Ministry of Agriculture and Rural Development

VIETNAM

VIETNAM'S MODIFIED SUBMISSION ON REFREENCE LEVELS FOR REDD+ RESULTS BASED PAYMENTS UNDER UNFCCC

Final Version on December 2016

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ABBREVIATIONS AND ACRONYMS

AD	Activity Data
BEF	Biomass Expansion Factor
BCEF	Biomass Conversion and Expansion Factor
CI	Confidence Interval
CH	Central Highland
EF	Emission Factors
FAO	Food and Agriculture Organization
FIPI	Forest Inventory and Planning Institute
FREC	Forest Resources and Environment Centre
FREL	Forest Emission Reference Level
FRL	Forest Reference Level
GHG	Greenhouse Gases
IPCC	Intergovernmental Panel on Climate Change
JICA	Japan International Cooperation Agency
LULUCF	Land Use, Land Use Change and Forestry
LUC	Land Use Changes
MARD	Ministry of Agriculture and Rural Development
MRD	Mekong River Delta
NFIMAP	National Forest Inventory, Monitoring and Assessment Programme
NCC	North Central Coast
NE	Northeast
NW	Northwest
PSP	Primary Sample Plot
RRD	Red River Delta
REDD+	Reducing Emissions from Deforestation and forest Degradation plus the conservation of forest carbon stocks, sustainable management of forests and enhancement of forest carbon stocks
RF	Removal Factor
SPS	Secondary Sample Plot
SCC	South Central Coast
SE	Southeast
UNFCCC	United Nations Framework Convention on Climate Change
UN-REDD	United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries
VAFS	Vietnamese Academy of Forest Sciences

INTRODUCTION

Vietnam is strongly committed to the reduction of GHG emissions and to REDD+ and has demonstrated this commitment over the past decade through the introduction of far-reaching legislation and policies. This commitment is enshrined in the national constitution and has the support of the Communist Party and the Prime Minister. It is mainstreamed into national development plans and is manifested through action plans and decisions of key ministries. Vietnam's policy framework strongly supports improvements in forest management and policy developments which will contribute to the conservation and enhancement of forest carbon stocks across the country. These commitments and policies have influenced greatly forestry sector in the country. Forest cover in Vietnam has been increasing over the past 25 years, from 28% in 1990 to about 41% in 2015.

Vietnam has approved its intended nationally determination contribution in 2016 and is now preparing for implementation phase. In this document, Vietnam commits to maximize the use of its resources to voluntarily reduce 8% of emissions and could increase emissions up to 25% with the external financial support. In addition to that, under the economic restructuring process, Vietnam is approaching the low carbon economy.

Vietnam has also been actively implementing the UN-REDD program since 2009. The national REDD+ action plan was first approved in 2011 which provided strong legal base for REDD+ implementation in Vietnam. By implementing the UN-REDD program and other REDD+ based support projects, numbers of policies, technical guidelines were prepared and particularly enhancement of capacity for concerned organization and stakeholders for REDD+ readiness. Recently, Vietnam has replaced the national REDD+ action plan by the newly approved Decision of Prime Minister on National REDD+ Action Program for 2017-2030. This Decision presents the government's priorities and efforts to address deforestation and forest degradation and promote forest rehabilitation, sustainable forest management and conservation.

Demontrating efforts in REDD+ implementation and other GHG mitigation in LULUCF in Vietnam, a national rerefence level for REDD+ was prepared as the base for the performance payment under the UNFCC. The first submission was made in January 2016 and the modified submission was on December 2016.

This document refers to the modified submission of FREL/FRL for REDD+ and comprises three parts. Part 1 represents the modified submission of FREL/FRL, icluding forest definition, stratification, scope of REDD+ activities, pools and gases and scale iof FREL/FRL. Part 2 provides detailed processes of historical forest cover maps development. And part 3 reports comprehensive estimation and calculation of forest carbon stocks.

1 PART 1: VIET NAM'S MODIFIED FREL/FRL FOR SUBMISSION TO THE UNFCCC

1.1 Forest definition

The definition of forests used for the construction of FREL/FRL for Vietnam, applies the definitions provided under Circular No. 34/2009/TT-BNNPTNT[1] on criteria for forest identification and classification, defining forests as: minimum 10% tree cover, at a minimum height of 5 meters, over a minimum area of 0.5 ha (see Box 1 below).

Newly planted or regenerated forests do not always reach the thresholds of the forest definition in situ. To avoid overestimation of forest land while at the same time assessing newly established forest plantations as early as possible, Circular 34 sets a separate minimum height for forest plantations. These thresholds are 1.5 meter height for slow growing plantations and 3 meter height for fast growing plantations and the density of at least 1,000 trees per ha.

Box 1.1: **Forest definition under the Circular 34:**

An area is identified as a forest when it meets the following 3 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 and of at least 3 tree lines.

This definition is consistent with the forestry definition used for the GHG inventory of the Viet Nam National Communication 2010.[2]

Prior to the issuance of the Circular 34 (which reflects changes made pertaining to tree cover first in the Law on Forest Protection and Development Law of 2004), the forest definition applied in Viet Nam (Decision 682B, 1984) set a minimum of 30% tree cover. This former definition was applied to the Clean Development Mechanism under the Kyoto Protocol. The main rationale behind Viet Nam's choice to change its forest definition was to standardize with internationally applied definitions (i.e., FAO FRA definition of forests).

[1] Promulgated by MARD on 10 June 2009

[2] It is also consistent with the forest definition described in the Emission Reduction Program Document for the Forest Carbon Partnership Facility.

Box 1.2: **Plantations**

According to "Decision 2855 (2008) on Identification of Rubber as Multi-purpose Trees", rubber is defined as a multi-purpose tree and is accounted as forest.

The planting of *Acacia* when occurring as nursing tree for improving native species growth is considered natural forest, and forest plantation otherwise.

For the purpose of FREL/FRLs development, data for the historical reference period have consistently been re-interpreted applying the new definition (i.e., 10% tree cover).

1.2 Classification and stratification systems

For the purpose of estimating historical emissions and removals with increased accuracy, Viet Nam has stratified its land use into 17 land use types including 12 forest types (Table 1.1.1). Emission Factors/Removal Factors (EFs/RFs) are calculated based on the average carbon stock in these forest and land use types.

Table 1.1: The 17 forest and land use types used to estimate EFs/RFs

ID	Forest type	Forest / Non-forest	Remarks
1	Evergreen broadleaf - rich forest	Forest	Average timber stock > 200 m^3/ha
2	Evergreen broadleaf - medium forest	Forest	Average timber stock 100-200 m^3/ha
3	Evergreen broadleaf - poor forest	Forest	Average timber stock < 100 m^3/ha
4	Evergreen broadleaf - regrowth forest	Forest	
5	Deciduous forest	Forest	
6	Bamboo forest	Forest	
7	Mixed timber and bamboo forest	Forest	
8	Coniferous forest	Forest	
9	Mixed broadleaf and coniferous forest	Forest	
10	Mangrove forest	Forest	
11	Limestone forest	Forest	
12	Plantation	Forest	
13	Limestone without trees	Non forest	
14	Other bare land (grass land, shrub land, land with scattered trees)	Non forest	
15	Water body	Non forest	
16	Residential area	Non forest	
17	Other land	Non forest	

In addition, to reduce the uncertainty of emissions and removals estimates as far as possible, Viet Nam further stratifies its EFs/RFs into ecological regions. Table 1.2 shows the eight agro-ecological regions of Viet Nam.

Table 1.2: Eight agro-ecological regions in Vietnam

ID	Agro-eco regions (MARD)	Provinces/Cities included
1	North West	Lai Chau, Dien Bien, Son La, Hoa Binh
2	North East	Cao Bang, Lang Son, Bac Kan, Thai Nguyen, Quang Ninh, Bac Giang, Lao Cai, Yen Bai, Ha Giang, Tuyen Quang, Phu Tho
3	Red River Delta	Hai Phong, Hai Duong, Bac Ninh, Hung Yen, Ha Noi, Thai Binh, Nam Dinh, Ha Nam, Ninh Binh, Vinh Phuc
4	North Central Coast	Thanh Hoa, Nghe An, Ha Tinh, Quang Binh, Quang Tri, Thua Thien – Hue
5	South Central Coast	Da Nang, Quang Nam, Quang Ngai, Binh Dinh, Phu Yen, Khanh Hoa, Ninh Thuan, Binh Thuan
6	Central Highlands	Gia Lai, Kon Tum, Dac Lac, Dac Nong, Lam Dong
7	South East	Dong Nai, Binh Duong, Binh Phuoc, Tay Ninh, Ho Chi Minh, Ba Ria - Vung Tau
8	Mekong River Delta	Long An, Ben Tre, Dong Thap, Soc Trang, Vinh Long, Can Tho, Hau Giang, Tien Giang, Bac Lieu, Ca Mau, Kien Giang, An Giang, Tra Vinh

However, since the National Forest Inventory (NFI) Cycles I to IV did not apply sufficient numbers of sample plots for the Red River Delta and Mekong River Delta regions, the Red River Delta region is combined with the North East region while the Mekong River Delta region is combined with the South East region when estimating historical average carbon stocks of forest types.

1.3 Scope of activities, pools and gases included in the FREL/FRL

1.3.1 Activities

The REDD+ activities applied under the FREL/FRLs of Viet Nam are as follows;

Reducing emissions from deforestation ("Deforestation"):

Activity of conversion of forests to non-forest land, as identified per NFI[3] results with modifications based on updates[4].

Where a series of activities including deforestation may have occurred between two NFI cycles, 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.) (See **Error! Reference source not found.** below).

Enhancement of forest carbon stocks from reforestation ("Reforestation"):

Activity of land use change from non-forest land to forest land.

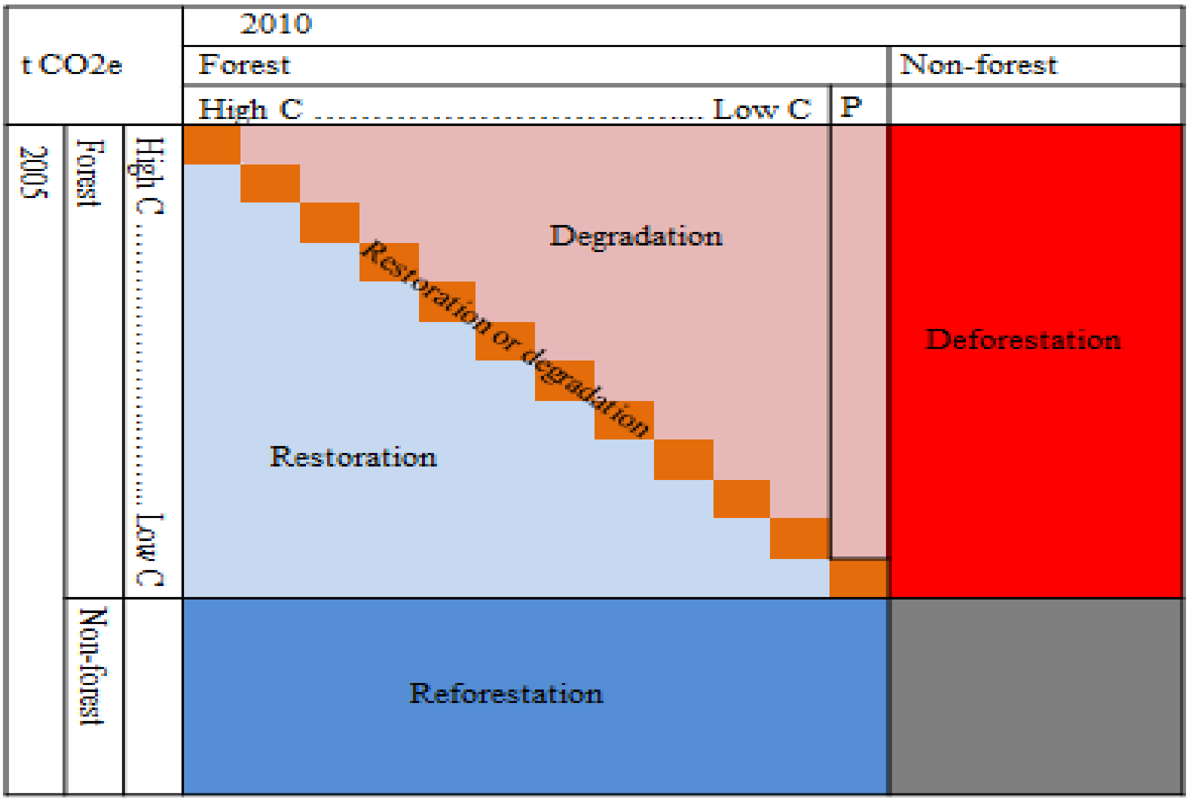
Enhancement of forest carbon stocks from forest restoration ("Restoration"):

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.) (see **Error! Reference source not found.**).

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

[4] Updates were made to the original results of the NFI cycles I to IV 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.

Table 1.3: Matrix of land type changes



Notes: C: carbon; P: plantation

Activities resulting in shifts upwards between the above mentioned volume-based sub-categories may occur as results of both current and past human interventions. Notwithstanding, all such shifts will be accounted for under the FRLs, and applying the principle of symmetrical reporting, all symmetrical downward shifts will be reported under degradation.

Conservation of forest carbon stock:

Conservation of forest carbon stocks is not defined or used in Viet Nam's FREL/FRL, but forest conservation related activities are accounted for, considering that all forest and land use change activities are captured through the land conversion matrix. Forest types remaining in the same category may be accounted for as degradation, restoration or no change depending on the carbon stock changes assessed from the NFI cycles as displayed in **Error! Reference source not found.**.

Sustainable management of forests:

Sustainable management of forests is not defined or used in Viet Nam's FREL/FRL, but forest activities that relate to sustainable management of forests are accounted for, considering that all forest and land use change activities are captured through the land conversion matrix.

Symmetrical reporting

Given the complex character of forest land dynamics, there is a risk of some overlap between the above-mentioned activities. E.g. deforestation may be preceded by forest degradation; forest degradation may be followed by restoration etc. Some of these dynamic processes only result in temporal emissions, the effect of which may be annulled if followed by an equal amount of removals in a short time-span. To avoid incomplete or partial reporting of these dynamics processes, Viet Nam proposes symmetrical reporting in the form of the land conversion matrix as displayed in **Error! Reference source not found.**. T hus, if a forest area (e.g. Rich Evergreen) is first degraded (to e.g. Poor Evergreen) and subsequently deforested (to e.g. Cropland) the accumulated carbon stock change would be the same as a direct deforestation from Rich Evergreen to Cropland and therefore emissions from forest degradation and deforestation are not double-counted. Furthermore, given the dynamic character of forest degradation where extraction and regrowth are happening alternately, the approximation of the magnitude of degradation can be simplified by considering net change over a larger area over time. The land change matrix provides both aspects of this dynamic process though forest degradation and restoration and since the assessment represents a wall-to-wall comparison with full country coverage, short-term temporary dynamics will not result in a biased or incomplete assessment. The full inclusion of REDD+ activities in the FRL minimizes the risk of leakage or displacement of emission reductions from one activity to another.

Box 1.3: Conversion of natural forests to plantations

Conversions of natural forests to plantations remain a part of the national forest development activities, but only targets degraded forests. In the context of REDD+, if and when this conversion takes place, this will be regarded either as "forest degradation" or as "enhancement of forest carbon stocks", depending on whether the carbon contents of the plantation is lower or higher than the degraded natural forest it replaces. The forest stratification applied to the past data collected on forests and planned for the Measurement, Reporting and Verification (MRV) system clearly separate plantations from natural forest.

A database of areas converted from natural forests to plantation will be included in the MRV system and these areas will be calculated as total loss of forest carbon stock and will not be included in future calculations for REDD+ MRV to avoid rewarding of future carbon removals as a result of conversion of natural forests into plantations.

1.3.2 Carbon pools included in FREL/FRL

The carbon pools included in the construction of FREL/FRL for Viet Nam are summarized in Table 1.4 below.

Table 1.4: Pools included in the FREL/FRL for Viet Nam

Carbon pools	Included
AGB	Yes
BGB	Yes
Soil organic carbon	No
Dead wood	No
Litter	No

Vegetation components included in the aboveground biomass pool

The carbon stocks of the forests are calculated as the sum of the aboveground part of the living trees equal or bigger than 6 cm in diameter as measured in the NFI. The lianas, shrubs and understorey are not included due to lack of information and as they are not considered a significant contributor to forest aboveground biomass (less than 5 to 10%[5]). If future NFI collect more information on these components they will be included in the future FREL/FRL submissions.

Justification for inclusion of BGB pool

Researches indicate that this pool constitutes from 0.2 to 1.0 times of 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, considering the high costs of developing country-specific R/S ratio, there are no foreseen plans for conducting future research in Viet Nam. Taking into account the above, this pool has been included in the FREL/FRL for Viet Nam applying the IPCC default value.

Justification for exclusion of deadwood, litter and soil organic carbon pools

[5] See international studies: Schnitzer, S. A. and Bongers, F. (2011) or Chave, J. et al. (2008)

Changes in deadwood, litter and soil organic carbon stocks from deforestation will not be reported due to lack of a reliable time series of data for the whole country, and also since these are not considered significant pools. For soil organic carbon related to peat soil burning, potential emissions may be significant on a per hectare basis, but peat soils represent a marginal area of the forest land of the country and this accounts for about 0.04% (Phuong *et al* 2010[6]) and therefore their overall contribution to country-wide emissions is considered not significant. Furthermore, burning of peat soils is reducing in occurrence. Phuong *et al* (2011) indicated that the area of peat land burned in 2009 represented 46 % of the area burned in 1976.

1.3.3 Gases included in FREL/FRL

Non-CO_2 gases 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).

Data on forest types impacted by fire is missing to accurately estimate the corresponding emissions, but a rough estimate based on the national statistics and Tier one combustion factors resulted in forest fire being responsible for less than 0.1% of Viet Nam non-CO_2 emissions for the period 2000-2010.

Therefore non-CO_2 gases are not included in the FREL/FRL for Viet Nam. CO_2 is the only gas included in Viet Nam's FREL/FRL.

1.4 Scale of the FREL/FRL

The scale of Viet Nam's FREL/FRL is national.

Viet Nam has a history of implementing NFIs since 1991, providing nation-wide data of its forest resources. Therefore, Viet Nam has sufficient data to develop a FREL/FRL at the national scale. The scale of Viet Nam's FREL/FRL is in agreement with the UNFCCC Decision 1/CP 16 paragraph 71, requesting countries to develop national FREL/FRLs.

1.5 Transparent, complete, consistent and accurate information used in the construction of the FREL/FRL

1.5.1 Consistency

The underlying methodology reference applied to the Viet Nam FREL/FRL is the IPCC GPG-LULUCF (2003), applying root-to-shoot (R/S) ratio and carbon fraction based on IPCC 2006 Guidelines as it contains updated default factors.

1.5.2 National circumstances and adjustments

Much of Viet Nam's forest cover was removed between 1943 and 1993 declining from at least 43% to 20%. Since then Viet Nam has made considerable efforts to increase its overall forest cover. Based on the forest cover maps generated by NFI, the actual forest area in Viet Nam has increased to 13.7 million ha in 2010 from 11.3 million ha in 1995. Much of the increase has been due to establishment of new plantations, which account for 2.1 million hectares, and the re-designation and inclusion of previously omitted limestone forests. It is generally acknowledged that the quality of natural forests continues to be more fragmented and degraded. As of 2010, over two-thirds of Viet Nam's natural forests are considered poor or regenerating, while rich and closed-canopy forest constitutes only 5 percent of the total. Between 1995 and 2010, the area of natural forest classified as rich decreased by 35,000 ha/year and medium forest reduced by 66,000 ha/year. These figures indicate that deforestation and forest degradation are still serious issues for Viet Nam. The key drivers of deforestation and forest degradation include: (i) Conversion of forest lands for agriculture and other purposes; (ii) Infrastructure development such as roads and hydropower plants; (iii) Unsustainable logging; and (iv) Forest fires.

Understanding the importance of forests and their environmental protection function, and recognizing the needs of effective policies to curb loss of forest cover from the end of 1980s to the early 1990s, since

[6] Peatland areas is estimated at 12 983 ha.

around the mid-1990s, the Government of Viet Nam has invested in a number of nation-wide reforestation, restoration and forest protection programmes; most notably the Programme No. 661 "Five million hectare reforestation programme" (1998-2010) has made considerable contributions to the recent national forest cover trends. The final report of Government of Vietnam (2016) refers to the main achievements from this national Programme including reforestation (conversion from non-forest to plantations and to natural forests) and restoration of approximately 5 million ha and concluded that the Programme has met its targets. Viet Nam should not be "penalized" with FREL/FRLs which set Viet Nam for positive performance only if it surpasses such past efforts, a performance difficult to be achieved in the future, for the reasons of reduced area for planting, and termination of funding for the said Programme (financed partly by Official Development Assistance).

Two studies have been conducted independently to estimate the successful implementation (success rate) of the Programme No. 661, covering different geographical areas. The first study conducted for Dien Bien province (Northwest region) estimated the success rate of plantations under the Programme at 41% (JICA 2014).[7] The second study took into consideration the results of the first study, and selected a broader range of sample provinces in the country with respect to 661 Programme implementation, regional representation, and data availability. This study reviewed the Programme success rate for five provinces, covering over 70,000 ha of both plantation and assisted regeneration[8] activities under the Programme. The study found that the overall success rate for plantations at 87% (VAFS 2016). The removals associated to the Programme No. 661 come from the plantation activity and amount to -123 $MtCO_2e$ over the programme period (see Box 1.4). Viet Nam adjusts its FRL by removing (discounting) this amount.

Box 1.4: Calculation of adjustments for plantations under the Programme No. 661

The studies implemented on Programme No. 661 success rate yielded significantly different success rates for Dien Bien province (41%) and the other provinces (87%). These differences were explained mainly by the low market accessibility and pressure from competing land use in Dien Bien province (Northwest eco-region), considering that the majority of species used in Programme No. 661 were *Acacia* species, and targeted woodchips for the pulp and paper industry. Provinces that have similar circumstances to Dien Bien in terms of market access and pressure from competing land use are Son La and Lai Chau provinces neighboring Dien Bien province. Taking into account the above, and also to maintain conservativeness in the estimation of removals from the Programme No. 611, the following success rates were attributed:

Parameters	Dien Bien, Son La, Lai Chau provinces	Rest of country	Total
Area implemented (ha)	119,534	2,330,476	2,450,010
Success rate	41%	87%	n.a.
Area counted for 661 removals (ha)	49,009	2,027,514	2,076,523

The emission and removal factors for the period 2005-2010 were used (noting that exact year of planting could not be identified). For plantation activities, the removal factor for the conversion from non-forest to plantation at the national level was -59 $MtCO_2e$. Based on the above information, a total of 123 MtCO2e is estimated to have been stocked as a result of the programme implementation and the Viet Nam FRL is adjusted by removing this amount.

[7] Available at: http://vietnam-redd.org/Upload/CMS/Content/REDD%20projects/JICA-DienBienREDDpilot/SUSFORM-NOW/FinalReport_EN.pdf

[8] As the information on the original land cover for which assisted regeneration activities were implemented was not available at the time of the modified FREL/FRLs development, no emission factor could be associated to this activity thus corresponding removals were not calculated.

Box 1.5: Other national initiatives promoting enhancement in forest carbon stocks

In addition to No. Programme 661 Viet Nam has implemented several other initiatives, such as Programme No. 327 encouraging forest planting and restoration. However, since some of these initiatives started as far back as 1992 and the resulting carbon stock increases of these initiatives were not adequately monitored, Viet Nam will consider these as its own effort and not include results from these initiatives either for results-based payments or as an adjustment to discount past performance from its FREL/FRL.

1.5.3 Historical data: activity data and emission factors

1.5.3.1 Activity data

Viet Nam applied IPCC Approach 3 for representing activity data when developing its FREL/FRL.[9]

To date, forest cover maps have been developed every five years since 1991, at national scale, through the NFI. Remote sensing imageries used for the development of these maps have varied, as well as the applied forest definition and forest type classifications. In order to develop national FREL/FRL, Viet Nam has made efforts to harmonize these forest cover maps, making them compatible and consistent over time by applying the same forest definition and a harmonization method for classification (Karsten Raae *et al*. 2010)[10].

The maps for the historical reference period have been reviewed for correction, applying the 2010 forest cover map as a baseline map, and applying the most recent forest definition cited above, and a harmonized forest classification system (i.e. the forest and land use types presented in Table 1.1.5). Forest changes for the three NFI results relevant to the three historical time periods 1995-2000, 2000-2005 and 2005-2010 were checked against logic of possible changes, and where illogical changes were detected, corrections were made including with reference to satellite imageries taken near the time of map creation. A grid of 1 km by 1 km was used nationwide to control the illogical changes and a threshold of 3 % of the control points was set as acceptable number of illogical changes for each province.

Area statistics of forest and land use dynamics during 1995-2010, which were derived from the upgraded NFI forest cover maps, are provided in **Error! Reference source not found.**. Details on how these r esults were derived are provided in Part 2 - "Historical processes of forest cover map generation and review and the description of the latest map review and Activity Data generation process".

Table 1.5: Areas of national forest and land use 1995 – 2010 (unit: 1,000 ha)

No	Forest and land use types	1995	2000	2005	2010
	Total area	**33,015**	**33,015**	**33,017**	**33,017**
I	***Forest***	***11,357***	***11,938***	***12,741***	***13,661***
1	Evergreen broadleaf – rich	856	804	693	681
2	Evergreen broadleaf – medium	2,004	1,889	1,783	1,674
3	Evergreen broadleaf – poor	1,918	1,785	1,621	1,581
4	Evergreen broadleaf – regrowth	2,399	2,699	3,283	3,654
5	Deciduous	751	722	665	646
6	Bamboos	526	547	490	441
7	Mixed timber – bamboos	734	751	751	748

[9] This will allow for nesting of the FREL/FRL of regional REDD+ projects, namely the FCPF Carbon Fund's ER Program for Viet Nam under the national FREL/FRL.

[10] Available at: http://vietnam-redd.org/Web/Default.aspx?tab=download&zoneid=152&subzone=156&child=210&lang=en-US.

No	Forest and land use types	1995	2000	2005	2010
8	Coniferous	172	177	164	162
9	Mixed broadleaf - coniferous	64	56	54	53
10	Mangrove	199	178	134	142
11	Limestone forest	740	749	759	757
12	Plantation	994	1,582	2,343	3,122
II	***Bare land***	***7,979***	***7,264***	***6,249***	***4,893***
13	Limestone without trees	232	224	207	205
14	Other bare land	7,748	7,039	6,042	4,688
III	***Agriculture and other land***	***13,678***	***13,814***	***14,027***	***14,463***
15	Water body	824	846	851	870
16	Residential area	1,498	1,569	1,669	1,798
17	Agriculture and other land	11,356	11,399	11,507	11,796

1.5.3.2 Emission and Removal Factors (EFs/RFs)

Following the forest activity data, NFI plot measurement data are available for Viet Nam for each of the five-year NFI cycles since 1995.

The raw data from NFI Cycles I-IV were improved by internal and external reviews (JICA and VNForest 2012)[11] and when used in combination with country-specific allometric equations (Phuong, V.T. *et al* 2012)[12], the uncertainty of average carbon stocks were reduced. The most optimal allometric equations are selected after testing various allometric equations per forest type per agro-ecological region. The resulting national average carbon stocks per forest type together with uncertainty at the 95% confidence interval are provided in Table 1.6.

Table 1.6: Carbon stock estimates above and belowground (in tC/ha) for the four NFI cycles[13]

Forest types	Cycle I	Cycle II	Cycle III	Cycle IV
1. Evergreen broadleaf – rich	150 ± 4%	152 ± 3%	146 ± 5%	140 ± 3%
2. Evergreen broadleaf – medium	73 ± 1%	73 ± 1%	75 ± 1%	75 ± 1%
3. Evergreen broadleaf – poor	32 ± 3%	32 ± 2%	32 ± 3%	32 ± 3%
4. Evergreen broadleaf – regrowth	32 ± 6%	30 ± 5%	26 ± 5%	26 ± 6%
5. Deciduous	40 ± 14%	36 ± 5%	32 ± 5%	31 ± 8%
6. Bamboos	14 ± 10%	13 ± 9%	13 ± 7%	15 ± 11%
7. Mixed timber – bamboos	50 ± 9%	47 ± 8%	43 ± 8%	42 ± 7%
8. Coniferous	87 ± 18%	72 ± 13%	83 ± 13%	95 ± 11%
9. Mixed broadleaf - coniferous	85 ± 24%	78 ± 16%	84 ± 25%	67 ± 45%
10. Mangrove	58 (*)	58 (*)	58 (*)	58 (*)
11. Limestone forest	36 ± 25%	26 ± 100%	23 ± 27%	19 ± 83%
12. Plantation	20 ± 22%	19 ± 20%	17 ± 11%	16 ± 13%

(*) Carbon stocks for Mangroves are based on literature review.

[11] Available at: http://vietnam-redd.org/Web/Default.aspx?tab=download&zoneid=152&subzone=156&child=210&lang=en-US

[12] Available at: http://vietnam-redd.org/Web/Default.aspx?tab=download&zoneid=152&subzone=156&child=196&lang=en-US

[13] Carbon stock estimates for a number of forest types have considerably high uncertainty. These occur mainly for forest types covering only small areas and therefore, with few sample measurement plots (i.e. Coniferous forest, etc.), or for forest types that by nature are difficult to access (i.e. Limestone forest). On the other hand, for Evergreen broadleaved forests, between 400 and 1,100 secondary plots were measured nationwide in each sub-category per NFI cycle, and results in lower uncertainty.

Table 1.6 presents information on the trends at national level for Cycle IV but the calculations of actual EFs/RFs used in the FREL/FRL were implemented at the agro-ecological region level (Table 1.6 should be seen only as reference). The detailed carbon stock estimates per land cover type and agro-ecological region are presented in Part 3 - "Calculation of forest carbon stocks and emission/removal factors from NFIMAP Cycles I to IV plot measurement data".

For mangrove forests, since the number of sample plots applied in each cycle is not sufficient, the average carbon stocks for this forest type have been substituted by results of a research conducted by the Viet Nam Academy of Forest Sciences. According to this research, the average carbon stock of mangrove forest is 35.2 tC/ha in the North East, Red River Delta and North Central Coast regions and 64.4 tC/ha in the South Central Coast, South East and Mekong River Delta regions. As 22% of the mangrove forests were located in the North and 78% in the South, the national level weighted average carbon stock is 58.0 tC/ha.

Carbon stocks of non-forest land use types are assumed zero.

The EFs/RFs resulting from the conversion of land types were calculated as the difference of carbon stocks between the two land types, and converted to tonnes CO_2e. These EFs/RFs are calculated separately for each agro-ecological region and the results are provided in Part 3 - "Calculation of forest carbon stocks and emission/removal factors from NFIMAP Cycles I to IV plot measurement data".

1.5.4 The FREL/FRL

1.5.4.1 Method of construction

Viet Nam considers it transparent to separately present removals and emissions 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 policies and measures of enhancing forest carbon stocks and reducing emissions from deforestation and forest degradation. This also helps the REDD+ strategy to focus different actions on reducing emissions and on increasing removals.

Due to the separation of the FREL and the FRL, Viet Nam acknowledges that associated considerations emerge with regards performance and how results-based payments are claimed. In this regard, Box 1.6 below informs of the on-going discussions in Viet Nam on this issue.

Box 1.6: **On-going considerations on Results-Based Payments**

At the time of the modified submission of its FREL/FRL, Viet Nam is considering the following in claiming results-based payments. The decision on this matter will be taken by Viet Nam based on evolving international dialogue on results-based payments into the future.

- [Under the MRV, in the event that Viet Nam performs against the FRL, while underperforming against the FREL, Viet Nam proposes to waive any results-based payments. [OR]
- Under the MRV, in the event that Viet Nam performs against the FRL, while underperforming against the FREL, Viet Nam proposes to claim only for results-based payments for the amount of removals that exceeds the underperformance against the FREL.]
- On the other hand, in the event that Viet Nam performs against the FREL, while underperforming against the FRL, Viet Nam will claim for results-based payments for the full performance against the FREL.

1.5.4.2 The reference period

Since the NFI has provided both AD and EF/RF from 1995 to 2010, the period 1995 – 2010 was selected as the historical reference period for Viet Nam. This reference period is in accordance with NFI cycles.

1.5.4.3 The FREL/FRL of Viet Nam

Emissions and removals in one period are obtained by multiplying the activity data by the corresponding EFs/RFs and summing them up. Emissions/removals are in principle estimated by agro-ecological region for three periods 1995 – 2000, 2000 – 2005 and 2005 – 2010, and then aggregated to the national level. The historical emissions and removals are shown in Figure 1.1.

Figure 1.1: Historical emissions/removals in Viet Nam (in M tCO_2e per year)

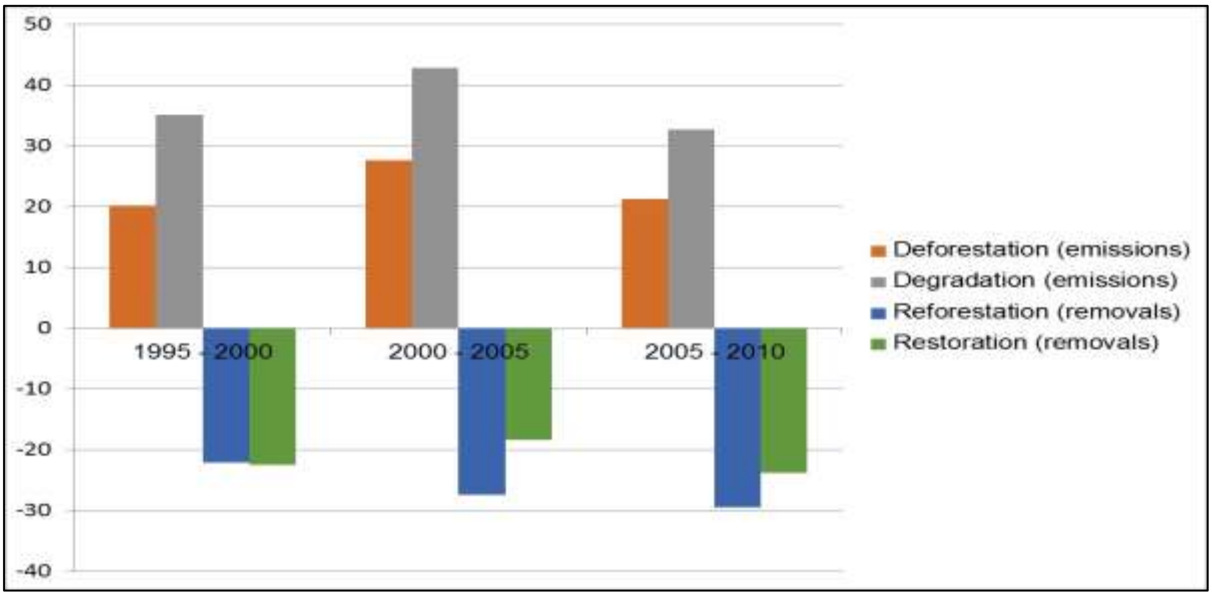


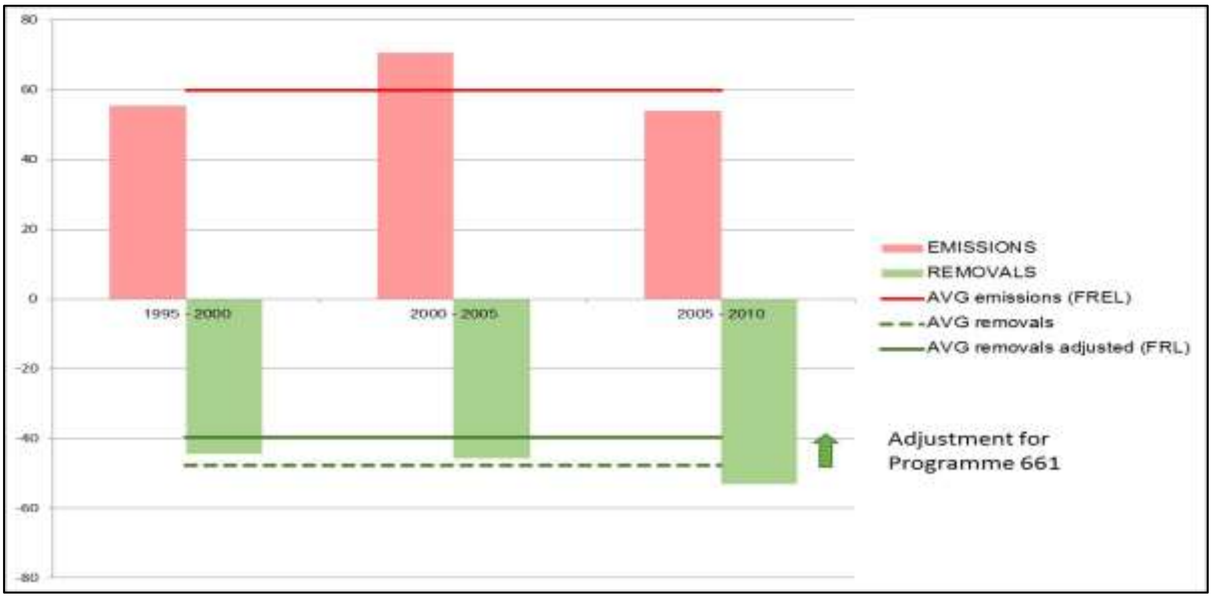
Figure 1.1 shows that there is no clear trend on the historical emissions/removals. Therefore, the average of historical emissions/removals during the reference period will be used as FREL/FRL for Viet Nam.

The proposed FREL/FRL for Viet Nam is provided in **Error! Reference source not found.** and i llustrated in Figure 1.2. According to **Error! Reference source not found.**, the proposed FREL for Viet Nam is 59.96 million tCO_2e/year and the proposed FRL is -39.6 million tCO_2e/year.

Table 1.7: The proposed FREL/FRL for Viet Nam

FREL/FRL	Emissions/Removals(tCO_2e/year)
Average emission (FREL)	+59,960,827
Average removal with adjustment (FRL)	-39,602,735
Average removal without adjustment	-47,786,072

Figure 1.2: Proposed FREL/FRL for Viet Nam in M tCO_2e per year



1.5.4.4 Uncertainty of the Emissions/Removals

A study conducted by FIPI and JICA (2014)[14] estimated that the uncertainty of change between forest and non-forest, between forest types and between volume based sub categories of evergreen broadleaf forests was respectively 5%, 20% and 26%. This analysis was mainly conducted on the NFIMAP Cycle IV map which was based on high resolution images and therefore the provided numbers may underestimate the uncertainty of change between the past maps. Additional uncertainty assessment is under implementation.

The standard deviation and the uncertainty at 95% of the confidence interval of the carbon stocks estimates were calculated to take into consideration the sampling design used for collecting the data. No systematic errors are expected from the forest inventory as it was reviewed several times and included quality control procedures. However the uncertainty due to the models applied (biomass and volume equations) was not included in the study. A more complete uncertainty analysis, including NFI cluster based sampling design, model and estimated variables (wood density, tree height) error is under implementation.

1.5.4.5 Transparency

To ensure the transparency of the data used to calculate the FREL/FRL, Viet Nam will host the historical maps, tables of carbon stocks per eco-region and REDD+ initiatives on a web geoportal available on internet.[15] Graphs representing the importance of the main activities from national to provincial level, the land use change matrix and the emissions and removals will be hosted on the portal.

1.6 Improvements for the future FREL/FRL

Potential improvements in future FREL/FRL submissions include:

- Plantation species cannot be separated in the current data, but on-going efforts are anticipated to allow measuring separately the different forest plantation species for the past and present data. Plantation forest type could be separated per species with specific EFs/RFs and activity data in the future.

- If dead wood, litter and soil organic carbon should be measured in the future NFIs, they are proposed for inclusion in the carbon pools considered in future FREL/FRL submissions. The same applies to the lianas, shrubs and understorey component of aboveground and belowground biomass.
- Uncertainty estimates for the error propagation from tree measurement to carbon stocks and emission/removal factors, and for the activity data would help to understand the uncertainty of the FREL/FRL.

[14]Available at: http://vietnam-redd.org/Web/Default.aspx?tab=download&zoneid=152&subzone=156&child=210&lang=en-US

[15] At the time of the submission of the Modified submission of the Viet Nam FREL/FRL, the REDD+ Geoportal is still under development.

2 PART 2: HISTORICAL PROCESSES OF FOREST COVER MAP GENERATION AND REVIEW AND THE DESCRIPTION OF THE LATEST MAP REVIEW AND ACTIVITY DATA GENERATION PROCESS

2.1. Methods for estimating activity data

2.1.1. Review and upgrade historical forest cover maps

2.1.1.1. Input maps

The forest cover maps used to develop the national FREL/FRL were inherited from the outcomes of the MARD project "Calculation of forest carbon stock and development of national forest emission reference level" implemented by FIPI. The steps taken for upgrading these inherited maps are as follows:

- Using ERDAS/IMAGINE software to pre-process Landsat imagery: Colour compositing, pan sharpening, spectral enhancement, display adjustment etc.
- Using ERDAS/IMAGINE to verify and transform Landsat imagery from UTM WGS84 to VN2000 projection system.
- Using ERDAS/IMAGINE to normalize and mosaic Landsat images by year and by agro-ecoregion.
- Using the normalized and mosaic images to upgrade and correct the forest cover maps by automatical segmentation and removing illogical changes.

After improvement, the provincial forest cover maps were aggregated by agro-ecoregions to generate the regional forest cover maps. The national forest cover maps were aggregated from regional forest cover maps.

2.1.1.2. Classification system

This task applies the forest and land use classification system used in the forest cover maps improved by the earlier project supported by JICA. This classification system is based on Circular No. 34/2009/TT-BNN. The original forest cover maps for the year 1995, 2000 and 2005 produced by the NFIMAP used a classification system based on Decision 84 while the map for the year 2010 used a classification system based on Circular No. 34. With support from JICA, the older maps have been harmonized to a classification system based on Circular No. 34. Note that although also based on Circular No. 34, the classification system of the original forest cover map in 2010 (produced by NFIMAP) has more classes than the harmonized one (see table below).

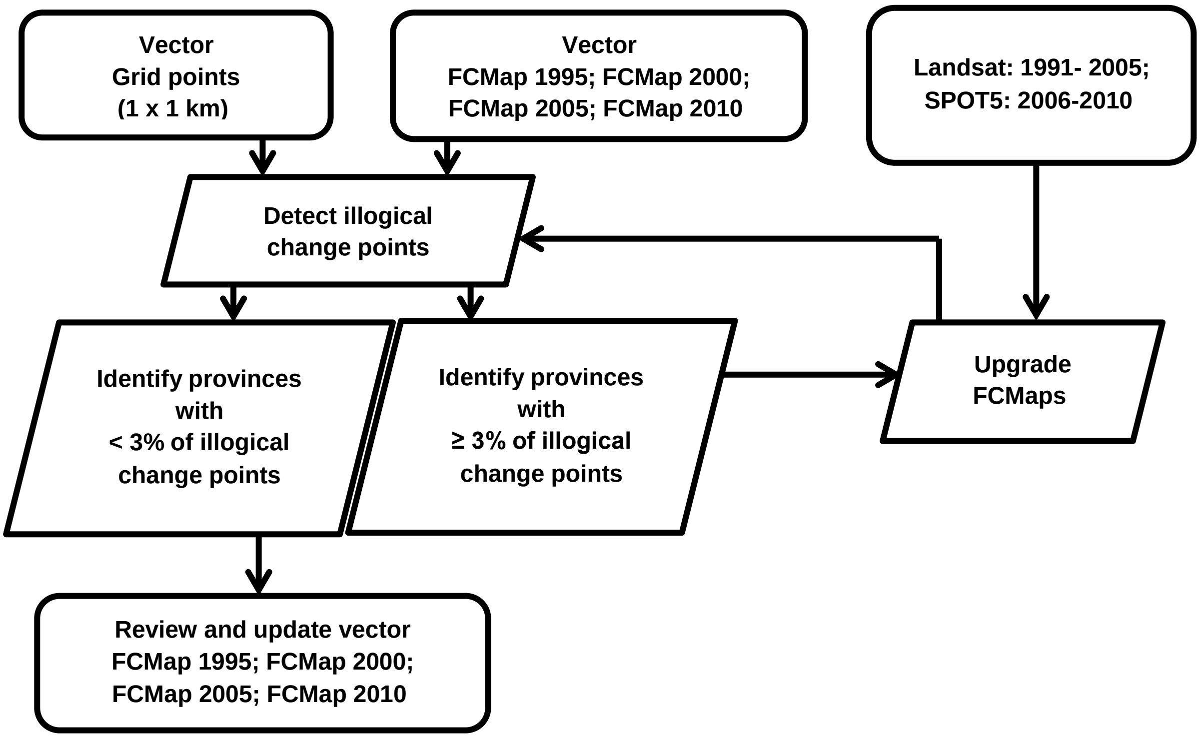
Table 2.1: The forest and land use classification system

Code	Forest and land use type
1	Evergreen broadleaf – rich
2	Evergreen broadleaf – medium
3	Evergreen broadleaf – poor
4	Evergreen broadleaf – regrowth
5	Deciduous
6	Bamboo
7	Mixed woody – bamboo
8	Coniferous
9	Mixed broadleaf – coniferous
10	Mangroves
11	Limestone forest
12	Plantations
13	Limestone without forest
14	Bared land
15	Water bodies
16	Residence
17	Other land

2.1.1.3. *Review and upgrade*

The review and upgrade process is shown in figure 2.1.

Figure 2.1: Method of review and upgrade forest cover maps



There are four existing forest cover maps for the years 1995, 2000, 2005 and 2010. The review process examined changes of different forest classes and non-forest areas of different periods. Six periods were examined, namely: 2005-2010, 2000-2010, 1995-2010, 2000-2005, 1995-2005, and 1995-2000. Illogical forest and land use changes were detected to find problems of interpretation of those maps for further upgrading and re-interpretation. Illogical changes in the examined time periods were discussed and determined by Vietnamese forestry experts as presented in **Error! Reference source not found.** t o **Error! Reference source not found.**2.2 below. The numbers in the rows indicate the forest and land use class (c.f. **Error! Reference source not found.**2.1 above) of the respective maps where changes r ecorded were considered illogical:

Table 2.2: Illogical changes of features between Map 2010 and Map 2005

Map 2010	Map 2005	Problem1-ID
1	3, 4, 5, 6, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17	P1.1
2	5, 6, 10, 11, 12, 13, 14, 15, 16, 17	P1.2
3	5, 6, 8, 10, 11, 12, 13, 14, 15, 16, 17	P1.3
4	5, 10, 11, 13	P1.4
5	1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12	P1.5
6	5, 8, 10, 11, 13	P1.6
7	5, 8, 10, 11, 13	P1.7
8	1, 2, 3, 4, 5, 6, 7, 10, 11, 12, 13	P1.8
9	1, 2, 3, 10, 11, 13	P1.9
10	1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 13	P1.10
11	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 14, 15	P1.11
12		
13	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 14, 15	P1.13
14		
15		
16		
17		

Table 2.3: Illogical changes of features between Map 2010 and Map 2000

Map 2010	Map 2000	Problem2-ID
1	5, 6, 10, 11, 12, 13, 14, 15	P2.1
2	5, 6, 10, 11, 12, 13, 14, 15	P2.2
3	5, 6, 10, 11, 12, 13, 14, 15	P2.3
4		
5		
6		
7		
8		
9		
10		
11	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 14, 15	P2.11
12		
13	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 14, 15	P2.13
14		
15		
16		
17		

Table 2.4: Illogical changes of features between Map 2010 and Map 1995

Map 2010	Map 1995	Problem3-ID
1	5, 6, 10, 11, 12, 13, 14, 15	P3.1
2	5, 6, 10, 11, 12, 13, 14, 15	P3.2
3	5, 6, 10, 11, 12, 13, 14, 15	P3.3
4		
5		
6		
7		
8		
9		
10		
11	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 14, 15	P3.11
12		
13	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 14, 15	P3.13
14		
15		
16		
17		

Table 2.5: Illogical changes of features between Map 2005 and Map 2000

Map 2005	**Map 2000**	**Problem4-ID**
1	3, 4, 5, 6, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17	P4.1
2	5, 6, 10, 11, 12, 13, 14, 15, 16, 17	P4.2
3	5, 6, 8, 10, 11, 12, 13, 14, 15, 16, 17	P4.3
4	5, 10, 11, 13	P4.4
5	1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12	P4.5
6	5, 8, 10, 11, 13	P4.6
7	5, 8, 10, 11, 13	P4.7
8	1, 2, 3, 4, 5, 6, 7, 10, 11, 12, 13	P4.8
9	1, 2, 3, 10, 11, 13	P4.9
10	1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 13	P4.10
11	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 14, 15	P4.11
12		
13	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 14, 15	P4.13
14		
15		
16		
17		

Table 2.6: Illogical changes of features between Map 2005 and Map 1995

Map 2005	Map 1995	Problem5-ID
1	5, 6, 10, 11, 12, 13, 14, 15	P5.1
2	5, 6, 10, 11, 12, 13, 14, 15	P5.2
3	5, 6, 10, 11, 12, 13, 14, 15	P5.3
4		
5		
6		
7		
8		
9		
10		
11	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 14, 15	P5.11
12		
13	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 14, 15	P5.13
14		
15		
16		
17		

Table 2.7: Illogical changes of features between Map 2000 and Map 1995

Map 2000	Map 1995	Problem6-ID
1	3, 4, 5, 6, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17	P6.1
2	5, 6, 10, 11, 12, 13, 14, 15, 16, 17	P6.2
3	5, 6, 8, 10, 11, 12, 13, 14, 15, 16, 17	P6.3
4	5, 10, 11, 13	P6.4
5	1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12	P6.5
6	5, 8, 10, 11, 13	P6.6
7	5, 8, 10, 11, 13	P6.7
8	1, 2, 3, 4, 5, 6, 7, 10, 11, 12, 13	P6.8
9	1, 2, 3, 10, 11, 13	P6.9
10	1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 13	P6.10
11	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 14, 15	P6.11
12		
13	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 14, 15	P6.13
14		
15		
16		
17		

In order to assess illogical changes, a set of 329,114 points were distributed systematically by applying a 1 x 1 km grid over the entire national territory. Every point was then associated with features from forest cover maps 1995, 2000, 2005, and 2010. Results of each processing step were documented for validation at later stage. A threshold of 3% per province was set as the level of acceptable illogical change points occurring over the total number of points distributed for each province.

2.1.2. Generating forest and land use change maps and matrices

Forest and land use change maps were generated using the intersect tool of ArcGIS by opening the two maps of the two-time points and applying the Analysis Tools\ Overlay\ Intersect tools. This process was applied for each of the periods 1995-2000, 2000-2005 and 2005-2010 in each province. The provincial forest and land use change maps are then aggregated to generate the regional and national forest and land use change maps.

To generate the forest and land use change matrices, the area for each polygon in the forest and land use change maps was calculated using ArcGIS. The process included exporting the attributes of the forest and land use change maps to Microsoft Excel spreadsheet files and using the PivotTable to generate the forest and land use change matrices.

2.1.3. Accuracy assessment

The accuracy assessment process was implemented based on forest and land use change maps of two time points (i.e. not on forest cover maps). The flowchart of the accuracy assessment process is illustrated in

- The process contains the following steps:

Step 1. Convert the 17-class forest and land use cover maps to 3-class forest cover maps:

- The classes 1-4, 6-11 of the 17-class maps were combined and assigned as “evergreen forest”.
- The class 5 of the 17-class was assigned as class “deciduous forest”.
- The classes 13-17 of the 17-class maps were combined and assigned as “non-forest”

Step 2. Overlay forest cover maps of two time points

The forest change maps have 9 possible combinations of changes as follows:

1. “Deciduous forest” to “evergreen forest”,
2. “Deciduous forest” to “non-forest” (deforestation),
3. “Evergreen forest” to “deciduous forest”,
4. “Evergreen forest” to “non-forest” (deforestation),
5. “Non-forest” to “deciduous forest” (forest gain),
6. “Non-forest” to “evergreen forest” (forest gain),
7. Stable deciduous forest,
8. Stable evergreen forest,
9. Stable non-forest.

Step 3. Determine sample size and allocate evaluation sample points for each type of change:

- Calculate the areas of each class on the 3-class maps.
- The number of sample points required per class is determined by three main parameters[16]: 1) the level of precision required of the estimates, 2) the proportion of each mapped class in the map and 3) the expert-estimated, conservative map accuracy of each class.

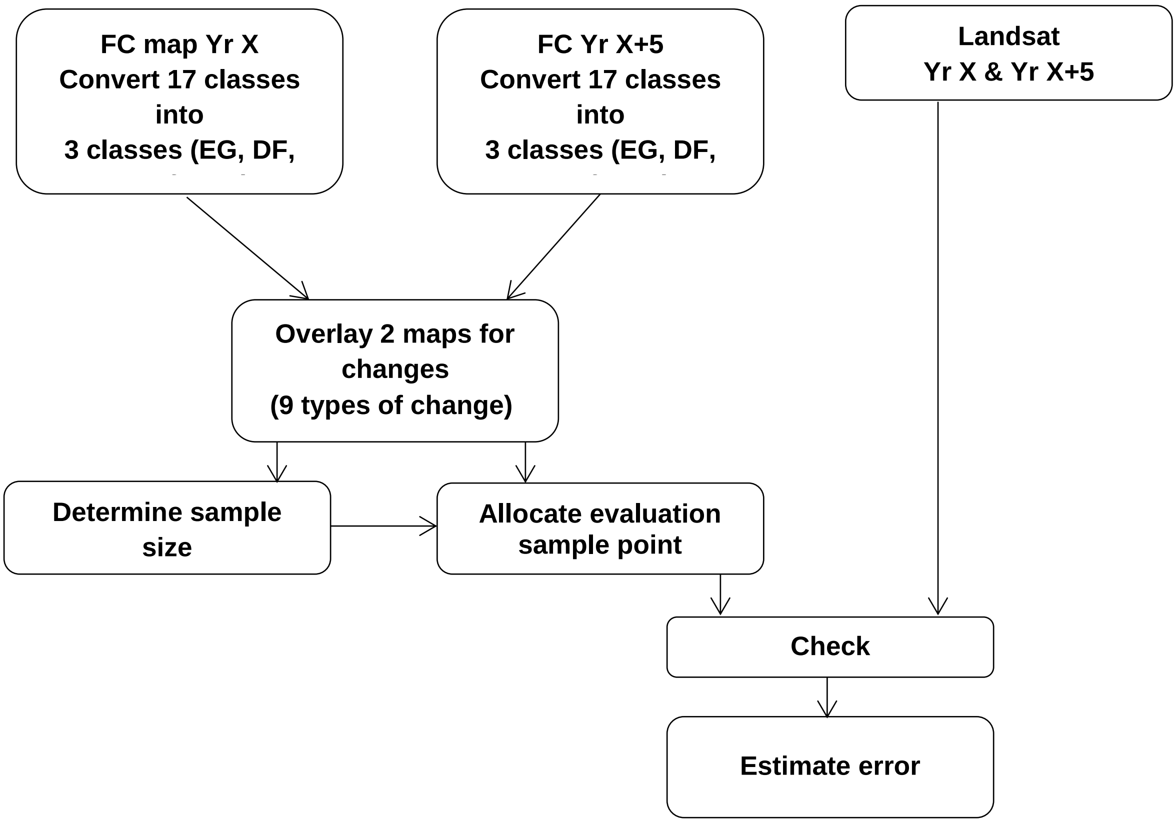
Step 4. Assess every evaluation sample point on Landsat images of “year X” and “year X+5”

- At each of the evaluation sample points, the classification was independently evaluated.
- Since maps were based on Landsat data, Landsat data can also be used to evaluate the classification[17].
- Google Earth Engine tool was applied to mosaic Landsat images.
- OpenForis Collect Earth[18] tool was applied to conduct accuracy assessment and record results.

Step 5. Summarize the results and estimate errors for each type of change.

[16] For this step, a pre-compiled spreadsheet for determining sample size and allocation was provided by an FAO expert.
[17] In fact, Landsat data is likely to be the only data set available for the historical periods for map evaluation.
[18] www.openforis.org/tools/collect-earth.html

Figure 2.2: Method for accuracy assessment of forest change maps



2.2. Results of estimating activity data

2.2.1. Results of reviewing and upgrading forest cover maps

2.2.1.1. Results of reviewing forest cover maps

There were 49 points (0.5% of total number of points) with no feature information. This gap of data occurred particularly on boundaries between provinces but also within provincial boundaries. However, since the fraction of these points is not significant, these errors can be accepted. The numbers of illogical change points for each province are provided in the table below:

Table 2.8: Illogical change points by province

Province*	# of illogical points	Total points	%
Đắk Lắk	4671	13063	35.8%
Quảng Nam	291	10580	2.8%
Lai Châu	247	9050	2.7%
Quảng Trị	115	4722	2.4%
Bắc Kạn	101	4862	2.1%
Thừa Thiên Huế	91	4903	1.9%
Kon Tum	159	9711	1.6%
Hà Giang	123	7962	1.5%
Nghệ An	220	16434	1.3%
Lào Cai	79	6353	1.2%
Yên Bái	73	6887	1.1%
Khánh Hòa	49	4781	1.0%

Province*	# of illogical points	Total points	%
Thanh Hóa	108	11056	1.0%
Sơn La	136	14089	1.0%
Ninh Thuận	32	3352	1.0%
Quảng Bình	74	7987	0.9%
Gia Lai	135	15549	0.9%
Thái Nguyên	30	3522	0.9%
Bình Định	49	6076	0.8%
Đắk Nông	51	6510	0.8%
Quảng Ngãi	40	5149	0.8%
Điện Biên	69	9531	0.7%
TP. Đà Nẵng	7	970	0.7%
Phú Yên	35	5011	0.7%
Lâm Đồng	64	9783	0.7%
Cao Bằng	42	6710	0.6%
Đồng Nai	30	5869	0.5%
Hà Tĩnh	28	5955	0.5%
Vĩnh Phúc	5	1239	0.4%
Hòa Bình	16	4578	0.3%
Tuyên Quang	20	5855	0.3%
Bình Thuận	27	7933	0.3%
Lạng Sơn	23	8316	0.3%
Phú Thọ	9	3525	0.3%
Bà Rịa - Vũng Tàu	3	1880	0.2%
Quảng Ninh	9	5917	0.2%
Tây Ninh	4	4031	0.1%
Bắc Giang	2	3882	0.1%
Bình Phước	3	6881	0.0%
Bình Dương	1	2696	0.0%

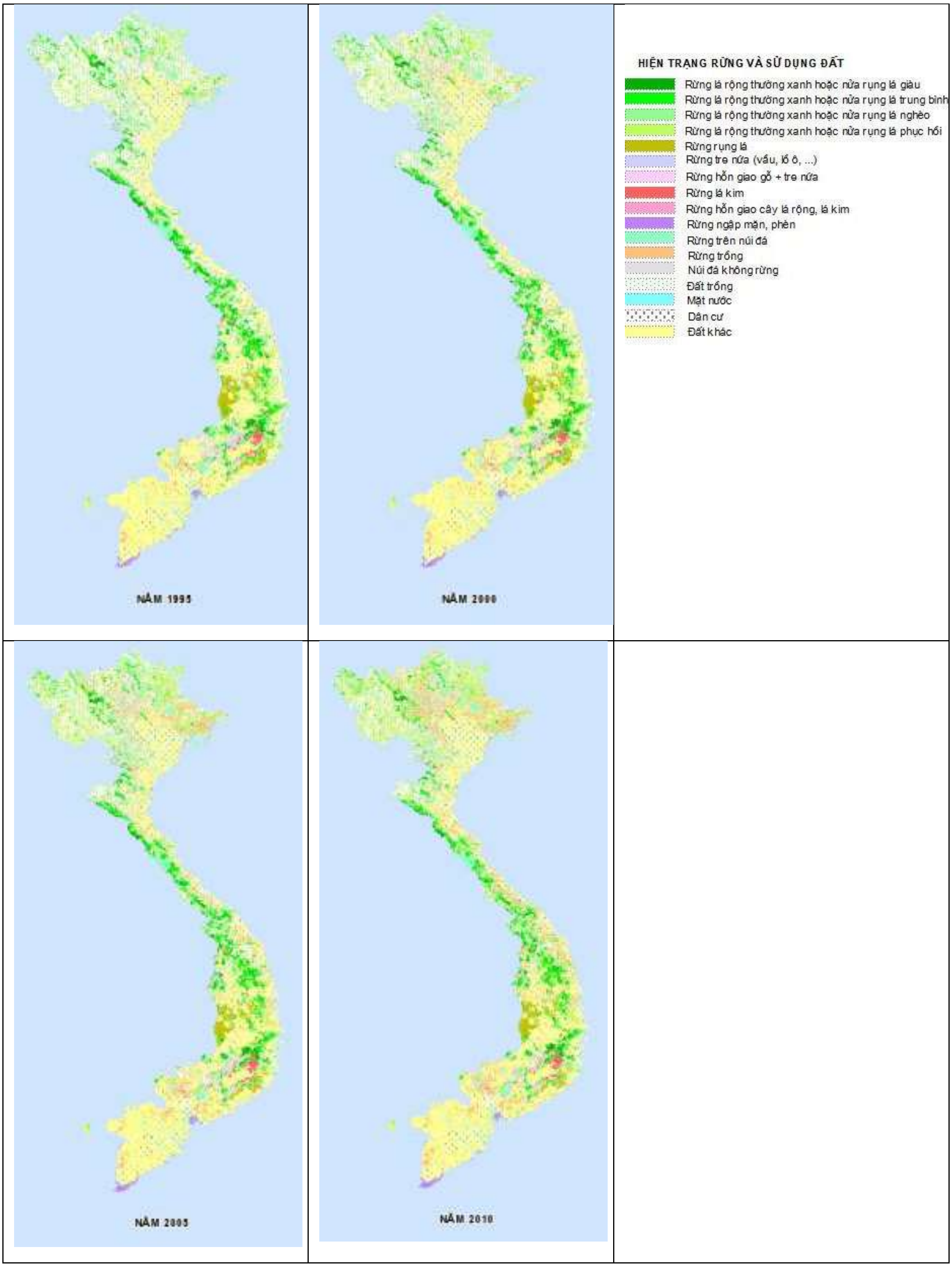
* Only provinces with illogical change points are listed.

From **Error! Reference source not found.**2.8 it is observed that only Dak Lak province had illogical change points larger than the predefined threshold 3% per province (i.e. 4,671 points; 35.8%). Most of those points belong to Problem ID-6 (i.e. change during period 1995-2000). Therefore, the forest cover maps in 1995 and 2000 of Dak Lak were upgraded further using the method described above. After the upgrading, the forest cover maps 1995 and 2000 of Dak Lak province were reviewed again, which resulted in the number of illogical change points reduced to 119 points (0.9%) or below the predefined threshold of 3%.

2.2.1.2. Results of upgrading forest cover maps

National forest cover maps for 1995, 2000, 2005 and 2010 are provided in Figure 2.3 below.

Figure 2.3: National Forest cover maps 1995, 2000, 2005 and 2010



The summary of forest and land use areas in Vietnam between 1995 - 2010 is provided in the table below:

Table 2.9: Areas of forest and land use in Vietnam for period 1995-2010 (ha)

No	Forest and land use category	1995	2000	2005	2010
	Natural area	**33,014,931**	**33,014,983**	**33.016.827**	**33.016.827**
I	***Forest land***	***11,357,483***	***11,937,502***	***12.741.124***	***13.661.080***
1	EGBL - rich	855,650	803,894	692.802	680.968
2	EGBL - medium	2,004,486	1,888,565	1.783.193	1.674.100
3	EGBL - poor	1,918,127	1,785,122	1.621.104	1.581.286
4	EGBL - regrowth	2,398,799	2,699,070	3.282.841	3.653.656
5	Deciduous	751,451	721,690	664.818	645.592
6	Bamboo	526,429	546,702	490.421	440.682
7	Mixed woody - bamboo	733,989	750,661	751.415	748.141
8	Coniferous	171,646	176,502	164.188	162.427
9	Mixed broadleaf - coniferous	63,846	55,981	54.011	52.723
10	Mangroves	198,822	178,223	133.989	141.941
11	Limestone forest	739,917	749,096	758.861	757.312
12	Plantations	994,320	1,581,996	2.343.481	3.122.254
II	***Bared land***	***7,979,314***	***7,263,586***	***6.248.637***	***4.892.711***
13	Limestone without forest	231,658	224,148	206.902	204.599
14	Other bared land	7,747,657	7,039,438	6.041.735	4.688.112
III	***Agriculture and others***	***13,678,133***	***13,813,895***	***14.027.066***	***14.463.036***
15	Water bodies	823,781	846,082	851.020	869.873
16	Residence	1,498,236	1,568,851	1.668.871	1.797.651
17	Other land	11,356,116	11,398,962	11.507.175	11.795.512

Based on the results of the upgraded forest cover maps, national statistics on forest and land use have been re-estimated for the corresponding years.

2.2.2. Results of generating forest and land use change maps and matrices

The forest and land use change matrices for periods 1995-2000, 2000-2005 and 2005-2010 for Vietnam (national) are in the following tables:

Table 2.10: Forest and land use change matrix in Vietnam for period 1995-2000 (1000 ha)

		Year 2000																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total
Year 1995	1	713	104	17	11	0	2	2	0	0	0	0	0	0	6	0	0	1	856
	2	83	1,619	143	86	0	5	10	0	0	0	0	1	0	49	0	0	7	2,004
	3	3	131	1,421	174	0	8	19	0	0	0	0	7	0	133	0	0	21	1,918
	4	2	17	168	1,814	0	16	19	0	0	0	0	31	0	272	1	0	58	2,399
	5	0	0	0	0	709	0	0	0	0	0	0	0	0	24	3	0	15	751
	6	1	2	2	13	0	391	41	0	0	0	0	2	0	37	1	0	36	526
	7	1	4	11	29	0	19	619	0	0	0	0	2	0	21	0	0	28	734
	8	0	0	0	0	0	0	0	168	1	0	0	0	0	1	0	0	1	172
	9	0	0	0	2	0	0	0	6	53	0	0	1	0	1	0	0	1	64
	10	0	0	0	0	0	0	0	0	0	164	0	2	0	0	0	0	33	199
	11	0	0	0	0	0	0	0	0	0	0	736	0	2	1	0	0	0	740
	12	0	0	0	2	0	0	0	0	0	0	0	877	0	28	0	1	85	994
	13	0	0	0	0	0	0	0	0	0	0	11	0	219	0	0	0	1	232
	14	1	10	19	520	8	91	29	2	1	1	1	534	2	6,084	11	17	416	7,748
	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	813	1	8	824
	16	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	1,491	3	1,498
	17	0	2	3	48	3	15	9	0	0	13	0	125	0	378	16	58	10,685	11,356
	Total	804	1,889	1,785	2,699	721	546	750	177	56	178	749	1,582	224	7,039	846	1,569	11,400	33,015

Table 2.11: Forest and land use change matrix in Vietnam for period 2000-2005(1000 ha)

		Year 2005																	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**Total**
Year 2000	**1**	626	112	23	12	0	1	2	0	0	0	0	0	0	10	0	0	17	804
	2	54	1,526	155	88	0	4	17	0	0	0	0	1	0	36	0	0	7	1,889
	3	6	111	1,267	209	0	6	35	0	0	0	0	13	0	112	0	0	25	1,785
	4	4	16	136	1,995	0	9	28	0	0	0	0	59	0	377	0	1	73	2,699
	5	0	0	0	0	657	0	0	0	0	0	0	4	0	28	1	0	30	722
	6	0	1	2	23	0	373	39	0	0	0	0	12	0	52	0	0	44	547
	7	0	4	12	41	0	29	584	0	0	0	0	6	0	37	0	0	37	751
	8	0	0	0	0	0	0	0	160	0	0	0	3	0	11	0	0	1	177
	9	0	0	0	1	0	0	0	1	53	0	0	0	0	1	0	0	0	56
	10	0	0	0	0	0	0	0	0	0	116	0	20	0	1	0	0	41	178
	11	0	0	0	0	0	0	0	0	0	0	741	1	2	2	0	0	2	749
	12	0	0	0	12	0	1	2	0	0	0	0	1,268	0	88	1	5	203	1,582
	13	0	0	0	0	0	0	0	0	0	0	16	1	203	2	0	0	2	224
	14	2	10	20	839	4	54	31	2	0	0	1	620	1	4,942	2	20	492	7,039
	15	0	0	0	0	0	0	0	0	0	1	0	0	0	1	836	2	6	846
	16	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1,559	8	1,569
	17	0	2	4	59	2	13	12	0	0	17	0	333	0	343	12	82	10,519	11,399
	Total	693	1,783	1,621	3,282	665	490	752	164	54	134	759	2,343	207	6,042	851	1,669	11,507	33,015

Table 2.12: Forest and land use change matrix in Vietnam for period 2005-2010 (1000 ha)

		Year 2010																	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**Total**
Year 2005	**1**	601	48	18	15	0	1	4	0	0	0	0	1	0	4	0	0	0	693
	2	70	1,464	117	70	0	3	19	0	0	0	0	3	0	31	0	0	5	1,783
	3	4	125	1,192	155	0	9	25	0	0	0	0	18	0	69	0	0	22	1,621
	4	4	26	194	2,458	1	12	34	0	1	0	0	62	0	394	0	1	94	3,283
	5	0	0	0	0	640	0	0	0	0	0	0	0	0	16	1	0	6	665
	6	0	1	2	24	0	318	48	0	0	0	0	12	0	40	0	0	44	490
	7	0	2	16	45	0	19	564	0	0	0	0	15	0	39	0	0	50	751
	8	0	0	0	0	0	0	0	153	2	0	0	1	0	1	0	0	5	164
	9	0	0	0	1	0	0	0	3	48	0	0	1	0	1	0	0	1	54
	10	0	0	0	0	0	0	0	0	0	104	0	12	0	0	0	0	18	134
	11	0	0	0	0	0	0	0	0	0	0	755	0	1	1	0	0	1	759
	12	0	0	1	4	0	3	1	0	0	2	0	2,076	0	57	1	6	193	2,343
	13	0	0	0	0	0	0	0	0	0	0	1	0	202	1	0	0	2	207
	14	1	6	34	814	3	60	42	3	1	1	0	724	1	3,808	6	29	512	6,042
	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	843	1	6	851
	16	0	0	0	1	0	0	0	0	0	0	0	1	0	1	1	1,649	15	1,669
	17	0	1	5	66	2	15	11	2	1	35	0	195	0	224	17	111	10,821	11,507
	Total	681	1,674	1,581	3,654	646	441	748	162	53	142	757	3,122	205	4,688	870	1,798	11,796	33,017

2.2.3. Results of accuracy assessment

The study by JICA and VNFOREST 2012 estimated that the uncertainty of change between three variables at forest and non-forest at 5%, forest types 20% and between volume-based sub-categories of evergreen broadleaf forests at 26%. This analysis was conducted on the NFIMAP cycle IV map ("2010 map") which was based on high resolution images and therefore these results may be considerably higher than if the same were to have been conducted for the older historical maps. Additional uncertainty assessment continues to be under implementation (as of December 2015) but the quality of the remote sensing products available for the period 1995-2010 pose considerable challenges in the process.

2.2.4. Summary statistics of forest and land use for 1995, 2000, 2005, 2010 based on updated maps

Table 2.13: Areas of forest and land use in the Northwest region (ha)

No	Land use category	1995	2000	2005	2010
	Natural area	***3,731,102***	***3,731,157***	***3,731,205***	***3,731,205***
I	***Forest land***	**942,397**	**1,101,265**	**1,448,902**	**1,629,612**
1	EGBL - rich	23,247	19,905	14,005	11,424
2	EGBL - medium	180,642	160,390	144,743	135,314
3	EGBL - poor	180,392	159,223	145,775	147,797
4	EGBL - regrowth	272,316	420,199	792,542	914,267
6	Bamboo	49,696	56,955	52,438	65,075
7	Mixed woody - bamboo	69,231	70,832	55,320	57,029
11	Limestone forest	130,729	138,060	148,713	148,729
12	Plantations	36,144	75,702	95,364	149,976
II	***Bared land***	2,049,567	1,877,383	1,533,485	1,325,701
13	Limestone without forest	53,905	46,571	35,866	35,874
14	Other bared land	1,995,661	1,830,812	1,497,619	1,289,826
III	***Agriculture and others***	739,138	752,509	748,818	775,893
15	Water bodies	39,068	39,274	39,690	39,720
16	Residence	43,031	52,685	58,848	68,532
17	Other land	657,039	660,551	650,281	667,640

Table 2.14: Areas of forest and land use in Northeast region (ha)

No	Land use category	1995	2000	2005	2010
	Natural area	**6,423,909**	**6,424,088**	**6,423,952**	**6,423,949**
I	***Forest land***	***2,323,954***	***2,703,092***	***3,063,808***	***3,516,966***
1	EGBL - rich	86,300	75,032	63,431	58,208
2	EGBL - medium	312,047	263,453	222,334	210,122
3	EGBL - poor	449,630	404,456	354,944	317,736
4	EGBL - regrowth	674,239	824,449	972,218	1,152,541
6	Bamboo	52,523	72,165	68,756	63,003
7	Mixed woody - bamboo	188,097	194,367	198,317	201,911
10	Mangroves	20,377	18,860	20,180	19,357
11	Limestone forest	352,826	355,420	355,229	353,484
12	Plantations	187,915	494,890	808,399	1,140,604
II	***Bared land***	***2,662,500***	***2,306,665***	***1,854,341***	***1,282,763***
13	Limestone without forest	143,830	143,073	135,992	134,216
14	Other bared land	2,518,670	2,163,592	1,718,349	1,148,547
III	***Agriculture and others***	***1,437,455***	***1,414,331***	***1,505,803***	***1,624,220***
15	Water bodies	129,140	129,986	131,698	140,294
16	Residence	148,710	163,021	200,079	244,348
17	Other land	1,159,605	1,121,324	1,174,026	1,239,578

Table 2.15: Areas of forest and land use in Red River Delta region (ha)

No	Forest and land use category	1995	2000	2005	2010
	Natural area	***1,488,881***	***1,488,936***	***1,488,889***	***1,488,889***
I	***Forest land***	**104,439**	**111,165**	**119,422**	**116,212**
1	EGBL - rich	1,254	882	836	145
2	EGBL - medium	6,993	5,804	5,735	5,008
3	EGBL - poor	7,620	6,199	7,272	7,589
4	EGBL - regrowth	4,416	4,066	5,459	4,171
6	Bamboo	26	26	26	26
7	Mixed woody - bamboo	0	3	3	0
10	Mangroves	8,402	8,493	8,574	8,829
11	Limestone forest	46,712	46,600	46,598	46,710
12	Plantations	29,016	39,093	44,919	43,733
II	***Bared land***	31,374	24,832	18,593	19,086
13	Limestone without forest	8,953	9,109	8,996	8,416
14	Other bared land	22,421	15,723	9,597	10,670
III	***Agriculture and others***	1,353,068	1,352,938	1,350,875	1,353,590
15	Water bodies	91,945	89,562	89,013	89,198
16	Residence	294,545	313,261	327,493	351,079
17	Other land	966,578	950,115	934,368	913,314

Table 2.16: Areas of forest and land use in North Central Coast region (ha)

No	Forest and land use category	1995	2000	2005	2010
	Natural area	**5,117,912**	**5,118,118**	**5,118,664**	**5,118,664**
I	***Forest land***	***2,180,493***	***2,319,111***	***2,497,217***	***2,780,243***
1	EGBL - rich	311,769	282,049	233,925	226,630
2	EGBL - medium	522,626	512,254	497,577	452,912
3	EGBL - poor	453,611	453,863	448,678	472,252
4	EGBL - regrowth	257,218	288,052	393,081	515,480
6	Bamboo	126,702	158,983	148,770	137,708
7	Mixed woody - bamboo	107,361	107,353	115,221	121,894
10	Mangroves	1,863	1,167	1,147	1,535
11	Limestone forest	204,442	203,992	203,838	203,970
12	Plantations	194,901	311,398	454,981	647,862
II	***Bared land***	***1,437,430***	***1,289,876***	***1,117,774***	***771,750***
13	Limestone without forest	13,484	13,840	13,790	13,783
14	Other bared land	1,423,947	1,276,036	1,103,984	757,967
III	***Agriculture and others***	***1,499,988***	***1,509,131***	***1,503,673***	***1,566,671***
15	Water bodies	120,313	123,221	123,814	124,803
16	Residence	181,981	191,419	202,184	230,909
17	Other land	1,197,694	1,194,491	1,177,675	1,210,958

Table 2.17: Areas of forest and land use in South Central Coast region (ha)

No	Forest and land use category	1995	2000	2005	2010
	Natural area	**4,396,832**	**4,396,636**	**4,396,753**	**4,396,753**
I	***Forest land***	***1,896,058***	***1,842,120***	***1,818,119***	***1,969,814***
1	EGBL - rich	139,778	148,427	109,810	99,655
2	EGBL - medium	376,853	355,544	333,130	313,540
3	EGBL - poor	394,828	364,373	313,220	344,970
4	EGBL - regrowth	562,717	507,383	478,532	470,117
5	Deciduous	184,410	165,863	152,427	143,953
6	Bamboo	30,541	24,021	19,001	17,171
7	Mixed woody - bamboo	54,558	51,809	52,424	46,357
8	Coniferous	9,434	9,345	9,378	9,544
9	Mixed broadleaf - coniferous	15,317	15,272	15,106	14,949
11	Limestone forest	4,238	4,055	3,514	3,449
12	Plantations	123,385	196,027	331,578	506,109
II	***Bared land***	***1,066,414***	***1,077,765***	***1,038,379***	***882,301***
13	Limestone without forest	11,100	11,178	11,907	11,979
14	Other bared land	1,055,314	1,066,586	1,026,472	870,323
III	***Agriculture and others***	***1,434,359***	***1,476,751***	***1,540,255***	***1,544,638***
15	Water bodies	95,729	102,568	104,996	109,678
16	Residence	185,438	188,759	199,586	203,966
17	Other land	1,153,193	1,185,424	1,235,673	1,230,994

Table 2.18: Areas of forest and land use in Central Highlands region (ha)

No	Forest and land use category	1995	2000	2005	2010
	Natural area	**5,472,625**	**5,472,323**	**5,473,560**	**5,473,561**
I	***Forest land***	***2,994,241***	***2,978,407***	***2,967,115***	***2,858,527***
1	EGBL - rich	287,219	271,793	267,411	281,613
2	EGBL - medium	564,916	551,304	544,783	523,203
3	EGBL - poor	368,269	338,543	298,259	242,121
4	EGBL - regrowth	496,469	522,491	523,406	486,664
5	Deciduous	552,588	542,091	504,731	494,477
6	Bamboo	202,184	186,004	181,752	142,736
7	Mixed woody - bamboo	211,277	236,088	254,443	255,850
8	Coniferous	162,212	167,157	154,810	152,883
9	Mixed broadleaf - coniferous	48,530	40,709	38,906	37,774
12	Plantations	100,577	122,225	198,615	241,206
II	***Bared land***	***559,469***	***538,245***	***492,105***	***478,784***
13	Limestone without forest	368	354	328	308
14	Other bared land	559,101	537,891	491,777	478,476
III	***Agriculture and others***	***1,918,916***	***1,955,671***	***2,014,340***	***2,136,250***
15	Water bodies	46,718	59,532	61,018	65,701
16	Residence	134,705	140,144	145,413	150,138
17	Other land	1,737,493	1,755,995	1,807,908	1,920,410

Table 2.19: Areas of forest and land use in Southeast region (ha)

No	Forest and land use category	1995	2000	2005	2010
	Natural area	**2,344,300**	**2,344,339**	**2,344,395**	**2,344,395**
I	***Forest land***	***635,892***	***603,592***	***508,605***	***471,685***
1	EGBL - rich	5,690	5,411	2,991	2,899
2	EGBL - medium	36,784	36,190	31,249	30,255
3	EGBL - poor	61,033	56,026	50,517	46,384
4	EGBL - regrowth	100,150	101,569	86,865	79,896
5	Deciduous	14,453	13,737	7,659	7,161
6	Bamboo	64,756	48,547	19,678	14,963
7	Mixed woody - bamboo	103,465	90,209	75,687	65,099
10	Mangroves	41,398	42,834	33,675	24,831
11	Limestone forest	970	970	970	970
12	Plantations	207,193	208,101	199,314	199,227
II	***Bared land***	***149,984***	***128,588***	***187,238***	***122,774***
13	Limestone without forest	18	23	23	23
14	Other bared land	149,966	128,565	187,215	122,751
III	***Agriculture and others***	***1,558,425***	***1,612,159***	***1,648,551***	***1,749,937***
15	Water bodies	127,686	128,632	127,628	127,322
16	Residence	188,701	189,496	195,772	198,124
17	Other land	1,242,037	1,294,031	1,325,151	1,424,491

Table 2.20: Areas of forest and land use in Mekong River Delta region (ha)

No	Forest and land use category	1995	2000	2005	2010
	Natural area	**4,039,371**	**4,039,386**	**4,039,411**	**4,039,411**
I	***Forest land***	***280,009***	***278,750***	***317,937***	***318,022***
1	EGBL - rich	394	394	394	394
2	EGBL - medium	3,626	3,626	3,642	3,746
3	EGBL - poor	2,744	2,439	2,440	2,437
4	EGBL - regrowth	31,274	30,861	30,738	30,520
10	Mangroves	126,783	106,869	70,413	87,388
12	Plantations	115,189	134,560	210,312	193,537
II	***Bared land***	***22,578***	***20,232***	***6,722***	***9,551***
14	Other bared land	22,578	20,232	6,722	9,551
III	***Agriculture and others***	***3,736,784***	***3,740,405***	***3,714,752***	***3,711,838***
15	Water bodies	173,182	173,307	173,163	173,157
16	Residence	321,126	330,067	339,495	350,554
17	Other land	3,242,476	3,237,031	3,202,094	3,188,127

2.2.5. Forest and land use change matrices at the regional level

Table 2.21: Forest and land use change matrix in Northwest region for period 1995-2000 (1000 ha)

		Year 2000																	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**Total**
Year 1995	**1**	18	4	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	23
	2	1	140	14	11	0	0	1	0	0	0	0	0	0	11	0	0	1	181
	3	0	12	117	26	0	0	3	0	0	0	0	0	0	21	0	0	2	180
	4	0	1	20	217	0	1	1	0	0	0	0	0	0	29	0	0	3	272
	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	6	0	0	0	1	0	37	0	0	0	0	0	0	0	8	0	0	3	50
	7	0	0	0	2	0	2	57	0	0	0	0	0	0	6	0	0	2	69
	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	11	0	0	0	0	0	0	0	0	0	0	130	0	1	0	0	0	0	131
	12	0	0	0	0	0	0	0	0	0	0	0	36	0	0	0	0	0	36
	13	0	0	0	0	0	0	0	0	0	0	8	0	46	0	0	0	0	54
	14	0	3	6	157	0	13	7	0	0	0	0	36	0	1,678	0	5	90	1,996
	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	39	0	0	39
	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	43	0	43
	17	0	0	1	7	0	3	1	0	0	0	0	3	0	77	0	5	560	657
	Total	20	160	159	420	0	57	71	0	0	0	138	76	47	1,831	39	53	661	3,731

Table 2.22: Forest and land use change matrix in Northwest period 2000-2005(1000 ha)

		Year 2005																	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**Total**
Year 2000	**1**	12	7	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	20
	2	2	121	14	18	0	0	1	0	0	0	0	0	0	5	0	0	0	160
	3	0	13	103	30	0	0	1	0	0	0	0	0	0	11	0	0	1	159
	4	0	0	21	340	0	0	1	0	0	0	0	3	0	51	0	0	5	420
	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	6	0	0	0	6	0	41	0	0	0	0	0	0	0	7	0	0	2	57
	7	0	0	1	9	0	1	47	0	0	0	0	0	0	11	0	0	2	71
	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	11	0	0	0	0	0	0	0	0	0	0	138	0	0	0	0	0	0	138
	12	0	0	0	1	0	0	0	0	0	0	0	67	0	4	0	0	3	76
	13	0	0	0	0	0	0	0	0	0	0	11	0	36	0	0	0	0	47
	14	0	3	6	378	0	8	4	0	0	0	0	19	0	1,349	0	2	61	1,831
	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	39	0	0	39
	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	53	0	53
	17	0	0	1	11	0	2	1	0	0	0	0	6	0	60	0	4	575	661
	Total	14	145	146	793	0	52	55	0	0	0	149	95	36	1,498	40	59	650	3,731

Table 2.23: Forest and land use change matrix in Northwest region for period 2005-2010 (1000 ha)

		Year 2010																	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**Total**
Year 2005	**1**	10	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14
	2	1	120	9	10	0	0	1	0	0	0	0	0	0	4	0	0	0	145
	3	0	11	108	17	0	0	1	0	0	0	0	0	0	7	0	0	1	146
	4	0	1	28	595	0	2	4	0	0	0	0	12	0	131	0	0	20	793
	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	6	0	0	0	6	0	38	1	0	0	0	0	1	0	5	0	0	3	52
	7	0	0	1	5	0	1	43	0	0	0	0	1	0	4	0	0	1	55
	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	11	0	0	0	0	0	0	0	0	0	0	149	0	0	0	0	0	0	149
	12	0	0	0	1	0	1	0	0	0	0	0	80	0	5	0	0	7	95
	13	0	0	0	0	0	0	0	0	0	0	0	0	36	0	0	0	0	36
	14	0	1	2	271	0	19	7	0	0	0	0	48	0	1,101	0	3	47	1,498
	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	40	0	0	40
	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	59	0	59
	17	0	0	0	10	0	4	1	0	0	0	0	7	0	33	0	7	588	650
	Total	11	135	148	914	0	65	57	0	0	0	149	150	36	1,290	40	69	668	3,731

Table 2.24: Forest and land use change matrix in Northeast region for period 1995-2000 (1000 ha)

		Year 2000																	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**Total**
Year 1995	**1**	68	13	2	2	0	0	0	0	0	0	0	0	0	2	0	0	0	86
	2	7	233	29	28	0	0	2	0	0	0	0	0	0	10	0	0	2	312
	3	0	14	348	47	0	2	4	0	0	0	0	2	0	29	0	0	4	450
	4	0	2	15	551	0	2	4	0	0	0	0	20	0	72	0	0	9	674
	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	6	0	0	0	2	0	39	3	0	0	0	0	0	0	7	0	0	1	53
	7	0	1	3	7	0	3	162	0	0	0	0	0	0	9	0	0	4	188
	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10	0	0	0	0	0	0	0	0	0	17	0	0	0	0	0	0	3	20
	11	0	0	0	0	0	0	0	0	0	0	351	0	1	0	0	0	0	353
	12	0	0	0	2	0	0	0	0	0	0	0	176	0	7	0	0	3	188
	13	0	0	0	0	0	0	0	0	0	0	3	0	140	0	0	0	0	144
	14	0	1	6	172	0	24	16	0	0	0	1	285	2	1,886	1	7	119	2,519
	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	128	0	0	129
	16	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	145	1	149
	17	0	0	1	15	0	3	4	0	0	1	0	11	0	137	1	10	974	1,160
	Total	75	263	404	824	0	72	194	0	0	19	355	495	143	2,164	130	163	1,121	6,424

Table 2.25: Forest and land use change matrix in Northeast region for period 2000-2005 (1000 ha)

		Year 2005																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total
Year 2000	1	58	12	1	3	0	0	0	0	0	0	0	0	0	1	0	0	0	75
	2	4	197	32	19	0	1	3	0	0	0	0	1	0	6	0	0	1	263
	3	0	9	291	58	0	1	3	0	0	0	0	9	0	27	0	0	6	404
	4	0	2	20	628	0	1	6	0	0	0	0	29	0	117	0	0	20	824
	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	6	0	0	0	2	0	53	4	0	0	0	0	1	0	8	0	0	3	72
	7	0	1	2	9	0	3	165	0	0	0	0	1	0	10	0	0	4	194
	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10	0	0	0	0	0	0	0	0	0	17	0	0	0	0	0	0	2	19
	11	0	0	0	0	0	0	0	0	0	0	349	1	2	1	0	0	2	355
	12	0	0	0	10	0	0	1	0	0	0	0	441	0	13	0	3	27	495
	13	0	0	0	0	0	0	0	0	0	0	5	1	134	1	0	0	2	143
	14	0	1	6	220	0	7	11	0	0	0	0	265	0	1,456	1	16	179	2,164
	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	127	0	2	130
	16	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	156	5	163
	17	0	0	2	23	0	2	5	0	0	3	0	59	0	78	3	24	921	1,121
	Total	63	222	355	972	0	69	198	0	0	20	355	808	136	1,718	132	200	1,174	6,424

Table 2.26: Forest and land use change matrix in Northeast region for period 2005-2010 (1000 ha)

		Year 2010																	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**Total**
Year 2005	**1**	55	5	1	2	0	0	0	0	0	0	0	0	0	1	0	0	0	63
	2	3	185	16	11	0	0	2	0	0	0	0	0	0	5	0	0	1	222
	3	0	13	253	60	0	1	5	0	0	0	0	5	0	13	0	0	4	355
	4	0	6	36	759	0	2	15	0	0	0	0	31	0	94	0	1	29	972
	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	6	0	0	1	3	0	47	4	0	0	0	0	6	0	5	0	0	2	69
	7	0	1	2	16	0	3	157	0	0	0	0	5	0	8	0	0	5	198
	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10	0	0	0	0	0	0	0	0	0	18	0	0	0	0	0	0	2	20
	11	0	0	0	0	0	0	0	0	0	0	352	0	1	1	0	0	1	355
	12	0	0	0	1	0	0	0	0	0	0	0	765	0	11	1	4	26	808
	13	0	0	0	0	0	0	0	0	0	0	1	0	132	1	0	0	1	136
	14	0	1	6	270	0	7	15	0	0	0	0	303	0	969	2	18	127	1,718
	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	128	0	3	132
	16	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	192	5	200
	17	0	0	4	30	0	2	4	0	0	1	0	24	0	39	8	29	1,033	1,174
	Total	58	210	318	1,153	0	63	202	0	0	19	353	1,141	134	1,149	140	244	1,240	6,424

Table 2.27: Forest and land use change matrix in Red River Delta region for period 1995-2000 (1000 ha)

		Year 2000																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total
Year 1995	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	2	0	5	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
	3	0	0	5	1	0	0	0	0	0	0	0	1	0	1	0	0	0	8
	4	0	0	0	3	0	0	0	0	0	0	0	1	0	1	0	0	0	4
	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	1	8
	11	0	0	0	0	0	0	0	0	0	0	46	0	0	0	0	0	0	47
	12	0	0	0	0	0	0	0	0	0	0	0	26	0	1	0	0	2	29
	13	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	9
	14	0	0	0	0	0	0	0	0	0	0	0	8	0	12	0	0	1	22
	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	84	1	6	92
	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	294	1	295
	17	0	0	0	0	0	0	0	0	0	1	0	2	0	0	5	19	939	967
	Total	1	6	6	4	0	0	0	0	0	8	47	39	9	16	90	313	950	1,489

Table 2.28: Forest and land use change matrix in Red River Delta region for period 2000-2005 (1000 ha)

		Year 2005																	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**Total**
Year 2000	**1**	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	2	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
	3	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
	4	0	0	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	4
	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	2	8
	11	0	0	0	0	0	0	0	0	0	0	47	0	0	0	0	0	0	47
	12	0	0	0	0	0	0	0	0	0	0	0	38	0	0	0	0	1	39
	13	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	9
	14	0	0	0	2	0	0	0	0	0	0	0	4	0	9	0	0	1	16
	15	0	0	0	0	0	0	0	0	0	1	0	0	0	0	88	0	1	90
	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	312	1	313
	17	0	0	0	0	0	0	0	0	0	1	0	3	0	0	1	15	929	950
	Total	1	6	7	5	0	0	0	0	0	9	47	45	9	10	89	328	934	1,489

Table 2.29: Forest and land use change matrix in Red River Delta region for period 2005-2010 (1000 ha)

		Year 2010																
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total
Year 2005	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	2	0	4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
	3	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
	4	0	0	0	4	0	0	0	0	0	0	0	1	0	1	0	0	0	5
	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	9
	11	0	0	0	0	0	0	0	0	0	0	47	0	0	0	0	0	0	47
	12	0	0	0	0	0	0	0	0	0	0	0	39	0	2	0	0	3	45
	13	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	9
	14	0	0	0	0	0	0	0	0	0	0	0	1	0	8	0	0	0	10
	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	89	0	0	89
	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	327	1	327
	17	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	24	908	934
	Total	0	5	8	4	0	0	0	0	0	9	47	44	8	11	89	351	913	1,489

Table 2.30: Forest and land use change matrix in North Central Coast region for period 1995-2000(1000 ha)

		Year 2000																	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**Total**
Year 1995	**1**	270	34	5	1	0	0	0	0	0	0	0	0	0	1	0	0	0	312
	2	11	449	39	7	0	1	2	0	0	0	0	0	0	12	0	0	1	523
	3	1	25	367	20	0	2	2	0	0	0	0	1	0	32	0	0	3	454
	4	0	1	36	164	0	2	3	0	0	0	0	3	0	41	0	0	6	257
	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	6	0	0	0	2	0	110	3	0	0	0	0	1	0	8	0	0	3	127
	7	0	1	2	3	0	3	94	0	0	0	0	0	0	2	0	0	1	107
	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	2
	11	0	0	0	0	0	0	0	0	0	0	204	0	0	0	0	0	0	204
	12	0	0	0	0	0	0	0	0	0	0	0	171	0	15	0	0	9	195
	13	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	13
	14	0	2	3	86	0	37	1	0	0	0	0	115	0	1,106	1	3	69	1,424
	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	119	0	1	120
	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	182	0	182
	17	0	0	1	4	0	3	1	0	0	0	0	21	0	59	2	6	1,101	1,198
	Total	282	512	454	288	0	159	107	0	0	1	204	311	14	1,276	123	191	1,194	5,118

Table 2.31: Forest and land use change matrix in North Central Coast region for period 2000-2005(1000 ha)

		Year 2005																	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**Total**
Year 2000	**1**	223	49	6	2	0	0	0	0	0	0	0	0	0	2	0	0	0	282
	2	10	421	50	16	0	1	3	0	0	0	0	0	0	11	0	0	1	512
	3	0	24	346	31	0	3	10	0	0	0	0	1	0	34	0	0	3	454
	4	0	1	37	192	0	2	1	0	0	0	0	2	0	47	0	0	6	288
	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	6	0	0	0	10	0	117	4	0	0	0	0	2	0	21	0	0	5	159
	7	0	1	4	3	0	4	90	0	0	0	0	0	0	4	0	0	1	107
	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
	11	0	0	0	0	0	0	0	0	0	0	204	0	0	0	0	0	0	204
	12	0	0	0	0	0	0	0	0	0	0	0	268	0	27	0	1	14	311
	13	0	0	0	0	0	0	0	0	0	0	0	0	14	0	0	0	0	14
	14	0	2	4	128	0	17	6	0	0	0	0	164	0	895	0	0	59	1,276
	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	121	0	2	123
	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	191	0	191
	17	0	0	1	10	0	4	1	0	0	0	0	18	0	63	2	9	1,086	1,194
	Total	234	498	449	393	0	149	115	0	0	1	204	455	14	1,104	124	202	1,178	5,118

Table 2.32: Forest and land use change matrix in North Central Coast region for period 2005-2010 (1000 ha)

		Year 2010																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total
Year 2005	1	202	18	8	3	0	0	1	0	0	0	0	0	0	1	0	0	0	234
	2	23	393	46	18	0	2	6	0	0	0	0	2	0	7	0	0	1	498
	3	1	37	347	27	0	5	3	0	0	0	0	6	0	19	0	0	4	449
	4	0	3	57	287	0	4	1	0	0	0	0	6	0	24	0	0	11	393
	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	6	0	0	1	9	0	98	16	0	0	0	0	1	0	15	0	0	8	149
	7	0	0	8	5	0	7	84	0	0	0	0	0	0	8	0	0	2	115
	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
	11	0	0	0	0	0	0	0	0	0	0	203	0	0	0	0	0	0	204
	12	0	0	0	1	0	0	0	0	0	0	0	430	0	13	0	1	9	455
	13	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	14
	14	0	2	4	155	0	17	9	0	0	0	0	175	0	630	2	6	102	1,104
	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	121	0	2	124
	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	201	1	202
	17	0	0	0	9	0	4	1	0	0	1	0	27	0	40	1	23	1,071	1,178
	Total	227	453	472	515	0	138	122	0	0	2	204	648	14	758	125	231	1,211	5,118

Table 2.33: Forest and land use change matrix in South Central Coast region for period 1995-2000(1000 ha)

		Year 2000																	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**Total**
Year 1995	**1**	111	20	6	2	0	0	0	0	0	0	0	0	0	1	0	0	0	140
	2	36	286	32	12	0	0	1	0	0	0	0	0	0	8	0	0	1	377
	3	1	49	257	39	0	1	1	0	0	0	0	2	0	42	0	0	4	395
	4	0	1	68	370	0	2	3	0	0	0	0	4	0	99	1	0	16	563
	5	0	0	0	0	159	0	0	0	0	0	0	0	0	16	0	0	9	184
	6	0	0	0	3	0	20	1	0	0	0	0	0	0	6	0	0	1	31
	7	0	0	2	4	0	0	46	0	0	0	0	1	0	2	0	0	0	55
	8	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	9
	9	0	0	0	0	0	0	0	0	14	0	0	0	0	1	0	0	0	15
	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	11	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	4
	12	0	0	0	0	0	0	0	0	0	0	0	122	0	1	0	0	1	123
	13	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	11
	14	0	0	1	67	4	1	0	0	0	0	0	64	0	850	6	0	61	1,055
	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	96	0	0	96
	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	185	0	185
	17	0	0	0	10	3	0	0	0	0	0	0	3	0	42	0	3	1,092	1,153
	Total	148	356	364	507	166	24	52	9	15	0	4	196	11	1,067	103	189	1,185	4,397

Table 2.34: Forest and land use change matrix in South Central Coast region for period 2000-2005(1000 ha)

		Year 2005																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total
Year 2000	1	95	18	10	3	0	0	0	0	0	0	0	0	0	6	0	0	16	148
	2	13	282	34	15	0	0	1	0	0	0	0	0	0	9	0	0	1	356
	3	1	31	244	51	0	0	2	0	0	0	0	1	0	30	0	0	3	364
	4	0	2	20	341	0	1	2	0	0	0	0	14	0	112	0	0	14	507
	5	0	0	0	0	146	0	0	0	0	0	0	3	0	12	0	0	3	166
	6	0	0	0	2	0	16	1	0	0	0	0	0	0	4	0	0	1	24
	7	0	0	1	2	0	0	45	0	0	0	0	0	0	1	0	0	1	52
	8	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	9
	9	0	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0	0	15
	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	11	0	0	0	0	0	0	0	0	0	0	3	0	1	0	0	0	0	4
	12	0	0	0	0	0	0	0	0	0	0	0	160	0	36	0	0	1	196
	13	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	11
	14	0	0	3	55	4	1	0	0	0	0	0	115	0	779	0	0	108	1,067
	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	102	0	0	103
	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	188	0	189
	17	0	0	0	8	2	0	0	0	0	0	0	39	0	35	3	11	1,087	1,185
	Total	110	333	313	479	152	19	52	9	15	0	4	332	12	1,026	105	200	1,236	4,397

Table 2.35: Forest and land use change matrix in South Central Coast region for period 2005-2010 (1000 ha)

		Year 2010																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total
Year 2005	1	90	12	4	2	0	0	0	0	0	0	0	0	0	1	0	0	0	110
	2	9	264	36	12	0	0	0	0	0	0	0	0	0	10	0	0	1	333
	3	0	32	242	16	0	0	1	0	0	0	0	0	0	18	0	0	2	313
	4	0	4	39	345	1	0	2	0	0	0	0	8	0	69	0	0	11	479
	5	0	0	0	0	140	0	0	0	0	0	0	0	0	10	0	0	2	152
	6	0	0	1	0	0	14	1	0	0	0	0	0	0	3	0	0	1	19
	7	0	0	1	3	0	0	41	0	0	0	0	2	0	5	0	0	1	52
	8	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	9
	9	0	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0	0	15
	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	11	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	4
	12	0	0	0	0	0	0	0	0	0	0	0	317	0	8	0	0	6	332
	13	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	12
	14	0	1	21	80	2	1	1	0	0	0	0	142	0	711	1	2	63	1,026
	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	104	0	0	105
	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	195	4	200
	17	0	0	1	11	1	0	0	0	0	0	0	38	0	34	4	6	1,140	1,236
	Total	100	314	345	470	144	17	46	10	15	0	3	506	12	870	110	204	1,231	4,397

Table 2.36: Forest and land use change matrix in Central Highlands region for period 1995-2000 (1000 ha)

		Year 2000																	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**Total**
Year 1995	**1**	239	33	4	6	0	1	1	0	0	0	0	0	0	1	0	0	0	287
	2	28	468	26	27	0	3	4	0	0	0	0	0	0	7	0	0	3	565
	3	1	29	278	36	0	2	5	0	0	0	0	0	0	8	0	0	8	368
	4	1	13	24	399	0	8	7	0	0	0	0	1	0	25	0	0	18	496
	5	0	0	0	0	537	0	0	0	0	0	0	0	0	8	2	0	5	553
	6	1	2	1	4	0	149	25	0	0	0	0	1	0	8	1	0	11	202
	7	1	2	2	9	0	6	187	0	0	0	0	0	0	2	0	0	3	211
	8	0	0	0	0	0	0	0	159	1	0	0	0	0	1	0	0	1	162
	9	0	0	0	2	0	0	0	6	38	0	0	1	0	0	0	0	1	49
	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	12	0	0	0	0	0	0	0	0	0	0	0	92	0	1	0	0	7	101
	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	14	1	3	3	31	4	13	4	2	1	0	0	5	0	447	2	0	42	559
	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	46	0	1	47
	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	134	1	135
	17	0	2	1	8	0	5	2	0	0	0	0	21	0	31	8	6	1,653	1,737
	Total	272	552	339	523	541	186	236	167	41	0	0	122	0	538	59	140	1,757	5,473

Table 2.37: Forest and land use change matrix in Central Highlands region for period 2000-2005(1000 ha)

		Year 2005																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total
Year 2000	1	234	25	4	4	0	0	1	0	0	0	0	0	0	1	0	0	1	272
	2	23	471	23	19	0	1	4	0	0	0	0	0	0	5	0	0	4	551
	3	5	31	243	28	0	1	12	0	0	0	0	1	0	6	0	0	11	339
	4	3	10	24	392	0	4	14	0	0	0	0	9	0	41	0	0	24	522
	5	0	0	0	0	504	0	0	0	0	0	0	0	0	13	1	0	24	542
	6	0	1	1	4	0	133	23	0	0	0	0	5	0	7	0	0	12	186
	7	0	1	1	16	0	17	185	0	0	0	0	2	0	4	0	0	10	236
	8	0	0	0	0	0	0	0	152	0	0	0	3	0	11	0	0	1	167
	9	0	0	0	1	0	0	0	1	38	0	0	0	0	0	0	0	0	41
	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	12	0	0	0	1	0	0	1	0	0	0	0	103	0	1	0	0	15	122
	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	14	1	3	1	52	1	21	9	2	0	0	0	29	0	368	0	1	49	538
	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	58	0	1	60
	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	140	0	140
	17	0	2	1	6	0	3	3	0	0	0	0	44	0	34	2	4	1,656	1,756
	Total	267	544	298	523	505	182	255	155	39	0	0	198	0	492	61	145	1,807	5,473

Table 2.38: Forest and land use change matrix in Central Highlands region for period 2005-2010 (1000 ha)

		Year 2010																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total
Year 2005	1	241	11	4	7	0	0	3	0	0	0	0	0	0	1	0	0	0	267
	2	34	467	9	17	0	1	9	0	0	0	0	1	0	5	0	0	2	545
	3	3	29	205	24	0	1	10	0	0	0	0	6	0	9	0	0	11	298
	4	3	13	22	380	0	3	11	0	1	0	0	5	0	65	0	0	21	523
	5	0	0	0	0	494	0	0	0	0	0	0	0	0	6	1	0	4	505
	6	0	1	0	4	0	108	27	0	0	0	0	3	0	12	0	0	26	182
	7	0	1	1	14	0	9	187	0	0	0	0	2	0	11	0	0	30	254
	8	0	0	0	0	0	0	0	145	2	0	0	1	0	1	0	0	5	155
	9	0	0	0	1	0	0	0	2	33	0	0	1	0	0	0	0	1	39
	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	12	0	0	0	1	0	1	1	0	0	0	0	116	0	5	0	0	73	199
	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	14	0	1	1	32	0	13	5	3	1	0	0	53	0	292	0	0	90	492
	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	61	0	0	61
	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	140	5	145
	17	0	1	0	6	0	5	4	2	1	0	0	52	0	71	3	9	1,653	1,808
	Total	282	523	242	487	494	143	256	153	38	0	0	241	0	478	66	150	1,920	5,474

Table 2.39: Forest and land use change matrix in Southeast region for period 1995-2000 (1000 ha)

		Year 2000																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total
Year 1995	1	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
	2	0	34	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	37
	3	0	2	47	5	0	2	4	0	0	0	0	0	0	1	0	0	0	61
	4	0	0	5	81	0	1	1	0	0	0	0	1	0	6	0	0	5	100
	5	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0	1	14
	6	0	0	0	1	0	37	10	0	0	0	0	1	0	0	0	0	16	65
	7	0	0	2	4	0	5	74	0	0	0	0	0	0	1	0	0	17	103
	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10	0	0	0	0	0	0	0	0	0	40	0	0	0	0	0	0	1	41
	11	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
	12	0	0	0	0	0	0	0	0	0	0	0	150	0	2	0	0	54	207
	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	14	0	0	0	7	0	3	1	0	0	1	0	17	0	88	1	1	32	150
	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	127	0	0	128
	16	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	188	0	189
	17	0	0	0	3	0	1	0	0	0	2	0	38	0	30	0	0	1,168	1,242
	Total	5	36	56	102	14	49	90	0	0	43	1	208	0	129	129	189	1,294	2,344

Table 2.40: Forest and land use change matrix in Southeast region for period 2000-2005 (1000 ha)

		Year 2005																
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total
Year 2000	1	2	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
	2	1	26	3	1	0	0	5	0	0	0	0	0	0	0	0	0	0	36
	3	0	2	31	10	0	1	7	0	0	0	0	0	0	3	0	0	1	56
	4	0	0	13	69	0	0	4	0	0	0	0	3	0	9	0	0	4	102
	5	0	0	0	0	7	0	0	0	0	0	0	1	0	3	0	0	3	14
	6	0	0	0	0	0	13	6	0	0	0	0	4	0	5	0	0	21	49
	7	0	1	3	2	0	4	52	0	0	0	0	2	0	7	0	0	19	90
	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10	0	0	0	0	0	0	0	0	0	33	0	6	0	0	0	0	3	43
	11	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
	12	0	0	0	0	0	0	0	0	0	0	0	85	0	5	0	0	118	208
	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	14	0	0	0	4	0	0	0	0	0	0	0	13	0	81	0	0	30	129
	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	127	1	1	129
	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	189	0	189
	17	0	0	0	0	0	1	1	0	0	1	0	86	0	73	1	5	1,126	1,294
	Total	3	31	51	87	8	20	76	0	0	34	1	199	0	187	128	196	1,325	2,344

Table 2.41: Forest and land use change matrix in Southeast region for period 2005-2010 (1000 ha)

		Year 2010																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total
Year 2005	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
	2	0	28	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	31
	3	0	3	29	11	0	1	5	0	0	0	0	0	0	2	0	0	0	51
	4	0	0	13	59	0	0	2	0	0	0	0	0	0	11	0	0	2	87
	5	0	0	0	0	6	0	0	0	0	0	0	0	0	1	0	0	1	8
	6	0	0	0	1	0	12	0	0	0	0	0	1	0	0	0	0	4	20
	7	0	0	3	2	0	0	52	0	0	0	0	4	0	3	0	0	12	76
	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10	0	0	0	0	0	0	0	0	0	23	0	9	0	0	0	0	2	34
	11	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
	12	0	0	0	0	0	0	0	0	0	0	0	154	0	7	0	0	38	199
	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	14	0	0	0	5	0	2	5	0	0	1	0	1	0	92	0	0	81	187
	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	126	1	0	128
	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	195	0	196
	17	0	0	0	0	1	0	0	0	0	1	0	30	0	7	0	2	1,285	1,325
	Total	3	30	46	80	7	15	65	0	0	25	1	199	0	123	127	198	1,424	2,344

Table 2.42: Forest and land use change matrix in Mekong River Delta region for period 1995-2000(1000 ha)

		Year 2000																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total
Year 1995	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	2	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
	3	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
	4	0	0	0	30	0	0	0	0	0	0	0	0	0	1	0	0	0	31
	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10	0	0	0	0	0	0	0	0	0	98	0	2	0	0	0	0	27	127
	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	12	0	0	0	0	0	0	0	0	0	0	0	105	0	1	0	0	9	115
	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	14	0	0	0	0	0	0	0	0	0	0	0	3	0	17	0	0	3	23
	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	173	0	0	173
	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	321	0	321
	17	0	0	0	0	0	0	0	0	0	9	0	25	0	2	0	9	3,198	3,242
	Total	0	4	2	31	0	0	0	0	0	107	0	135	0	20	173	330	3,237	4,039

Table 2.43: Forest and land use change matrix in Mekong River Delta region for period 2000-2005(1000 ha)

		Year 2005																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total
Year 2000	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	2	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
	3	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
	4	0	0	0	30	0	0	0	0	0	0	0	1	0	0	0	0	0	31
	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10	0	0	0	0	0	0	0	0	0	58	0	14	0	0	0	0	35	107
	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	12	0	0	0	0	0	0	0	0	0	0	0	108	0	2	0	0	24	135
	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	14	0	0	0	1	0	0	0	0	0	0	0	11	0	5	0	0	4	20
	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	173	0	0	173
	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	330	0	330
	17	0	0	0	0	0	0	0	0	0	12	0	77	0	0	0	9	3,138	3,237
	Total	0	4	2	31	0	0	0	0	0	70	0	210	0	7	173	339	3,202	4,039

Table 2.44: Forest and land use change matrix in Mekong River Delta region for period 2005-2010 (1000 ha)

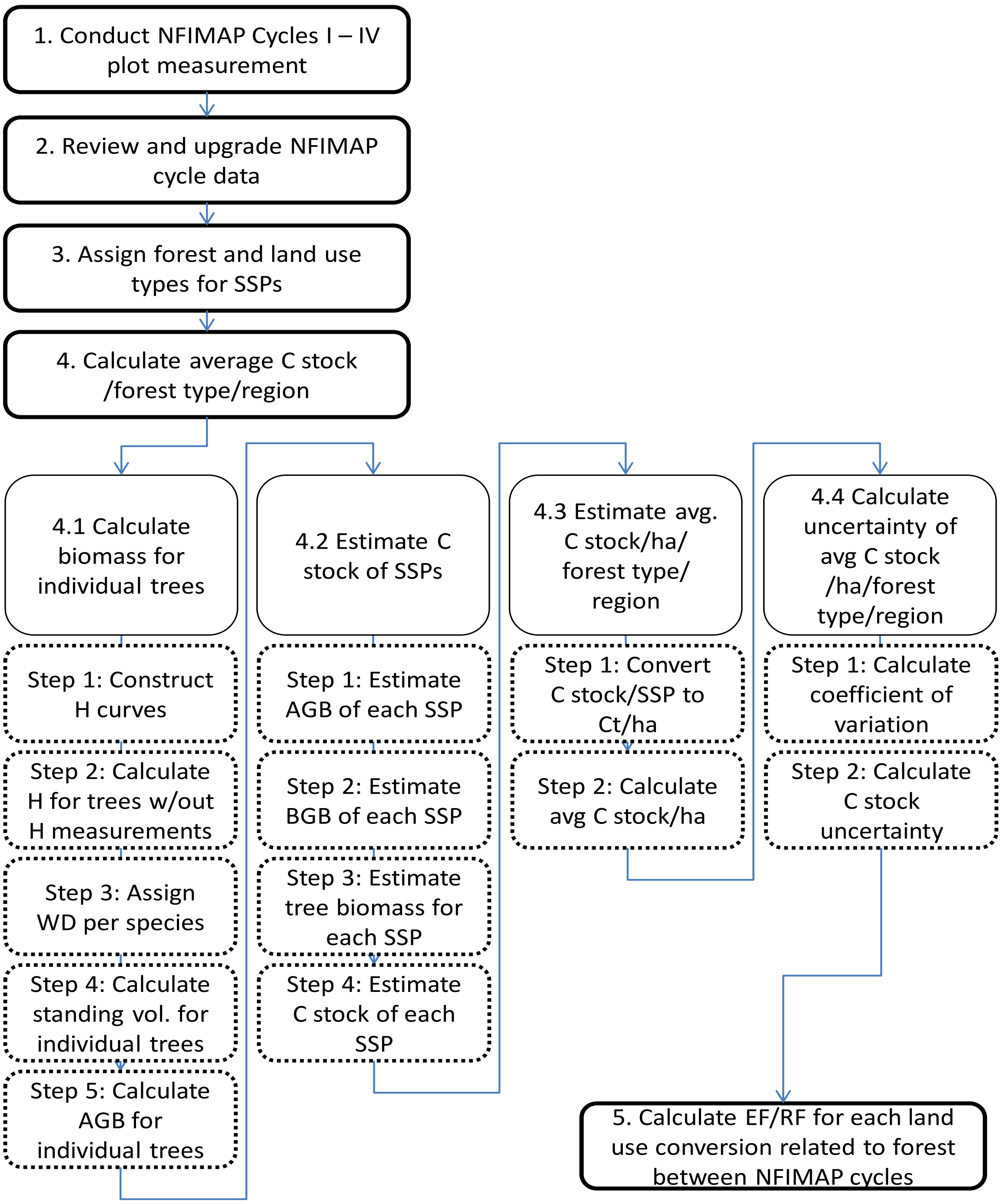
		Year 2010																	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**Total**
Year 2005	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	2	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
	3	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
	4	0	0	0	31	0	0	0	0	0	0	0	0	0	0	0	0	0	31
	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10	0	0	0	0	0	0	0	0	0	54	0	3	0	0	0	0	13	70
	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	12	0	0	0	0	0	0	0	0	0	2	0	174	0	5	0	0	30	210
	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	14	0	0	0	0	0	0	0	0	0	0	0	1	0	5	0	0	1	7
	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	173	0	0	173
	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	339	0	339
	17	0	0	0	0	0	0	0	0	0	31	0	16	0	0	0	11	3,144	3,202
	Total	0	4	2	31	0	0	0	0	0	87	0	194	0	10	173	351	3,188	4,039

3 PART 3: CALCULATION OF FOREST CARBON STOCKS AND EMISSION/REMOVAL FACTORS FROM NFIMAP CYCLES I TO IV PLOT MEASUREMENT DATA

3.1. Methods for estimating emission/removal factors

The construction of the EF/RFs for applying to the Viet Nam FREL/FRL undertook the process as demonstrated in the following diagram.

Figure 3.1. Flow diagram of the process to construct the EF/RF for Viet Nam's FREL/FRL



3.1.1. Description of the NFIMAP plot measurement as input data

The NFIMAP cycles used a system of primary sample plots (PSPs) which are systematically laid out in a national grid of 8 x 8 km to collect data for assessing forest quality. Each cycle was implemented in a 5 year period to report forest quality at the end of the inventory cycle. The Cycle I was implemented from 1991 to 1995 (and often referred to as 1995 data), and so on every five years up to Cycle IV which was implemented from 2006 to 2010 (and often referred to as 2010 data).

As a general rule, only plots with forests or on bare land of types IB, IC are inventoried, but the number of plots visited varied from one cycle to the other depending on government objectives and funding availability. After removing PSPs without any tree or bamboo, the total number of PSPs inventoried in the Cycles I to IV is respectively: 1,706 plots, 2,500 plots, 2,750 plots and 2,049 plots.

The method for establishment and measurement of PSPs has basically been the same over the historical cycles. Below is the method for establishment and measurement of a PSP and its secondary sample plots (SSPs) taken from the Technical Guidelines of Cycle IV (FIPI, 2006).

3.1.1.1. Establishing a PSP and SSPs

a) Locating the PSP center

The PSP in Cycle IV are designed and determined in UTM (or VN-2000) topography maps at the scale 1:50,000 according to the following:

- The ID of the PSP in the national sample plot system.
- The ID of the UTM (or VN-2000) map at the scale of 1:50,000 and the grid coordinates (in km).
- Based on the above information, mark the location of the PSP center on the UTM (or VN-2000) map at the scale of 1:50,000.

The PSPs are surveyed on a rolling-basis such that each of the PSPs is surveyed once in single cycle, and the same SPSs are surveyed again after an approximately five year duration (i.e. the next cycle).

Based on the UTM (or VN-2000) topography map at the scale of 1:50,000 marking the location of the PSP center, and the map and field form of the corresponding PSP of Cycle III, the inventory team will select the most convenient access to the PSP center of Cycle III. In cases where the maps used are in VN-2000 projection, the coordinates of the PSP center should be changed from UTM coordinates to the corresponding VN-2000 coordinates. The following cases should be considered:

- When the PSP center of Cycle III is located in the field, and the coordinates of the center of Cycle III are less than or equal to 250m from the designed coordinates in the field form of Cycle III, the PSP center of Cycle III should be used for Cycle IV.
- When the landmark associated with the PSP center cannot be established due to obstacles such as lakes, rivers, rocky mountain etc., a more accessible location not exceeding 50 m from the plot center should be identified. In this case, information about the landmark such as GPS coordinate, distance and azimuth to the plot center is noted in the field form.
- In the case the PSP center of Cycle III could not be found or the location of the PSP center of Cycle III is > 250m from the design coordinates (the coordinates noted in the field form of Cycle III), it is necessary to re-establish the PSP center. The location of the PSP center should be taken from the field form of Cycle III. In this case, a note should be added to the field form of Cycle IV.

b) Establishing the SSPs

From the PSP center, establish two strips, each containing 20 SSPs. The directions of the strips are based on the PSP map which was generated in Cycle III. The establishment of strips is as follows:

The first strip established from the PSP center to the North direction:

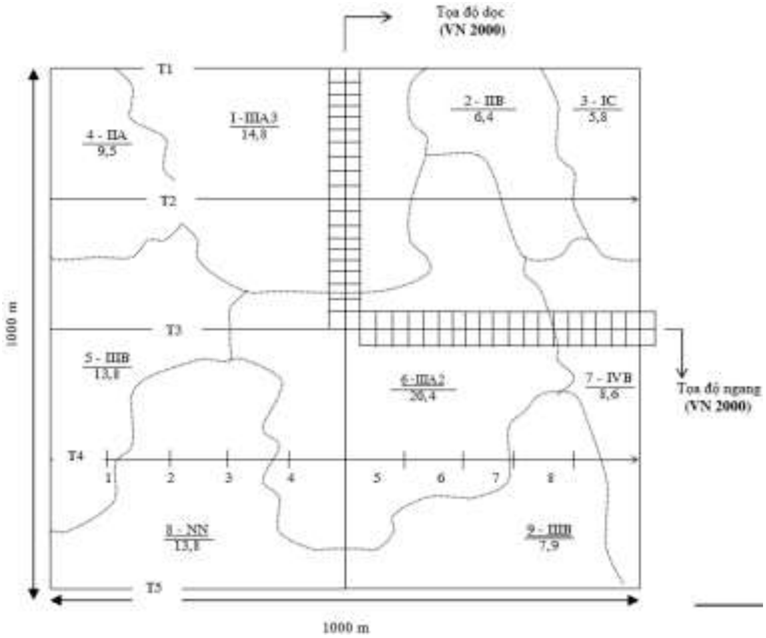
- Use a compass and marking poles to establish a line with the length of 500m (horizontal distance) and the azimuth of 0º. Establish the first strip by placing poles on the boundaries of two SSPs every 25m. From these poles, draw a perpendicular line to both sides of the strip center line and place two poles that are 10 m from the center line. These poles form the corners of SSPs each with an area of 500m^2 (25m x 20m, Figure 6).
- Use red paint to write the ID of SSPs from 1 – 20. The numbers should be directed toward the SSP centers. Note that the SSP no. 1 has one of its boundary poles coincide with the center of the PSP (Figure 6).

The second strip established from the PSP center to the East direction:

- Use a compass and marking poles to establish a line with the length of 500m (horizontal distance) and the azimuth of 0º. Establish the second strip by putting up poles on the boundaries of two SSPs every 25m. From these poles, draw a perpendicular line to both sides of the strip center line and place two poles that are 10 m from the center line. These poles form the corners of SSPs, each with an area of 500m^2 (25m x 20m, Figure 6)

- Use red paint to write the ID of SSPs from 21 – 40. The numbers should be directed toward the SSP centers. The SSP no. 21 is nearest to the PSP.

Figure 3.2: Establishment of two strips of SSPs in a PSP



In the case the strips cannot be established as above (due to topography features such as rocky mountains, water bodies etc.), an alternative direction of the strips is identified following these rules:

- In cases where the first strip cannot be established toward the North direction, change its direction to the South.
- In cases where the second strip cannot be established toward the East direction, change its direction to the West.
- In these cases, the reasons for change of direction should be entered in the field form.

3.1.1.2. Measuring forest resources

Conduct inventory of forest resources on forested land and on non-forested land of statuses IB, IC as follows:

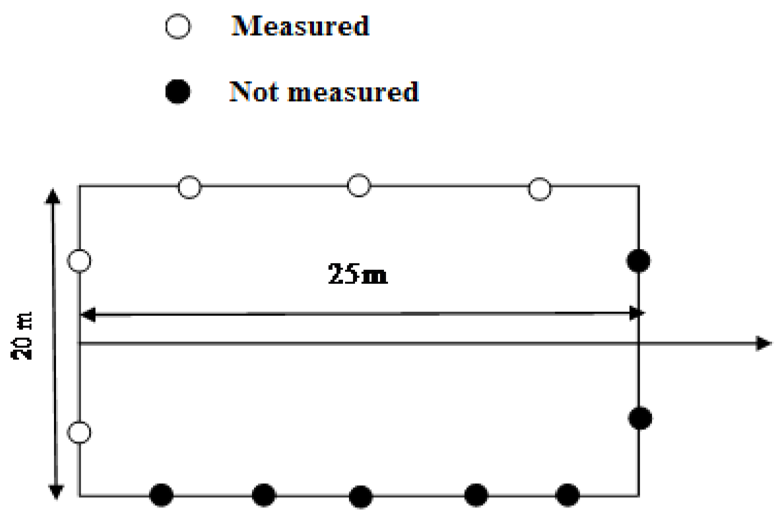
a) Trees

Timber forest or timber-bamboo mixed forest:

- Object to be measured: All timber trees with DBH1.3 ≥ 6cm, within the plot boundaries (Figure 3.3).

- Diameter measurement:
  - Measure diameters of timber trees at breast height position (1.3 m).
  - The unit is cm.
  - When a caliper tape is used, measure the diameters along two perpendicular directions (the East-West and North-South directions) and take the average value.
  - Mark the measured position by two dashes parallel to the ground on two sides of the stem (one line for each side).
  - For trees with many stems: If the position of the fork is below 1.3m, measure as two separate trees. Otherwise, measure it as usual.
  - Measure diameters also for dead trees. For dead trees with stump heights below 1.3 m, measure the diameters at the highest position. In these cases, the exact position of diameter measurement should be noted as Remarks in the field form.

Figure 3.3: Method of counting trees on the boundary of a SSP



- Determining species:

  Species names should be determined for every tree for which the diameter is measured following the regulations on species names issued by FIPI. For unknown species, tree samples should be taken for species identification to ensure that at least 90% of the measured trees are identified.

- Determining tree quality:

  Quality should be determined for each tree for which DBH is measured. Tree quality (only for living trees) is classified into three classes A, B, C:

  - Quality class A: Trees look healthy, with a straight trunk and balanced canopy, with no diseases or hollows.
  - Quality class B: Trees have characteristics such as not straight trunk, un-balanced canopy, with notches or small defects but still capable to grow and develop to mature stage; or already mature trees with small defects, but these do not impact much on the growing capacity nor the use of timber.
  - Quality class C: If already mature, trees with large defects (diseases, bent over, hollows, top-cut etc.) such that the tree has almost no timber use value; or in the case of immature trees, those with many defects (diseases, bent over, hollows, top-cut or abnormal growth) such that the trees are difficult to continue to grow and develop to become mature trees.

- Measuring heights:

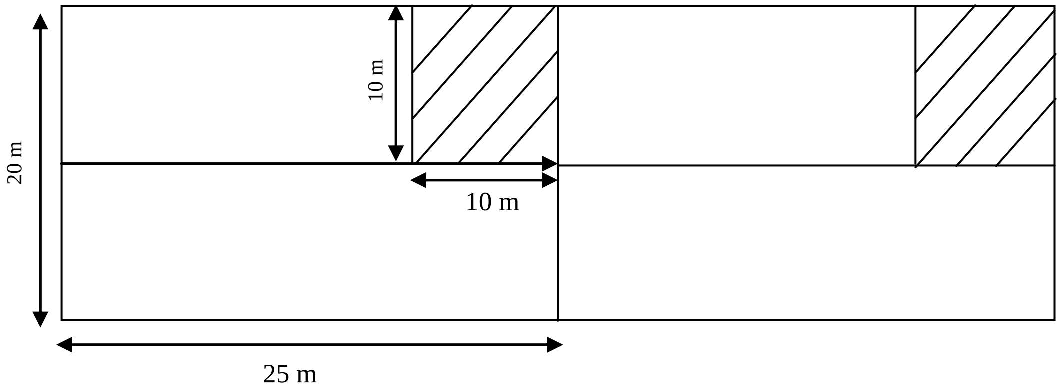
  - In each SSP, measure the total height and the bole height of three timber trees nearest to the plot center for which DBH was measured. Only trees with quality A and B are selected for height measurement. Do not select trees with two or more trunks for height measurement.

- The unit for height measurement is meter (m), rounded up to 0.5m.
   i. Plantations: (1) For plantations with the average DBH (at the 1.3m position) ≥ 6cm; (2) For trees with DBH ≥ 6cm, measure as normal; and (3) For trees with DBH < 6cm, only determine tree species and count the total number of trees in the secondary sample plot (500m^2), observe the average DBH and height and fill in the field form.
   ii. For plantations with the average DBH (at the 1.3m position) < 6cm: Only determine tree species and count the total number of trees in the right half of SSPs. For each tree species measure the total heights of three normal trees nearest to the plot center.
   iii. Non-forested land: (1) Conduct the measurement as with natural timber forest regardless of tree species and use (including trees for wood, fruit trees and industrial trees); (2) Measure the total height and bole height of all trees for which their DBH was measured; and (3) In the case a tree has a fork below the 1.3 m level but its stem has a special shape which makes it difficult to determine the number of stems, measure the DBH at the position right below the fork.

b) Bamboo

Only measure bamboo in the area of 100 m^2 (10m x 10m) located at the far-left (looking from the center) corner of the SSP (striped parts in Figure 3.4), regardless of the origin being natural or planted. In each bamboo plot, select only one normally-growing stem for measuring $D_{1.3}$ and total height (from the base to the position having diameter of 1.0 cm).

Figure 3.4: Layout of sample plots for bamboo measurement



The following cases should be distinguished:

- Bamboo growing scattered: Determine the bamboo species name and count the number of stems by three age classes: young, medium-aged, and old.

- Bamboo growing in clumps: Determine the species and the number of clumps in the measurement area, select one representative clump and count the number of stems by three age classes (young, medium-aged and old). Clumps on the plot boundary are treated as follows: If more than half of the clump is inside the measurement area, treat this clump as it is in the measurement area. Otherwise, treat this clump as it is outside the measurement area.

- For forest of small *Nua* with Dbq < 3.0 cm (*Nua tep*): Make a visual estimation of the average parameters: average number of stems per ha (N/ha), average diameter (Dbq), and average height (Hbq).

- For forest of small *Giang* or *Le* with Dbq < 3.0 cm (*Giang tep*): do not measure every stems but only make a visual estimation of the parameters N/ha, Dbq, Hbq.

- For *Giang* forest with Dbq ≥ 3.0 cm: Count all stems and select an average stem for measurement of stem height, diameter and number of branches. Select an average branch and measure the diameter and length of the branch.

3.1.2. Review and upgrading of input data

For the purpose of estimating EF/RFs for the FREL/FRL, the data of NFIMAP Cycles I to IV were reviewed and upgraded through the following processes:

a) Removal of duplicated records

Records entered multiple times were identified in each cycle (e.g. records with the same PSP name, SSP name and tree index). The "Pivot Table" function in Microsoft Excel was used to indentify these records. If entries were duplicated with the exact same data, only one record is kept. Otherwise, where there were duplicated entries with varying details, field notes were checked in order to identify the correct record for keeping.

b) Addition of missing records

Some SSPs had missing records (e.g. trees index number 4 and 6 were recorded but tree index 5 was missing). These missing records are checked against field notes. If these records exist in the field notes, their data will be added to the database.

c) Additional input of missing SSPs

Some SSPs had forest type entries but no tree or bamboo data. These SSPs were identified and field notes checked. If the field notes had data, they will be entered to the database.

d) Verify and correct data on total height and stem height (conducted so far only for Cycle IV)

Trees with total height measurements should in theory also have stem height measured. Scan all trees with total height smaller than stem height (potential typographical errors) and check against field notes to correct the data as appropriate. Trees with unrealstic total height (bigger than 100 m) are also checked against field notes for correction as possible.

e) Verify and correct DBH and total height of trees (conducted so far only for Cycle IV)

Identify trees with DBH < 6 cm and not in plantation and have their field notes checked to correct if necessary.

Develop the height curves for each eco-region and identify outlier trees; check with their field notes to correct if errors exist.

Method to identify outlier trees are as follows:

- Using the logarithm function with error following the normal distribution and the variance being the power function of DBH as follows:

  $Hvn = a + b\ln(DBH) + N(0, DBH^k)$

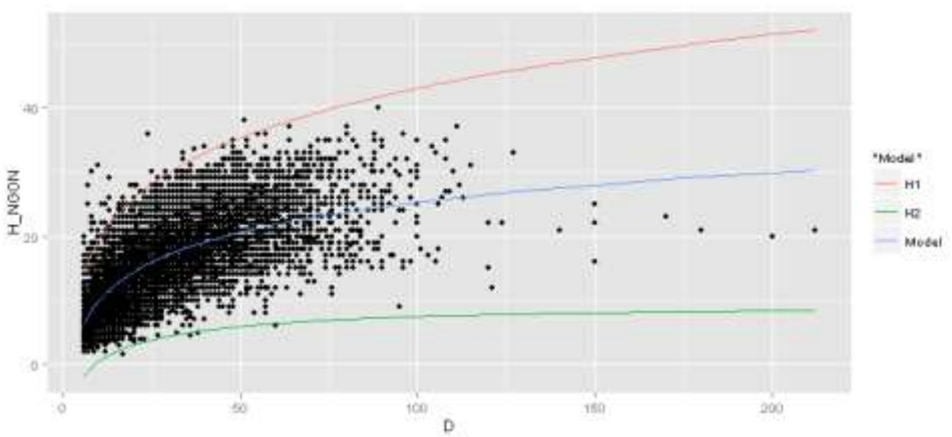
- Applying regression analysis to identify the optimal values a, b and k for the height curve per each eco-region. Then, develop two height curves H1 and H2 as follows:

  $H1 = A + B\ln(DBH) + 5\times DBH^k$

  $H2 = A + B\ln(DBH) - 5\times DBH^k$

- Trees with total heights above the H1 curve (in red) or below the H2 curve (in green) in Figure 3.5 are identified as outliers.

Figure 3.5: Method for determine trees with abnormal D-H correlations



For unknown reason, original tree heights measurement in Cycle II were missing and tree heights calculated from a height curve were used instead. The reason for using this height curve was not recorded. In Cycle III, tree heights were measured only for plantations and stem heights were measured for natural forests. For these reasons, tree heights measured in Cycle IV were used to develop the height curves per eco-region and these height curves will be used to estimate tree heights for all cycles.

f) Correct misspelled species names and assign scientific names for each record

3.1.3. Assigning forest and land use types for SSPs

Each SSP was originally assigned a field land-use code according the Regulation No 84. However, the forest cover maps used to generate activity data for the FREL/FRL for Viet Nam apply a classification system of 17 forest and land use types as described in the table below.[19]

Table 3.1: The forest and land use classification system applied in FREL/FRL development

Code	Forest and land use type
1	Evergreen broadleaf - rich
2	Evergreen broadleaf - medium
3	Evergreen broadleaf - poor
4	Evergreen broadleaf - regrowth
5	Deciduous
6	Bamboo
7	Mixed woody - bamboo
8	Coniferous
9	Mixed broadleaf - coniferous
10	Mangroves
11	Limestone forest
12	Plantations
13	Limestone without forest
14	Bared land
15	Water bodies
16	Residence
17	Other land

The classification system in the forest cover maps follows Circular 34 (issued by MARD in 2009). Therefore, there is a need to assign the forest and land use type for each SSP following the classification system in forest cover maps. The following approach is applied:

a) Use expert knowledge to create a look-up table between forest and land use types in Regulation No 84 and the ones in Circular 34.20
b) Use this look-up table to assign new forest and land use types for each SSP.
c) Calculate parameters such as average numbers of trees per hectare (N/ha), average number of bamboo stems per hectare (T/ha), average diameter (Dbq), average volume stock per hectare (M/ha) and species composition for each SSP.
d) Based on the above parameters and in combination with the original forest and land use types of the SSP and surrounding SSPs, assign new forest and land use class for the SSP as necessary. This step is conducted by experienced forest inventory experts.[21]

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[19] For more details on this, see Part 2

[20] Details on this process can be found in:
Karsten Raae et al. (2010) Technical report Technical Assistance in the Development of the National REDD Programme of Vietnam Component of Collecting Information and Analyzing Trends of Forest Resources and Forest Carbon Stock for Establishment of the Interim Baseline Reference Scenarios. Danish Forestry Extension and Nordeco

[21] Note that in previous efforts for national FREL/FRL development supported through various projects, steps c) and d) above were not conducted. The main reason for conducting these steps is because in previous efforts on FREL/FRL developement, the number of SSPs for each forest type is not appropriate when comparing with their area. For example, the total area of evergreen

3.1.4. Calculating average carbon stock for each forest type per eco-region

The next step is to estimate average carbon stock for each forest type per eco-region. Since the number of PSPs in the Red River Delta is limited, this region was combined with the Northeast region for the estimation of average carbon stocks. For the same reason, the Mekong River Delta was combined with the Southeast region. It is noted that the forest cover in these two regions is very small compared to the other regions.

3.1.4.1. Calculating biomass for individual trees and bamboo

In this section the tree diameter at breast height (DBH) is expressed in cm, the tree total height (H) in m, the basic wood density (ratio of dry mass and fresh volume, WD) in g/cm^3, the volume (V) in m^3 and the trees aboveground biomass (AGB) in kg.

a) Trees

Step 1: Constructing of height curves (D-H correlation curves)

In each SSP, three normal live trees nearest to the center were chosen for total height and stem heigh measurement. From the data of those trees, a D-H correlation equation was developed. The logarithm function is chosen as the correlation model:

$$Hvn = a + b\ln(DBH) \qquad (1)$$

Where *Hvn* is the total heights of the trees, measured in the unit of m. *DBH* is the diameter at the 1.3 m height position, expressed in the unit of cm. *a* and *b* are the coefficients of the function. Their optimal values can be found by using the regression method. Apply regression analysis using non-linear mixed effects on forest sub-types to find the optimal values for these parameters. In this work, the regression is conducted by a script written in the statistical software R which uses the nlme() function. The R script is given below:

Box 3.1: Script written for statistical software R

```
# Calculation of start values for a and b
start <- coefficients(lm(log(H)~log(DBH), data=t))
names(start) <- c("a","b")
start[1]<-exp(start[1])
# Regression using non-linear mixed effects models
Max_like1 <- nlme(H~a*log(DBH)+b, data=t, fixed=a+b~1,
        start=start,groups=~forest_subtype,weights=varPower(form=~DBH))
t$Max_like1.fit <- fitted.values(Max_like1)
t$Max_like1.res <- residuals(Max_like1)
t$Max_like1.res.weigh <- residuals(Max_like1)/t$DBH^k
# calculation of AIC
AIC(Max_like1)
# calculation of R2
R2 <- 1- sum((t$H - t$Max_like1.fit)^2)/sum((t$H - mean(t$H))^2)
```

The forest group used for non-linear mixed effects are given in the Table below:

---

broadleaf–rich forests is only half of that of evergreen broadleaf-medium forests, but with a 1.5 times the number of SSPs. After careful examination, it was identified that the IIIA3 class in Regulation No 84 had an average volume stock of 210 m3/ha near the boundaries of the two forest types. In all previous efforts, all SSPs of IIIA3 class in Regulation No 84 were assigned to evergreen broadleaf–rich forest while in fact more than one third of these SSPs belong to the evergreen broadleaf–medium class (<200m3/ha).

Table 3.2: Grouping of forest types for development of height curves using non-linear mixed effects models

Forest and land use type	Code of forest group
EGBL, Bamboo, mixed timber - bamboo, bare land (IB, IC)	1
Deciduous forest	2
Coniferous, mixed broadleaf - coniferous	3
Mangrove forest	4
Plantations	5

Using the non-linear mixed effects models, D-H correlation equations are developed specifically for each forest type: evergreen broadleaf forest, deciduous forest, coniferous forest, mangrove forest and plantation.

Step 2: Calculating total height for trees without height measurements

Apply the developed height curves to calculate the total height for other trees that do not have total height measurements.

Step 3: Assigning wood density (WD) for each species

WD is associated with each species identified in the NFIMAP cycles based on 1,300 WD measurements collected in Viet Nam by the Vietnam Forestry University, the Vietnamese Academy of Forest Sciences (VAFS) and the Tay Nguyen University (reports not published to date) and completed by the international Global Wood density database (Chave *et al.*, 2009).

WD was not available for all species. Therefore, for each species of the NFIMAP cycle data, the WD value attributed was selected with the following hierarcy of preference: 1) species average in the Vietnamese database, 2) species average in the Global Wood Density database, 3) average at genus level in the Vietnamese database, 4) average at genus level in the Global wood density database, and 5) national average of the Vietnamese database: 0.584 g/cm^3.

In terms of number of species, 55% of the species had a WD value available at species or genus level in the Vietnamese database and only 10% of the species were attributed a default global average.

Step 4: Calculating standing volume for individual trees

In the NFIMAP, the standing volume of a tree is the volume of the stem from the base to the stem top. The calculation of standing volume for each field-collected forest type is as follows:

- Evergreen broadleaf forest
  Apply the national two-parameter volume tables in the Forest Inventory and Planning Manual (FIPI, 1995). There are five national volume tables corresponding to five form groups. The volume table for form group 1 gives the smallest volumes and the volumes increase as the form group goes up from 1 to 5. Here, the national volume table for the form group 3 is used, since most of the tree species belong to this group. For making the calculation easier, an allometric equation equivalent to the volume table for the form group 3 is used. The equation is:

  $$V = 0.748 \times DBH^2 \times Hmt^{0,764} \times 10^{-4} \qquad (2)$$

  Where *DBH* is the diameter at the 1.3 m height position, in the unit of cm; *Hmt* is the length of the tree stem, in the unit of m. According to the Forest Inventory and Planning Manual (FIPI, 1995), the length along the tree stem can be calculated from the total tree height using the following formula:

  $$Hmt = Hvn \times 1.04 \qquad (3)$$

- Deciduous forest
  Apply the allometric volume equation specific to natural deciduous forests in the Central Highlands in the Forest Inventory and Planning Manual (FIPI, 1995):

  $$V = 0.686 \times DBH^{1.9825} \times Hmt^{0.8163} \times 10^{-4} \qquad (4)$$

- Natural coniferous forest
  Apply the allometric volume equation specific to natural coniferous forest in Central Highlands in the Forest Inventory and Planning Manual (FIPI, 1995):

$$V = 0.744 \times DBH^{1.9909} \times Hmt^{0.7814} \times 10^{-4} \quad (5)$$

- Mangrove forests
  Since Viet Nam currently does not have general allometric equations for mangrove forests and the total area of this forest type is limited, for simplification, the allometric equation of evergreen broadleaf forest has been applied for this forest type. As mangroves cover a small area, the data collected during NFIMAP cycles may not be representative. The species distribution and carbon stock estimates for this forest types is based on litteraure review for the FREL/FRL construction.

- Plantation
  There are many species of plantation in Viet Nam. Therefore, for simplification, the calculation method for plantation was applied as follows:
  For *Pinus spp.* plantations, apply the equation for calculating tree volume as specified in the section "Natural coniferous forest" above.
  For other plantations, apply the same standing volume equation as with evergreen broadleaf forests.

Step 5: Calculating above ground biomass (AGB) for individual trees

a) Trees

- Evergreen broadleaf forests, bamboo forests, and mixed timber and bamboo forests
  Country-specific allometric equation (UN-REDD, 2015) with three predictors (DBH, total height and WD) was used to estimate the AGB for each individual tree:

$$AGB = 0.757 \times (DBH^2 \times H_{mt} \times WD/10)^{0.930} \quad (8)$$

- Deciduous forest
  Country-specific allometric equations (UN-REDD, 2015) with two predictors (DBH and total height) were applied to estimate AGB of each individual tree. The equation applied is:

$$AGB = 310.3 \times (DBH^2 \times H_{mt}/10000) \quad (9)$$

- Natural coniferous forest
  Since no allometric biomass equation specific to Vietnamese natural coniferous forest is available, the indirect method of calculation using tree volume is applied as follows:

$$AGB = V \times BEF \times WD \quad (10)$$

  Where *BEF* is the biomass expansion factor. Since the tree volume used in Viet Nam is not the merchantable volume, the default BEF value provided in IPCC guidelines may not be appropriate. In this study, the BEF of 1.3 (Brown, 1997) and the WD of 500 kg/m^3 are used for coniferous forests.

- Plantation
  Since there are many species of plantation in Viet Nam, for simplification, the allometric equation for evergreen broadleaf forest mentioned above was applied.

b) Bamboo

Allometric equations for estimating AGB of four main bamboo species (*Lo o*, *Luong*, *Nua* and *Vau*) have been developed (UN-REDD, 2015). The allometric equations for these four species are given below:

- *Lo o* (*Bambusa balcooa*):

$$AGB = 0.0612 \times DBH^{2.0848} \times H^{0.2778} \quad (11.a)$$

- *Luong* (*Dendrocalamus membranaceus*):

$$AGB = 0.1012 \times DBH^{1.9667} \times H^{0.2778} \quad (11.b)$$

- *Nua* (*Bambusa chirostachyoides*):

$$AGB = 0.3558 \times DBH^{1.2154} \times H^{0.2778} \quad (11.c)$$

- *Vau* (*Indosasa angustata*):

$$AGB = 0.2829 \times DBH^{1.4306} \times H^{0.2778} \quad (11.d)$$

For other bamboo species, AGB can be approximated by applying one of the above four equations. The table below shows the equations applied to other bamboo species:

Table 3.3: Equations applied for bamboo species without species-specific equations.

No	Bamboo species	Equation applied	No	Bamboo species	Equation applied
1	*Bương*	*Luong*	8	*Mai*	*Luong*
2	*Dùng*	*Nua*	9	*Mây song*	*Nua*
3	*Giang*	*Nua*	10	*Mét*	*Luong*
4	*Hốc*	*Luong*	11	*Mum*	*Lo o*
5	*Hóp*	*Luong*	12	*Róc*	*Luong*
6	*Le*	*Lo o*	13	*Tre*	*Luong*
7	*Lùng*	*Nua*	14	*Trúc*	*Vau*

3.1.4.2. Estimating carbon stock of SSPs

Step 1: Estimating total AGB of each SSP

Total AGB of trees in each SSP is estimated as the sum of all individual tree AGBs in the SSP.

$$AGB\_GO_i = \sum_{j=1}^{n_i} AGB\_GO_{ij} \quad (12.a)$$

Where AGB_GO_i is the total AGB of trees in SSP *i*, n_i is the number of trees in SSP *i*, and AGB_GO_{ij} is the AGB of the *j*th tree in SSP *i*.

Total AGB of bamboo in each SSP is estimated as the sum of all individual bamboo AGBs in the SSP.

$$AGB\_TN_i = \sum_{j=1}^{m_i} AGB\_TN_{ij} \quad (12.b)$$

Where AGB_TN_i is the total AGB of bamboo in SSP *i*, m_i is the number of bamboo in SSP *i*, and AGB_TN_{ij} is the AGB of the *j*th in SSP *i*.

Since the area of bamboo measurement in each SSP (500 m^2) is 100 m^2, the total AGB of both trees and bamboo in SSP *i* is:

$$AGB_i = AGB\_GO_i + 5 \times AGB\_TN_i \quad (12.c)$$

Step 2: Estimating total BGB of each SSP

BGB will be estimated for each SSP as follows:

$$BGB_i = AGB_i \times R \quad (13)$$

Where BGB_i is the BGB of SSP *i*; *R* is the root-to-shoot ratio. In this work, the default values proposed by Mokany *et al.* (2006) for *R*, which is 0.205 for SSPs with AGB < 125 tons/ha or 0.235 for SSPs with AGB ≥ 125 tons/ha, are applied.

Step 3: Estimating total living biomass (AGB and BGB) for each SSP

Total living biomass in SSP *i* is the sum of AGB and BGB of the SSP:

$$B_i = AGB_i + BGB_i \tag{14}$$

Step 4: Estimating total carbon stock of each SSP

Total carbon stock of SSP *i* is calculated as follows:

$$C_i = B_i \times CF \tag{15}$$

Where *Bi* is total living biomass of SSP *i* in kg; CF is the carbon fraction coefficient. This work applied the IPCC default value for CF, which is 0.47 (IPCC guidelines 2006).

3.1.4.3. Estimating average carbon stock per hectare of each forest type per eco-region

Step 1: Converting carbon stock of each SSP to tons of carbon per hectare

Carbon stock of each SSP is in kg. Area of each SSP is 500m^2. The following equation is applied to convert carbon stock to average carbon stock per hectare in tons of carbon per hectare:

$$tC/ha_i = \frac{C_i \times 10^4}{10^3 \times 500} = \frac{C_i}{50} \tag{16}$$

Step 2: Calculating average carbon stock per hectare

The average carbon stock per hectare of each combination of forest type and eco-region (called hereafter class) *i* is the mean of the average carbon stock per hectare of all SSPs in this forest type.

$$\bar{x}_i = \frac{1}{np_i} \sum_{j=1}^{np_i} x_{ij} \tag{17}$$

Where np_i is the number of SSP in the class *i*; x_{ij} is the average carbon stock per hectare of SSP *j* in class *i*.

3.1.4.4. Calculating uncertainty of average carbon stock per hectare of each forest type per eco-region

Step 1: Calculating coefficient of variation

The coefficient of variation of average carbon stock per hectare in class *i* is estimated by equation below:

$$CV\%_i = \frac{SE_i \times \sqrt{np_i}}{\bar{x}_i} \times 100 \tag{18}$$

Where SE_i is the standard error of average carbon stocks per hectare of SSPs in forest type *i*.

Since the sample plots in NFIMAP is a grid of PSPs, each PSP containing 40 SSPs, the standard error was adapted from Cochran (1977) ratio estimator. The resulting formula for calculating the standard error of the carbon stock estimates is:

$$\boldsymbol{SE_i = \frac{1}{n_i} \times \sqrt{\frac{N_i}{(N_i - 1)} \times \sum_{j=1}^{N_i} \left(\sum_{k=1}^{n_{i,j}} (c_{i,j,k}) - C_i \times n_{i,j} \right)}} \tag{19}$$

Where:
N_i the number of PSPs having at least one SSP in the class i,
n_i the total number of SSPs in the class i,
$n_{i,j}$ the number of SSPs in the PSP j and the class i,
$c_{i,j,k}$ the carbon stock, in tonne per ha, of the SSP k, in the PSP j and the class i,
C_i the average carbon stock, in tonne per ha, of the class i.

Step 2: Calculation of carbon stock uncertainty

Apply the following formula for calculation of uncertainty for class *i*:

$$U\%_i = \frac{t_{\alpha,l_i-1} \times CV\%_i}{\sqrt{np_i}} \tag{20}$$

Where t_{α,l_i-1} is value of the *t* distribution of l_i-1 degrees of freedom for the 1-α confidence interval (CI). In this work, uncertainty are estimated at the 95% CI (α = 0.05).

3.1.5. Calculating EF/RF for each land use conversion related to forest

After calculation of average carbon stock per hectare for each forest type per eco-region, these values are used to estimate the EF/RF for each land use conversion related to forests. The equation for estimating emission/removal factors is as follows:

$$EF/RF_{ij}(\text{tC/ha}) = \left(C_i - C_j\right) \tag{21}$$

Where EF/RF_{ij} is the EF/RF when converting from land use type *i* to land use type *j* in each eco-region. It will be an EF if its value is larger than zero and a RF otherwise. C_i and C_j are the average carbon stocks per hectare of land use type *i* and land use type *j*, respectively. For forest land use types, the average carbon stocks per hectare are from the calculation results in section 1.4 above. For non-forest land use types, this work applied the IPCC default values of zero.

The uncertainty associated with each EF/RF was calculated using the formula for additions and subtraction from the IPCC guidelines 2006, chapter 3 on Uncertainties:

$$\boldsymbol{U}\left(\boldsymbol{e}_{a,b}\right)\% = \frac{\sqrt{(\boldsymbol{U}(\boldsymbol{C}_a)\%\times\boldsymbol{C}_a)^2 + (\boldsymbol{U}(\boldsymbol{C}_b)\%\times\boldsymbol{C}_b)^2}}{|\boldsymbol{C}_a + \boldsymbol{C}_b|} \tag{22}$$

Where $\boldsymbol{e}_{a,b}$ the EF/RF for the conversion from forest type *a* in year *x* to forest type *b* in the year *x*+5 (*a* can be equal to *b*), $\boldsymbol{C}_a$ the carbon stok of the forest type *a* in the year *x*, and $\boldsymbol{U}(\boldsymbol{C}_a)\%$ its uncertainty at the 95% CI.

The results of the uncertainty of the EF/RF is not presented here but can be easily recalculated based on the information presented. The uncertainty for changes between evergreen broadleaf forest categories ranges from 3 to 10 % of the EF/RFs. The factors with the highest uncertainty are associated to changes from or to coniferous or limestone forests (uncertainty higher than 100 %). As these forest types have a very limited area, the NFIMAP cycles did not capture their variability well, but at the same time this does not increase the overall accuracy for the same reason.

3.2. Results of estimating emission/removal factors

3.2.1. Review and upgrade data of NFIMAP Cycles I to IV

3.2.1.1. Results for Cycle I

The process of review and upgrade the data of NFIMAP Cycle I achieved the following results:

- Addition of approximately 250 new records in SSPs already present in the database;
- Addition of plot data for 14 new SSPs;
- Revision of data (species name, DBH, total height, stem height, number of trees) for approximately 850 records.

3.2.1.2. Results for Cycle II

The process of review and upgrade the data of NFIMAP Cycle II achieved the following results:

- Removal of approximately 850 duplicated records;
- Addition of approximately 450 new records in SSPs already present in the database;
- Addition of plot data for 28 new SSPs;

- Revision of data (species name, DBH, total height, stem height, number of trees) for approximately 1,300 records.

3.2.1.3. Results for Cycle III

The process of review and upgrade the data of NFIMAP Cycle III achieved the following results:

- Removal of approximately 730 duplicated records;
- Addition of approximately 600 new records in SSPs already present in the database;
- Addition of plot data for 36 new SSPs;
- Revision of data (species name, DBH, total height, stem height, number of trees) for approximately 1,400 records.

3.2.1.4. Results for Cycle IV

The process of review and upgrade the data of NFIMAP Cycle IV achieved the following results:

- Removal of approximately 1,000 duplicated records;
- Addition of approximately 400 new records in SSPs already present in the database;
- Addition of plot data for 25 new SSPs;
- Revision of data (species name, DBH, total height, stem height, number of trees) for approximately 1,200 records.

3.2.2. Calculation of average forest carbon stock and associated uncertainty per forest type per eco-region

The carbon stock estimates presented in this section correspond to AGB and BGB. The estimate is made with the uncertainty at 95% confidence.

3.2.2.1. Northwest region (NW)

Average carbon stocks per hectare for each forest type in the Northwest region are given in the Table below (when no plot was measured in the region for a forest type, the national average is reported):

Table 3.4: NW average carbon stock per hectare (tC/ha) per forest type

Forest type code	Cycle I		Cycle II		Cycle III		Cycle IV		Remark
	PSP (SSP)	Carbon stock	PSP (SSP)	Carbon stock	PSP (SSP)	Carbon stock	PSP (SSP)	Carbon stock	
1	20 (160)	129 ± 11%	13 (185)	198 ± 32%	12 (193)	181 ± 24%	8 (125)	145 ± 47%	
2	48 (268)	67 ± 5%	20 (122)	65 ± 8%	23 (145)	66 ± 9%	22 (273)	65 ± 8%	
3	118 (974)	28 ± 8%	52 (560)	27 ± 12%	72 (762)	28 ± 6%	34 (350)	28 ± 24%	
4	108 (891)	17 ± 12%	71 (983)	17 ± 16%	135 (1926)	15 ± 10%	92 (1269)	17 ± 14%	
5	174 (4887)	40 ± 14%	321 (8822)	43 ± 5%	264 (7600)	32 ± 5%	165 (4401)	31 ± 8%	National
6	61 (721)	15 ± 21%	41 (464)	20 ± 17%	83 (1102)	16 ± 18%	26 (306)	16 ± 31%	
7	19 (202)	33 ± 23%	14 (108)	35 ± 53%	45 (514)	31 ± 18%	24 (238)	30 ± 21%	
8	31 (607)	87 ± 18%	73 (1707)	67 ± 13%	57 (1341)	83 ± 13%	36 (645)	95 ± 11%	National
9	29 (340)	85 ± 24%	49 (473)	73 ± 17%	25 (293)	84 ± 25%	19 (227)	67 ± 45%	National
10	NA	35	NA	35	NA	35	NA	35	VAFS
11	1 (2)	30	1 (28)	17	7 (112)	23 ± 28%	2 (19)	14 ± 928%	National
12	3 (18)	17 ± 149%	8 (55)	16 ± 62%	18 (176)	13 ± 31%	11 (83)	12 ± 36%	

3.2.2.2. *Northeast and Red River Delta region (NE and RRD)*

Average carbon stocks per hectare for each forest type in the Northeast and Red River Delta region are given in the Table 3.5 below:

Table 3.5: NE and RRD average carbon stock (tC/ha) per forest type

Forest type code	Cycle I		Cycle II		Cycle III		Cycle IV		Remark
	PSP (SSP)	Carbon stock	PSP (SSP)	Carbon stock	PSP (SSP)	Carbon stock	PSP (SSP)	Carbon stock	
1	23 (124)	122 ± 18%	10 (46)	112 ± 6%	6 (17)	119 ± 9%	9 (47)	107 ± 12%	
2	43 (275)	64 ± 7%	21 (170)	65 ± 4%	17 (100)	62 ± 7%	36 (224)	64 ± 6%	
3	71 (459)	28 ± 9%	70 (748)	24 ± 9%	78 (1052)	21 ± 11%	64 (532)	20 ± 12%	
4	165 (1794)	12 ± 14%	149 (2097)	11 ± 11%	245 (3619)	12 ± 11%	224 (3294)	16 ± 10%	
5	174 (4887)	40 ± 14%	321 (8822)	43 ± 5%	264 (7600)	32 ± 5%	165 (4401)	31 ± 8%	National
6	121 (1340)	15 ± 12%	87 (967)	15 ± 21%	150 (1739)	15 ± 12%	65 (639)	17 ± 17%	
7	52 (626)	35 ± 19%	78 (1040)	28 ± 22%	106 (1282)	21 ± 10%	114 (1382)	27 ± 10%	
8	31 (607)	87 ± 18%	73 (1707)	67 ± 13%	57 (1341)	83 ± 13%	1 (14)	119	National
9	29 (340)	85 ± 24%	49 (473)	73 ± 17%	25 (293)	84 ± 25%	1 (23)	27	National
10	NA	35	NA	35	NA	35	NA	35	VAFS
11	5 (74)	30 ± 103%	5 (34)	26 ± 98%	8 (116)	23 ± 27%	3 (15)	12 ± 129%	National
12	42 (429)	21 ± 29%	22 (176)	16 ± 29%	122 (1318)	17 ± 15%	139 (1710)	14 ± 15%	

3.2.2.3. *North Central Coastal region (NCC)*

Average carbon stocks per hectare for each forest type in the North Central Coastal region are given in the Table 3.6 below:

Table 3.6: NCC average carbon stock (tC/ha) per forest type

Forest type code	Cycle I		Cycle II		Cycle III		Cycle IV		Remark
	PSP (SSP)	Carbon stock	PSP (SSP)	Carbon stock	PSP (SSP)	Carbon stock	PSP (SSP)	Carbon stock	
1	116 (1813)	169 ± 10%	220 (3654)	175 ± 7%	163 (2820)	162 ± 13%	78 (1225)	141 ± 9%	
2	139 (1463)	70 ± 2%	268 (3305)	70 ± 2%	260 (3447)	73 ± 2%	172 (2398)	70 ± 3%	
3	144 (1335)	32 ± 5%	265 (3018)	31 ± 4%	248 (2925)	33 ± 4%	185 (2481)	31 ± 4%	
4	62 (491)	29 ± 17%	120 (1233)	24 ± 16%	176 (1810)	21 ± 10%	155 (1663)	19 ± 18%	
5	174 (4887)	40 ± 14%	321 (8822)	43 ± 5%	264 (7600)	32 ± 5%	165 (4401)	31 ± 8%	National
6	110 (1320)	16 ± 23%	75 (1085)	13 ± 17%	215 (3418)	13 ± 11%	96 (1463)	15 ± 18%	
7	46 (523)	68 ± 22%	40 (482)	70 ± 23%	124 (1480)	42 ± 10%	91 (1131)	40 ± 11%	
8	31 (607)	87 ± 18%	73 (1707)	67 ± 13%	57 (1341)	83 ± 13%	36 (645)	95 ± 11%	National
9	29 (340)	85 ± 24%	49 (473)	73 ± 17%	25 (293)	84 ± 25%	19 (227)	67 ± 45%	National
10	NA	35	NA	35	NA	35	NA	35	VAFS
11	2 (27)	36 ± 76%	4 (6)	66 ± 22%	1 (4)	43	2 (11)	38 ± 287%	
12	6 (76)	22 ± 56%	6 (69)	28 ± 25%	24 (234)	20 ± 39%	42 (444)	22 ± 30%	

3.2.2.4. *South Central Coastal region (SCC)*

Average carbon stocks per hectare for each forest type in the SCC are given in the Table below:

Table 3.7: SCC average carbon stocks (tC/ha) per forest type

Forest type code	Cycle I		Cycle II		Cycle III		Cycle IV		Remark
	PSP (SSP)	Carbon stock	PSP (SSP)	Carbon stock	PSP (SSP)	Carbon stock	PSP (SSP)	Carbon stock	
1	117 (1489)	142 ± 8%	210 (3003)	136 ± 4%	187 (2576)	134 ± 4%	87 (1341)	134 ± 6%	
2	152 (1429)	71 ± 3%	297 (3328)	72 ± 2%	316 (4447)	72 ± 2%	148 (2132)	76 ± 3%	
3	133 (1286)	32 ± 7%	239 (2164)	32 ± 4%	214 (1612)	33 ± 3%	140 (1572)	32 ± 5%	
4	162 (2443)	32 ± 9%	185 (2737)	30 ± 7%	226 (2634)	29 ± 6%	160 (2461)	27 ± 13%	
5	42 (1120)	34 ± 70%	71 (2028)	26 ± 14%	51 (1583)	24 ± 17%	41 (1163)	28 ± 21%	
6	15 (150)	15 ± 88%	23 (237)	14 ± 54%	34 (295)	13 ± 81%	17 (115)	13 ± 27%	
7	20 (183)	50 ± 32%	28 (358)	46 ± 24%	28 (345)	44 ± 20%	41 (529)	50 ± 23%	
8	2 (45)	117 ± 175%	5 (142)	115 ± 66%	2 (43)	76 ± 3%	1 (40)	91	
9	5 (115)	81 ± 71%	5 (49)	104 ± 113%	2 (47)	79 ± 174%	2 (32)	40 ± 89%	
10	NA	64	NA	64	NA	64	NA	64	VAFS
11	5 (74)	30 ± 103%	5 (34)	26 ± 98%	8 (116)	23 ± 27%	7 (45)	19 ± 83%	National
12	2 (28)	12 ± 41%	5 (32)	11 ± 114%	28 (299)	13 ± 33%	30 (298)	10 ± 23%	

3.2.2.5. *Central Highlands region (CH)*

Average carbon stocks per hectare for each forest type in the CH region are given in the Table below:

Table 3.8: CH average carbon stocks (tC/ha) per forest type

Forest type code	Cycle I		Cycle II		Cycle III		Cycle IV		Remark
	PSP (SSP)	Carbon stock	PSP (SSP)	Carbon stock	PSP (SSP)	Carbon stock	PSP (SSP)	Carbon stock	
1	239 (2960)	145 ± 3%	372 (4732)	142 ± 4%	291 (3490)	138 ± 2%	209 (3095)	141 ± 3%	
2	281 (2526)	75 ± 2%	523 (5596)	76 ± 1%	489 (6208)	78 ± 2%	306 (3537)	79 ± 2%	
3	199 (1008)	35 ± 5%	435 (3079)	34 ± 3%	345 (1974)	37 ± 4%	238 (1698)	38 ± 4%	
4	266 (3023)	45 ± 7%	337 (4309)	43 ± 7%	391 (4575)	42 ± 5%	221 (2748)	43 ± 8%	
5	130 (3713)	43 ± 5%	250 (6794)	40 ± 5%	213 (6017)	35 ± 5%	124 (3238)	32 ± 8%	
6	106 (1138)	11 ± 25%	170 (2394)	10 ± 16%	163 (1977)	11 ± 20%	78 (819)	12 ± 27%	
7	124 (1525)	53 ± 12%	211 (3203)	49 ± 10%	206 (3160)	48 ± 10%	142 (2012)	51 ± 11%	
8	29 (562)	84 ± 19%	68 (1565)	68 ± 12%	55 (1298)	83 ± 14%	34 (591)	95 ± 12%	
9	24 (225)	87 ± 28%	44 (424)	75 ± 12%	23 (246)	85 ± 29%	16 (172)	77 ± 48%	
10	NA	35	NA	35	NA	35	NA	35	VAFS
11	5 (74)	30 ± 103%	5 (34)	26 ± 98%	8 (116)	23 ± 27%	7 (45)	19 ± 83%	National
12	5 (36)	22 ± 70%	9 (127)	23 ± 43%	34 (525)	21 ± 25%	32 (371)	23 ± 42%	

3.2.2.6. Southeast and Mekong River Delta region (SE and MRD)

Average carbon stocks per hectare for each forest type in the SE and MRD region are given in the Table below:

Table 3.9: SE and MRD average carbon stocks (tC/ha) per forest type

Forest type code	Cycle I		Cycle II		Cycle III		Cycle IV		Remark
	PSP (SSP)	Carbon stock	PSP (SSP)	Carbon stock	PSP (SSP)	Carbon stock	PSP (SSP)	Carbon stock	
1	8 (30)	176 ± 13%	18 (71)	148 ± 7%	9 (57)	203 ± 30%	12 (137)	161 ± 16%	
2	15 (119)	81 ± 8%	33 (297)	81 ± 5%	10 (58)	81 ± 9%	24 (255)	82 ± 8%	
3	28 (188)	33 ± 19%	56 (643)	35 ± 9%	10 (66)	38 ± 14%	28 (227)	34 ± 17%	
4	37 (699)	41 ± 11%	37 (568)	35 ± 19%	6 (83)	40 ± 35%	11 (314)	52 ± 19%	
5	2 (54)	23 ± 142%	321 (8822)	43 ± 5%	264 (7600)	32 ± 5%	165 (4401)	31 ± 8%	
6	33 (472)	11 ± 30%	25 (413)	11 ± 21%	15 (200)	16 ± 44%	11 (75)	16 ± 81%	
7	30 (549)	50 ± 28%	22 (450)	51 ± 19%	24 (611)	79 ± 30%	17 (293)	56 ± 27%	
8	31 (607)	87 ± 18%	31 (607)	80 ± 19%	57 (1341)	83 ± 13%	36 (645)	95 ± 11%	National
9	29 (340)	85 ± 24%	29 (340)	80 ± 24%	25 (293)	84 ± 25%	19 (227)	67 ± 45%	National
10	NA	64	NA	64	NA	64	NA	64	VAFS
11	5 (74)	30 ± 103%	5 (34)	26 ± 98%	8 (116)	23 ± 27%	7 (45)	19 ± 83%	National
12	2 (17)	10 ± 334%	50 (459)	19 ± 20%	6 (105)	10 ± 42%	15 (305)	15 ± 29%	

3.2.2.7. National

Average carbon stocks per hectare for each forest type at the national level are given in the Table below, noting that this was not used for the purpose of constructing Viet Nam's FREL/FRL.

Table 3.10: National - average carbon stocks (tC/ha) per forest type

Forest type code	Cycle I		Cycle II		Cycle III		Cycle IV		Remark
	PSP (SSP)	Carbon stock	PSP (SSP)	Carbon stock	PSP (SSP)	Carbon stock	PSP (SSP)	Carbon stock	
1	523 (6576)	150 ± 4%	843 (11691)	152 ± 3%	668 (9153)	146 ± 5%	403 (5970)	140 ± 3%	
2	678 (6080)	73 ± 1%	1162 (12818)	73 ± 1%	1115 (14405)	75 ± 1%	708 (8819)	75 ± 1%	
3	693 (5250)	32 ± 3%	1117 (10212)	32 ± 2%	967 (8391)	32 ± 3%	689 (6860)	32 ± 3%	
4	800 (9341)	32 ± 6%	899 (11927)	30 ± 5%	1179 (14647)	26 ± 5%	863 (11749)	26 ± 6%	
5	174 (4887)	40 ± 14%	321 (8822)	36 ± 5%	264 (7600)	32 ± 5%	165 (4401)	31 ± 8%	
6	446 (5141)	14 ± 10%	421 (5560)	13 ± 9%	660 (8731)	13 ± 7%	293 (3417)	15 ± 11%	
7	291 (3608)	50 ± 9%	393 (5641)	47 ± 8%	533 (7392)	43 ± 8%	429 (5585)	42 ± 7%	
8	31 (607)	87 ± 18%	73 (1707)	72 ± 13%	57 (1341)	83 ± 13%	36 (645)	95 ± 11%	
9	29 (340)	85 ± 24%	49 (473)	78 ± 16%	25 (293)	84 ± 25%	19 (227)	67 ± 45%	
10	NA	58	NA	58	NA	58	NA	58	VAFS
11	3 (29)	36 ± 25%	5 (34)	26 ±100%	8 (116)	23 ± 27%	7 (45)	19 ± 83%	
12	60 (604)	20 ± 22%	50 (459)	19 ± 20%	232 (2657)	17 ± 11%	269 (3211)	16 ± 13%	

3.2.3. Calculation of EF/RFs

Based on the average carbon stocks per hectare for each forest type per eco-region calculated above and combined with average carbon stocks per hectare for mangrove based on literature review conducted by VAFS (35,2 tC/ha for the Northeast, Red River Delta and North Central Coast; 64,4 tC/ha for South Central Coast, Southeast and Mekong River Delta regions) and the assumption that avearge carbon stocks for non-forest land types being zero, the EF (> 0) and RF (< 0) for each forest and land use conversion are calculated and provided in the following tables.

3.2.3.1. Northwest region

Table 3.11: NW region - matrix of EF/RF (tC/ha) for forest and LUC 1995-2000

		2000																
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1995	1	-69	64	101	112	85	109	94	62	56	94	111	112	129	129	129	129	129
	2	-131	3	40	51	24	48	32	0	-5	32	50	51	67	67	67	67	67
	3	-170	-37	1	11	-15	8	-7	-39	-45	-7	11	12	28	28	28	28	28
	4	-181	-48	-10	0	-26	-3	-18	-50	-56	-18	-1	0	17	17	17	17	17
	5	-158	-24	13	24	-3	21	5	-27	-32	5	23	24	40	40	40	40	40
	6	-183	-50	-13	-2	-28	-5	-20	-52	-58	-20	-3	-2	15	15	15	15	15
	7	-165	-32	5	16	-11	13	-2	-34	-40	-2	15	16	33	33	33	33	33
	8	-112	22	59	70	43	67	52	20	14	52	69	70	87	87	87	87	87
	9	-113	20	58	68	42	65	50	18	12	50	68	69	85	85	85	85	85
	10	-163	-29	8	18	-8	16	0	-32	-38	0	18	19	35	35	35	35	35
	11	-168	-34	3	13	-13	11	-5	-37	-43	-5	13	14	30	30	30	30	30
	12	-181	-48	-10	0	-26	-3	-18	-50	-56	-18	-1	0	17	17	17	17	17
	13	-198	-65	-27	-17	-43	-20	-35	-67	-73	-35	-17	-16	0	0	0	0	0
	14	-198	-65	-27	-17	-43	-20	-35	-67	-73	-35	-17	-16	0	0	0	0	0
	15	-198	-65	-27	-17	-43	-20	-35	-67	-73	-35	-17	-16	0	0	0	0	0
	16	-198	-65	-27	-17	-43	-20	-35	-67	-73	-35	-17	-16	0	0	0	0	0
	17	-198	-65	-27	-17	-43	-20	-35	-67	-73	-35	-17	-16	0	0	0	0	0

Table 3.12: NW region - matrix of EF/RF (tC/ha) for forest and LUC 2000 - 2005

		2005																
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
2000	1	17	133	170	183	166	182	167	115	114	163	176	186	198	198	198	198	198
	2	-117	-1	37	49	32	49	34	-18	-19	29	42	52	65	65	65	65	65
	3	-154	-38	0	12	-5	12	-4	-56	-57	-8	5	15	27	27	27	27	27
	4	-165	-49	-11	1	-16	1	-14	-66	-67	-18	-6	4	17	17	17	17	17
	5	-138	-22	16	28	11	27	12	-40	-41	8	21	31	43	43	43	43	43
	6	-162	-46	-8	4	-13	4	-11	-63	-64	-16	-3	7	20	20	20	20	20
	7	-146	-30	7	20	3	19	4	-48	-49	0	13	23	35	35	35	35	35
	8	-114	2	39	52	35	51	36	-16	-17	32	45	55	67	67	67	67	67
	9	-109	7	45	57	41	57	42	-10	-11	38	50	60	73	73	73	73	73
	10	-146	-30	7	20	3	19	4	-48	-49	0	13	23	35	35	35	35	35
	11	-164	-48	-10	2	-15	2	-14	-65	-67	-18	-5	5	17	17	17	17	17
	12	-165	-49	-11	1	-16	1	-15	-66	-68	-19	-6	4	16	16	16	16	16
	13	-181	-66	-28	-15	-32	-16	-31	-83	-84	-35	-23	-13	0	0	0	0	0
	14	-181	-66	-28	-15	-32	-16	-31	-83	-84	-35	-23	-13	0	0	0	0	0
	15	-181	-66	-28	-15	-32	-16	-31	-83	-84	-35	-23	-13	0	0	0	0	0
	16	-181	-66	-28	-15	-32	-16	-31	-83	-84	-35	-23	-13	0	0	0	0	0
	17	-181	-66	-28	-15	-32	-16	-31	-83	-84	-35	-23	-13	0	0	0	0	0

Table 3.13: NW region - matrix of EF/RF (tC/ha) for forest and LUC 2005 -2010

		2010																
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
2005	**1**	36	117	153	164	150	166	152	87	115	146	168	169	181	181	181	181	181
	2	-79	1	37	48	34	50	36	-29	-1	30	52	54	66	66	66	66	66
	3	-117	-37	0	11	-3	12	-2	-67	-39	-7	14	16	28	28	28	28	28
	4	-130	-49	-13	-2	-16	0	-14	-79	-51	-20	2	3	15	15	15	15	15
	5	-113	-32	4	15	1	17	3	-63	-34	-3	19	20	32	32	32	32	32
	6	-129	-49	-12	-1	-15	0	-14	-79	-51	-19	2	4	16	16	16	16	16
	7	-114	-34	3	14	0	15	1	-64	-36	-4	17	19	31	31	31	31	31
	8	-62	18	55	66	52	67	53	-12	16	48	69	71	83	83	83	83	83
	9	-61	19	56	67	53	68	54	-11	17	49	71	72	84	84	84	84	84
	10	-110	-29	7	18	4	20	6	-60	-31	0	22	23	35	35	35	35	35
	11	-122	-42	-6	5	-9	7	-7	-72	-44	-13	9	11	23	23	23	23	23
	12	-132	-52	-16	-5	-19	-3	-17	-82	-54	-23	-1	1	13	13	13	13	13
	13	-145	-65	-28	-17	-31	-16	-30	-95	-67	-35	-14	-12	0	0	0	0	0
	14	-145	-65	-28	-17	-31	-16	-30	-95	-67	-35	-14	-12	0	0	0	0	0
	15	-145	-65	-28	-17	-31	-16	-30	-95	-67	-35	-14	-12	0	0	0	0	0
	16	-145	-65	-28	-17	-31	-16	-30	-95	-67	-35	-14	-12	0	0	0	0	0
	17	-145	-65	-28	-17	-31	-16	-30	-95	-67	-35	-14	-12	0	0	0	0	0

3.2.3.2. Northeast and Red River Delta region

Table 3.14: NE and RRD region - matrix of EF/RF (tC/ha) for forest and LUC 1995 - 2000

		2000																
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
1995	**1**	10	56	98	110	78	107	94	55	49	87	96	106	122	122	122	122	122
	2	-48	-1	40	53	21	49	36	-3	-9	29	38	48	64	64	64	64	64
	3	-84	-37	4	17	-15	14	0	-39	-45	-7	2	12	28	28	28	28	28
	4	-100	-53	-12	1	-31	-2	-16	-55	-61	-23	-14	-4	12	12	12	12	12
	5	-72	-25	16	29	-3	26	13	-27	-32	5	15	24	40	40	40	40	40
	6	-98	-51	-10	3	-29	0	-13	-53	-58	-21	-11	-2	15	15	15	15	15
	7	-77	-31	11	23	-9	20	7	-32	-38	-1	9	18	35	35	35	35	35
	8	-25	21	63	75	43	72	59	20	14	52	61	70	87	87	87	87	87
	9	-27	20	61	74	42	71	57	18	12	50	59	69	85	85	85	85	85
	10	-77	-30	11	24	-8	21	7	-32	-38	0	9	19	35	35	35	35	35
	11	-82	-35	6	19	-13	16	2	-37	-43	-5	4	14	30	30	30	30	30
	12	-92	-45	-3	9	-23	6	-7	-47	-52	-15	-5	4	21	21	21	21	21
	13	-112	-65	-24	-11	-43	-15	-28	-67	-73	-35	-26	-16	0	0	0	0	0
	14	-112	-65	-24	-11	-43	-15	-28	-67	-73	-35	-26	-16	0	0	0	0	0
	15	-112	-65	-24	-11	-43	-15	-28	-67	-73	-35	-26	-16	0	0	0	0	0
	16	-112	-65	-24	-11	-43	-15	-28	-67	-73	-35	-26	-16	0	0	0	0	0
	17	-112	-65	-24	-11	-43	-15	-28	-67	-73	-35	-26	-16	0	0	0	0	0

Table 3.15: NE and RRD region - matrix of EF/RF (tC/ha) for forest and LUC 2000- 2005

		2005																
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
2000	**1**	-7	50	91	100	80	97	91	29	28	77	89	96	112	112	112	112	112
	2	-54	4	44	53	33	50	45	-18	-19	30	42	49	65	65	65	65	65
	3	-95	-38	3	12	-8	9	3	-59	-60	-11	1	7	24	24	24	24	24
	4	-108	-50	-10	-1	-21	-4	-9	-72	-73	-24	-12	-5	11	11	11	11	11
	5	-76	-18	22	31	11	28	23	-40	-41	8	20	27	43	43	43	43	43
	6	-104	-47	-7	2	-18	-1	-6	-68	-70	-21	-9	-2	15	15	15	15	15
	7	-91	-34	6	15	-4	12	7	-55	-56	-7	5	11	28	28	28	28	28
	8	-52	5	46	55	35	52	46	-16	-17	32	44	51	67	67	67	67	67
	9	-46	11	51	60	41	57	52	-10	-11	38	50	56	73	73	73	73	73
	10	-84	-26	14	23	3	20	14	-48	-49	0	12	19	35	35	35	35	35
	11	-93	-36	4	13	-6	10	5	-57	-58	-9	3	9	26	26	26	26	26
	12	-103	-45	-5	4	-16	1	-4	-67	-68	-19	-7	0	16	16	16	16	16
	13	-119	-62	-21	-12	-32	-15	-21	-83	-84	-35	-23	-17	0	0	0	0	0
	14	-119	-62	-21	-12	-32	-15	-21	-83	-84	-35	-23	-17	0	0	0	0	0
	15	-119	-62	-21	-12	-32	-15	-21	-83	-84	-35	-23	-17	0	0	0	0	0
	16	-119	-62	-21	-12	-32	-15	-21	-83	-84	-35	-23	-17	0	0	0	0	0
	17	-119	-62	-21	-12	-32	-15	-21	-83	-84	-35	-23	-17	0	0	0	0	0

Table 3.16: NE and RRD region - matrix of EF/RF (tC/ha) for forest and LUC 2005- 2010

		2010																
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
2005	**1**	12	55	99	103	88	102	92	0	92	84	107	105	119	119	119	119	119
	2	-45	-2	42	45	30	44	34	-57	35	26	50	47	62	62	62	62	62
	3	-85	-43	1	5	-10	4	-6	-97	-6	-14	10	7	21	21	21	21	21
	4	-94	-52	-8	-4	-19	-5	-15	-106	-15	-23	1	-2	12	12	12	12	12
	5	-74	-32	12	16	1	15	5	-86	5	-3	21	18	32	32	32	32	32
	6	-91	-49	-5	-1	-16	-2	-12	-103	-12	-20	4	1	15	15	15	15	15
	7	-86	-43	1	4	-10	4	-7	-98	-6	-14	9	6	21	21	21	21	21
	8	-24	19	63	67	52	66	56	-36	56	48	71	69	83	83	83	83	83
	9	-23	20	64	68	53	67	57	-34	57	49	73	70	84	84	84	84	84
	10	-71	-29	15	19	4	18	8	-83	8	0	24	21	35	35	35	35	35
	11	-83	-41	3	7	-8	6	-4	-95	-4	-12	12	9	23	23	23	23	23
	12	-90	-48	-4	0	-15	-1	-11	-102	-11	-19	5	2	17	17	17	17	17
	13	-107	-64	-20	-16	-31	-17	-27	-119	-27	-35	-12	-14	0	0	0	0	0
	14	-107	-64	-20	-16	-31	-17	-27	-119	-27	-35	-12	-14	0	0	0	0	0
	15	-107	-64	-20	-16	-31	-17	-27	-119	-27	-35	-12	-14	0	0	0	0	0
	16	-107	-64	-20	-16	-31	-17	-27	-119	-27	-35	-12	-14	0	0	0	0	0
	17	-107	-64	-20	-16	-31	-17	-27	-119	-27	-35	-12	-14	0	0	0	0	0

3.2.3.3. North Central Coastal region

Table 3.17: NCC region - matrix of EF/RF (tC/ha) for forest and LUC 1995-2000

		2000																
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
1995	**1**	-6	99	137	145	126	156	99	102	96	134	102	141	169	169	169	169	169
	2	-104	0	39	46	27	57	0	3	-2	35	4	42	70	70	70	70	70
	3	-142	-38	1	8	-11	19	-38	-35	-41	-3	-34	4	32	32	32	32	32
	4	-146	-42	-3	5	-15	15	-42	-38	-44	-6	-38	0	29	29	29	29	29
	5	-134	-30	9	16	-3	27	-30	-27	-32	5	-26	12	40	40	40	40	40
	6	-159	-55	-16	-8	-28	2	-55	-51	-57	-19	-51	-13	16	16	16	16	16
	7	-107	-3	36	44	24	54	-3	1	-5	32	1	39	68	68	68	68	68
	8	-88	16	55	63	43	73	16	20	14	52	20	58	87	87	87	87	87
	9	-90	15	54	61	42	72	15	18	12	50	19	57	85	85	85	85	85
	10	-139	-35	4	11	-8	22	-35	-32	-38	0	-31	7	35	35	35	35	35
	11	-139	-34	5	12	-7	23	-34	-31	-37	1	-30	8	36	36	36	36	36
	12	-153	-48	-9	-2	-21	9	-48	-45	-51	-13	-44	-6	22	22	22	22	22
	13	-175	-70	-31	-24	-43	-13	-70	-67	-73	-35	-66	-28	0	0	0	0	0
	14	-175	-70	-31	-24	-43	-13	-70	-67	-73	-35	-66	-28	0	0	0	0	0
	15	-175	-70	-31	-24	-43	-13	-70	-67	-73	-35	-66	-28	0	0	0	0	0
	16	-175	-70	-31	-24	-43	-13	-70	-67	-73	-35	-66	-28	0	0	0	0	0
	17	-175	-70	-31	-24	-43	-13	-70	-67	-73	-35	-66	-28	0	0	0	0	0

Table 3.18: NCC region - matrix of EF/RF (tC/ha) for forest and LUC 2000 - 2005

		2005																
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
2000	**1**	13	102	141	154	142	162	133	92	91	139	132	154	175	175	175	175	175
	2	-92	-2	37	49	38	57	28	-13	-14	35	28	50	70	70	70	70	70
	3	-130	-41	-2	10	-1	18	-11	-52	-53	-4	-11	11	31	31	31	31	31
	4	-138	-49	-9	3	-8	11	-18	-59	-60	-11	-19	4	24	24	24	24	24
	5	-118	-29	10	22	11	30	1	-40	-41	8	1	23	43	43	43	43	43
	6	-149	-59	-20	-8	-19	0	-29	-70	-71	-22	-29	-7	13	13	13	13	13
	7	-91	-2	37	49	38	57	28	-13	-14	35	28	50	70	70	70	70	70
	8	-95	-6	34	46	35	54	25	-16	-17	32	25	47	67	67	67	67	67
	9	-89	0	40	52	41	60	31	-10	-11	38	30	52	73	73	73	73	73
	10	-127	-37	2	14	3	22	-7	-48	-49	0	-7	15	35	35	35	35	35
	11	-95	-6	33	45	34	53	24	-17	-18	31	24	46	66	66	66	66	66
	12	-134	-44	-5	7	-4	15	-14	-55	-56	-7	-14	8	28	28	28	28	28
	13	-162	-73	-33	-21	-32	-13	-42	-83	-84	-35	-43	-20	0	0	0	0	0
	14	-162	-73	-33	-21	-32	-13	-42	-83	-84	-35	-43	-20	0	0	0	0	0
	15	-162	-73	-33	-21	-32	-13	-42	-83	-84	-35	-43	-20	0	0	0	0	0
	16	-162	-73	-33	-21	-32	-13	-42	-83	-84	-35	-43	-20	0	0	0	0	0
	17	-162	-73	-33	-21	-32	-13	-42	-83	-84	-35	-43	-20	0	0	0	0	0

Table 3.19: NCC region - matrix of EF/RF (tC/ha) for forest and LUC 2005 -2010

		2010																
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
2005	**1**	21	92	131	143	131	147	122	67	95	127	124	140	162	162	162	162	162
	2	-68	2	42	53	42	58	33	-22	6	37	34	51	73	73	73	73	73
	3	-108	-37	2	14	2	18	-6	-62	-33	-2	-5	11	33	33	33	33	33
	4	-120	-49	-10	2	-10	6	-19	-74	-46	-14	-17	-1	21	21	21	21	21
	5	-109	-38	1	13	1	18	-7	-63	-34	-3	-6	10	32	32	32	32	32
	6	-128	-57	-18	-6	-18	-2	-27	-82	-54	-22	-25	-9	13	13	13	13	13
	7	-99	-28	11	23	11	27	2	-53	-24	7	4	20	42	42	42	42	42
	8	-58	13	52	64	52	68	43	-12	16	48	45	61	83	83	83	83	83
	9	-57	14	53	65	53	69	44	-11	17	49	46	62	84	84	84	84	84
	10	-106	-35	4	16	4	20	-4	-60	-31	0	-3	13	35	35	35	35	35
	11	-99	-28	12	23	11	28	3	-52	-24	7	4	20	43	43	43	43	43
	12	-121	-50	-11	1	-11	6	-19	-74	-46	-15	-18	-2	20	20	20	20	20
	13	-141	-70	-31	-19	-31	-15	-40	-95	-67	-35	-38	-22	0	0	0	0	0
	14	-141	-70	-31	-19	-31	-15	-40	-95	-67	-35	-38	-22	0	0	0	0	0
	15	-141	-70	-31	-19	-31	-15	-40	-95	-67	-35	-38	-22	0	0	0	0	0
	16	-141	-70	-31	-19	-31	-15	-40	-95	-67	-35	-38	-22	0	0	0	0	0
	17	-141	-70	-31	-19	-31	-15	-40	-95	-67	-35	-38	-22	0	0	0	0	0

3.2.3.4. South Central Coastal region

Table 3.20: SCC region - matrix of EF/RF (tC/ha) for forest and LUC 1995-2000

		2000																
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
1995	**1**	5	70	110	112	116	128	96	27	38	77	116	131	142	142	142	142	142
	2	-65	-1	39	41	46	58	25	-43	-32	7	46	61	71	71	71	71	71
	3	-104	-40	0	2	7	19	-14	-82	-72	-32	6	21	32	32	32	32	32
	4	-104	-40	0	2	7	18	-14	-82	-72	-32	6	21	32	32	32	32	32
	5	-102	-38	2	4	9	21	-12	-80	-70	-30	9	23	34	34	34	34	34
	6	-121	-57	-17	-15	-10	2	-31	-99	-88	-49	-10	5	15	15	15	15	15
	7	-86	-22	18	20	25	37	4	-64	-54	-14	24	39	50	50	50	50	50
	8	-19	45	85	87	92	104	71	3	14	53	92	107	117	117	117	117	117
	9	-56	9	49	51	55	67	35	-34	-23	16	55	70	81	81	81	81	81
	10	-72	-8	32	34	39	51	18	-50	-39	0	39	54	64	64	64	64	64
	11	-106	-42	-2	0	5	16	-16	-84	-74	-34	4	19	30	30	30	30	30
	12	-124	-60	-20	-18	-13	-2	-34	-102	-92	-52	-14	1	12	12	12	12	12
	13	-136	-72	-32	-30	-26	-14	-46	-115	-104	-64	-26	-11	0	0	0	0	0
	14	-136	-72	-32	-30	-26	-14	-46	-115	-104	-64	-26	-11	0	0	0	0	0
	15	-136	-72	-32	-30	-26	-14	-46	-115	-104	-64	-26	-11	0	0	0	0	0
	16	-136	-72	-32	-30	-26	-14	-46	-115	-104	-64	-26	-11	0	0	0	0	0
	17	-136	-72	-32	-30	-26	-14	-46	-115	-104	-64	-26	-11	0	0	0	0	0

Table 3.21: SCC region - matrix of EF/RF (tC/ha) for forest and LUC 2000-2005

		2005																
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
2000	**1**	2	64	103	108	113	123	92	60	58	72	113	124	136	136	136	136	136
	2	-62	0	39	44	49	59	28	-4	-6	8	49	60	72	72	72	72	72
	3	-102	-40	-1	4	9	19	-12	-44	-46	-32	9	20	32	32	32	32	32
	4	-104	-42	-3	2	7	17	-14	-46	-48	-34	7	18	30	30	30	30	30
	5	-109	-47	-7	-3	2	12	-19	-51	-53	-39	2	13	26	26	26	26	26
	6	-121	-59	-19	-15	-10	0	-31	-63	-65	-51	-10	1	14	14	14	14	14
	7	-88	-26	13	17	22	33	2	-30	-32	-18	23	33	46	46	46	46	46
	8	-20	42	82	86	91	101	70	38	36	50	91	102	115	115	115	115	115
	9	-30	31	71	75	80	90	60	27	25	39	81	91	104	104	104	104	104
	10	-70	-8	31	36	41	51	20	-12	-14	0	41	52	64	64	64	64	64
	11	-108	-47	-7	-3	2	12	-18	-51	-53	-39	3	13	26	26	26	26	26
	12	-123	-62	-22	-18	-13	-3	-33	-66	-68	-54	-12	-2	11	11	11	11	11
	13	-134	-72	-33	-29	-24	-13	-44	-76	-79	-64	-23	-13	0	0	0	0	0
	14	-134	-72	-33	-29	-24	-13	-44	-76	-79	-64	-23	-13	0	0	0	0	0
	15	-134	-72	-33	-29	-24	-13	-44	-76	-79	-64	-23	-13	0	0	0	0	0
	16	-134	-72	-33	-29	-24	-13	-44	-76	-79	-64	-23	-13	0	0	0	0	0
	17	-134	-72	-33	-29	-24	-13	-44	-76	-79	-64	-23	-13	0	0	0	0	0

Table 3.22: SCC region - matrix of EF/RF (tC/ha) for forest and LUC 2005 -2010

		2010																
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
2005	**1**	0	59	102	107	106	121	84	43	95	70	115	124	134	134	134	134	134
	2	-61	-3	40	45	44	59	22	-19	33	8	54	62	72	72	72	72	72
	3	-101	-43	0	5	5	20	-18	-58	-7	-31	14	23	33	33	33	33	33
	4	-105	-47	-4	1	0	15	-22	-63	-11	-36	10	18	29	29	29	29	29
	5	-110	-52	-9	-4	-5	10	-27	-68	-16	-41	5	13	24	24	24	24	24
	6	-120	-62	-19	-14	-15	0	-37	-78	-26	-51	-5	3	13	13	13	13	13
	7	-90	-31	12	17	16	31	-6	-47	5	-20	25	34	44	44	44	44	44
	8	-58	1	44	49	48	63	26	-15	37	12	57	66	76	76	76	76	76
	9	-55	3	46	51	50	65	28	-13	39	14	60	68	79	79	79	79	79
	10	-70	-11	32	37	36	51	14	-27	25	0	45	54	64	64	64	64	64
	11	-111	-52	-9	-4	-5	10	-27	-68	-16	-41	4	13	23	23	23	23	23
	12	-121	-63	-20	-15	-16	-1	-38	-79	-27	-52	-6	2	13	13	13	13	13
	13	-134	-76	-32	-27	-28	-13	-50	-91	-40	-64	-19	-10	0	0	0	0	0
	14	-134	-76	-32	-27	-28	-13	-50	-91	-40	-64	-19	-10	0	0	0	0	0
	15	-134	-76	-32	-27	-28	-13	-50	-91	-40	-64	-19	-10	0	0	0	0	0
	16	-134	-76	-32	-27	-28	-13	-50	-91	-40	-64	-19	-10	0	0	0	0	0
	17	-134	-76	-32	-27	-28	-13	-50	-91	-40	-64	-19	-10	0	0	0	0	0

3.2.3.5. Central Highlands region

Table 3.23: CH region - matrix of EF/RF (tC/ha) for forest and LUC 1995-2000

		2000																
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
	1	3	70	111	103	106	135	96	77	70	110	120	123	145	145	145	145	145
	2	-67	0	41	33	36	65	26	7	0	40	50	53	75	75	75	75	75
	3	-108	-41	0	-8	-5	24	-15	-34	-41	-1	9	12	35	35	35	35	35
	4	-97	-31	11	3	5	35	-4	-23	-30	10	19	23	45	45	45	45	45
	5	-100	-33	8	0	3	32	-7	-26	-33	7	17	20	43	43	43	43	43
	6	-131	-65	-23	-31	-29	1	-38	-57	-64	-24	-15	-11	11	11	11	11	11
	7	-89	-23	19	11	13	43	4	-15	-22	18	27	31	53	53	53	53	53
	8	-58	8	50	42	45	74	35	16	9	49	58	62	84	84	84	84	84
1995	**9**	-55	11	53	45	47	77	38	19	12	52	61	65	87	87	87	87	87
	10	-107	-41	1	-7	-5	25	-14	-33	-40	0	9	13	35	35	35	35	35
	11	-112	-46	-4	-12	-10	20	-19	-38	-45	-5	4	8	30	30	30	30	30
	12	-121	-54	-12	-21	-18	11	-28	-47	-53	-13	-4	-1	22	22	22	22	22
	13	-142	-76	-34	-43	-40	-10	-49	-68	-75	-35	-26	-23	0	0	0	0	0
	14	-142	-76	-34	-43	-40	-10	-49	-68	-75	-35	-26	-23	0	0	0	0	0
	15	-142	-76	-34	-43	-40	-10	-49	-68	-75	-35	-26	-23	0	0	0	0	0
	16	-142	-76	-34	-43	-40	-10	-49	-68	-75	-35	-26	-23	0	0	0	0	0
	17	-142	-76	-34	-43	-40	-10	-49	-68	-75	-35	-26	-23	0	0	0	0	0

Table 3.24: CH region - matrix of EF/RF (tC/ha) for forest and LUC 2000 - 2005

		2005																
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
	1	4	65	106	100	108	132	94	59	57	107	119	121	142	142	142	142	142
	2	-62	-2	39	34	41	65	28	-7	-9	41	53	55	76	76	76	76	76
	3	-104	-44	-2	-8	0	24	-14	-49	-51	-1	11	13	34	34	34	34	34
	4	-96	-35	6	0	8	32	-5	-41	-43	7	19	21	43	43	43	43	43
	5	-99	-38	3	-2	5	29	-8	-43	-45	5	16	19	40	40	40	40	40
	6	-128	-67	-26	-32	-24	0	-38	-73	-75	-25	-13	-11	10	10	10	10	10
	7	-89	-28	13	7	15	39	2	-34	-36	14	26	28	49	49	49	49	49
	8	-70	-9	32	26	34	58	21	-15	-17	33	45	47	68	68	68	68	68
2000	**9**	-63	-3	39	33	41	65	27	-8	-10	40	52	54	75	75	75	75	75
	10	-103	-43	-1	-7	1	25	-13	-48	-50	0	12	14	35	35	35	35	35
	11	-112	-52	-11	-16	-9	15	-22	-57	-59	-9	3	5	26	26	26	26	26
	12	-116	-55	-14	-19	-12	12	-25	-61	-63	-13	-1	1	23	23	23	23	23
	13	-138	-78	-37	-42	-35	-11	-48	-83	-85	-35	-23	-21	0	0	0	0	0
	14	-138	-78	-37	-42	-35	-11	-48	-83	-85	-35	-23	-21	0	0	0	0	0
	15	-138	-78	-37	-42	-35	-11	-48	-83	-85	-35	-23	-21	0	0	0	0	0
	16	-138	-78	-37	-42	-35	-11	-48	-83	-85	-35	-23	-21	0	0	0	0	0
	17	-138	-78	-37	-42	-35	-11	-48	-83	-85	-35	-23	-21	0	0	0	0	0

Table 3.25: CH region - matrix of EF/RF (tC/ha) for forest and LUC 2005 -2010

		2010																
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	1	-3	59	101	95	106	127	88	44	61	103	119	115	138	138	138	138	138
	2	-63	-2	40	35	46	66	27	-17	1	43	59	55	78	78	78	78	78
	3	-105	-43	-1	-7	4	25	-14	-58	-40	1	18	13	37	37	37	37	37
	4	-99	-37	4	-1	10	30	-9	-52	-35	7	23	19	42	42	42	42	42
	5	-107	-45	-3	-9	2	23	-16	-60	-42	-1	16	11	35	35	35	35	35
	6	-131	-69	-27	-33	-22	-1	-40	-84	-66	-25	-8	-13	11	11	11	11	11
	7	-93	-31	10	5	16	36	-3	-47	-29	13	29	25	48	48	48	48	48
	8	-58	4	46	40	51	71	32	-11	6	48	64	60	83	83	83	83	83
2005	9	-56	6	48	42	53	73	34	-9	8	50	66	62	85	85	85	85	85
	10	-106	-44	-2	-8	3	23	-16	-59	-42	0	16	12	35	35	35	35	35
	11	-118	-56	-14	-20	-9	12	-28	-71	-54	-12	4	0	23	23	23	23	23
	12	-120	-58	-17	-22	-11	9	-30	-73	-56	-14	2	-2	21	21	21	21	21
	13	-141	-79	-38	-43	-32	-12	-51	-95	-77	-35	-19	-23	0	0	0	0	0
	14	-141	-79	-38	-43	-32	-12	-51	-95	-77	-35	-19	-23	0	0	0	0	0
	15	-141	-79	-38	-43	-32	-12	-51	-95	-77	-35	-19	-23	0	0	0	0	0
	16	-141	-79	-38	-43	-32	-12	-51	-95	-77	-35	-19	-23	0	0	0	0	0
	17	-141	-79	-38	-43	-32	-12	-51	-95	-77	-35	-19	-23	0	0	0	0	0

3.2.3.6. Southeast and Mekong River Delta region

Table 3.26: SE and MRD region - matrix of EF/RF (tC/ha) for forest and LUC 1995-2000

		2000																
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	1	28	94	141	141	132	164	125	96	96	111	150	156	176	176	176	176	176
	2	-66	0	46	46	38	70	31	1	1	17	55	62	81	81	81	81	81
	3	-115	-49	-2	-2	-11	21	-18	-47	-47	-32	7	13	33	33	33	33	33
	4	-106	-40	6	6	-2	30	-9	-39	-39	-23	15	22	41	41	41	41	41
	5	-125	-58	-12	-12	-21	11	-28	-57	-57	-42	-3	3	23	23	23	23	23
	6	-137	-70	-24	-24	-32	0	-40	-69	-69	-53	-15	-9	11	11	11	11	11
	7	-98	-31	15	15	7	39	-1	-30	-30	-14	24	31	50	50	50	50	50
	8	-61	5	52	52	43	75	36	7	7	22	61	67	87	87	87	87	87
1995	9	-63	4	50	50	42	74	34	5	5	21	59	66	85	85	85	85	85
	10	-83	-17	29	29	21	53	14	-16	-16	0	39	45	64	64	64	64	64
	11	-117	-51	-5	-5	-13	19	-20	-50	-50	-34	4	11	30	30	30	30	30
	12	-138	-72	-25	-25	-34	-2	-41	-70	-70	-55	-16	-10	10	10	10	10	10
	13	-148	-81	-35	-35	-43	-11	-51	-80	-80	-64	-26	-19	0	0	0	0	0
	14	-148	-81	-35	-35	-43	-11	-51	-80	-80	-64	-26	-19	0	0	0	0	0
	15	-148	-81	-35	-35	-43	-11	-51	-80	-80	-64	-26	-19	0	0	0	0	0
	16	-148	-81	-35	-35	-43	-11	-51	-80	-80	-64	-26	-19	0	0	0	0	0
	17	-148	-81	-35	-35	-43	-11	-51	-80	-80	-64	-26	-19	0	0	0	0	0

Table 3.27: SE and MRD region - matrix of EF/RF (tC/ha) for forest and LUC 2000- 2005

		2005																
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
2000	**1**	-55	67	109	108	115	132	69	65	64	83	124	138	148	148	148	148	148
	2	-122	1	43	41	49	66	2	-2	-3	17	58	71	81	81	81	81	81
	3	-168	-46	-3	-5	3	19	-44	-48	-49	-29	12	25	35	35	35	35	35
	4	-168	-46	-3	-5	3	19	-44	-48	-49	-29	12	25	35	35	35	35	35
	5	-160	-37	5	4	11	28	-35	-40	-41	-21	20	33	43	43	43	43	43
	6	-192	-69	-27	-29	-21	-4	-68	-72	-73	-53	-12	1	11	11	11	11	11
	7	-153	-30	12	11	18	35	-28	-32	-33	-14	27	41	51	51	51	51	51
	8	-123	-1	42	40	48	64	1	-3	-4	16	57	70	80	80	80	80	80
	9	-123	-1	42	40	48	64	1	-3	-4	16	57	70	80	80	80	80	80
	10	-139	-16	26	25	32	49	-14	-19	-20	0	41	54	64	64	64	64	64
	11	-177	-55	-12	-14	-6	10	-53	-57	-58	-39	3	16	26	26	26	26	26
	12	-184	-61	-19	-20	-13	4	-59	-63	-65	-45	-4	9	19	19	19	19	19
	13	-203	-81	-38	-40	-32	-16	-79	-83	-84	-64	-23	-10	0	0	0	0	0
	14	-203	-81	-38	-40	-32	-16	-79	-83	-84	-64	-23	-10	0	0	0	0	0
	15	-203	-81	-38	-40	-32	-16	-79	-83	-84	-64	-23	-10	0	0	0	0	0
	16	-203	-81	-38	-40	-32	-16	-79	-83	-84	-64	-23	-10	0	0	0	0	0
	17	-203	-81	-38	-40	-32	-16	-79	-83	-84	-64	-23	-10	0	0	0	0	0

Table 3.28: SE and MRD region - matrix of EF/RF (tC/ha) for forest and LUC 2005 - 2010

		2010																
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
2005	**1**	42	121	169	151	172	187	147	108	137	139	184	188	203	203	203	203	203
	2	-81	-2	46	29	49	64	24	-14	14	16	62	65	81	81	81	81	81
	3	-123	-44	4	-14	7	22	-18	-57	-28	-26	19	23	38	38	38	38	38
	4	-122	-43	6	-12	9	24	-16	-55	-27	-25	21	25	40	40	40	40	40
	5	-129	-50	-2	-20	1	16	-24	-63	-34	-32	13	17	32	32	32	32	32
	6	-146	-67	-18	-36	-15	-1	-40	-79	-51	-49	-3	1	16	16	16	16	16
	7	-83	-4	45	27	48	63	23	-16	12	14	60	64	79	79	79	79	79
	8	-78	1	49	31	52	67	27	-12	16	19	64	68	83	83	83	83	83
	9	-77	2	50	32	53	68	28	-11	17	20	65	69	84	84	84	84	84
	10	-97	-18	30	12	33	48	8	-30	-2	0	45	49	64	64	64	64	64
	11	-138	-59	-11	-29	-8	7	-33	-72	-43	-41	4	8	23	23	23	23	23
	12	-151	-72	-24	-42	-21	-6	-46	-85	-57	-54	-9	-5	10	10	10	10	10
	13	-161	-82	-34	-52	-31	-16	-56	-95	-67	-64	-19	-15	0	0	0	0	0
	14	-161	-82	-34	-52	-31	-16	-56	-95	-67	-64	-19	-15	0	0	0	0	0
	15	-161	-82	-34	-52	-31	-16	-56	-95	-67	-64	-19	-15	0	0	0	0	0
	16	-161	-82	-34	-52	-31	-16	-56	-95	-67	-64	-19	-15	0	0	0	0	0
	17	-161	-82	-34	-52	-31	-16	-56	-95	-67	-64	-19	-15	0	0	0	0	0

3.2.3.7. National

Table 3.29: National - matrix of EF/RF (tC/ha) for forest and LUC 1995 -2000

		2000																
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
1995	**1**	-1	77	119	121	114	138	103	78	72	92	124	131	150	150	150	150	150
	2	-79	-1	41	43	36	60	26	0	-6	15	46	53	73	73	73	73	73
	3	-120	-42	0	2	-5	19	-15	-41	-47	-26	5	12	32	32	32	32	32
	4	-120	-42	0	2	-5	19	-15	-41	-46	-26	5	12	32	32	32	32	32
	5	-111	-33	9	11	4	28	-6	-32	-38	-18	14	21	40	40	40	40	40
	6	-138	-60	-18	-16	-23	1	-33	-58	-64	-44	-12	-6	14	14	14	14	14
	7	-101	-23	18	21	14	38	3	-22	-28	-8	24	31	50	50	50	50	50
	8	-65	13	55	57	50	74	40	14	9	29	61	67	87	87	87	87	87
	9	-67	12	53	55	49	72	38	13	7	27	59	66	85	85	85	85	85
	10	-94	-15	26	28	22	45	11	-14	-20	0	32	39	58	58	58	58	58
	11	-116	-38	4	6	-1	23	-11	-37	-43	-22	9	16	36	36	36	36	36
	12	-132	-53	-12	-10	-16	7	-27	-52	-58	-38	-6	1	20	20	20	20	20
	13	-152	-73	-32	-30	-36	-13	-47	-72	-78	-58	-26	-19	0	0	0	0	0
	14	-152	-73	-32	-30	-36	-13	-47	-72	-78	-58	-26	-19	0	0	0	0	0
	15	-152	-73	-32	-30	-36	-13	-47	-72	-78	-58	-26	-19	0	0	0	0	0
	16	-152	-73	-32	-30	-36	-13	-47	-72	-78	-58	-26	-19	0	0	0	0	0
	17	-152	-73	-32	-30	-36	-13	-47	-72	-78	-58	-26	-19	0	0	0	0	0

Table 3.30: National - matrix of EF/RF (tC/ha) for forest and LUC 2000- 2005

		2005																
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
2000	**1**	6	77	120	126	119	138	108	69	68	94	128	135	152	152	152	152	152
	2	-72	-1	41	47	41	60	30	-10	-11	15	50	57	73	73	73	73	73
	3	-114	-43	0	6	0	18	-11	-51	-52	-26	9	15	32	32	32	32	32
	4	-116	-45	-2	4	-2	16	-13	-53	-54	-28	7	13	30	30	30	30	30
	5	-109	-38	4	10	4	23	-7	-47	-48	-22	13	20	36	36	36	36	36
	6	-133	-62	-19	-14	-20	-1	-31	-70	-71	-45	-11	-4	13	13	13	13	13
	7	-99	-28	15	21	15	34	4	-36	-37	-11	24	30	47	47	47	47	47
	8	-73	-2	40	46	40	59	29	-11	-12	14	49	55	72	72	72	72	72
	9	-68	3	46	52	46	65	35	-5	-6	20	55	61	78	78	78	78	78
	10	-88	-17	26	32	26	45	15	-25	-26	0	35	41	58	58	58	58	58
	11	-120	-49	-6	0	-6	13	-17	-57	-58	-32	3	9	26	26	26	26	26
	12	-126	-55	-13	-7	-13	6	-24	-63	-65	-39	-4	3	19	19	19	19	19
	13	-146	-75	-32	-26	-32	-13	-43	-83	-84	-58	-23	-17	0	0	0	0	0
	14	-146	-75	-32	-26	-32	-13	-43	-83	-84	-58	-23	-17	0	0	0	0	0
	15	-146	-75	-32	-26	-32	-13	-43	-83	-84	-58	-23	-17	0	0	0	0	0
	16	-146	-75	-32	-26	-32	-13	-43	-83	-84	-58	-23	-17	0	0	0	0	0
	17	-146	-75	-32	-26	-32	-13	-43	-83	-84	-58	-23	-17	0	0	0	0	0

Table 3.31: National - matrix of EF/RF (tC/ha) for forest and LUC 2005-2010

		2010																
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
2005	**1**	6	70	114	119	115	131	104	51	79	88	127	130	146	146	146	146	146
	2	-65	-1	43	48	44	60	33	-20	8	17	56	59	75	75	75	75	75
	3	-108	-43	0	6	1	17	-10	-63	-35	-26	13	16	32	32	32	32	32
	4	-114	-49	-6	0	-5	12	-16	-69	-40	-32	7	10	26	26	26	26	26
	5	-108	-43	0	6	1	18	-10	-63	-34	-26	13	16	32	32	32	32	32
	6	-126	-62	-19	-13	-18	-1	-29	-81	-53	-45	-6	-3	13	13	13	13	13
	7	-97	-32	11	17	12	29	1	-52	-23	-15	24	27	43	43	43	43	43
	8	-57	8	51	57	52	68	41	-12	16	25	64	67	83	83	83	83	83
	9	-56	9	52	58	53	70	42	-11	17	26	65	68	84	84	84	84	84
	10	-82	-17	26	32	27	43	16	-37	-9	0	39	42	58	58	58	58	58
	11	-117	-52	-9	-3	-8	9	-19	-72	-43	-35	4	7	23	23	23	23	23
	12	-123	-58	-15	-10	-14	2	-25	-78	-50	-41	-2	1	17	17	17	17	17
	13	-140	-75	-32	-26	-31	-15	-42	-95	-67	-58	-19	-16	0	0	0	0	0
	14	-140	-75	-32	-26	-31	-15	-42	-95	-67	-58	-19	-16	0	0	0	0	0
	15	-140	-75	-32	-26	-31	-15	-42	-95	-67	-58	-19	-16	0	0	0	0	0
	16	-140	-75	-32	-26	-31	-15	-42	-95	-67	-58	-19	-16	0	0	0	0	0
	17	-140	-75	-32	-26	-31	-15	-42	-95	-67	-58	-19	-16	0	0	0	0	0

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