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Annex 6: Reference Level Report

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ABBREVIATIONS

AD	Activity data
AE	Allometric Equation
AGB	Above Ground Biomass
BCEF	Biomass Conversion and Expansion Factors
BGB	Below Ground Biomass
BUR	Biannual Updated Report
CF	Carbon Fraction
DBH	Diameter at Breast Height
EF	Emission Factor
EBF-R	Evergreen Broadleaf Forests, Rich
EBF-M	Evergreen Broadleaf Forests, Medium
EBF-P	Evergreen Broadleaf Forests, Poor
FAO	Food and Agriculture Organization
FIPI	Forest Inventory and Planning Institute
FRL	Forest Reference Level
FREL	Forest Reference Emission Level
FPCF	Forest Carbon Fund Facility
GHG	Green House Gases
IPCC	Intergovernmental Panel on Climate Change
INDC	Intended Nationally Determined Contribution
JICA	Japan International Cooperation Agency
LULUCF	Land use, Land Use Change and Forestry
MARD	Ministry of Agriculture and Rural Development
MONRE	Ministry of Natural Resources and Environment
Mha	Millions hectare
Mt CO_2e	Million tonnes carbon dioxide equivalent
NCC	North Central Coast
NFIMAP	National Forest Inventory, Monitoring and Assessment Program
PSU	Primary Sample Unit
REDD+	Reducing Emission from Deforestation, forest Degradation, forest carbon conservation and enhancement and sustainable management of forests
RF	Removal Factors
SCC	South Central Coastal
tCO2	Tonne of carbon dioxide equivalent
UNFCCC	United Nation Framework in Climate Change
WD	Wood Density

1. INTRODUCTION

This report is prepared under the FPCF support to develop a forest reference level (FREL /FRL/RL) for North Central Coastal (NCC) region of Vietnam as a part of the proposal for ER-program. The aim of this report is to construct reference level as a baseline for assessing interventions of REDD+ activities. The reference level is required for accounting a real emissions reduction and removal enhancement.

The reference level is developed based on two key parameters namely the activity data (AD) and emissions and removal factors (EF). The development of activity data and emission and removal factors are presented in separate reports: Development of Activity Data for the NCC (Annex 4), and The Development of Emissions and Removals Factors for the NCC (Annex 5).

This report presents the methodological framework for construction of reference level for NCC, the proposed reference level, uncertainty analysis and possibilities of emissions reduction and removal enhancement.

2. METHODOLOGICAL FRAMEWORK FOR FREL/FRL CONSTRUCTION

2.1. Forest definition

The definition of forests used for Forest Reference Emission Level/Forest Reference Level (FREL/FRL) for Vietnam, applies the definitions provided under Circular 34 (2009)[1]. This definition is in line with the definition of forests used for the national GHG inventory[2]. It is also consistent with the definition as described in the Emission Reduction Program Idea Note (ER-PIN) submitted in May 2014 to the Forest Carbon Partnership Facility.

Following this definition, an area is identified as a forest when it meets the following three criteria:

1. An ecosystem of which the major component is perennial timber trees, bamboos and palms of all kinds of a minimum height of 5 meters (except new forest plantations and some species of coastal submerged forest species), and capable of providing timber and non-timber forest products and other direct and indirect values such as biodiversity conservation, environmental and landscape protection.

   New forest plantations of timber trees and newly regenerated forests of forest plantations are identified as forests if they reach the average height of over 1.5 meters for slow-growing species, and over 3.0 meters for fast-growing species and a density of at least 1,000 trees per hectare.

   Agricultural and aqua-cultural ecosystems with scattered perennial trees, bamboos or palms etc. will not be regarded as forests.
2. Having a minimum tree cover of 10% for trees which constitute the major component of the forest.
3. Having a minimum plot area of 0.5 hectares or forest tree strips of at least 20 meters in width of at least three tree lines.

2.2. Stratification

As noted above Circular 34 regulates the forest definition and forest classification. In this Circular, there are a numbers of criteria for classifying forest such as based on wood stock, biological characters etc. To reduce the complexity of such a system and for the purpose of improving estimation of forest carbon stock and emissions and removals, the harmonization of forest and land uses classification is proposed (Karsten et al, 2010). JICA (2012) also use this proposed classification in its study. In this system, there are 17 land uses, of which 12 land uses are forests. However, in this study, we simplify by merging rehabilitated evergreen broadleaf forest and rocky forests into poor forest; bamboo and mangrove forests are combined into other forest; and all non-forest lands (bare land, water body, residential area and other) are combined

[1] Issued by Ministry of Agriculture and Rural Development in 2009.
[2] MONRE, 2014. First Biannual Updated Report (BUR) for 2010

as carbon stocks of those are considered zero. The reason for this is that the sub-classifying evergreen broadleaf forest based on wood stock needs to be consistent and carbon stock for rehabilitated evergreen broadleaf forest and poor evergreen broadleaf forest is quite similar (Dien, 2015). In addition, the number of PSU for such forest types are quite limited and if they are separated, the accuracy of the carbon stock estimation is not confident. Such simplified forest classification will help reduce uncertainty in the AD and emission factors. The forest stratification used for construction of reference level includes five types of forestland and non-forest land (see Table 2.1).

Table 2.1 Stratification of land use types

ID	Forest type	Code	Forest / Non-forest
1	Evergreen broadleaf forest, rich forest	EBF-R	Forest
2	Evergreen broadleaf forest, medium forest	EBF-M	Forest
3	Evergreen broadleaf forest, poor forest	EBF-P	Forest
4	Other forests	OFO	Forest
5	Plantation	PLA	Forest
8	Non-forest lands	NOF	Non-forest

2.3. Description of Sources and Sinks selected

The sources considered in the ER program are deforestation and forest degradation. Those contribute significant emissions in the project areas. However, there also exist significant carbon sinks that are removals from forest enhancement and reforestation. The sources and sinks considered for the program are presented in the Table 2.2.

Table 2.2 Sources and sinks included in the ER program

Sources/Sinks	Included?	Justification / Explanation
Emissions from deforestation	Yes	Deforestation is mainly taken place in natural forests such as conversion of forests to agricultural cultivation, infrastructure development etc. In the project area, the spatial analysis of deforestation shows significant area of deforestation. The annual average forest loss is 31,822 ha for a period of 2005 - 2015.
Emissions from forest degradation	Yes	Forest degradation is the gradual reduction in the density of biomass due to anthropogenic variables such as illegal logging. This is a source t to significant loss of forest biomass. It is estimated that in the project area, annual forest area of 28,004 ha is degraded during a period of 2005 – 2015.
Removal from forest enhancement	Yes	Forest enhancement is accelerated through promoting natural regeneration and forest enrichment. Over the past 20 years, a number of programs on recovering forest vegetation has been implemented. In the project area, it is estimated that annual area of 16,345 ha of forests has been restored over 2005-2015.
Removal from reforestation	Yes	Vietnam has made great efforts in implementing reforestation programs to convert non-forests area to forested area. Those programs contributed considerably to the increase of forest cover of the country, particularly for the period of 2000 onward. It is estimated that annual rate of reforestation in the project area for period of 2005 – 2015 is about 75,823 ha.
Emissions and/or removals from conservation of carbon stock	No	The national REDD+ activities are not clearly defined the conservation of carbon stock. In this context, the conservation of carbon stock is not accounted for as it is conservatively assumed emissions are equal to removals.
Emissions and/or removals from sustainable management of forests	No	There is unclear definition of this activity under national REDD+ scheme and there are no clear boundaries for forest areas under sustainable management. Therefore, this activity is included either in above REDD+ activities.

2.4. Carbon pools and gases included

Carbon pools to be included in the construction of FREL/FRL are above ground biomass (AGB) and below ground biomass (BGB). The reason for inclusion of the BGB is that studies indicate that BGB constitutes from 0.2 to 1.0 of the AGB pool, depending on the forest type, and therefore is a significant pool. This pool is often estimated indirectly via a root-to-shoot (R/S) ratio. Viet Nam does not have a country-specific R/S ratio, and therefore will apply the IPCC default value. This will cause a high uncertainty estimate for this pool. However, due to the high costs of developing country-specific R/S ratio, there are no plans for conducting future research in Viet Nam. Other carbon pools such as dead wood, litter layer and soil organic carbon are excluded as a national dataset on such pools is not available and if using Tier 1 approach for such pools will create more uncertainties (see Table 2.3 for details).

Table 2.3 Carbon pools included construction of FREL/REL

Carbon Pools	Selected?	Justification / Explanation
Above Ground Biomass (AGB)	Yes	This is the largest carbon pool and is impacted by the sources of deforestation and forest degradation.
Below Ground Biomass (BGB)	Yes	but The BGB is a significant carbon pool. As there is no country specific data on BGB, it is estimated using IPCC 2006 default values.
Dead wood	No	This carbon pool is not significant because of the poor forest quality. Phuong et al (2009) indicates that average dead wood biomass of forests accounts for less than 2% of total AGB biomass. In addition, in the national forest inventories there are no data on dead wood. The national GHG inventories for LULUCF and National submissions of reference level to UNFCCC have not included this pool.
Litter	No	Conservative. IPCC 2006 (Vol 4, Chapter 2) notes that Tier 1: Carbon stock of DOM is assumed to be 0 for non-forestland use categories. The conversion of forests to non-forests, the carbon of post deforestation is also considered 0. Furthermore, litter data is not collected under the national forest inventories and this pool is also excluded in national GHG inventories and national submission of reference level
Soils	No	Conservative. IPCC 2006 notes that as Tier 1 soil carbon does not change for forest remaining forests. Other emissions and/or removals from conversion of forest to non-forests and non-forest to forests may be lower than reference level and not significant. Therefore, such exclusion is conservative.
Harvested Wood Products	No	Not required by the Methodological Framework and is thus excluded.

Gases included in the estimation of FREL/FRL are only CO_2. Non-CO_2 gases[3] such as CH_4, CO, N_2O, NOx etc. caused by burning of biomass (for example, forest fire) is not counted as such an emission is not significant. Non-CO_2 emissions resulted from burning biomass accounts for 0.04 % of total Viet Nam's emissions (MONRE, 2010).

Table 2.4. Gases included in construction of FREL/REL

Greenhouse gases	Selected?	Justification / Explanation
CO_2	Yes	The ER Program shall always account for CO_2 emissions and removals. The emissions are caused by deforestation and forest degradation. The removals are generated from reforestation and forest enhancement.
Non-CO2	No	Non-CO_2 gases (such as CH4, CO, N2O) are emitted only through incidents of forest fires. The national statistics of Viet Nam report on average 2,339 ha of forest burning per year during the period 2005-2013 (0.01% of the country area). In addition, The BUR (MONRE, 2014) indicated that non-CO_2 gases emissions caused by burning of biomass (for example, forest fire) accounted for less than 10 % of total region's emissions. Therefore, non-CO2 emissions are not significant and are excluded.

[3] In National GHG inventory, it only requires to estimate emission of CH_4, N_2O and NOx if this is significant.

2.5. Reference period

From the start of preparing the ER Program, the requirements of the reference period for the ER-Program area follows the Carbon Fund Methodological Framework (2013) that the reference period should be 10 years from the latest data available prior to 2013. The newly adopted requirements of the Methodological Framework (2016) for reference period requires that the reference period end date should be no later than 2 years before the first mission of the TAP (i.e. 2016 – 2 years = 2014). Vietnam has a long history of national forest inventory and monitoring and assessment program (NFIMAP) from 1990 and it is implemented through a 5 year cycle. To date, data from the national forest inventories are only available for 1990 – 2010. Vietnam is now implementing the 2015 national forest inventory and statistics[4].

The forest cover and land use change in Vietnam is currently in a very dynamic state throughout the NCC. After consulting with the TAP and CFP, it was proposed and agreed that Vietnam would update the Reference Period to 2005-2015. The year 2015 is proposed because it is consistent with Vietnam's national forest planning cycles (5 year increments beginning in 1995), and because it provides the most up to date baseline for planning future REDD+ activities and measuring the future changes in emissions and removals. While this is technically not in compliance with the latest MF (since it is later than 2014), Vietnam believes that this will form the best basis for the FCPF program. To develop this Reference Level, Vietnam generated a forest cover map for 2015 following the consistent methodologies used in NFIMAP for generating the previous 2005 and 2010 cover maps, and applied Emission/Removal Factors also based on consistent NFIMAP inventory data to estimate total Emissions and Removals over the Reference Period.

The forest cover map from 2010 is defined as the base map for forest type boundaries that are present across years. The 2005 forest type map has been rectified to match 2010 cover class boundaries where such exist, and the 2010 map was used as the baseline for producing the 2015 map where the same boundaries also existed. This will address the concerns raised by the TAP regarding independence of maps and introduction of errors arising when 'differencing' maps. This will also facilitate tracking the time series of change over time for individual parcels, to enable better classification of forest cover change activities and to enable detection of indirect conversion of natural forest to plantation.

Vietnam is choosing to work with the 2005 and 2010 forest cover maps (rather than reanalyzing the underlying imagery) because of the significant level of effort through multiple international projects that has gone into developing and checking those maps, and because the forest cover maps provide the linkage to the estimates of biomass and carbon available from the historical forest inventory programs

2.6. References for the calculations of the FREL/FRL

Viet Nam considers it more transparent to present removals and emissions separately rather than presenting net emissions/removals. This separation allows a more adequate representation of the trends in both emissions and removals over time and it provides an improved way of monitoring the different efforts of enhancing forest carbon stocks and reducing emissions from deforestation and forest degradation. In the NCC, the separation of emissions and removals are also applied.

JICA (2012) indicates that it is difficult to foresee the trend of emissions and removals in the future. The historically time averaged emissions and removals based on forest inventory data over a period of 2000-2010 is used as the reference level for REDD+ activities in the NCC and this is consistent with FPCF Methodological Framework (FPCF, 2013).

2.7. Scope of REDD+ Activity Data included

Five (5) REDD+ activities are defined[5]. However, the indicators for sustainable forest management activities are not clear and there remains a question of how carbon benefits can be gained from sustainable management of forest and conservation of forest carbon stock. The following definitions are applied for the five REDD+ activities in the context of Vietnam, which are all accounted for under FREL/FRLs of Viet Nam. A land use change matrix is used to detect REDD+ Activities (see Table 2.5).

[4] The final maps and data is expected to be published in early 2017.
[5] Decision 1/CP.16 of UNFCCC

- **Reducing emissions from deforestation ("Deforestation")**: Activity of conversion of forests to non-forest land, as identified per NFIMAP[6] results with modifications based on updates[7]. Where a series of activities including deforestation may have occurred within a single cycle of NFI, the deforestation activity occurring as a transitional activity will not necessarily be captured by the NFI, thus will be reported as degradation;
- **Reducing emissions from forest degradation ("Degradation")**: Activity resulting in a downward shift in terms of carbon stock between forest types, including Evergreen broadleaf forest volume-based sub-types of "rich, medium, and poor" (based on the average standing volume per ha) and other forest types (deciduous, bamboos etc.);
- **Enhancement of forest carbon stocks from reforestation ("Reforestation"):** Any **a**ctivity resulted in land use change from non-forest land to forest land.;
- **Enhancement of forest carbon stocks from forest restoration ("Restoration"):** Activity resulting in upward shift of carbon stock between forest types, including Evergreen broadleaf forest volume-based sub-types of "rich, medium, and poor" (based on the average standing volume per ha) and other forest types (deciduous, bamboos etc.);
- **Conservation of forest carbon stock:** Forest types remaining in the same forest types, are regarded as "conservation of forest carbon stock". For these forest types, it is assumed to have no net emissions and removals. The future forest inventories, changes of carbon stock in forests remaining the same forest type may be monitored more robustly and the corresponding emissions/removals accounted for; and
- **Sustainable management of forests:** Since Viet Nam does not have exact boundaries for areas for sustainable management of forests, this activity is included as part of the Restoration or Conservation of forest carbon stocks.

2.8. Generation of activity data (AD) and Emission Factors (EF)

A Tier 3 approach of IPCC is applied for generating the AD for the construction of the reference level. AD is prepared using NFIMAP for 2000 – 2005 and 2006-2010 with updates and newly developed cover map of 2015 for NCC. The details of AD development are presented separately in Annex 4 – Activity Data Report.

Tier 2 approach is used to generate EF for NCC. The estimates of EF are based on regionally developed allometric equations for NCC. These equations are used to estimate above ground biomass at tree level using the plot measurement data of NFIMAP 2001-2015 (for estimate of 2005 AGB of forests) and NFIMAP 2006-2010 (for estimate of 2010 and 2015 AGB of forests). Several default values of IPCC 2006 are used for estimating forest carbon stock such as root to shoot ratio (R=0.20 if AGB < 125 tdm/ha and R =0.24 if AGB > 125 tdm/ha), carbon fraction (CF =0.47). Details of calculation of EF are presented in Annex 5 – Emission Factor Report.

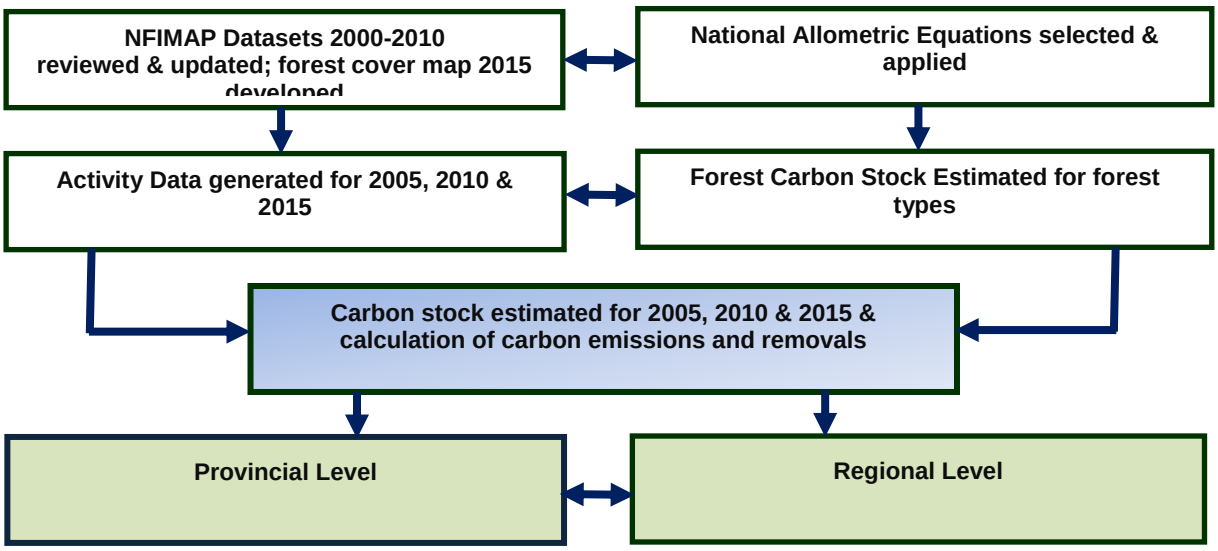
2.9. Construction of reference level

The approach for the estimation of emissions and removals is based on AD data and estimated forest carbon stock using national equations and measurement data of the NFIMAP cycle 4. The emissions and removals are estimated for 2 periods (2005-2010 and 2010-2015) for every province and then summed up to regional level (see Figure 2.1).

[6] Including both plot measurements and remotely sensed information.

[7] Updates were made to the original results of the NFI cycles 1-4 by the same implementing body Forest Inventory and Planning Institute (FIPI) under MARD with technical and financial assistance from (in sequential order) Finland, Japan, MARD and UN-REDD throughout 2011-2015.

Figure 2.1 Approach to Reference Level construction



Based on developed AD and EF, a spread sheet is used to calculate the emissions and removals for reference period using Stock Change Method. Since there is no plot measurement data for 2015, the "conservative approach" is used to assume that the 2015 forest carbon stock is equal to 2010 forest carbon stock.

For land cover changes which result in Emissions, the entire expected emission is assumed to occur over the time period in question. For land cover changes which result in Removals (e.g. forest which increases from poor to medium or medium to rich quality), we apply an Adjustment Factor (AF) ranging from 25% to 50% to reduce the expected Removals in the year they are first observed. This recognizes that forest accretion occurs more slowly over time than do forest removals (IPCC 2006).

The Adjustment Factors consist of:

- 25% per 5-year inventory cycle for forest land which changes to a higher biomass type. A 25% AF implies an expectation that 4 inventory cycles (20 years) are required for the full accretion of biomass to occur.

- 50% per 5 year inventory cycle for non-forest land which becomes forest plantation. At 50% AF implies 2 inventory cycles (10 years) required for full biomass accretion to occur.

Table 2.4 shows how emissions and removals are estimated using AF. This calculation is made to regional level and for all provinces in the region. Details of the calculation of emissions and removals over the time-series is shown in Appendix 1. This separate spreadsheet of calculation is available to share.

Table 2.4. Example of application of AFs to the time series land cover changes in NCC from 2005-2015

2005	2010	2015	Area_ha	Estimated	Estimated	Raw Change	Adjustment Factor	Adjusted	Estimated	Raw Change	Adjustment Factor	Adjusted
				2005 tCO2	2010 tCO2	2005-2010	05-10 change	2010 tCO2	2015 tCO2	2010-2015	10-15 change	2015 tCO2
EVR_R	EVR_R	EVR_R	147,402	92,545,507	80,260,514	12,284,993	100%	80,260,514	80,260,514	0	100%	80,260,514
EVR_R	EVR_R	EVR_M	46,044	28,908,293	25,070,849	3,837,444	100%	25,070,849	12,023,878	13,046,971	100%	12,023,878
EVR_R	EVR_R	EVR_P	1,385	869,255	753,866	115,390	100%	753,866	148,336	605,529	100%	148,336
EVR_R	EVR_R	Other-forest	1	935	811	124	100%	811	81	731	100%	81
EVR_R	EVR_R	Non-forest	654	410,804	356,272	54,532	100%	356,272	0	356,272	100%	0
EVR_R	EVR_M	EVR_R	537	337,120	140,219	196,901	100%	140,219	292,369	-152,150	25%	178,257
EVR_R	EVR_M	EVR_M	33,200	20,844,549	8,669,911	12,174,639	100%	8,669,911	8,669,911	0	100%	8,669,911
EVR_R	EVR_M	EVR_P	1,247	783,021	325,683	457,338	100%	325,683	133,621	192,063	100%	133,621
EVR_R	EVR_M	Plantation	1	760	316	444	100%	316	105	211	100%	105
EVR_R	EVR_M	Non-forest	297	186,708	77,658	109,050	100%	77,658	0	77,658	100%	0
EVR_R	EVR_P	EVR_M	610	382,740	65,314	317,426	100%	65,314	159,194	-93,880	25%	88,784
EVR_R	EVR_P	EVR_P	8,230	5,166,837	881,709	4,285,128	100%	881,709	881,709	0	100%	881,709
EVR_R	EVR_P	Plantation	2	1,055	180	875	100%	180	145	35	100%	145
EVR_R	EVR_P	Non-forest	69	43,623	7,444	36,178	100%	7,444	0	7,444	100%	0
EVR_R	Other-forest	EVR_P	4	2,336	201	2,134	100%	201	399	-197	25%	251
EVR_R	Other-forest	Other-forest	51	32,271	2,782	29,489	100%	2,782	2,782	0	100%	2,782
EVR_R	Plantation	EVR_P	**57**	35,913	4,946	30,967	100%	4,946	6,128	-1,183	25%	5,241
EVR_R	Plantation	Plantation	**372**	233,269	32,123	201,146	100%	32,123	32,123	0	100%	32,123
EVR_R	Plantation	Non-forest	**1**	640	88	552	100%	88	0	88	100%	0
EVR_R	Non-forest	EVR_P	322	202,366	0	202,366	100%	-	34,533	-34,533	25%	8,633
EVR_R	Non-forest	Other-forest	12	7,685	0	7,685	100%	-	662	-662	25%	166
EVR_R	Non-forest	Plantation	1	753	0	753	100%	-	104	-104	50%	52
EVR_R	Non-forest	Non-forest	187	117,105	0	117,105	100%	-	0	0	100%	0
……	…..	…..	…..	…..	……	…..	….	….	….	….	….	….

2.10. Uncertainty analysis

2.10.1. Identification of uncertainty sources

Assessment of uncertainty for estimation of emissions and removals for the reference period follows the IPCC guidelines (Chapter 3, IPCC, 2006). Table 5 shows potential causes of uncertainties that may be associated with reference level construction and the application of uncertainties assessment in the context of development of the reference level for the NCC.

Table 2.5 Potential causes of uncertainties in RL construction and assessment scope

Potential Cause of Uncertainty	Relevance for the NCC RL/REL?	Applied (yes/no) and explanations
Lack of completeness	Not believed to be relevant. The components of forest emissions and removals are generally known in theory, significant unknown gaps are unlikely	Not applicable.
Model	Relevant, significant. Uncertainty in statistical models used to estimate biomass as function of tree parameters, models to estimate aggregate biomass/ha, and models to classify forest type as a function of spectral signature	Applicable, model errors are assessed and incorporated for the tree biomass model, the root:shoot factor, and the Carbon:biomass factor (see EF report)
Lack of data	Relevant, minor. Data do not exist to estimate contributions from several pools (litter, deadwood, soil) and gases (CH4, NOx) which are assumed to be small (< 10%) relative to contribution of C from AGB and BGB.	Not applicable
Lack of representativeness of data	Not believed to be relevant. Emission factors come from a statistical systematic sample across the whole NCC region. Activity data comes from wall to wall forest cover mapping.	Not applicable.
Statistical random sampling error	Relevant, significant. Affects estimation of Emission Factors from forest inventory sample.	Applicable, sampling error is included in the estimates of AGB/ha from the NFIMAP sample.
Measurement error	Relevant, minor. Measurement of tree species group, DBH assumed to be with minimal error.	Not applicable as no data and information
Misreporting or misclassification	Relevant, significant. Activity Data comes from wall to wall satellite mapping, it is known that classification errors will exist.	Applicable, see AD report. This uncertainty is quantified using the accuracy assessment.
Missing data	Not believed to be relevant. Sampling and forest cover mapping covers 100% of the area of interest.	Not applicable

2.10.2. Uncertainty assessment

Accuracy assessment of AD:
Accuracy assessment is conducted using independent spatial information and follows Olofsson's 2014 method. A total of 1,082 sampling points was used to assess accuracy of AD for 2005 – 2015. The results of accuracy assessment for AD is in Table 2.6 and details are in Annex 4 – Activity Data Report.

Table 2.6 Accuracy assessment of AD

Land uses	2005-2010	2010-2015
SF - Stable Forest	0.96	0.93
SNF - Stable Non Forest	0.96	0.95
AF - Afforestation	0.92	0.94
DF - Deforestation	0.90	0.97
FE - Forest enhancement	0.97	0.93
FD- Forest degradation	0.93	0.97

Accuracy assessment of EF:

Uncertainty of EF relates to the carbon estimation for classified forests. A propagation errors of carbon estimation is applied. A propagation error is derived from: i) error of sampling; ii) error of equations used for biomass estimation; iii) error of converting BGB from AGB; and iv) error of using carbon fractions for converting biomass to carbon stock.

As the lack of detailed estimation of uncertainties for forest area changes, a Tier 1 approach is used for assessment of uncertainties of emissions and removals estimated in reference level. The formula for uncertainty assessment is as follows:

$$U_{total} = \sqrt{U_1^2 + U_2^2 + ... + U_n^2}$$

Where: *Utotal* is percentage uncertainty in the products of parameters

Ui is percentage uncertainty associated with each the parameters

The uncertainty will be estimated for emissions and removals as the main products. As limited independent data information and during the updating forest cover maps the different remote sensing information was used. As noted in Table 5, the uncertainty analysis of emissions and removals estimation considers the uncertainty parameters of AD and EF. The other potential sources associated with uncertainties are not included due to the lack of detailed assessment.

The uncertainties of forest carbon estimation are from 0.9 – 13.4% for 2005 forest carbon stock and from 0.9 – 7.7% for 2010 forest carbon stock. The propagations of uncertainties of forest carbon stock is derived from error of aboveground biomass estimation based on error of sampling and error of used equations, error of belowground biomass using root to shoot ratio, error of carbon fraction. The SE for R is 20% (GOFC-GOLD sourcebook 2015), SE of carbon fraction is 2.7% (IPCC 2006). The results of uncertainty of forest carbon stock estimates are shown in Table 2.7.

Table 2.7 Uncertainty assessment of forest carbon stock for the NCC

Parameters	EBF-R	EBF-M	EBF-P	Other forest	Plantation
1. AGB error from sampling (calculated in EF report)	0.078	0.010	0.009	0.013	0.030
2. AGB error from biomass equation (UNREDD, 2015)	0.096	0.096	0.096	0.180	0.100
3. Root to shoot ratio error (GOFC-GOLD sourcebook 2015)	0.200	0.200	0.200	0.200	0.200
4. Carbon Fraction factor (IPCC 2006)	0.027	0.027	0.027	0.027	0.027
Total Error (% SE)	**23.6%**	**22.4%**	**22.4%**	**27.1%**	**22.7%**

Quantification of uncertainties of emissions and removals:

The uncertainty is estimated separately for emissions and removals using error propagation. We combine the SE from activity data with the SE from EF to get the total SE for the estimated emissions or removals. The formula for estimating uncertainty is as follows:

$$U_{total} = \frac{\sqrt{(U_1 * x_1)^2 + (U_2 * x_2)^2 ... (U_n * x_n)^2}}{|x_1 + x_2 ... + x_n|}$$

Where: $U_1, U_2, U_3, \ldots Un$ is percentage of uncertainty associated with each of the parameters

$X_1, X_2, \ldots Xn$ is the value of each parameters

Utotal is percentage uncertainty in the sum of parameters

Then in the error propagation, we combine the SE from activity data with the SE from EF to get the total SE for the estimated emissions or removals.

3. RESULTS OF REFERENCE LEVEL CONSTRUCTION

3.1. Estimation of emissions and removals

Estimation of emissions and removal is counted for two periods 2005-2010 and 2010-2015 for every province and then the whole NCC region based on the AD and EF. The estimation shows that emissions from deforestation and forest degradations for the region in 2005-2015 are 108.9 Mt CO_2e or the annually averaged emission is 10.8 Mt CO_2e/yr. The removals for this period are -62.7 Mt CO_2e or the annually averaged removal is -6.2 Mt CO_2e/yr (see Table 3.1). Details of emissions and removals calculation is in Appendix 1.

Table 3.1 Reference emissions and removal for the NCC in 2005 – 2015

Activities	Emissions (+)/Removal (-) for 2005-2010 (tCO_2e)	Emissions (+)/Removal (-) for 2010-2015 (tCO_2e)	Total emissions (+)/Removals (-) for 2005-2015 (tCO_2e)
1. Deforestation	9,825,826	15,775,066	25,600,892
2. Forest degradation	64,041,960	19,351,671	83,393,631
3. Reforestation	-8,473,390	-6,661,003	-15,134,393
4. Forest restoration	-12,949,438	-34,672,979	-47,622,417
5. Total emissions	**73,867,786**	**35,126,737**	**108,994,523**
6. Total removals	**-21,422,828**	**-41,333,982**	**-62,756,810**
7. Net emissions	**52,444,958**	**-6,207,245**	**46,237,713**

Emissions and removals vary from province to province during the period 2005 – 2015. Nghe An is a province having highest emissions, with total emissions of 27.7 Mt CO_2e and QuangTri is lowest emitting province, with a total emission of 8.8 Mt CO_2e. Removal amount is highest in Nghe An province, about -20 Mt CO_2e and lowest removal amount is found in Ha Tinh province (-6.2 Mt CO_2e). In term of net emissions, out of six provinces in the NCC region, only Thanh Hoa province that carbon sink province and remaining provinces are carbon emitting provinces (see Table 3.2).

Table 3.2 Emissions and removals (tCO_2e) for period of 2005 – 2015 by NCC provinces

Activities/items	Thanh Hoa	Nghe An	Ha Tinh	Quang Binh	Quang Tri	Thua Thien Hue
1. Total emissions	13,095,641	27,759,041	20,034,000	25,791,356	8,804,458	13,510,099
2. Total removals	-13,245,704	-20,978,403	-6,219,721	-8,775,050	-6,336,054	-7,236,766
3. Net emissions	-150,063	6,780,638	13,814,279	17,016,306	2,468,404	6,273,333
4. Annually averaged emissions	**1,309,564**	**2,775,904**	**2,003,400**	**2,579,136**	**880,446**	**1,351,010**
5. Annually averaged removals	**-1,324,570**	**-2,097,840**	**-621,972**	**-877,505**	**-633,605**	**-723,677**

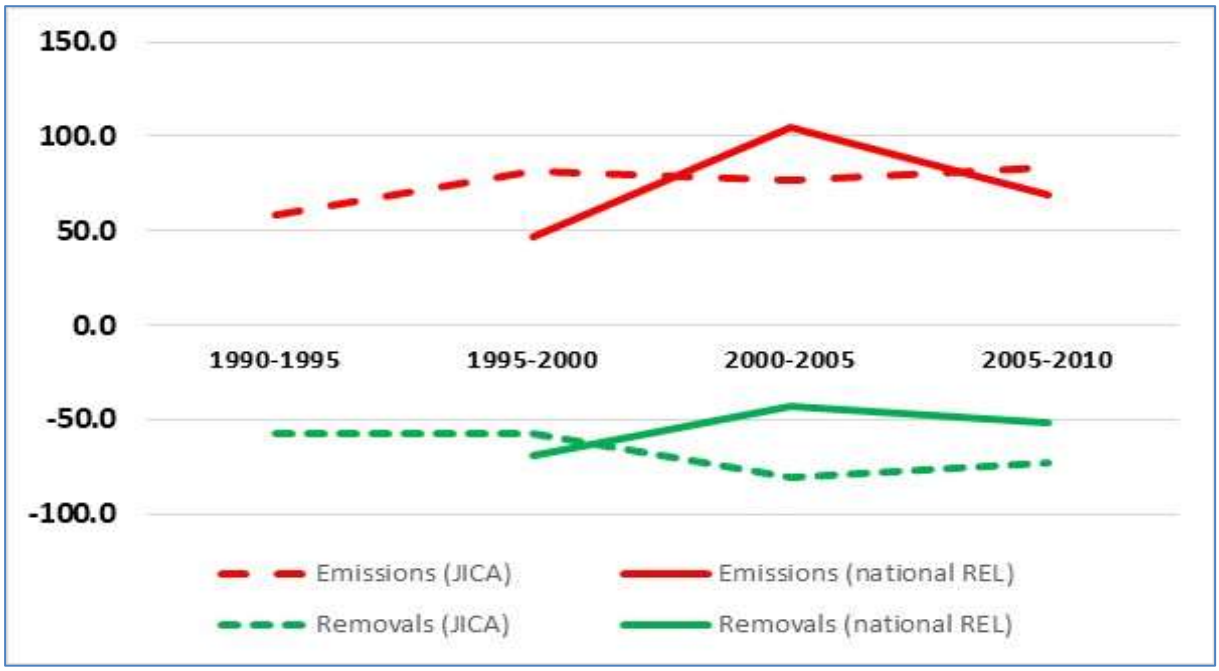
With the same dataset, this estimation of emissions and removals for 2005-2010 is lower than the figures reported in JICA (2012) study. Emissions of the NCC estimated in the JICA study for 2005-2010 was 8.3 Mt CO_2e/year. However, this emission amount of NCC is a bit higher than the emission amount estimated by national reference level for REDD+ (MARD 2015). The estimated emissions for NCC for 2005-2010 under the national reference level for REDD+ was 6.9 Mt CO_2e/year. The differences in emissions and removals for NCC for 2005 – 2010 given that the same dataset was used are caused by certain factors, for example improved AD and EF and application of root to shoot ratio based on AGB as well as application of adjustment factors (see details in discussion section).

We analyzed the recent historical trends of reference level estimated by JICA's study (for 1990-2010) and National REDD+ Reference Level (1995-2010) for NCC and those showed that there were different trends (see Figure 3.1). The JICA's study indicated the increasing emission trends over 1990-2010 while removal

trend was unclear. Note that both analyses use the original (unadjusted) forest cover maps for estimating emissions and removals, and so are not directly comparable to the estimates in the ER-PD.

As for national REDD+ reference level, emission and removal trends were a mixture of increasing and decreasing trends depending on the inventory cycles. That means it is not technically feasible to extrapolate the trends for the national REDD+ reference level. Similarly, with two points of time for estimating reference level for NCC (2005-2010 and 2010-2015), there was insufficient information to conclude the future trends of emissions and removals for NCC. Therefore, the reasonable estimate of emissions and removals reference level for NCC is to use average emissions and removals over the two calculating periods (2005-2010 and 2010 – 2015). This will be tracked over time in the future, and if adjustments seem to be warranted we will conduct analysis and make recommendations accordingly

Figure 3.1. Analysis of historical emissions and removals by estimate sources



3.2 Caveat regarding underestimation of emissions from forest degradation in stable forest, 2010-2015

As noted in Section 3.3 of Annex 5 on Emission Factors, there are currently no forest inventory data available to estimate Emission Factors for 2015. After analysis of trends in historical inventory data from 2000-2010, it was decided to use the 2010 inventory data for estimating carbon stocks in 2015 because it is the closest observation in time. While this is the best available data for estimating 2015 carbon stocks, and provides unbiased estimates for emissions and reductions associated with changes in forest type, this approach does not allow for estimation of forest degradation associated with emissions from stable forests, as explained below.

We estimate forest degradation in two different components:

- Forest degradation which results from changes that cause an area of higher biomass forest to become classified as a lower biomass forest is referred to as **type-change degradation**. For example, a parcel of Evergreen Rich forest in 2005 which loses biomass and becomes Evergreen Medium forest in 2010 is classified as type-change degradation.

- Forest degradation which results from changes which do not cause any changes in the classification of forest type is referred to as **stable forest degradation**. For example, Evergreen Rich forest in 2005 has an estimated carbon stock of 627.8 tCO2e/ha (Annex 5 – EF report); that

same forest type has an estimated carbon stock of 544.5 tCO2e/ha in 2010, and the difference is assumed to be a result of stable forest degradation.

In both cases we assume that all loss of carbon stock in natural forest in the NCC is a result of human activities, and thus is classified as forest degradation. We recognize that this is an oversimplification; but given the high rate of human impact throughout the NCC area, we believe that most reduction in natural forest carbon stocks are associated directly or indirectly with some form of human activity and thus can be treated generally as forest degradation. Plantations are treated separately.

Since Vietnam does not have the forest growth models or parameter estimates needed to support a gain-loss approach to estimating carbon change over time, we use instead a version of a stock change approach where change is estimated as the difference of (area affected) x (carbon stock per unit area) at the start and end of the period of change. It is not a perfect application since, as noted above, we do not have carbon stock estimates for 2015.

Our method of quantifying the carbon stock associated with forest degradation depends on the type of degradation, as follows:

- Emissions associated with **type-change degradation** are calculated as the difference in carbon stock between the higher biomass type existing at the start of the period and the lower biomass type existing at the end of the period. Emissions associated with type change are assumed to take place entirely over the 5 year period 2005-2010 or 2010-2015 as determined by the area estimation.

- Emissions associated with **stable-forest degradation** are calculated as the difference in the carbon stock/ha at the start of the 5 year period and the carbon stock at the end of the 5 year period, using the emission factors reported in Annex 5. Note that this approach confounds degradation (reduction in carbon stock) with the natural growth of the forest (increase in carbon stock), focusing on the net difference. If degradation rates are low, then stable forest degradation is difficult to detect and measure.

However, as noted above, we do not yet have updated inventory data for estimating carbon stocks for the year 2015; we are using the 2010 estimates as the best available estimate of likely carbon stock in 2015. As a result, **we are unable to estimate stable forest degradation for the period 2010-2015**; our present dataset assumes that the emission factors are constant from 2010 to 2015 which in effect assumes that there is no forest degradation within stable forest type. In essence this likely results in an underestimation of carbon emissions associated with forest degradation for 2010-2015.

The potential magnitude of this omission can be observed in Table 3.1 above. Emissions associated with forest degradation accounted for 64.0 million tCO2e from 2005-2010, but only 19.4 million tCO2e from 2010-2015. The omission of stable forest degradation from the 2010-2015 estimate is likely a reason for much of this difference.

In an effort to better understand the relative magnitude of the differentiation between type-change degradation and stable-forest degradation, we analyzed the change over time using the time series analysis described above in Section 2.9, separating out type-change from stable forest degradation. The results are as follow:

Table 3.3. Estimate of emission for type change degradation and forest degradation in stable forests

Items	Emissions for 2005-2010 (tCO2e)	Emissions for 2010-2015 (tCO2e)
1.Type-Change Degradation	35,312,949	19,351,671
2.Stable-Forest Degradation	28,729,011	<missing>
3.Total Degradation	**64,041,960**	**19,351,671**

Approximately 45% of the emissions associated with degradation in 2005-2010 came from forests which did not change forest type. These stable forest emissions are missing from the 2010-2015 estimates. More detailed analysis shows that approximately 16.3 million tons of the 2005-2010 stable forest emissions come from the Evergreen Rich forest type, which has the largest change in emission factor from 2005- 2010 (627.8 tCO2e/ha to 544.5 t CO2e/ha, Annex 5). Reported changes in emission factors for the other forest types are much smaller.

We considered several alternatives for addressing this omission in the final calculation of the Reference Level:

- **Option 1 - Ignore degradation entirely as an Activity for reporting emissions, until such time as we have complete data**. We eliminated this alternative because forest degradation is clearly a significant source of emissions in the NCC area, so it needs to be included in the RL. We have sufficient data to characterize the majority of forest degradation emissions.

- **Option 2 - Use one set of average emissions factors for the entire Reference Period, rather than dividing the analysis into 2005-2010 and 2010-2015**. This would have the effect of 'smoothing' out the differences between the two time periods, and is somewhat justified by the fact that the estimates of emission factors are not statistically different between 2005 and 2010 (Annex 5). We eliminated this alternative because this approach has the effect of ignoring all emissions associated with stable-forest degradation – use of a single set of emission factors over time would eliminate any difference within a given forest type. Ignoring all stable forest degradation would increase the magnitude of underestimation of emissions from forest degradation. Substituting average emission factors would reduce the Reference Level estimate of emissions from 109 million tons CO2e to 81 million tons CO2e, and would reduce removals from 63 million tons CO2e to 59 million tons CO2e.

- **Option 3 – Make an assumption about the amount of stable forest degradation for 2010-2015, e.g. by projecting the rate of change in emission factors or by assuming a constant ratio of stable-forest degradation to type-change degradation.** This would enable us to estimate the missing emissions associated with stable forest in 2010-2015 with a placeholder value that could be updated later. We eliminated this alternative because we have no information to justify any particular assumptions about stable-forest degradation rates in 2010-2015. Making such an assumption might lead to overestimating the actual emissions in the Reference Period, which would not be a conservative approach for future benchmarking during the ER-PD performance period.

- **Option 4 – Use all available data, recognize that a component of emissions are missing for 2010-2015, explain the reason for this omission, and propose that the omission be addressed through a stepwise improvement process when the next set of forest inventory data become available, likely in 2019**. This is the option that we are including in the ER-PD. We have used the currently available data to calculate the Reference Level, recognizing that there is likely an underestimation in the emissions from stable forest degradation in 2010-2015. This likely is a conservative approach which has the effect of lowering the estimated Reference Level relative to 'reality'. This puts the risk burden on Vietnam to achieve additional future emission reductions in order to qualify for future carbon credits.

When the 2019 forest inventory data become available, we will update our Reference Level analysis and decide at that time whether we wish to make a case for adjusting the Reference Level based on the new information. The analysis will consider the trend in historical estimates of carbon stocks by forest types, factoring in differences in forest inventory methods over time. We will also consider the spatial analysis of plot level data, to look for spatial patterns and aberrations in change of carbon stock over time. The new inventory data should become available in 2019, which is very early in the ER-PD implementation phase, so most of any changes reported should reflect the 'business as usual' in NCC forests, prior to the initiation of ER-PD program activities.

3.3. Uncertainty assessment

Uncertainty of emissions estimated for 2005-2010 is from 24.5 - 30.4% and this is 24.3 – 29.7 % for removals. The overall uncertainty of emissions associated with deforestation is 24.4% and is 29.3% for forest degradation. This value for removals associated with reforestation and forest restoration is 24.4-30.0%[8] (see details in Table 3.4).

Table 3.4 Estimated uncertainties for emissions and removals for the NCC 2005 - 2015

Emissions/Removals	2005 - 2010		2010 - 2015		Weighted average uncertainty 2005-2015 (%)
	Amount (tCO2e)	Uncertainty (%)	Amount (tons)	Uncertainty (%)	
1. Emissions caused by Deforestation	9,825,826	24.5	14,409,627	24.3	24.4
2. Emissions caused by Forest degradation	64,041,960	29.0	20,717,110	29.6	29.3
3. Removals resulting from reforestation	-8,473,390	24.5	-6,661,003	24.4	24.4
4. Removal resulting from forest restoration	-12,949,438	30.4	-34,672,979	29.7	30.0

3.4. Estimated reference level for NCC

Historical emissions associated with deforestation and forest degradation and removals generated by reforestation and forest enhancement are estimated for reference period for ER program. The Table 3.5 below summarizes the estimated reference level.

Table 3.5 The estimated ER Program Reference level 2005 - 2015

ERPA term year *t*	Average annual historical emissions from deforestation over the Reference Period (tCO_{2-e}/yr)	If applicable, average annual historical emissions from forest degradation over the Reference Period (tCO_{2-e}/yr)	If applicable, average annual historical removals by sinks (reforestation) over the Reference Period (tCO_{2-e}/yr)	If applicable, average annual historical removals by sinks (restoration) over the Reference Period (tCO_{2-e}/yr)	Reference Level	
					Emissions (tCO_{2-e} /yr)	Removals (tCO_{2-e} /yr)
2018	2,560,089	8,339,363	-1,513,439	-4,762,242	10,899,452	-6,275,681
2019	2,560,089	8,339,363	-1,513,439	-4,762,242	10,899,452	-6,275,681
2020	2,560,089	8,339,363	-1,513,439	-4,762,242	10,899,452	-6,275,681
2021	2,560,089	8,339,363	-1,513,439	-4,762,242	10,899,452	-6,275,681
2022	2,560,089	8,339,363	-1,513,439	-4,762,242	10,899,452	-6,275,681
2023	2,560,089	8,339,363	-1,513,439	-4,762,242	10,899,452	-6,275,681
2024	2,560,089	8,339,363	-1,513,439	-4,762,242	10,899,452	-6,275,681
2025	2,560,089	8,339,363	-1,513,439	-4,762,242	10,899,452	-6,275,681
Total	**20,480,714**	**66,714,904**	**-12,107,514**	**-38,097,933**	**87,195,618**	**-50,205,448**

[8] Details of uncertainty assessment is calculated in a separate spreadsheet

4. DISCUSSIONS

This section discusses the differences of emissions and removals reported in this new (2017) ER-PD document, relative to the estimates of emissions and removals reported in the previous (2016) ER-PD. There are several significant changes in data sources and methods between the two drafts, and each change in methods causes differences in the results.

Change in Reference Period – removal of the period 2000-2005 and addition of the period 2010-2015. A major cause of change from the previous ER-PD to the new ER-PD is that the Reference Period now covers a different period of time. Vietnam is a very dynamic landscape, it is not surprising that the net change over 2005-2015 is very different than the change from 2000-2010.

The results of reference level (RL) depends on Activity Data (AD) and Emission Factors. Generally, we agreed that AD of 2005-2010 used for construction of new RL for 2005-2015 is slightly different, but EF is different for 2005-2010. The differences in AD was resulted from requirement of TAP that AD needs link to different time points (2005, 2010 and 2015) in the reference period (time-series data), so the boundaries of any changes need to refer to the base cover maps. In this case, we use 2010 cover map as the base to cross-check the boundaries of changes for 2005 and 2015 cover maps. This type of work was not done in the old version of RL, therefore some illogical changes of the area may not be detected for 2005 cover map.

In the old RL (2000-2010), only single EF was applied for whole RL period and this EF was generated using regional equations of plot measurement data of NFIMAP Cycle IV. However, the new RL applied 2 EFs, one for 2005 – 2010 using the regional equations and plot measurement data of NFIMAP cycle III and the other (2010-2015) was estimated using plot measurement data of NFIMAP cycle IV. This application is in line with national RL for REDD+ under UN-REDD (see table below for EF used in old and new RL construction).

The EFs used for period of 2000-2010 (old RL) and for 2010-2015 (new RL) are slightly different given the same plot measurement data used. The differences come from the improved allometric equations for NCC was available that was improved by using more sample trees producing better accuracy of the equations for estimates of AGB. The other factor influencing this change is the application of the root to shoot ratio (R). In the old RL, only one R (=0.20) was applied, but IPCC guidelines requires different R based on the volume of AGB (R =0.24 if AGB > 125 tons/ha and R =0.20 if AGB < 125 tons/ha). In the new estimates of EF, we applied those ratios consistent with IPCC guidance.

Table 4.1. Comparison of forest carbon stock (tCO_2/ha) by estimated sources

Land uses	EF used in old RL for estimates of emissions and removals for 2000-2010	EF used in new RL for estimate of emissions & removals for 2005-2010	EF used in new RL for estimate of emissions & removals for 2010-2015
1. Evergreen forest-Rich	543.5	627.8	544.5
2. Evergreen forest-Medium	264.9	269.2	261.1
3. Evergreen forest-Poor	115.5	116.2	107.2
4. Other forests	82.9	47.9	54.1
5. Plantations	89.0	76.9	86.4
6. Non-forest	0	0	0

The removals of old RL and new RL were also different. During the TAP assessment, it was noted that Vietnam overestimated removals due to applying the full average values of EF to any changes of forests when detected. In facts, the growing of forests need certain time period to achieve such carbon stock, so the new ER-PD phases removals in over 20 years (for natural forest) or 10 years (for plantations).

To better see difference of emissions and removals between new estimate for NCC for 2005-2010 and national RL and JICA study (see Table 4.2).

Table 4.2. Emissions and removals 2005-2010 (tCO_2) for NCC estimated by sources for NCC

Emissions/removals	New RL NCC (2017)	National REDD+ RL (2016)	JICA study (2012)
Total emissions	73,867,786	69,359,868	83,289,882
Total removals	-21,422,828	-51,190,464	-72,628,746

In summary, there are numbers of factors influencing the differences of emissions and removals in the new reference period. The dynamic land use change causing the significant change of EF could be an important factor. In addition, the use of improved equations and proper application of root to shoot ratio also lead to a better estimate of forest carbon stock.

The FCPF Methodological Framework requires upward adjustments of Reference Levels if clear increasing trend of emission was observed (criterion 13). In case of clear increasing trend exists, there was clear guidance on upward adjustment of historical reference level with maximum of 0.1% per year (indicator 13.4). However, there was no quantitative guidance on downward adjustment of the reference level in the case of decreasing or ambiguous trends. In the context of reference level for NCC, there were two trends (increasing and decreasing trends for emissions and removals) over the two periods of accounting (2005-2010 and 2010-2015), therefore there it is impossible to establish clear trend for whole period of 2005-2015. The average trend of emissions and removals are used as conservative approach.

5. CONCLUSION AND RECOMMENDATIONS

Emission and removal reference level for the NCC are estimated separately using the forest dataset of NFIMAP cycles 3 and 4 with review and updates and the newly developed forest cover maps for 2015. The reference level is constructed using time average approach for period of 2005 – 2015. A tier 2 approach is used for AD generation while tier 2 approach is applied for EF development. The estimated annual emissions and removals for this period are 10.8 Mt CO_2e and -6.2 Mt CO_2e respectively. The RL excluded the emissions associated with emissions from forest type change degradation and degradation. The estimate of RL is conservative approach and it is likely an underestimate of emissions resulted from forest degradation for stable area.

Uncertainty analysis of emissions and removals for reference level is calculated following Tier 1 approach of IPCC guidelines. The overall weighted uncertainty of emissions and removals associated with deforestation, forest degradation reforestation and forest restoration is 24.4 – 30.0%.

It is recommended that the 2015 forest carbon stock should be calculated when the plot measurement data of NFIMAP 5 is made available. This could show better trends of forest carbon following the dynamic land use change in the region.

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Appendix 1. Time-series calculation of emissions and removals for 2005-2015 for NCC

ID	2005	2010	2015	Area_ha	Estimated	Estimated	Raw Change	Adjustment Factor	Estimated	Raw Change	Adjustment Factor	Adjusted Emissions (Removals), tCO2				
					2005 tCO2	2010 tCO2	2005-2010	05-10 change	2015 tCO2	2010-2015	10-15 change	2005-2010 Emis	2005-2010 Remo	2010-2015 Emis	2010-2015 Remo	2005-2015 (net)
1	EVR_R	EVR_R	EVR_R	147,402	92,545,507	80,260,514	12,284,993	100%	80,260,514	0	100%	12,284,993		0		12,284,993
2	EVR_R	EVR_R	EVR_M	46,044	28,908,293	25,070,849	3,837,444	100%	12,023,878	13,046,971	100%	3,837,444		13,046,971		16,884,415
3	EVR_R	EVR_R	EVR_P	1,385	869,255	753,866	115,390	100%	148,336	605,529	100%	115,390		605,529		720,919
4	EVR_R	EVR_R	Other-forest	1	935	811	124	100%	81	731	100%	124		731		855
5	EVR_R	EVR_R	Non-forest	654	410,804	356,272	54,532	100%	0	356,272	100%	54,532		356,272		410,804
6	EVR_R	EVR_M	EVR_R	537	337,120	140,219	196,901	100%	292,369	-152,150	25%	196,901			-38,038	158,864
7	EVR_R	EVR_M	EVR_M	33,200	20,844,549	8,669,911	12,174,639	100%	8,669,911	0	100%	12,174,639		0		12,174,639
8	EVR_R	EVR_M	EVR_P	1,247	783,021	325,683	457,338	100%	133,621	192,063	100%	457,338		192,063		649,400
9	EVR_R	EVR_M	Plantation	1	760	316	444	100%	105	211	100%	444		211		655
10	EVR_R	EVR_M	Non-forest	297	186,708	77,658	109,050	100%	0	77,658	100%	109,050		77,658		186,708
11	EVR_R	EVR_P	EVR_M	610	382,740	65,314	317,426	100%	159,194	-93,880	25%	317,426			-23,470	293,956
12	EVR_R	EVR_P	EVR_P	8,230	5,166,837	881,709	4,285,128	100%	881,709	0	100%	4,285,128		0		4,285,128
13	EVR_R	EVR_P	Plantation	2	1,055	180	875	100%	145	35	100%	875		35		910
14	EVR_R	EVR_P	Non-forest	69	43,623	7,444	36,178	100%	0	7,444	100%	36,178		7,444		43,623
15	EVR_R	Other-forest	EVR_P	4	2,336	201	2,134	100%	399	-197	25%	2,134			-49	2,085
16	EVR_R	Other-forest	Other-forest	51	32,271	2,782	29,489	100%	2,782	0	100%	29,489		0		29,489
17	EVR_R	Plantation	EVR_P	**57**	35,913	4,946	30,967	100%	6,128	-1,183	25%	30,967			-296	30,671
18	EVR_R	Plantation	Plantation	**372**	233,269	32,123	201,146	100%	32,123	0	100%	201,146		0		201,146
19	EVR_R	Plantation	Non-forest	**1**	640	88	552	100%	0	88	100%	552		88		640
20	EVR_R	Non-forest	EVR_P	322	202,366	0	202,366	100%	34,533	-34,533	25%	202,366			-8,633	193,733
21	EVR_R	Non-forest	Other-forest	12	7,685	0	7,685	100%	662	-662	25%	7,685			-166	7,519
22	EVR_R	Non-forest	Plantation	1	753	0	753	100%	104	-104	50%	753			-52	702

23	EVR_R	Non-forest	Non-forest	187	117,105	0	117,105	100%	0	0	100%	117,105		0		117,105
24	EVR_M	EVR_R	EVR_R	13,523	3,639,919	7,363,137	-3,723,219	25%	7,363,137	-2,792,414	100%		-930,805		-2,792,414	-3,723,219
25	EVR_M	EVR_R	EVR_M	4,815	1,296,016	2,621,691	-1,325,675	25%	1,257,353	370,082	100%		-331,419	370,082		38,663
26	EVR_M	EVR_R	EVR_P	519	139,662	282,519	-142,858	25%	55,591	119,785	100%		-35,714	119,785		84,071
27	EVR_M	EVR_R	Other-forest	5	1,437	2,908	-1,470	25%	289	1,516	100%		-368	1,516		1,148
28	EVR_M	EVR_R	Non-forest	101	27,262	55,147	-27,885	25%	0	34,233	100%		-6,971	34,233		27,262
29	EVR_M	EVR_M	EVR_R	6,526	1,756,671	1,704,265	52,406	100%	3,553,543	-1,849,278	25%	52,406			-462,320	-409,914
30	EVR_M	EVR_M	EVR_M	352,254	94,816,153	91,987,555	2,828,598	100%	91,987,555	0	100%	2,828,598		0		2,828,598
31	EVR_M	EVR_M	EVR_P	26,075	7,018,484	6,809,105	209,379	100%	2,793,626	4,015,479	100%	209,379		4,015,479		4,224,858
32	EVR_M	EVR_M	Other-forest	95	25,577	24,814	763	100%	5,142	19,671	100%	763		19,671		20,434
33	EVR_M	EVR_M	Plantation	10	2,759	2,677	82	100%	886	1,790	100%	82		1,790		1,873
34	EVR_M	EVR_M	Non-forest	2,011	541,387	525,236	16,151	100%	0	525,236	100%	16,151		525,236		541,387
35	EVR_M	EVR_P	EVR_M	9,656	2,599,025	1,034,512	1,564,513	100%	2,521,489	-1,486,978	25%	1,564,513			-371,744	1,192,769
36	EVR_M	EVR_P	EVR_P	73,339	19,740,688	7,857,552	11,883,136	100%	7,857,552	0	100%	11,883,136		0		11,883,136
37	EVR_M	EVR_P	Other-forest	60	16,166	6,435	9,732	100%	3,250	3,184	100%	9,732		3,184		12,916
38	EVR_M	EVR_P	Plantation	109	29,420	11,710	17,710	100%	9,450	2,260	100%	17,710		2,260		19,970
39	EVR_M	EVR_P	Non-forest	1,991	535,896	213,307	322,589	100%	0	213,307	100%	322,589		213,307		535,896
40	EVR_M	Other-forest	EVR_P	51	13,800	2,775	11,026	100%	5,493	-2,718	25%	11,026			-680	10,346
41	EVR_M	Other-forest	Other-forest	806	216,876	43,606	173,270	100%	43,606	0	100%	173,270		0		173,270
42	EVR_M	Other-forest	Plantation	1	318	64	254	100%	102	-38	100%	254			-38	216
43	EVR_M	Other-forest	Non-forest	45	12,102	2,433	9,669	100%	0	2,433	100%	9,669		2,433		12,102
44	EVR_M	Plantation	EVR_P	**580**	156,105	50,142	105,963	100%	62,136	-11,993	25%	105,963			-2,998	
45	EVR_M	Plantation	Plantation	856	230,415	74,011	156,403	100%	74,011	0	100%	156,403		0		156,403
46	EVR_M	Plantation	Non-forest	191	51,288	16,474	34,814	100%	0	16,474	100%	34,814		16,474		51,288
47	EVR_M	Non-forest	EVR_P	2,502	673,584	0	673,584	100%	268,112	-268,112	25%	673,584			-67,028	606,556
48	EVR_M	Non-forest	Other-forest	183	49,261	0	49,261	100%	9,905	-9,905	25%	49,261			-2,476	46,785

49	EVR_M	Non-forest	Plantation	61	16,368	0	16,368	100%	5,258	-5,258	50%	16,368			-2,629	13,739
50	EVR_M	Non-forest	Non-forest	1,974	531,339	0	531,339	100%	0	0	100%	531,339		0		531,339
51	EVR_P	EVR_M	EVR_M	38,975	4,530,162	10,177,858	-5,647,697	25%	10,177,858	-4,235,773	100%		-1,411,924		-4,235,773	-5,647,697
52	EVR_P	EVR_M	EVR_P	3,444	400,298	899,345	-499,047	25%	368,982	156,078	100%		-124,762	156,078		31,317
53	EVR_P	EVR_M	Other-forest	2	277	622	-345	25%	129	234	100%		-86	234		148
54	EVR_P	EVR_M	Plantation	36	4,127	9,273	-5,146	25%	3,070	2,344	100%		-1,286	2,344		1,057
55	EVR_P	EVR_M	Non-forest	565	65,699	147,604	-81,906	25%	0	86,175	100%		-20,476	86,175		65,699
56	EVR_P	EVR_P	EVR_M	40,830	4,745,757	4,374,480	371,277	100%	10,662,234	-6,287,754	25%	371,277			-1,571,938	-1,200,662
57	EVR_P	EVR_P	EVR_P	892,475	103,735,389	95,619,813	8,115,576	100%	95,619,813	0	100%	8,115,576		0		8,115,576
58	EVR_P	EVR_P	Other-forest	7,295	847,945	781,608	66,338	100%	394,816	386,792	100%	66,338		386,792		453,129
59	EVR_P	EVR_P	Plantation	20,411	2,372,429	2,186,826	185,603	100%	1,764,728	422,098	100%	185,603		422,098		607,701
60	EVR_P	EVR_P	Non-forest	64,922	7,546,076	6,955,721	590,355	100%	0	6,955,721	100%	590,355		6,955,721		7,546,076
61	EVR_P	Other-forest	EVR_P	221	25,718	11,975	13,743	100%	23,706	-11,731	25%	13,743			-2,933	10,810
62	EVR_P	Other-forest	Other-forest	12,488	1,451,560	675,868	775,692	100%	675,868	0	100%	775,692		0		775,692
63	EVR_P	Other-forest	Plantation	320	37,145	17,295	19,850	100%	27,630	-10,335	100%	19,850			-10,335	9,515
64	EVR_P	Other-forest	Non-forest	1,180	137,174	63,870	73,304	100%	0	63,870	100%	73,304		63,870		137,174
65	EVR_P	**Plantation**	EVR_P	**906**	105,331	78,350	26,981	100%	97,090	-18,740	25%	26,981			-4,685	22,296
66	EVR_P	Plantation	Plantation	5,463	634,955	472,310	162,645	100%	472,310	0	100%	162,645		0		162,645
67	EVR_P	Plantation	Non-forest	2,024	235,212	174,962	60,250	100%	0	174,962	100%	60,250		174,962		235,212
68	EVR_P	Non-forest	EVR_P	22,868	2,657,990	0	2,657,990	100%	2,450,046	-2,450,046	25%	2,657,990			-612,512	2,045,479
69	EVR_P	Non-forest	Other-forest	6,241	725,355	0	725,355	100%	337,736	-337,736	25%	725,355			-84,434	640,921
70	EVR_P	Non-forest	Plantation	6,089	707,790	0	707,790	100%	526,489	-526,489	50%	707,790			-263,244	444,546
71	EVR_P	Non-forest	Non-forest	27,003	3,138,675	0	3,138,675	100%	0	0	100%	3,138,675		0		3,138,675
72	Other-forest	EVR_P	EVR_P	18,990	910,761	2,034,590	-1,123,829	25%	2,034,590	-842,872	100%		-280,957		-842,872	-1,123,829
73	Other-forest	EVR_P	Other-forest	500	23,973	53,554	-29,581	25%	27,052	4,316	100%		-7,395	4,316		-3,079
74	Other-forest	EVR_P	Plantation	870	41,715	93,188	-51,474	25%	75,201	-20,618	100%		-12,868		-20,618	-33,487

75	Other-forest	EVR_P	Non-forest	2,014	96,581	215,757	-119,176	25%	0	126,375	100%		-29,794	126,375		96,581
76	Other-forest	Other-forest	EVR_P	5,117	245,398	276,917	-31,519	100%	548,205	-271,288	25%		-31,519		-67,822	-99,341
77	Other-forest	Other-forest	Other-forest	76,593	3,673,395	4,145,207	-471,812	100%	4,145,207	0	100%		-471,812	0		-471,812
78	Other-forest	Other-forest	Plantation	6,963	333,946	376,839	-42,892	100%	602,023	-225,184	25%		-42,892		-56,296	-99,188
79	Other-forest	Other-forest	Non-forest	14,284	685,080	773,072	-87,992	100%	0	773,072	100%		-87,992	773,072		685,080
80	Other-forest	Plantation	Plantation	2,744	131,579	237,205	-105,626	100%	237,205	0	100%		-105,626	0		-105,626
81	Other-forest	Plantation	Non-forest	64	3,063	5,521	-2,459	100%	0	5,521	100%		-2,459	5,521		3,063
82	Other-forest	Non-forest	EVR_P	3,211	153,999	0	153,999	100%	344,024	-344,024	25%	153,999			-86,006	67,993
83	Other-forest	Non-forest	Other-forest	6,549	314,070	0	314,070	100%	354,409	-354,409	25%	314,070			-88,602	225,468
84	Other-forest	Non-forest	Plantation	4,305	206,457	0	206,457	100%	372,190	-372,190	50%	206,457			-186095.2071	20,362
85	Other-forest	Non-forest	Non-forest	6,734	322,984	0	322,984	100%	0	0	100%	322,984		0		322,984
86	Plantation	Other-forest	Non-forest	**8**	592	417	175	25%	0	548	100%	44		548		592
87	Plantation	Plantation	EVR_P	**875**	67,275	75,648	-8,373	100%	93,742	-18,094	25%		-8,373		-4,523	-12,897
88	Plantation	Plantation	Other-forest	**62**	4,756	5,348	-592	100%	3,348	2,001	25%		-592	500		-92
89	Plantation	Plantation	Plantation	378,897	29,133,359	32,759,399	-3,626,040	100%	32,759,399	0	100%		-3,626,040	0		-3,626,040
90	Plantation	Plantation	Non-forest	48,420	3,723,038	4,186,421	-463,382	100%	0	4,186,421	100%		-463,382	4,186,421		3,723,038
91	Plantation	Non-forest	EVR_P	**473**	36,392	0	36,392	100%	50,709	-50,709	25%	36,392			-12,677	23,715
92	Plantation	Non-forest	Other-forest	**70**	5,405	0	5,405	100%	3,805	-3,805	25%	5,405			-951	4,454
93	Plantation	Non-forest	Plantation	7,342	564,555	0	564,555	100%	634,821	-634,821	50%	564,555			-317410.6551	247,144
94	Plantation	Non-forest	Non-forest	18,764	1,442,789	0	1,442,789	100%	0	0	100%	1,442,789		0		1,442,789
95	Non-forest	EVR_P	EVR_M	**11.31**	0	1,212	-1,212	25%	2,953	-2,651	25%		-303		-663	-966
96	Non-forest	EVR_P	EVR_P	130,578	0	13,990,133	-13,990,133	25%	13,990,133	-10,492,600	100%		-3,497,533		-10,492,600	-13,990,133
97	Non-forest	EVR_P	Other-forest	1,821	0	195,106	-195,106	25%	98,555	-49,778	100%		-48,777		-49,778	-98,555
98	Non-forest	EVR_P	Plantation	10,258	0	1,099,012	-1,099,012	25%	886,882	-612,129	100%		-274,753		-612,129	-886,882
99	Non-forest	EVR_P	Non-forest	30,373	0	3,254,133	-3,254,133	25%	0	813,533	100%		-813,533	813,533		0

100	Non-forest	Other-forest	EVR_P	339	0	18,349	-18,349	25%	36,325	-31,738	25%		-4,587		-7,934	-12,522
101	Non-forest	Other-forest	Other-forest	13,872	0	750,778	-750,778	25%	750,778	-563,084	100%		-187,695		-563,084	-750,778
102	Non-forest	Other-forest	Plantation	2,409	0	130,361	-130,361	25%	208,260	-175,669	25%		-32,590		-43,917	-76,508
103	Non-forest	Other-forest	Non-forest	4,002	0	216,610	-216,610	25%	0	54,152	100%		-54,152	54,152		0
104	Non-forest	Plantation	EVR_P	272.81	0	23,587	-23,587	25%	29,229	-23,332	25%		-5896.78815		-5,833	-11,730
105	Non-forest	Plantation	Plantation	165,763	0	14,331,848	-14,331,848	50%	14,331,848	-7,165,924	100%		-7165924.115		-7,165,924	-14,331,848
106	Non-forest	Plantation	Non-forest	30,108	0	2,603,139	-2,603,139	50%	0	1,301,569	100%		-1301569.272	1,301,569		0
107	Non-forest	Non-forest	EVR_P	145,613	0	0	0	100%	15,600,935	-15,600,935	25%	0			-3,900,234	-3,900,234
108	Non-forest	Non-forest	Other-forest	26,229	0	0	0	100%	1,419,496	-1,419,496	25%	0			-354,874	-354,874
109	Non-forest	Non-forest	Plantation	136,346	0	0	0	100%	11,788,506	-11,788,506	50%	0			-5,894,253	-5,894,253
110	Non-forest	Non-forest	Non-forest	1,949,893	0	0	0	100%	0	0	100%	0		0		0
	Total area (ha)			**5,144,519**												

Summary emissions and removals 2005-2015 (tCO2e)

Emissions & removals	2005-2010	2010-2015	Total 2005-2015
Emissions from Deforestation	9,825,826	15,775,066	**25,600,893**
Emission from Degradation	64,041,960	19,351,671	**83,393,630**
Removals from reforestation	-8,473,390	-6,661,003	**-15,134,394**
Removals from enhancement	-12,949,438	-34,672,979	**-47,622,417**