Ministry of Agriculture and Rural Development
VIETNAM

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Annex 4: Activity Data Report

ER Program

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Acronyms and Abbreviations

AD	Activity data
DF	Deforestation
EBF-M	Evergreen Broadleaf Forests, Medium
EBF-P	Evergreen Broadleaf Forests, Poor
EBF-R	Evergreen Broadleaf Forests, Rich
FAO	Food and Agriculture Organization
FD	Forest Degradation
FE	Forest Enhancement
FIPI	Forest Inventory and Planning Institute
FORMIS	Forest Resource Monitoring System
FPCF	Forest Carbon Fund Facility
FPD	Forest Protection Department
FREC	Forest Resources and Environment Centre
RL	Reference Level
FREL	Forest Reference Emission Level
FRL	Forest Reference Level
JICA	Japan International Cooperation Agency
MARD	Ministry of Agriculture and Rural Development
NCC	North Central Coast
NDVI	Normalized difference vegetation index
NFI	National Forest Inventory
NFIMAP	National Forest Inventory, Monitoring and Assessment Program
NFIS	National Forest Inventory and Statistics
REDD+	Reducing Emission from Deforestation, forest Degradation, forest carbon conservation and enhancement and sustainable management of forests
SF	Stable forest
SNF	Stable non-forest

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1 INTRODUCTION

This report presents the development of activity data for construction of reference level for NCC for the period of 2005-2015. The objectives of this work are to: 1) review and upgrade the historical forest cover maps for 2005 and 2010; and 2) generate forest cover map for 2015 and land use change maps and matrices to serve the development of a forest reference level for the North Central Coastal (NCC) region of Vietnam.

To achieve the mentioned objectives, the following tasks were undertaken: 1) Review and update historical forest cover maps for 2005 and 2010; generate forest cover maps for 2015 for each province, aggregate them to regional maps for the NCC; 2) Develop the forest and land use change maps and matrices for the periods 2005-2010 and 2010-2015; and 3) Assess the accuracy of the forest cover map.

2 METHODOLOGY

Historical forest cover maps have been reviewed and improved through a number of technical and financial assistance projects funded by international development partners including Finland, Japan, and UNREDD, and also through a follow up project under MARD. Limitations of the existing maps included that 1) they have not been standardized due to the difference of applied methods; 2) the classification system and coordinate system is different with different formats (hardcopy and softcopies); and 3) they have differences in forest definition, in terms of canopy cover (30% canopy cover was applied before 2004 and 10% after the 2004, this change was according to Forest Protection and Development Law 2004). The process of improving original historical forest cover maps is presented below:

The following maps were used:

- The map in 2005: a digital map of National forest inventory, monitoring and assessment program (NFIMAP) cycle 3 for the period 2001 – 2005; and
- The map in 2010: a digital map of National forest inventory, monitoring and assessment program cycle 4 for the period 2006 – 2010.

Nordeco Project[1]

The main activities of this project were the digitization of the hard copy maps of the NFIS for the period of 1998-2000 and standardizing of digital output map and the mapping of NFIMAP cycles 3 and 4; including: classification system, coordination, and structure of attributes. However, there were some limitations such as the satellite images of 2005 and 2010, which were less used to supplement and update the maps accordingly. The content that needed to be updated included: polygon boundaries, names of forest type and logical forest change over time.

JICA project[2]

This study was aimed at the enhancement of the quality of the maps produced by the Nordeco project, including: Landsat images covering the periods 2005 and 2010 were used for enhancing the quality of the maps by applying visual interpretation methods, including: polygon boundaries, names of forest type and misclassification of forest changes over time. The main limitation of this mapping was that the results were subjective and depended on the knowledge and experience of the interpreters, hence the quality of the enhanced map is uneven.

National FREL/FRL establishment:

[1] Project "Technical Assistance in the Development of the National REDD Programme of Vietnam" funded by Finland

[2] Project "Potential Forests and Land Related to "Climate Change and Forests" in The Socialist Republic of Vietnam

Under the work for the establishment of the national FREL/ FRL continued efforts focused on enhancement of the quality of maps produced by JICA project has continued, including: the result of an “Object based” classification method applied for Landsat images to upgrade the quality of maps produced by the JICA project, including: polygon boundaries, names of forest type and correcting of large areas having misclassification of forest changes over time. Sample plots implemented more or less the same year as the maps have also been used for correcting the name of the forest type of the polygon containing that plot, if the forest type is different. The limitation is that only regional forest maps were produced and no consultation was conducted to produce forest cover maps for each province in North Central Coast (NCC) region.

2.1 Time interval

Vietnam has a long story of national forest inventory, which started in 1990, and this is being implemented in a 5-year cycle. Considering availability of forest data and the consistency with national forest inventory, Vietnam has decided to use end date for RL was December 2015. This will provide for a shorter time interval between the end of the Reference Period and the start of the Performance Period. It also gives Vietnam the flexibility to use the existing forest cover map for 2005 to define the start of the Reference Period. Therefore, the reference period for RL for NCC in ER-P will be 2005 – 2015. This will require the creation of a NCC forest cover map for the year 2015, using methods consistent with both the existing 2005 and 2010 maps, as well as the future MMR system. Concurrently, we will also define the 2010 forest cover map to be the base map, and will adjust boundaries on the 2005 and 2015 maps (where they exist) to correspond to the 2010 map, thereby addressing the issue of independence of maps leading to differencing errors.

The time period to calculate the activity data (AD) serving for emission/removal estimation for the NCC region is determined to be 5 years (2005, 2010 and 2015) and is based on the following criteria:

1) To date, the forest cover maps at the regional level of Vietnam have been standardized, and quality has been upgraded through several projects with set intervals of 5 years (2005 and 2010), which also is the time period of implementation of NFIMAP cycle.

2) The period of 5 years for a cycle is chosen to ensure that monitoring and evaluation of forest changes in Vietnam is in line with the plantation forest cycle where the planted trees are mostly fast growing species with a cycle of 6 - 7 years. Therefore, if the period of time to assess forest changes is longer than the cycle of forest plantation, (e.g. 10 years) that will lead to inaccuracies, as many newly areas that are planted at the beginning of the cycle would have been harvested at the end of the cycle.

3) For the past decades, the forest cover in Vietnam have been rapidly fluctuating as a result of the effects of regeneration and deforestation such as conversion of forest use purposes, shifting cultivation etc. Therefore, the time period of 10 years for evaluating forest changes would not fully reflect the changes of the forest.

4) Previously, the reference level (RL) of North Central Coast (NCC) region has been developed for reference period of 2000 - 2010. This is consistent the requirements of the Methodological Framework (a 10 year period ending no later than 2 years before the first TAP mission). However, it is recognized that in a dynamic landscape such as Vietnam, a more up-to-date Reference Period would be a better basis for planning the FCPF program and for establishing a current Reference Level. As for Vietnam, the first TAP mission was conducted in July 2016; therefore the end-date for RL for NCC should be no later than July 2014.

Consequently, the input forest cover maps for AD calculation serving for the construction of the FREL/FRL were taken from the outcomes of the Project “National forest reference level” as based on the level of enhancement of the quality of forest cover maps described above, including the forest cover maps of 2005, 2010 and 2015.

2.2 Land uses and forest stratification

This work applies to the forest and land use classification system used in the forest cover maps improved by the JICA Project. This classification system is based on Circular No. 34/2009/TT-BNN. The original forest cover maps for the year 2005 produced by the NFIMAP used in the classification system that was based on Decision 84 while the map for the year 2010 used a classification system that is based on Circular No. 34. With the support from the JICA Project, these maps have been harmonized to a classification system that is based on Circular No. 34.

Table 2.1 Forest and land use classification system for national scale

Type	Forest and land use type	Forest/non-forest
1	Evergreen broadleaves forest - rich	Forest
2	Evergreen broadleaves forest - medium	Forest
3	Evergreen broadleaves forest - poor	Forest
4	Evergreen broadleaves forest - regrowth	Forest
6	Bamboo forest	Forest
7	Mixed woody - bamboo	Forest
10	Mangroves forest	Forest
11	Limestone forest	Forest
12	Plantations	Forest
13	Limestone without forest	Non-forest
14	Bared land	Non-forest
15	Water bodies	Non-forest
16	Residence	Non-forest
17	Other land	Non-forest

Based on the result of the average timber stock volume calculation for the forest types in the NCC region in the report on national reference level establishment conducted by Forest Inventory and Planning Institute (FIPI), the forest type numbers 3, 4 and 7 have more or less the same value of stock volume, however, it is quite difficult to distinguish among those classes when using Landsat data for image interpretation. As a result, it is suggested that those types should be combined in to one forest type to reduce uncertainty during the forest and land use mapping/updating. The harmonized classification system in the NCC is shown in Table 2.2.

Table 2.2 Forest and land use classification system for the NCC

Type	Forest and land use type	Forest/non-forest
1	Evergreen broadleaves forest – rich (EBF_R)	Forest
2	Evergreen broadleaves forest – medium (EBF_M)	Forest
3	Evergreen broadleaves forest – poor (EBF_P)	Forest
4	Other Forest	Forest
5	Plantations	Forest
6	Non-forest land	Non-Forest

2.3 Updating Activity Data

2.3.1. Methods

The 2010 forest cover map was used as base map for FCPF activity data, to reference past and future forest cover maps.

The “Object based” approach with the support of eCognition software was applied to classify Landsat images acquired in 2015 into the 6 forest cover classes for the 6 NCC provinces.

Change detection using Landsat images and map overlay methods was applied for registration of 2015 forest cover map boundaries into the 2010 forest cover map, ensuring consistent parcel boundaries over time where such boundaries exist.

Change detection using map overlay methods was applied for registration of 2005 forest cover map boundaries into the 2010 forest cover map, ensuring consistent parcel boundaries over time where such boundaries exist.

Map overlay method was used to develop land use change matrixes showing land use changes patterns for period 2005-2010 and 2010-2015. The AD is then calculated accordingly.

Olofsson's method was applied to assess the accuracy of forest change and accuracy assessment results are used to calculate uncertainty of AD in the period 2005-2010 and 2010-2015.

2.3.1 Data collection and image pre-processing

- Collecting Landsat images closest to three- time spot 2015, 2010 and 2005;
- Collecting other available data sources (such as high resolution satellite images, sample plots and classified key conducted during NFIS implementation process); and
- Collecting relevant data and reports on the forest status and forest changes in the period 2010-2015 in NCC.

2.3.2 Establishment of 2015 forest cover map

Landsat image 2015 classification.

The Landsat images are classified by applying "Object based" approach with the support of eCognition software, including steps as following:

- Creating a training sample set;
- Selecting index used for classification and calculating threshold for each index;
- Running Landsat image classification; and
- Checking and verifying the classified result.

Updating classified result based on the image analysis

- Overlaying classified result with base map layers (roads, rivers, administrative boundaries);
- Based on the overlaid result, adjust polygon boundaries to match known geography; and
- Using high spatial resolution satellite images, sample plots as well as classification keys to improve the quality of classified results of 2015.

Registration of 2015 maps to the boundaries of 2010 maps

The forest cover map 2010 will serve as the base map for 2015 forest cover mapping under FCPF. As a first step, the boundaries on the 2015 forest cover maps will be remained to correspond to the same boundaries on the 2010 map (where such boundaries exist with no change). The boundaries on the 2015 maps will only be adjusted for change areas. This will eliminate the problems arising from mismatching boundaries during the overlay process when mapping the forest change. The steps applied are as follows:

- Detecting forest cover change during the periods of 2010-2015 by overlaying classified Landsat images of 2015 with forest cover maps of 2010;
- The polygon boundary of forest cover map 2015 in the area of no change (or change within small predefined threshold less than 1ha and 0.5ha for plantation forest) will be kept as polygon boundary for forest cover map 2010 correspondingly;
- The polygon boundary and class name on the forest cover map 2015 of the changed area during 2010-2015 correspondingly will be adjusted based on the Landsat image classification/change detection results and reference data; and
- Overlay forest cover maps 2015, 2010 for final check and error correction.

2.3.3 Registration of 2005 maps to the boundaries of 2010 maps

The forest cover map 2010 will serve as the base map for 2005 forest cover mapping under FCPF. As a first step, the boundaries on the 2005 forest cover maps will be remained to correspond to the same boundaries on the 2010 map (where such boundaries exist with no change). The boundaries on the 2005 maps will only be adjusted for change areas. This will eliminate the problems arising from mismatching boundaries during the overlay process when mapping the forest change. The steps applied are as follows:

- Detecting forest cover change during the periods of 2005-2010 by overlaying existing forest cover map of 2005 with forest cover maps of 2010;
- The polygon boundary of forest cover map 2005 in the area of no change (or change within small predefined threshold less than 1ha for natural forest and 0.5ha for plantation forest) will be kept as polygon boundary for forest cover map 2010 correspondingly;
- The polygon boundary and class name on the forest cover map 2015 of the changed area during 2005-2010 correspondingly will be adjusted based on the change detection results and reference data; and
- Overlay forest cover maps 2010, 2005 for final check and error correction.

Appendix 1 shows some examples of how the 2005-2010 polygon boundaries match up, both before and after alignment and Appendix 2 provides summary statistics of maps for land cover.

2.4 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 beginning and ending years and applying the Analysis Tools\ Overlay\ Intersect tool. This process has been applied for period 2005 – 2010 and 2010 - 2015 over six provinces. The provincial forest and land use change maps are then aggregated to generate the NCC forest and land use change maps.

To generate the forest and land use change matrices, calculations of the area for each polygon in the forest and land use change maps was done using ArcGIS. The attributes of the forest and land use change maps were exported to EXCEL file and using the Pivot Table to generate the forest and land use change matrices.

The time series change for each province and for NCC region in the period 2005 – 2010 – 2015 was also calculated by overlaying three forest cover maps for 2005, 2010 and 2015 with the support of ArcGIS. The attributes of the forest and land use change maps were exported to EXCEL file and using the Pivot Table to generate time series change which will be used as Activity Data for constructing FREL/FRL (see Appendix 3-5 for data on forests and land uses; Appendix 6-12 for the time series data for NCC and provinces).

Based on the forest and land use change map, deforestation, forest degradation, forest enhancement and afforestation determined by using the selection tool in ARC/GIS.

Detection of forest degradation: all forest type changes from higher timber stock volume to lower timber stock volume incurred in the inventory cycle (see Table 2.3 for matrix of detecting forest deforestation).

Table 2.3 Forest degradation during a 5 year period

Map year X	Map year X+5	Change-ID
1	2, 3, 4, 5	FD1
2	3, 4, 5	FD2
3	4, 5	FD3
5	4	FD4

Detection of deforestation: All changes from forest to non-forested type incurred in the inventory cycle (see Table 2.4 for matrix of detecting deforestation).

Table 2.4 Deforestation during a 5 year period

Map year X	Map year X+5	Change-ID
1	6	D1
2	6	D2
3	6	D3
4	6	D4
5	6	D5

Detection of forest Enhancement: all forest type changes from lower timber stock volume to higher timber stock volume in the inventory cycle (see Table 2.5 for matrix of detecting forest enhancement).

Table 2.5 Forest enhancement during a 5 year period

Map year X	Map year X+5	Change-ID
2	1	FE1
3	2	FE2
4	3, 5	FE3
5	3	FE4

Detection of afforestation: all changes from non-forested to forests incurred in the inventory cycle (see Table 2.6 for matrix of detecting afforestation).

Table 2.6 Afforestation during period of 5 year

Map year X	Map year X+5	Change-ID
6	3	A1
6	4	A2
6	5	A3

2.5 Accuracy assessment

The accuracy assessment of the forest cover maps for 2005, 2010 and 2015 are made on the basis of existing data at more or less the same year, using the methods of Olofsson 2014, and based on the following:

- Satellite images with high spatial resolution;
- Aerial photographs; and
- Ground truth points: sample plots etc.

However, in the project area, there were no aerial photos available for 2005 and 2010, thus the accuracy assessment cannot be achieved by applying the above aerial photo methods.

The ground truth points system using the sample plots were implemented at various times in 2005 and 2010 (during the NFIMAP cycles 3 and 4) and have been fully utilized in the improvement of the quality of the forest cover maps in the project "National FREL/FRL construction", thus they cannot continue to be used in the assessment of the accuracy of those maps.

Consequently, the accuracy assessment will be conducted using the following steps:

Step 1. Create forest change maps for the period 2005 – 2010 and 2010 - 2015

- By overlaying the forest cover maps in 2 points of time, the forest change map is created with 23 possible changes, seven misclassification (illogical change) and six stable forest and land use types;

- Based on the Tables 2.5, 2.6, 2.7 and 2.8 the forest change maps for two points of time will be revised and combined as a group of change to create the final forest change map with 6 main change categories as follows:

Table 2.3 Combination of forest changes

Code	Category	Description
FD	Forest degradation (FD1, FD2, FD3, FD4)	All forest type changes from higher timber stock volume to lower timber stock volume.
DF	Deforestation (D1, D2, D3, D4, D5)	All changes from forest to non-forested type
FE	Forest Enhancement (FE1, FE2, FE3, FE4)	All forest type changes from lower timber stock volume to higher timber stock volume
AF	Afforestation (A1, A2, A3)	All changes from non-forested to forest type
SF	Stable forest	No change in forest type
SNF	Stable non-forest	No change in non-forest type

The vector maps of the forest change for the period 2005-2010 and 2010-2015 will be rasterized with the pixel size of 30*30m to create the raster maps of forest change for these two periods.

Step 2. Sampling design

- Determine sample size:
  - Calculate the areas of each change category on the final forest change maps;
  - The number of sample points required per change category is determined by three main parameters: 1) the level of precision required of the estimates, 2) the proportion of each mapped category in the map and 3) the expert-estimated, conservative map accuracy of each category.
  - If the total number of sample points of any change category is less than 30, then it will be given as 30 in order to be satisfied minimum sample size for that category. The sample points of other change categories will then be recalculated.
- Allocate sample points for each category of change
  - Based on the total number of determined sample points, the map of sample points will be stratified randomly created for each forest change category by applying ARC/GIS software. Sample points are separated by at least 400 m.

Step 3. Assess every sample point on Landsat images of “year X” and “year X+5”

Landsat images covering NCC region for 2005, 2010 and 2015 will be downloaded from the Webpage: http://earthexplorer.usgs.gov/ . The details are shown in Table 2.8.

Table 2.8 Metadata of Landsat images

Path/Row	Information	2005	2010	2015
125_48	LANDSAT_SCENE_ID	"LT51250482005140BKT00"	"LT51250482010186BKT01"	"LC81250482015232LGN00"
	DATE_ACQUIRED	20/05/2005	05/07/2010	20/08/2015
	CLOUD_COVER	0	0	2.53

Path/Row	Information	2005	2010	2015
125_49	LANDSAT_SCENE_ID	"LT51250492005124BKT01"	"LT51250492010042BKT00"	"LC81250492015024LGN00"
	DATE_ACQUIRED	04/05/2005	11/02/2010	24/01/2015
	CLOUD_COVER =	7	0	0.3
126_47	LANDSAT_SCENE_ID	"LT51260472005195BKT00"	"LT51260472009238BJC00"	"LC81260472015127LGN00"
	DATE_ACQUIRED	14/07/2005	26/08/2009	07/05/2015
	CLOUD_COVER =	1	1,63	4.62
126_48	LANDSAT_SCENE_ID	"LT51260482005275BKT00"	"LT51260482009238BKT00"	"LC81260482015271LGN00"
	DATE_ACQUIRED	02/10/2005	26/08/2009	28/09/2015
	CLOUD_COVER =	7	2	10.56
127_46	LANDSAT_SCENE_ID	"LT51270462004344BKT01"	"LT51270462010040BKT00"	"LC81270462015150LGN00"
	DATE_ACQUIRED	09/12/2004	09/02/2010	30/05/2015
	CLOUD_COVER	1	0	2.31
	LANDSAT_SCENE_ID	"LT51270462005314BJC00"		
	DATE_ACQUIRED	10/11/2005		
	CLOUD_COVER	10		
127_47	LANDSAT_SCENE_ID	"LT51270472005026BKT01"	"LT51270472010056BKT00"	"LC81270472015182LGN00"
	DATE_ACQUIRED	26/01/2005	25/02/2010	01/07/2015
	CLOUD_COVER	8	0	6.77
	LANDSAT_SCENE_ID	"LT51270472005314BKT01"		
	DATE_ACQUIRED	10/11/2005		
	CLOUD_COVER	16		
128_46	LANDSAT_SCENE_ID	"LT51280462005065BKT02"	"LT51280462010111BKT01"	"LC81280462015029LGN00"
	DATE_ACQUIRED	06/03/2005	21/04/2010	29/01/2015
	CLOUD_COVER	8	2	0.2
128_47	LANDSAT_SCENE_ID	"LT51280472005065BKT01"	"LT51280472010303BKT00"	"LC81280472015093LGN00"
	DATE_ACQUIRED	06/03/2005	30/10/2010	03/04/2015
	CLOUD_COVER	0	2	0.08

- Overlay the evaluation sample points on the Landsat images in 2005, 2010 and 2015;
- At each of the evaluation sample points, the forest changes were independently evaluated by three experts in the field of remote sensing and forest change monitoring and assessment by applying visual interpretation method.

Step 4. Summarize the results and create errors matrix.

- The independent evaluated results of three experts will be combined as the consensus reference sample points which will be used to create the errors matrix.

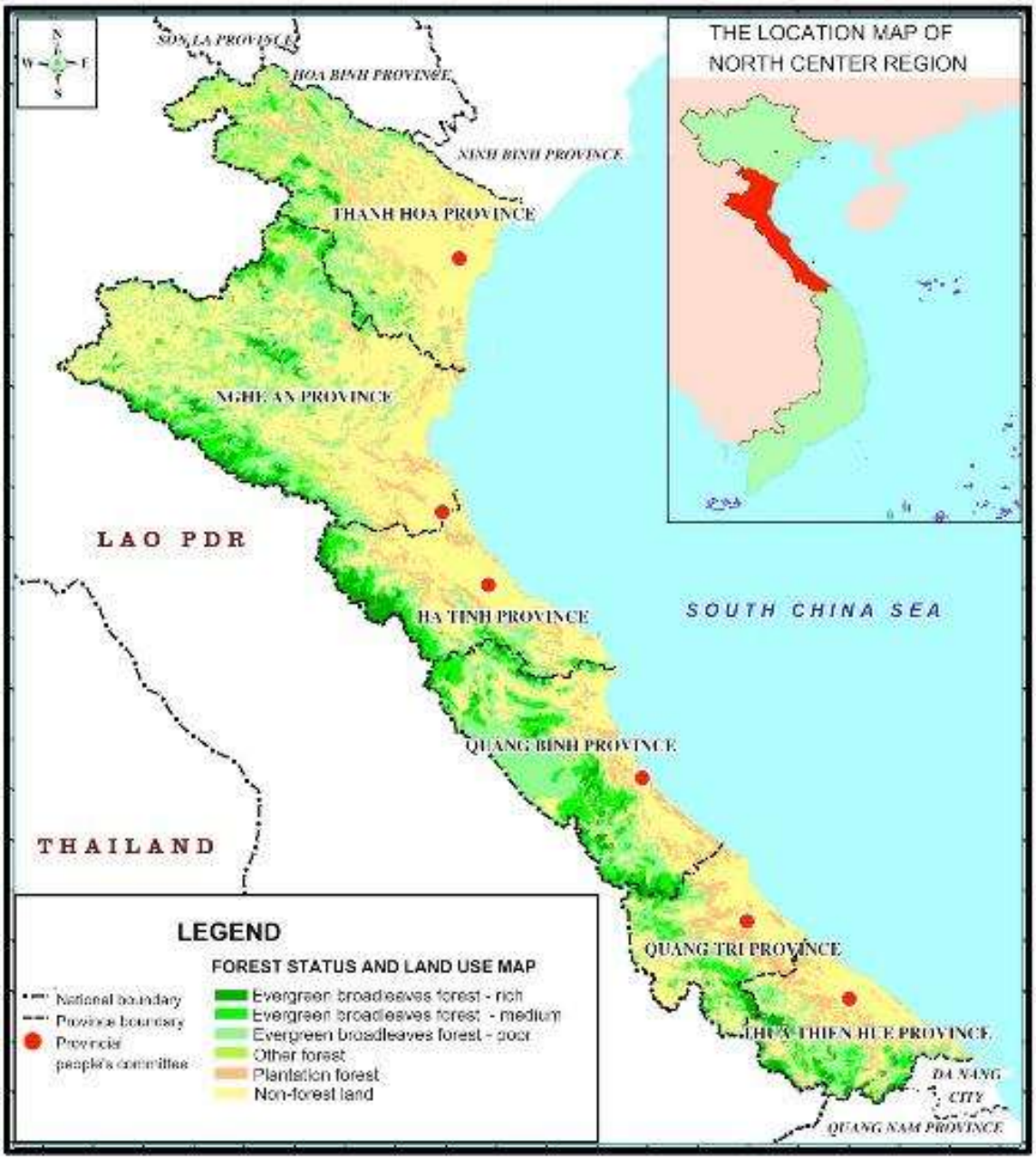
Step 5. Accuracy calculating by applying Olofsson's method[3] This is used to derive statistically adjusted estimates of stratum size, but the current methods do not provide guidance or detail on how to crosswalk these adjusted area estimates back to the original stratification in order to be able to combine with Emission Factors and derive estimates of emissions and removals. This is identified in the ER-PD as a possible area for future stepwise improvements (See ER-PD section 9.4).

3 RESULTS AND DISCUSSION

3.1 Forest cover maps

Forest cover maps are finalized for all provinces and then combined for the NCC region for 2005, 2010 and 2015 are provided in the following figures. Appendix 2 shows summary statistics on numbers of polygon by size for each map.

Figure 3.1: Forest cover map of NCC in 2005



[3] Good practices for estimating area and assessing accuracy of land change

Figure 3.2: Forest cover map of NCC in 2010

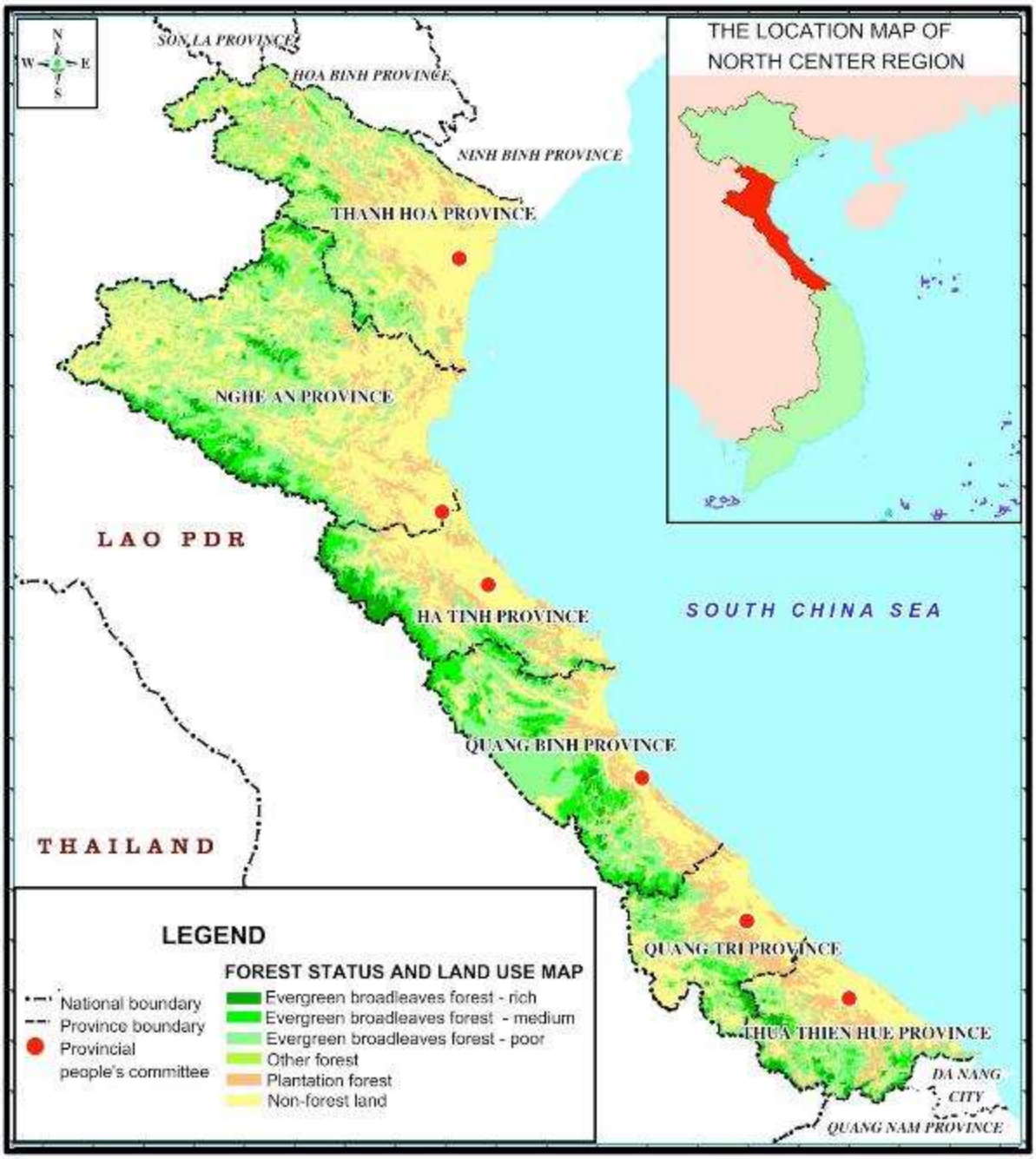
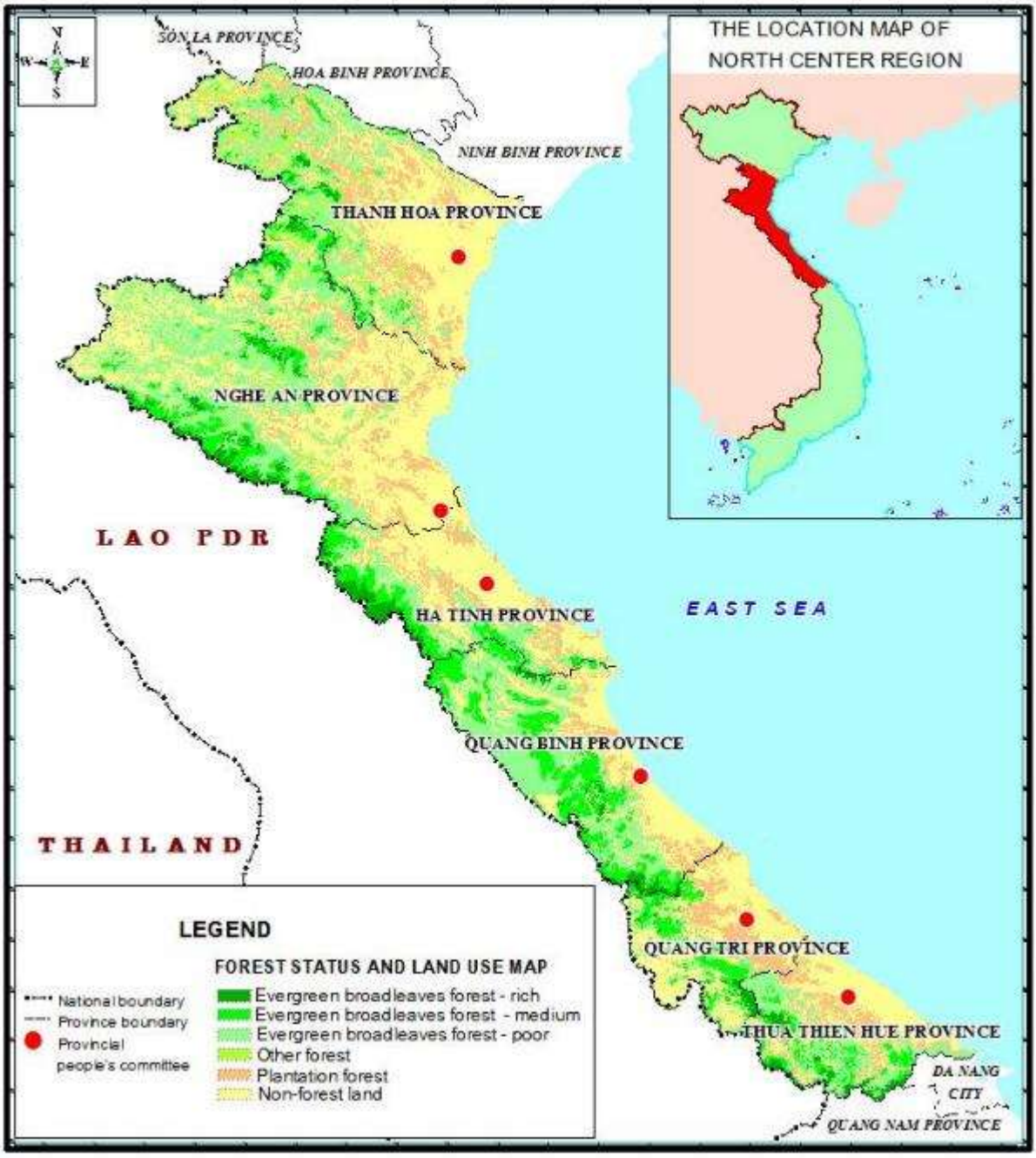


Figure 3.3: Forest cover map of NCC in 2015

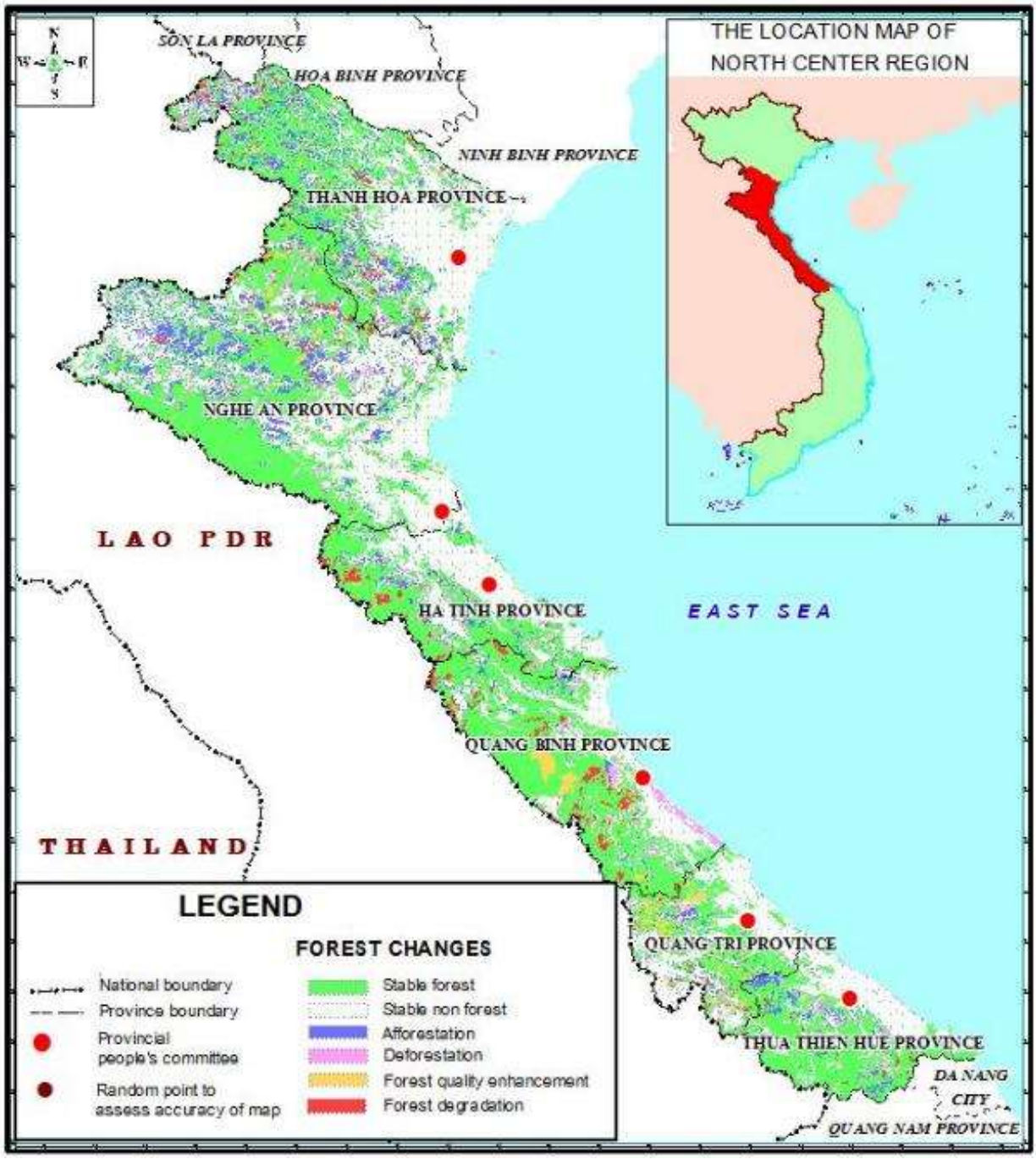


3.2 Forest cover changes maps

Forest cover change maps are prepared for two time periods, 2005-2010 and 2010 – 2015. The forest cover change maps are also prepared for every province and whole region.

Figure 3.4: Forest cover change map of NCC for the period of 2005 – 2010

Figure 3.5: Forest cover change map of NCC for the period of 2010 – 2015



3.3 Forest and land use area

The result of forest and land use area calculation for each point of time is shown in the Table 3.1 as follows:

Table 3.1: Area of forest and land use (ha) in the NCC

No	Land uses	2005	2010	2015
1	***Forest land***	***2,496,632***	***2,771,547***	***2,936,639***
1.1	Evergreen broadleaves forest - rich	240,687	214,449	167,988
1.2	Evergreen broadleaves forest - medium	498,340	465,277	526,394
1.3	Evergreen broadleaves forest - poor	1,153,757	1,315,413	1,339,694
1.4	Other Forest	148,937	138,755	152,936
1.5	Plantations	454,912	637,654	749,627
2	***Non-forest land***	***2,647,888***	***2,372,973***	***2,207,880***
Total		**5,144,520**	**5,144,520**	**5,144,520**

The above results show that the total area of forest land in the NCC region tends to increase in the period of 2005 – 2015 with a total increased area of 440,007 ha, or an average of 44,001 ha per year, equivalent to about 1.8% per year.

Plantation forests have fairly rapid growth rate of 29,472 ha/year, equivalent of 6.6% per year. This result reflects the efforts of the Government of Vietnam through the 661 Program - 5 million hectares of afforestation during this period. Thus, during the process of FRELs/FRLs construction, it is needed to take account of the outputs from the implementation of forestry projects and/or programs before implementing REDD+, which includes the 661 Program. According to the final report on the 661 Program of the government4, this program meets the requirements of "high transparency" of information. Therefore, the construction FRELs/FRLs will include the success rate of 661 Program in forest development activities, contributing to reduction of emissions, and increase in the removal capacity of the forest.

Natural forests tend to increase slightly, only about 0.7% per year. However, each forest type has a different rate of increase (or decrease), of these, only evergreen forest - poor is likely to increase, at more than 1.6%. The forest types that have higher volumes such as evergreen forest - rich tends to decrease, an equivalent of 3.1% per year. Other forests almost have no change. It shows that the forest degradation is still occur quite common in the NCC region in the period 2005 - 2015.

3.4 Land cover changes

Land use change for the period of 2005 – 2010 is extracted from forest cover change maps for this period (see Table 3.2 and Table 3.3). Note that these tables are presented to provide an overview of the magnitude of changes taking place over 5 year intervals, and not for purposes of estimating emissions and removals. Estimation of carbon emissions and removals use the time series data presented in Appendix 6, which reflect the full sequence of change over the 10 year reference period which is used to classify parcels with respect to Activity class.

[4] Executive Summary The project report on "5 million hectares afforestation" and forest planning, protection and development in period 2011-2020

Table 3.2: Land cover change matrix (ha) in the period of 2005 – 2010

2005	2010						Total
	1	2	3	4	5	6	
1	195,486	35,283	8,910	55	430	522	**240,687**
2	18,963	386,972	85,155	903	1,627	4,720	**498,340**
3		43,022	1,025,933	14,209	8,393	62,201	**1,153,757**
4			22,373	102,957	2,807	20,799	**148,937**
5				8	428,254	26,650	**454,912**
6			173,041	20,623	196,144	2,258,080	**2,647,887**
Total	**214,449**	**465,277**	**1,315,413**	**138,755**	**637,654**	**2,372,973**	**5,144,520**

Table 3.3: Forest change (ha) for NCC in the period of 2005 – 2010

Province	Forest degradation	Deforestation	Forest Enhancement	Afforestation
1. Thanh Hoa	22,128	36,994	21,902	72,600
2. Nghe An	41,300	27,051	34,704	116,772
3. Ha Tinh	29,347	8,426	626	53,949
4. Quang Binh	30,801	8,054	13,555	55,159
5. Quang Tri	13,735	16,204	6,048	40,117
6. Thua Thien Hue	17,660	18,163	10,330	51,210
Total region	**154,972**	**114,892**	**87,166**	**389,807**

The above results (Table 3.3) show that, for the period of 2005 – 2010, the total area of degraded forest in the NCC region is 154,972 hectares. In that, Nghe An province is the largest with an area of 41,300 ha, accounting for 26.7%, followed by Quang Binh and Ha Tinh province – approximately 30,800 ha, accounting for 19,9% of the total area of degraded forest in the region. Thanh Hoa, Quang Tri, and Thua Thien Hue provinces have quite a similar area of degraded forest with a total area of 53,524 ha, accounting for 34,5% of the total area of degraded forest in the region.

The total forest area increasing in quality over this period is 87,166 ha. That is lower than the total area of degraded forest in the NCC region. Of which, Nghe An province has largest area of forest enhancement – 34,704 ha, equivalent to 39,8% and Thanh Hoa province is the second with 21,902 ha, accounting for 25,1% of total area of forest enhancement in the regional. Ha Tinh is a province having the lowest forest enhancement area, only 626 ha

The total area of deforestation for the period 2005 - 2010 in the NCC region is 114,892 ha, of which Thanh Hoa province, accounted for over 32.2% of the total deforestation area in the region. Followed by Nghe An, accounting for 23.5%; Quang Tri and Thua Thien Hue provinces have more or less the same area of deforestation, with nearly 15% for each province. Ha Tinh and Quang Binh is almost the same, this area accounts for nearly 7% of the total area in the region.

Among the major changes of forest, the area of afforestation which is increasing in this period is the largest at 389,807 ha, more than 3.5 times compared to the deforestation area. This result reflects the efforts to achieve the success of the afforestation and reforestation regeneration by Government of Vietnam during this period. Among them, Nghe An is the most successful province, with 116,772 ha of new forest cover, accounting for nearly 30%, followed by Thanh Hoa province with 72,600 ha, equivalent to 18.6% of the total afforestation area in the region. The difference in area of afforestation is negligible for the remaining provinces, accounting for 11-15% of total area for each province.

Table 3.4: Land cover change matrix (ha) in the period of 2010 – 2015

2010	2015						Total
	1	2	3	4	5	6	
1	160,925	50,859	1,903	7		756	**214,449**
2	7,063	424,429	30,766	97	47	2,874	**465,277**
3		51,106	1,123,612	9,676	31,649	99,369	**1,315,413**
4			5,732	103,811	9,693	19,520	**138,755**
5			2,691	62	554,093	80,807	**637,654**
6			174,989	39,283	154,145	2,004,555	**2,372,973**
Total	**167,988**	**526,394**	**1,339,694**	**152,936**	**749,627**	**2,207,880**	**5,144,520**

Table 3.5: Forest change (ha) for NCC in the period of 2010 – 2015

Province	Forest degradation	Deforestation	Forest enhancement	Afforestation
1. Thanh Hoa	25,043	27,607	8,981	119,412
2. Nghe An	30,419	70,066	21,490	150,231
3. Ha Tinh	18,926	25,280	3,531	30,884
4. Quang Binh	36,189	40,202	23,032	19,386
5. Quang Tri	5,221	18,413	18,860	17,029
6. Thua Thien Hue	9,268	21,758	392	31,475
Total region	**125,067**	**203,325**	**76,285**	**368,418**

A review of the period 2005 - 2010, shows that the total area deforestation in the NCC region in this period is larger. Meanwhile, the total area of forest enhancement and afforestation are less. This shows that the development of forest at a later period is better than the previous one. This can be explained through the results of the 661 Program. The initial period was from 2000 to 2005, and was then followed by a 5-year end phase of the program, thus, the forests formed and developed in the late phase of the program were better than the previous one.

For forest degradation, in the period 2005 - 2010, Quang Binh province has the largest area, accounting for nearly 28.9%, followed by Nghe An with over 24,2% of total area degraded forest and Thanh Hoa with approximately 20%. The lowest is Quang Tri, accounting for only 4,1% of total area of degraded forest.

The area of deforestation has mostly occurred in Nghe An province, and accounts for approximately 27% of the total area. Followed by Quang Binh accounting for approximately 20% of the total forests lost in this region. The provinces of Thanh Hoa and Ha Tinh are nearly the same, Quang Tri and Thua Thien Hue have an area of relatively uniform deforestation.

During this period, Quang Binh province has the largest area of forest enhancement, accounting for over 30,2% of the total area. Followed by Quang Tri and Nghe An, with over 27%. Thanh Hoa provinces is about 11%; Ha Tinh is 4,6% and Thua Thien Hue have the lowest, only about 392 ha of forest enhancement.

The area of regeneration, restoration of natural forests and new planted forests in Nghe An and Thanh Hoa province occupies the largest proportion in the region, corresponding to 40.8% and 32.4%. Ha Tinh and Thua Thien Hue province are almost the same, represents 8,4% of the total area of afforestation.

4 ACCURACY ASSESSMENT

4.1 Determine sample size

The result of determined sample size is shown in the Tables 4.1 and 4.2.

Table 4.1: Sample size for each forest change category in the period of 2005 – 2010

Change category	**SF**	**SNF**	**AF**	**DF**	**FE**	**FD**	Total
Accuracy of class	0.95	0.95	0.9	0.9	0.85	0.85	
Area in pixels	23,770,978	25,087,270	4,330,757	1,276,455	937,306	1,752,848	57,155,613
Wi (Mapped Proportion)	0.42	0.44	0.08	0.02	0.02	0.03	1.00
Si (Standard Deviation)	0.22	0.22	0.30	0.30	0.36	0.36	
Wi*Si	0.09	0.10	0.02	0.01	0.01	0.01	0.23
SE overall accuracy							**0.01**
Total Number of Samples							**541**

	Sample size per stratum						Total
Equal	90	90	90	90	90	90	541
Proportional	225	237	41	12	9	17	541
Allocation of points	**201**	**213**	**37**	**30**	**30**	**30**	**541**

The final result of the determined sample size for each forest change category in the period of 2005 – 2010 showing that the total sample size is 541 points, where as the sample size for DF, FE and FD categories will be given 30 points because the calculated result for these 3 category is less than 30 points. The sample sizes for SF, SNF and AF are allocated as 201, 213 and 37 respectively.

Table 4.2: Sample size for each forest change category in the period of 2010 – 2015

Change category	**SF**	**SNF**	**AF**	**DF**	**FE**	**FD**	Total
Accuracy of class	0.95	0.95	0.9	0.9	0.85	0.85	
Area in pixels	26,295,928	22,270,606	4,093,119	2,258,943	740,530	1,496,487	57,155,613
Wi (Mapped Proportion)	0.46	0.39	0.07	0.04	0.01	0.03	1.00
Si (Standard Deviation)	0.22	0.22	0.30	0.30	0.36	0.36	
Wi*Si	0.10	0.08	0.02	0.01	0.00	0.01	0.23
SE overall accuracy							**0.01**
Total Number of Samples							**541**

	Sample size per stratum						Total
Equal	90	90	90	90	90	90	541
Proportional	249	211	39	21	7	14	541
Allocation of points	**225**	**191**	**35**	**30**	**30**	**30**	**541**

The final result of the determined sample size for each forest change category in the period of 2005 – 2010 showing that the total sample size is 541 points, where as the sample size for DF, FE and FD categories will be given 30 points because the calculated result for these 3 category is less than 30 points. The sample sizes for SF, SNF and AF are allocated as 225, 191 and 35 correspondently.

Figure 4.1 Reference sample points map of NCC for the period of 2005 – 2010

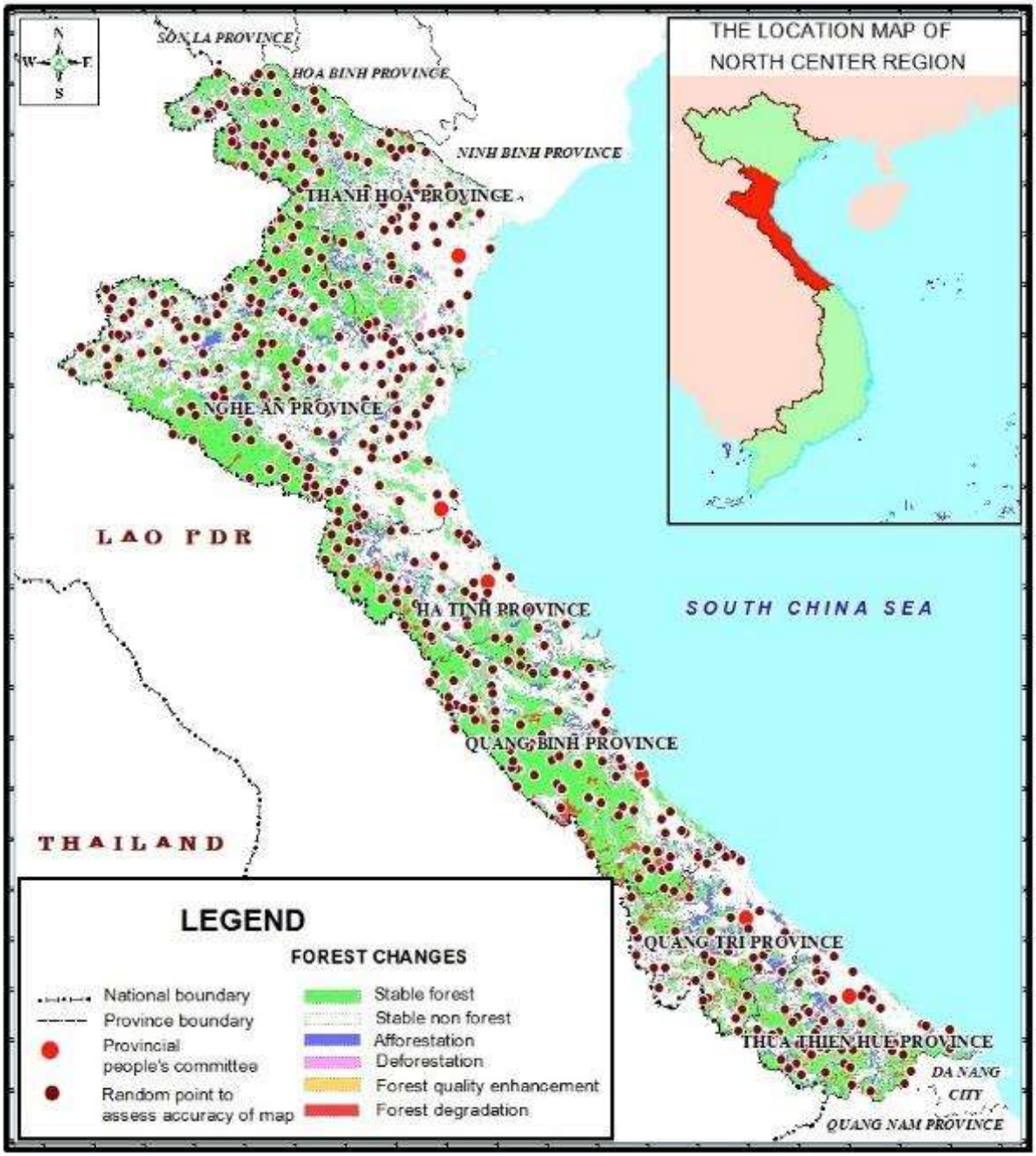
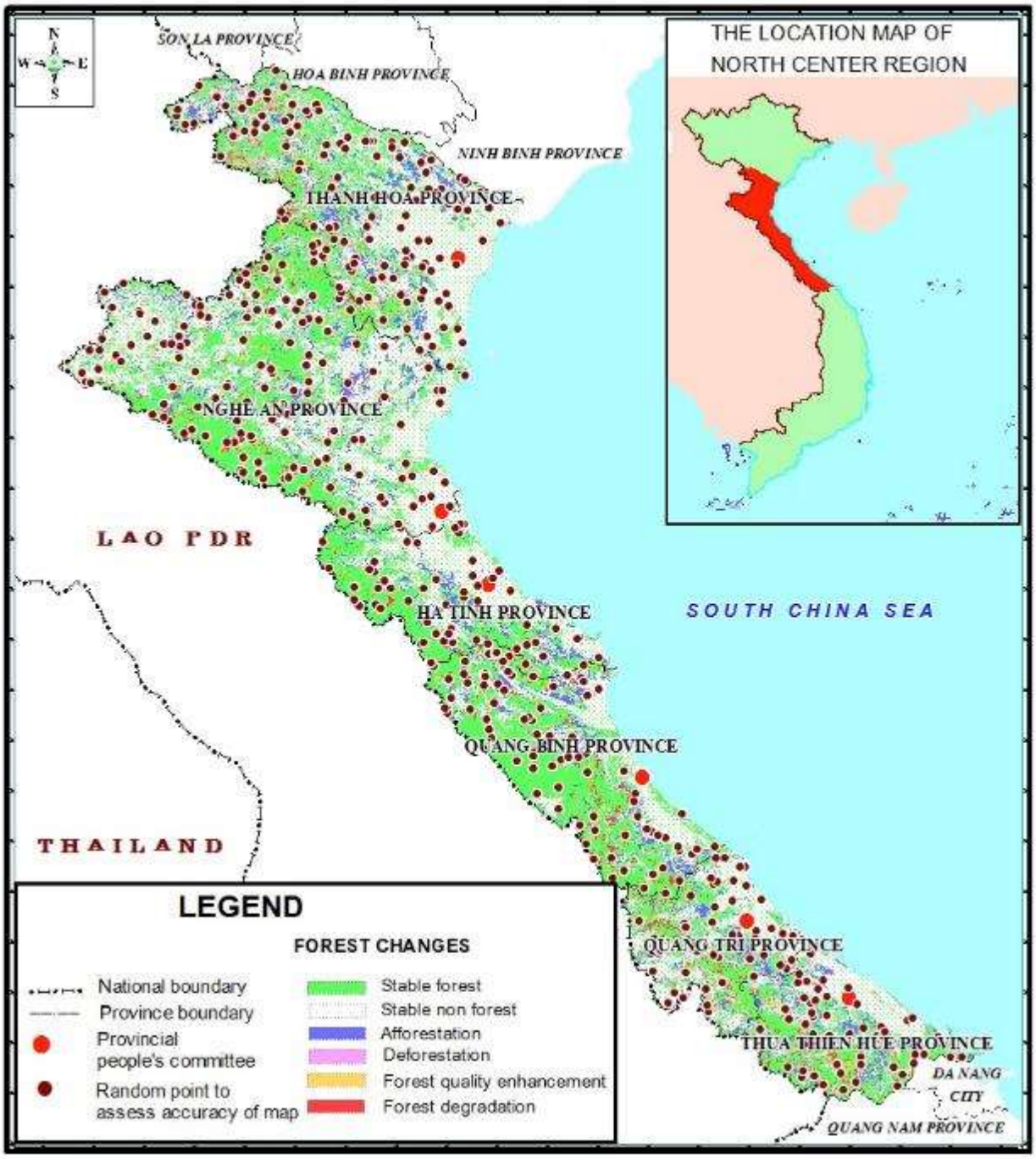


Figure 4.2 Reference sample points map of NCC for the period of 2010 – 2015



4.2 Accuracy assessment results

The assessment using a total sampling size of 1,083 independent points (541 points for each period) for six classified land uses. The errors matrix are presented in table 4.3 and 4.4.

Table 4.3: Errors matrix of forest change in the period of 2005 – 2010

Map Class	Reference Class						Total
	SF	SNF	AF	DF	FE	FD	
SF	193	5		3			201
SNF	9	204					213
AF	1	2	34				37
DF		1		27		2	30
FE				1	29		30
FD	2					28	30
Total	**205**	**212**	**34**	**31**	**29**	**30**	**541**

Table 4.4: Errors matrix of forest change in the period of 2010 – 2015

Map Class	Reference Class						Total
	SF	SNF	AF	DF	FE	FD	
SF	210	10		2	1	2	225
SNF	8	182		1			191
AF			33		1	1	35
DF				29		1	30
FE	2				28		30
FD			1			29	30
Total	220	192	34	32	30	33	**541**

Based on the error matrix, accuracy is calculated and presented in Table 4.5 and 4.6. The results show that the overall accuracy for period of 2005-2015 is 95.4% and is 94.4% for period of 2010 – 2015.

Table 4.5: Accuracy assessment for forest change in the period of 2005 – 2010

Map Class	Reference Class					
	SF	SNF	AF	DF	FE	FD
SF	0.3993	0.0103	0.0000	0.0062	0.0000	0.0000
SNF	0.0185	0.4204	0.0000	0.0000	0.0000	0.0000
AF	0.0020	0.0041	0.0696	0.0000	0.0000	0.0000
DF	0.0000	0.0007	0.0000	0.0201	0.0000	0.0015
FE	0.0000	0.0000	0.0000	0.0005	0.0159	0.0000
FD	0.0020	0.0000	0.0000	0.0000	0.0000	0.0286
Cond Ref Class Proportion	0.4220	0.4356	0.0696	0.0269	0.0159	0.0301
SE	0.0087201	0.0081525	0.0034471	0.0037767	0.0000000	0.0017573
95% CI	0.0174402	0.0163051	0.0068942	0.0075534	0.0000000	0.0035146
Adjusted area est (ha)	2,170,909	2,240,793	358,201	138,150	81,554	154,913
95% CI	89,722	83,882	35,467	38,859	-	18,081
User accuracy	0.960	0.958	0.919	0.900	0.967	0.933
Producer accuracy	0.946	0.965	1.000	0.748	1.000	0.951
Overall accuracy	0.954					

Table 4.6: Accuracy assessment for forest change in the period of 2010 – 2015

Map Class	Reference Class					
	SF	SNF	AF	DF	FE	FD
SF	0.4294	0.0204	0.0000	0.0041	0.0020	0.0041
SNF	0.0163	0.3713	0.0000	0.0020	0.0000	0.0000
AF	0.0000	0.0000	0.0675	0.0000	0.0020	0.0020
DF	0.0000	0.0000	0.0000	0.0382	0.0000	0.0013
FE	0.0009	0.0000	0.0000	0.0000	0.0121	0.0000
FD	0.0000	0.0000	0.0009	0.0000	0.0000	0.0253
Cond Ref Class Proportion	0.4466	0.3917	0.0684	0.0443	0.0162	0.0328
SE	0.0095323	0.0087184	0.0029814	0.0037712	0.0028927	0.0038741
95% CI	0.0190646	0.0174368	0.0059627	0.0075425	0.0057854	0.0077482
Adjusted area est (ha)	2,297,483	2,015,294	351,855	228,082	83,256	168,550
95% CI	98,078	89,704	30,675	38,803	29,763	39,861
User accuracy	0.933	0.953	0.943	0.967	0.933	0.967
Producer accuracy	0.962	0.948	0.987	0.862	0.747	0.773
Overall accuracy	**0.944**					

Estimates of standard error of the area for each kind of Activity Data are assessed. The accuracy assessment produces both estimates of the adjusted (unbiased) area, as well as SE for those estimates. The uncertainties of AD for different AD are summarised in Table 4.7. This uncertainty is combined with the uncertainty of emission factors using the propagation of error approach to derive the overall estimate of total uncertainty for emissions and removals.

Table 4.7: Uncertainties (%) of activity data for 2005-2015

Type of change	2005-2010	2010-2015
1. Deforestation	14.04	8.51
2. Forest degradation	5.84	11.81
3. Reforestation	4.95	4.36
4. Forest enhancement	17.02	17.02

5 CONCLUSIONS AND RECOMMENDATIONS

For this assignment, the input forest cover maps for activity data calculation serving for FREL/FRL construction were taken from the outcomes of the Project “National forest reference level”.

The accuracy assessment was made for the forest change maps in period of 2005-2010 and 2010-2015 by using Landsat images revealed that the overall accuracy is 95.4% and 94.4% respectively or the uncertainties are from 4 – 17%. However, the system of satellite imagery with a higher resolution or aerial photos taken in 2005, 2010 and 2015 is still needed to assess the accuracy of forest change maps through periods in a full and exact way.

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APPENDIX 1: EXAMPLES OF THE EFFECTS OF 2005 BOUNDARY ADJUSTMENT

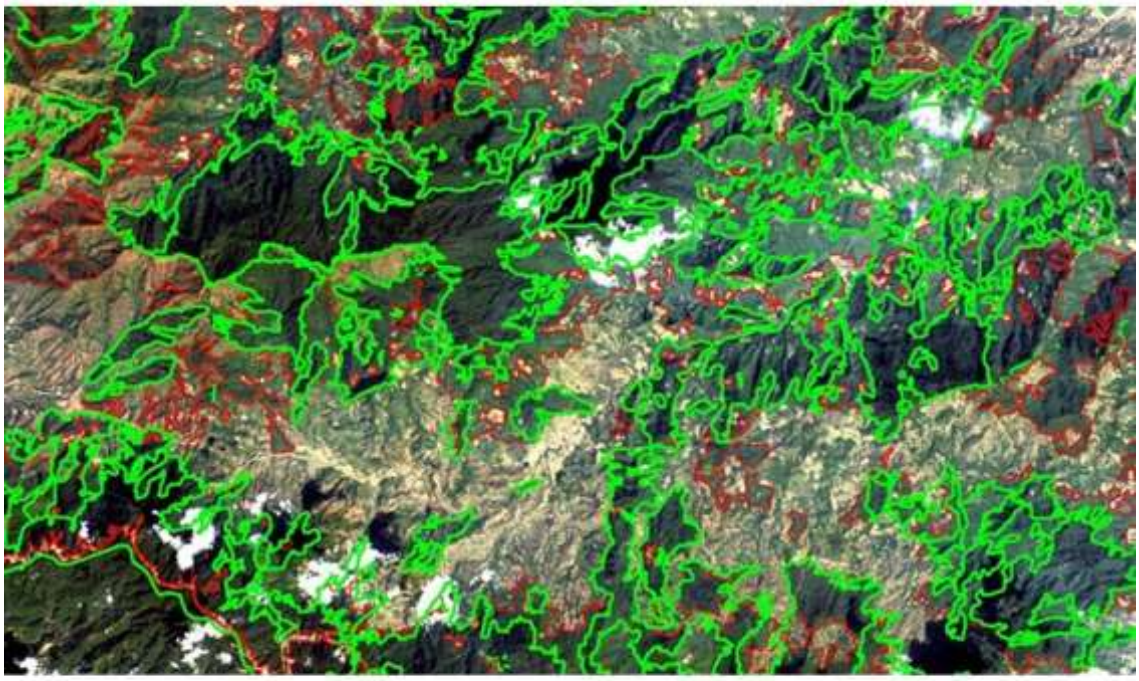
Boundary alignment to create 2005 map

Boundary deliniated based on the changes on Landsat image 2005

Boundary of 2010 map keeping for 2005 map (No change)

Boundary of the old 2005 map

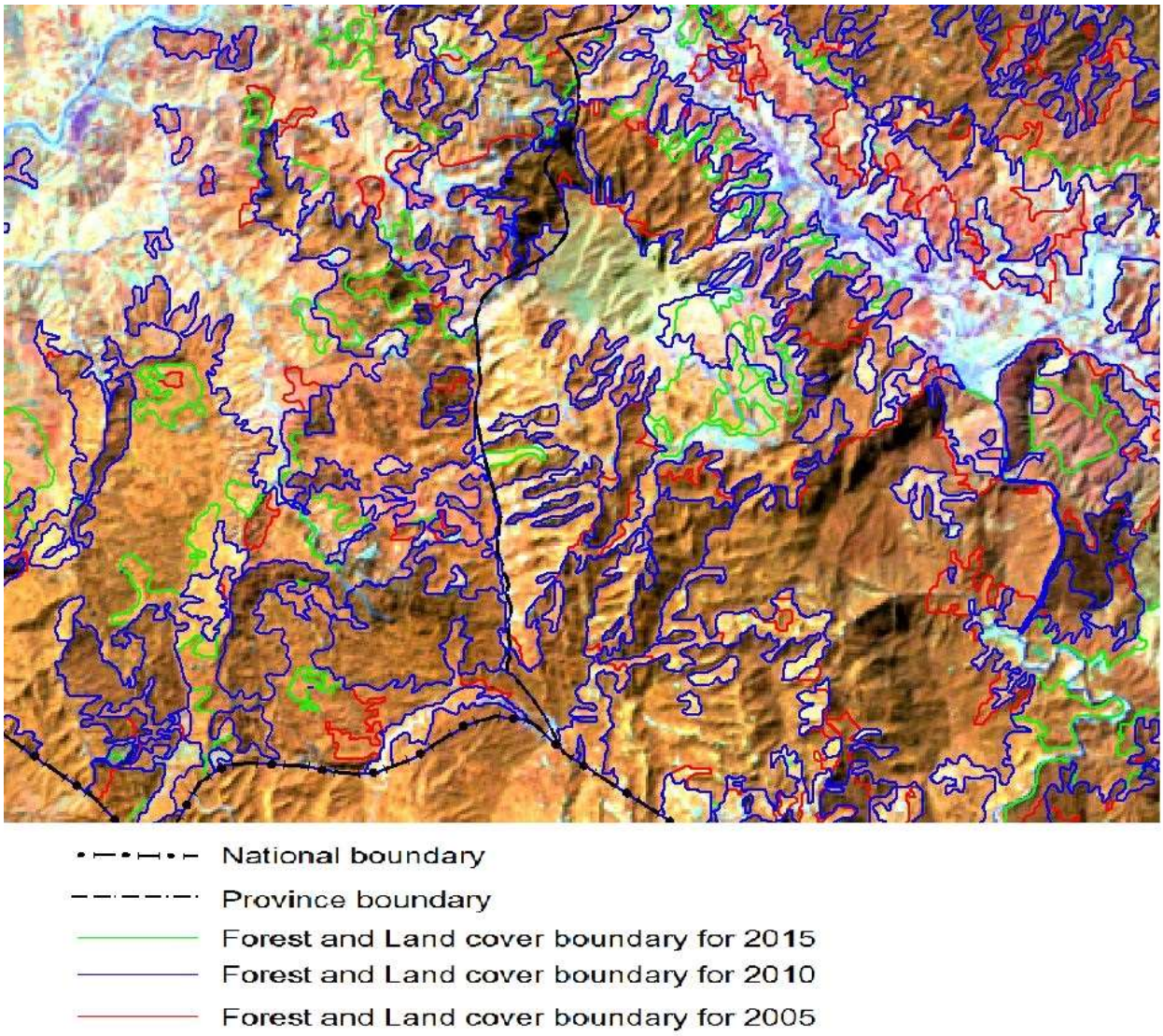
Boundary alignment to create 2015 map



Boundary deliniated based on the changes on Landsat image 2015

Boundary of 2010 map keeping for 2015 map (No change)

Boundary alignment for 2005, 2010 and 2015 forest cover maps.



APPENDIX 2: SUMMARY STATISTICS FOR THE MAPS OF LAND COVER

These summary statistics are presented to give an overview of the distribution of polygon size by cover class for the mapping conducted for 2005, 2010, and 2015.

Table 6.1: Frequency table showing number of polygons by size class for the original 2005 map, adjusted 2005 map, 2010 map and 2015 map

Polygon size	Number of polygons in each map year			
	Unadjusted 2005	Adjusted 2005	2010	2015
< 1 ha	545,808	294	550	868
1 to <10 ha	112,660	8,677	11,096	11,547
10 to <100 ha	23,853	6,632	7,736	8,786
100 to < 1000 ha	5,493	2,250	2,344	2,431
> 1000 ha	648	479	481	499

Table 6.2: Frequency tables of polygon by size class and main change for period 2005 – 2010

ID	Changes	Total number of polygons	No of polygons (1-10ha)	No of polygons (10-100ha)	No of polygons (100-1000ha)	No of polygons (>1000ha)
1	Stable forest	14,204	6,340	5,450	2,031	383
2	Stable non forest	6,727	4,527	1,903	268	29
3	Afforestation	13,444	9,007	3,715	684	38
4	Deforestation	9,829	7,662	2,000	164	3
5	Enhancement	3,785	2,874	759	150	2
6	Degradation	6,138	4,436	1,398	297	7

Table 6.3: Frequency tables of polygon by size class and main change for period 2010 - 2015

ID	Changes	Total number of polygons	No of polygons (1-10ha)	No of polygons (10-100ha)	No of polygons (100-1000ha)	No of polygons (>1000ha)
1	Stable forest	16,036	7,405	6,151	2,064	416
2	Stable non forest	7,308	4,875	2,117	282	34
3	Afforestation	10,112	5,319	4,113	649	31
4	Deforestation	10,163	6,420	3,445	289	9
5	Enhancement	903	456	329	112	6
6	Degradation	3,095	1,823	1,000	258	14

Table 6.4: Frequency tables of polygon by size class and detail change for period 2005 – 2010

ID	2010	2015	Total number of polygons	No of polygons (1-10ha)	No of polygons (10-100ha)	No of polygons (100-1000ha)	No of polygons (>1000ha)
11	EVR_R	EVR_R	314	54	109	111	40
12	EVR_R	EVR_M	711	495	160	53	3
13	EVR_R	EVR_P	625	490	118	17	0
14	EVR_R	Other Forest	13	12	1	0	0
15	EVR_R	Plantation	50	43	6	1	0
16	EVR_R	Non-Forest	98	92	5	1	0
21	EVR_M	EVR_R	609	484	74	51	0
22	EVR_M	EVR_M	1,518	516	636	289	77
23	EVR_M	EVR_P	2,765	1,900	687	174	4
24	EVR_M	Other Forest	116	91	25	0	0
25	EVR_M	Plantation	226	200	22	4	0
26	EVR_M	Non-Forest	954	856	97	1	0
32	EVR_P	EVR_M	2,088	1,581	443	63	1
33	EVR_P	EVR_P	4,963	2,003	1,928	852	180
34	EVR_P	Other Forest	862	609	225	28	0
35	EVR_P	Plantation	625	492	118	15	0
36	EVR_P	Non-Forest	5,799	4,666	1,052	79	2
43	Other Forest	EVR_P	1,087	808	242	36	1
44	Other Forest	Other Forest	1,037	327	468	227	15
45	Other Forest	Plantation	145	104	36	5	0
46	Other Forest	Non-Forest	1,243	842	359	42	0
54	Plantation	Other Forest	1	1	0	0	0
55	Plantation	Plantation	6,372	3,440	2,309	552	71
56	Plantation	Non-Forest	1,735	1,206	487	41	1
63	Non-Forest	EVR_P	6,881	4,875	1,693	295	18
64	Non-Forest	Other Forest	1,418	1,010	372	36	0
65	Non-Forest	Plantation	5,145	3,122	1,650	353	20
66	Non-Forest	Non-Forest	6,727	4,527	1,903	268	29

Table 6.5: Frequency tables of polygon by size class and detail change for period 2010 - 2015

ID	2010	2015	Total number of polygons	No of polygons (1-10ha)	No of polygons (10-100ha)	No of polygons (100-1000ha)	No of polygons (>1000ha)
11	EVR_R	EVR_R	261	40	84	100	37
12	EVR_R	EVR_M	260	106	79	63	12
13	EVR_R	EVR_P	60	33	22	5	0
14	EVR_R	Other Forest	3	3	0	0	0
16	EVR_R	Non-Forest	53	32	19	2	
21	EVR_M	EVR_R	83	32	30	20	0
22	EVR_M	EVR_M	1,455	389	665	329	72
23	EVR_M	EVR_P	617	336	209	71	1
24	EVR_M	Other Forest	6	2	4	0	0
25	EVR_M	Plantation	10	9	1	0	0
26	EVR_M	Non-Forest	301	217	84		
32	EVR_P	EVR_M	474	184	210	75	5
33	EVR_P	EVR_P	5,090	2,050	2,061	773	206
34	EVR_P	Other Forest	400	233	153	13	1
35	EVR_P	Plantation	1,130	656	394	80	0
36	EVR_P	Non-Forest	5,725	3,621	1,941	162	1
43	Other Forest	EVR_P	181	113	57	11	0
44	Other Forest	Other Forest	1,254	378	611	253	12
45	Other Forest	Plantation	609	445	138	26	0
46	Other Forest	Non-Forest	1,147	735	379	33	0
53	Plantation	EVR_P	160	124	30	6	0
54	Plantation	Other Forest	5	3	2	0	0
55	Plantation	Plantation	7,976	4,548	2,730	609	89
56	Plantation	Non-Forest	2,937	1,815	1,022	92	8
63	Non-Forest	EVR_P	4,028	2,114	1,618	279	17
64	Non-Forest	Other Forest	1,097	456	553	88	
65	Non-Forest	Plantation	4,987	2,749	1,942	282	14
66	Non-Forest	Non-Forest	7,308	4,875	2,117	282	34

APPENDIX 3: AREA OF FOREST AND LAND USE (HA) IN 2005 FOR NCC

No	Type	Thanh Hoa	Nghe An	Ha Tinh	Quang Binh	Quang Tri	TT. Hue	Total
1	Forest land	482,190	753,249	270,916	524,575	211,535	254,165	**2,496,631**
1.1	*Natural forest*	372,908	669,351	199,931	464,491	148,505	186,534	**2,041,720**
1.1.1	EVR_R	13,049	66,801	58,972	50,371	15,333	36,159	**240,687**
1.1.2	EVR_M	47,140	129,532	60,451	157,335	56,505	47,376	**498,340**
1.1.3	EVR_P	240,729	397,133	79,611	256,619	76,666	102,998	**1,153,756**
1.1.4	Other forest	71,990	75,884	896	166	0	0	**148,937**
1.2	*Plantation*	109,282	83,899	70,985	60,084	63,031	67,631	**454,912**
2	Non-forest land	630,760	895,749	328,815	280,962	262,447	249,156	**2,647,889**
Total		**1,112,950**	**1,648,998**	**599,731**	**805,537**	**473,982**	**503,321**	**5,144,520**

APPENDIX 4: AREA OF FOREST AND LAND USE (HA) IN 2010 FOR NCC

No	Type	Thanh Hoa	Nghe An	Ha Tinh	Quang Binh	Quang Tri	Thua Thien Hue	Total
1	Forest land	517,797	842,970	316,438	571,681	235,449	287,212	**2,771,547**
1.1	*Natural forest*	379,247	716,837	216,676	481,877	149,030	190,226	**2,133,894**
1.1.1	EVR_R	14,046	66,728	39,660	44,452	16,251	33,313	**214,450**
1.1.2	EVR_M	37,733	116,540	70,901	150,912	46,520	42,670	**465,276**
1.1.3	EVR_P	265,696	457,966	104,901	286,348	86,260	114,242	**1,315,413**
1.1.4	Other forest	61,772	75,603	1,214	166	0	0	**138,755**
1.2	*Plantation*	138,550	126,133	99,762	89,804	86,419	96,986	**637,653**
2	Non-forest land	595,153	806,029	283,293	233,856	238,533	216,110	**2,372,973**
Total		1,112,950	1,648,998	599,731	805,537	473,982	503,321	**5,144,520**

APPENDIX 5: AREA OF FOREST AND LAND USE (HA) IN 2015 FOR NCC

No	Type	Thanh Hoa	Nghe An	Ha Tinh	Quang Binh	Quang Tri	Thua Thien Hue	Total
1	Forest land	609,603	923,135	322,042	550,865	234,065	296,929	**2,936,639**
1.1	*Natural forest*	386,071	741,644	222,977	487,429	139,478	209,414	**2,187,013**
1.1.1	EVR_R	10,641	63,887	24,936	27,283	16,893	24,348	**167,988**
1.1.2	EVR_M	39,849	122,053	86,634	167,678	58,378	51,802	**526,394**
1.1.3	EVR_P	250,622	489,109	110,192	292,301	64,207	133,264	**1,339,694**
1.1.4	Other forest	84,959	66,595	1,216	166	0	0	**152,936**
1.2	*Plantation*	223,532	181,491	99,065	63,436	94,587	87,515	**749,627**
2	Non-forest land	503,347	725,863	277,689	254,672	239,917	206,392	**2,207,880**
Total		**1,112,950**	**1,648,998**	**599,731**	**805,537**	**473,982**	**503,321**	**5,144,520**

APPENDIX 6: TIME SERIES CHANGE MATRIX 2005 – 2010 - 2015 (HA) FOR NCC

2005	2010	2015	Area_ha
EVR_R	EVR_R	EVR_R	147,402
EVR_R	EVR_R	EVR_M	46,044
EVR_R	EVR_R	EVR_P	1,385
EVR_R	EVR_R	Other-forest	1
EVR_R	EVR_R	Non-forest	654
EVR_R	EVR_M	EVR_R	537
EVR_R	EVR_M	EVR_M	33,200
EVR_R	EVR_M	EVR_P	1,247
EVR_R	EVR_M	Plantation	1
EVR_R	EVR_M	Non-forest	297
EVR_R	EVR_P	EVR_M	610
EVR_R	EVR_P	EVR_P	8,230
EVR_R	EVR_P	Plantation	2
EVR_R	EVR_P	Non-forest	69
EVR_R	Other-forest	EVR_P	4
EVR_R	Other-forest	Other-forest	51
EVR_R	Plantation	EVR_P	**57**
EVR_R	Plantation	Plantation	**372**
EVR_R	Plantation	Non-forest	**1**
EVR_R	Non-forest	EVR_P	322
EVR_R	Non-forest	Other-forest	12
EVR_R	Non-forest	Plantation	1
EVR_R	Non-forest	Non-forest	187
EVR_M	EVR_R	EVR_R	13,523
EVR_M	EVR_R	EVR_M	4,815
EVR_M	EVR_R	EVR_P	519
EVR_M	EVR_R	Other-forest	5
EVR_M	EVR_R	Non-forest	101
EVR_M	EVR_M	EVR_R	6,526
EVR_M	EVR_M	EVR_M	352,254
EVR_M	EVR_M	EVR_P	26,075
EVR_M	EVR_M	Other-forest	95
EVR_M	EVR_M	Plantation	10
EVR_M	EVR_M	Non-forest	2,011
EVR_M	EVR_P	EVR_M	9,656
EVR_M	EVR_P	EVR_P	73,339
EVR_M	EVR_P	Other-forest	60

2005	2010	2015	Area_ha
EVR_M	EVR_P	Plantation	109
EVR_M	EVR_P	Non-forest	1,991
EVR_M	Other-forest	EVR_P	51
EVR_M	Other-forest	Other-forest	806
EVR_M	Other-forest	Plantation	1
EVR_M	Other-forest	Non-forest	45
EVR_M	Plantation	EVR_P	**580**
EVR_M	Plantation	Plantation	856
EVR_M	Plantation	Non-forest	191
EVR_M	Non-forest	EVR_P	2,502
EVR_M	Non-forest	Other-forest	183
EVR_M	Non-forest	Plantation	61
EVR_M	Non-forest	Non-forest	1,974
EVR_P	EVR_M	EVR_M	38,975
EVR_P	EVR_M	EVR_P	3,444
EVR_P	EVR_M	Other-forest	2
EVR_P	EVR_M	Plantation	36
EVR_P	EVR_M	Non-forest	565
EVR_P	EVR_P	EVR_M	40,830
EVR_P	EVR_P	EVR_P	892,475
EVR_P	EVR_P	Other-forest	7,295
EVR_P	EVR_P	Plantation	20,411
EVR_P	EVR_P	Non-forest	64,922
EVR_P	Other-forest	EVR_P	221
EVR_P	Other-forest	Other-forest	12,488
EVR_P	Other-forest	Plantation	320
EVR_P	Other-forest	Non-forest	1,180
EVR_P	**Plantation**	EVR_P	**906**
EVR_P	Plantation	Plantation	5,463
EVR_P	Plantation	Non-forest	2,024
EVR_P	Non-forest	EVR_P	22,868
EVR_P	Non-forest	Other-forest	6,241
EVR_P	Non-forest	Plantation	6,089
EVR_P	Non-forest	Non-forest	27,003
Other-forest	EVR_P	EVR_P	18,990
Other-forest	EVR_P	Other-forest	500
Other-forest	EVR_P	Plantation	870
Other-forest	EVR_P	Non-forest	2,014
Other-forest	Other-forest	EVR_P	5,117

2005	2010	2015	Area_ha
Other-forest	Other-forest	Other-forest	76,593
Other-forest	Other-forest	Plantation	6,963
Other-forest	Other-forest	Non-forest	14,284
Other-forest	Plantation	Plantation	2,744
Other-forest	Plantation	Non-forest	64
Other-forest	Non-forest	EVR_P	3,211
Other-forest	Non-forest	Other-forest	6,549
Other-forest	Non-forest	Plantation	4,305
Other-forest	Non-forest	Non-forest	6,734
Plantation	Other-forest	Non-forest	**8**
Plantation	Plantation	EVR_P	**875**
Plantation	Plantation	Other-forest	**62**
Plantation	Plantation	Plantation	378,897
Plantation	Plantation	Non-forest	48,420
Plantation	Non-forest	EVR_P	**473**
Plantation	Non-forest	Other-forest	**70**
Plantation	Non-forest	Plantation	7,342
Plantation	Non-forest	Non-forest	18,764
Non-forest	EVR_P	EVR_M	**11.31**
Non-forest	EVR_P	EVR_P	130,578
Non-forest	EVR_P	Other-forest	1,821
Non-forest	EVR_P	Plantation	10,258
Non-forest	EVR_P	Non-forest	30,373
Non-forest	Other-forest	EVR_P	339
Non-forest	Other-forest	Other-forest	13,872
Non-forest	Other-forest	Plantation	2,409
Non-forest	Other-forest	Non-forest	4,002
Non-forest	Plantation	EVR_P	272.81
Non-forest	Plantation	Plantation	165,763
Non-forest	Plantation	Non-forest	30,108
Non-forest	Non-forest	EVR_P	145,613
Non-forest	Non-forest	Other-forest	26,229
Non-forest	Non-forest	Plantation	136,346
Non-forest	Non-forest	Non-forest	1,949,893
Total area (ha)			**5,144,519**

APPENDIX 7. TIME SERIES CHANGE MATRIX 2005 – 2010 - 2015 (HA) THANH HOA PROVINCE

2005	2010	2015	Area_ha
EVR_R	EVR_R	EVR_R	8,725.9
EVR_R	EVR_R	EVR_M	2,813.9
EVR_R	EVR_R	EVR_P	521.0
EVR_R	EVR_R	Other-forest	1.5
EVR_R	EVR_R	Non-forest	92.4
EVR_R	EVR_M	EVR_R	
EVR_R	EVR_M	EVR_M	577.6
EVR_R	EVR_M	EVR_P	7.7
EVR_R	EVR_M	Plantation	1.2
EVR_R	EVR_M	Non-forest	14.1
EVR_R	EVR_P	EVR_M	
EVR_R	EVR_P	EVR_P	208.0
EVR_R	EVR_P	Plantation	
EVR_R	EVR_P	Non-forest	18.7
EVR_R	Other-forest	EVR_P	
EVR_R	Other-forest	Other-forest	16.6
EVR_R	Plantation	EVR_P	
EVR_R	Plantation	Plantation	
EVR_R	Plantation	Non-forest	
EVR_R	Non-forest	EVR_P	35.3
EVR_R	Non-forest	Other-forest	12.2
EVR_R	Non-forest	Plantation	1.2
EVR_R	Non-forest	Non-forest	2.2
EVR_M	EVR_R	EVR_R	1,847.2
EVR_M	EVR_R	EVR_M	
EVR_M	EVR_R	EVR_P	7.4
EVR_M	EVR_R	Other-forest	
EVR_M	EVR_R	Non-forest	36.8
EVR_M	EVR_M	EVR_R	67.9
EVR_M	EVR_M	EVR_M	30,888.4
EVR_M	EVR_M	EVR_P	636.1
EVR_M	EVR_M	Other-forest	56.8
EVR_M	EVR_M	Plantation	10.3
EVR_M	EVR_M	Non-forest	246.9
EVR_M	EVR_P	EVR_M	
EVR_M	EVR_P	EVR_P	11,356.1

2005	2010	2015	Area_ha
EVR_M	EVR_P	Other-forest	53.5
EVR_M	EVR_P	Plantation	40.1
EVR_M	EVR_P	Non-forest	254.0
EVR_M	Other-forest	EVR_P	32.2
EVR_M	Other-forest	Other-forest	599.8
EVR_M	Other-forest	Plantation	1.2
EVR_M	Other-forest	Non-forest	15.5
EVR_M	Plantation	EVR_P	
EVR_M	Plantation	Plantation	100.0
EVR_M	Plantation	Non-forest	
EVR_M	Non-forest	EVR_P	462.2
EVR_M	Non-forest	Other-forest	180.5
EVR_M	Non-forest	Plantation	59.0
EVR_M	Non-forest	Non-forest	188.2
EVR_P	EVR_M	EVR_M	5,113.5
EVR_P	EVR_M	EVR_P	
EVR_P	EVR_M	Other-forest	1.1
EVR_P	EVR_M	Plantation	30.6
EVR_P	EVR_M	Non-forest	81.0
EVR_P	EVR_P	EVR_M	456.1
EVR_P	EVR_P	EVR_P	184,529.9
EVR_P	EVR_P	Other-forest	5,045.9
EVR_P	EVR_P	Plantation	7,145.3
EVR_P	EVR_P	Non-forest	10,668.5
EVR_P	Other-forest	EVR_P	151.4
EVR_P	Other-forest	Other-forest	7,200.2
EVR_P	Other-forest	Plantation	268.4
EVR_P	Other-forest	Non-forest	736.9
EVR_P	Plantation	EVR_P	
EVR_P	Plantation	Plantation	467.5
EVR_P	Plantation	Non-forest	
EVR_P	Non-forest	EVR_P	3,985.0
EVR_P	Non-forest	Other-forest	5,879.0
EVR_P	Non-forest	Plantation	4,392.5
EVR_P	Non-forest	Non-forest	4,576.1
Other-forest	EVR_P	EVR_P	10,526.0
Other-forest	EVR_P	Other-forest	362.6
Other-forest	EVR_P	Plantation	733.0

2005	2010	2015	Area_ha
Other-forest	EVR_P	Non-forest	1,281.6
Other-forest	Other-forest	EVR_P	2,281.6
Other-forest	Other-forest	Other-forest	30,635.7
Other-forest	Other-forest	Plantation	3,558.2
Other-forest	Other-forest	Non-forest	5,123.0
Other-forest	Plantation	Plantation	1,834.9
Other-forest	Plantation	Non-forest	46.2
Other-forest	Non-forest	EVR_P	2,054.3
Other-forest	Non-forest	Other-forest	6,115.4
Other-forest	Non-forest	Plantation	3,718.3
Other-forest	Non-forest	Non-forest	3,719.5
Plantation	Other-forest	Non-forest	**7.7**
Plantation	Plantation	EVR_P	
Plantation	Plantation	Other-forest	**61.9**
Plantation	Plantation	Plantation	105,035.5
Plantation	Plantation	Non-forest	2,564.4
Plantation	Non-forest	EVR_P	
Plantation	Non-forest	Other-forest	**70.3**
Plantation	Non-forest	Plantation	644.4
Plantation	Non-forest	Non-forest	898.0
Non-forest	EVR_P	EVR_M	
Non-forest	EVR_P	EVR_P	22,376.7
Non-forest	EVR_P	Other-forest	953.8
Non-forest	EVR_P	Plantation	6,559.7
Non-forest	EVR_P	Non-forest	3,126.7
Non-forest	Other-forest	EVR_P	97.8
Non-forest	Other-forest	Other-forest	6,859.8
Non-forest	Other-forest	Plantation	2,065.9
Non-forest	Other-forest	Non-forest	2,120.2
Non-forest	**Plantation**	EVR_P	
Non-forest	Plantation	Plantation	27,267.7
Non-forest	Plantation	Non-forest	1,172.1
Non-forest	Non-forest	EVR_P	11,353.2
Non-forest	Non-forest	Other-forest	20,852.1
Non-forest	Non-forest	Plantation	59,597.5
Non-forest	Non-forest	Non-forest	466,356.4
Total province			**1,112,950.0**

APPENDIX 8: TIME SERIES CHANGE MATRIX 2005 – 2010 - 2015 (HA) NGHE AN PROVINCE

2005	2010	2015	Area_ha
EVR_R	EVR_R	EVR_R	55,409.2
EVR_R	EVR_R	EVR_M	3,257.4
EVR_R	EVR_R	EVR_P	272.7
EVR_R	EVR_R	Other-forest	
EVR_R	EVR_R	Non-forest	428.4
EVR_R	EVR_M	EVR_R	364.7
EVR_R	EVR_M	EVR_M	3,732.5
EVR_R	EVR_M	EVR_P	676.6
EVR_R	EVR_M	Plantation	
EVR_R	EVR_M	Non-forest	69.2
EVR_R	EVR_P	EVR_M	247.8
EVR_R	EVR_P	EVR_P	2,264.8
EVR_R	EVR_P	Plantation	
EVR_R	EVR_P	Non-forest	6.0
EVR_R	Other-forest	EVR_P	3.7
EVR_R	Other-forest	Other-forest	34.8
EVR_R	**Plantation**	EVR_P	
EVR_R	**Plantation**	Plantation	
EVR_R	**Plantation**	Non-forest	
EVR_R	Non-forest	EVR_P	
EVR_R	Non-forest	Other-forest	
EVR_R	Non-forest	Plantation	
EVR_R	Non-forest	Non-forest	33.3
EVR_M	EVR_R	EVR_R	6,476.1
EVR_M	EVR_R	EVR_M	688.3
EVR_M	EVR_R	EVR_P	152.9
EVR_M	EVR_R	Other-forest	5.3
EVR_M	EVR_R	Non-forest	37.6
EVR_M	EVR_M	EVR_R	1,637.3
EVR_M	EVR_M	EVR_M	86,189.3
EVR_M	EVR_M	EVR_P	6,564.1
EVR_M	EVR_M	Other-forest	38.3
EVR_M	EVR_M	Plantation	
EVR_M	EVR_M	Non-forest	321.2
EVR_M	EVR_P	EVR_M	3,431.0

2005	2010	2015	Area_ha
EVR_M	EVR_P	EVR_P	22,739.4
EVR_M	EVR_P	Other-forest	6.6
EVR_M	EVR_P	Plantation	69.2
EVR_M	EVR_P	Non-forest	299.6
EVR_M	Other-forest	EVR_P	19.1
EVR_M	Other-forest	Other-forest	205.9
EVR_M	Other-forest	Plantation	
EVR_M	Other-forest	Non-forest	29.5
EVR_M	Plantation	EVR_P	
EVR_M	Plantation	Plantation	116.1
EVR_M	Plantation	Non-forest	
EVR_M	Non-forest	EVR_P	316.4
EVR_M	Non-forest	Other-forest	2.6
EVR_M	Non-forest	Plantation	1.8
EVR_M	Non-forest	Non-forest	184.9
EVR_P	EVR_M	EVR_M	15,665.3
EVR_P	EVR_M	EVR_P	1,114.7
EVR_P	EVR_M	Other-forest	1.3
EVR_P	EVR_M	Plantation	
EVR_P	EVR_M	Non-forest	166.1
EVR_P	EVR_P	EVR_M	8,841.0
EVR_P	EVR_P	EVR_P	298,558.3
EVR_P	EVR_P	Other-forest	2,249.3
EVR_P	EVR_P	Plantation	12,067.4
EVR_P	EVR_P	Non-forest	30,663.4
EVR_P	Other-forest	EVR_P	69.8
EVR_P	Other-forest	Other-forest	5,288.1
EVR_P	Other-forest	Plantation	51.2
EVR_P	Other-forest	Non-forest	443.3
EVR_P	Plantation	EVR_P	
EVR_P	Plantation	Plantation	1,070.5
EVR_P	Plantation	Non-forest	60.8
EVR_P	Non-forest	EVR_P	9,924.5
EVR_P	Non-forest	Other-forest	361.5
EVR_P	Non-forest	Plantation	1,076.3
EVR_P	Non-forest	Non-forest	9,460.4
Other-forest	EVR_P	EVR_P	8,464.0
Other-forest	EVR_P	Other-forest	137.2

2005	2010	2015	Area_ha
Other-forest	EVR_P	Plantation	136.8
Other-forest	EVR_P	Non-forest	732.2
Other-forest	Other-forest	EVR_P	2,835.1
Other-forest	Other-forest	Other-forest	45,155.8
Other-forest	Other-forest	Plantation	3,404.9
Other-forest	Other-forest	Non-forest	9,155.4
Other-forest	Plantation	Plantation	908.6
Other-forest	Plantation	Non-forest	17.6
Other-forest	Non-forest	EVR_P	1,156.7
Other-forest	Non-forest	Other-forest	425.0
Other-forest	Non-forest	Plantation	537.6
Other-forest	Non-forest	Non-forest	2,817.0
Plantation	Other-forest	Non-forest	
Plantation	Plantation	EVR_P	
Plantation	Plantation	Other-forest	
Plantation	Plantation	Plantation	77,953.6
Plantation	Plantation	Non-forest	5,192.0
Plantation	Non-forest	EVR_P	
Plantation	Non-forest	Other-forest	
Plantation	Non-forest	Plantation	179.0
Plantation	Non-forest	Non-forest	574.3
Non-forest	EVR_P	EVR_M	
Non-forest	EVR_P	EVR_P	50,930.3
Non-forest	EVR_P	Other-forest	867.2
Non-forest	EVR_P	Plantation	2,113.6
Non-forest	EVR_P	Non-forest	13,140.8
Non-forest	Other-forest	EVR_P	241.3
Non-forest	Other-forest	Other-forest	6,459.8
Non-forest	Other-forest	Plantation	342.8
Non-forest	Other-forest	Non-forest	1,862.4
Non-forest	Plantation	EVR_P	
Non-forest	Plantation	Plantation	33,373.3
Non-forest	Plantation	Non-forest	7,440.2
Non-forest	Non-forest	EVR_P	82,804.2
Non-forest	Non-forest	Other-forest	5,356.7
Non-forest	Non-forest	Plantation	48,088.9
Non-forest	Non-forest	Non-forest	642,727.4
Total province			**1,648,998.2**

APPENDIX 9: TIME SERIES CHANGE MATRIX 2005 – 2010 - 2015 (HA) HA TINH PROVINCE

2005	2010	2015	Area_ha
EVR_R	EVR_R	EVR_R	**24,752.0**
EVR_R	EVR_R	EVR_M	**14,466.2**
EVR_R	EVR_R	EVR_P	**2.7**
EVR_R	EVR_R	Other-forest	**0.0**
EVR_R	EVR_R	Non-forest	**19.3**
EVR_R	EVR_M	EVR_R	47.4
EVR_R	EVR_M	EVR_M	18,985.1
EVR_R	EVR_M	EVR_P	318.7
EVR_R	EVR_M	Plantation	0.0
EVR_R	EVR_M	Non-forest	195.2
EVR_R	EVR_P	EVR_M	**24.6**
EVR_R	EVR_P	EVR_P	**140.0**
EVR_R	EVR_P	Plantation	**0.0**
EVR_R	EVR_P	Non-forest	**21.1**
EVR_R	Other-forest	EVR_P	**0.0**
EVR_R	Other-forest	Other-forest	**0.0**
EVR_R	Plantation	EVR_P	**0.0**
EVR_R	Plantation	Plantation	**0.0**
EVR_R	Plantation	Non-forest	**0.0**
EVR_R	Non-forest	EVR_P	**0.0**
EVR_R	Non-forest	Other-forest	**0.0**
EVR_R	Non-forest	Plantation	**0.0**
EVR_R	Non-forest	Non-forest	**0.0**
EVR_M	EVR_R	EVR_R	47.9
EVR_M	EVR_R	EVR_M	363.6
EVR_M	EVR_R	EVR_P	0.0
EVR_M	EVR_R	Other-forest	0.0
EVR_M	EVR_R	Non-forest	8.1
EVR_M	EVR_M	EVR_R	**88.5**
EVR_M	EVR_M	EVR_M	**49,249.4**
EVR_M	EVR_M	EVR_P	**1,406.5**
EVR_M	EVR_M	Other-forest	**0.0**
EVR_M	EVR_M	Plantation	**0.0**
EVR_M	EVR_M	Non-forest	**404.1**
EVR_M	EVR_P	EVR_M	2,081.4

2005	2010	2015	Area_ha
EVR_M	EVR_P	EVR_P	6,409.0
EVR_M	EVR_P	Other-forest	0.0
EVR_M	EVR_P	Plantation	0.0
EVR_M	EVR_P	Non-forest	172.4
EVR_M	Other-forest	EVR_P	0.0
EVR_M	Other-forest	Other-forest	0.0
EVR_M	Other-forest	Plantation	0.0
EVR_M	Other-forest	Non-forest	0.0
EVR_M	Plantation	EVR_P	0.0
EVR_M	Plantation	Plantation	**19.0**
EVR_M	Plantation	Non-forest	**0.0**
EVR_M	Non-forest	EVR_P	193.3
EVR_M	Non-forest	Other-forest	0.0
EVR_M	Non-forest	Plantation	0.0
EVR_M	Non-forest	Non-forest	8.0
EVR_P	EVR_M	EVR_M	**183.5**
EVR_P	EVR_M	EVR_P	**16.0**
EVR_P	EVR_M	Other-forest	**0.0**
EVR_P	EVR_M	Plantation	**0.0**
EVR_P	EVR_M	Non-forest	**6.9**
EVR_P	EVR_P	EVR_M	1,269.8
EVR_P	EVR_P	EVR_P	70,056.3
EVR_P	EVR_P	Other-forest	0.0
EVR_P	EVR_P	Plantation	930.5
EVR_P	EVR_P	Non-forest	4,096.7
EVR_P	Other-forest	EVR_P	0.0
EVR_P	Other-forest	Other-forest	0.0
EVR_P	Other-forest	Plantation	0.0
EVR_P	Other-forest	Non-forest	0.0
EVR_P	Plantation	EVR_P	0.0
EVR_P	Plantation	Plantation	**791.8**
EVR_P	Plantation	Non-forest	**141.0**
EVR_P	Non-forest	EVR_P	1,671.3
EVR_P	Non-forest	Other-forest	0.0
EVR_P	Non-forest	Plantation	101.5
EVR_P	Non-forest	Non-forest	345.8
Other-forest	EVR_P	EVR_P	0.0
Other-forest	EVR_P	Other-forest	0.0

2005	2010	2015	Area_ha
Other-forest	EVR_P	Plantation	0.0
Other-forest	EVR_P	Non-forest	0.0
Other-forest	Other-forest	EVR_P	0.0
Other-forest	Other-forest	Other-forest	**635.1**
Other-forest	Other-forest	Plantation	**0.0**
Other-forest	Other-forest	Non-forest	**6.0**
Other-forest	Plantation	Plantation	**0.0**
Other-forest	Plantation	Non-forest	**0.0**
Other-forest	Non-forest	EVR_P	**0.0**
Other-forest	Non-forest	Other-forest	8.1
Other-forest	Non-forest	Plantation	48.9
Other-forest	Non-forest	Non-forest	198.0
Plantation	**Other-forest**	Non-forest	0.0
Plantation	Plantation	EVR_P	0.0
Plantation	Plantation	Other-forest	0.0
Plantation	Plantation	Plantation	**57,522.3**
Plantation	Plantation	Non-forest	**7,611.2**
Plantation	Non-forest	EVR_P	
Plantation	Non-forest	Other-forest	
Plantation	Non-forest	Plantation	3,445.5
Plantation	Non-forest	Non-forest	2,406.0
Non-forest	EVR_P	EVR_M	**10.0**
Non-forest	EVR_P	EVR_P	**14,474.0**
Non-forest	EVR_P	Other-forest	
Non-forest	EVR_P	Plantation	**1,422.1**
Non-forest	EVR_P	Non-forest	**3,793.1**
Non-forest	Other-forest	EVR_P	
Non-forest	Other-forest	Other-forest	552.9
Non-forest	Other-forest	Plantation	
Non-forest	Other-forest	Non-forest	19.9
Non-forest	Plantation	EVR_P	**9.4**
Non-forest	Plantation	Plantation	**24,882.7**
Non-forest	Plantation	Non-forest	**8,784.6**
Non-forest	Non-forest	EVR_P	15,494.3
Non-forest	Non-forest	Other-forest	19.9
Non-forest	Non-forest	Plantation	9,901.0
Non-forest	Non-forest	Non-forest	249,451.4
Total province			**599,731.0**

APPENDIX 10: TIME SERIES CHANGE MATRIX 2005 – 2010 - 2015 (HA) QUANG BINH PROVINCE

2005	2010	2015	Area_ha
EVR_R	EVR_R	EVR_R	**22,356**
EVR_R	EVR_R	EVR_M	**17,066**
EVR_R	EVR_R	EVR_P	**405**
EVR_R	EVR_R	Other-forest	
EVR_R	EVR_R	Non-forest	**57**
EVR_R	EVR_M	EVR_R	43
EVR_R	EVR_M	EVR_M	5,895
EVR_R	EVR_M	EVR_P	155
EVR_R	EVR_M	Plantation	
EVR_R	EVR_M	Non-forest	15
EVR_R	EVR_P	EVR_M	
EVR_R	EVR_P	EVR_P	**3,923**
EVR_R	EVR_P	Plantation	
EVR_R	EVR_P	Non-forest	**5**
EVR_R	Other-forest	EVR_P	
EVR_R	Other-forest	Other-forest	
EVR_R	Plantation	EVR_P	**57**
EVR_R	Plantation	Plantation	**99**
EVR_R	Plantation	Non-forest	**1**
EVR_R	Non-forest	EVR_P	**219**
EVR_R	Non-forest	Other-forest	
EVR_R	Non-forest	Plantation	
EVR_R	Non-forest	Non-forest	**74**
EVR_M	EVR_R	EVR_R	2,329
EVR_M	EVR_R	EVR_M	1,888
EVR_M	EVR_R	EVR_P	331
EVR_M	EVR_R	Other-forest	
EVR_M	EVR_R	Non-forest	19
EVR_M	EVR_M	EVR_R	**2,554**
EVR_M	EVR_M	EVR_M	**117,874**
EVR_M	EVR_M	EVR_P	**14,557**
EVR_M	EVR_M	Other-forest	
EVR_M	EVR_M	Plantation	
EVR_M	EVR_M	Non-forest	**830**
EVR_M	EVR_P	EVR_M	
EVR_M	EVR_P	EVR_P	13,792

2005	2010	2015	Area_ha
EVR_M	EVR_P	Other-forest	
EVR_M	EVR_P	Plantation	
EVR_M	EVR_P	Non-forest	311
EVR_M	Other-forest	EVR_P	
EVR_M	Other-forest	Other-forest	
EVR_M	Other-forest	Plantation	
EVR_M	Other-forest	Non-forest	
EVR_M	Plantation	EVR_P	580
EVR_M	Plantation	Plantation	**497**
EVR_M	Plantation	Non-forest	**191**
EVR_M	Non-forest	EVR_P	807
EVR_M	Non-forest	Other-forest	
EVR_M	Non-forest	Plantation	
EVR_M	Non-forest	Non-forest	775
EVR_P	EVR_M	EVR_M	**7,202**
EVR_P	EVR_M	EVR_P	**1,546**
EVR_P	EVR_M	Other-forest	
EVR_P	EVR_M	Plantation	**3**
EVR_P	EVR_M	Non-forest	**236**
EVR_P	EVR_P	EVR_M	17,753
EVR_P	EVR_P	EVR_P	214,032
EVR_P	EVR_P	Other-forest	
EVR_P	EVR_P	Plantation	200
EVR_P	EVR_P	Non-forest	6,446
EVR_P	Other-forest	EVR_P	
EVR_P	Other-forest	Other-forest	
EVR_P	Other-forest	Plantation	
EVR_P	Other-forest	Non-forest	
EVR_P	Plantation	EVR_P	906
EVR_P	Plantation	Plantation	**2,511**
EVR_P	Plantation	Non-forest	**1,821**
EVR_P	Non-forest	EVR_P	1,357
EVR_P	Non-forest	Other-forest	
EVR_P	Non-forest	Plantation	62
EVR_P	Non-forest	Non-forest	2,544
Other-forest	EVR_P	EVR_P	
Other-forest	EVR_P	Other-forest	
Other-forest	EVR_P	Plantation	
Other-forest	EVR_P	Non-forest	

2005	2010	2015	Area_ha
Other-forest	Other-forest	EVR_P	
Other-forest	Other-forest	Other-forest	**166**
Other-forest	Other-forest	Plantation	
Other-forest	Other-forest	Non-forest	
Other-forest	Plantation	Plantation	
Other-forest	Plantation	Non-forest	
Other-forest	Non-forest	EVR_P	
Other-forest	Non-forest	Other-forest	
Other-forest	Non-forest	Plantation	
Other-forest	Non-forest	Non-forest	
Plantation	Other-forest	Non-forest	
Plantation	Plantation	EVR_P	875
Plantation	Plantation	Other-forest	
Plantation	Plantation	Plantation	**35,614**
Plantation	Plantation	Non-forest	**21,380**
Plantation	Non-forest	EVR_P	
Plantation	Non-forest	Other-forest	
Plantation	Non-forest	Plantation	
Plantation	Non-forest	Non-forest	2,215
Non-forest	EVR_P	**EVR_M**	
Non-forest	EVR_P	EVR_P	**25,265**
Non-forest	EVR_P	Other-forest	
Non-forest	EVR_P	Plantation	**37**
Non-forest	EVR_P	Non-forest	**4,584**
Non-forest	Other-forest	EVR_P	
Non-forest	Other-forest	Other-forest	
Non-forest	Other-forest	Plantation	
Non-forest	Other-forest	Non-forest	
Non-forest	Plantation	EVR_P	**263**
Non-forest	Plantation	Plantation	**20,703**
Non-forest	Plantation	Non-forest	**4,306**
Non-forest	Non-forest	EVR_P	13,231
Non-forest	Non-forest	Other-forest	
Non-forest	Non-forest	Plantation	3,710
Non-forest	Non-forest	Non-forest	208,861
Total province			**805,537**

APPENDIX 11: TIME SERIES CHANGE MATRIX 2005 – 2010 - 2015 (HA) QUANG TRI PROVINCE

2005	2010	2015	Area_ha
EVR_R	EVR_R	EVR_R	12,023.6
EVR_R	EVR_R	EVR_M	1,060.9
EVR_R	EVR_R	EVR_P	160.7
EVR_R	EVR_R	Other-forest	
EVR_R	EVR_R	Non-forest	41.5
EVR_R	EVR_M	EVR_R	70.9
EVR_R	EVR_M	EVR_M	1,380.6
EVR_R	EVR_M	EVR_P	88.8
EVR_R	EVR_M	Plantation	
EVR_R	EVR_M	Non-forest	
EVR_R	EVR_P	EVR_M	334.8
EVR_R	EVR_P	EVR_P	139.7
EVR_R	EVR_P	Plantation	
EVR_R	EVR_P	Non-forest	12.5
EVR_R	Other-forest	EVR_P	
EVR_R	Other-forest	Other-forest	
EVR_R	Plantation	EVR_P	
EVR_R	Plantation	Plantation	1.2
EVR_R	Plantation	Non-forest	
EVR_R	Non-forest	EVR_P	2.5
EVR_R	Non-forest	Other-forest	
EVR_R	Non-forest	Plantation	
EVR_R	Non-forest	Non-forest	15.8
EVR_M	EVR_R	EVR_R	2,625.9
EVR_M	EVR_R	EVR_M	310.5
EVR_M	EVR_R	EVR_P	27.8
EVR_M	EVR_R	Other-forest	
EVR_M	EVR_R	Non-forest	
EVR_M	EVR_M	EVR_R	2,172.8
EVR_M	EVR_M	EVR_M	36,693.8
EVR_M	EVR_M	EVR_P	2,836.2
EVR_M	EVR_M	Other-forest	
EVR_M	EVR_M	Plantation	
EVR_M	EVR_M	Non-forest	192.2
EVR_M	EVR_P	EVR_M	3,979.8
EVR_M	EVR_P	EVR_P	6,515.4

2005	2010	2015	Area_ha
EVR_M	EVR_P	Other-forest	
EVR_M	EVR_P	Plantation	
EVR_M	EVR_P	Non-forest	616.5
EVR_M	Other-forest	EVR_P	
EVR_M	Other-forest	Other-forest	
EVR_M	Other-forest	Plantation	
EVR_M	Other-forest	Non-forest	
EVR_M	Plantation	EVR_P	
EVR_M	Plantation	Plantation	50.2
EVR_M	Plantation	Non-forest	
EVR_M	Non-forest	EVR_P	283.4
EVR_M	Non-forest	Other-forest	
EVR_M	Non-forest	Plantation	
EVR_M	Non-forest	Non-forest	200.5
EVR_P	EVR_M	EVR_M	2,316.6
EVR_P	EVR_M	EVR_P	702.6
EVR_P	EVR_M	Other-forest	
EVR_P	EVR_M	Plantation	
EVR_P	EVR_M	Non-forest	65.1
EVR_P	EVR_P	EVR_M	12,301.4
EVR_P	EVR_P	EVR_P	42,074.7
EVR_P	EVR_P	Other-forest	
EVR_P	EVR_P	Plantation	33.9
EVR_P	EVR_P	Non-forest	10,587.8
EVR_P	Other-forest	EVR_P	
EVR_P	Other-forest	Other-forest	
EVR_P	Other-forest	Plantation	
EVR_P	Other-forest	Non-forest	
EVR_P	Plantation	EVR_P	
EVR_P	Plantation	Plantation	545.0
EVR_P	Plantation	Non-forest	
EVR_P	Non-forest	EVR_P	1,459.1
EVR_P	Non-forest	Other-forest	
EVR_P	Non-forest	Plantation	319.6
EVR_P	Non-forest	Non-forest	6,260.6
Other-forest	EVR_P	EVR_P	
Other-forest	EVR_P	Other-forest	
Other-forest	EVR_P	Plantation	

2005	2010	2015	Area_ha
Other-forest	EVR_P	Non-forest	
Other-forest	Other-forest	EVR_P	
Other-forest	Other-forest	Other-forest	
Other-forest	Other-forest	Plantation	
Other-forest	Other-forest	Non-forest	
Other-forest	Plantation	Plantation	
Other-forest	Plantation	Non-forest	
Other-forest	Non-forest	EVR_P	
Other-forest	Non-forest	Other-forest	
Other-forest	Non-forest	Plantation	
Other-forest	Non-forest	Non-forest	
Plantation	Other-forest	Non-forest	
Plantation	Plantation	EVR_P	
Plantation	Plantation	Other-forest	
Plantation	Plantation	Plantation	53,814.0
Plantation	Plantation	Non-forest	1,554.5
Plantation	Non-forest	EVR_P	
Plantation	Non-forest	Other-forest	
Plantation	Non-forest	Plantation	2,148.7
Plantation	Non-forest	Non-forest	5,513.6
Non-forest	EVR_P	EVR_M	
Non-forest	EVR_P	EVR_P	5,127.8
Non-forest	EVR_P	Other-forest	
Non-forest	EVR_P	Plantation	
Non-forest	EVR_P	Non-forest	4,535.4
Non-forest	Other-forest	EVR_P	
Non-forest	Other-forest	Other-forest	
Non-forest	Other-forest	Plantation	
Non-forest	Other-forest	Non-forest	
Non-forest	Plantation	EVR_P	
Non-forest	Plantation	Plantation	29,646.2
Non-forest	Plantation	Non-forest	807.9
Non-forest	Non-forest	EVR_P	4,787.9
Non-forest	Non-forest	Other-forest	
Non-forest	Non-forest	Plantation	8,028.2
Non-forest	Non-forest	Non-forest	209,513.1
Total province			**473,982.0**

APPENDIX 12: TIME SERIES CHANGE MATRIX 2005 – 2010 - 2015 (HA) T.T HUE PROVINCE

2005	2010	2015	Area_ha
EVR_R	EVR_R	EVR_R	**24,135**
EVR_R	EVR_R	EVR_M	**7,379**
EVR_R	EVR_R	EVR_P	**23**
EVR_R	EVR_R	Other-forest	
EVR_R	EVR_R	Non-forest	**15**
EVR_R	EVR_M	EVR_R	10
EVR_R	EVR_M	EVR_M	2,630
EVR_R	EVR_M	EVR_P	
EVR_R	EVR_M	Plantation	
EVR_R	EVR_M	Non-forest	4
EVR_R	EVR_P	EVR_M	**2**
EVR_R	EVR_P	EVR_P	**1,554**
EVR_R	EVR_P	Plantation	**2**
EVR_R	EVR_P	Non-forest	**7**
EVR_R	Other-forest	EVR_P	
EVR_R	Other-forest	Other-forest	
EVR_R	Plantation	EVR_P	
EVR_R	Plantation	Plantation	**272**
EVR_R	Plantation	Non-forest	
EVR_R	Non-forest	EVR_P	**65**
EVR_R	Non-forest	Other-forest	
EVR_R	Non-forest	Plantation	
EVR_R	Non-forest	Non-forest	**61**
EVR_M	EVR_R	EVR_R	197
EVR_M	EVR_R	EVR_M	1,564
EVR_M	EVR_R	EVR_P	
EVR_M	EVR_R	Other-forest	
EVR_M	EVR_R	Non-forest	
EVR_M	EVR_M	EVR_R	**5**
EVR_M	EVR_M	EVR_M	**31,359**
EVR_M	EVR_M	EVR_P	**76**
EVR_M	EVR_M	Other-forest	
EVR_M	EVR_M	Plantation	
EVR_M	EVR_M	Non-forest	**17**
EVR_M	EVR_P	EVR_M	163
EVR_M	EVR_P	EVR_P	12,528

2005	2010	2015	Area_ha
EVR_M	EVR_P	Other-forest	
EVR_M	EVR_P	Plantation	
EVR_M	EVR_P	Non-forest	337
EVR_M	Other-forest	EVR_P	
EVR_M	Other-forest	Other-forest	
EVR_M	Other-forest	Plantation	
EVR_M	Other-forest	Non-forest	
EVR_M	Plantation	EVR_P	
EVR_M	Plantation	Plantation	**73**
EVR_M	Plantation	Non-forest	
EVR_M	Non-forest	EVR_P	440
EVR_M	Non-forest	Other-forest	
EVR_M	Non-forest	Plantation	
EVR_M	Non-forest	Non-forest	617
EVR_P	EVR_M	EVR_M	**8,494**
EVR_P	EVR_M	EVR_P	**65**
EVR_P	EVR_M	Other-forest	
EVR_P	EVR_M	Plantation	**2**
EVR_P	EVR_M	Non-forest	**10**
EVR_P	EVR_P	EVR_M	209
EVR_P	EVR_P	EVR_P	83,224
EVR_P	EVR_P	Other-forest	
EVR_P	EVR_P	Plantation	33
EVR_P	EVR_P	Non-forest	2,460
EVR_P	Other-forest	EVR_P	
EVR_P	Other-forest	Other-forest	
EVR_P	Other-forest	Plantation	
EVR_P	Other-forest	Non-forest	
EVR_P	Plantation	EVR_P	
EVR_P	Plantation	Plantation	**77**
EVR_P	Plantation	Non-forest	**1**
EVR_P	Non-forest	EVR_P	4,471
EVR_P	Non-forest	Other-forest	
EVR_P	Non-forest	Plantation	138
EVR_P	Non-forest	Non-forest	3,816
Other-forest	EVR_P	EVR_P	
Other-forest	EVR_P	Other-forest	
Other-forest	EVR_P	Plantation	

2005	2010	2015	Area_ha
Other-forest	EVR_P	Non-forest	
Other-forest	Other-forest	EVR_P	
Other-forest	Other-forest	Other-forest	
Other-forest	Other-forest	Plantation	
Other-forest	Other-forest	Non-forest	
Other-forest	Plantation	Plantation	
Other-forest	Plantation	Non-forest	
Other-forest	Non-forest	EVR_P	
Other-forest	Non-forest	Other-forest	
Other-forest	Non-forest	Plantation	
Other-forest	Non-forest	Non-forest	
Plantation	Other-forest	Non-forest	
Plantation	Plantation	EVR_P	
Plantation	Plantation	Other-forest	
Plantation	Plantation	Plantation	**48,957**
Plantation	Plantation	Non-forest	**10,118**
Plantation	Non-forest	EVR_P	**473**
Plantation	Non-forest	Other-forest	
Plantation	Non-forest	Plantation	925
Plantation	Non-forest	Non-forest	7,157
Non-forest	EVR_P	EVR_M	**1**
Non-forest	EVR_P	EVR_P	**12,404**
Non-forest	EVR_P	Other-forest	
Non-forest	EVR_P	Plantation	**125**
Non-forest	EVR_P	Non-forest	**1,193**
Non-forest	Other-forest	EVR_P	
Non-forest	Other-forest	Other-forest	
Non-forest	Other-forest	Plantation	
Non-forest	Other-forest	Non-forest	
Non-forest	Plantation	EVR_P	
Non-forest	Plantation	Plantation	**29,890**
Non-forest	Plantation	Non-forest	**7,597**
Non-forest	Non-forest	EVR_P	17,942
Non-forest	Non-forest	Other-forest	
Non-forest	Non-forest	Plantation	7,021
Non-forest	Non-forest	Non-forest	172,983
Total province			**503,321**