Annex 14

Greenhouse Gas Accounting

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1. Estimated GHG Emissions from LUCF in Timor-Leste

A GHG inventory made in the INC submitted to UNFCCC in 2014 shows that the total GHG emission in 2010 is 1,482 Gg CO_2-eq, of which 65% is from agriculture sector, followed by energy (17%), land use change and forestry (LUCF) (14%), and waste (4%). The estimated emissions in the period from 2005 to 2010 varies from 1,245 to 2,196 Gg CO_2-eq, this fluctuation of the total is mainly attributed from the fluctuation of emission from LUCF as shown in the table below. The NDC stresses that 'emissions from agriculture, forests, and other land uses are the main sources of GHG emissions' in TL. Therefore, the forestry and agriculture are expected to play a significant role in mitigating climate change in TL.

Table 1-1 Changes in Estimated GHG Emissions from 2005 to 2010

(Unit: Gg CO_2-eq)

Sources	2005	2006	2007	2008	2009	2010
Energy	200	207	313	262	222	251
Agriculture	883	901	957	997	933	966
LUCF	**115**	**1,037**	**734**	**441**	**225**	**206**
Waste	47	52	54	56	58	60
Total	**1,245**	**2,196**	**2,059**	**1,756**	**1,438**	**1,492**

Source: Timor-Leste's Initial National Communication under UNFCCC, State Secretary of Environment, GoTL, 2014

In the estimation of GHG emission from LUCF, deforestation (conversion of forest into grassland or non-forest lands) was considered as the main source of emissions, while carbon sequestration in forests and woodlots was considered as the major carbon offset. Hence, the figures of CO_2 emission in LUCF in the table above are the balance between the emission from land use change and absorption (uptake) by forest and grassland. In 2010, the emission from forest conversion was estimated as 564 Gg CO_2-eq, while the estimated total uptake of the sector was 358 Gg CO_2-eq; therefore 100% of CO_2 emission in LUCF in 2010 originated from deforestation[1].

The average annual deforestation was 2.2% based on the INC, which was slightly higher than the one in the Forest Conservation Plan (2012)[2], where the average annual deforestation rate was estimated at 1.7%. In addition to deforestation, forest degradation should be considered as another major source of CO_2 emission. The Forest Conservation Plan (2012) indicates that around 171,000 ha of dense forests have been converted into sparse forests between 2003 and 2012, while around 184,000 ha of total forests have disappeared for the same period. Thus, the contribution of LUCF to GHG emission would be higher than the level estimated in the INC, if the emission from forest degradation was counted.

[1] Timor-Leste's Initial National Communication, Timor-Leste's State Secretariat for Environment, GoTL, 2014

[2] Forest Conservation Plan issued by the National Directorate of Forest (NDF), MAF with technical assistance from JICS in 2012

2. Estimated GHG Emissions from Deforestation and Forest Degradation

2.1 LULC Classes and Forest Strata in Timor-Leste

The assessment study conducted by the Forest Conservation Plan is the sole study to be referred for grasping the current status of forests in the country. The study analyzed the satellite images taken in the different years, namely 1990, 2003, and 2012 and developed the national forest status maps in 2003 and 2012 with verification by interpretation of aerial photos taken in 2001 and ground truth surveys in the field. The forest and vegetation cover in the country was classified into nine types of forest and land use as tabulated below.

Table 2-1 Definition and Characteristics of Nine Types of Forest and Land Use

Forest/land use		Descriptions
Forest*1	Dense Forest	Forest with crown cover of more than 60% is classified as Dense forest. This class includes various types of combination of tree species, which vary with regions and locations where forests stand. Coffee plantations with matured shade trees, such as Falcataria spp. and Albizia spp., are also included in this class.
	Sparse Forest	Forest with crown cover of 10-60% is classified as Sparse Forest. Although it uses the term of "Sparse," this class also includes forests with medium crown density. A wide range of types of forest are included in the class.
Non-forest	Very Sparse Forest	Grasslands with sporadic Eucalyptus Alba stands and Eucalyptus Alba scrub whose basal diameter is less than 10 cm are classified as "Very Sparse Forest." As its crown density is below 10% or trees will not be able to reach 5m in situ, this class is categorized as one of the non-forest classes.
	Paddy Field	Bare lands confirmed as rice fields through ground truth surveys and aerial photo interpretation are classified as Paddy Field.
	Dry Field	Bare lands confirmed as upland crops farms such as permanent farms and shifting cultivation farms through ground truth surveys and aerial photo interpretation are classified as Dry Field.
	Grassland	Grasslands or pasture lands without any trees are classified as Grassland.
	Settlements	The populated areas, such as cities and towns, are classified as Settlements. This class does not include the areas where houses are built.
	Inland Water	The water bodies, such as lakes, marshes, and rivers, are classified as Inland water. Dry riverbeds are included in this class.
	Bare Land	Bare lands which are not classified into those described above are classified as Bare land. Slope failures are also included in this class.

Note: The FAO's definition of forest stipulated in FRA Working Paper (1998)[3] was adopted for classification of forest lands; hence, lands spanning more than 0.5 ha with trees higher than 5 m and a canopy cover of more than 10%, or trees able to reach these thresholds in situ, are classified as forests.
Source: Revised by JICA Project Team (2017) based on Forest Conservation Plan in Timor-Leste (Draft)

Further assessments of changes in forest covers and estimation of CO_2 emissions, which are described in the sections/ sub-sections below, were made based on the definitions given in the table above.

2.2 Estimated CO_2 Emissions from Deforestation and Forest Degradation in Timor-Leste

2.2.1 Changes in Forest Covers in Timor-Leste

The table below show the historical changes of forest area in the country between 2003 and 2012 based on the results of the assessment study of the Forest Conservation Plan (2013).

[3] http://www.fao.org/3/ad665e/ad665e06.htm

Table 2-2 Change of forest area between 2003 and 2012

	2003		2012	
	Area (ha)	**Ratio (%)**	**Area (ha)**	**Ratio (%)**
Dense Forest (including coffee plantations)	484,028	32.4	312,930	21.0
Sparse Forest	568,990	38.1	556,200	37.3
Total	1,053,018	70.6	869,130	58.3

Source: Forest Conservation Plan in Timor-Leste (2013)

The results of the analysis suggest that:

- The total forest area in the country has decreased by 183,888 ha (17.5% of total forest area) between 2003 and 2012;
- Around 171,000 ha of dense forests have been converted into sparse forests or other forms of land use (such as grassland) for the same period; and
- A large area of forests may have been converted into non-forest forms, such as farms, grasslands and bushes/ woodlots, which are mainly fallow lands after shifting cultivation, since independence.

2.2.2 Estimated CO_2 Emissions from Deforestation and Forest Degradation

The assessment study of the Forest Preservation Program (2013) also estimated the average carbon stock in the respective types of existing forests in the country based on the results of the forest inventory survey conducted in all the 13 municipalities in 2011/2012. The average carbon stock in dense and sparse forests in the country in 2012 were calculated as 165 t-C/ha and 72 t-C/ha, respectively.

Thus, it is estimated that about 27.6 million t-C have been removed from existing forests in the country between 2003 and 2012 at a pace of 3.1 million t-C p.a., which is equivalent to about 11.3 million t-CO_2. The CO_2 emissions based on the Forest Conservation Plan (2012) are far higher than that of the INC. Counting CO_2 emission from forest degradation is considered as one of the reasons for the gap between the data of the two reports.

Table 2-3 Change of forest area and carbon stock between 2003 and 2012

	Forest Area (ha)			Carbon-stock (t-C)		
	2003	**2012**	**Difference**	**2003**	**2012**	**Difference**
Dense forest	484,028	312,931	171,097	77,084,391	51,678,617	25,405,774
Sparse forest	568,990	556,200	12,790	42,294,607	40,056,587	2,238,020
Total	1,053,018	869,130	183,888	119,378,998	91,735,204	27,643,794

Source: Made by the JICA project team (2020) based on Forest Conservation Plan (2012)

By visible observation in satellite image analysis, the assessment study suggests that the majority of dense forests were converted into sparse forests rather than non-forest forms and almost the same areas of sparse forest were changed into non-forestlands, such as farms and grasslands. The CO_2 emissions from deforestation and forest degradation between 2003 and 2012 are estimated on the basis of this assumption as tabulated below.

Table 2-4 Carbon and CO_2 emission from deforestation and forest degradation between 2003 and 2012

Degradation/Deforestation	Carbon emission (C-ton)	CO_2 emission (t-CO_2)
Forest degradation	17,542,850	64,323,783
Deforestation	10,100,944	37,036,795
Total	27,643,794	101,360,578

Note: Ratio of carbon stock of dense forest and sparse forest was used for determining the proportion of carbon emissions from deforestation and forest degradation.
Source: Estimated by the JICA project team (2020) based on Forest Conservation Plan (2012)

As shown above, the estimated CO_2 emission from deforestation and forest degradation for 9 years is about 101 million t-CO_2, of which about 63% (or 64.3 million t- CO_2) is originated from forest degradation of dense forests.

2.3 Estimated CO_2 Emissions from Deforestation and Forest Degradation in the target Watershed

2.3.1 Changes in Forest Covers in the target watershed

The table below shows the areas of the respective types of forest and land use in the four watersheds in 2012.

Table 2-5 Forest Covers and Land Use in the Four Watersheds in 2012

(unit: ha)

Watersheds	Dense Forest	Sparse Forest	V. Sparse Forest	Paddy & dry field	Glass land	Bareland	Others	Total
Caraulun	12,840	20,550	240	1,680	26,010	270	3,190	64,780
Tafara	5,960	13,910	0	260	8,950	1,430	1,208	31,718
Laclo	17,270	53,270	31,690	2,440	25,230	840	5,118	135,858
Comoro	5,300	5,770	1,380	190	8,120	1,230	1,192	23,182
Total	41,370	93,500	33,310	4,570	68,310	3,770	10,708	255,538

Source: Forest Conservation Plan (2012)

More than 50% of the total area of the four watersheds are covered with forests, of which one third (about 30% of the existing forests or 41,370 ha) are still in dense conditions. The Forest Preservation Program also assess the historical changes in forest covers between 2003 and 2012. The changes in forest cover in the four watersheds are summarized below.

Table 2-6 Changes in Forests between 2003 and 2012

Municipality	2003			2012			Difference		
	Dense Forest (ha)	Sparse Forest (ha)	Total (ha)	Dense Forest (ha)	Sparse Forest (ha)	Total (ha)	Dense Forest (ha)	Sparse Forest (ha)	Total (ha)
Caraulun	24,720	23,180	47,900	12,840	20,550	33,390	-11,880	-2,630	-14,510
Tafara	13,410	13,310	26,720	5,960	13,910	19,870	-7,450	+600	-6,850
Laclo	23,740	51,280	75,020	17,270	53,270	70,540	-6,470	+1,990	-4,480
Comoro	9,170	8,180	17,350	5,300	5,770	11,070	-3,870	-2,410	-6,280
Total	71,040	95,950	166,990	41,370	93,500	134,870	29,670	-2,450	-32,120

Source: Revised by JICA Project Team (2017) based on Forest Transition of 1990, 2003 and 2010 in Timor-Leste

As shown above, about 32,120 ha of forests had been converted into non-forest lands from 2003 to 2012. Particularly, about 29,670 ha of dense forests were degraded or converted into either sparse forests or non-forest land uses, such as grasslands and dry fields, for the same period. The results suggested that the extensive deforestation and forest degradation had occurred after the independence in 2002. As shown in the table below. The rates of forest degradation (reduction rate of dense forest) and deforestation (reduction of sparse forest) between 2003 and 2012 are quite high in the respective watersheds.

Table 2-7 Rates of Forest Degradation and Deforestation (2003-2012)

Municipality	Degradation rate	Deforestation rate
Caraulun	- 7.02%	- 3.93%
Tafara	-8.62%	- 3.24%
Laclo	-3.47%	- 0.68%

Municipality	Degradation rate	Deforestation rate
Comoro	-5.91%	- 4.87%
Average <1	-5.83%	-1.69%

Note: geometric mean
Source: JICA (2020)

2.3.2 Estimated CO_2 Emission from Deforestation and Forest Degradation in the target Watersheds

Carbon dioxide emission from deforestation and forest degradation in the four watersheds were estimated by using data on historical changes in areas of dense and sparse forests shown in Section 2.3.1. Consequently, CO_2 emission from both forest degradation and deforestation were estimated under the assumption that i) dense forests were changed into sparse forest while sparse forests were converted into non-forest areas; and ii) forestry biomass removed from dense and sparse forests were released as carbon dioxide in the atmosphere. The results of the estimation of carbon and CO_2 emission from forest areas in the target watersheds between 2003 and 2012 are shown in **Table 1,** and summarized below.

Table 2-8 Carbon and CO2 emission from Forest Area each watershed between 2003 and 2012

Watershed	Carbon emission (t-C)			CO_2 emission (t-CO_2)		
	Forest Degradation	Deforestation	Total	Forest Degradation	Deforestation	Total
Caraulun	2,246,983	1,383,674	3,630,657	8,238,938	5,073,471	13,312,409
Tafara	1,109,827	843,852	1,953,679	4,069,366	3,094,124	7,163,490
Laclo	1,074,020	319,245	1,393,265	3,938,073	1,170,565	5,108,638
Comoro	747,529	525,950	1,273,479	2,740,940	1,928,483	4,669,423
Total	5,178,359	3,072,721	8,251,080	18,987,317	11,266,643	30,253,960

Source: Revised by JICA Project Team (2020) based on Forest Conservation Plan (Draft)

The annual averages of CO_2 emission in the target watersheds were also estimated as shown in the table below.

Table 2-9 Average annual CO2 Emission in the Watersheds between 2003 and 2012

Watershed	Annual CO_2 emissions (t-CO_2/year)		
	Forest Degradation	Deforestation	Total
Caraulun	915,438	563,719	1,479,157
Tafara	452,152	343,792	795,944
Laclo	437,564	130,063	567,627
Comoro	304,549	214,276	518,825
Total	2,109,703	1,251,850	3,361,553

Source: Revised by JICA Project Team (2020) based on Forest Conservation Plan (Draft)

The emission in Caraulun watershed is the largest among those of the four watersheds, which is almost twice as large as that of Tafara watershed. The one in Tafara watershed is the second largest, followed by Laclo and Comoro watersheds, whose annual CO_2 emission levels are almost the same. In all the watersheds, the estimated emissions from forest degradation are higher than those from deforestation. Particularly, about 80% of the emission in Laclo watershed is originated from forest degradation. Details of the estimation of the average annual CO_2 emissions in the target watersheds are presented in **Table 1.**

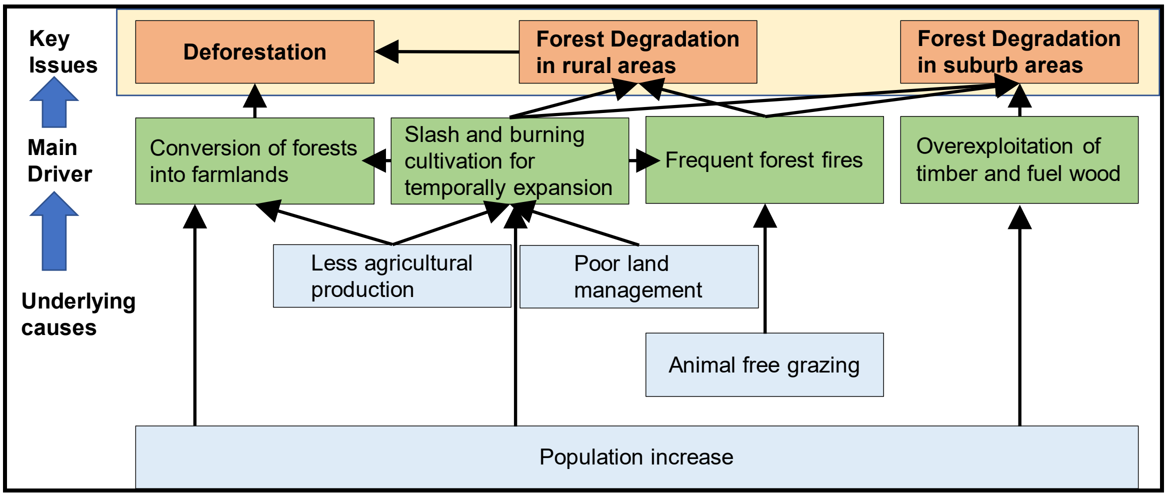
3. Major Drivers of Deforestation and Forest Degradation

3.1 Overview of Drivers of Deforestation and Forest Degradation in the Country

Many existing studies and assessment reports developed by donors and international organizations have indicated several drivers of deforestation and forest degradation in Timor-Leste as listed below.

- Conversion of forests into farms or expansion of farmlands
- Shifting cultivation or slash and burn cultivation
- Frequent forest fires
- Illegal exploitation
- Overexploitation of firewood
- Free animal grazing

Although there has been no study or research made to clarify the extents of the influence by the respective drivers, the review and analysis of the existing reports including Forest Conservation Plan and interviews made by the JICA CBNRM Project indicate the following a causal relation between/ among the possible drivers and deforestation and forest degradation in Timor-Leste.



Source: JICA (2020)

Figure 3-1 Results of the Analysis of Major Drivers of Deforestation and Forest Degradation

As shown above, the conversion of forests into farmlands is considered as the main and direct driver of deforestation, which is often led by shifting cultivation. Forest degradation, particularly degradation of dense forests into sparse forests, has been caused by shifting cultivation and forest fires, which is often attributed to shifting cultivation as well as free animal grazing. Overexploitation of timber and fuel woods are another main driver of forest degradation in suburb areas, such as Metenalo and Hera in Dili Municipality. Low productivity and poor land management are the underlying causes of expansion of farmlands through shifting cultivation mainly in rural areas.

3.2 Description of Drivers of Deforestation and Forest Degradation

The following sections give the general descriptions of the major drivers of deforestation and forest degradation in Timor-Leste.

(1) Conversion of Forest into Farm

As described in the previous section, the conversion of forests into farmlands is considered as the main and direct driver of deforestation. It is particularly observed that deforestation or conversion of forests has occurred in gentle and medium level sloping lands in hilly and mountainous areas since independence, when local communities were allowed to use the areas where they used to cultivate for crop production in the Portuguese colonial era. At present, the majority of the existing dense forests are located in either steep sloping lands or remote areas far from communities, which are not suitable for farming. The pace of deforestation may have become slower than that for a few years after independence as communities may have already opened enough farms to secure food for their families. Nevertheless, deforestation has still progressed along with shifting cultivation, and if anything, the situations might get worse in the future as the number of households increases with population increase.

(2) Shifting Cultivation

Shifting cultivation is still a common farming practice in Timor-Leste, particularly in the western and southern parts of the country. In general, a family uses a few to several plots for shifting cultivation on a rotation basis. As the fallow period is more or less 3 to 5 years on average, the areas used for shifting cultivation seem like bushes or grasslands in many cases. Those who do not have enough farms may further slash and burn forests for opening a new farm. Currently the direct impact of shifting cultivation may not be as high as that in the early 2000s as described above, but this practice is also considered as a major cause of forest fires in addition to the conversion of forests.

(3) Forest Fire

Frequent forest fire is considered as one of the main cause of deforestation and forest degradation in Timor-Leste, although there is no statistical or cumulative data of forest fires in the county. High incidence of forest fires in the dry season, especially before the onset of the rainy season, is the common issue to be addressed for forest protection in the country. Shifting cultivation, bush fires for generation of new grasses, and hunting of wild animals are considered as major causes of forest fires.

(4) Firewood Collection

Firewood is the most prevailing source of energy in Timor-Leste. In fact, the majority of families, even those in Dili, use firewood for cooking. Intensive firewood collection to supply fuel wood to the populated cities and towns has caused forest degradation in the suburbs, such as Post-Administrative Laulara and Metinaro. Nevertheless, the impact caused by firewood collection in the remote areas may not necessarily be significant, as human pressures might be balanced with natural regenerating capacity of existing forests.

(5) Illegal Logging

Illegal logging has been commonly found in Timor-Leste. Although it may not lead to large-scale deforestation, it is one of the causes of forest degradation throughout the country. Such an illegal act is conducted by not only communities but also groups organized by people from outsides.

(6) Animal Free Grazing

Free animal grazing is a practice commonly found in Timor-Leste. In many areas of the country, communities graze their large animals (cow, buffalo, and horse) in dense and sparse forests in and around their villages. Such a practice does not directly cause deforestation, but it significantly affects natural regeneration of existing trees, particularly the growth of the understory vegetation. Furthermore, communities who used forests for animal grazing have often burned the areas to promote regeneration of new grasses for securing animal feed.

3.3 Agents of Deforestation and Forest Degradation

The major drivers of deforestation and forest degradation, particularly conversion of forests, and shifting cultivation are attributed to human activities. Hence, local communities and farmers are the main agents of deforestation and forest degradation in Timor-Leste. The village-level monthly monitoring initiated by the CBNRM project in its target villages also showed that local communities in and around the villages were often directly involved in the occurrence of some major drivers, such as forest fires, illegal cutting, and animal grazing, although they were not on a large scale. The following table shows the numbers of cases of forest fires, illegal cutting, and animal grazing in the CBNRM project villages for two years.

Table 3-1 Number of incidents happened in the villages from September 2017 to August 2019

Village	Free grazing	Forest fire	Illegal cutting	others
Bocoleo	14	3	1	0
Fahisoi (Liquidoe)	6	1	1	1
Fahisoi (Remexio)	22	11	11	4
Fatisi	14	2	0	1
Total	**56**	**17**	**13**	**6**

Source: JICA Project Team (2020)

3.4 Relationship between project activities and the major drivers of deforestation and forest degradation

The proposed project activities based on the CBNRM approach will address the major drivers of deforestation and forest degradation directly and indirectly. The table below summarizes its effectiveness for reduction of deforestation and forest degradation.

Table 3-2 Reduction of deforestation and forest degradation by each Activity

Activity	Description of Activity	Effects on the major drivers
1.1.1 & 1.2.1 (PLUP and PLUP monitoring)	➢ Conduct participatory land use planning (PLUP) with climate change vulnerability assessment (CCVA) to assist local communities in the formulation and adoption of village-level NRM regulations which regulate any acts causing forest fire, illegal cutting and animal grazing. ➢ Assist local communities in the enforcement of village-level NRM regulations through regular meetings at village level.	■ Local community develops a future land use plan and village-level NRM regulations to protect and manage natural resources on their own initiatives. The regulations explicitly prohibit any acts causing forest fires (including shifting cultivation), illegal cutting, and animal grazing. ■ Through the regular monitoring and continuous capacity enhancement of village leaders for enforcement, the incidence of forest fire, illegal exploitation and animal grazing can be minimized. ■ Hence, PLUP and PLUP monitoring will directly address the major drivers of forest degradation.
1.2.2 (Watershed Management	➢ Formulate and strengthen the sub-watershed level coordinating platforms for enhancement of the local capacity for protection of forests and	■ Watershed management council at post-administrative level will be developed in the target watersheds. The council can function as a coordinating body where local leaders can coordinate their activities for

Activity	Description of Activity	Effects on the major drivers
Council)	natural resources on a watershed scale.	effective protection of forests and other natural resources in the respective watersheds/ post-administrative. ■ Such a mechanism can be effective in reducing the leakage risks (e.g., shifting cultivation, illegal cutting, animal grazing, and forest fires in the border or adjacent areas), which may cause the progress of forest degradation outside the project area, ■ Likewise, the Activity is expected to address the major drivers of forest degradation directly.
2.1.1 (Micro Program)	➢ Conduct a series of hands-on training or field farmers schools on climate resilient agriculture, reforestation and sustainable forest management, horticulture development, and livelihood improvement at village level to enhance local communities' capacity to improve their livelihoods and crop production in a sustainable manner.	■ Local communities could learn the techniques and skills on the following topics: ✓ Climate resilient agriculture with sloping land agriculture techniques ✓ Community nursery and reforestation with mechanisms to generate additional sources of income ✓ Rehabilitation and improvement of aged coffee plantations ✓ Development of alternative sources of income using resources available in localities ■ Over the course of the micro program implementation, local communities can not only learn the techniques but also replicate the same in their own farms/ plots by effectively using the traditional collective working system where local communities living nearby help each other when necessary. ■ Local communities could increase crop production or the sources of income through the replication of the techniques introduced by the Activity, which would be effective in reducing the human pressure on forests for expansion of farmlands. ■ Thus, this Activity will indirectly address the main driver of deforestation.

Source: JICA (2020)

The effectiveness of the Activities on the major drivers of deforestation and forest degradation is summarized below.

Table 3-3 Effectiveness of Project Activities to each driver of deforestation and forest degradation

Driver of deforestation and forest degradation	Activities 1.1.1 & 1.2.1 (PLUP)	Activity 1.2.2 (WMC)	Activity 2.1.1 (MP)
Forest Fire	+++	+++	-
Conversion of Forest into Farm	++	+	+++
Shifting Cultivation	+++	+	++
Firewood Collection	+	-	-
Illegal Logging	+++	+	+
Animal Free Grazing	+++	+	+

Remarks: +++: High, ++: Fair, +: Less, -: None
Source: JICA (2020)

As indicated above, an integrated approach is essential to effectively address the major drivers of deforestation and forest degradation in the country. To transform the forest sector in Timor-Leste into the one taking low-emission but sustainably developing pathways, a large scale project like the proposed one with significant investment and technical expertise is required. This is why the GCF support is requisite for realization of the paradigm shift.

4. Potential Impacts of the CBNRM Mechanism

4.1 Positive impact of CBNRM

Significant positive changes have been observed in the villages where the CBNRM mechanism is in place. The end-of-project evaluation of the JICA CBNRM Project (Phase I) jointly made by the GoTL and JICA in 2015 reported the following positive impacts of the CBNRM mechanism[4] to reduce deforestation and forest degradation.

- The number of forest fire, illegal cutting and free grazing practices, which have often happened in the villages, is reduced after introduction of the CBNRM mechanism.
- About 30~100 % of the total households in the villages have applied the techniques introduced by the micro programs, such as sloping agriculture land techniques/ sustainable upland farming techniques, to their own farms, and continued the practices even in the post project period.
- Interventions and approaches adopted in the CBNRM mechanism are effective and contribute to forest conservation and livelihood development at village level.
- The situation is likely to continue to prevail even after the completion of the project since communities in the villages have found it economically beneficial to maintain the CBNRM mechanism.
- Many local communities who participated in the project activities continue to apply the techniques that they learned as such techniques have help them improve land productivity and increase crop production.
- The impacts generated in the project villages seem to be maintained even without any support from the project as the elements of the CBNRM mechanism, namely village regulations and micro program techniques (e.g., sustainable upland farming techniques) can sustain in the localities.

4.2 Evaluation methodology

The ongoing JICA Project, namely the Project for Community-Based Sustainable Natural Resource Management in Timor-Leste, Phase II (JICA CBNRM Project Phase II), has recently conducted an assessment survey to assess the impacts of the CBNRM mechanism in terms of mitigation of climate change.

In this evaluation survey, changes in forest covers in the project villages and non-project villages were estimated by satellite image analysis. Reduction of forest degradation rates in the project villages after introduction of the CBNRM mechanism were compared to that of non-project villages. The methodology of the assessment survey is summarized below.

- Two project villages, where JICA CBNRM Project Phase 1 had worked between 2010 and 2015, and another two non-project villages were selected for the survey. All of them are located in the same sub-watershed (Noru sub-watershed) in Laclo watershed.

[4] Report of the Joint Terminal Evaluation on the Project for Community-Based Sustainable Natural Resource Management in the Democratic Republic of Timor-Leste, July 2015, JICA and MAF

- A satellite image analysis was conducted to assess the changes of dense forests in the surveyed villages with supplemental visible interpretation of SPOT imageries taken in 2001, 2013, and 2017.
- Focus of the assessment was placed on the assessment of CO_2 emission from degradation of dense forest since the major source of CO_2 emission in the country was the conversion of dense forests into sparse forests. Particularly such a tendency was remarkable in Laclo watershed. (See Section 2.3.2 for more details.)
- As existing sparse forests in the surveyed villages are patchy and dispersed in a mosaic-like way, it was considered that high resolution imageries or aerial photo maps covering the target areas would be required with experienced experts for detection of deforestation, which would make the works time-consuming and costly.

4.3 Results of the assessment survey

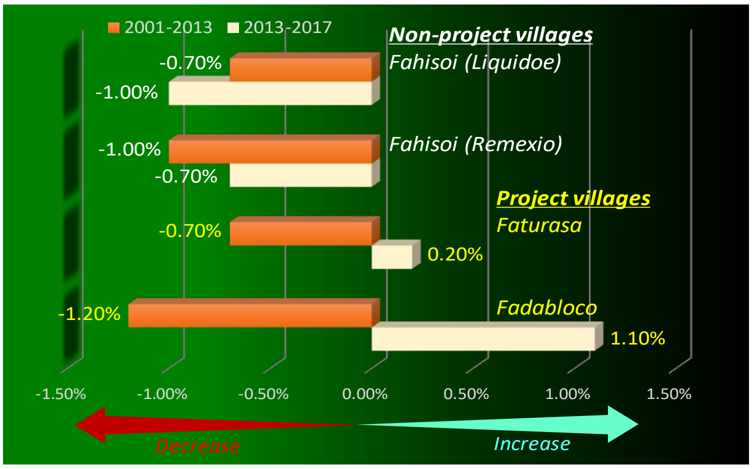
The areas of dense forest increased in the project villages from 2013 to 2017, where the CBNRM mechanism was in place in 2010/2011, while dense forests continuously reduced in the non-project villages throughout the assessment period from 2001 to 2017 as shown below table.

Table 4-1 Changes in Dense Forest Areas in the Sampled Villages

Project/ Non-project	Village	Size of Dense Forests (ha)			Decreasing/ Increasing Rate (%/year)	
		2001	2013	2017	2001-2013	2013-2017
Non-porject village	Fahisoi (Remexio)	434.9	385.6	374.3	-1.00%	-0.70%
	Fahisoi (Liquidoe)	175.2	160.7	154.5	-0.70%	-1.00%
Project village	Fadabloco	443.3	384.2	401.3	-1.20%	1.10%
	Faturasa	837.6	773	778.5	-0.70%	0.20%

Source: JICA (2020)

While the project villages were able to halt the process of deforestation/degradation of dense forests, the decrease rate in the non-project villages was kept high (-1.0% to -0.7% per year) throughout the assessment period as shown figure.



Source: JICA (2020)

Figure 4-1 Changes in Rates of Increase/Decrease in Dense Forest Areas

The comments given by local communities in the project villages, namely "the village has become greenish" and "the greenery has increased in the villages," support the above-mentioned results.

It can be concluded that the CBNRM Mechanism has brought positive impacts on the conservation and even restoration of degraded forests. Since CO_2 emission from conversion of dense forests into sparse forests is considered significant, the CBNRM mechanism has been proven as an effective measure to mitigate the emission, at least, from forest degradation. Although the impact assessment survey did not clarify the efficacy of reduction of deforestation due to time and budget limitations, there is no denying that the mechanism could be effective in reduction of deforestation, since the communities have applied, under the CBNRM mechanism, their NRM regulations wherever necessary for protection, regardless of dense/ sparse forests.

5. Estimation of reduced GHG Emissions from Deforestation and Forest Degradation

5.1 With-project and without-project condition

Reduced GHG emissions from forest degradation was estimated by comparing “the area of dense forest” under the “with-project” and “without project” conditions. The following table shows the basic assumptions in the changes of forest status with-project and without-project conditions.

Table 5-1 Outline of with-project and without-project condition

Indicator	With-Project Conditions	Without-Project Conditions
Area of dense forest	The reduction rates of dense forest will decline in villages where the village-level NRM or CBNRM mechanism is in place.	The reduction rates of dense forest will be maintained as it is. The degradation rates between 2003 and 2012 is used as the BAU scenario. The VCS methodology (VM0006) is referred to estimate the degradation rate of dense forests.

Source: JICA (2020)

In addition to reduced CO_2 emissions from reduction of forest degradation, the possible contribution to the reduction of CO_2 emission from deforestation is also estimated in section 5.4 of this Annex. The methodology for calculating the mitigation impacts follows the general guidance of the Intergovernmental Panel on Climate Change (IPCC) as described in the 2006 Guidelines for national GHG inventories and the 2003 Good Practice Guidance for LULUCF that provides sector-specific recommendations. For a project level methodology, VCS methodology (VM0006) was referred to estimate the deforestation rate in the target watersheds to set the baseline trend.

5.2 Methodologies for Estimation of the reduced GHG emissions

Since the conversion of dense forests or forest degradation is considered as the major source of CO_2 emissions in the country as described in Chapters 2, the focus of the benefit assessment on the reduced CO_2 emissions was placed on those from reduction of forest degradation in this evaluation.

The methodologies of estimating and calculating the reduced CO_2 emission are summarized below.

Table 5-2 Summary of Methodologies for Estimation of the CO_2 emission

	Outline of Calculation
Summary description of the methodology	Project benefits from Reduced CO_2 emission =∑(Changes in dense forests under the “with-project” and “without-project” conditions x (Average carbon stock of dense forest – Average carbon stock of sparse forest) Summary of the equation: $$ER_y = (A_{B,y} - A_{D,y}) \times (NT_D - NT_S) \times 44/12 \times (1 - DF)$$ ER_y = Net anthropogenic GHG emission reduction by the project in year *y* (t-CO_2e/y) $A_{B,y}$ = The area of stratum *D* in year *y* based on the baseline assumption within

Outline of Calculation	
	the project area (ha) $A_{D,y}$ = The area of stratum D in year y within the project area (ha) NT_D = Carbon stock in the stratum D 'dense forest' in year y (t-C/ha) NT_S = Carbon stock in the stratum S 'sparse forest' in year y (t-C/ha) DF = Discount factor (20% was applied as a conservative accounting, comparing with other project level application, such as the JCM-REDD+ Cambodia as 20%, and VCS project ranging from 15-30%.)
Project Boundary	➢ Project boundary: The spatial extent of the project boundary encompasses the project village areas. ➢ Gases - GHG sources included in the project boundary: Carbon dioxide (CO_2) (Methane (CH_4), Nitrous Oxide (N_2O), and Fluorinated gases are excluded). ➢ Carbon pool included in the project boundary: Above-ground biomass and Below-ground biomass. (Dead wood, litter, soil organic carbon, and wood products are excluded.) ➢ Forest definition[5]: - 'Dense forest' is defined as a land with tree crown cover of more than 60% and more than 0.5 ha. - 'Sparse forest' is defined as a land with tree crown cover of more than 10% and more than 0.5 ha. ➢ Leakage: Migration of many farmers and farming activities out of the project boundary is not assumed in the course of the project implementation.
Assumptions	1) The area of dense forests under "with-project" condition is estimated by assuming that the degradation rate would be reduced gradually and stopped 5 years after the village regulations are in place in the project villages; 2) The area of dense forests under "without-project" condition (the baseline scenario) is estimated by assuming that dense forest would be reduced at the current degradation rates of 3.5% ~ 8.6% p.a. of the respective watersheds (5.8% p.a. on average). 3) Average carbon stock of dense forest is 272.4 tC or 998.1 tCO_{2eq} per ha[6]; 4) Average carbon stock of sparse forest is 97.9 tC or 358.9 tCO_{2eq} per ha. The estimated reduction of CO_2 emissions is adjusted by the discount factor of 20% in consideration of the potential risk of reversals of net emission reduction due to unexpected events or changes of internal/external conditions, as a conservative rate.
Evaluation period	The evaluation period is set as 20 years, which is the same as the project life.

Source: JICA (2020)

The total reduced CO_2 emission in each watershed over the project life span are summarized below.

Table 5-3 Summary of the reduced CO_2 emission

Watershed	Reduced CO_2 emission (tCO_2)
Laclo	1,858,622
Comoro	536,581
Tafara	547,964
Caraulun	1,471,915
Overall	4,415,082

Source: JICA (2020)

5 Refer to the definition used by the National Forest Conservation Plan, JICS, 2012 with adjustment based on FAO definition (FRA 2015, Terms and Definitions).

6 Carbon stock was calculated by using the volume equation form proposed by FAO and default value from IPCC Guidelines for National Greenhouse Gas Inventories (2006) and Good Practice Guidance for Land Use, Land-Use Change and Forestry (2003).

Details of the calculation of the reduced CO_2 emission are further described in the following sections.

5.3 Reduced CO_2 Emissions through Reduction of Forest Degradation

5.3.1 Reduction of Forest Degradation

As indicated in chapter 4, the impact assessment survey conducted by the JICA CBNRM Project reveals that Activities 1.1.1, 1.2.1 and 1.2.2, namely i) PLUP with CCVA, ii) Enhancement of local governance capacity for sustainable NRM with village level regulations, and iii) Formation and operation of watershed management councils as coordination platforms at post-administrative/ sub-watershed level, could drastically reduce the degradation rate as they can effectively address shifting cultivation, forest fires, and other major drivers of forest degradation in the target watersheds.

It was, therefore, assumed that the forest degradation rates of 3.5~8.6%/year of the respective target watersheds (5.8 %/year on average) would be constantly reduced at a rate of 20% annually after completion of PLUP and cut to zero within 5 years after PLUP under the "with-project" condition. In contrast, the areas of dense forests in the four watersheds were presumed to constantly reduce at the same degradation rates observed between 2003 and 2012 under the "without-project" condition as the baseline.

The following table shows the effect of reduction of forest degradation by implementation of PLUP or Activities 1.1.1 and 1.2.1 in the target watersheds under the assumption explained above. Details of calculation are described in **Table 2** and **Appendix-1**.

Table 5-4 Effects of reducing forest degradation under with-project conditions

Year	Number of villages to be introduced PLUP in the watersheds				Total areas to be introduced PLUP in the watersheds (%)				Reduction rate of forest degradation in the watersheds (%)			
	Laclo	Comoro	Tafara	Caraulun	Laclo	Comoro	Tafara	Caraulun	Laclo	Comoro	Tafara	Caraulun
2021	5	4	1	3	13.7	17.5	8.8	11.6	0.0	0.0	0.0	0.0
2022	8	4	3	5	35.6	34.9	35.2	30.8	2.7	3.5	1.8	2.3
2023	9	3	3	6	60.3	48.0	61.6	53.9	9.9	10.5	8.8	8.5
2024	8	3	3	6	82.2	61.1	88.0	77.1	21.9	20.1	21.1	19.3
2025	0	0	0	0	82.2	61.1	88.0	77.1	38.4	32.3	38.7	34.7
2026	0	0	0	0	82.2	61.1	88.0	77.1	54.8	44.5	56.3	50.1
2027	0	0	0	0	82.2	61.1	88.0	77.1	68.5	53.2	72.2	63.2
2028	0	0	0	0	82.2	61.1	88.0	77.1	77.8	58.5	82.7	72.4
2029	0	0	0	0	82.2	61.1	88.0	77.1	82.2	61.1	88.0	77.1
2030	0	0	0	0	82.2	61.1	88.0	77.1	82.2	61.1	88.0	77.1
2031	0	0	0	0	82.2	61.1	88.0	77.1	82.2	61.1	88.0	77.1
2032	0	0	0	0	82.2	61.1	88.0	77.1	82.2	61.1	88.0	77.1
2033	0	0	0	0	82.2	61.1	88.0	77.1	82.2	61.1	88.0	77.1
2034	0	0	0	0	82.2	61.1	88.0	77.1	82.2	61.1	88.0	77.1
2035	0	0	0	0	82.2	61.1	88.0	77.1	82.2	61.1	88.0	77.1
2036	0	0	0	0	82.2	61.1	88.0	77.1	82.2	61.1	88.0	77.1
2037	0	0	0	0	82.2	61.1	88.0	77.1	82.2	61.1	88.0	77.1
2038	0	0	0	0	82.2	61.1	88.0	77.1	82.2	61.1	88.0	77.1
2039	0	0	0	0	82.2	61.1	88.0	77.1	82.2	61.1	88.0	77.1
2040	0	0	0	0	82.2	61.1	88.0	77.1	82.2	61.1	88.0	77.1

Source: JICA (2020)

Areas of dense forests under the "with-project" condition were estimated by multiplying the reduction rate of forest degradation indicated above with the annual incremental areas of degraded forests in the respective target watersheds under the "without-project" conditions. The results of the estimation are shown below.

Table 5-5 Areas of Dense Forests in the Target Watersheds under the With-Project and Without-Project Conditions

(unit: ha)

Year	With-Project Condition					Without-Project Condition				
	Laclo	Comoro	Tafara	Caraulun	Total	Laclo	Comoro	Tafara	Caraulun	Total
2021	12,563	3,064	2,649	6,669	24,945	12,563	3,063	2,649	6,669	24,945
2022	12,139	2,889	2,425	6,212	23,665	12,127	2,882	2,421	6,201	23,631
2023	11,760	2,737	2,234	5,814	22,545	11,706	2,712	2,212	5,766	22,395
2024	11,442	2,609	2,083	5,487	21,621	11,299	2,552	2,021	5,361	21,233
2025	11,200	2,507	1,976	5,241	20,924	10,907	2,401	1,847	4,985	20,139
2026	11,029	2,428	1,907	5,066	20,430	10,528	2,259	1,688	4,635	19,110
2027	10,914	2,366	1,867	4,946	20,093	10,162	2,125	1,543	4,309	18,140
2028	10,836	2,314	1,844	4,862	19,856	9,809	2,000	1,410	4,007	17,226
2029	10,775	2,268	1,829	4,798	19,670	9,468	1,882	1,288	3,726	16,364
2030	10,717	2,225	1,816	4,738	19,496	9,139	1,770	1,177	3,464	15,551
2031	10,661	2,184	1,804	4,682	19,331	8,822	1,666	1,076	3,221	14,785
2032	10,607	2,146	1,793	4,630	19,176	8,515	1,567	983	2,995	14,061
2033	10,554	2,110	1,783	4,582	19,029	8,220	1,475	898	2,785	13,377
2034	10,503	2,076	1,774	4,537	18,890	7,934	1,388	821	2,589	12,732
2035	10,454	2,044	1,765	4,495	18,758	7,659	1,306	750	2,407	12,122
2036	10,407	2,014	1,757	4,456	18,634	7,392	1,228	686	2,238	11,545
2037	10,361	1,986	1,750	4,420	18,517	7,136	1,156	627	2,081	10,999
2038	10,317	1,960	1,744	4,387	18,408	6,888	1,088	573	1,935	10,483
2039	10,275	1,935	1,738	4,356	18,304	6,649	1,023	523	1,799	9,994
2040	10,234	1,912	1,733	4,327	18,206	6,418	963	478	1,673	9,532

Source: JICA (2020)

Hence the area of dense forest protected by the project was estimated by calculating difference in dense forest areas under the "with-project" and "without-project" conditions. The following is the calculation formula used for estimation.

Areas of dense forest protected ＝ Areas of dense forest with-project － Areas of dense forest without-project

As indicated in the table below, approximately 2,000 ha of dense forest is expected to be protected by the project at the end of the project in 2027, and more than 8,600 ha of dense forest can be protected from forest degradation during the project life span (by 2040). Details of calculation are described in **Table 3** and **Appendix-1**.

Table 5-6 Dense Forest protected by the Project

Year					
	Laclo	Comoro	Tafara	Caraulun	Total
2021	0	0	0	0	0
2022	12	7	4	11	34
2023	54	25	22	48	149
2024	143	57	62	126	388
2025	293	106	129	256	784
2026	501	169	219	431	1,320
2027	752	241	324	637	1,954
2028	1,027	314	434	855	2,630
2029	1,307	386	541	1,072	3,306
2030	1,578	455	639	1,274	3,946
2031	1,839	518	728	1,461	4,546
2032	2,092	579	810	1,635	5,116
2033	2,334	635	885	1,797	5,651
2034	2,569	688	953	1,948	6,158
2035	2,795	738	1,015	2,088	6,636
2036	3,015	786	1,071	2,218	7,090
2037	3,225	830	1,123	2,339	7,517
2038	3,429	872	1,171	2,452	7,924
2039	3,626	912	1,215	2,557	8,310
2040	3,816	949	1,255	2,654	8,674

Source: JICA (2020)

In the estimations above, the potential leakage was assumed to be zero, since the village-level NRM regulations with continuous governance capacity enhancement as well as local livelihood improvement was expected to cause a behavioural change among local communities in the target villages. Operations of the watershed management councils at post-administrative level was also expected to enhance the village level mechanism and result in the reduction of inter-village cases of illegal cutting, wildfires, and animal grazing in the sub-watersheds/ post-administratives. As for firewood collection for household consumption, local communities in the target villages collect dead trees/ fallen branches and/or prune branches of shade trees in coffee plantations and regenerated trees in fallow areas for shifting cultivation. Thus, the introduction of the village-level regulations is not expected to affect their firewood collection practices or cause any shifting of firewood collection activities to existing forests, particularly dense forests, in the target villages. If anything, the project activities of Activities 2.1.1 (micro programs) and 2.3.1 (CF) will enable local communities to sustainably produce firewood trees in their own lands through reforestation, production of fodder trees, and introduction improved silvicultural practices. The potential leakages will also be monitored by the use of monthly monitoring meetings arranged under Activity 1.2.1. If any leakage, namely overexploitation of firewood in existing forests, is reported in the meetings, TET and MAF Monitoring Teams will conduct a drone survey as well as field observation survey to assess the impact on the reduced GHG emissions.

5.3.2 Average Carbon Stock of Dense and Sparse Forests

Carbon stocks, which were further converted into CO_2 equivalent, of dense and sparse forests were estimated, respectively. Above-ground and below-ground tree biomasses were counted as major carbon pools of dense and sparse forests. Other carbon pools, i.e. above-ground non-tree biomass, dead wood, litter and soil organic carbon, were not used in the estimation due to a lack of data and also for conservative estimation.

In order to estimate the average stocks in the respective types of forests, NDFWM and NDNC technical officials and forest guards of the respective municipalities concerned conducted the forest inventory survey with technical assistance from the JICA CBNRM Project Phase II from July 2019 to January 2020. To supplement the survey results, data of the Forest Conservation Plan (2012) were also fully used for estimation.

As shown in the table below, the average CO_2 stocks of dense and sparse forests are estimated at 998.1 ton CO_{2eq}/ha and 358.9 ton CO_{2eq}/ha, respectively.

Table 5-7 Average Carbon and CO_2 Stocks in Dense and Sparse Forests in the Watersheds

Watersheds	Dense forest <1		Sparse forest		Balance
	Carbon stock (t C/ha)	CO_2 stock (t CO_{2eq}/ha)	Carbon stock (t C/ha)	CO_2 stock (t CO_{2eq}/ha)	CO_2 stock (t CO_{2eq}/ha)
Laclo	281.4	1031.8	88.3	323.6	708.2
Comoro	241.8	886.5	75.8	277.8	608.7
Tafara	276.7	1014.4	127.7	468.2	546.2
Caraulun	289.0	1059.7	99.9	366.2	693.5
Average	272.2	998.1	97.9	358.9	639.2

Note: CO_2 stock is calculated by multiplying 3.67 with the carbon stocks.
Source: JICA (2020)

5.3.3 Estimation of Reduced CO_2 Emission from Dense Forests

The potential reduced CO_2 emission was estimated by assessing the differences in CO_2 emissions from degradation of dense forest (conversion of dense forest into sparse forest) in the target watersheds under the “with-project” and “without-project” scenarios.

(1) Without-project Scenario (Baseline Scenario)

CO_2 emissions of the baseline scenario from forest degradation in the target watersheds are tabulated below. As shown below, a total of 10.8 million tCO_{2eq} will be emitted from forest degradation in the next 20 years.

Table 5-8 CO_2 Emission from forest degradation in the Target Watersheds under the without-project condition

(unit: tCO_{2eq})

Year	Laclo	Comoro	Tafara	Caraulun	Total
2021	275,117	135,986	136,558	349,532	897,193
2022	265,379	128,194	124,538	324,566	842,677
2023	256,249	120,402	114,162	301,679	792,492
2024	247,727	113,322	104,328	280,874	746,251
2025	238,597	106,946	95,044	260,762	701,349
2026	230,685	100,573	86,849	242,730	660,837
2027	222,772	94,197	79,204	225,394	621,567
2028	214,859	89,239	72,648	210,133	586,879
2029	207,555	83,574	66,092	194,876	552,097
2030	200,251	78,617	60,632	181,702	521,202
2031	192,947	74,367	55,169	168,524	491,007
2032	186,252	69,410	50,798	156,735	463,195
2033	180,165	65,868	46,427	145,636	438,096
2034	174,079	61,618	42,060	135,234	412,991
2035	167,992	58,076	38,782	126,218	391,068
2036	161,905	54,534	35,504	117,205	369,148
2037	156,427	51,704	32,226	108,882	349,239
2038	150,949	48,162	29,495	101,251	329,857
2039	145,471	45,327	26,767	94,318	311,883
2040	140,602	42,497	24,581	87,384	295,064
Total	4,015,980	1,622,613	1,321,864	3,813,635	10,774,092

Source: JICA (2020)

(2) With-project Scenario (Project Scenario)

It was assumed that dense forests located in the project villages, 74 villages in the target watersheds in total, would be protected from degradation under the "with-project" scenario. As mentioned in the previous section, PLUP is expected to exert a reduction effect on forest degradation from the following year after PLUP. The calculation was made on the assumption that the forest degradation rate would be constantly reduced by 20% annually, and become 0% from the 6th year. The following table shows that estimated CO_2 emissions of project scenario

Table 5-9 CO_2 Emissions from forest degradation in the Target Watersheds under the with-project condition

(unit: tCO_{2eq})

Year	Laclo	Comoro	Tafara	Caraulun	Total
2021	275,117	135,986	136,558	349,532	897,193
2022	258,075	123,944	122,353	316,936	821,308
2023	230,685	107,653	104,328	276,019	718,685
2024	193,556	90,655	82,478	226,780	593,469
2025	147,297	72,241	58,447	170,603	448,588
2026	104,082	55,953	37,690	121,367	319,092
2027	69,997	43,912	21,850	83,222	218,981
2028	47,476	36,828	12,562	58,256	155,122
2029	37,129	32,578	8,195	44,385	122,287
2030	35,303	30,455	7,102	41,609	114,469
2031	34,085	29,040	6,556	38,837	108,518

Year	Laclo	Comoro	Tafara	Caraulun	Total
2032	32,868	26,913	6,010	36,062	101,853
2033	32,259	25,498	5,463	33,290	96,510
2034	31,042	24,079	4,917	31,207	91,245
2035	29,825	22,664	4,917	29,128	86,534
2036	28,607	21,248	4,371	27,045	81,271
2037	27,999	19,829	3,824	24,966	76,618
2038	26,781	18,414	3,278	22,887	71,360
2039	25,564	17,706	3,278	21,498	68,046
2040	24,955	16,291	2,732	20,112	64,090
Total	1,692,702	951,887	636,909	1,973,741	5,255,239

Source: JICA (2020)

(3) Estimation of Reduced CO_2 Emissions

The reduced CO_2 emissions in the target watersheds were calculated by assessing the differences in CO_2 emissions under the “with-project” and “without-project” scenarios. The formula used for calculation is shown below.

Reduced CO_2 emission = CO_2 emission under the with-project condition － CO_2 emission under the without-project condition

Annual CO_2 emissions are expected to be reduced by approximately 21,369 ~ 431,757 ton CO_2 as shown in Table 4 as well as the table below. More details are described in **Appendix-1**.

Table 5-10 Estimated Reduction of CO_2 Emission in the Target Watersheds

(unit: tCO_2)

Year	Laclo	Comoro	Tafara	Caraulun	Total
2021	0	0	0	0	0
2022	7,304	4,250	2,185	7,630	21,369
2023	25,564	12,749	9,834	25,660	73,807
2024	54,171	22,667	21,850	54,094	152,782
2025	91,300	34,705	36,597	90,159	252,761
2026	126,603	44,620	49,159	121,363	341,745
2027	152,775	50,285	57,354	142,172	402,586
2028	167,383	52,411	60,086	151,877	431,757
2029	170,426	50,996	57,897	150,491	429,810
2030	164,948	48,162	53,530	140,093	406,733
2031	158,862	45,327	48,613	129,687	382,489
2032	153,384	42,497	44,788	120,673	361,342
2033	147,906	40,370	40,964	112,346	341,586
2034	143,037	37,539	37,143	104,027	321,746
2035	138,167	35,412	33,865	97,090	304,534
2036	133,298	33,286	31,133	90,160	287,877
2037	128,428	31,875	28,402	83,916	272,621
2038	124,168	29,748	26,217	78,364	258,497
2039	119,907	27,621	23,489	72,820	243,837
2040	115,647	26,206	21,849	67,272	230,974
Total	2,323,278	670,726	684,955	1,839,894	5,518,853

Source: JICA (2020)

(4) Adjustment of the Reduced CO_2 Emissions

The reduced CO_2 emissions estimated above were adjusted by the discount factor of 20%[7] in consideration of the potential risks of reversals of net emission reduction due to unexpected

[7] The factor was decided on the basis of the existing cases of REDD+ projects in south East Asian countries.

events or changes of internal and external conditions of the project. The following formula was used for adjustment.

CO_2 emission reductions = Reduced CO_2 emissions x (1-discount factor (20%))

The results of the adjustment are described in Table 5 and Appendix-1, and also summarized below. As a result, the reduced CO_2 emissions are estimated at 17,095 ~ 345,406 ton CO_{2eq}/year. Around 4.4 million tCO_2 eq will be reduced from forest degradation by the project interventions over the project life span.

Table 5-11 Estimated CO_2 emission reductions to be credited in the Target Watersheds

(unit: tCO_2)

Year	Laclo	Comoro	Tafara	Caraulun	Total
2021	0	0	0	0	0
2022	5,843	3,400	1,748	6,104	17,095
2023	20,451	10,199	7,867	20,528	59,046
2024	43,337	18,134	17,480	43,275	122,226
2025	73,040	27,764	29,278	72,127	202,209
2026	101,282	35,696	39,327	97,090	273,396
2027	122,220	40,228	45,883	113,738	322,069
2028	133,906	41,929	48,069	121,502	345,406
2029	136,341	40,797	46,318	120,393	343,848
2030	131,958	38,530	42,824	112,074	325,386
2031	127,090	36,262	38,890	103,750	305,991
2032	122,707	33,998	35,830	96,538	289,074
2033	118,325	32,296	32,771	89,877	273,269
2034	114,430	30,031	29,714	83,222	257,397
2035	110,534	28,330	27,092	77,672	243,627
2036	106,638	26,629	24,906	72,128	230,302
2037	102,742	25,500	22,722	67,133	218,097
2038	99,334	23,798	20,974	62,691	206,798
2039	95,926	22,097	18,791	58,256	195,070
2040	92,518	20,965	17,479	53,818	184,779
Total	1,858,622	536,581	547,964	1,471,915	4,415,082

Source: JICA (2020)

5.4 Potential Impact on CO_2 Emissions from Deforestation

To assess the potential impact on CO_2 emissions from deforestation, the possible reduced CO_2 emissions from reduction of deforestation were also estimated based on the same assumption used for forest degradation. In the assessment, it was assumed that the deforestation rates in the respective watersheds would be constantly reduced by 20% per annum from one year after introduction of PLUP and cut to zero in the 6th year.

The changes in forest areas in the watersheds under the “with-project” and “without-project” conditions and the number of villages where the village-level NRM regulations is in place are shown in **Table 6**, and summarized below.

Table 5-12 Estimated Changes in Forest Areas in the Watersheds

Year	With-Project condition	Without-Project condition	Balance	No. of villages with NRM regulations
2021	111,442 ha	111,442 ha	0 ha	13
2022	109,306 ha	109,253 ha	53 ha	20
2023	107,382 ha	107,135 ha	247 ha	21
2024	105,751 ha	105,086 ha	665 ha	20
2025	104,483 ha	103,103 ha	1,380 ha	0
2026	103,556 ha	101,183 ha	2,373 ha	0
2027	102,904 ha	99,323 ha	3,581 ha	0
2028	102,436 ha	97,522 ha	4,914 ha	0

Year	With-Project condition	Without-Project condition	Balance	No. of villages with NRM regulations
2029	102,059 ha	95,777 ha	6,282 ha	0
2030	101,697 ha	94,086 ha	7,611 ha	0
2031	101,347 ha	92,448 ha	8,899 ha	0
2032	101,009 ha	90,860 ha	10,149 ha	0
2033	100,683 ha	89,321 ha	11,362 ha	0
2034	100,366 ha	87,828 ha	12,538 ha	0
2035	100,060 ha	86,379 ha	13,681 ha	0
2036	99,764 ha	84,973 ha	14,791 ha	0
2037	99,478 ha	83,609 ha	15,869 ha	0
2038	99,201 ha	82,284 ha	16,917 ha	0
2039	98,933 ha	80,998 ha	17,935 ha	0
2040	98,674 ha	79,749 ha	18,925 ha	0

Source: JICA (2020)

As shown in **Table 7**, a total of 78,363 ha of existing forests, of which 16,242 ha are dense forest, are expected to be under the coverage of the village-level NRM regulations, which will be introduced and enhanced by Activities 1.1.1 and 1.2.1.

Tables 8 and **9** show the results of the calculation of reduced CO_2 emission from deforestation in the target watersheds in consideration of the discount factor of 20%. The results of the estimations indicate that around 993,000 tCO_{2eq} may be reduced by the project at the end of the project as shown below.

Table 5-13 Reduced CO_2 Emissions from Deforestation

(Unit: ton CO_2eq)

Items	Laclo	Comoro	Tafara	Caraulun	Total
Reduced CO_2 Emissions from Deforestation after adjustment with DF (20%) in 2027	180,606	116,198	303,906	392,450	993,160
Reduced CO_2 Emission after adjustment with DF (20%) in 2040	1,107,442	490,088	1,639,118	1,984,912	5,221,560

Source: JICA (2020)

5.5 Economic Benefit from Reduced CO_2 Emission

Annex 9 attached to the funding proposal describes the details of economic project benefits generated from reduced CO_2 emissions from reduction of forest degradation by the project activities. In the estimation in Annex 9, the project cost (including co-finance) per tCO_2eq was also estimated to confirm the economic effectiveness and efficiency of the proposed project for climate change mitigation.

The unit cost per tCO_2eq is estimated at US$ 3.38/ tCO_2eq against the overall project cost. Compared to the recent estimate that carbon prices would be at least USD 40-80/tCO_2 by 2020 and USD50-100/tCO_2 by 2030 to reach the objectives of the Paris Agreement[8], the cost for CO_2 saved by the proposed project is highly cost-effective. Since the project might further reduce the emission from deforestation as explained above, and moreover, increase CO_2 absorption by reforestation under Activity 2.1.1, its cost effectiveness is expected to become higher.

[8] CPLC, Report of the High-Level Commission on Carbon Prices, May 29, 2017

It also can be said to be very cost competitive within the forestry sector as well. Because many of the carbon pricing schemes for forests sets the price of US$5 per tCO_2eq (Such as the Forest Carbon Partnership Facility and the GCF Result Based Payment pilot scheme). Given the fact that this project has not only mitigation but also adaptation effects, it can be said that this project is a cost-effective mitigation and adaptation project for climate change impacts in climate vulnerable countries.

6. Monitoring and Reporting Plan

6.1 Monitoring

The project will periodically undertake the following monitoring activities to calculate GHG benefits generated by the project.

- Monitoring of the incidence of major drivers of forest degradation or deforestation (i.e., forest fire and illegal logging) in the target villages.
- Annual monitoring of conditions and status of forests in selected plots in the target villages by using drone/UAV.
- Monitoring of LULC class and forest strata transitions in the selected target villages at the program end evaluation.

(1) Monitoring of the incidence of major drivers of forest degradation or deforestation (i.e., forest fire and illegal logging) in the target villages

Local communities in the target villages will monitor and report the incidence of forest fires, illegal logging, and any types of acts which might cause damage to forests and natural resources in the monthly monitoring meetings arranged under Activity 1.2.1. If there is any large-scale forest fire and illegal logging reported in the meetings, TET will conduct a drone survey together with MAF Monitoring Teams to measure the extents of the damage. Annual reduced CO_2 emissions will be adjusted with the estimated damage based on the drone survey.

(2) Annual monitoring of conditions and status of forests in selected plots in the target villages by using drone/UAV

In addition to the village level monitoring, TET together with MAF Central Project Monitoring Team will monitor the reduction of deforestation and forest degradation and estimate the annual GHG emission reduction so that JICA will report the same to GCF Secretariat in its Annual Performance Report. The following methodologies will be adopted for annual monitoring of the GHG emission reduction.

a) TET and the Central Project Monitoring Team will select one monitoring plot (1 ha) each from dense and sparse forests in the 12 villages selected for baseline data collection in the target 4 watersheds (or the three villages in each target watershed);

b) TET will take aerial photos of the monitoring plots in using drone during or immediate after PLUP in Activity 1.1.1;

c) TET and the Central Project Monitoring Team will select four villages (one village each in the watershed) among the 12 villages every year and take aerial photos of the monitoring plots in the four villages to observe changes in forest cover and status in the plots;

d) TET will estimate the reduction rates in deforestation and forest degradation in the monitoring plots and compare them with the ones used for calculation of the mitigation impact in this proposal;

e) TET will make the necessary adjustment of those used for calculation of the mitigation impact if the rates are lower than originally expected;

f) TET will calculate the GHG emissions in the target villages where the sustainable NRM mechanism is put in place using the reduction rates (the ones either adjusted or originally set) and estimate the annual emission reduction in the villages in comparison to the GHG emissions under BSU scenario;

The results of monitoring of deforestation and forest degradation with geo-referenced data of the monitoring plots will be integrated into the baseline GIS data which will be developed in the initial stage of the proposed project.

The same monitoring activities are expected to be undertaken by MAF in the post-project period by adopting the same procedures as its technical officials could learn the methodologies.

In relation to the above, the GHG emission reductions achieved throughout the duration of the GCF project will be monitored and annually reported through APRs and their annexes, reflecting the monitoring protocol of the emission reduction estimation method adopted.

The TET and Central Project Monitoring team will further clarify the following characteristics of the emission reduction monitoring and reporting protocol based on the above-mentioned methodology.

i. The variables measured on deforestation and forest degradation by names, values and confidence intervals;

ii. The calculation methodologies utilized to measure emissions reductions;

iii. The metadata on the database developed to track annual emissions reductions.; and

iv. The quality assurance/quality control methods used in preparing and reporting the data and the emission reduction calculations.

(3) Monitoring of LULC class and forest strata transition

The drone survey will be conducted at three villages each in the target watersheds for baseline data collection and program-end evaluation. The project will analyze aerial photos taken by the drone survey and develop forest cover and land use maps of the villages. Changes in forest cover and land use in the selected villages during the project period will be analyzed to assess the impact of the proposed project.

6.2 Reporting

JICA will estimate the annual reduced CO_2 with necessary adjustments based on the results of the monitoring activities, particularly (1) and (2) described above. The estimated CO_2 reduction as well as other topics relating to the CO_2 emissions from forests will be reported as part of the annual report to be submitted to GCF.