Annex 9

Economic analysis

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1. Introduction

A cost and benefit analysis including a sensitivity analysis was made to evaluate the proposed project in terms of its economic viability. The project benefits, namely, incremental benefits to be generated by the project, and the project costs were estimated in economic terms for the analysis. The overall framework of the project evaluation, results of the estimation of the project benefits, calculation of the economic project costs, and evaluation of the cost and benefit analysis are described in the sections below.

Overall Framework of Project Evaluation

Items	Description
1) Evaluation Method	A cost and benefit analysis is used for assessment of the project viability. In particular, Economic Internal Rate of Return (EIRR) and the benefit, cost ratio (B/C ratio) and net present values (NPV) are used as indicators for evaluation.
2) Project Benefits used for Evaluation	The following three types of project outcomes are counted as project benefits. - Reduced CO_2 emission through reduction of deforestation and forest degradation by the project* - Increased livelihoods opportunities of local communities participating in hands-on training courses of Activity 2.1.1** - Absorbed CO_2 from the atmosphere through implementation of reforestation/ afforestation micro program whose areas could be used for carbon offsetting projects * Only the benefits from the reduced CO_2 emissions through reduction of forest degradation is estimated in the evaluation since forest degradation or conversion of dense forests is considered as the major source of CO_2 emissions in the country. **For estimation purpose, the agricultural benefit to be generated from training courses on climate resilient agriculture is estimated and used as the benefit of increased livelihood opportunities.
3) Project Cost	Direct project costs and indirect costs except government staff salary are counted as the project costs for the analysis.
4) Inflation	The influence of inflation is not considered in the estimation of the benefits and costs in the future. Likewise, taxes and government subsidies are excluded from the estimation of the project economic cost and benefit.
5) Discount rate	A discount rate of 11.87% is adopted for the calculation of the net present values of the project benefits and costs referring to the average real interest rate in Timor-Leste for the last five years, which is published by World Bank[1]. Although the real interest rate may not necessarily be used as the discount rate for the investment project in Timor-Leste due to market distortions, the rate of 11.87% is still justifiable because of the following reasons: 1) ADB has used 12% as the standard discount rate for any public investment projects in the region until recently. 2) The standard discount rate is now replaced with 9% considering the economic development in the counties in the region. However, Timor-Leste is one of the counties newly established and still categorized as the least developing countries. The 12% is considered still appropriate. 3) The proposed project can be categorized as a social-targeting and environmental protection project, which justify a lower rate (i.e., 6% in the ADB guidelines); hence the evaluation with 11.87% is considered as more conservative.
6) Conversion factor	To correct the price distortion, the conversion factor is to be used for estimation of the project cost. In general, Timor-Leste imports goods with tariff much more than exports the products. Hence, the standard conversion factor (SCF), which much be less than 1.0, should be applied for estimation of appropriate economic values of the project cost. Nevertheless, as the proposed project plan to use few imported/ exported/ subsidized items or goods for implementation of the Activities unlike an infrastructure development project, the SCF of 1.0 is used for simple and quick but conservative assessment. By correcting the price distortion, the total estimated amount of the economic project cost would be lower than financial ones. Hence, the use of the SCF of 1.0 means that

[1] Real interest rate was referred to the data published by World Bank at the URL/https://data.worldbank.org/.

<table>
<tr><th>Items</th><th>Description</th></tr>
<tr><td></td><td>the cost-benefit analysis is made in a conservative way.</td></tr>
<tr><td>7) Evaluation period</td><td>The evaluation period is set as 20 years, which is the same as the project life.</td></tr>
<tr><td>8) With-project and without-project conditions for estimation of the project benefits</td><td>The project benefits were estimated by comparing “the area of dense forest”, “the production of maize” and “carbon sequestration by afforestation” under the “with-project” and “without project” conditions. The following table shows the basic assumptions in the changes of forest status and agricultural production with-project and without-project conditions.
<table>
<tr><th>Benefit</th><th>With-Project Conditions</th><th>Without-Project Conditions</th></tr>
<tr><td>Area of dense forest</td><td>The reduction rates of dense forest will decline in villages where the village-level NRM or CBNRM mechanism is in place.</td><td>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.</td></tr>
<tr><td>Agricultural production</td><td>Yield of maize produced by trained farmers/ families of Activity 2.1.1 (households who participate in Activity 2.1.1) will increase after the training courses on climate smart agriculture.</td><td>Yield of maize produced by households will be maintained as the status quo. It may range from 0.3 ~ 2.0 ton/ha in the target watersheds based on the sampled survey done in 2018/2019.</td></tr>
<tr><td>Carbon sequestration by afforestation</td><td>Trees planted by reforestation/ afforestation micro program of Activity 2.1.1 will be properly managed by the community.</td><td>Reforestation/ afforestation micro program will not be implemented in the target villages.</td></tr>
</table></td></tr>
</table>

Source: JICA (2020)

In addition to the economic analysis, the possible contribution to the reduction of CO_2 emission from reduction of deforestation is estimated in Chapter 5 of this report. 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.

2. Economic Benefit of the Project

2.1 Summary of the Results of Estimation of Economic Benefits

The following benefits were estimated and converted into monetary value. 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 3 and 6, the focus of the benefit assessment on the reduced CO_2 emissions was placed on those from reduction of forest degradation in this evaluation.

a. Benefits from reduced CO_2 emission through reduction of forest degradation of dense forests in the project villages
b. Benefits from increased maize production in the farms of trained farmers in the project villages

c. Benefits from carbon sequestration by reforestation/ afforestation micro program in the project villages

The methodologies of estimating and calculating the monetary values of the respective benefits are summarized below.

Summary of Methodologies for Estimation of the Project Benefits

Type of benefits	Outline of Calculation
Reduced CO_2 emission	➢ Summary description of the methodology on Project benefits 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) x unit price of CO_2 at the carbon market) 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-CO2e/y) $A_{B,y}$ = The area of stratum *D* in year *y* based on the baseline assumption within 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: ・The spatial extent of the project boundary encompasses the project village areas. ・GHG sources included in the project boundary: CO_2 (CH_4 and N_2O 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: '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.[2] ・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[3]; 4) Average carbon stock of sparse forest is 97.9 tC or 358.9 tCO_{2eq} per ha ; and 5) Unit price of t-CO_{2eq} of US$ 4.2/t CO_{2eq}[4] was applied, which is the average price

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

[3] 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).

Type of benefits	Outline of Calculation
	of carbon credit for REDD+ project in 2016, as a conservative accounting given the GCF REDD+ Result Based Payment pilot phase and other international recognized forest carbon price is US$ 5/t $CO_{2eq.}$ 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. The potential leakage is assumed to be zero, since the village-level NRM regulations with continuous governance capacity enhancement as well as local livelihood improvement is expected to cause a behavioural change among local communities in the target villages. Operations of the watershed management councils at post-administrative level will 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/ posts-administrative. 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.
Increased maize production	➢ Summary description of the methodology on Project benefits Increased maize production =∑((Changes in maize yield under the "with-project" and "without-project" conditions x Average unit farmgate price of maize – Balance amount of the production costs under the "with-project" and "without-project" conditions) x total area of trained farmers' farms) ➢ Assumptions: 1) Maize yield would increase up to 1.5 ton/ha in Laclo and Comoro watersheds (northern parts of the country) and 2.4 ton/ha in Tafara and caraulun watersheds (central and southern parts of the country) one year after 2-year hands-on training courses end in the project villages; 2) Average unit farmgate price of maize is US$ 0.75/ kg; 3) Balance amount of the production costs under both the conditions is estimated by calculating the increased cost of farm laborers; and 4) Total area of farms used by trained farms is estimated by multiplying the number of trained farmers (120 households/village) with the average maize cropping area of household (0.5 ha/household).
Carbon sequestration by reforestation/ afforestation	➢ Summary description of the methodology on Project benefits Project benefits from carbon sequestration by reforestation/ afforestation =∑(Changes in carbon stock of planted trees) x unit price of CO_2 at the carbon market) ➢ Assumptions: 1) Changes in carbon stock of trees planted by the micro program is estimated by referring to the existing carbon offset project in Timor-Leste. The basic conditions of the existing project are as follows: ✓ Tree species: Casuarina angustifolia, Swietenia macrophylla, Gmelina arborea, Tectona grandis, Paraserianthes falcataria and Gliricidia sepium ✓ Carbon pools: Tree biomass (Above and below ground), soil organic carbon, long lived harvested products, litter and dead wood ✓ 15% of risk buffer was applied. ✓ Risk level of leakage was considered low and set zero. 2) Unit price of t-CO_{2eq} of US$ 8.1/t CO_{2eq} was applied, which was the average price of carbon credit for afforestation/reforestation project in 2016.

[4] State of the Voluntary Carbon Markets 2017.

Source: JICA (2020)

The total values of the economic benefits generated in each watershed over the project life span are summarized below.

Summary of the Economic Benefits

Watershed	Type of benefits	Total estimated values
Laclo	Reduced CO_2 emission	US$ 7,806,212
	Increase of maize production	US$ 17,652,240
	Carbon sequestration by reforestation/ afforestation	US$ 48,058
Comoro	Reduced CO_2 emission	US$ 2,253,640
	Increase of maize production	US$ 6,999,960
	Carbon sequestration by reforestation/ afforestation	US$ 21,357
Tafara	Reduced CO_2 emission	US$ 2,301,449
	Increase of maize production	US$ 2,699,640
	Carbon sequestration by reforestation/ afforestation	US$ 16,021
Caraulun	Reduced CO_2 emission	US$ 6,182,045
	Increase of maize production	US$ 5,165,340
	Carbon sequestration by reforestation/ afforestation	US$ 37,377
Overall	Reduced CO_2 emission	US$ 18,543,346
	Increase of maize production	US$ 32,517,180
	Carbon sequestration by reforestation/ afforestation	US$ 122,813

Source: JICA (2020)

Details of the calculation of the project benefits are further described in the following sections.

2.2 Benefits from Reduced CO_2 Emissions through Reduction of Forest Degradation

2.2.1 Reduction of Forest Degradation

As indicated in Section 5.3 of the Pre-FS, the impact assessment survey conducted by the JICA CBNRM Project reveals that the project activities of Activities 1.1.1, 1.2.1 and 1.2.2, namely i) participatory formulation of village regulations, ii) continuous capacity building for sustainable village level governance, and iii) enhancement of adaptive management capacity at post-administrative level, could drastically reduce the degradation rate.

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.

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.

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

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
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.

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).

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

Year	Laclo	Comoro	Tafara	Caraulun	Total
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 estimation above, the potential leakage was assumed to be zero as the village-level NRM regulations with continuous governance capacity enhancement as well as local livelihood improvement is expected to cause a behavioural change among local communities in the target villages. The watershed management councils to be formed and operated in Activity 1.2.2 will also function as a coordination body to address and minimize inter-village issues, particularly the incidence of wildfire, illegal logging, and animal grazing.

2.2.2 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, the 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.

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)

2.2.3 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.

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

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
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

Year	Laclo	Comoro	Tafara	Caraulun	Total
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 the table below.

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 as a result of the project interventions were adjusted by the discount factor of 20%[5] in consideration of the potential risks of reversals of net emission reduction due to unexpected 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 tabulated below. The reduced CO_2 emissions are estimated at 17,095 ~ 345,406 ton CO_{2eq}/year. Around 4.4 million tCO2 eq will be reduced from forest degradation by the project interventions over the project life span. The estimated project cost

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

(including co-finance) per tCO2eq is, therefore, estimated at US$3.38 per tCO2eq for this project overall.

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) Benefits from Reduced CO_2 Emission

The reduced CO_2 emissions were converted into the monetary values by using the market carbon price of US$ 4.2/ t CO_2, which is used for REDD+ project in the voluntary carbon market in 2016[6], to estimate the project benefits from reduced CO_2 emissions. The calculation formula used for estimation is shown below.

Benefits from CO_2 Reduction = Estimated CO_2 emission reductions to be credited x USD 4.2/t CO_2

The estimated annual incremental benefits from reduced CO_2 emission through reduction of forest degradation of dense forest in the target watersheds are shown below. The total benefit from CO_2 reduction during the project life span is estimated at US$ 18,543,346.

Annual and Total Benefits from CO_2 Reduction through Protection of Dense Forests

(unit: US$)

Year	Laclo	Comoro	Tafara	Caraulun	Total
2021	0	0	0	0	0
2022	24,541	14,280	7,342	25,637	71,800
2023	85,895	42,837	33,042	86,218	247,992
2024	182,015	76,161	73,416	181,756	513,348
2025	306,768	116,609	122,966	302,934	849,277
2026	425,386	149,923	165,174	407,780	1,148,263
2027	513,324	168,958	192,709	477,698	1,352,689
2028	562,407	176,101	201,889	510,307	1,450,704
2029	572,631	171,347	194,534	505,650	1,444,162
2030	554,225	161,824	179,861	470,712	1,366,622
2031	533,776	152,299	163,340	435,748	1,285,163
2032	515,370	142,790	150,488	405,461	1,214,109
2033	496,964	135,643	137,639	377,483	1,147,729
2034	480,604	126,131	124,800	349,531	1,081,066

[6] State of the Voluntary Carbon Markets 2017

Year	Laclo	Comoro	Tafara	Caraulun	Total
2035	464,241	118,984	113,786	326,222	1,023,233
2036	447,881	111,841	104,607	302,938	967,267
2037	431,518	107,100	95,431	281,958	916,007
2038	417,204	99,953	88,089	263,303	868,549
2039	402,888	92,807	78,923	244,675	819,293
2040	388,574	88,052	73,413	226,034	776,073
Total	7,806,212	2,253,640	2,301,449	6,182,045	18,543,346

Source: JICA (2020)

2.3 Benefits from Increased Maize Production in Trained Famers' Farms

2.3.1 Estimation of Increased Maize Yields under the With-Project and Without-Project Conditions

Maize yield under the with-project condition was estimated by fully referring to the results of the impact survey made by the JICA. The same survey indicated that the project interventions, namely enhancement of local capacity for climate resilient agriculture through hands-on training, would increase maize yield by 1.5 ton/ha even under the unfavorable weather conditions in the drier areas and 2.4 ton/ha under the normal weather conditions in the same areas.

Consequently, the potential increase of yield which trained farmers could achieve was set at 1.5 ton/ha in Laclo and Comoro watershed and 2.4 ton/ha in Tafara and Caraulun watersheds for conservative estimation of the total incremental maize production. It was also assumed that the yield would achieve 50% of the target in the 2nd year (or the last year) of the training courses and 100% of the same in the 3rd year (or one year after the end of the training courses) in the target villages.

2.3.2 Estimation of Crop Budgets under the With-Project and Without-Project Conditions

Crop budgets of maize production by trained farmers under the with-project and without-project conditions were also estimated by converting maize production and family labor cost into monetary values. The table below compares the estimated crop budgets per household between the with-project and without-project conditions, taking into account the opportunity costs for crop production in shifting cultivation areas by households who convert the farming practices.

Estimated Crop Budgets for Laclo and Comoro watersheds

Items	Under the with-project condition					Under the without-project condition							Incremental Benefit =1)-2)-3) (USD/hh)
	Value from land with Climate-resilient agriculture					Value from the existing land					Opportunity cost of giving up shifting cultivation***		
	Q'ty (kg/ha)	Price (USD)	Value (USD/ha)	Land size (ha/HH)	1) Value (USD/hh)	Q'ty (kg/ha)	Price (USD)	Value (USD/ha)	Land size (ha/HH)	2) Value (USD/hh)	Land size (ha/HH)	3) Value (USD/hh)	
Total production & sales													
2nd year (50%)*	900	0.75	675	0.5	337.5	300	0.75	225	0.5	112.5	0.5	112.5	
3rd year on wards (100%)**	1500	0.75	1,125	0.5	562.5	300	0.75	225	0.5	112.5	0.5	112.5	
Production cost													
Family labor	40 MD	4	160	0.5	80.0	22MD	4	88	0.5	44.0			
Gross Profits													
2nd year (50%)*			515	0.5	257.5			137	0.5	68.5	0.5	68.5	121
3rd year on wards (100%)**			965	0.5	482.5			137	0.5	68.5	0.5	68.5	346

Note: * Baseline value (300kg)+ Incremental effects (1200kg) x 50% ** Baseline value (300kg) +Incremental effects (1200kg) x 100%, *** The value from land that should have been expanded/ used for shifting cultivation.

Source: JICA (2020)

Estimated Crop Budgets for Tafara and Caraulun watersheds

Items	Under the with-project condition					Under the without-project condition							Incremental Benefit =1)-2)-3) (USD/hh)
	Value from land with Climate-resilient agriculture					Value from the existing land					Opportunity cost of giving up shifting cultivation***		
	Q'ty (kg/ha)	Price (USD)	Value (USD/ha)	Land size (ha/HH)	1) Value (USD/hh)	Q'ty (kg/ha)	Price (USD)	Value (USD/ha)	Land size (ha/HH)	2) Value (USD/hh)	Land size (ha/HH)	3) Value (USD/hh)	
Total production & sales													
2nd year (50%)*	1700	0.75	1,275	0.5	637.5	1000	0.75	750	0.5	375.0	0.5	375.0	
3rd year on wards (100%)**	2400	0.75	1,800	0.5	900.0	1000	0.75	750	0.5	375.0	0.5	375.0	
Production cost													
Family labor	40 MD	4	160	0.5	80.0	22MD	4	88	0.5	44.0			
Gross Profits													
2nd year (50%)*			1,115	0.5	557.5			662	0.5	331.0	0.5	331.0	-105
3rd year on wards (100%)**			1,640	0.5	820.0			662	0.5	331.0	0.5	331.0	158

Note: * Baseline value (1000kg) + Incremental effects (1400kg) x 50% ** Baseline value (1000kg) +Incremental effects (1400kg) x 100%, *** The value from land that should have been expanded/ used for shifting cultivation.

Source: JICA (2020)

Any farm inputs except family laborers were not counted in the estimation of crop budgets, as no external input, such as commercial fertilizer or agrochemical, is used for maize production under both the conditions.

In the estimation given above, the average farmgate prices of maize and family labor were set at USD 0.75/ kg and USD 4.0/MD, respectively. The incremental benefits per household (HH) in the 3rd year and afterwards were estimated at USD 346/HH in Laclo and Comoro watersheds, USD 158/HH in Tafara and Caraulun watersheds.

2.3.3 Estimation of Total Beneficiaries and Areas used for Maize Production

It was assumed that all the 68 villages covered by Activity 2.1.1 would choose "climate resilient agriculture" as the topics of hands-on training on climate change adaptation measure and 120 HHs/ families in each village would take part in the training courses. Hence, 120 farmers/ families per village and 8,160 HHs/ families in total are expected to learn climate resilient agriculture techniques through the 2-year training courses. (8,160 HHs = 120 families/village x 68 villages)

Assuming that each trained farmer would apply the learned techniques to 0.5 ha of their farms for upland crop production, it was estimated that 60 ha of upland farms per village or 4,080 ha of upland farms in total will be used for maize production with climate resilient agriculture techniques.

2.3.4 Estimation of Benefit from Increased Maize Production

The total incremental benefits in the target watersheds were estimated by summing up those of the target villages according to the work schedule of Activity 2.1.1. The results of the calculation are summarized below. The total benefit during evaluation period is US$ 32,517,180.

Benefit from yield increase of agricultural products

(unit: US$)

Year	Laclo	Comoro	Tafara	Caraulun	Total
2021	0	0	0	0	0
2022	0	0	0	0	0
2023	28,920	14,460	-12,540	-25,080	5,760
2024	169,680	84,840	-6,120	-12,240	236,160
2025	461,820	209,220	19,260	38,520	728,820
2026	820,500	333,600	76,140	152,280	1,382,520

Year	Laclo	Comoro	Tafara	Caraulun	Total
2027	1,079,880	429,060	158,100	328,740	1,995,780
2028	1,160,880	456,060	189,600	360,240	2,166,780
2029	1,160,880	456,060	189,600	360,240	2,166,780
2030	1,160,880	456,060	189,600	360,240	2,166,780
2031	1,160,880	456,060	189,600	360,240	2,166,780
2032	1,160,880	456,060	189,600	360,240	2,166,780
2033	1,160,880	456,060	189,600	360,240	2,166,780
2034	1,160,880	456,060	189,600	360,240	2,166,780
2035	1,160,880	456,060	189,600	360,240	2,166,780
2036	1,160,880	456,060	189,600	360,240	2,166,780
2037	1,160,880	456,060	189,600	360,240	2,166,780
2038	1,160,880	456,060	189,600	360,240	2,166,780
2039	1,160,880	456,060	189,600	360,240	2,166,780
2040	1,160,880	456,060	189,600	360,240	2,166,780
Total	17,652,240	6,999,960	2,699,640	5,165,340	32,517,180

Source: JICA (2020)

2.4 Benefits from Carbon Sequestration by Reforestation/ Afforestation activities

2.4.1 Net Benefit of Carbon Sequestration by Reforestation/ Afforestation

The amount of carbon dioxide absorption of trees planted by reforestation/ afforestation micro program under Activity 2.1.1 was estimated by fully referring to the existing carbon offset project named "Halo Verde Timor Community Forest Carbon project" in Timor-Leste. The project planted 6 tree species about 75 ha in 9 villages in Manatuto Municipality. The estimated average net benefits from the plantations for 20 years are tabulated below.

Average net benefit reported by Halo Verde Timor Community Forest Carbon project

Age of planted tree (year)	Average net benefit (tCO_2/ha)	Annual net benefit (tCO_2/ha/year)
1	8.4	8.4
2	13.9	5.5
3	19.7	5.8
4	25.4	5.7
5	30.7	5.3
6	36.1	5.4
7	41.8	5.7
8	46.8	5.0
9	52.4	5.6
10	58.2	5.8
11	64.0	5.8
12	70.1	6.1
13	75.9	5.8
14	82.4	6.5
15	89.4	7.0
16	96.9	7.5
17	104.9	8.0
18	113.5	8.6
19	122.6	9.1
20	132.4	9.8

Source: Project Design Document of Halo Verde Timor Community Forest Carbon (2020)

The same assumptions and estimation employed by the Halo Verde Timor Community Forest Carbon project were used for estimation of carbon sequestration by plantations developed by reforestation/ afforestation micro program of the proposed project.

2.4.2 Plantation Area of Community Nursery and Reforestation program

Assuming that reforestation/ afforestation micro program will be implemented in one third of the target villages or 23 villages in the target watersheds and each village will develop a total of 8 ha of new plantation, which is the same size as the villages of the Halo Verde Timor

Community Forest Carbon project developed, the total plantation areas to be developed in the respective watersheds are estimated as shown below.

Plantation area for reforestation/ afforestation activities

Watersheds	Target villages for Activity 2.1.1	No of villages targeted by Refo/Affo MP	Plantation area (ha)
Laclo	28	9	72
Comoro	11	4	32
Tafara	10	3	24
Caraulun	19	7	56
Average	68	23	184

Source: JICA (2020)

2.4.3 Estimation of Benefits from Carbon Sequestration by Reforestation/ Afforestation

(1) Estimation of CO_2 absorption from the atmosphere

The amount of carbon sequestration by reforestation/ afforestation in the target watersheds were calculated by multiplying annual net CO_2 absorption with the estimated plantation area of each watershed. The formula used for calculation is shown below.

Estimated CO_2 absorption from the atmosphere = Annual net CO_2 absorption of existing carbon offset project x Plantation area of each watershed

Annual CO_2 absorption from the atmosphere is expected to be reduced by approximately 920 ~ 1,546 ton CO_2 as shown in the table below.

Estimated CO_2 absorption from the atmosphere by reforestation/ afforestation in the Target Watersheds

(unit: tCO_2)

Year	Laclo	Comoro	Tafara	Caraulun	Total
2021	0	0	0	0	0
2022	0	0	0	0	0
2023	0	0	0	0	0
2024	0	0	0	0	0
2025	0	0	0	0	0
2026	0	0	0	0	0
2027	605	269	202	470	1,546
2028	396	176	132	308	1,012
2029	418	186	139	325	1,067
2030	410	182	137	319	1,049
2031	382	170	127	297	975
2032	389	173	130	302	994
2033	410	182	137	319	1,049
2034	360	160	120	280	920
2035	403	179	134	314	1,030
2036	418	186	139	325	1,067
2037	418	186	139	325	1,067
2038	439	195	146	342	1,122
2039	418	186	139	325	1,067
2040	468	208	156	364	1,196
Total	5,933	2,637	1,978	4,614	15,162

Source: JICA (2020)

(2) Benefits from carbon sequestration by reforestation/ afforestation

The amount of carbon sequestration from the atmosphere by reforestation/ afforestation micro program was converted into the monetary values by using the market carbon price of US$ 8.1/ t CO_2, which was used for reforestation/ afforestation project in the voluntary

carbon market in 2016[7], to estimate the project benefits from carbon sequestration by reforestation/ afforestation. The calculation formula used for estimation is shown below.

Benefits from Carbon sequestration = Estimated CO_2 absorption from the atmosphere by reforestation/ afforestation *x USD 8.1/t* CO_2

As reforestation/ afforestation micro program of Activity 2.1.1 will be finished in 2027, it was assumed that the incremental project benefit of carbon sequestration would start in 2027 for conservative estimation. As a result, the total benefit from carbon sequestration during the project life span is estimated at US$ 122,813.

Benefit from carbon sequestration by reforestation/ afforestation activities

(unit: US$)

Year	Laclo	Comoro	Tafara	Caraulun	Total
2021	0	0	0	0	0
2022	0	0	0	0	0
2023	0	0	0	0	0
2024	0	0	0	0	0
2025	0	0	0	0	0
2026	0	0	0	0	0
2027	4,899	2,177	1,633	3,810	12,519
2028	3,208	1,426	1,069	2,495	8,198
2029	3,383	1,503	1,128	2,631	8,645
2030	3,324	1,477	1,108	2,586	8,495
2031	3,091	1,374	1,030	2,404	7,899
2032	3,149	1,400	1,050	2,449	8,048
2033	3,324	1,477	1,108	2,586	8,495
2034	2,916	1,296	972	2,268	7,452
2035	3,266	1,452	1,089	2,540	8,347
2036	3,383	1,503	1,128	2,631	8,645
2037	3,383	1,503	1,128	2,631	8,645
2038	3,558	1,581	1,186	2,767	9,092
2039	3,383	1,503	1,128	2,631	8,645
2040	3,791	1,685	1,264	2,948	9,688
Total	48,058	21,357	16,021	37,377	122,813

Source: JICA (2020)

3 Economic Cost

3.1 Project cost

As explained in Chapter 1 of this Annex, the SCF (Standard Conversion Factor) of 1.0 was used for estimation of the economic costs of the project components. Consequently, the total economic cost of the project was estimated at US$ 15.4 million as shown below.

Table Economic Cost of the Project

(unit: US$)

	Cost Items (Output)	Financial Cost	SCF	Economic Cost
Component 1	Activity 1.1.1	2,366,939	1.0	2,366,939
	Activity 1.2.1	1,237,619	1.0	1,237,619
	Activity 1.2.2	709,033	1.0	709,033
Component 2	Activity 2.1.1	6,885,182	1.0	6,885,182
	Activity 2.2.1	229,829	1.0	229,829
	Activity 2.3.1	1,331,517	1.0	1,331,517
	Activity 2.4.1	24,773	1.0	24,773
Component 3	Activity 3.1.1	216,842	1.0	216,842
	Activity 3.2.1	261,056	1.0	261,056
	Activity 3.3.1	199,742	1.0	199,742

[7] State of the Voluntary Carbon Markets 2017

	Cost Items (Output)	Financial Cost	SCF	Economic Cost
Component 4	Activity 3.4.1	342,972	1.0	342,972
	Activity 4.1.1	28,350	1.0	28,350
	Activity 4.1.2	267,778	1.0	267,778
	Activity 4.2.1	140,404	1.0	140,404
Project management	Preparatory works, planning, procurement, monitoring, and coordination	912,811	1.0	912,811
Contingency	2.5% of total GCF cost	243,322	1.0	243,322
TOTAL		**15,398,169**		**15,398,169**

Source: JICA (2020)

3.2 Operation and Maintenance Cost

Expenditures required for maintenance of the project effects at village and post-administrative levels were counted as operation and maintenance costs. Follow-up meetings, extension services and follow-up training, and regular meetings of the watershed management councils, which would be done on the initiative of MAF/DGFCIP, and Municipal Administrative Offices concerned, would be included. It was assumed that 1% of the Activities 1.1.1, 1.2.1, 1.2.2 and 2.1.1 would be allocated as annual O&M cost in the post-project period. The annual O&M cost in the post project period is estimated at USD 111,988/ year.

4. Cost-Benefit Analysis

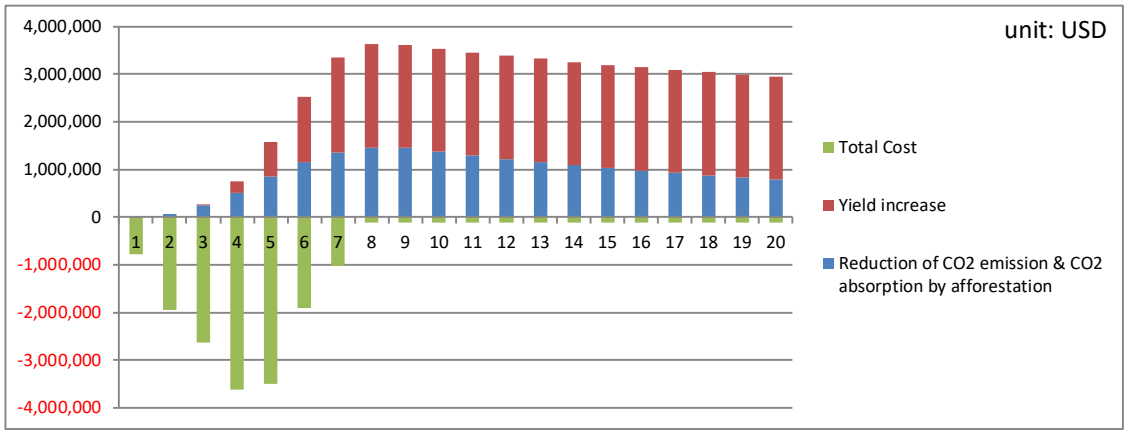
4.1 Cash Flow Analysis

The cash flow of the economic cost and benefits during the project life span is presented in the table and figure shown below.

Cash Flow of Economic Costs and Benefits of the Project

Year	Project Cost			O&M Cost		Total Cost	Benefit			Total Benefit	Balance
	Activities 1.1.1, 1.2.1 and 1.2.2	Activity 2.1.1	Others	Activities 1.1.1, 1.2.1 and 1.2.2	Activity 2.1.1		Yield increase	Reduction of GHG emission	CO2 absorption by afforestation		
1	359,917	77,222	334,065			771,205	0	0	0	0	-771,205
2	877,414	496,020	581,791			1,955,226	0	71,800	0	71,800	-1,883,426
3	984,399	1,144,379	496,603			2,625,381	5,760	247,992	0	253,752	-2,371,629
4	1,106,798	1,738,310	770,915			3,616,024	236,160	513,348	0	749,508	-2,866,516
5	678,029	1,912,336	915,561			3,505,925	728,820	849,277	0	1,578,097	-1,927,828
6	211,834	1,127,097	572,055			1,910,985	1,382,520	1,148,263	0	2,530,783	619,798
7	95,200	389,817	528,406			1,013,423	1,995,780	1,352,689	12,519	3,360,988	2,347,565
8				43,136	68,852	111,988	2,166,780	1,450,704	8,198	3,625,682	3,513,694
9				43,136	68,852	111,988	2,166,780	1,444,162	8,645	3,619,587	3,507,599
10				43,136	68,852	111,988	2,166,780	1,366,622	8,495	3,541,897	3,429,909
11				43,136	68,852	111,988	2,166,780	1,285,163	7,899	3,459,842	3,347,854
12				43,136	68,852	111,988	2,166,780	1,214,109	8,048	3,388,937	3,276,949
13				43,136	68,852	111,988	2,166,780	1,147,729	8,495	3,323,004	3,211,016
14				43,136	68,852	111,988	2,166,780	1,081,066	7,452	3,255,298	3,143,310
15				43,136	68,852	111,988	2,166,780	1,023,233	8,347	3,198,360	3,086,372
16				43,136	68,852	111,988	2,166,780	967,267	8,645	3,142,692	3,030,704
17				43,136	68,852	111,988	2,166,780	916,007	8,645	3,091,432	2,979,444
18				43,136	68,852	111,988	2,166,780	868,549	9,092	3,044,421	2,932,433
19				43,136	68,852	111,988	2,166,780	819,293	8,645	2,994,718	2,882,730
20				43,136	68,852	111,988	2,166,780	776,073	9,688	2,952,541	2,840,553
					NPV	11,415,047	9,591,972	6,462,167	34,035	16,088,174	4,673,127

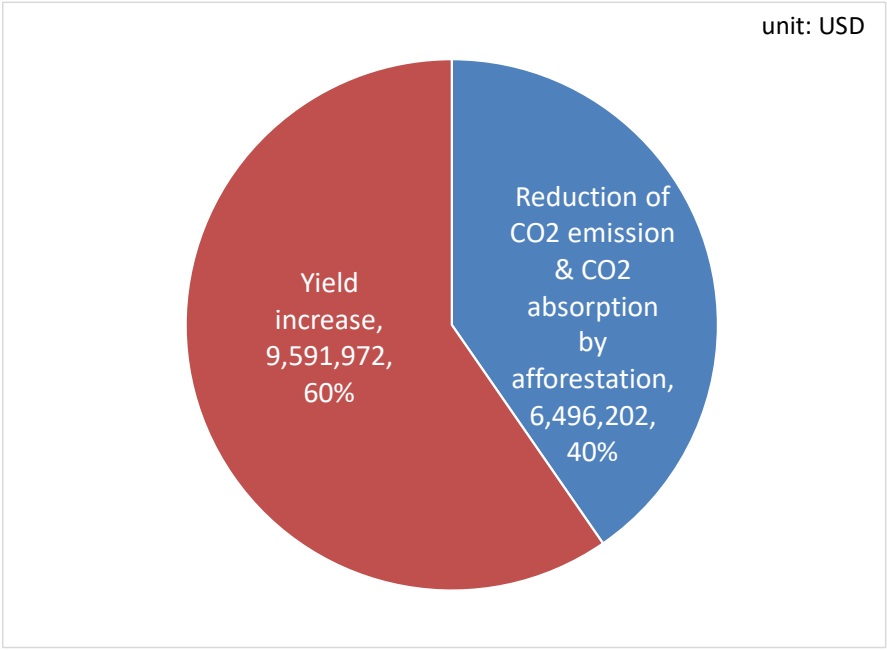
Source: JICA (2020)



Cash Flow of Economic Costs and Benefits of the Project

Source: JICA (2020)

The composition of the present value of the benefits is shown in the figure below. The benefit from reduced CO_2 emissions and absorption of CO_2 from the atmosphere account for 40% of the total amount, while the rest, 60% of the total amount, derives from the benefit from increased maize production



Share of the Present Value of Benefit

Source: JICA (2020)

The economic rate of return (EIRR), cost-benefit ratio (B/C) and the net present values (NPV) were estimated by using the discount rate of 11.87% to validate the economic feasibility of the project. The results of the respective indicators are shown below.

Table Result of Economic Analysis each watershed

Watershed	EIRR	B/C	NPV (US$)
Overall	18.7%	1.41	4,673,127

Source: JICA (2020)

As the B/C is above 1.0, validity of the project to be implemented as public project is confirmed. The results also showed that the project economic viability turned positive from

the year 6 of the project, and the project was predicted to generate benefits throughout the lifetime period of the project.

4.2 Sensitivity Analysis

To evaluate the reliability and stability of the project effect from the economic viewpoint, a sensitive analysis was made with the following scenarios. Increase of work volume or project inputs and delay in the project activities due to unpredictable reasons are considered as the main factors affecting the project cost, while the price fall of carbon values and maize price in the markets is the major factor affecting the project benefit.

- Case 1: 10% increase of the project cost
- Case 2: 20% increase of the project cost
- Case 3: 10% reduction of the project benefit
- Case 4: 20% reduction of the project benefit
- Case 5: 10% increase of the project cost &10% reduction of the project benefit
- Case 6: 10% increase of the project cost &20% reduction of the project benefit
- Case 7: 20% increase of the project cost &10% reduction of the project benefit
- Case 8: 20% increase of the project cost &20% reduction of the project benefit

The calculation results of the sensitivity analysis are shown in the table below.

Result of Sensitivity Analysis of the Economic Analysis of the Project

	EIRR	EIRR Difference from the Base Case	B/C	NPV (US$)
Base Case	18.7%	-	1.41	4,673,127
Case1: Cost +10%	16.7%	- 2.0%	1.28	3,531,623
Case2: Cost +20%	14.9%	- 3.8%	1.17	2,390,118
Case3: Benefit -10%	16.5%	- 2.2%	1.27	3,064,310
Case4: Benefit -20%	14.1%	- 4.6%	1.13	1,455,493
Case5: Cost +10% & Benefit -10%	14.6%	- 4.1%	1.15	1,922,805
Case6: Cost +10% & Benefit -20%	12.3%	- 6.4%	1.03	313,988
Case7: Cost +20% & Benefit -10%	12.9%	-5.8%	1.06	781,301
Case8: Cost +20% & Benefit -20%	10.8%	- 7.9%	0.94	-827,517

Source: JICA (2020)

The sensitivity analysis indicates that the project may be still feasible even under the scenario of 10% reduction of project benefits plus 20% increase of project costs or 20% reduction of project benefits plus 10% increase of project costs.

5. 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 estimated based on the same assumption used for the assessment of reduced CO_2 emissions from 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 6^{th} 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 1 and summarized below.

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
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 2, 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 3 and 4 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.

Reduced CO_2 Emissions from Deforestation

(Unit: ton CO2eq)

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)

Furthermore, the estimated project cost (including co-finance) per tCO_2eq was US$ 3.38/ tCO_2eq for this project overall. Compared to the estimate that carbon prices are needed to 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], this proposed project can be said as a cost-effective way to reduce carbon emission. Since the project would further reduce the emission from deforestation as explained above, and moreover, increase CO_2 absorption by reforestation under CF, its cost effectiveness is expected to become higher. Hence, 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

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

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.

6 Other Intangible Benefits/Impacts of the Project

In addition to the quantified benefits described above, the proposed project is expected to generate the following intangible benefits/ impacts, which could not be counted in the monetary value due to a lack of related data or difficulty in the conversion. Some of the major intangible benefits are highlighted below.

Table Summary of Intangible Benefits

Expected Benefits	Project Component	Remarks
Protection of crops from damage caused by free grazing animals	Activities 1.1.1 and 1.2.1	PLUP with participatory planning of the village regulations in Activity 1.1.1 and the follow-up meetings for capacity enhancement of local leaders in Activity 1.2.1 could reduce the number of cases of crop damage caused by animals, as those activities could regulate free animal grazing practices.
Stabilization of domestic water supply at village level	Activities 1.1.1 and 1.2.1	Protection of forests, particularly dense forest, would contribute to the stabilization and improvement of water flow in the water sources used for drinking and domestic purposes. The experience of the JICA CBNRM Project indicates that the CBNRM approach would be effective in the restoration of dried sources.
Reduction of soil erosions	Activities 1.1.1, 1.2.1, and 2.1.1	PLUP in Activity 1.1.1 would reduce the practice of shifting cultivation in the project villages, while hands-on training on climate resilient agriculture including techniques on sloping agricultural land techniques in Activity 2.1.1 could prevent the progress of soil erosion in the sloping farms in the villages.
Stabilization of peak flows and reduction of downstream flooding	Activities 1.1.1, 1.2.1, 1.2.2 and 2.3.1	Sustainable forest protection and management including rehabilitation of degraded forests under Activities 1.1.1, 1.2.1, 1.2.2 and 2.3.1 at village and watershed levels would contribute to the stabilization of water flow of the mainstream in the target watersheds.
Reduction of domestic violence	Activities 1.1.1 and 1.2.1	Likewise, PLUP with participatory planning of the village regulations in Activity 1.1.1 and the follow-up meetings for capacity enhancement of local leaders in Activity 1.2.1 could reduce the incidence of domestic violence as domestic violence issues would be monitored by local leaders.
Stabilization of food security	Activities 1.1.1, 1.2.1, and 2.1.1	Hands-on training on climate change adaptation measures in Activity 2.1.1 would help local communities increase crop production or produce marketable products to either secure the means of livelihood or income generation. Sustainable natural resource management at village level through Activities 1.1.1 and 1.2.1 would enable local communities to have non-timber forest products which could be used for sale at markets or supplemental or emergency foods for household consumption.
Biodiversity conservation	Activities 1.1.1, 1.2.1, 1.2.2 and 2.3.1	Protection of dense forests and improvement of degraded forests near dense forests would improve existing natural habitats of wild animals in the target watersheds.
Improvement of women's status in rural communities	Activities 1.1.1, 1.2.1, 1.2.2, 2.1.1, 2.2.1, 2.3.1, 2.4.1 and 3.2.1	As proposed in the Gender Action Plan of the proposed project, the significant number of women would be involved in the project activities at village and government levels in a substantial way. Naturally, the project is expected to improve the status of women in local communities as well as the government institutions.

Source: JICA (2020)

7 Financial Impacts on Household Economy

In order to assess the financial viability of the proposed project, financial impacts on household economy of local communities in the target villages are estimated assuming that local communities either adopt the climate resilient agriculture with sloping agricultural land techniques or establish a plantation to be used for a carbon offset project. To this end, the household budgets of the following two cases are estimated for assessment of the potential financial impacts of the project on household income.

Case 1: Households who replicate the climate resilient agriculture techniques in their own plot (0.5 ha)

Case 2: Households who establish a plantation for a carbon offset project in their own plot (0.5 ha)

Sales of surplus maize or saving of expenditures for buying maize are counted as cash earnings in Case 1, while the share of carbon credit sales is considered as the major source of income for Case 2. The tables below show the results of the estimation.

Household Budget Analysis of Case 1

Items / Year	2nd year	3rd year on ward
1. Gross income (Sales of Maize/ Saving of expenditures) per household *1		
1) Incremental maize production	300 kg (Laclo/Comoro) 350 kg (Tafara/ Caraulun)	600 kg (Laclo/Comoro) 700 kg (Tafara/ Caraulun)
2) Unit price of maize	US$ 0.75/kg	US$ 0.75/kg
3) Sales of maize production	US$ 225 (Laclo/Comoro) US$ 263 (Tafara/ Caraulun)	US$ 450 (Laclo/Comoro) US$ 525 (Tafara/ Caraulun)
2. Cost of Production	US$ 0	US$ 0
3. Gross revenue per household	US$ 225 (Laclo/Comoro) US$ 263 (Tafara/ Caraulun)	US$ 450 (Laclo/Comoro) US$ 525 (Tafara/ Caraulun)

*Note *1 The same assumptions used for the calculation of benefits from increased maize production in Table 12-5 are used for estimation of household gross income.*

Source: JICA (2020)

Household Budget Analysis of Case 2

Items / Year	1st year	2nd year	3rd year	4th year	5th ~10th year
1. Gross income (Share of sales of carbon credit trading)					
1) Estimated CO_2 absorption *1	4.2 tCO_2/HH	2.75 tCO_2/HH	2.90 tCO_2/HH	2.85 tCO_2/HH	2.65~2.90 tCO_2/HH
2) Unit price of CO_2	US$ 8.1/tCO_2				
3) Carbon sales	US$ 34.0/HH	US$ 22.3/HH	US$ 23.5/HH	US$ 23.0/HH	US$ 21.5~23.5/HH
2. Cost of maintenance	US$ 0.0	US$ 0.0	US$ 0.0	US$ 0.0	US$ 0.0
3. Gross revenue	US$ 34.0/HH	US$ 22.3/HH	US$ 23.5/HH	US$ 23.0/HH	US$ 21.5~23.5/HH

*Note: *1 Estimated by JICA based on the existing carbon offset project in Timor-Leste, "Halo Verde Timor Community Forest Carbon (2020)"*

Source: JICA (2020)

The results of the assessments indicate that local communities in the target villages, particularly those who replicate the climate resilient agriculture techniques, would improve their household economy significantly. Households involved in a carbon offset project can also increase the gross revenue from carbon trading by expanding their plantations, though the estimated revenue of Case 2 is rather lower as compared to the ones of Case 1.