’s, while the Forest Reserves are depleted of the high-value timber and the income and the revenues for the licensee are low. SFM in Sabah needs capital that is not readily available locally, as the Deramakot experience shows. By the end of 2001 it was decided to stop rehabilitation activities, amongst others because of the escalating costs that were beyond the financial capacity of Deramakot (Mannan, 2002). When there is no positive cash-flow from timber harvesting, licensees rely on external investment for forest rehabilitation (Su Mei Toh, 2006). This is what is happening in USM, where rehabilitation along the Segama river in the Northern part of the Forest Reserve is funded by NGO’s and by private companies as part of their CSR policy. Ong (2005) suggests that the biggest constraint to implementing silvicultural treatmens, is the uncertainty of the overall economic viability of managing logged forests under a natural forest management regime. He further states that enrichment planting is best viewed as a restorative measure for long-term benefits rather than a commercial investment.

In the 10 years prior to the start of the project activity and throughout the 1990s, the sustainable forest management project in the Deramakot Forest Reserve is the main activity that is similar to the proposed project activity, in terms of forest rehabilitation. This project started in 1989 and has been implemented with funding from the German development cooperation organisation GTZ, aimed at producing a model for sustainable forest management, and cannot be considered as a project with a pure commercial interest. Deramakot does not represent common practice in forest management in Sabah, but is instead considered as a learning model for SFM in Sabah (Mannan, 2002; Su Mei Toh, 2006). Another similar activity is enrichment planting in Taliwas, that is now part of the Ulu Segama – Malua Forest Reserve. In 1979 an area of 22,000 hectares was planned for treatment. In reality about 1,600 hectares have been treated between 1980 – 1984 and the project was abandoned in 1986 mainly due to the high costs (Ong, 2005). There are no IFM activities known within Sabah that are similar to the scale of INFAPRO and have been entirely funded through private or commercial investments.

This investment barrier does not apply to the alternative land-use scenarios, as there is no or limited investment in improved forest management, except for land use scenario C. However, the high costs for rehabilitation makes this scenario unrealistic.

Technological barriers

The time the project activity started, there was not much experience with enrichment planting especially for large scale projects in the country. During the first three years of the project many applied research activities were undertaken operationally, with the objective to optimize raising, planting and tending to seedlings, as well as preparatory activities in the field. The experience from rehabilitation of 3,000 hectares in the first phase has led to revolutionaising the following phases of the project activity. More long term studies were investigated including planting width experiments, experiments with seedling sizes for outplanting, a vegetative propagation study, species trials, a myccorhizae study and other research. Knowledge on forest rehabilitation was available previously at a limited scale, mainly oriented to small scale experimental non-commercial activities, but not for the scale at which forest rehabilitation was carried out by INFAPRO. Part of the research in INFAPRO is reflected in the technical reports – a list of these technical reports is provided in the INFAPRO Forest Management Plan (Infapro, 2001). The Forest Management Plan also contains a reference list of publications that are based on research and experiences in INFAPRO. An overview of research that has been conducted in the first phase of the project is available in the internal report ‘INFAPRO Research programme 1992 to 1995 – Results and recommendations’ (Moura Costa, 1995). The current forest rehabilitation activities that are going on in Ulu Segama - Malua is based on a replication of the INFAPRO project concept (SFD, 2006). The success of INFAPRO is also widely known as the Model for Forest Rehabilitation in Sabah and the region considering many local and internationally known visitors and donors have visited the place since its inception (INFAPRO Visitor Book Records). This also applies to the pioneering role of the project in carbon sequestration research activities (Yap, 2000).

This barrier does not apply to the alternative land-use scenarios, as enrichment planting is not part of these scenarios, except in land use scenario C. The extra costs associated with research and testing of enrichment planting (including nursery management) would make this scenario even more unrealistic.

Barriers due to prevailing practice

The project activity is the first project of its kind considering its scale and intensity. Not before nor during the start of the implementation period similar activities were being undertaken in Sabah. The plans for enrichment planting of 22,000 hectares in Taliwas in the 1980s were not fully implemented, and in total about 1,600 hectares had been treated. The sustainable forest management project in Deramakot Forest Reserve that started in 1989, includes a set of activities related to SFM. One of these activities is forest rehabilitation and its implementation did not start before 1995, 3 years after the INFAPRO project start date. Staff from Deramakot visited INFAPRO to learn from the rehabilitation activities of the project (pers. com. Yap). In the period 1996 – 2001 on average an area of 190 hectares per year has been rehabilitated in Deramakot (Mannan, 2002) and until 2005 a total area of 1,200 hectares was treated with enrichment planting (Ong, 2005). Another initiative that has similarities with INFAPRO is the INIKEA project, that started in 1998 with signing a Memorandum of Understanding between Innoprise (part of Yayasan Sabah) and the Sow a

Seed Foundation (initiated by the IKEA Group). The aim of the project is to restore biodiversity in the Kalabakan Commercial Forest Reserve in Tawau, Sabah, which is part of the Yayasan Sabah Concession Area. The project area consists of 18,500 hectares of forest that has been affected by logging and forest fires due to severe droughts in the period 1982 – 1983. The annual rate of rehabilitation is about 800 hectares.

Silvicultural treatment of degraded forests and especially rehabilitation by enrichment planting were not common practice. Since the project was introduced, the vision within the forest sector and also within the State government on forest management in Sabah has gradually changed in favour of more sustainable forest management, under leadership of the Sabah Forest Department since 1997. Early activities such as INFAPRO, the New England project on Reduced Impact Logging, the INIKEA project and the SFM project in Deramakot Forest Reserve, have an important role in creating awareness and fostering support for sustainable forest management. As a result, silvicultural treatment of logged forests is now more widely applied in forest management and also forest rehabilitation similar to INFAPRO is practiced. Several companies and NGO's have financially contributed to the rehabilitation of Orang utan habitats in the Northern part of the Ulu Segama Forest Reserve.

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

The alternative land use scenario A represents the common practice in forest management and does not face barriers to implementation. Land use scenarios B and D would also not be prevented by these barriers. The land use scenario C 'Forest management with IFM activities' would be prevented by all of the three barriers.

Step 4 Common practice analysis

In the 10 years prior to the start of the project activity no similar activities were carried out at a similar scale within Sabah. Initiatives that have similarities with INFAPRO are discussed under step 3a 'barriers due to prevailing practice'. The Deramakot SFM project started in the 10 year period before the start of INFAPRO, but implementation of rehabilitation in Deramakot started in 1995/1996. The scale of rehabilitation in Deramakot is different to INFAPRO (about 190 hectares per year were rehabilitated in Deramakot), and further implementation was stopped in 2001, due to the high costs. The INIKEA project started 6 years later than the INFAPRO project. Its objective is to restore biodiversity in forests affected by fires, and it is not a commercial project and has only been realised with external funding.

3 Monitoring:

3.1 Title and reference of the VCS methodology (which includes the monitoring requirements) applied to the project activity and explanation of methodology choices:

The VCS methodology applied to the project activity is VM0005, Version 1.0, Methodology for Improved Forest Management: Conversion from Low Productive to High Productive Forest. This methodology has been selected because it is intended for project activities that prevent emissions from relogging and / or rehabilitate degraded forests by enrichment planting and silvicultural treatment. The project activity satisfies all applicability criteria of the methodology – see section 2.2 of this Project Document.

3.2 Monitoring, including estimation, modelling, measurement or calculation approaches:

The purpose of monitoring is to provide management information and transparency on the implementation of the project activity and to quantify the actual net GHG emission reductions resulting from the implementation of the project activity. Management information on project implementation allows the checking of the achievement of project goals and quality of the work.

The type and origin of data and information to be reported is described in the sections 3.3 and 3.4 below. Section 3.4 deals with monitoring frequency, roles and responsibilities and management of data quality.

3.3 Data and parameters monitored / Selecting relevant GHG sources, sinks and reservoirs for monitoring or estimating GHG emissions and removals:

Table 3.3.1 Data and parameters monitored for quantification of GHG emissions and removals.

Data / Parameter	Data unit	Description	Source of data	Description of measurement method	QA/QC procedures
$A_{i,t}$	ha	Area of stratum *i* at year *t*	Mapping of project compartments	Measurements are taken with GPS device	Follow the SOP for boundary survey
$A_{sp,i}$	ha	Total area of all sample plots in stratum *i*	Field measurements	Fixed plot size is multiplied by the number of plots	Follow the SOP for carbon monitoring
DBH	cm	Diameter at breast height of tree	Field measurements	Measured at 1.3 m above ground. All trees with DBH>5cm are included	Follow the SOP for carbon monitoring + section 3.4.2.6 for description of QA/QC
H	m	Height of tree	Calculated	Calculation is based on the measured DBH of tree	See QA/QC procedures for *DBH*
t_2 and t_1	yr	Years of the monitoring activity	Measured	Recording of year in which monitoring activity takes place	-
$\Delta C_{P,i,t}$	t CO_2-e yr^{-1}	Net carbon stock change in with-project scenario in stratum *i* at year *t*	Calculated	Calculation based on the measured variables *DBH* and $A_{i,t}$	See QA/QC procedures for *DBH*
$\Delta C_{AGB,i,t}$	t CO_2-e yr^{-1}	Net carbon stock change in above-ground tree biomass in the with-project scenario	Calculated	Calculation based on the measured variables *DBH* and $A_{i,t}$	See QA/QC procedures for *DBH*
$\Delta C_{BGB,i,t}$	t CO_2-e yr^{-1}	Net carbon stock change in below-ground tree	Calculated	Calculation based on $\Delta C_{AGB,i,t}$ and the root:shoot ratio	-

		biomass in the with-project scenario			
$E_{biomassloss,i,t}$	t CO_2-e yr^{-1}	Emissions due to site preparation for project activities in stratum *i* at year *t*	Calculated	Calculation based on the measured variable *DBH*	See QA/QC procedures for *DBH*
$C_{AGB,l,j,sp,i,t}$	t C $tree^{-1}$	Carbon stock in above-ground biomass of tree *l* of species *j* in plot *sp* in stratum *i* at year *t*	Calculated	Calculation based on the measured variable *DBH*	See QA/QC procedures for *DBH*
$V_{l,j,sp,i}$	m^3 $tree^{-1}$	Stem volume of tree *l* of species *j* in plot *sp* in stratum *i*	Calculated	Calculation based on the measured variable *DBH*	See QA/QC procedures for *DBH*
$C_{AGB,,sp,i,t}$	t C	Carbon stock in trees in plot *sp* in stratum *i* at year *t*	Calculated	Calculation based on the measured variable *DBH*	See QA/QC procedures for *DBH*

3.4 Description of the monitoring plan

3.4.1 Monitoring of baseline carbon stock changes and GHG emissions

The carbon stock changes in the existing vegetation in the baseline scenario is monitored ($\Delta C_{tree\text{-}exist,i,t}$) – see also section 4.2.6 of this Project Document. The carbon stock changes in existing vegetation include above-ground ($\Delta C_{tree\text{-}exist\text{-}AB,j,i,t}$) and below-ground ($\Delta C_{tree\text{-}exist\text{-}BB,j,i,t}$) tree biomass. Following the methodology in section 4.3.5, these parameters are quantified based on the same approach as for changes in carbons stocks in above-ground tree biomass in the with-project scenario. The monitoring requirements for the estimation of $\Delta C_{tree\text{-}exist,i,t}$ are similar to those provided in the following section 3.4.2 on monitoring of project carbon stock changes.

3.4.2 Monitoring of project carbon stock changes and GHG emissions

Included in the monitoring of the project carbon stock changes are the above-ground tree biomass ($\Delta C_{AGB,i,t}$) and the below-ground tree biomass ($\Delta C_{BGB,i,t}$), while carbon stock changes in wood products ($\Delta C_{WP,i,t}$) and in dead wood ($\Delta C_{DW,i,t}$) are excluded – see also section 4.3.1.1 of the Project Description on the procedure for quantification of the project carbon stock changes.

3.4.2.1 Updating strata

Strata are based on forest type and the period in which the forest has been treated. At each monitoring and verification event the strata are updated with newly treated areas. The table below shows the strata that are defined in the Project Area.

Table 3.4.2.1.1 Strata in the with-project scenario.

	Forest type		
Rehabilitation period	92-00 & Open Canopy	92-00 & Pioneer dominated	92-00 & Remnant/Pioneer
	02-04 & Open Canopy	02-04 & Pioneer dominated	02-04 & Remnant/Pioneer

	06-09 & Open Canopy	06-09 & Pioneer dominated	06-09 & Remnant/Pioneer
	10-13 & Open Canopy	10-13 & Pioneer dominated	10-13 & Remnant/Pioneer
	14-16 & Open Canopy	14-16 & Pioneer dominated	14-16 & Remnant/Pioneer
	17-19 & Open Canopy	17-19 & Pioneer dominated	17-19 & Remnant/Pioneer
	20-22 & Open Canopy	20-22 & Pioneer dominated	20-22 & Remnant/Pioneer
	23-25 & Open Canopy	23-25 & Pioneer dominated	23-25 & Remnant/Pioneer

3.4.2.2 Sampling framework

Sampling is done following a sampling approach in two phases. The first phase consists of manually classifying virtual plots into forest types, based on a 200 m x 200 m grid imposed on an aerial photo – see section 4.2.2 of this Project Document where the stratification of the Project Area into forest types is discussed in detail. The second phase consists of measuring permanent inventory sample plots. Initially this was in a zone along roads in the Project Area. This zone is a 250 m wide strip along each side of the road, excluding the first 30 meters next to the road, in order to exclude road effects. See also section 4.2.2 for justification of this approach. The 30 meter wide strip along the road, if not monitored, is excluded from the area of the with-project strata ($A_{i,t}$) for which VCU's are claimed. In order to avoid potential biases in the sampling of living tree carbon stocks, extra sample plots have been added in the area beyond the sampling zone along the road (i.e. further than 250 m from the road). These additional plots are part of the sampling framework. The plots in the interior zones that have been introduced at a later moment, are given a different weight factor than the plots in the zone along the road. Statistical weighing of each plot is applied, based on the representative area of the inventory plot. The representative area of the inventory plot is calculated by dividing the area of strata in the roadzone and interior zone by the number of inventory plots in the respective zones. The following statistical approach is applied for calculating the weighted mean and standard error of above-ground carbon stocks:

$$\bar{y}_i = \frac{1}{W_i}\sum_{sp=1}^{n} y_{sp,i} w_{sp,i}$$

$$W_i = \sum_{sp=1}^{n} w_{sp,i}$$

$$s_i^2 = \frac{1}{W_i - 1}\sum_{sp=1}^{n} (y_{sp,i} - \bar{y}_i)^2 w_{sp,i}$$

Where:

Parameter	Description
$\bar{y}_i$	Weighted mean of above-ground carbon stocks in stratum *i*
W_i	Sum of plot weights in stratum *i*
$y_{sp,i}$	Above-ground carbon stock in plot *sp* and in stratum *i*
$w_{sp,i}$	Weight of plot *sp* in stratum *i*
s_i^2	Variance of mean above-ground carbon stocks in stratum *i*

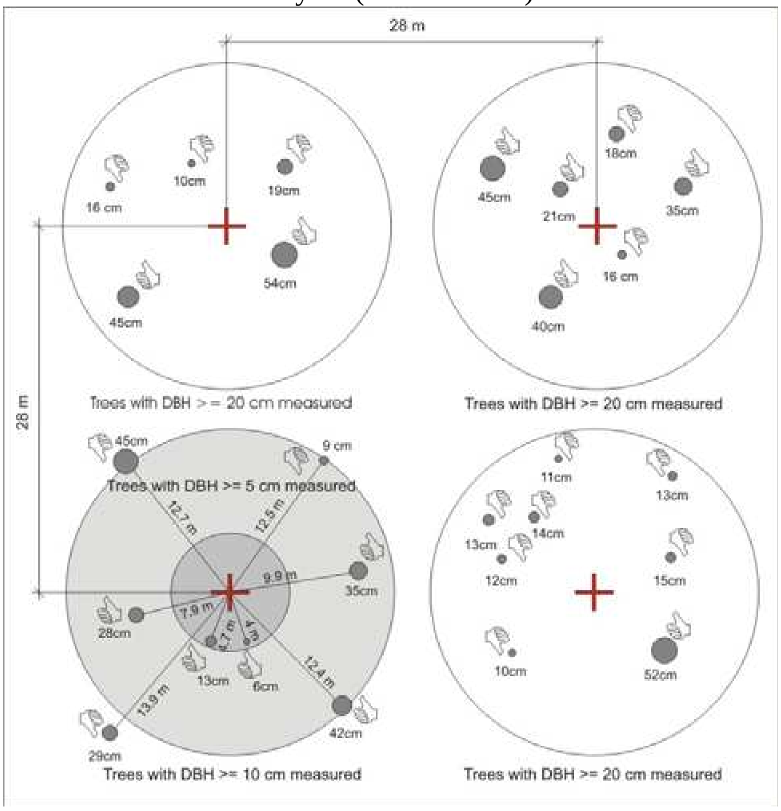
The plot coordinates are fixed before the start of the field measurements. The number of plots in the first monitoring event are 50 plots in the untreated area and 240 plots in the treated area.

A nested plot approach is applied as shown in table 3.4.2.2.1 below. The size of a plot is 2.000 m^2 and each plot consists of four circles of 500 m^2. The circle in the South-West corner is the key circle. The distance between the circle centres is 28 meter and they are positioned in the form of a square – see picture 3.4.2.2.1. The key circle contains a smaller circle with radius of 5 meter where small trees are measured – see table 3.4.2.2.1. Regeneration (i.e. trees larger than 20 cm in height up to 50 mm DBH) is monitored in a circle with a radius of 2 meter within the key circle. The plot can be rotated clockwise around the key circle centre in steps of 20 degrees in order to keep a plot within one stratum or to avoid entering slopes that are too steep to walk on.

Table 4.3.2.2.1 DBH classes used in nested sample plots.

Tree type	Tree dimensions	Sample area (m^2)	Circle radius (m)
Regeneration	>0.2 m of height – 50 mm of DBH	12.56	2 – key circle
Small trees	DBH = 50 mm – 100 mm	78.5	5 – key circle
Medium trees	DBH = 100 mm – 200 mm	500	12.62 – key circle
Large trees	DBH =200 mm and larger	2000	Whole inventory plot

Picture 4.3.2.2.1. Plot layout (Source: IFER)



For monitoring of the carbon stocks the targeted precision level is 10% of the mean at a 95% confidence level. This is reached by stratification of the Project Area and measuring a reasonable amount of sample plots. Where this precision level is not reached, the associated uncertainty is expressed based on the tool VT0003 for uncertainty assessment that is part of the methodology VM0005.

3.4.2.3 Carbon stock changes and GHG emissions

The BEF method from section 5.2.2 of the methodology is selected to estimate the carbon stock changes in above-ground tree biomass. This includes the following steps.

Step1: The diameter at breast height (DBH) is measured for trees with DBH ≥ 5 cm in permanent sample plots.

Step 2: The volume of the trees is calculated based on volume equations. All species that occur in INFAPRO are divided in 15 species groups and for each species group is a specific equation for the calculation of height and volume. Height is calculated based on the measured DBH whereas volume is calculated based on measured DBH and calculated height. The table 4.3.2.1 below provides the equations for all the species groups. The equations are locally developed by Forestal International Ltd. for dipterocarp forest in Sabah (Forestal International Limited, 1973, in: Pinard, 1995). They are based on destructive sampling of trees in the Ulu Segama Forest Reserve, which comprises the INFAPRO Project Area. As the equations are both local and specific to species group, they provide the most suitable method to calculate tree volumes and consequently tree carbon stocks. These equations are not suitable for small trees (DBH category of 5 to 10 centimetres) and therefore a specific equation (locally developed within the same Forest Reserve) by Pinard (1995) is applied:

LOGe (dry weight in kg) = 0.539 x DBH – 1.25

Table 4.3.2.1 Height and volume equations for species groups.

Species group	Height equation	Volume equation
1	$H = 5.506 + 0.4119 \times D - 0.00162 \times D^2$	$V = 0.038 + 0.0053 \times (D^2 \times H) / 100$
2	$H = 2.614 + 0.5529 \times D - 0.00302 \times D^2$	$V = 0.1532 + 0.005 \times (D^2 \times H) / 100$
3	$H = -0.3622 + 0.6403 \times D - 0.00337 \times D^2$	$V = -0.0362 + 0.005 \times (D^2 \times H) / 100 + 0.00000005 \times ((D^2 \times H) / 100)^2$
4	$H = -0.3152 + 0.7511 \times D - 0.00429 \times D^2$	$V = -0.0364 + 0.005 \times (D^2 \times H) / 100$
5	$H = 2.517 + 0.5997 \times D - 0.00322 \times D^2$	$V = 0.164 + 0.0041 \times (D^2 \times H) / 100 + 0.00000041 \times ((D^2 \times H) / 100)^2$
6	$H = 5.0849 + 0.33498 \times D - 0.00102 \times D^2$	$V = 0.1363 + 0.0046 \times (D^2 \times H) / 100 + 0.00000007 \times ((D^2 \times H) / 100)^2$
7	$H = 3.999 + 0.425 \times D - 0.00195 \times D^2$	$V = 0.1292 + 0.0047 \times (D^2 \times H) / 100 + 0.00000015 \times ((D^2 \times H) / 100)^2$
8	$H = 2.528 + 0.3635 \times D - 0.0019 \times D^2$	$V = 0.0582 + 0.0048 \times (D^2 \times H) / 100$
9	$H = 2.297 + 0.3304 \times D - 0.00144 \times D^2$	$V = -0.0145 + 0.0056 \times (D^2 \times H) / 100$
10	$H = 3.981 + 0.2848 \times D - 0.00119 \times D^2$	$V = 0.0322 + 0.0054 \times (D^2 \times H) / 100$
11	$H = 2.056 + 0.4659 \times D - 0.00221 \times D^2$	$V = -0.0195 + 0.0047 \times (D^2 \times H) / 100$
12	$H = 11.46 + 0.263 \times D - 0.00114 \times D^2$	$V = -0.1918 + 0.0058 \times (D^2 \times H) / 100$
13	$H = 3.497 + 0.238 \times D - 0.00152 \times D^2$	$V = 0.0547 + 0.0053 \times (D^2 \times H) / 100$
14	$H = -3.189 + 0.7358 \times D - 0.00472 \times D^2$	$V = 0.02997 + 0.0039 \times (D^2 \times H) / 100 + 0.00000018 \times ((D^2 \times H) / 100)^2$
15	$H = 3.329 + 0.2638 \times D - 0.00136 \times D^2$	$V = -0.0021 + 0.0051 \times (D^2 \times H) / 100$

Step 3: Selection of the Biomass Expansion Factor (BEF). The BEF is selected from Brown for good tropical hill forest in Malaysia (Pinard, 1995). The study site of Pinard represents the same forest type as INAPRO and is within 5 kilometres from INFAPRO. The value of the BEF is 1.895.

Step 4: The stem volumes of trees are converted into carbon stocks of above-ground tree biomass via the basic wood density, the BEF and the carbon fraction. A carbon fraction (CF_j) of 0.5 is selected (i.e. the IPCC default value). The wood densities are species specific and selected from the following sources: Burgess (1966), Tree Flora of Sabah & Sarawak (Soepadmo, 1996), unpublished research by Yap, PROSEA (Plant Resources of South-East Asia), Forester's Manual of Dipterocarps (Symington, 1943, revised in 2004).

Step 5: The carbon in all trees per species and in all species is summed up to provide one single value per sample plot of the above-ground tree carbon stock.

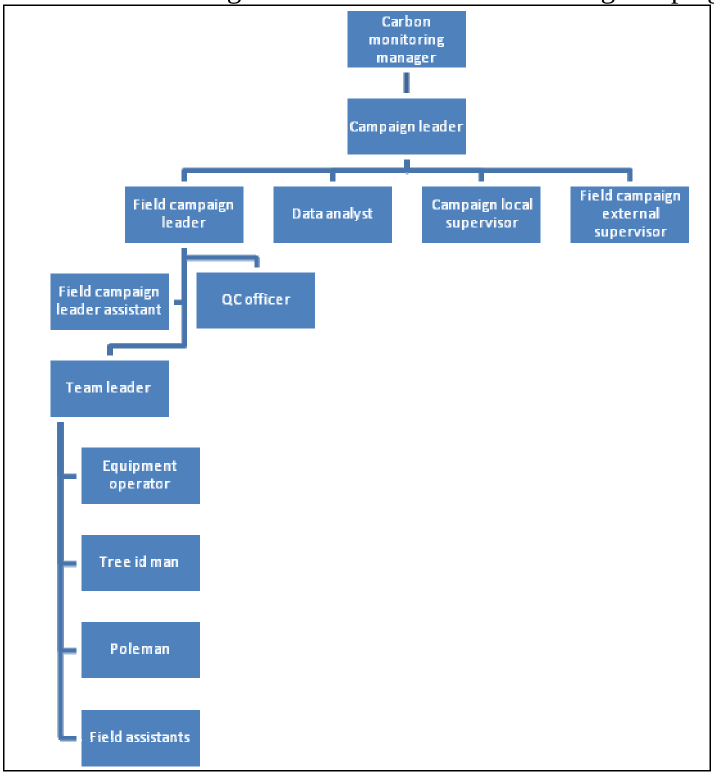
Step 6: The mean carbon stock in above-ground tree biomass per stratum is calculated. For this step the total area for all sample plots per stratum is required ($A_{sp,i}$) – this parameter is one of the variables to be monitored.

The quantification of carbon stocks in below-ground tree biomass ($\Delta C_{BGB,i,t}$) is based on the $\Delta C_{AGB,i,t}$ multiplied with the root:shoot ratio R_j, which is based on Pinard and Putz (1996). The factor is developed in a study in similar forest within 5 kilometers from INFAPRO. Their estimate is that below-ground tree biomass is about 17% of above-ground tree biomass. Therefore a root:shoot ratio of 1.17 is adopted for the Project Activity.

3.4.2.4 Roles and responsibilities for monitoring activities

Monitoring of carbon stocks is done in teams equipped with monitoring tools. The chart 3.4.2.4.1 below gives an overview of all the roles in the monitoring campaign.

Chart 3.4.2.4.1 Organizational chart for monitoring campaigns.



A description of the responsibilities for each of the positions in the organizational chart is provided in the table 3.4.2.4.1 below.

Table 3.4.2.4.1 Description of responsibilities of staff involved in monitoring.

Position	Responsibility
Carbon monitoring manager	The carbon monitoring manager is responsible for planning the monitoring campaign and contracting staff for implementing the campaign. The manager is also responsible for writing the Monitoring Report.
Campaign leader	The leader of the campaign is responsible for the methodology of the campaign. He designs the project structure and supervises the data evaluation.
Field campaign leader	Leader is responsible for the operations on the ground. The main tasks of the leader are to select and hire local staff capable of works related to computer aided field data collection, manage monitoring teams in the training phase and also later in the field, organize repairs of broken equipment and assigned other responsibilities to team leaders.

Field campaign external supervisor	External supervisor is responsible for teaching the correct methodological approach to the local workers. He is present in the beginning of the campaign to ensure that all problems related to equipment and project database structure are solved and all questions regarding the methodology of data collection are answered. He leads the training of local staff. He is also present at the end of the campaign to check data quality and to check the quality of field work by revisiting random selection of inventory plots and re-measuring them.
Data analyst	Data analyst is responsible for data check and data evaluation. He carries out the statistical computations and produces the final results.
Campaign local supervisor	Local supervisor is responsible for transportation in the field, supply of local workers and for other administrative tasks and logistics.
QC officer	QC officer is responsible for remeasurement of monitoring plots for Quality Control.
Field campaign leader assistant	Assistant takes over responsibilities of field campaign leader when necessary. E.g. when the campaign leader is not available.
Equipment operator	Equipment operator is responsible for the data collection. He is operating the technology in the field and therefore must be familiar with it.
Team leader	Team leader is responsible for managing local workers in the field, on the inventory plots. He is also responsible for daily backup of collected data.
Tree id man	With so many species present in Sabah, tree identification man is crucial for the monitoring team. He is skilled in tree identification and is responsible for correct species data.
Poleman	Poleman is operating measuring pole and measuring DBH. He is familiar with the correct procedures for measuring DBH, positions of the trees and also procedure for navigation to the plot.
Field assistant	A field assistant provides support to the team by carrying monitoring equipment and numbering trees in the plot, amongst others.

The inventory team members are trained on using the monitoring equipment and on the procedures for monitoring. In the selection procedure of the inventory staff the experience with monitoring is a very important criterion. At least half of the supervisory staff (i.e. the managers, leaders and supervisors) is educated in forest monitoring and research and has multiple years of experience in forest inventories.

The position of a field campaign leader assistant is optional. The positions of the carbon monitoring manager, the campaign leader, the data analyst, the field campaign external supervisor and the QC officer can be combined.

3.4.2.5 Monitoring equipment

The equipment used for monitoring consists of the following items:

- A field computer for entering the monitoring data at plot location.
- A GPS device for navigating to plot centres and to store geographic coordinates of sample plots.
- A calliper or measurement tape to measure the diameter at breast height (DBH – at 1.3 meter).

- Optionally a laser rangefinder combined with a compass and inclinometer for navigating, height measurements and determining the tree positions.
- Accessories such as batteries, (telescopic) poles, number cards, ribbons, aluminium tags and rain covers.

Equipment is calibrated according to the requirements that are provided by the suppliers of the equipment.

3.4.2.6 Quality assurance and quality control procedures

Standard Operation Procedures (SOP) are prepared for the inventory teams. The SOP include procedures for all monitoring steps. Specific procedures are provided for plots that are measured for the first time and for plots that are re-measured. The main items in the SOP are:

- Navigating to the plot centre
- Fixing (first measurement) or finding (re-measurement) the plot centre
- Measuring and describing trees
- Describing other parameters of the plot
- Checking the database
- Creating data backup

The SOP contains rules for how DBH measurements are taken in specific circumstances, e.g. on steep slopes, for slanted trees and for trees with buttresses. The SOP is written in English and in Bahasa Malaysia to make sure that the inventory team members have a good understanding of the procedures. The procedures are described following a step-wise approach, where steps are accompanied with specific pictures or screenshots. The content of the SOP is in line with the content of the monitoring training sessions.

Other quality assurance measures are:

1. Training of inventory team members. Training is given on-site by an experienced monitoring professional (the field campaign external supervisor). At each new monitoring campaign (taking place at a 3 year interval) the staff is retrained in order to refresh their knowledge and skills.
2. The field campaign external supervisor is present for advice during the first week after the training.
3. The database structure on the field computer is designed to minimize input errors:
    a. Predefined lookup lists are provided (e.g. for species names).
    b. Dependency checks are included: conditional lookup lists shorten the choice for subordinate variables.
    c. The species lookup list only contains species that occur in the Project Area.
    d. A warning is given by the software if a value is out of reasonable bounds. The inventory team member is given the opportunity to check the value and correct it if applicable.
    e. The software gives a warning if a tree is located outside of the plot boundary.
    f. After completion of each plot, an automatic software check is run to see whether any input variables are missing (e.g. DBH or species name).
    g. There is an option to switch on a measurement wizard that guides the operator of the field computer through the measurement steps.

Quality control includes the checking of the database with measurement data. SQL queries are performed for a final check of the database. Quality control also includes the re-measurement of a selection of inventory plots. The leader of the quality control measurements is not involved in the original measurement of the plot. A minimum of 5% and a maximum of 10% of the inventory plots are re-measured. The mean difference in measured carbon stock of a plot between the original measurement and the re-measurement across all plots shall be 5%

at maximum. If the difference is larger than 5%, the cause(s) of the difference will be identified and addressed.

3.4.2.7 Data archiving procedures

The database with the monitoring data is stored at several locations:

1. There is a daily backup of the data on the field computer itself and on a computer in the office at the INFAPRO site. The data are transferred via a flash drive and after the transfer the data will also be kept on the flash drive.
2. Once in two weeks the data are sent to the Conservation & Environmental Management Division (CEMD) office in Kota Kinabalu and stored on an office computer.
3. At minimum two times during the monitoring campaign the database is stored on the computer of the field campaign external advisor.
4. The processed data are stored on the computer of the data analyst and on the computer of the carbon monitoring manager. The final database is saved on the network server of Face the Future and a copy is saved at the CEMD office in Kota Kinabalu with the field campaign leader.

All data collected are kept at least for two years after the end of the last crediting period.

The spreadsheets used for calculating the net carbon stock changes and GHG emissions and the Monitoring Plans are saved in electronic and paper form at the office of Face the Future in the Netherlands, at the CEMD office in Kota Kinabalu and at the INFAPRO office.

3.4.2.8 Monitoring of project GHG emissions

The approach to quantify project GHG emissions ($GHG_{WPS\text{-}E,t}$) is provided in section 4.3.2 of this Project Document. In order to quantify the project GHG emissions in each Monitoring Report, the following records are kept:

1. The generation of electricity in kWh by the genset at the INFAPRO site. The annual electricity production is provided in the INFAPRO Annual Reports, which are available at the CEMD office in Kota Kinabalu and at the office of Face the Future in the Netherlands. The Annual Reports are shared with the Steering Committee members.
2. The amount of fuel consumed by project vehicles. The record is available at the INFAPRO site.
3. A record of all flights to INFAPRO by project staff, consultants and auditors. The record is available at the INFAPRO site.
4. A record of areas that have been cleared of forest for the purpose of establishing infrastructure. The record is available at the INFAPRO site.
5. A record of newly established roads or roads that are maintained each year. The record is available at the INFAPRO site.

3.4.3 Monitoring of leakage carbon stock changes and GHG emissions

Leakage carbon stocks changes and related GHG emissions are not monitored. Leakage due to the market effect of avoided harvesting in the Project Area is quantified at validation of the project activity and is not subject to changes in carbon stocks in the baseline scenario that take place after the logging event. Leakage is in this Project Document calculated as the leakage factor (LF_{ME}) times the emissions from relogging ($\Delta C_{REL,i,t}$), see equation (46) in the methodology. The parameter $\Delta C_{REL,i,t}$ is calculated once and is not monitored. In contrast, the parameter C_{BSL} is subject to monitoring because it changes if regrowth in the baseline scenario takes place, expressed by the parameter $\Delta C_{tree\text{-}exist,i,t}$. However, this parameter $\Delta C_{tree\text{-}exist,i,t}$ does not have an effect on the leakage parameter ΔC_{LK}. Therefore, leakage is not be monitored.

3.4.4 Estimation of ex-post total net carbon stock changes and GHG emissions

The total net GHG emission reductions (ΔC_{IFM}) of the project are calculated as in section 4.4.1 of the Project Document. The Monitoring Report includes the estimation of the total net GHG emission reductions, based on the monitoring results, i.e. the monitoring of changes in carbon stocks and GHG emissions in the with-project scenario and the monitoring of changes in carbon stocks in existing tree vegetation in the baseline.

3.4.5 Monitoring of project implementation

3.4.5.1 Monitoring of the project boundary

The size of areas to be rehabilitated are defined in contracts between Face the Future and Yayasan Sabah, which cover an implementation period of several years. These areas were first explored by the officers and rangers to determine if the sites are suitable for rehabilitation. General features of the project area such as rivers, topography and already existing roads are digitized from a variety of maps. The contract area is located within the Project Area and is divided into compartments. The boundary of the contract area and the compartments is determined by the survey team by following the physical and natural site features such as former logging roads and skid trails, river and ridges. The team demarcates the boundary on the ground with coloured sticks and paint on the stems of existing trees. The field team was formerly part of the Survey Unit of Rakyat Berjaya but are now staff of CEMD under INFAPRO. The team is part of the Operation unit. The survey team is supervised by the Rakyat Berjaya survey unit based in Lahad Datu. The team uses simple mapping tools such as GPS, Suunto Prismatic Compass, Suunto Clinometer and measuring tapes while demarcating boundaries at the same time. The GPS is used for establishing reference points. The compass is used for mapping the boundaries. The procedures are documented in the SOP Operation Guidelines. Before the data is sent for processing, supervision is conducted by the Head of Unit to ensure the boundary is made properly and the raw data is valid. The raw data is then transferred from the field book to graph paper and sent to the Mapping and Technical Services Section of the Forestry Division (FD) in the Yayasan Sabah office in Kota Kinabalu to map the surveyed compartments. This section is responsible for processing the data and the production of maps for the whole Yayasan Sabah Concession Area. Once the map and GIS files are completed, they are sent to CEMD and INFAPRO offices for operation use. Each compartment receives a specific ID number, that is composed of the contract area number, the coupe (year of logging) and a serial number. All spatial data are archived at the INFAPRO office, the CEMD office in Kota Kinabalu and the Face the Future office in the Netherlands.

3.4.5.2 Monitoring of forest rehabilitation and management

The nursery management, forest rehabilitation and forest management activities implemented by INFAPRO staff are described in section 1.9 of this Project Document. The progress of project implementation is monitored by INFAPRO staff.

Table 3.4.5.2.1 shows all the parameters that are monitored for each activity. For ground truthing, the number of planting points per category is monitored. These categories are planting points, unplantable points and natural regeneration points. Seedling despatch refers to the transport of seedlings from the nursery to the compartment where they are going to be planted. Maintenance refers to three types of activities: row slashing, ring weeding and liberation thinning. Climber cutting is also a maintenance activity, but is separately included in the table because it is also a pre-planting activity. A 100% census of the survival of seedlings is carried out three months after enrichment planting. After three years another 100% is carried out. Natural regeneration of desired species are included in the census. Previously three census rounds were carried out: a 100% census after three months, a 10% census after one year and a 10% census after three years.

The table 3.4.5.2.1 indicates where the monitoring data are published and stored. Monitoring data that is available on a compartment level is stored in a general record book and in more specific compartment files (field record books) that are present at the INFAPRO office. Electronic copies are archived both in the INFAPRO office and in the CEMD office in Kota Kinabalu. Monitoring data is summarized in tables that are published in Quarterly Reports and Annual Reports. These reports are drafted by the INFAPRO manager and endorsed by the Group Manager of the Conservation & Environmental Management Division (CEMD) in Kota Kinabalu. The reports are sent to Face the Future in the Netherlands. The annual report is shared with stakeholders at the annual Steering Committee meeting. An electronic copy of the reports is available at the INFAPRO office. Paper version of the reports are available at the INFAPRO office, District Forest Officer of the Sabah Forestry Department office, the CEMD office and the Face the Future office.

The Management Information System, Research, Training and Development unit (MIS-RTD) is responsible for carrying out the census. The Nursery and Tagging unit is responsible for keeping the records on nursery management and ground truthing. Within the Operations unit the Site Preparation team is responsible for the records for compassing and climber cutting. The Planting and Maintenance team is responsible for the records on enrichment planting and maintenance. Each unit is supervised by a Head of Unit who reports to the INFAPRO Manager. Under the Head of Unit the team leaders are supervising the casual rangers – see also section 1.15. To check the quality of the fieldwork activities regular joint inspections are carried out with the INFAPRO Manager, the officers and the rangers. The data in the field records are verified during these inspections.

Table 3.4.5.2.1 Monitoring of nursery management, forest rehabilitation and forest management.

Activity	Parameters	Unit	Reporting & Archiving
Nursery management	- list of species - number of seedlings per species	Nursery unit	Quarterly Report, Annual Report
Compassing	Per compartment: - start date / end date - number of mandays - number of lines	Operation unit	Compartment file, Quarterly Report, Annual Report
Climber cutting	Per compartment: - start date / end date - rounds of climber cutting	Operation unit	Compartment file, Quarterly Report, Annual Report
Ground truthing	Per compartment: - start date / end date - number of mandays - number of planting points per category	Operation unit	Compartment file, Quarterly Report, Annual Report
Seedling despatch	- species and number of seedlings	Nursery unit	Compartment file
Enrichment planting	Per compartment: - start date / end date - total number of planted seedlings	Operation unit	Compartment file, Quarterly Report, Annual Report
Maintenance	Per compartment: - type of maintenance - start date / end date - number of mandays	Operation unit	Compartment file, Quarterly Report, Annual Report

	- number of lines and / or planting points, if applicable		
Survival of seedlings	Per compartment: - survival rate without natural regeneration - survival rate with natural regeneration - survival rate without natural regeneration after re-supply - survival rate with natural regeneration after re-supply	Census unit	Compartment file, Quarterly Report, Annual Report

Standard Operation Procedures (SOP) are prepared for census of seedling survival. The SOP are also applicable to the nursery management and all the forest management activities. The forest management activities have a very limited impact on the soil. See section 5 of this Project Document on Environmental Impacts for how soil impact is minimized and mitigated.

4 GHG Emission Reductions:

4.1 Explanation of methodological choice:

The VCS IFM methodology VM0005 version 1.0 for the Conversion of Low Productive to High Productive Forest is applied to the project. This methodology applies to projects that achieve emission reductions and removals through forest rehabilitation and avoidance of relogging. It has been developed for this project activity. The project fulfils all the criteria listed in the methodology – see further section 2.2.

4.2 Quantifying GHG emissions and/or removals for the baseline scenario:

4.2.1 Net CO_2 equivalent emissions in the baseline scenario

The net emissions in the baseline scenario is calculated with equation (2) from the methodology:

$$\Delta C_{BSL} = \sum_{t=1}^{t^*} \sum_{i=1}^{M_{BSL}} \left(\Delta C_{REL,i,t} + \Delta C_{tree-exist,i,t}\right) + GHG_{BSL-E,t}$$

Where:

Parameter	Description	Unit
ΔC_{BSL}	Net CO_2 equivalent emissions in the baseline scenario up to year t^*	t CO_2-e
$\Delta C_{REL,i,t}$	Net carbon stock change due to relogging in the baseline scenario in stratum i at year t	t CO_2-e yr^{-1}
$\Delta C_{tree\text{-}exist,i,t}$	Net carbon stock change in existing tree vegetation in the baseline scenario in stratum i at year t	t CO_2-e yr^{-1}
$GHG_{BSL\text{-}E,t}$	Greenhouse gas emissions as a result of relogging within the project boundary in stratum i at year t	t CO_2-e yr^{-1}
i	1, 2, 3 …M_{BSL} strata in the baseline scenario	
t	1, 2, 3, … t^* years elapsed since the project start	

The stratification in the baseline is presented in section 4.2.2, followed by the quantification of the carbon stocks at the start of the project in section 4.2.3. In section 4.2.4 the net carbon stock changes due to relogging ($\Delta C_{REL,i,t}$) are calculated, followed by calculation of the GHG emissions from relogging ($GHG_{BSL\text{-}E,t}$) in section 4.2.5 and the net carbon stock changes in existing tree vegetation in the baseline ($\Delta C_{tree\text{-}exist,i,t}$) in section 4.2.6. Table 4.2.1.1 below shows the result of the calculation of the emissions in the baseline scenario.

Table 4.2.1.1 Emissions in the baseline scenario.

Project Year (t)	ΔC_{BSL}	Open Canopy forest type		Pioneer dominated forest type		Remnant Forest type		$GHG_{BSL-E,t}$
		$\Delta C_{REL,i,t}$	$\Delta C_{tree-exist,i,t}$	$\Delta C_{REL,i,t}$	$\Delta C_{tree-exist,i,t}$	$\Delta C_{REL,i,t}$	$\Delta C_{tree-exist,i,t}$	
1	-875,767	-	-	-47,335	-	-113,853	-	-714,580
2	517,277		17,409		288,119		211,749	
3	517,277		17,409		288,119		211,749	
4	517,277		17,409		288,119		211,749	
5	444,593		21,181		234,763		188,649	
6	444,593		21,181		234,763		188,649	
7	444,593		21,181		234,763		188,649	
8	444,593		21,181		234,763		188,649	
9	222,297		10,590		117,382		94,325	
10	222,297		10,590		117,382		94,325	
11	222,297		10,590		117,382		94,325	
12	222,297		10,590		117,382		94,325	
13	222,297		10,590		117,382		94,325	
14	333,445		15,885		176,073		141,487	
15	333,445		15,885		176,073		141,487	
16	333,445		15,885		176,073		141,487	
17	333,445		15,885		176,073		141,487	
18	333,445		15,885		176,073		141,487	
19	333,445		15,885		176,073		141,487	
20	333,445		15,885		176,073		141,487	
21	333.,445		15,885		176,073		141,487	
22	333,445		15,885		176,073		141,487	
23	333,445		15,885		176,073		141,487	
24	333,445		15,885		176,073		141,487	
25	333,445		15,885		176,073		141,487	
26	277,871		13,238		146,727		117,906	

27	222,297		10,590		117,382		94,325	
28	166,722		7,943		88,036		70,743	
29	111,148		5,295		58,691		47,162	
30	55,574		2,648		29,345		23,581	
Total	8400.871		420,239	-47,335	4,943,369	-113,853	3,913,030	-714,580

4.2.2 Baseline stratification

The Project Area is not homogenous, which is caused by a complex interaction of several factors, of which the most important are differences in soil types and intensity and the configuration of logging, see section 1.7 of this Project Document. Primary dipterocarp forest is not homogenous from itself to start with. The impact of logging adds to the heterogeneity of the forest, because of the different harvesting techniques (high lead and tractor yarding), the availability of timber, accessibility of the terrain and the establishment of skid trails, log landings and forest roads. As a result the biomass levels in the Project Area vary from values close to zero to values that are similar to dense primary forest. Depending on local site conditions, levels of disturbance and availability of seeds there is a differentiated response of the forest vegetation to the disturbance, adding to the variability in carbon densities. Differences between forest patches are gradual and it is therefore difficult to discern clear boundaries between strata or even to define various strata. Because of the heterogeneity in the Project Area, the year in which logging took place is not a good predictor of the tree carbon stocks and is therefore not selected as a variable for stratification. E.g. areas within logging coupe 1984 can have a lower carbon stock than areas within logging coupe 1992.

In order to reduce the variability for sampling of the tree carbon stocks, stratification has been applied to the Project Area, based on the structure of the forest. Since the start of the project the local staff makes a distinction between open areas (referred to as Open Canopy, or OC), forest patches dominated by pioneers (the so-called Pioneer dominated forest, or Pd) but also contain climax species and forest patches that contain remnant trees as well as pioneers (the Remnant/Pioneer forest type, or RP). Based on their extensive experience in the forest, the staff recognizes the three forest types in the field. Stratification of the Project Area into the three forest types has been done for two purposes: 1) to reduce the variability and decrease the number of sample plots and 2) to allow for sampling in a specified zone within the Project Area. This sampling zone is an area along the forest roads, starting 30 meter from the road and ending at 250 meter from the road. Although there are many forest roads in the Project Area, and the sampling zone covers a large part of the Project Area (i.e. 42.5% within the treated area), it remains a possibility that there is a difference between the average carbon stocks in the sampling zone and the average carbon stocks in the area beyond the sampling zone. Stratification of the forest reduces this bias, assuming that a forest type stratum in the sampling zone is similar to the same forest type stratum in the area beyond the sampling zone. However, in order to eliminate the risk of the bias, additional sample plots are installed beyond the 250 m wide zone along the road. These plots are measured in the monitoring events.

Stratification of the Project Area is based on an aerial photo taken in 2002 with a resolution of 1 meter. A grid is imposed on the aerial photo and each gridpoint represents a virtual plot. The distance between each gridpoint is 200 meter. Each virtual plot is manually assessed (Yap, 2007) to determine the forest type – see picture 4.2.2.1. In total 7322 plots have been classified. Based on the percentage of the number of virtual plots of a specific forest class relative to the total number of virtual plots, the area of the stratum is determined. A random sample of the virtual plots (within the sampling zone) is selected as inventory plots. The carbon stock per stratum is based on the inventory plots.

Picture 4.2.2.1 Classification of the Project Area based on aerial photos.

● Remnant Pioneer forest
▲ Pioneer dominated forest
■ Open Canopy
▲ Non-forest

Table 4.2.2.1 Baseline strata identified in the Project Area.

Stratum (forest type)	Stratum size (ha)	Stratum size (%)
Remnant / Pioneer forest	13,450	45.1
Pioneer dominated forest	14,194	47.6
Open Canopy forest	2,198	7.4
Non-forest	571	-
Total	30,413	

Stratification of the whole Project Area was not done at the start of the project in 1992, because there were no standards and methodologies available that required stratification and the assessment of carbon stocks in the Project Area. Preliminary assessments of forest carbon stocks in the Project Area have been implemented in 2000 (Yap, 2000) – however, these measurements do not meet the standards set by the adopted VCS methodology VM0005. The first rigorous carbon stock inventory, with the help of the above described stratification, was carried out in 2007. Assessment of baseline carbon stocks is based on sample plots located within parts of the Project Area that have not been touched by the project – referred to as the untreated Project Area.

Due to the time gap between the start of the project activity and the inventory, the measured carbon stocks do not necessarily reflect the carbon stocks at the start of the project. The vegetation has slowly developed since 1992 and consequently the carbon stocks have increased. Considering the carbon stocks measured in 2007 as the carbon stocks at the start of the project, means that the baseline carbon stocks are overestimated, resulting into a conservative estimate of the net GHG removals by the project. The use of footage from 2002 for stratification of the baseline carbon stocks leads to an overestimation of baseline carbon stocks. As the forest has developed over time, the share of less carbon dense strata has decreased at the time the aerial photo was made, relative to the start of the project.

4.2.3 Estimation of the carbon stock at the start of the project

The carbon stock at the start of the project activity is defined as $C_{AGB,i,t}$ at t0 (carbon in above-ground tree biomass at *t* is zero) plus the carbon in below-ground biomass $C_{BGB,i,t}$ at t0 (using the root:shoot ratio R_j). Following section 4.3.6 of the methodology the carbon stocks at the start of the project activity is estimated based on an inventory in parts of the Project Area that have not been silviculturally treated. In INFAPRO no inventory was made of the carbon stocks before the start of the project activity. The project started in 1992 and monitoring of carbon stock changes was not a common practice. Therefore the $C_{AGB,i,t}$ at t0 needs to be determined indirectly and conservatively by measuring plots in parts of the Project Area where no project intervention took place. This way the carbon stocks at t0 are overestimated, as the vegetation has developed in the period between 1992 and the first inventory (i.e. in 2007), resulting into a conservative estimate of project benefits.

The Project Area was stratified into forest types (see section 4.2.2) for the purpose of the inventory. The approach described in sections 4.3.1.1 and 4.3.1.2 has been followed to measure and calculate the parameters $C_{AGB,i,t}$ and $C_{BGB,i,t}$. In 2007 50 plots of 0.2 hectares have been measured to quantify the carbon stocks at t0. Table 4.2.3.1 below shows the results of the inventory. The calculation is in the spreadsheet 'INFAPRO inventory data 2007'.

Table 4.2.3.1 Carbon stock is above-ground and below-ground tree biomass at t0 (in tC/ha).

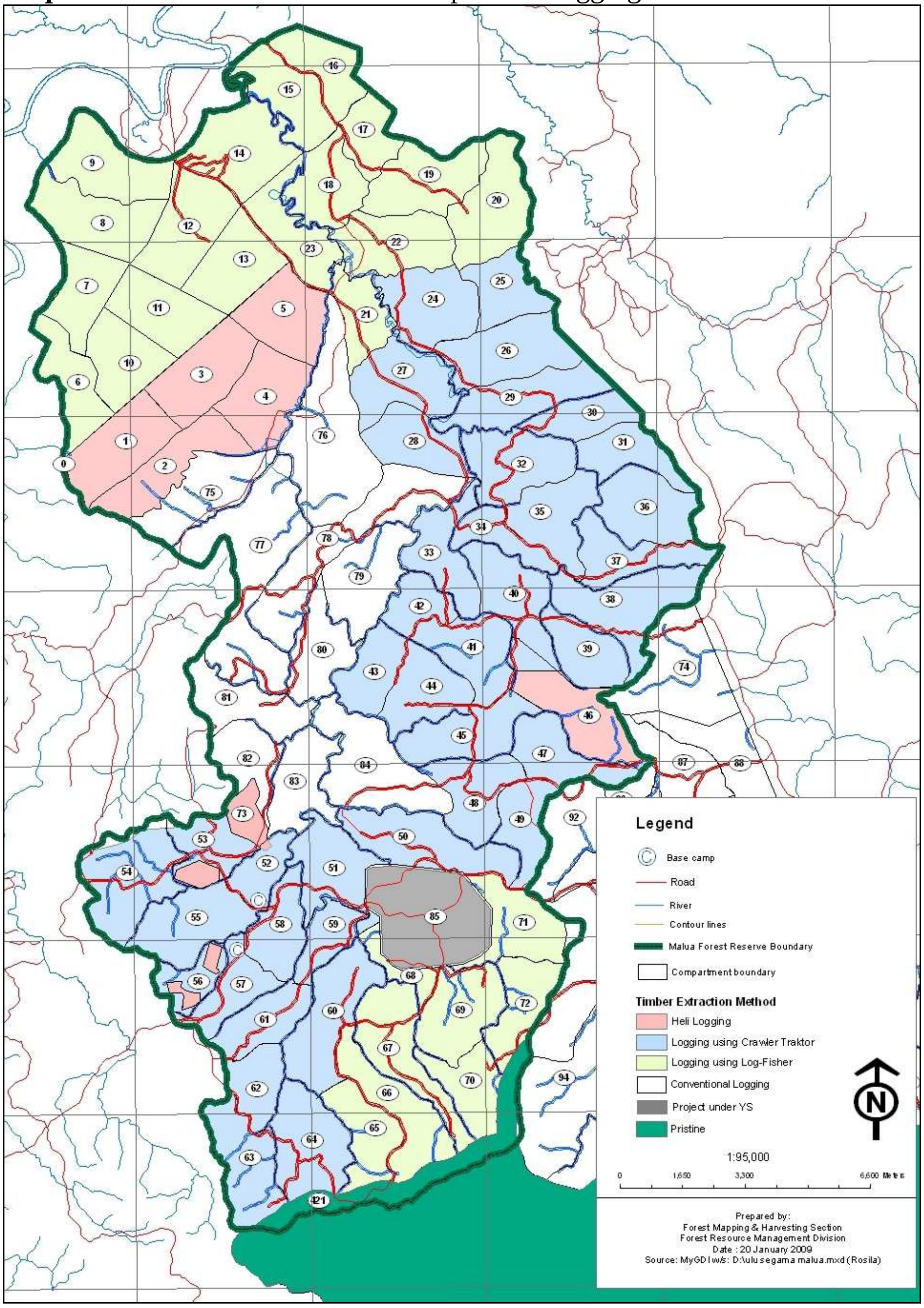
Stratum	$C_{AGB,i,t}$	$C_{BGB,i,t}$	$C_{AGB,i,t} + C_{BGB,i,t}$
Remnant / Pioneer forest	109.9	18.7	128.6
Pioneer dominated forest	65.4	11.1	76.5
Open Canopy forest	14.3	2.4	16.8
Weighted mean all strata	81.7	13.9	95.6

4.2.4 Net carbon stock change due to relogging in the baseline

The net carbon stock change due to relogging is determined based on the method 'using pre-relogging a-spatial data' from the methodology, combined with the use of a Reference Area, as described in methodology section 4.3.2. In this approach the level of forest degradation is determined through available information on relogging harvesting volumes, carbon losses from harvesting damage and the carbon stocks in deadwood and wood products. If this information is not available in e.g. management plans for the Project Area, the methodology allows for applying data from a Reference Area, provided that the selected Reference Area meets the similarity conditions provided in the methodology. No relevant data on planned harvesting volumes are available for the INFAPRO Project Area, because the project started already in 1992 and by then it was too early to plan for a second round of logging. Therefore the harvesting volumes have been obtained from a neighbouring Reference Area that is similar to the Project Area (see section 4.2.4.1 for the analysis on similarity).

The selected Reference Area is the Malua Forest Reserve, which is located at the North-western boundary of INFAPRO and is part of the Yayasan Sabah Concession Area. It consists of lowland dipterocarp forest and has a size of 33,969 hectares. It was first gazetted in 1961 and regazetted in 1984 when it received the status of a Commercial Forest Reserve (Class II). Malua has been logged since the 1960s and relogging took place in 2007 by three different contractors using Reduced Impact Logging techniques – see map 4.2.4.1.

Map 4.2.4.1 Malua Forest Reserve map with relogging extraction methods.



The net carbon stock change due to relogging is expressed in parameter $\Delta C_{REL,i,t}$ and is calculated based on equation (3) of the methodology:

$$\Delta C_{REL,i,t} = A_{REL,i,t} \times (C_{harvest,i} + (C_{damage,i} - C_{DW,i}) - C_{WP,i}) \times 44/12$$

Where:

Parameter	Description	Unit
$\Delta C_{REL,i,t}$	Net carbon stock change due to relogging in the baseline scenario in stratum *i* at year *t*	t CO_2-e yr^{-1}
$A_{REL,i,t}$	Area relogged in baseline stratum *i* at year *t*	ha yr^{-1}
$C_{harvest,i}$	Carbon stock in harvested timber in stratum *i*	t C ha^{-1}

$C_{damage,i}$	Carbon loss due to damage to the residual stand in stratum *i*	t C ha^{-1}
$C_{WP,i}$	Post-relogging carbon stock stored in wood products in the baseline scenario in stratum *i*	t C ha^{-1}
$C_{DW,i}$	Post-relogging carbon stock in dead wood in the baseline scenario in stratum *i*	t C ha^{-1}
i	1, 2, 3 … M_{BSL} strata in the baseline scenario	
44/12	The ratio of molecular weight of carbon dioxide to carbon	t CO_2-e t C^{-1}

The relogged area in the baseline ($A_{REL,i,t}$) is determined in section 4.2.4.2, $C_{harvest,i}$ is quantified in section 4.2.4.3 and $C_{WP,i}$ is calculated in section 4.2.4.4. Carbon losses due to harvesting damage ($C_{damage,i}$) is conservatively not accounted for in the calculation of the relogging carbon stock changes. Therefore the quantification of the carbon stocks in deadwood ($C_{DW,i}$) is also excluded. Carbon stock changes from relogging are not calculated for the stratum Open Canopy as it can reasonably be assumed that no relogging takes place in areas that contain very low timber stocks. The strata included are Pioneer dominated forest and Remnant/Pioneer forest. Relogging takes place in one year – see section 4.2.4.2. The value of $\Delta C_{REL,i,t}$ is given in table 4.2.4.1 below.

Table 4.2.4.1 Carbon stock change due to relogging in the baseline.

Stratum	$\Delta C_{REL,i,t}$	$A_{REL,i,t}$	$C_{harvest,i}$	$C_{WP,i}$
Pd	47,335	8,064	1.7	0.075
RP	113,853	7,641	4.3	0.191
All strata	161,188	15,705		

4.2.4.1 Similarity of Reference Area

The similarity of the Reference area to the Project Area is demonstrated by meeting the following conditions:

- Supporting comparable quantities of pre-relogging carbon stocks in above-ground woody biomass, or tree biomass with DBH ≥ 5 cm, and dead wood before relogging and comparable predicted yields of commercial timber (all ±20%); and
- Having been subjected to the same management regime for first-round logging, as evidenced in management and/or logging plans; and
- Having comparable legal rights and harvesting rights.

<u>Comparable quantities of pre-relogging carbon stocks</u>

The quantification of pre-relogging carbon stocks in above-ground tree biomass in the Reference Area is based on an inventory in Malua that took mainly place in 2007. The purpose of the inventory was to assess volume reduction as a result of relogging with RIL techniques. The same plots were measured before and after relogging. Per compartment 3 – 6 circular plots with a radius of 15 meters were established. All trees with DBH >= 10 cm were measured and DBH and species were recorded. In total the data of 295 plots are available, based on 56 compartments. The total number of trees included in the dataset is about 9,700.

The above-ground carbon stock per tree is calculated following the same approach as described in section 3.4.2.3 of the Project Document,with species specific volume equations and wood densities, with a BEF of 1.895 and a Carbon Fraction of 0.5. The carbon stocks are summarized per plot and per compartments. The Reference Area is stratified based on the carbon stock per compartment. The stratum with a similar carbon stock as the Pioneer dominated stratum in the Project Area has a size of 4,967 ha and an average above-ground tree carbon stock of 72.9 tC/ha. The above-ground tree carbon stock in the Project Area for this stratum is 65.4 tC/ha. The stratum with a similar carbon stock as the Remnant / Pioneer stratum in the Project Area has a size of 15,655 ha and an average above-ground tree carbon stock of 119.4 tC/ha. The above-ground tree carbon stock in the Project Area for this stratum is 109.9 tC/ha.

The Malua data do not include trees in the DBH class 5 – 10 cm. In order to assess the significance in terms of carbon from omitting this DBH class from the inventory, the above-ground tree carbon stocks per stratum are determined based on data from the inventory in the Project Area in 2007. Only data from plots in untreated parts of the Project Area are used, because it provides the best representation of the forest in the Reference Area. In the Pioneer dominated stratum the carbon stock in above-ground tree biomass in DBH class 5 – 10 cm is 4.8 tC/ha and for the Remnant / Pioneer stratum this is 4.7 tC/ha. The height of these carbon stocks does not affect the similarity of the strata identified in the Reference Area. The data and the calculations are provided in the spreadsheet 'Carbon in dbh class 5 – 10 cm'.

Deadwood is not quantified in the Reference Area, as this carbon pool is not accounted for.

Comparable predicted yields of commercial timber

Both the Project Area and the Reference Area consist of lowland dipterocarp forest, that has been conventionally logged in the same period, in a concession that belongs to the same operator. The two areas border each other and are under the same climatic conditions. The major part of tree species in both areas is similar. The Project Area and the Reference Area support a similar above-ground carbon stock in similar strata (see the text above on 'comparable quantities of relogging carbon stocks'). It is therefore concluded that the commercial timber stocks before relogging are comparable in both areas, and a comparable predicted yield does apply. See below for more details on similarity of both areas.

Management regime for the first logging round

Logging licenses were issues for Malua Forest Reserve (that includes the Reference Area) in the period 1963 – 1981 for the first round of logging. The biggest licensee in Malua is Yayasan Sabah that received its license in 1976. In Ulu Segama, logging licenses were issued in the period 1957 – 1982 and Yayasan as the biggest licensee received the concession in 1970. Both areas were conventionally harvested (SFD, 2008). Management of both areas during the first logging round by the operator was under the License Agreement for Timber 1970, which is an agreement between Yayasan Sabah and the Sabah State Government. No forest management plan was in place until in the 1980s, when the Yayasan Sabah Forest Management Plan 1984 – 2032 came into force. This management plan applied to both the Ulu Segama and Malua Forest Reserves.

Legal rights and harvesting rights

The Project Area and the Reference Area are both part of the Yayasan Sabah concession area and are both within a Class II Commercial Forest Reserve (SFMLA, 1997). The operator is allowed to harvest commercial trees in both areas.

Management of the Reference Area

The methodology also requires to demonstrate that the management of the Reference Area is not affected by its selection as such. This can be based on evidence that the planning of relogging occurred prior to the assignment as Reference Area by the IFM project proponent. Planning for relogging with RIL techniques in Malua took place in 2006 (pers. comm. DFO Ulu Segama - Malua), while the Project activity was still assessed under the SGS Carbon Offset Verification programme. During the assessment early 2008 by SGS, Malua was not selected as Reference Area – no Reference Area was selected at all. This is evident from the SGS verification report. In the minutes of the 9th Steering Committee meeting in 2008 it is described for the first time that Malua is being selected as a Reference Area.

4.2.4.2 Relogged areas in the baseline

The area where harvesting would take place in the Project Area ($A_{REL,i,t}$) is based on areas in INFAPRO that are both physically and contractually accessible for clearing/harvesting. Based on legal prescription and on logging practices in the Reference Area, it is assumed that a conservation area buffer, riparian reserves, perennial stream buffers and areas with steep slopes are excluded from logging. The table 4.2.4.2.1 gives an overview of the areas excluded from relogging. The area excluded for relogging is overestimated, since no correction is made for overlap of the excluded areas (e.g. steep slopes within the Danum Valley buffer). This results into a conservative estimate of project benefits.

Table 4.2.4.2.1 Areas excluded from relogging in the baseline.

Area	Size (ha)
Danum Valley buffer	1,450
Reserves within INFAPRO	646.4
Riparian reserves	625.4
Streams	55
Stream buffers	221.2
Steep slopes	2,750
Total area excluded	5,748
INFAPRO Project Area	25,000
Relogged area in the baseline ($A_{REL,i,t}$), including areas cleared for infrastructure	19,252

A detailed description of the excluded areas is given below.

Danum Valley buffer is a 1,450 ha 'no-harvest' buffer zone within the Project Area that lies along the border with the Danum Valley Conservation Area (DVCA). This buffer zone's area is calculated by multiplying the border length between the two areas (29 km, measured using GIS software) by a buffer width of 500 m which equals 14,500m^2 or 1,450 ha. This buffer has been applied for relogging in Malua Forest Reserve in 2007, at the border with DVCA. This is not a legal requirement but considered as good practice since it minimizes disturbance of logging operations in DVCA. It is doubtful whether a buffer with a similar width would apply to INFAPRO because the length of the boundary is much longer and it would result in considerable loss of the harvestable area. In contrast to the boundary between Malau and DVCA, a large part of the boundary between INFAPRO and DVCA is delineated by the Segama river, where a smaller buffer width of 60 m would be sufficient. It is however conservatively assumed that the 500 m wide buffer would be applied along the whole boundary, thereby reducing the harvestable area.

Reserves refers to the combined area of the two sections within the INFAPRO boundary that would not likely be eligible for harvesting. These are the Rafflesia area (428.5 ha) in the western part of the Project Area (in coupe 1992) and a ridged area located in the central part of the Project Area (217.9 ha). These areas were not harvested during the first logging round and it is safe to assume that, for conservation purposes and due to limited accessibility, these areas would not be logged during the second logging round. The total area is for these sections is 646.36 ha.

Riparian reserves refers to the 'no harvest' zones on both sides of perennial rivers in the Project Area. As required by the Environment Protection Department, these 'no harvest' zones consists of 30 m on either sides of rivers in INFAPRO (i.e. 30m x 2 =60m). Since the combined length of all perennial rivers in INFAPRO is 104,231.7 m (measured using GIS software), this figure can then be multiplied by the 60 m ‘no harvest’ zone width to calculate the total riparian reserve area of 6,253,899.3 m^2 or 625.4ha. This figure is an over-estimation and thus conservative since some of the perennial rivers border the Project Area and thus only half their ‘no-harvest’ zones fall inside the Project Area. The INFAPRO contract area of 25,000 ha excludes the areas of rivers themselves, therefore, the area of rivers need not be deducted. See spreadsheet ‘Streams and rivers’.

Streams refers to the total area of perennial streams within the INFAPRO project boundary. Since harvesting, and thus infrastructure, would not occur in streams, the total stream area must be subtracted from the total INFAPRO contract area. Using GIS software, it is determine that the total length of all streams in INFAPRO is 184,327 m. This length is then multiplied by an estimated average stream width of 3 meters to calculate a total stream area of 553,983 m^2 or 55 ha. See spreadsheet ‘Streams and rivers’.

Stream buffers refer to the buffer zones on either side of perennial streams that would not be harvested. For the perennial streams, the buffer zone consists of two times the width of the stream (3m) at each side of the stream. Therefore the estimated average buffer of 12m (3m x 2 x 2) is multiplied by the total length of all perennial streams in the project area (184,327m) to arrive at a total stream buffer area of 2,211,931m^2 or 221.2 ha. See spreadsheet ‘Streams and rivers’.

Slopes refers to the areas within INFAPRO that have a slope gradient of more than 25 degrees. To be conservative, all areas within INFAPRO with a gradient of more than 25 degrees are eliminated on the assumption that infrastructure would not occur in these areas. In INFAPRO, 11% of the area has a slope greater than 25 degrees (see spreadsheet‘Infapro slope area’. Therefore the slope area to be subtracted from INFAPRO area is 2,750 ha (i.e. 25,000 ha x 11%).

The net area for relogging is the harvestable area (19,252 ha) minus the area cleared for the establishment of infrastructure (2,310 ha), resulting into 16,942 ha (see section 4.2.5.1.1 on area calculations for establishment of infrastructure). The areas for relogging per stratum are calculated based on the relative share of the strata within the Project Area, which is given in section 4.2.2. The fraction for the Pioneer dominated foresttype is 47.6% and for the Remant / Pioneer forest type this is 45.1%. The $A_{REL,i,t}$ is therefore 8,064 ha and 7,641 ha respectively. Relogging takes place in one year.

4.2.4.3 Carbon stock in harvested timber

The carbon stock in harvested timber $C_{harvest,i}$ is calculated based on equation (4) from the methodology:

$$C_{harvest,i} = \sum_{j=1}^{s} (V_{harvest,i,j} \times D_j \times CF)$$

Where:

Parameter	Description	Unit
$C_{harvest,i}$	Carbon stocks in harvested timber in the baseline scenario in stratum *i*	t C ha^{-1}
$V_{harvest,i,j}$	Volume of timber harvested in the baseline scenario of species *j* in stratum *i*	m^3 ha^{-1} yr^{-1}

D_j	Basic density of the harvested wood of species *j*	t d.m. m^{-3}
CF	Carbon fraction of dry matter[1]	t d.m.$^{-1}$
i	1, 2, 3 … M_{BSL} strata in the baseline scenario	
j	1, 2, 3 … *S* tree species	

The $V_{harvest,j,i}$ is determined for the strata Pioneer dominated forest type and Remnant / Pioneer forest type in the Project Area, based on similar strata in the Reference Area. The total area of the Pioneer dominated stratum in the Reference area is 4,967 ha, and for the Remnant / Pioneer stratum this is 15,655 ha. The total volume of harvested timber in the Pioneer dominated stratum is 38,900 m^3, and for the Remnant / Pioneer stratum this is 311,228 m^3. The $V_{harvest,i}$ per stratum is obtained by dividing total volume of harvested timber by the total stratum area, which results into 7.8 m^3/ha in the Pioneer dominated stratum and 19.9 m^3/ha for the Remnant / Pioneer stratum. No species specific data were available for $V_{harvest,i}$.

The basic density for harvested wood D_j is based on the default wood density that is determined for the Project Area, which is 0.428. The carbon fraction *CF* is 0.5. The $C_{harvest,i}$ is therefore 1.7 tC/ha for the Pioneer dominated stratum and 4.3 tC/ha for the Remnant / Pioneer stratum. The weighted average of $V_{harvest}$ across both strata in the Project Area is 13.7 m^3/ha.

4.2.4.4 Carbon stock in wood products

The carbon stock in harvested wood products is quantified based on section 4.3.2 of the methodology VM0005.

Step 1: Estimate the biomass carbon of the volume extracted by wood product type *ty* at year *t* from within the project boundary. In line with the VCS guidelines on wood products, long-term storage in this pool is accounted for using the below equations.

The mean stock of extracted biomass carbon by class of wood product *ty* from stratum *i* at year *t* is estimated using equation (6) of the methodology:

$$C_{XB,ty,i,t} = \frac{1}{A_i} \times \sum_{j=1}^{S} \left(V_{ex,ty,j,i,t} \times D_j \times CF \right)$$

Table 4.2.4.4.1 $C_{XB,ty,i,t,}$

Wood product class ($_{ty}$)	$C_{XB,\ Pd,\ 2007}$ (tC/ha)	$C_{XB,\ RP,\ 2007}$ (tC/ha)
Sawn wood	0.54	1.38
Wood based Panels	0.97	2.45
Paper and paper board	0.18	0.46
Other industrial round wood	0.32	0.82

Where:

Parameter	Description	Unit
$C_{XB,ty,i,t}$	Mean stock of extracted biomass carbon by class of wood product *ty* from stratum *i* at year *t*	t C ha^{-1}
A_i	Total area of stratum *i*	ha
$V_{ex,ty,j,i,t}$	Volume of timber extracted from within stratum *i* (does not include slash left onsite) by species *j* and wood product class *ty* at year *t*	m^3

1 IPCC default value = 0.50

D_j	Mean wood density of species *j*	t d.m.m^{-3}
CF	Carbon fraction of biomass	t C t^{-1} d.m.
t	1, 2, 3, … t^* years elapsed since the project start	
j	1, 2, 3 … *S* tree species	
ty	Wood product class – defined here as sawnwood, wood-based panels, other industrial roundwood, paper and paper board, and other	

$A_{i:}$ There are two strata in INFAPRO where harvesting would occur: the Pioneer dominated forest type (Pd) and the Remnant / Pioneer (RP). The Pd area represents 47.6% of the total Project Area and the RP area represents 45.1% of the Project Area (see section 4.2.2 for Pd and RP area percentages). Since it is known that the Project Area has a total 'harvestable' area of 19,252 ha (see section 4.2.4.2) the percentage of the Pd area (47.6%) and RP area (45.1%) are multiplied by the 'harvestable' area in INFAPRO to calculate A_{Pd} and A_{RP}. Therefore, A_{Pd} is 9,153 ha and A_{RP} is 8,683 ha.

$V_{ex,ty,j,i,t}$:

$V_{ex:}$ The volume of timber extracted from A_{Pd} and A_{RP} is calculated by multiplying these areas by the average harvesting volume of strata Pd (7.8 m^3/ha) and RP (19.9 m^3/ha) – see section 4.2.4.3 on how these are calculated. Therefore the V_{ex} of stratum Pd is 71,686 m^3 and the V_{ex} of stratum RP is 172,618 m^3.

ty: Based on Sabah-wide statistics (Chapter 16 of the SFD Annual Report, 2007) the total extracted timber volume in is divided into 4 broad product classes: Sawn wood, Wood based panels, Paper and paper board and Other round wood. The table below shows total volume and percentages that each of the product class accounts for:

Table 4.2.4.4.2: Volume breakdown by wood product class

Wood product class (*ty*)	**Total volume of wood extracted in Sabah in 2007 by *ty* (m^3)**	**Percentage of total volume extracted in Sabah in 2007 by *ty* (%)**
Sawn wood	2,048,916	27
Wood based Panels	3,602,421	48
Paper and paper board	639,692	9
Other industrial round wood	1,266,571	16

j: Species-specific data does not exist for volumes of timber extracted in the Reference Area.

t: Since relogging took place during 1 year in the Reference Area (2007), therefore *t*=2007 only.

$V_{ex,ty,j,i,t}$: The volume extracted (V_{ex}) in stratum Pd (71,686 m^3) and RP (172,618 m^3) is multiplied by the percentage of extracted wood which corresponds to the 4 wood product classes (see right-most column in Table 4.2.4.4.2 above) to solve for $V_{ex,ty,j,i,t}$:

Table 4.2.4.4.3 $V_{ex,ty,j,i,t}$

Wood product class (*ty*)	**V_{ex} in Stratum (*i*) Pd in 2007 (m^3)**	**V_{ex} in Stratum (*i*) RP in 2007 (m^3)**
Sawn wood	19,355	46,607
Wood based Panels	34,409	82,857
Paper and paper board	6,452	15,536
Other industrial round wood	11,470	27,619

Dj: Since species-specific data does not exist for volumes of timber extracted in the Reference Area, the average weighted wood density to be applied for all is 0.428 (see section 4.2.4.3). As stated in the methodology, this weighted average will be increased by 20% to ensure a conservative (higher) estimate of $C_{WP,i,t}$ below. Therefore *Dj* is 0.514 (i.e. 0.428 x 1.2).

CF: The carbon fraction is 0.5 (IPCC default value).

$C_{XB,ty,i,t}$: Since $V_{ex,ty,j,i,t}$ has been calculated (see Table 4.2.4.4.3 above), these values can be multiplied by D_j (0.514) and then by *CF* (0.5) to calculate the total stock of extracted biomass carbon by class of wood product *ty* from stratum *i* at year *t*.

Table 4.2.4.4.4 Total stock of extracted biomass carbon by *ty*, from stratum *i* at year *t*.

Wood product class (*ty*)	***Total tC* extracted in Stratum Pd in 2007 (tC)**	***Total tC* extracted in Stratum RP in 2007 (tC)**
Sawn wood	4,974	11,978
Wood based Panels	8,843	21,294
Paper and paper board	1,658	3,993
Other industrial round wood	2,948	7,098

Since $C_{XB,ty,i,t,}$ is concerned with the *mean* stock of extracted biomass carbon by class of wood product *ty* from stratum *i* at year *t*, the values from the column titled '*Total tC* extracted in Stratum Pd in 2007' in the table above can be divided by A_{Pd} (9,153 ha) and, the values from the column titled '*Total tC* extracted in Stratum RP in 2007' in the table above can be divided by A_{RP} (8,683 ha). See Table 4.2.4.4.1 for the results of these calculations, and thus the $C_{XB,ty,i,t}$.

NOTE: In step 2 below, equation (7) from the original methodology is changed from

$$C_{WP,i,t} = \sum_{s,w,oir,p,o}^{ty} C_{XB,ty,i,t} \times (1 - WW_{ty}) \times (1 - SLF_{ty}) \times (1 - OF_{ty})$$

To

$$C_{WP,i,t} = \sum_{s,w,oir,p,o}^{ty} C_{XB,ty,i,t} \times (1 - ww_{ty}) \times (1 - slp_{ty}) \times (1 - fo_{ty})$$

In this way, equation (7) is made more clear and equation (8) and (9) (which represent calculations for parameters *SLF* and *OF*) are made redundant since the results of these equations are the same as the parameters *slp* and *of*. Therefore, eqations (8) and (9) are eliminated. Furthermore, the parementers *SLP* and *OF* are eliminated and replaced in equation (7) with *slp* and *fo*.

Step 2: Estimate the proportion of biomass carbon extracted at year *t* that remains sequestered in long-term wood products after 100 years. The carbon stock in wood products pool (stock remaining in wood products after 100 years) in stratum *i* at year *t* is estimated using equation (7) of the methodology:

$$C_{WP,i,t} = \sum_{s,w,oir,p,o}^{ty} C_{XB,ty,i,t} \times (1 - ww_{ty}) \times (1 - slp_{ty}) \times (1 - fo_{ty})$$

Table 4.2.4.4.5 $C_{WP,i,t}$

Wood product class (*ty*)	$C_{XB,Pd,2007}$ **x (1-*ww*) x (1-*slp*) x (1-*fo*) =** $C_{WP\ ty,Pd,2007}$ **(tC/ha)**	$C_{XB,RP,2007}$ **x (1-*ww*) x (1-*slp*) x (1-*fo*) =** $C_{WP\ RP,2007}$ **(tC/ha)**
Sawn wood	0.54 x (1-0.24) x (1-0.2) x (1-0.84) = 0.053	1.38 x (1-0.24) x (1-0.2) x (1-0.84) = 0.134
Wood based Panels	0.97 x (1-0.24) x (1-0.1) x (1-0.97) =0.020	2.45 x (1-0.24) x (1-0.1) x (1-0.97) = 0.050
Paper and paper board	0.18 x (1-0.24) x (1-0.3) x (1-0.99) = 0.001	0.46 x (1-0.24) x (1-0.3) x (1-0.99) =0.002
Other industrial round wood	0.32 x (1-0.24) x (1-0.4) x (1-0.99) = 0.001	0.82 x (1-0.24) x (1-0.4) x (1-0.99) = 0.004
$C_{WP,i,t}$	$C_{WP,Pd,2007}$	$C_{WP,RP,2007}$
	0.075 tC/ha	**0.191 tC/ha**

In other words: Out of the 2.04 tC/ha extracted in stratum Pd, 0.075 tC/ha will remain in wood products after 100 years (i.e 26%). Out of the 4.58 tC/ha extracted in stratum RP, 0.191 tC/ha will remain in wood products after 100 years (i.e. 27%).

Where:

Parameter	Description	Unit
$C_{WP,i,t}$	Carbon stock in wood products pool (stock remaining in wood products after 100 years) in stratum *i* at year *t*	t C ha^{-1}
$C_{XB,ty,i,t}$	Mean stock of extracted biomass carbon by class of wood product *ty* from stratum *i* at year *t*	t C ha^{-1}
ww_{ty}	Wood waste. The fraction immediately emitted through mill inefficiency	
slp_{ty}	Short-lived proportion - 0.2 for sawnwood, 0.1 for woodbase panels, 0.3 for other industrial roundwood, 0.4 for paper and paperboard and 1 for other	t C t C^{-1}
fo_{ty}	Fraction oxidized - default values	t C t C^{-1}
ty	Wood product class – defined here as sawnwood, wood-based panels, other industrial roundwood, paper and paper board, and other	
i	*1, 2, 3, …* M_{BSL} strata in the baseline scenario	
T	1, 2, 3, … t^* years elapsed since the project start	

$C_{XB,ty,i,t}$: The mean stock of extracted biomass carbon by class of wood product *ty* from stratum *i* at year *t* can be found in Table 4.2.4.4.1.

ww: The methodology gives a default wood waste fraction (*ww*) of 0.24 for developing countries:

Wood product class (*ty*)	***ww***
Sawn wood	0.24
Wood based Panels	0.24
Paper and paper board	0.24
Other industrial round wood	0.24

slp: The methodology provides the following short lived proportion (*slp)* by wood product types (ty):

Wood product class (*ty*)	***slp***
Sawn wood	0.2
Wood based Panels	0.1
Paper and paper board	0.3
Other industrial round wood	0.4

fo: The methodology gives annual oxidation fractions (fo) for each class of wood products split by forest region. This methodology uses the fractions for tropical wood products, projected over 95 years to give the additional proportion that is oxidized between the 5^{th} and 100^{th} years after initial harvest:

Wood Product Class (*ty*)	***fo***
Sawnwood	0.84
Woodbase panels	0.97
Other industrial roundwood	0.99
Paper and paperboard	0.99

4.2.5 GHG emissions from relogging

This section is concerned with calculating the Baseline Activity Emissions – specifically, the emissions from relogging. Therefore, the emissions associated with activities in the baseline are, based on equation (23) of the methodology, estimated as:

$$GHG_{BSL\text{-}E,t} = E_{clearing,t} + E_{harvesting,t} + E_{extraction,t} + E_{transport,t}$$
$$GHG_{BSL\text{-}E,t} = 710{,}607.38 + 861.58 + 0 + 3{,}110.5$$
$$GHG_{BSL\text{-}E,t} = 714{,}579.46 \text{ t } CO_2\text{-e}$$

Where:

Parameter	**Description**	**Unit**
$GHG_{BSL\text{-}E,t}$	Baseline emissions from sources in the baseline scenario at year *t*	t CO_2-e yr^{-1}
$E_{clearing,t}$	Emissions due to the new establishment of infrastructure such as the construction of roads or log landings for baseline logging at year *t*	t CO_2-e yr^{-1}
$E_{harvesting,t}$	Emissions due to the harvesting operations such as felling and debranching, etc. at year *t*	t CO_2-e yr^{-1}

$E_{extraction,t}$	Extraction of logs from the tree stump to the log landing at year *t*	t CO_2-e yr^{-1}
$E_{transport,t}$	Emissions due to transport of the logs from the log landing to the whaRP for export, the sawmill, or to the depot for onward sale at year *t*	t CO_2-e yr^{-1}
t	1, 2, 3, … t^* years elapsed since the project start	

4.2.5.1 $E_{clearing,t}$: Emissions due to clearing of the area for infrastructure establishment

Emissions due to the establishment of infrastructure such as the construction of roads and log landings are estimated by considering the emissions due to the removal of biomass, the emissions from the equipment used to remove the biomass and the emissions from the equipment used to grade the roads (fuel emissions). The parameter $E_{clearing,t}$ is calculated based on equation (24) of the methodology:

$E_{clearing,t} = E_{biomass,t} + E_{felling,t} + E_{grading,t}$
$E_{clearing,t} = 691{,}998.9 + 1{,}727.8 + 16{,}881.48$
$E_{clearing,t} = 710{,}607.38\ CO_2\text{-e}$

Where:

Parameter	Description	Unit
$E_{clearing,t}$	Emissions due to the establishment of infrastructure at year *t*	t CO_2-e yr^{-1}
$E_{biomass,t}$	Emissions due to the removal of the biomass itself at year *t*	t CO_2-e yr^{-1}
$E_{felling,t}$	Emissions due to the equipment use for felling the biomass (fuel emissions) at year *t*	t CO_2-e yr^{-1}
$E_{grading,t}$	Emissions due to the equipment used for the grading of the roads (fuel emissions) at year *t*	t CO_2-e yr^{-1}

Note that the harvesting activities in the Reference Area (including infrastructure development) occurred in 1 year (2007). Therefore all equations are only applicable to 1 year (*t*=1).

4.2.5.1.1. $E_{biomass,t}$: Emissions due to the removal of the biomass itself

$E_{biomass,t}$ is calculated based on equation (25) from the methodology:

$E_{biomass,t} = C_{biomass} \times A_{infrastructure,t} \times (44/12)$
$E_{biomass,t} = 81.7 \times 2{,}310 \times (44/12)$
$E_{biomass,t} = 691{,}998.9\ tCO_2\text{-e}$

Where :

Parameter	Description	Unit
$E_{biomass,t}$	Emissions due to the removal of the biomass on the area dedicated to infrastructure at year *t*	t CO_2-e yr^{-1}
$C_{biomass}$	Carbon in biomass lost due to the clearing for infrastructure	t C ha^{-1}
$A_{infrastructure,t}$	Area designated for infrastructure at year *t*	ha yr^{-1}
44/12	The ratio of molecular weight of carbon dioxide to carbon	t CO_2-e t C^{-1}

$C_{biomass}$ equals the area-weighted C_{BSLpre} value of 81.7 tC/ha. The C_{BSLpre} is based on the inventory of carbon stocks in 2007 in untreated parts of the Project Area, which represents the best value of carbon stocks at the moment when relogging would take place – see section 4.2.3 for the calculation of the weighted average of these carbon stocks.

$A_{infrastructure,t}$ equals an area of 2,310 ha. This figure is calculated by multiplying to the total 'harvestable' area within INFAPRO boundary of 19,252 ha with a conservative percent of area cleared for infrastructure of 12%, as provided in the methodology. See section 4.2.4.2 for 'harvestable' area calculations.

4.2.5.1.2 $E_{felling,t}$: emissions due to the use of equipment for biomass removal

Emissions due to the use of equipment for the removal of biomass are quantified based on equation (26) of the methodology:

$E_{felling,t}$ = $FC_{equip} \times EF_{fuel} \times V_{infrastructure,t}$
$E_{felling,t}$ = 0.00128 x 2.9 × 456,465
$E_{felling,t}$ = 1,727.8 t CO_2-e

Where:

Parameter	Description	Unit
$E_{felling,t}$	Emissions due to the use of equipment for removal of the biomass on the area dedicated to infrastructure at year *t*	t CO_2-e yr^{-1}
FC_{equip}	Fuel consumption of equipment employed for felling	kL m^{-3}
EF_{fuel}	Fuel emission factor	t CO_2-e kL^{-1}
$V_{infrastructure,t}$	Volume of trees felled to clear the area designated for infrastructure at year *t*	m^3 yr^{-1}

FC_{equip} : Two default fuel consumption values for FC_{equip} are provided by the methodology: 1.28 litre per m^3 felled for new and efficient machinery and 1.73 liter per m^3 felled for older, less efficient machinery. To be conservative, the 1.28 liter per m^3 value will be chosen. For this equation, this value must be converted to kL m^3 to adhere to the appropriate unit parameters set out in the table above: 1.28 L m^3 = 0.00128 kL m3.

EF_{fuel} :Default parameter values for EF_{fuel} are provided in the methodology (p39): 2.9 tCO_2 – e kL^{-1}.

$V_{infrastructure,}$: $V_{infrastructure}$ is calculated beginning with the average weighted tree volume in the Project Area before relogging, which can be calculated from the project's $C_{BSL,pre}$ of 81.7 tC/ha. With an average wood density of 0.428, an average Biomass Expansion Factor (BEF) of 1.895 and a carbon fraction of 0.5, the volume corresponding to the project's $C_{BSL,pre}$ is 201.5 m^3/ha. This figure is then multiplied by $A_{infrastructure,t}$ (2,310 ha) to arrive at a $V_{infrastructure}$.value of 465,465 m^3.

4.2.5.1.3. $E_{grading,t}$: emissions due to the use of equipment for road grading

Emissions due to the use of equipment for grading roads are quantified based on equation (27) of the methodology:

$E_{grading,t}$ = $FC_{grader} \times EF_{fuel} \times A_{infrastructure,t}$
$E_{grading,t}$ = 2.52 × 2.9 × 2,310
$E_{grading,t}$ = 16,881.48 t CO_2-e

Where:

Parameter	Description	Unit
$E_{grading,t}$	Emissions due to road grading at year *t*	t CO_2-e yr^{-1}
FC_{grader}	Fuel consumption of equipment employed for road grading	kL ha^{-1}
EF_{fuel}	Fuel emission factor	t CO_2-e kL^{-1}
$A_{infrastructure,t}$	Area designated for infrastructure at year *t*	ha yr^{-1}

FC_{grader}: Since no default factor is given for the fuel consumption of equipment employed for grading, this value is drawn from literature. On average, 588 gallons of diesel are consumed for every mile of road graded (Balcom, 1998, as cited in Loeffler et al., 2009). The 588 gallons/mile value assumes that forest roads have an average width of 18 feet and are graded on slopes less than 50% (Balcom, 1998). This factor can be applied for estimating fuel consumption for forest grading in the INFAPRO since 1) all roads in the Project Area have less than 50% grade and 2) the average width for roads in the Project Area is approximately 18 feet. In order to calculate FC_{grader}, the 588 gallons/mile value must first be converted a kL/ha value to adhere to the unit parameters in the table above. The following describes how this conversion is undertaken:

> Step 1: 1 mile of road is converted into a hectare value by converting the road area measurements made in miles/feet to km values. The length of 1 mile of road is equal to 1.609 km. The average road width of 18 feet is equal to 0.005486 km. Therefore, 1 mile of road is equal to 0.0088269km^2 or 0.88269 ha. Therefore, 588 gallons of diesel fuel is used to grade 0,88269 ha of road.
>
> Step 2: 588 gallons must be converted into a kL value. Since 1 US gallon = 0.00378541178 kilolitres, 588 gallons therefore equals to 2.2258 kLs. Therefore, 2.2258 kLs of diesel are used to grade 0.88269ha of road.
>
> Step 3: The 0.88269 ha value can therefore be multiplied by 1.1329 to arrive at a value of 1 ha. The kL value of 2.2258 kL must also be multiplied by 1.1329 to arrive at the FC_{grader} value of 2.52 kL/ha.

$EF_{fuel:}$ Default parameter values for EF_{fuel} are provided in the methodology (p39): 2.9 tCO_2 –e kL^{-1}.

$A_{infrastructure,t}$: $A_{infrastructure,t}$ equals an area of 2,310 ha.

4.2.5.2. $E_{harvesting,t}$: emissions due to the extraction of logs from the forest

Using equation (28) emissions due to the extraction of logs from forest are estimated as:

$$E_{harvesting,t} = FC_{equip} \times EF_{fuel} \times V_{harvested,t}$$
$$E_{harvesting,t} = 0.00128 \times 2.9 \times 232{,}105.4$$
$$E_{harvesting,t} = 861.58 \text{ t CO2-e}$$

Where:

Parameter	Description	Unit
$E_{harvesting,t}$	Emissions due to harvesting at year *t*	t CO2-e yr-1
FC_{equip}	Fuel consumption of the equipment employed for	kL m-3

	harvesting	
EF_{fuel}	Fuel emission factor	t CO2-e kL-1
$V_{harvested,t}$	Volume harvested at year *t*	m-3 yr-1

FC_{equip} :Two default fuel consumption values for FC_{equip} are provided by the methodology: 1,28litre per m^3 felled for new and efficient machinery and 1.73 L per m^3 felled for older, less efficient machinery. To be conservative, the 1.28 L per m^3 value will be chosen. For this equation, this value must be converted into kL m^3 : 1.28 L m^3 = 0.00128 kL m^3.

EF_{fuel}: Default parameter values for EF_{fuel} are provided in the methodology (p39): 2,9 tCO_2 –e kL^{-1}.

$V_{harvested,t}$: For this parameter, the quantification of the volume harvested was selected based on harvesting in the Reference Area. During the 2007 relogging activities in the Reference Area, an average weighted volume of 13.7 m^3/ha was harvested (see section 4.2.4.2). This average weighted harvesting volume is then multiplied by the ‘harvestable’ area in INFAPRO excluding $A_{infrastructure,t}$, since emissions associated with felling for infrastructure have already been accounted for in solving for $E_{felling,t}$. The ‘harvestable’ area excluding $A_{infrastructure,t}$ is 16,942 ha (19,252 ha – 2,310 ha). Therefore, $V_{harvested,t}$ is 232,105.4 m^3 (16,942 ha x 13.7 m^3/ha).

4.2.5.3. $E_{extraction,t}$: emissions due to the extraction of the timber

Parameter $E_{extraction,t}$: is conservatively omitted from the calculation of baseline activity emissions.

4.2.5.4. $E_{transport,t}$: emissions due to the transport of the logs from the log landing onwards

Equation (32) is used to estimate emissions due to the transport of the timber from the log landings to point of onward sale/transport:

$E_{transport,t} = (D_{trans\_total} / Eff_{fuel}) \times EF_{fuel}$
$E_{transport,t} = (3,217,779.3 / 3,000) \times 2.9$
$E_{transport,t} = 3,110.5$ t CO_2-e

Estimations of total transport distance is achieved using equation (33):

$D_{trans\_total} = D_{aver\ trans} \times N_{trucks} \times 2$
$D_{trans\_total} = 61 \text{ km} \times 26,375.24 \times 2$
$D_{trans\_total} = 3,217,779.3$ km

Estimation of total truck used are achieved by equation (34) of the methodology:

$N_{trucks} = V_{trans} / Cap_{truck}$
$N_{trucks} = 263,752.4 / 10$
$N_{trucks} = 26,375.24$

Where:

Parameter	Description	Unit
$E_{transport,t}$	Emissions due to the transport of the timber from the log landings to point of onward sale/transport at year *t*	t CO_2-e yr^{-1}
D_{trans_total}	Total timber transport distance	km

Eff_{fuel}	Fuel efficiency for medium-sized bulldozers/trucks/trailer	km kL^{-1}
EF_{fuel}	Fuel emission factor	t CO_2-e kL^{-1}
$D_{aver\ trans}$	Average transport distance of logs log landing to point of onward sale/transport	km
N_{trucks}	Number of trucks	
V_{trans}	Volume of timber transported	m^{-3}
Cap_{truck}	Capacity of the truck	m^3 $truck^{-1}$

D_{trans_total} :The total transport distance equation (34) of the methodology. This is calculated by multiplying the $D_{aver\ trans}$ value of 61 km by the N_{trucks} value of 29,070.5 and by 2. This equals 3,546,601 km.

Eff_{fuel} : The methodology provides a Eff_{fuel} default value of 3,000 km kL^{-1}.

EF_{fuel} : The methodology provides a EF_{fuel} default value of 2.9 t CO_2-e kL^{-1}.

$D_{aver\ trans}$: The average distance from INFAPRO Project Area to Silam, where the timber processing mill is located, is 61 km.

N_{trucks} : equation (34) of the methodology is given to calculate $N_{truck.s}$. The number of trucks (or truck loads) used is 27,599.78.

V_{trans} is calculated by taking the average wighted harvested volume in the Reference Area (13.7 m^3/ha) and multiplying it by the total 'harvestable' area in INFAPRO (19,252 ha) to arrive at a V_{trans} value of 263,752.4 m^3. It is assumed that the volume of timber from commercial species felled during the clearing for infrastructure is also transported from the Project Area to the mill at Silam.

Cap_{truck}: A default value for Cap_{truck} of 10 m^3 $truck^{-1}$ is provided by the methodology (p39).

4.2.6 Net carbon stock change in existing tree vegetation in the baseline scenario

Regrowth of the existing tree vegetation does take place in the baseline scenario. After being logged in the 1980s, the forest still suffers from the disturbance caused by harvesting. Damaged trees fall over even years after logging took place, causing damage to other trees. The forest regrowth is suppressed by vines and climbers. The regrowth that does take place is offset by mortality. When the mortality is reduced to normal levels after one or two decades, there is net growth in the logged-over untreated forests. This growth can even be similar to growth in the with-project scenario, for a couple of years. Growth in the with-project scenario is determined by two factors: enrichment planting and climber cutting. Climber cutting has mainly a positive effect on growth in the first years directly after cutting (Ong, 2005). The effect of enrichment planting on growth is on the longer term. The majority of the trees grow in the shade, and their growth does still not have a big impact on biomass levels in the forest during the first 20 years. After this start-up period the effect of the planted trees becomes very significant. Growth in the baseline can therefore be similar to growth in the with-project scenario during the period where the effect of climber cutting has stopped and the effect of enrichment planting is not significant yet.

Regrowth in the baseline is determined following section 4.3.5 of the methodology. Regrowth is conservatively estimated as the regrowth of the pre-relogged residual forest applied to the entire area of the stratum, despite any relogging in the stratum. It is measured in plots established in the untreated areas (i.e. not treated with silvicultural techniques) within the

Project Area. Equation (21) of the methodology is applied to quantify the carbon stock changes due to regrowth in the baseline:

$$\Delta C_{tree-exist,i,t} = A_{i,t} \times \sum_{j=1}^{S} \Delta C_{tree-exist,j,i,t}$$

Where:

Parameter	Description	Unit
$\Delta C_{tree\text{-}exist,i,t}$	Change in carbon stock in existing tree vegetation in the baseline in stratum *i* at year *t*	t CO_2-e yr^{-1}
$A_{i,t}$	Area of baseline stratum *i* at year *t*	ha
$\Delta C_{tree\text{-}exist,j,i,t}$	Change in carbon stock in existing tree vegetation in the baseline in species *j* in stratum *i* at year *t*	t CO_2-e ha^{-1} yr^{-1}
j	1, 2, 3 … *S* tree species	
i	1, 2, 3 … M_{BSL} strata in the baseline scenario	
t	1, 2, 3, … t^* years elapsed since the project start	

Both above-ground and below-ground carbon stocks are included in the calculation of $\Delta C_{tree\text{-}exist,j,i,t}$, as in equation (22) from the methodology:

$$\Delta C_{tree-exist,j,i,t} = \Delta C_{tree-exist-AB,j,i,t} + \Delta C_{tree-exist-BB,j,i,t}$$

Where $\Delta C_{tree\text{-}exist\text{-}AB,j,i,t}$ represents changes in the above-ground carbon stock and $\Delta C_{tree\text{-}exist\text{-}BB,j,i,t}$ represents changes in the below-ground carbon stock. See sections 4.3.1.1 and 4.3.1.2 for how above-ground and below-ground carbon stock changes are calculated, using the BEF method. The table 4.2.6.1 shows the results of the ex-ante calculation for regrowth in the baseline. It is based on measurements in inventory plots in untreated parts of the Project Area.

The *ex-ante* estimation of the growth of vegetation in the baseline is partly based on monitoring that has already been implemented in the Project Area. It is also based on research and modelling of forest growth by others. The area ($A_{i,t}$) on which baseline regrowth takes place, is equal to the cumulative area that has been treated up to that year.

Ex-ante estimation of regrowth of existing tree vegetation in the baseline is based on Mean Annual Increment figures (MAI), which are converted to carbon stocks using the BEF method from the methodology. Modeling of regrowth for the period 2007 – 2010 is based on inventories in untreated parts of the Project Area (i.e. *t*=1 to *t*=4). The estimation for the remaining Crediting Period is based on literature, combined with available data from the Project Area.

Paoli and Curran (2007) report an average woody biomass increment of 12 Mg/ha/yr for mature Dipterocarp forest in Southwestern Kalimantan. Lincoln (2008) reports a mortality of about 10 Mg/ha/yr for a period of 3 to 12 years after conventional logging of dipterocarp forest in Sabah, in plots adjacent to the Project Area. It is assumed that in the Project Area, where logging took place on average 22 years before the project start date, the mortality rates have decreased, as the effect of logging damage fades away. The monitoring results for 2007 and 2010 in untreated parts of the Project Area suggest that growth strongly exceeds mortality. The net baseline growth of biomass for the Project Area is estimated as 7 Mg/ha/yr, which is calculated by the woody biomass increment from Paoli and Curran (2007) of 12 Mg/ha/yr, minus half the biomass mortality reported by Lincoln (i.e. 5 Mg/ha/yr). The biomass increment is converted to volume increment (MAI) based on the BEF (1.895) and the average wood density (0.428), which results into a MAI of 8.6 m^3/ha/yr. This MAI is further calibrated based on monitoring results of inventories in 2007 and 2010 in untreated parts of the Project Area and varies per forest type stratum. For the Open Canopy forest type the MAI of 6 m^3/ha/yr for the period 2007-2010 is lower than 8.6 m^3/ha/yr. Therefore the average rounded value of 7.3 m^3/ha/yr is applied. For the Pioneer dominated forest type the MAI in 2007 – 2010 is 13.5 m^3/ha/yr – averaging this value with 8.6 m^3/ha/yr results into 11 m^3/ha/yr. For the Remnant/Pioneer forest type the MAI in 2007 – 2010 is 11 m^3/ha/yr – averaging this value with 8.6 m^3/ha/yr results into 9.8 m^3/ha/yr.These MAI figures are applicable to the period 2010 – 2015.

Pinard and Cropper (2000) simulated the recovery of conventionally logged dipterocarp forest. After 30 years post-logging the major part of the colonizing pioneers species (mainly *Macaranga* spp.) start dying. As logging in the Project Area took place in the 1980s, which is on average around 1985, the pioneer mortality effect is assumed to become apparent around 2015. Therefore the MAI in the ex-ante estimations is reduced with 50%. After 5 more years, in 2020, the pioneer mortality effect is assumed to have ended and the MAI will increase with 50%. Since 2035, on average 50 years after logging, no net growth of the existing tree vegetation is expected, based on modeling results by Pinard and Cropper (2000). An overview of the volume increment figures (MAI) used for the ex-ante estimations of baseline regrowth is presented in table 4.2.6.2. The calculations are provided in the spreadsheet ‘Ex-ante calculation baseline regrowth’.

Table 4.2.6.1 Change in carbon stock in existing tree vegetation in the baseline per stratum.

Project Year (t)	$\Delta C_{tree\text{-}exist,i,t}$			
	All forest types	**Open Canopy forest type**	**Pioneer dominated forest type**	**Remnant Forest type**
1	0	0	0	0
2	517.277	17.409	288.119	211.749
3	517.277	17.409	288.119	211.749
4	517.277	17.409	288.119	211.749
5	444.593	21.181	234.763	188.649
6	444.593	21.181	234.763	188.649
7	444.593	21.181	234.763	188.649
8	444.593	21.181	234.763	188.649
9	222.297	10.590	117.382	94.325
10	222.297	10.590	117.382	94.325
11	222.297	10.590	117.382	94.325
12	222.297	10.590	117.382	94.325
13	222.297	10.590	117.382	94.325
14	333.445	15.885	176.073	141.487
15	333.445	15.885	176.073	141.487
16	333.445	15.885	176.073	141.487
17	333.445	15.885	176.073	141.487
18	333.445	15.885	176.073	141.487
19	333.445	15.885	176.073	141.487
20	333.445	15.885	176.073	141.487
21	333.445	15.885	176.073	141.487
22	333.445	15.885	176.073	141.487
23	333.445	15.885	176.073	141.487
24	333.445	15.885	176.073	141.487
25	333.445	15.885	176.073	141.487
26	277.871	13.238	146.727	117.906

27	222.297	10.590	117.382	94.325
28	166.722	7.943	88.036	70.743
29	111.148	5.295	58.691	47.162
30	55.574	2.648	29.345	23.581
Total	**9.276.638**	**420.239**	**4.943.369**	**3.913.030**

Table 4.2.6.2 Mean Annual Increment figures (MAI) for modelling baseline regrowth.

Project Year (t)	**MAI (m^3/ha/yr)**		
	Open Canopy forest type	**Pioneer dominated forest type**	**Remnant Forest type**
1	0,0	0,0	0,0
2	6,0	13,5	11,0
3	6,0	13,5	11,0
4	6,0	13,5	11,0
5	7,3	11,0	9,8
6	7,3	11,0	9,8
7	7,3	11,0	9,8
8	7,3	11,0	9,8
9	3,7	5,5	4,9
10	3,7	5,5	4,9
11	3,7	5,5	4,9
12	3,7	5,5	4,9
13	3,7	5,5	4,9
14	5,5	8,3	7,4
15	5,5	8,3	7,4
16	5,5	8,3	7,4
17	5,5	8,3	7,4
18	5,5	8,3	7,4
19	5,5	8,3	7,4
20	5,5	8,3	7,4
21	5,5	8,3	7,4
22	5,5	8,3	7,4
23	5,5	8,3	7,4
24	5,5	8,3	7,4
25	5,5	8,3	7,4
26	4,6	6,9	6,1
27	3,7	5,5	4,9
28	2,7	4,1	3,7
29	1,8	2,8	2,5
30	0,9	1,4	1,2

4.3 Quantifying GHG emissions and/or removals for the project:

The net CO_2 equivalent emissions in the with-project scenario is expressed in parameter ΔC_{WPS} and is determined following equation (35) from the methodology:

$$\Delta C_{WPS} = \sum_{t=1}^{t*} \sum_{i=1}^{M_{WPS}} \Delta C_{P,i,t} + GHG_{WPS-E,t}$$

Where:

Parameter	Description	Unit
ΔC_{WPS}	Net CO_2 equivalent emissions in the with-project scenario up to year *t**	t CO_2-e yr^{-1}
$\Delta C_{P,i,t}$	Net carbon stock change due to forest regrowth and silvicultural interventions in the with-project scenario in stratum *i* at year *t*	t CO_2-e yr^{-1}
$GHG_{WPS\text{-}E,t}$	Greenhouse gas emissions related to project implementation at year *t*	t CO_2-e yr^{-1}

The calculation of the net carbon stock changes ($\Delta C_{P,i,t}$) is provided in section 4.3.1 and the calculation of the project emissions ($GHG_{WPS\text{-}E,t}$) is provided in section 4.3.2. The values of the net carbon stock changes and the emissions due to project implementation for the ex-ante calculation are given in the tables 4.3.1.1 and 4.3.2.1.

Based on the sum of the $\Delta C_{P,i,t}$ and the $GHG_{WPS\text{-}E,t}$ for all strata and all project years (see tables 4.3.1.1 and 4.3.2.1), the ΔC_{WPS} is 12,623,919 – 18,151 = 12,605,768 tCO_2-e.

4.3.1 Net with-project carbon stock changes

The net carbon stock change due to forest regrowth and silvicultural interventions in the with-project scenario is calculated based on equation (36) from the methodology:

$$\Delta C_{P,i,t} = \Delta C_{AGB,i,t} + \Delta C_{BGB,i,t} + \Delta C_{DW,i,t} + \Delta C_{WP,i,t} - E_{biomassloss,i,t}$$

Where:

Parameter	Description	Unit
$\Delta C_{P,i,t}$	Net carbon stock change due to forest regrowth and silvicultural interventions in the with-project scenario in stratum *i* at year *t*	t CO_2-e yr^{-1}
$\Delta C_{AGB,i,t}$	Net carbon stock change in above-ground tree biomass in the with-project scenario in stratum *i* at year *t*	t CO_2-e yr^{-1}
$\Delta C_{BGB,i,t}$	Net carbon stock change in below-ground tree biomass in the with-project scenario in stratum *i* at year *t*	t CO_2-e yr^{-1}
$\Delta C_{DW,i,t}$	Net carbon stock change in dead wood in the with-project scenario in stratum *i* at year *t*	t CO_2-e yr^{-1}
$\Delta C_{WP,i,t}$	Net carbon stock change in wood products in the with-project scenario in stratum *i* at year *t*	t CO_2-e yr^{-1}
$E_{biomassloss,i,t}$	Emissions due to site preparation for project activities in stratum *i* at year *t*	t CO_2-e yr^{-1}
t	1, 2, 3 … *t** years elapsed since the start of the project activity	
i	1, 2, 3 … M_{WPS} strata in the with-project scenario	

The net carbon stock changes in above-ground and below-ground tree biomass are quantified in sections 4.3.1.1 and 4.3.1.2, and the emissions due to site preparation is in section 4.3.1.3. The carbon stock in dead wood and wood products in the project scenario is conservatively accounted as zero.

The table 4.3.1.1 presents the values for the net carbon stock changes ($\Delta C_{P,i,t}$) per stratum and per project year, which is based on the carbon stock changes in above-ground and below-ground tree biomass and based on the emissions due to site preparation that are all included in the same table.

Table 4.3.1.1 Net carbon stock change in the with-project scenario, summarized over all rehabilitation periods and all three forest types.

Project Year (t)	$\Delta C_{P,i,t}$	$\Delta C_{AGB,i,t}$	$\Delta C_{BGB,i,t}$
1	-	-	-
2	529.657	452.698	76.959
3	529.619	452.665	76.953
4	532.173	454.849	77.324
5	483.678	413.400	70.278
6	481.862	411.848	70.014
7	487.346	416.535	70.811
8	493.524	421.816	71.709
9	318.035	271.825	46.210
10	333.883	285.370	48.513
11	346.782	296.395	50.387
12	361.379	308.871	52.508
13	373.049	318.846	54.204
14	444.769	380.145	64.625
15	445.214	380.524	64.689
16	446.901	381.967	64.934
17	447.787	382.724	65.063
18	451.167	385.613	65.554
19	456.570	390.231	66.339
20	456.312	390.010	66.302
21	456.200	389.915	66.286
22	454.998	388.887	66.111
23	453.252	387.395	65.857
24	450.165	384.757	65.409
25	446.837	381.912	64.925
26	419.349	358.418	60.931
27	403.590	344.948	58.641
28	388.320	331.897	56.423
29	373.606	319.321	54.285
30	357.895	305.893	52.002
Total	**12.623.919**	**10.789.675**	**1.834.245**

4.3.1.1 Net carbon stock change in above-ground tree biomass

The ex-ante calculation for the with-project scenario is based on the growth of the existing forest matrix (i.e. existing tree vegetation, as in section 4.2.6) following climber cutting and on the growth of the planted and/or tended seedlings. The Biomass Expansions Factor (BEF) method as described in the methodology in section 5.2.2 is selected to quantify the net carbon stock changes in above-ground biomass for the existing forest matrix. The growth of planted seedlings is based on the Allometric Equations method. The results of the ex-ante calculations are presented in the table 4.3.1.1. The spreadsheet ‘Ex-ante calculation with-project scenario’ contains the calculations for estimating the net carbon stock changes in the with-project scenario.

<u>Net carbon stock changes of the existing tree vegetation</u>
Ex-ante estimations of regrowth of the existing tree vegetation is based on Mean Annual Increment (MAI) figures, which are converted to carbon stocks using the BEF method from the methodology. This is described in more detail in section 4.2.6. It is assumed that the MAI figures for the existing tree vegetation in the with-project scenario are similar to those in the baseline scenario, except for the first 10 years after the first round of climber cutting. The

effect of climber cutting on the growth of the forest is expected to last not much longer than 10 years (Ong, 2005). After this 10 years the treated forest is healthier than similar untreated forests, but it is conservatively assumed that it does not have a significant effect on growth rates. See section 4.2.6 for the MAI values that are applicable to the baseline scenario and to the existing tree vegetation in the with-project scenario, 10 years after climber cutting. An exception is made for the Open Canopy forest type, because this the most degraded forest type and the differences in growth rates between the treated and untreated area is relatively large. An evaluation of growth rates for the Open Canopy forest type between 2007 and 2010 in the Project Area, show that the MAI for untreated parts is 6 m^3/ha/yr and for treated parts is 10.5 m^3/ha/yr. The MAI for the first 10 years for all forest types is based on growth figures derived from monitoring data of treated and untreated parts in the Project Area in 2007, which is calculated in spreadsheet 'Growth rates in forest matrix in the with-project scenario'.

Net carbon stock changes of the planted and/or tended seedlings
Ex-ante estimations of carbon stock changes of the planted and/or tended seedlings, is based on DBH increment data, that is partly from literature and partly from inventory data in the Project Area. An average DBH increment of 1.0 cm/yr is applied based on Ong (2005). For the first 5 years after planting a DBH increment of 0.5 cm/yr is applied, because initial growth rates are expected to be smaller for seedlings. An allometric equation from Basuki et al. (2009) and the carbon faction (0.5) is applied to convert the DBH to tree carbon stock. The equation from Basuki is developed for lowland dipterocarp forest for the species grouping 'mixed species', and is derived from a sample of trees ranging from 6 cm to 200 cm DBH. The equation is:

$$\ln(TAGB) = -1.201 + 2.196 \times \ln(DBH)$$

Where TAGB represent total above-ground biomass in kg and DBH is the diameter at breast height in cm. The equation is applied to trees with a DBH >= 5cm. After calculating the carbon stock per tree, this value is multiplied with the total number of planted and/or tended trees per hectare, which represents the $C_{AGB,i,t}$ for the planted seedlings . The initial number of seedlings is 225, which is calculated from the 4 meter interval of planting spots and the distance of 10 meter between planting lines, minus an initial loss of 10%. The 4 meter interval between the planting spots is an average of the 3 meter interval that was initially applied in the Project Area and the 5 meter interval that was introduced later on. An initial mortality rate of 5% is applied for the first 5 years, and for the period up to 30 years a mortality rate of 2% is applied. After 30 years it assumed that the trees are mature and well established and a mortality rate of 1% is applied. The 5% mortality rate is based on census results on survival from areas rehabilitated in 2003 and 2004 in the project area and the 2% mortality rate is based on Hassan et al. (1990).

Combined net carbon stock changes of existing tree vegetation and planted seedlings
The $C_{AGB,i,t}$ for the planted and/or tended seedling and for the existing tree vegetation is summed and multiplied with the rehabilitated area per year and the conversion factor for carbon to CO_2 (i.e. 44/12) in order to arrive at the $\Delta C_{AGB,i,t}$ for each calendar year.

4.3.1.2 Net carbon stock change in below-ground tree biomass

The net carbon stock change in below-ground tree biomass is based on the above-ground tree biomass multiplied with the root:shoot ratio, as in equation (42) of the methodology:

$$\Delta C_{BGB,i,t} = \Delta C_{AGB,i,t} \times R_j$$

Where:

Parameter	Description	Unit
$\Delta C_{BGB,i,t}$	Net carbon stock change in below-ground tree biomass in the with-project scenario in stratum *i* at year *t*	t CO_2 yr^{-1}
$\Delta C_{AGB,i,t}$	Net carbon stock change in above-ground tree biomass in the with-project scenario in stratum *i* at year *t*	t CO_2 yr^{-1}
R_j	Root:shoot ratio for tree species *j*	t root d.m. t^{-1} shoot d.m.
t	1, 2, 3 … *t** years elapsed since the start of the project activity	
i	1, 2, 3 … M_{WPS} strata in the with-project scenario	

The root:shoot ratio selected for INFAPRO is 1.17, based on Pinard (1996). See also section 3.3 in the parameter table for R_j.

4.3.1.3 Emissions due to site preparation for project activities

Site preparation for enrichment planting at INFAPRO initially involved 100 % climber and vine cutting, slashing of a 2 meter wide line and pioneer girdling along the planting strip. Since the introduction of reduced impact site preparation (RISP) in 1995, slashing is reduced to a 1 meter wide line, pioneer girdling abandoned and enrichment planting is only conducted where natural regeneration is lacking. Plot measurements have been carried out in 2000 (Yap, 2000) in order to quantify the biomass loss from the girdling of pioneer trees for the period 1992 – 1995. Since 2004, pioneer girdling is not practiced anymore based on recommendations from an external auditor (Kuper, 2004). All losses of tree biomass due to site preparation occurred well before the start of Crediting Period. Besides, these biomass losses are accounted for in the first monitoring event in 2007: the inventory of the carbon stocks in the Project Area in that time do not claim or include the biomass that is lost as a result of site preparation. Therefore, emissions due to site preparation, as reflected in the parameter $E_{biomassloss,i,t}$, is not accounted for.

Following the methodology, the removal of herbaceous vegetation is deemed an insignificant emission source and is therefore not accounted for in the with-project scenario.

4.3.2 GHG emissions related to project implementation

The emissions related to project implementation ($GHG_{WPS-E,t}$) involve the following sources:

1. Combustion of fuel for transport and electricity generation;
2. International and domestic flights of project staff, advisors and auditors;
3. Clearing of forest for the establishment of project infrastructure;
4. Felling of trees for road maintenance and associated GHG emissions for the use of machinery.

Following the text in the methodology in section 5.6, the quantification of the emissions is, for as far as applicable, based on the equations provided in the methodology section 4.3.7 on baseline activity emissions.

The table 4.3.2.1 below summarizes the GHG emissions related to project implementation.

Table 4.3.2.1 GHG emissions related to project implementation.

Project year *t*	Trans./Electr.	Flights	$E_{clearing,t}$	$E_{clearing-roads,t}$	$GHG_{WPS-E,t}$
	tCO_2-e/yr	tCO_2/yr	tCO_2-e/yr	tCO_2-e/yr	tCO_2-e/yr
1	364	10	-	230	604
2	433	10	-	230	673
3	364	10	-	230	604

4	390	10	-	230	630
5	357	10	2,0	233	602
6	357	10	2,0	233	602
7	357	10	2,0	233	602
8	357	10	2,0	233	602
9	357	10	2,0	233	602
10	357	10	2,0	233	602
11	357	10	2,0	233	602
12	357	10	2,0	233	602
13	357	10	2,0	233	602
14	357	10	2,0	233	602
15	357	10	2,0	233	602
16	357	10	2,0	233	602
17	357	10	2,0	233	602
18	357	10	2,0	233	602
19	357	10	2,0	233	602
20	357	10	2,0	233	602
21	357	10	2,0	233	602
22	357	10	2,0	233	602
23	357	10	2,0	233	602
24	357	10	2,0	233	602
25	357	10	2,0	233	602
26	357	10	2,0	233	602
27	357	10	2,0	233	602
28	357	10	2,0	233	602
29	357	10	2,0	233	602
30	357	10	2,0	233	602
Total					**18.151**

1. Combustion of fuel for transport and electricity generation

The annual fuel consumption for transport and electricity generation is multiplied by the emission factor for fuel (EF_{fuel}), which is 2.9 tCO_2-e/kL (value provided by the methodology). The quantification of emissions is partly based on actual fuel consumption since the start of the project activity and an ex-ante estimations of future emissions. Records for the period 1992 – 1995 are not available and the respective emissions are based on the average emissions over the period 1996 – 2000 (i.e. 26 kL/yr). The future emissions, starting from 2011, are calculated as the average emissions over 2006-2010 (i.e. 123 kL/yr).

2. Flight emissions

The emissions from flights related to project implementation are calculated with the help of the online International Civil Aviation Organization (ICAO) Carbon Emissions Calculator. This calculator is based on fuel data from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

3. Emissions from clearing of forest

Emissions from clearing of forest for the establishment of project infrastructure (excluding roads) is calculated with equation (24) from the methodology:

$$E_{clearing,t} = E_{biomass,t} + E_{felling,t} + E_{grading,t}$$

Where:

Parameter	Description	Unit
$E_{clearing,t}$	Emissions due to the establishment of infrastructure at year *t*	t CO_2-e yr^{-1}
$E_{biomass,t}$	Emissions due to the removal of the biomass itself at year *t*	t CO_2-e yr^{-1}
$E_{felling,t}$	Emissions due to the equipment use for felling the biomass (fuel emissions) at year *t*	t CO_2-e yr^{-1}
$E_{grading,t}$	Emissions due to the equipment used for the grading of the roads (fuel emissions) at year *t*	t CO_2-e yr^{-1}

In the initial years, before the start of the Project Activity, an area has been cleared for the construction of amongst others the nursery, offices, stores and housing. It is expected that in the future two small subcamps will be created in remote areas that are still to be rehabilitated. The emissions associated with the construction of these subcamps (1,000 m2 each) are evenly distributed over the remaining Crediting Period. The parameter $E_{grading,t}$ is not taken into account – the emissions associated with road construction is separately calculated. The emissions due to the removal of biomass is calculated with equation (25) from the methodology:

$$E_{biomass,t} = C_{biomass} \times A_{infrastructure,t} \times (44/12)$$

Where:

Parameter	Description	Unit
$E_{biomass,t}$	Emissions due to the removal of the biomass on the area dedicated to infrastructure at year *t*	t CO_2-e yr^{-1}
$C_{biomass}$	Carbon in biomass lost due to the clearing for infrastructure	t C ha^{-1}
$A_{infrastructure,t}$	Area designated for infrastructure at year *t*	ha yr^{-1}
44/12	The ratio of molecular weight of carbon dioxide to carbon	t CO_2-e t C^{-1}

The $C_{biomass}$ is equal to the area weighted $C_{BSL,pre}$, which is 81.7 tC/ha (see sections 4.2.3 and 4.2.5.1.1.). The $A_{infrastructure,t}$ is 0.007 ha/yr that will be cleared within the Project Area. The $E_{biomass,t}$ is then 2.0 tCO_2-e/yr.

The $E_{felling}$ is determined through equation (26) of the methodology:

$$E_{felling,t} = FC_{equip} \times EF_{fuel} \times V_{infrastructure,t}$$

Where:

Parameter	Description	Unit
$E_{felling,t}$	Emissions due to the use of equipment for removal of the biomass on the area dedicated to infrastructure at year *t*	t CO_2-e yr^{-1}
FC_{equip}	Fuel consumption of equipment employed for felling	kL m^{-3}
EF_{fuel}	Fuel emission factor	t CO_2-e kL^{-1}
$V_{infrastructure,t}$	Volume of trees felled to clear the area designated for infrastructure at year *t*	m^3 yr^{-1}

The $V_{infrastructure,t}$ is 1.24 m^3, which is based on the inventory data used for the calculation of $C_{BSL,pre}$ (i.e. 201.5 m^3/ha), multiplied by the $A_{infrastructure,t}$ (i.e. 0.007 ha/yr) The EF_{fuel} is 2.9

tCO_2-e/kL (value provided in the methodology). The FC_{equip} is 0.00128 kL m^{-3}. Therefore, the $E_{felling}$ is 0.005 tCO_2-e/yr.

The emissions due to clearing areas for the establishment for infrastructure in INFAPRO ($E_{clearing}$) is 2.0 tCO_2-e/yr.

4. Emissions from road construction and maintenance

All roads used for project implementation in INFAPRO were already present before the start of the project activity. INFAPRO makes use of the road network that was established during the logging operations in the 1980s. However, the roads require regular maintenance, mainly due to erosion caused by heavy rains. The machinery used for maintenance cause GHG emissions. There are also emissions from tree felling at parts of roads that remain very wet after rains: trees along the road are felled to allow the sun to reach and dry the road surface. The annual length of roads to be maintained is conservatively estimated at 12,000 meter, with a width of 6 meter. Less than 5% of the roads require roadside felling up to 5 meter at each side of the road. Therefore, annually 7.2 ha of road surface is maintained ($A_{infrastructure,t}$) and maximally 0.6 ha of annual roadside felling is carried out.

The emissions associated with roads is calculated with the equations for $E_{clearing}$, $E_{felling}$ and $E_{biomass}$ as provided in the text above on emission from the establishment of infrastructure. The parameter $E_{grading}$ is used to quantify the emissions for road maintenance (grading the road) and is calculated with equation (27) from the methodology:

$$E_{grading,t} = FC_{grader} \times EF_{fuel} \times A_{infrastructure,t}$$

Where:

Parameter	Description	Unit
$E_{grading,t}$	Emissions due to road grading at year *t*	t CO_2-e yr^{-1}
FC_{grader}	Fuel consumption of equipment employed for road grading	kL ha^{-1}
EF_{fuel}	Fuel emission factor	t CO_2-e kL^{-1}
$A_{infrastructure,t}$	Area designated for infrastructure at year *t*	ha yr^{-1}

The fuel consumption for grading (FC_{grader}) is 2.52 kL/ha (see section 4.2.5.1.3). The fuel emission factor (EF_{fuel}) is 2.9 tCO_2-e/kL. The $A_{infrastructure,t}$ is 7.2 ha. Road maintenance depends on where project activities are being carried out. $E_{grading,t}$ is calculated as 52.6 tCO2-e/yr.

The area that is annually cleared is 0.6 ha. The $C_{biomass}$ is equal to the area weighted $C_{BSL,pre}$, which is 81.7 tC/ha. This results into a value of $E_{biomass,t}$ of 179.7 tCO2-e/yr.

The $V_{infrastructure,t}$ is 201.5 m3/ha/yr, which is based on the inventory data used for the calculation of $C_{BSL,pre}$. The EF_{fuel} is 2.9 tCO_2-e/kL (value provided in the methodology). The FC_{equip} is 0.00128 kL/m. Therefore, the $E_{felling}$ is 0.45 tCO2-e/yr.

Following equation (24), $E_{clearing,t}$ for road construction and maintenance is the sum of $E_{biomass,t}$, $E_{felling,t}$ and $E_{grading,t}$, which is 232.8 tCO2-e/yr.

4.3.3 Leakage

A full calculation of market leakage is provided in the INFAPRO Leakage Assessment Report. A summary form the report is provided in this section.

The methodology gives two options for determining the project's leakage. Option 1 is selected to determine this project's leakage.

Option 1: The VCS Tool for AFOLU Methodological Issues provides adjustments to account for potential leakage resulting from reduced timber production. This methodology applies to Project Activities, which reduce harvest levels in comparison with the baseline and possible Reference Areas. Therefore, the following leakage credit adjustment can be applied.

Project Action	**Leakage Risk**	**Leakage credit adjustment (discount)**
Substantially reduce harvest levels permanently (e.g., RIL activity that reduces timber harvest by 25% or more across the Project Area; or, a forest protection/no logging project)	Moderate to High Depends on where timber harvest is likely to be shifted	Depends on where timber harvest is likely to be shifted to: • Similar carbon dense forests within the country: 40% • Less carbon dense forests within the country: 20% • More carbon dense forests within country: 70% • Out of country: 0% (according

Equation (46) of the methodology shows how the market leakage is calculated:

$\Delta C_{LK\text{-}ME} = LF_{ME} \times \Delta C_{REL}$
$\Delta C_{LK\text{-}ME} = 0.4 \times 161{,}188$
$\Delta C_{LK\text{-}ME} = 64{,}475$ tCO_2-e

Where:

Parameter	**Description**	**Unit**
$\Delta C_{LK\text{-}ME}$	Total GHG emissions due to market-effects leakage	t CO_2-e
LF_{ME}	Leakage factor for market-effects calculations	
ΔC_{REL}	Emissions from relogging displaced through implementation of the project activities across strata	t CO_2-e

$\Delta C_{REL:}$ this parameter is determined in section 4.2.4 of the Project Document.

LF_{ME} : LF_{ME}, the leakage factor, depends upon where in the country logging might be increased, as a result of a decrease in timber supply from the Project Area.

According to the parameters for identifying the appropriate LF_{ME} set out in the methodology:

$LF_{ME} = 0.4$ since $C_{BSLpre} \geq NCS \times 0.85$
$LF_{ME} = 0.4$ since 81.7 tC/ha $\geq$ 93.9 tC/ha $\times$ 0.85
$LF_{ME} = 0.4$ since 81.7 tC/ha $\geq$ 79.8 tC/ha

Where:

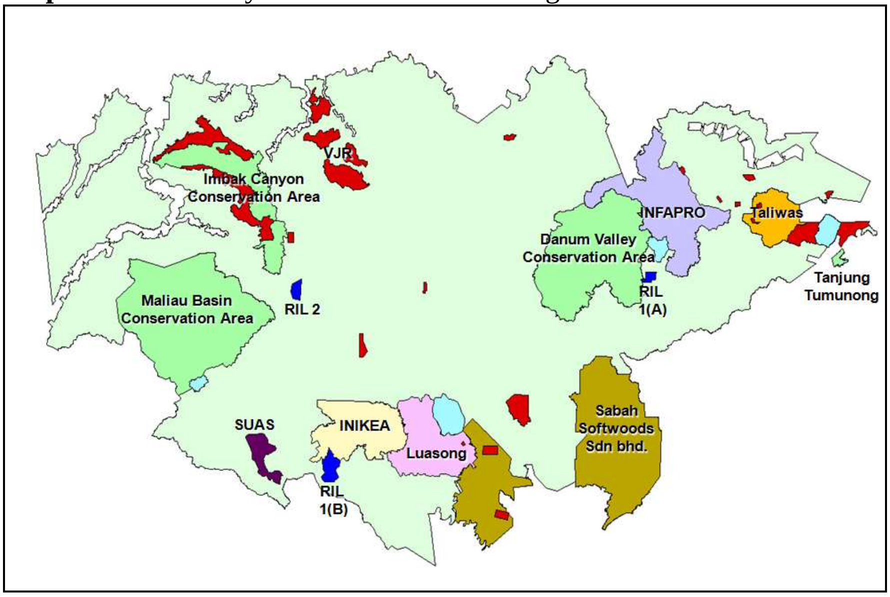
Parameter	**Description**	**Unit**
LF_{ME}	Leakage factor for market-effects calculations	
NCS	The mean national forest carbon stock	t C ha^{-1}
C_{BSLpre}	Pre-relogging mean carbon stock in above-ground tree biomass across strata in the baseline scenario	t C ha^{-1}

NCS : Malaysia's NCS is 93.9 tC ha. Details on how the NCS is calculated is provided in the Leakage Assessment Report.

C_{BSLpre} : The value of C_{BSLpre} is 81.7 tC/ha. The C_{BSLpre} is based on the inventory of carbon stocks in 2007 in untreated parts of the Project Area, which represents the best value of carbon stocks at the moment that relogging would take place – see section 4.2.3 for the calculation of the weighted average of these carbon stocks.

Apart from market leakage, the Project Activity does not result in activity shifting within the project proponent's operations. The map 4.3.3.1 below shows Yayasan Sabah's concession area, including areas where special projects are carried out and areas that have a conservation status. The conservation areas within the concession, like Danum Valley Conservation Area, Maliau Basin Conservation Area and Imbak Canyon Conservation Area consist of unlogged primary forest that will not be logged in the future. The fact that INFAPRO prevented a second round of logging in the Project Area, did not lead to a shifting of logging activities to these areas. The management of areas for special projects, like INIKEA and Taliwas, are not affected by the prevention of relogging in INFAPRO: no relogging took place in these area or the area is not suitable for relogging. In general, all the other areas that are classified as Commercial Forest Reserves have been relogged or are going to be relogged on the short term, and this would have taken place in the absence of INFAPRO as well. The concession area, with the exception of the Conservation Areas and special project areas, has been subject to logging mainly since the 1960s. The timber stocks have declined over time and there is not much timber available – bearing in mind that this is natural forest, where minimum diameter cuts apply. The timber revenues are a main source of income for the concession holder, so all available timber within the permitted diameter classes that can be economically extracted, is harvested. Relogging in INFAPRO would not have changed that.

Map 4.3.3.1 The Yayasan Sabah Forest Management Area.



4.4 Quantifying GHG emission reductions and removal enhancements for the GHG project:

4.4.1 Total net GHG emission reductions

The total net benefits that result from the project activity is calculated with equation (48) from the methodology:

$$\Delta C_{IFM} = \Delta C_{BSL} - \Delta C_{WPS} - \Delta C_{LK}$$

Where:

Parameter	Description	Unit
ΔC_{IFM}	Total net GHG emission reductions from the IFM project activity up to year *t*	t CO_2-e
ΔC_{BSL}	Sum of the carbon stock changes and greenhouse gas emissions under the baseline scenario up to year *t*	t CO_2-e
ΔC_{WPS}	Sum of the carbon stock changes and greenhouse gas emissions under the with-project scenario up to year *t*	t CO_2-e
ΔC_{LK}	Sum of the carbon stock changes and greenhouse gas emissions due to leakage up to year *t*	t CO_2-e

The ΔC_{BSL} is calculated in section 4.2, the ΔC_{WPS} is in section 4.3 and the ΔC_{LK} is in section 4.3.3 of this project document. Table 4.4.2 shows the values of all the parameters, including the total net GHG emission reductions for the IFM project (ΔC_{IFM}) - this table is table 3 from the methodology.

Table 4.4.1 Total net GHG emission reductions for the IFM project.

Project Year	ΔC_{IFM}		Project Year	ΔC_{IFM}	
	Annual	Cumulative		Annual	Cumulative
	tCO_2-e	tCO_2-e		tCO_2-e	tCO_2-e
2007	810,689	810,689	2022	112,854	1,967,406
2008	11,707	822,395	2023	113,740	2,081,146
2009	11,738	834,133	2024	117,120	2,198,266
2010	14,266	848,399	2025	122,523	2,320,789
2011	38,483	886,882	2026	122,265	2,443,054
2012	36,667	923,549	2027	122,153	2,565,207
2013	42,151	965,700	2028	120,951	2,686,158
2014	48,329	1,014,029	2029	119,205	2,805,363
2015	95,136	1,109,166	2030	116,118	2,921,481
2016	110,984	1,220,149	2031	112,790	3,034,272
2017	123,883	1,344,033	2032	140,876	3,175,148
2018	138,480	1,482,513	2033	180,691	3,355,838
2019	150,150	1,632,663	2034	220,996	3,576,834
2020	110,722	1,743,385	2035	261,856	3,838,690
2021	111,167	1,854,552	2036	301,719	4,140,409

Table 4.4.2 Calculation of total net GHG emission reductions for the IFM project including the parameters ΔC_{BSL}, ΔC_{WPS} and ΔC_{LK}.

Project year		ΔC_{BSL}				ΔC_{WPS}				ΔC_{LK}				ΔC_{IFM}			
	Calendar year	Carbon stock changes		GHG emissions		Carbon stock changes		GHG emissions		Carbon stock changes		GHG emissions		Carbon stocks		GHG emissions	
		annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative
Nr	yr	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
1	2007	-161,188	-161,188	-714,580	-714,580	-	-	-604	-604	64,475	64,475	-	-	96,713	96,713	713,976	713,976
2	2008	517,277	356,089	-	-714,580	529,657	529,657	-673	-1,277	-	64,475	-	-	12,380	109,093	-673	713,303
3	2009	517,277	873,366	-	-714,580	529,619	1,059,275	-604	-1,881	-	64,475	-	-	12,342	121,434	-604	712,699
4	2010	517,277	1,390,643	-	-714,580	532,173	1,591,449	-630	-2,511	-	64,475	-	-	14,896	136,331	-630	712,069
5	2011	444,593	1,835,236	-	-714,580	483,678	2,075,127	-602	-3,113	-	64,475	-	-	39,085	175,416	-602	711,467
6	2012	444,593	2,279,829	-	-714,580	481,862	2,556,989	-602	-3,715	-	64,475	-	-	37,269	212,685	-602	710,865
7	2013	444,593	2,724,422	-	-714,580	487,346	3,044,335	-602	-4,317	-	64,475	-	-	42,753	255,438	-602	710,263
8	2014	444,593	3,169,015	-	-714,580	493,524	3,537,859	-602	-4,919	-	64,475	-	-	48,931	304,369	-602	709,661
9	2015	222,297	3,391,312	-	-714,580	318,035	3,855,894	-602	-5,521	-	64,475	-	-	95,738	400,107	-602	709,059
10	2016	222,297	3,613,609	-	-714,580	333,883	4,189,777	-602	-6,123	-	64,475	-	-	111,586	511,693	-602	708,457
11	2017	222,297	3,835,906	-	-714,580	346,782	4,536,559	-602	-6,725	-	64,475	-	-	124,485	636,178	-602	707,855
12	2018	222,297	4,058,203	-	-714,580	361,379	4,897,938	-602	-7,327	-	64,475	-	-	139,082	775,260	-602	707,253
13	2019	222,297	4,280,500	-	-714,580	373,049	5,270,987	-602	-7,929	-	64,475	-	-	150,752	926,012	-602	706,651
14	2020	333,445	4,613,945	-	-714,580	444,769	5,715,757	-602	-8,531	-	64,475	-	-	111,324	1,037,337	-602	706,049
15	2021	333,445	4,947,390	-	-714,580	445,214	6,160,970	-602	-9,133	-	64,475	-	-	111,769	1,149,105	-602	705,447
16	2022	333,445	5,280,835	-	-714,580	446,901	6,607,872	-602	-9,735	-	64,475	-	-	113,456	1,262,562	-602	704,845
17	2023	333,445	5,614,280	-	-714,580	447,787	7,055,659	-602	-10,337	-	64,475	-	-	114,342	1,376,904	-602	704,243
18	2024	333,445	5,947,725	-	-714,580	451,167	7,506,826	-602	-10,939	-	64,475	-	-	117,722	1,494,626	-602	703,641
19	2025	333,445	6,281,170	-	-714,580	456,570	7,963,395	-602	-11,541	-	64,475	-	-	123,125	1,617,750	-602	703,039
20	2026	333,445	6,614,615	-	-714,580	456,312	8,419,707	-602	-12,143	-	64,475	-	-	122,867	1,740,617	-602	702,437

21	2027	333,445	6,948,060	-	-714,580	456,200	8,875,908	-602	-12,745	-	64,475	-	-	122,755	1,863,373	-602	701,835
22	2028	333,445	7,281,505	-	-714,580	454,998	9,330,905	-602	-13,347	-	64,475	-	-	121,553	1,984,925	-602	701,233
23	2029	333,445	7,614,950	-	-714,580	453,252	9,784,157	-602	-13,949	-	64,475	-	-	119,807	2,104,732	-602	700,631
24	2030	333,445	7,948,395	-	-714,580	450,165	10,234,323	-602	-14,551	-	64,475	-	-	116,720	2,221,453	-602	700,029
25	2031	333,445	8,281,840	-	-714,580	446,837	10,681,160	-602	-15,153	-	64,475	-	-	113,392	2,334,845	-602	699,427
26	2032	277,871	8,559,711	-	-714,580	419,349	11,100,509	-602	-15,755	-	64,475	-	-	141,478	2,476,323	-602	698,825
27	2033	222,297	8,782,008	-	-714,580	403,590	11,504,099	-602	-16,357	-	64,475	-	-	181,293	2,657,616	-602	698,223
28	2034	166,722	8,948,730	-	-714,580	388,320	11,892,418	-602	-16,959	-	64,475	-	-	221,598	2,879,213	-602	697,621
29	2035	111,148	9,059,878	-	-714,580	373,606	12,266,024	-602	-17,561	-	64,475	-	-	262,458	3,141,671	-602	697,019
30	2036	55,574	9,115,452	-	-714,580	357,895	12,623,919	-602	-18,163	-	64,475	-	-	302,321	3,443,992	-602	696,417

4.4.2 Uncertainty assessment

The net GHG emissions reductions (ΔC_{IFM}) are corrected for uncertainty based on equation (49) of the methodology:

$$C_{IFM\_ERROR} = \sqrt{Uncertainty_{BSL}^{\ 2} + Uncertainty_{WPS}^{\ 2}}$$

Where:

Parameter	Description	Unit
C_{IFM_ERROR}	Total uncertainty for IFM project activity	%
$Uncertainty_{BSL}$	Total uncertainty in baseline scenario	%
$Uncertainty_{WPS}$	Sum of the carbon stock changes and greenhouse gas emissions under the with-project scenario up to year *t*	%

The procedure for calculating the uncertainty is provided in the VT0003 Tool for the Estimation of Uncertainty in IFM Project Activities. The calculation of the GHG emission reductions in INFAPRO is based on an approach to reduce uncertainties or to make conservative estimations.

The relevant baseline parameters from the methodology that have been applied in this project document are in the table below. The table indicates whether uncertainty has been calculated or a conservative estimate was made. The list contains all parameters that are considered relevant in the tool VT0003.

Table 4.4.2.1 Uncertainty assessment of baseline parameters.

Parameter	Description of addressing uncertainty
$C_{harvest,i}$	No uncertainty calculated: the parameter is not based on samples but on full data of harvesting volumes in the Reference Area
$C_{damage,i}$	Not included in GHG accounting
$C_{DW,i}$	Not included in GHG accounting
$C_{WP,i}$	Not possible to quantify uncertainty; conservative estimate has been applied
$C_{BSLpre,i}$	This parameter is calculated in order to show similarity between Project Area and Reference Area. It is not used to quantify avoided emissions from relogging. The height of the value does not influence the amount GHG benefits from the project and uncertainty is therefore not calculated.
$C_{BSLpost,i}$	The a-spatial approach to quantify avoided emissions from relogging is selected from the methodology – therefore, this parameter has not been applied
$C_{DWpre,i}$	Not included in GHG accounting
$C_{tree\text{-}exist,i,t}$	Uncertainty is calculated based on the carbon stocks in sample plots that are used to quantify this parameter
$GHG_{BSL\text{-}E,t}$	Not possible to quantify uncertainty; conservative estimate has been applied

The uncertainty in the baseline per stratum and across strata is based on the carbon stocks in the existing vegetation in the baseline ($C_{tree\text{-}exist,i,t}$). As only one parameter is involved, equation (1) of the tool VT0003, which calculates the combined uncertainty in carbon stocks and greenhouse gas sources, does not need to be applied. The uncertainty across combined strata is calculated with the revised equation (2) from the tool VT0003:

$$Uncertainty_{BSL} = \frac{(U_{BSL,1} \times E_{BSL,1}) + (U_{BSL,2} \times E_{BSL,2})... + ...(U_{BSL,M_{BSL}} \times E_{BSL,M_{BSL}})}{E_{BSL,1} + E_{BSL,2} ... + ...E_{M_{BSL}}}$$

Where:

Parameter	Description	Unit
$Uncertainty_{BSL}$	Total uncertainty in baseline scenario;	%
$U_{BSL,i}$	Uncertainty in baseline scenario in stratum *i*;	%
$E_{BSL,i}$	Sum of combined carbon stocks and GHG sources (e.g. trees, down dead wood, etc.) in stratum *i* (1,2…n represent different carbon pools and/or GHG sources) multiplied by the area of stratum *i* (A_i) in the baseline case;	t CO2-e
i	1, 2, 3 …M_{BSL} strata in the baseline scenario	

The baseline uncertainty is based on the parameter $C_{tree\text{-}exist,i,t}$ for all three strata (i.e. the three forest types in INFAPRO). The changes in carbon stock in the existing vegetation is determined through monitoring of plots in untreated parts within the Project Area, in line with section 4.3.5 of the methodology. The quantification of uncertainty related to $C_{tree\text{-}exist,i,t}$ is therefore provided in the Monitoring Plans.

The relevant parameters for uncertainty calculations in the with-project scenario are in the table 4.4.2.2 below. The list contains all parameters that are considered relevant in the tool VT0003.

Table 4.4.2.2 Uncertainty assessment of with-project parameters.

Parameter	Description of addressing uncertainty
$E_{biomassloss,i,t}$	Included in uncertainty assessment
$\Delta C_{AGB,i,t}$	Included in uncertainty assessment
$\Delta C_{BGB,i,t}$	Included in uncertainty assessment
$\Delta C_{DW,i,t}$	Not included in GHG accounting
$\Delta C_{WP,i,t}$	Not included in GHG accounting
$GHG_{WPS\text{-}E,t}$	Not possible to quantify uncertainty; conservative estimate has been applied
ΔC_{LK}	Market leakage is determined based on the indirect approach with default values (comparing C_{BSLpre} with the mean national forest carbon stock). The leakage factor is then multiplied with ΔC_{REL}, which is based on $C_{harvest}$. It is not possible to quantify uncertainty for those parameters.

The uncertainty per stratum is calculated based on equation (3) of the tool VT0003:

$$Uncertainty_{WPS,i} = \frac{\sqrt{(U_{WPS,SS1,i} * E_{WPS,SS1,i})^2 + (U_{WPS,SS2,i} * E_{WPS,SS2,i})^2 + (U_{WPS,SS3,i} * E_{WPS,SS3,i})^2}}{E_{WPS,SS1,i} + E_{WPS,SS2,i} + E_{WPS,SS3,i}}$$

Where:

Parameter	**Description**	**Unit**
$Uncertainty_{WPS,i}$	Uncertainty in the with-project scenario in stratum *i*	%
$U_{WPS,SS,i}$	Percentage uncertainty (expressed as 90% confidence interval as a percentage of the mean where appropriate) for carbon stocks or greenhouse gas sources in the with-project case in stratum *i* (1,2…n represent different carbon pools and/or GHG sources)	%
$E_{WPS,SS,i}$	Carbon stock or GHG sources emission type (e.g. trees, down dead wood, etc.) in stratum *i* (1,2…n represent different carbon pools and/or GHG sources) in the with-project case	t CO_2-e
i	1, 2, 3 …M_{WPS} strata in the project scenario	

The equation (3) is applied per stratum to the parameters $E_{biomassloss,i,t}$, $\Delta C_{AGB,i,t}$ and $\Delta C_{BGB,i,t}$ (representing SS1, SS2 and SS3). The uncertainty across combined strata is calculated with the revised equation (4) from thet tool VT0003:

$$Uncertainty_{WPS} = \frac{(U_{WPS,1} \times E_{WPS,1}) + (U_{WPS,2} \times E_{WPS,2}) ... + ... (U_{WPS,M_{WPS}} \times E_{WPS,M_{WPS}})}{E_{WPS,1} + E_{WPS,2} ... + ... E_{M_{WPS}}}$$

Where:

Parameter	**Description**	**Unit**
$Uncertainty_{WPS}$	Total uncertainty in project scenario;	%
$U_{WPS,i}$	Uncertainty in project scenario in stratum *i*;	%
$E_{WPS,i}$	Sum of combined carbon stocks and GHG sources (e.g. trees, down dead wood, etc.) in stratum *i* (1,2…n represent different carbon pools and/or GHG sources) multiplied by the area of stratum *i* (A_i) in the with-project case;	t CO2-e
i	1, 2, 3 …M_{WPS} strata in the project scenario	

The calculation of uncertainty in the with-project scenario is based on monitoring results and is part of the Monitoring Plan.

The total error in the project is calculated with equation (5) of the tool VT0003:

$$C_{IFM\_ERROR} = \sqrt{Uncertainty_{BSL}^{\ 2} + Uncertainty_{WPS}^{\ 2}}$$

Where:

Parameter	Description	Unit
C_{IFM_ERROR}	Total uncertainty for IFM project activity	%
$Uncertainty_{BSL}$	Total uncertainty in baseline scenario	%
$Uncertainty_{WPS}$	Total uncertainty in the with-project scenario	%

If $C_{IFM\_ERROR} \leq 10\%$ of $\Delta C_{IFM,t}$ then no deduction shall result for uncertainty.

If $C_{IFM\_ERROR} > 10\%$ of $\Delta C_{IFM,t}$ then the total uncertainty percentage shall be deducted from the ΔC_{IFM}.

4.4.3 Calculation of Verified Carbon Units

The number of Verified Carbon Units is calculated with the following equation:

$$VCU_{t2} = (\Delta C_{IFM,t2} - \Delta C_{IFM,t1}) \times \left(\frac{100 - C_{IFM\_ERROR}}{100} \right) - Bufferwithholding_{t2}$$

Where:

Parameter	Description	Unit
$VCU_{,t2}$	Number of Voluntary Carbon Units at year *t2*	
$\Delta C_{IFM,\ t1}$	Total net GHG emission reductions from the IFM project activity up to year *t1*	t CO_2-e
$\Delta C_{IFM,\ t2}$	Total net GHG emission reductions from the IFM project activity up to year *t2*	t CO_2-e
C_{IFM_ERROR}	Total uncertainty for IFM project activity	%
$Bufferwithholding_{t2}$	The number of VCU's to be withheld in the VCS Buffer at year *t2*	

C_{IFM_ERROR} is only included in the equation if it is larger than 10%. The parameter *Bufferwithholding* is calculated as the buffer percentage times the net change in the project's carbon stocks. The net change in the carbon stocks applies to the parameters ΔC_P (net carbon stock change in the with-project scenario) and ΔC_{REL} (net carbon stock change due to relogging in the baseline). The buffer percentage is determined in the Risk Assessment, which is provided in a separate document. The calculation of VCU's is provided in each Monitoring Report.

5 Environmental Impact:

An Environmental Impact Assessment (EIA) is not required for forest rehabilitation projects. The Environment Protection Enactment of 2002 and Prescribed activities of 2005 determine that an EIA is required for felling or timber extraction operations covering an area of 500 ha or more, or for the development of forest plantation or reforestation covering an area of 500 ha or more. The project activity is not considered as reforestation because it is classified as forest land remaining forest land. Nevertheless, in 2000 an EIA was conducted in INFAPRO (INFAPRO, 2001). This EIA was conducted by in-house personnel. For each of the project activities, a critical assessment of their impact(s) was conducted based on observation and experience obtained throughout project implementation (table 5.1 and 5.2). Mitigation efforts, if necessary, have been formulated. These measures have been mitigated in all cases.

A Social Impact Assessment to address the impact on local communities was omitted because of the absence of such communities in the Project Area and its surroundings.

Table 5.1 List of key impacts and mitigation actions of INFAPRO rehabilitation activities.

Project activity	Impact	Mitigation
Road maintenance	Increased soil erosion	Use existing road network
		Maintenance of side, cross drains and culverts
		Surfacing with gravel where erosion risk is high
	Loss of carbon through roadside vegetation clearance	Clearance restricted to waterlogged stretches
	Loss of carbon through cutting trees for bridge and culvert construction	Careful construction to maximize lifespan of bridges and culverts
Climber cutting	Increasing forest stand growth	NA (positive impact)
	Initial carbon losses	Promotion of increased growth
	Temporary reduction of food source and habitat for wildlife	Planting of indigenous fruit tree species
Lining	Initial loss of carbon by cutting of saplings for lining stakes	Use of low wood density species
Renticing and row opening	Initial carbon losses	Reduction in strip width
	Possible cutting of desirable species	Tagging of natural regeneration
Planting	Increased productivity in degraded forest	NA
	Further alteration of species composition	Site species matching
Maintenance	Continual carbon losses	Increased growth of tended seedlings
	Possible cutting of desirable species	Tagging of natural regeneration
Liberation thinning	Carbon losses	Increased survival and growth of tended seedlings
		Reduction in size class and number of species to be girdled
	Possible cutting of desirable species	Tagging of natural regeneration

Table 5.2 Results of the EIA for INFAPRO base camp and nursery.

Activity	Impact	Mitigation
Seed collection	Reduced seed dispersal	NA (sufficient seeds remain available for dispersal and regeneration)
	Reduced food availability to wildlife	NA (sufficient seeds remain available for wildlife)
Wildling collection	Reduced original wildlings on forest floor	NA (enhancement of wildling survival due to reduced competition)
Soil collection	Loss of top soil and ground vegetation	Planting of seedlings and fast colonization of ground vegetation cover
		Soil collection on land slides
Site clearance	Soil erosion	Clearance is limited to very severely degraded sites

		Planting of trees and ground cover plants
Domestic refuse	Environmental pollution	Separation of biodegradable and non-biodegradable waste
		Recycling of non-biodegradable waste as far as possible
		Coordinated disposal of refuse, away from water courses
Water treatment	Damming of stream	Two surface-overflow dams are established only in one river that runs across the camp in a severely degraded forest, dominated by pioneer species
	Chemical pollution	Residuals from the water treatment plant are flushed into the pioneer dominated forest away from any perennial streams
		Optimization use of treated water by restricting usage for consumption only. Water for washing and other uses is supplied from non-treated water
Use of fertiliser and pesticides	Environmental pollution	Restricted use (spot treatment only)

6 Stakeholders comments:

Many experts and organisations have been involved in the establishment and further development of the project, such as FRIM, researchers of Danum Valley Field Centre, WWF Malaysia, Earthwatch, CIRAD-FORET, IKEA, GEF, local and overseas Universities and the Sabah Forestry Department. In the early stage of the project, WWF Malaysia has identified some issues regarding the low number of dipterocarp species and the lack of fruit trees selected for enrichment planting. The rehabilitation activities have been improved based on the advice and suggestions from stakeholders and experts. The project has been visited by many organizations, such as governmental bodies, research institutes, universities, schools and NGO's and visit records are kept in a visitors book and in quarterly and annual reports.

A Steering Committee was established in 1992 in order to provide guidance to the project and it serves as a platform for ongoing communication. The project stakeholders are represented in the Steering Committee. The Terms of Reference for the Steering Committee includes the following tasks:

- Evaluate and recommend technical and scientific progress of the project and contents of Plan of Operation and Annual Work Plan.
- Provide direction for activities of subsequent Plan of Operation and Annual Work Plan.
- Identify and provide general guidelines pertaining to research, training and publication under the research component of the project.
- Ensure that the project activities conform to the current Forest Enactment of the State of Sabah.

There are no local communities based within the INFAPRO Project Area. The nearest villages are located to the East of the Ulu Segama Forest Reserve boundary, along the lower part of the Segama river, at a distance of about 80 kilometers from INFAPRO. The people living in this area are descendants of people that lived centuries ago. This area, located toward the Southwest of the Project Area, is formally known as the Danum Valley Conservation Area,. Nearer villages are located at a distance of about 65 kilometers, not far from the entrance of the Ulu Segama – Malua Forest Reserve in the West, close to the town of Lahad Datu. These villages have been established lasting the past 20 years by immigrants.

7 Schedule:

Table 7.1 Schedule of the GHG project cycle.

GHG project cycle element	Year / Period / Interval
Project Start date	29 June 1992
Crediting period start date	1st January 2007
Project life time	99 years
Project crediting period	30 years
Monitoring and reporting frequency	Every three years
Project termination date	31st December 2046

The size of the area to be rehabilitated is determined in contracts between Face the Future and Rakyat Berjaya. Each contract covers a period of about three years. Table 7.2 shows the areas that have already been rehabilitated and the areas that are planned for rehabilitation.

Table 7.2 Implementation of forest rehabilitation in INFAPRO.

Contract	Period	Area
Contract 1	1992 – 1995	2,031
Contract 2	1995 – 1997	3,012
Contract 3	1998 – 2000	4,796
Contract 4	2002 – 2004	1,117
Contract 5	2006 – 2009	640
Contract 6	2010 – 2013	2,500
Contract 7	2014 – 2016	3,000
Contract 8	2017 – 2019	3,000
Contract 9	2020 – 2022	3,000
Contract 10	2023 – 2025	1,904
All contracts (total)	1992 – 2025	**25,000**

8 Ownership:

8.1 Proof of Title:

The INFAPRO Development Area is part of the Yayasan Sabah Sustainable Forest Management license area. Yayasan Sabah was allocated a forest concession in 1970, through a Licence Agreement for Timber between the State of Sabah and the Sabah Foundation (Yayasan Sabah). The concession covers a period of 100 years, starting January 1st 1970, ending December 31, 2069. The concession area (classified as state land) is defined in the License agreement and contains amongst other the following Forest Reserves:

Part of the Ulu Segama Forest Reserve (as constituted by Gazette Notification no. 598 of 1963) having a total area of approximately 423 square miles.

Part of the Malua Forest Reserve (as constituted by Gazette Notification no. 572 of 1961) having a total area of approximately 67 square miles.

Yayasan Sabah and Rakyat Berjaya Sdn Bhd signed an agreement on January 18, 1971 in which Yayasan Sabah assigns all rights and liabilities under the abovementioned License agreement to Rakyat Berjaya Sdn Bhd.

The License Agreement for Timber 1970 was replaced in 1997 by the Sustainable Forest Management Licence Agreement (SFMLA) between Yayasan Sabah and the Sabah State Government.

On June 29, 1992 The State Government of Sabah and Face entered into a Memorandum of Understanding in which both agree to join efforts and undertake a project to realise the rehabilitation of logged over forests, and degraded lands, and the afforestation and reforestation of wasteland in Sabah, Malaysia. The project will be implemented by Face and its Malaysian contract partner, being the concession holder or entity duly responsible for the management of the concession.

Referring to the MoU between Sabah and Face a project agreement was signed on June 29, 1992 between Face and Rakyat Berjaya. The agreement describes the forest rehabilitation project of an area of 25,000 hectares within the Ulu Segama Forest Reserve. On June 4, 1992 the Director of Forestry of the State government of Sabah approved the agreement.

Following the project agreement between Face, individual Forms of Agreement for CO_2 offsets have been entered by the parties in which specific rehabilitation activities are described. In these contracts Face is exclusively entitled to the CO_2 sequestered in the Project Area for the entire contract period, being 99 years.

Although a Memorandum of Understanding has been signed between Face and the State Government of Sabah, the project is not registered with a Federal Governmental Authority.

Face is exclusively entitled to any and all CO_2 sequestration and offset in the contract areas. Since 2009, 10% of the carbon ownership of all newly rehabilitated areas is shared with Yayasan Sabah.

8.2 Projects that reduce GHG emissions from activities that participate in an emissions trading program (if applicable):

This project activity does not include GHG emissions reductions from activities that participate in an emissions trading program. This section is not applicable to the project activity.

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