FOREST INVENTORY AND PLANNING INSTITUTE
FOREST RESOURCES AND ENVIRONMENT CENTER

REPORT

ESTABLISHMENT OF FOREST STATUS MAP IN 2011 AND ANALYSIS OF FOREST CHANGES DURING THE PERIOD FROM 2005 – 2011 IN DI LINH AND LAM HA DISTRICT OF LAM DONG PROVINCE

Ha Noi, September, 2011

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Submission to: **UN-REDD Vietnam programme**
FAO Vietnam

Implementation Agency: **Forest Resources and Environment Center (FREC)**
Forest Inventory and Planning Institute (FIPI)

Collaborative agencies**:**
Department of Agriculture and Rural Development of Lam Dong
District Forest Protection Department of Di Linh and Lam Ha

Geographical coverage: 35 communes of Di Linh and Lam Ha districts of Lam Dong province

Implementation duration: from July to September, 2011

Ha Noi, September, 2011

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ABBREVIATIONS

5MHRP	5 Million hectare of reforestation Program
DARD	Department of Agriculture and Rural Development
DoF	Department of Forestry
FLITCH	Forest Livelihood Improvement for Central Highland
FPD	Forest Protection Department
FREC	Forest Resources and Environment Center
GIS	Geographical Information System
GOV	Government of Vietnam
GPS	Global Positioning System
M & E	Monitoring and Evaluation
MARD	Ministry of Agriculture and Rural Development
MB	Management board
MONRE	Ministry of Natural Resources and Environment
NFI	National Forest Inventory
PC	People committee
PFES	Payment for Forest Environment Services
PPMU	Provincial Project Management Unit
REL	Referent Emission Level
RS	Remote Sensing
SFE	State forest enterprise
UN-REDD	United Nation – Reducing Emission from Deforestation and Forest degradation

1 BACKGROUND

In recent years, the forest management, protection and development have been of particular interest by the Vietnamese government and development partners, as indicated in various investment programs, projects and number of mechanisms and policies have been issued that has enhanced the effectiveness of forest management, protection and development.

The Vietnamese economy and society has undergone tremendous changed. The impact of rapid development of economic and social has directly and indirectly impacted forest area and quality in both directions, positive and negative. To maintain the sustainable development of forest resources, monitoring associated with assessment activities directly and indirectly impacting the forest resources plays a very important role.

Located in a key forest region of Vietnam, Lam Dong province has total area of 976,220 ha; including forest land area is 643,330 ha, accounting for the forest coverage of 61.5%. This is the highest forest coverage rate among provinces in Vietnam. However, the forestry sector of Lam Dong is still facing many difficulties in the limited management and production. One of the main constraints is that the area, timber volume and quality of forests cannot be exactly determined. Consequently, this problem will lead to difficulties in planning, protection and development planning of forests, forests land; forest land allocation and leasing; valuation of forest value, payment of forest environmental services especially implementing the REDD+ to reduce greenhouse gas emissions or enhancing carbon stocks in forests.

Earlier, a contract was signed between FREC and UN-REDD Viet Nam programme on the establishment of historical forest status maps and analysis of forest changes of Di Linh and Lam Ha district of Lam Dong province in the period 1990, 1995, 2000 and 2005. Its main outputs were:

Maps:

- Digital detailed forest status maps in 1990, 1995, 2000 and 2005 of all communes of Di Linh and Lam Ha Districts at scale of 1/10,000 in digital and printed versions;
- Synthesized forest status maps in 1990, 1995, 2000 and 2005 two districts at scale of 1/25,000

Data:

- The areas data on forest status and land use established for each commune in Lam Ha and Di Linh districts.
- Forest changes matrix for each commune and district over the periods.

Report:

- A report on establishment of land-use maps and analysis of land-uses changes (also in three sub-periods: 1990-1995, 1996-2000 and 2001-2005) in two districts;

However, as the historical forest maps and assessment for changes in forests was only up to the year 2005, and was still lacking updated data, establishment of a forest status map for 2011 was considered essential to update the analysis on forest changes. This report is based on a second contract between FREC and the UN-REDD Viet Nam Programme for

producing this updated forest status map and updated analysis of forest changes. The results of the generated database will be used as a basis for integrating REDD + in to forest protection and development plan as well as a basis for determining the forest area and quality of each stakeholder/forest manager.

The study area covers the two districts of Di Linh and Lam Ha and its 35 communes and towns.

2 OBJECTIVES AND CONTENTS

2.1 Objectives

The main objectives of this assignment are:

- To create high quality forest status maps for 2011 of two districts (Lam Ha and Di Linh) in Lam Dong province;
- To complete the analysis on trends of and major driving forces behind deforestation and forest degradation for the period from 1990 - 2011;
- To identify areas critical for the implementation of REDD+ and mainstreaming REDD+ implementation into district level land-use planning in two above-mentioned districts.

2.2 Contents

2.2.1 Relevant data collection

2.2.2 Establishing forest status map for Di Linh and Lam Ha districts

- Image classification
- Field work for adjusting indoor interpreted forest status map
- Finalize forest status map based on the field check results
- Area calculation

2.2.3 Assessing the forest change under the impact of socio-economic factors

- Forest status maps overlaying
- Socio-economic data collection
- Field survey and interviewing
- Changes matrix establishment
- Forest changes analysis

2.2.4 Report writing

2.2.5 Transfer and bring the results in to use

3 IMPLEMENTATION SOLUTIONS

3.1 Relevant data collection

3.1.1 Collection of existing forest status maps and data

Maps:

- Basic cadastral maps in VN2000 projection at commune and district level.
- Land use planning maps at commune level at the scale of 1:10,000.
- Forest status maps in the year 2005 at commune level, scale 1:10,000.
- Maps of Forest land allocation forest management and protection contractor.
- Maps of three forest functions reviewing.
- SPOT5 images acquired in 2011 with the spatial resolution of 2.5m x 2.5m.

Documents:

- Report on the results of forest inventory in the last several years.
- Report on the forest change monitoring and assessment.
- Document related to the forest land allocation, forest management and protection contractor.

3.1.2 SPOT5 images collection and pre-processing

False colour image of SPOT5 with resolution 2.5 m, including 6 scenes has been Ortho-rectified on the basis digital elevation model. All images are provided by the UN-REDD Programme (FAO) as follows:

Table 01: SPOT5 images

No	Scene ID	Parth/row	Date
1	487398	279/326	25/04/2010
2	487399	277/326	10/03/2009
3	487400	277/326	10/03/2009
4	487401	278/326	30/03/2009
5	487402	277/326	10/03/2009
6	487403	277/326	10/03/2009

3.1.3 Requirement equipments

- ERDAS IMAGINE 9.2 software using for SPOT5 images pre-processing;
- Map/Info 10.5 using for visual interpretation, updating, editing and managing the status forest maps;
- ARC/GIS software using for maps overlaying and area calculation;
- Garfile using for data transferring from GPS in to Computer ;
- Other equipments using for field verifying such as: GPS, compass, digital camera, binocular and field data sheet…

3.2 Forest status mapping

3.2.1 Forest and land-use classification

Forest and land-use classification in the 2 districts (Di Linh and Lam Ha) was developed in accordance with the existing classification systems stated in the circular No 34/2009/TT-BNNPTNT dated 10/6/2009 issued by MARD and decision No 23/2007/QD-BTNMT dated on 17/12/ 2007 issued by MONRE

3.2.2 Establishing image Interpretation keys

Following image interpretation method, all the status is separated on the basis of certain characteristics of typical targets (photo key sample) for that status. As such, the establishment of photo key samples must be based on the representativeness of land use types and features of the above enhanced colour – composited image. Indoor photo key samples must be made for each forest status.

Photo key sample development shall follow 3 steps as:

Step 1: Development of in-door photo key sample.

This step is developed mainly on the basis of forest status classification, land use system and typical characteristic of SPOT 5 satellite image. Nevertheless, each status shall not have entirely similar reflection on image due to implications of reflection quality at various topographical conditions, which is obviously manifested via direction of exposure. In fact, each forest status shall be defined by a spectrum, therefore, for each forest status; it is required to develop various samples, which distribute according to exposition, type of terrain, different ecological conditions, including the following steps:

Sample selection on image: The selected samples should strongly represent that forest status. Area for sample selection should ensure minimum area of $1cm^2$ on SPOT5 image of proportion 1:10,000.

Mark on image map; define central coordinates of the selected photo key samples for further identification on site via GPS.

In accordance with image development table, describe in details typical characteristics on image such as colour, structure, shape as well as other aerial photo as: ecological features, distribution, relation with natural and social factors.

Design checklist/table for recording site survey results of each photo key sample.

Step 2: Site survey

This step aims to carry out site survey, verify and supplement site description for the indoor developed photo key samples so as to develop the most typical photo key sample system for different forest status that need to be separated.

Design survey transect: on the basis of the in-door selected image sample, cooperate with local authority and people to define survey transect that could allow accessibility to selected samples as many as possible.

Use GPS that already recorded the central coordinates of indoor developed samples to identify precise direction and location of image sample center. However, in reality, not all the indoor selected samples could be checked on the site due to inaccessibility (too stiff and high topographical terrain).

Employ Biteclic, Bumley, Sunnto measurement and diameter measurement to quickly define forest resources quantification factors as: average volume, section, diameter, height, and forest cover so as to accurately define respective forest status.

Take photo of the observed area, record information of photos taken on site, including: status title, exposition, distance, time of taking photo, etc.

Record site observation and verification results according to the developed forms/tables.

Step 3: Completion of photo key sample.

Calculate average factor of sample plots for photo key samples (see details under items on processing and calculation of sample plot data).

Combine with the developed results, describe indoor photo key samples, site verification and supplementary results as well as sample plot calculation data to fill information in the description form applicable to 1 photo key sample to complete photo key sample set.

Reach common consensus on the photo key sample system among image interpreters.

Number of the developed photo key samples should ensure: for each forest status, there must be at least 3 samples that represent different ecological, topographical and regional conditions.

3.2.3 Image interpretation and indoor forest status mapping

After being processed, quality enhanced and geometric corrected, SPOT5 shall be interpreted for mapping of different forest and land status. Image interpretation method applicable to SPOT5 is eye observation. The observation results shall be directly drawn on computer by using MAP/INFO software and basis of the above developed photo key samples. Minimum area of a plot drawn on image is 0.25ha. During interpretation process, any suspicious or unnamed areas shall be marked for further verification during site survey. Indoor image interpretation procedures are as follows:

Demonstrate satellite image on computer via Map/Info software. It is important to enhance image contrast, darkness and light in order to improve separation possibility among various types of forest, land status.

Demonstrate information layers as river, stream, road system; other land plots as well as block, compartment boundary system so as to allow maximum use of aerial typical characteristics while interpreting image.

Interpret; demarcate main targets as forested area, non-forested area, agricultural and other land types on the basis of photo sample in combination based on the interpretation keys. This can be done by referring to the existing maps, including land inventory map of natural resources and environment sector, forest harvest design and some other maps.

Detailed interpretation for individual forest status plot according to classification system. It is necessary to zoom image to the possible extent so as to allow accurate demarcation of different forest status plots.

- Define title for each forest status plot that was drawn. At this step, a part from image features, it is necessary to apply accurate aerial photo information as ecological conditions, distribution, relation with natural and socio-economic conditions in order to clearly identify title of forest status that need to be separated. Experiences on images as well as site survey of image interpreters at this step, therefore, are so important and seen as decisive factor to the precise image interpretation results.

However, some plots that are difficult to recognize or suspicious due to inexplicit or confusion with other forest status shall be marked for further check and supplement during site survey.

During interpretation process, image interpreters shall discuss, cross check and jointly reach common consensus on interpretation results. Furthermore, interpretation results shall be rechecked by experienced and qualified interpreters for timely supplementary and adjustment.

Image interpretation shall be conducted for each commune in the 2 districts (Di Linh and Lam Ha) for subsequent synthesis to develop district mapping.

- **Topology checking and attribute filling.**

The FAMIS software is used to check topology errors then design forms and assign a name to each interpreted polygon. The structure of the attribute of these maps must follow the Structure of the attribute designed for the historical forest status maps which have been done by FREC.

Table 02: Structure of attribute table

Field	Name	Type
Name of Province	PROVINCE	Character 20
Name of District	DISTRICT	Character 20
Name of commune	COMMUNE	Character 40
Name of block	Block	Character 10
Name of compartment	Compartment	Character 10

Type	TYPE_year	Integer
Name of type	Name	Character 80
Computed area	DT_may	Decimal 20,2
Coefficient	Coeff	Decimal 20,7
Area after adjustment	DT_BS	Decimal 20,2

Indoor map edition

The interpreted forest status maps for commune (scale of 1:10,000) and for district (scale of 1:25,000) are established with the MAP/INFO software, concluding the layers as the same with the historical forest status maps which have been done by FREC.

3.2.4 Field survey to adjust, supplement forest status map

3.2.4.1 Preparation work

Map printing, include different layers as follows: targeted plot boundaries, specific forest status (that was identified in-door) on satellite image with different boundary layers related to administration, compartment, block, road, streams, and location title in order to enable inventory team and local people to collect and explore information during site survey.

Plan development and human resources preparation: qualified image interpreters shall carry out ground-truthing to increase accuracy of interpreted images after ground-truthing.

Equipments, materials and stationeries preparation: laptop, GPS, digital camera, compass, measuring tape, site survey checklist/tables and different kinds of pens to draw on map...

Team meeting: to reach common consensus on contents and technical measures.

Implementation

Site survey is conducted in accordance with the following steps:

a) Working with relevant agencies

At provincial level:

Organize meetings with relevant agencies as:

Provincial UN-REDD working group: presentation on contents, plan and method of the site survey.

Forest Protection Sub-department: presentation on contents, plan, method of the site survey and discuss cooperation modality for site survey implementation; collection of reports, data related to forest resources changes monitoring.

Forest sub-department: presentation of contents, plan on site survey implementation; collection of data, information related to previous and on-going forest programs, projects on the area.

Statistics Department: collection of annual statistics (different periods) on socio-economic development in the area.

Department of Industry and Trade: collection of data, information related to hydro-power development.

Resettlement Committee: collection of data on population growth, projects/programs related to sedentarization and resettlement.

District level

Organize meetings with the following agencies and organizations:

- District UN-REDD working group: presentation on contents, plan and method of the site survey.
- Forest Protection Station: approval of implementation plan, agreement on cooperation modality for implementation; collection of reports, data related to forest resources changes monitoring.
- Forest owners (protection forest management board, forest companies): activities related to forest protection and development; forest plantation profile …
- Agriculture and Rural development Section: collection of information, data related to forest programs, project on the area.

Conduction of some interviews on status of forest resources changes, conversion of land use purposes over the last time.

Collection of socio-economic information that relates to forest resources changes on the area over the last time.

At communal level

Meeting with communal leader: presentation on contents, methods and plan of site survey on communal area.

Conduction of some interview with communal staff on forest resources changes; collection of data, information related to forest resources changes.

Identification of survey transects, ground-truthing.

Conduction of some interview with households, individuals on forest resources changes, coffee development on the area.

b) Site survey implementation

Site survey was conducted on group basis and covered on the entire area of project communes. A working team includes: consultants, forest protection station staff, communal land administration officer and it is up to specific cases, additional members from natural resources and environment section and forest companies may join the team. Within the working team, consultants are responsible for professional aspects; forest protection force plays a monitoring role while the rest of the team (communal people's committee, natural resources and environment section, forest companies) provide necessary support.

Ground truthing shall be conducted on the above mentioned survey transects. Comparison and cross-checking of all forest status and land use between results generated from mapping interpretation and site survey. However, ground truthing will be targeted at the following key groups:

- Areas of concerns during indoor image interpretation;

- Areas with different image interpretation and ground truthing results;

Along survey transects and checking points:

Identify precise points by GPS.

Observe and identify precisely title of the observed areas.

Quickly identify some quantitative factors of the observed areas as: coverage, height, dominant species...

Take picture of the observed areas. Record data, information of the pictures taken on the site, direction, distance and time of taking picture, etc.

Fill in observation and ground truthing results on the designed tables and forms.

Compare and cross check results of indoor image interpretation and site survey to adjust results of direct interpretation on site survey mapping, including:

Mark boundaries by eye observation from the opposite site to adjust boundaries of status plots that reveal differences between in-door image interpretation and site survey results.

Adjust status title if there exist differences on image interpretation results between in-door and site survey.

Define precise title for the demarcated plots whose titles have not yet been identified during in-door image interpretation process.

The entire adjusted, supplemented results need to be discussed and agreed among the team members during the site survey. In addition to that, carry out interview with local people to get deeply understand on current situation related to forest resources management, protection, harvesting and use so as to supplement to the adjustment of the site survey results.

After site survey, all maps are defined with sufficient titles and necessary adjusted boundaries. Besides, the working team also produces preliminary results, which will be adopted, consensus and certified by communal people's committee.

Table 03: Some images of site surveys.

	
Working with Forest Protection staff	Cooperate with local forest ranger to conduct ground truthing

	
Cooperate with local forest ranger to conduct ground truthing	Agree on preliminary ground truthing data with Di Linh district

c) Workshop to report findings of site survey

At communal level: Report site survey results and together with communal leaders, preliminarily agree on forest status data and meeting minutes.

At district level: after completing site survey in all communes, organizing meeting with communal leaders and reaching common consensus on preliminary forest status data, further organize meeting to report site survey findings and reach agreement on forest status data with district leader through the signed meeting minutes.

At provincial level: after completing site survey and meeting with district leader, further organize meeting to report site survey findings and reach agreement on forest status data with DARD in Lam Dong province through the signed meeting minutes

3.2.5 Update map

All results related to supplementary and adjustment of forest and forest land status on site shall be updated by MAP/INFO software, including the following steps:

- Digitalize the adjusted boundaries on site and eliminate imprecise ones.
- Additionally interpreted areas where large differences exist if necessary.
- Check, create areas on map for forest status plots that were adjusted and supplemented according to the ground truthing results. This work aims to facilitate area calculation for individual forest status and develop mapping in accordance with the existing regulations.
- Assign the supplemented/adjusted status to each plot within the made polygon.

3.2.6 Processing, calculation of area data for different forest, land types

Map basis are forest and forest land area defined according to administrative boundaries, compartment, and block and are recorded on different map layers (results of SPOT5 image interpretation) and managed on MapInfo software.

- **Area calculation for forest plots**

Principles on area calculation:

- Area calculation for different forest plots according to communal administrative unit and on this basis, make accumulation to district level.
- Control data is natural area in commune (results of land inventory in 2010).

Area calculation method

$$\text{Adjusted coefficient} = \frac{\text{Actual natural area in commune (results of land inventory in 2010)}}{\text{Theoretical natural area in commune (calculated by MapInfo)}}$$

(Adjusted coefficient may have either positive or negative sign)

Adjusted plot = Theoretical plot area (calculated by MapInfo) * adjusted coefficient

(Adjusted plot may have either positive or negative sign)

Area of targeted plot = Area of theoretical plot (calculated by MapInfo) $\pm$ adjusted plot

3.3 Forest resources changes assessment for period 2005 – 2011

To this end, UN-REDD's results on "historical forest status mapping" produced by Center on Forest Resources and Environment is employed together with the forest status map in 2011 to compare forest resources changes from 2005 – 2011.

However, mapping of forest status for period 1990, 1995, 2000 and 2005 were mainly based on Landsat satellite image with resolution of 30m without ground truthing but verifying with some of the most recent forest status inventory results. As the results, it could not offer high accuracy in comparison with development of forest status map in 2011, which was based on SPOT5 in addition to ground truthing and its results are consistent with local data. To ensure logical forest resources changes assessment, it is important to check and adjust historical forest status map on the basis of the forest status map in 2011 and then skip out inappropriate changes between different periods.

3.3.1 Survey, interview and collect information related to forest resources changes on site.

Field survey was conducted with an aim to verify, cross-check collected information with the results of in-door forest resources changes calculation and to interview for further collection of other social-economic information related to forest resources changes. On this basis, analyze and identify implications of these factors to forest resources changes on the 2 districts (Di Linh and Lam Ha). Field work was focused on areas with large changes in terms of both positive and negative changes and on areas that reflect diversity and complexity during conversion of different forest and land types.

Interviewees are officers from forest state management agencies as: forest protection sub-department, forest development sub-department, forest protection management boards, forest protection stations, agriculture and rural development section in the 2 districts and forest owners. In addition, households were also interviewed in order to collect adequate and objective information related to forest resources changes on the two districts.

The entire interview results related to forest resources changes was recorded according to the developed interview sheets.

3.3.2 Identify conversion between various forest and land types

Employ map over-laying method to compare forest status map in 2005 and 2011 with support of the ARC/VIEW software so as to develop matrix reflecting changes of forest status and land use during the period.

Base on the developed matrix, analyze big changes among different status to have basis for identification of drivers related to forest and forest land changes.

3.3.3 Evaluate forest policy implication on forest resources changes

Survey, collect, analyze, assess policies that explicitly influence changes of forest and forest land on different areas by applying expert method.

3.3.4 Evaluate implication of forest projects, programs on forest resources changes

Survey and assess economic development activities on various territorial areas, including some outstanding social economic contents as follows:

- Economic development projects, programs that has influenced conversion of forest and forest land use, including:

  + Hydro-power plants, irrigation works, mining and road system development projects.

  + Coffee, fruit trees and specialty development projects.

  + Resettlement and new economic zone development programs.
- 5 million ha reforestation program: forest protection & regeneration, new plantation and harvest.
- Industrial material trees development projects.

3.3.5 Evaluate implication of social-economic factors on forest resources changes

Survey, assess implication of socio-economic factors on forest resources changes on different territorial areas, including the following outstanding factors:

- Poverty, population, population growth rate.
- Growth and social economic development.
- Land use planning.
- Forest management and protection.
- Local people's awareness and participation.

4 COORDINATING IMPLEMENTATION

4.1 Implementation

On the basis of identified activities, the staffs were grouped with a team leader to direct the entire study; experts, technicians distributed in group, a leader for each group, as follows:

- **Indoor group**

Main activates are:

- Collecting relevant documents, compiling the base maps and final maps: this team consist the experts experienced in the application of the MAP/INFO, ARC/GIS software for digitizing, compiling and printing the maps.
- Processing, classifying images and updating the maps: This team consist the experts experienced in Remote Sensing Image interpretation, using the ERDAS software to process satellite images.
- Examining, evaluating the classification results: this team consists experts experienced in satellite image interpretation, mapping forest and land use status. The tasks of this group are to examine the quality of the classified maps and provide criteria, correction methods if necessary.
- Map overlay, area calculation, analysis and writing report: This group consist mainly the following specialists in the application of GIS technology to overlay map layers over the periods, having extensive experience in identifying, analyzing and evaluating the causes and changing trends in forest and land use over time.

- **Field group**:

This group consist experts having extensive experience in field inventory, working with local partners, and skills on collecting information about the forest and land use management.

4.2 Cooperation of implementation

To improve the productive in the assignment implementation, the cooperation between the agency having expertise in the field of application of Remote Sensing and GIS in mapping the forests and assessment of forest changes and the provincial agencies in charge of the management and protection of forests is very important. This cooperation is to ensure the productivity and accuracy of the mapping process.

In order to satisfy this requirement, the FREC will cooperate with the provincial Forest Protection Department (FPD) of Lam Dong and district FPD of Di Linh and Lam Ha in implementation of the project. FREC will play a major role in terms of application of Remote Sensing and GIS technology in mapping the forest and land use. The FPDs will deploy the staff in investigation, gathering the relevant documents for establishing current forest status maps and determining the causes and analyze the situation and trends of forest change over periods.

5 RESULTS

5.1 Natural and socio-economic conditions

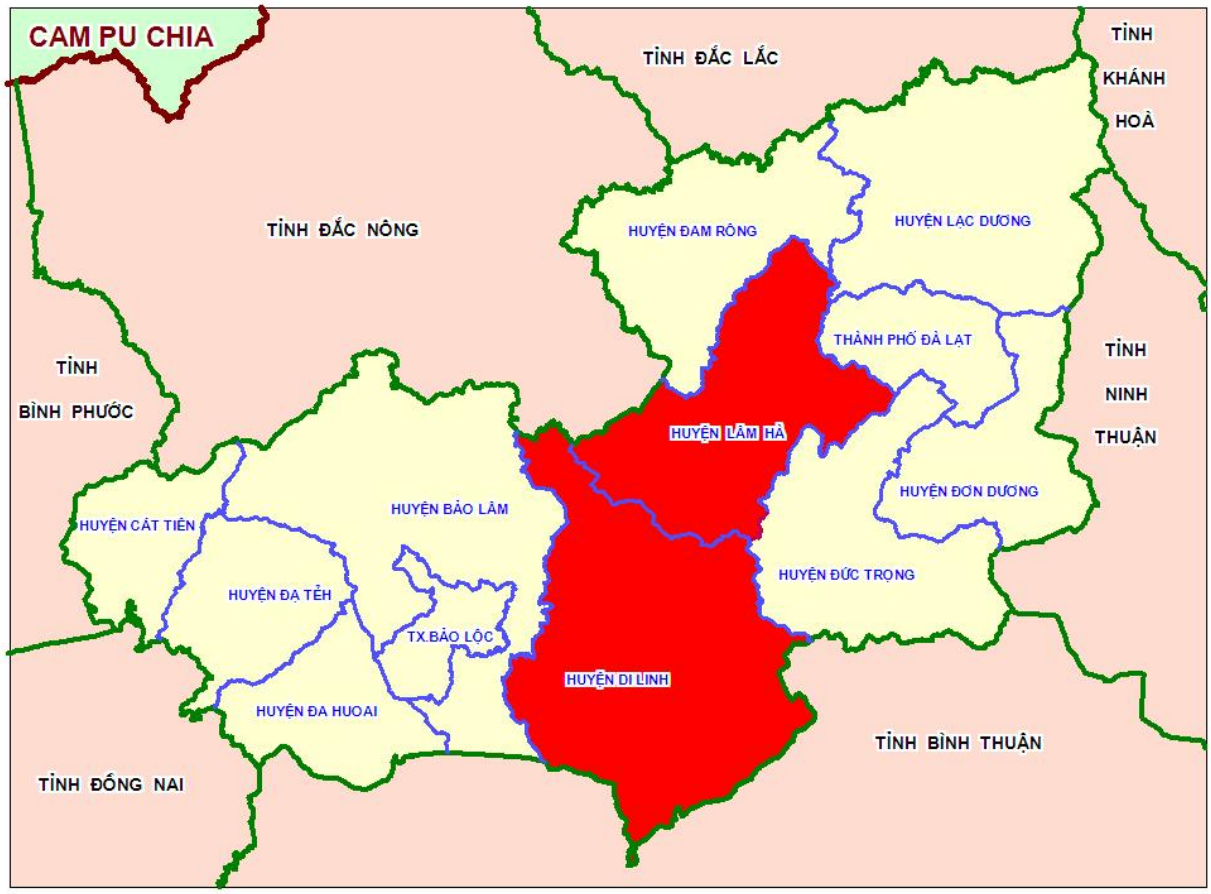
5.1.1 Natural features

Geographical position

The study area consists of Di Linh and Lam Ha districts. Geographic location as follows:

- - The north is Dak Lak province.
- - The southern is Binh Thuan province.
- - The East is Duc Trong, Lac Duong districts and Da Lat city.
- - The West is Bao Lam district and Dak Nong province.

Figure 02: Location of study area.



The study area has 3 towns and 31 communes. Geographical location relatively convenient to the distribution of the main roads such as Highway 27 connecting the main road of the province of Lam Dong and Dac Lac Province, Highway 20 (southeast of Da Lat) and Highway 28 (South Central and Central Highlands Dac Nong). Therefore, this area has many advantages in economic exchanges with the Central Highlands, Central coast especially with the southern economic region.

Terrain topography

The terrain is quite complex, fragmented by many small and large rivers and tend to be lower from north to south. Generally, there are three types of terrain as follows:

- Mountainous terrain types: Area: 138,487 ha, accounting for 53% of the total area of the region and concentrated distribution in the north and northeast of Lam Ha district (including the Ro Men, Phu Son and Phi To… communes) and south of the Di Linh district (including the Son Dien, Gia Bao Thuan Bac communes). The average elevation compared to sea level is from 1100m - 1500m. Average slope is approximately 20 degree. Generally, the terrain feature is not suitable for agricultural development. This is area of the distribution of the large area of protection forests having an important role in protecting water sources, especially for the Dong Nai river system.
- Low hilly terrain types: area of 108,125 ha, accounting for 41% of the total area of the region, concentrated distribution in the southern Lam Ha district (including Phuc Tho, Tan Thanh, Lien Ha, Dan Phuong ...communes) and the South and Southwest Di Linh district (including Dinh Lac, Nghia Lien Tan Dam, Tan Chau ...communes). The average elevation compared to sea level is from 900m-1100m, average slope 3-15degree. Almost of the area of these types is Ba Zan red soil, which is suitable for the development of perennial industrial crops. This is also why so many coffee growing regions have been formed and developed here.
- Valley terrain types: Area of 13.423ha, accounting for 5% of the total area of the region, distributed along rivers and large streams. Concentrated in some communes, such as Dinh Van, Tan Van (Lam Ha) and Di Linh town, Tan Chau, Hoa Trung (Di Linh). The average elevation from sea level of 800m or less. Common slope up to 8 degree. Most areas of this terrain type is alluvial soil types and slope convergence, abundant surface water resources, suitable for the development of rice and other shorterm crops.

Soil, mother rocks

Since the factors of climate, topography, geology and plant, the soil in this region is very diverse. According to the survey results of building a map of soil types of Forest Inventory and Planning Institute and National Institute for agriculture planning, the soil in this region has the following main groups:

- Red soil (F): Area of 120.853.ha, accounting for 46% natural area. This group has B Ferreliz floor (area of aluminum), crystal clarity. This is the soils have many good qualities of texture, water holding capacity and ability to absorb nutrients well, very suitable for the cultivation of perennial crops. However, attention should be paid to characteristics of climate and irrigation conditions for selecting species and plant. Most of the area is being exploited and used as agriculture land, especially where has moderate to good landfertility. Consequently, coffee is the preferred choice for this region. Some other species can also grow well such as tea, mulberry. This group includes: land on a red-brown stone Ba Zan (FK), yellow-brown soil on the rock Ba Zan (Fu), red and yellow soil on shale (Fs), red and yellow soil on rock Grannite (F), red soil gold modified by growing rice (Fl).

- Grey soil (Acrisols): The area of 99,533 hectares, accounting for 38% of natural area. Distributed mainly in Di Linh district, south of Highway 20 and a few in the north. Characteristics of this group is forming B floor. Acgic very clearly in the form of surgery, a significant increase in clay on the floor than the floor below. React strongly acidic soil and the amount of BS <50%. Most surgery is the CEC in the clay content <24mg/100g of clay.
- The other groups of remaining land: The area of 39,649 ha, accounting for 15% of the total natural area. Include the following groups: alluvial soil (P), black soil (R), red yellow soil humus in the mountains (Fh), Gley soil (Gleysols).

Climate and hydrology

The study area is located in a tropical monsoon climate; however, because the average of absolute elevation compared to the average sea surface is quite high, the climate in this region has following characteristics:

- The average temperature is low, but the range of temperature fluctuation between day and night are relatively large, it is hence suitable for the sub-tropical trees and temperate crops. This is also the advantages of the study area in particular and Lam Dong province in general in comparing to the other regions of South and South Central.
- Relatively high number of sunny days: 1700 - 2200 hours, air humidity 75-85%. Rainy season from April to November, dry season from December to March next year, average rainfall about 2500 – 3000mm. Almost no storms and frost. Generally very favourable climate for agricultural production, especially long-term industrial crops such as coffee, tea ... However, rainfall intensity and concentration likely to cause soil erosion and discoloration. Overall, this is the most restrictive features of the climate in the study area.
- Water surface of this region is mainly supplied from rivers and streams in the system of Da Dang River, Cam Ly River, Dai Nga River, Luy River and small and large reservoir in the region. Of which, Da Dang river has total basin area of 1225 km2 large, the average width of 40m, narrowing least 10m and 100m widest. Consequently, this region has high potential for hydropower development as well as providing water for agricultural activities.

5.1.2 Socio-economic conditions

Population

According to the Statistical Yearbook in 2009 of Lam Dong province, the population in this region is 292,265 people, where men accounted for 51% of 149,055 people and 143,210 women who constitute 49%. Natural growth rate of population is 1.48%. There are 29 ethnic groups living together in this region, main group rare the Kinh, Ko Ho, Cill, Ma, Tay, and Nung. In particular, the Kinh group is accounting for 69% with 201,663 people. The other ethnic minorities are 90,602 people, accounting for 31%. Most of Kinh people come from Ha Noi to build new economic zones after reunification.

In the period before 2000, population in project area increased rapidly, at an average growth rate of 7% per year (including natural growth of 2.5% and 4.5% of mechanical increase). The causes determined during this period were rapid increase in coffee prices; therefore migration flows should come freely from the provinces of northern, central and southern as new settlers and for coffee production. The most rapid population growth is in the period 1995 - 2000, the average annual increase from 11,000 to 15,000 people. Especially, there were some ethnic minorities such as H'Mong, Nung, Dao, and Tay coming from northern mountainous provinces. These groups of people normally migrate and live directly on the area of forests, particularly on the protection forests, for the purpose of occupying the forest land for building the houses and doing agriculture. This problem has created difficulties for the protection of forests.

In the years 2001-2005, the population gradually stabilized to a growth rate of 2.6%. In 2005, total population of project area was 289,808, accounting for 50% where there were 145,810 of men, and 143,998 of women making up the other 50%. To stabilize the population and reduce the negative effective of free migration, the local authorities in the two districts have the project ***"Stability of free migration"*** over the years. Through this program, local governments have created stable life for nearly 2,000 households with total investment exceeding 15 billion VND. Besides, local government also has positively developed other integrating projects such as local immigrant population, the farming - settled...

However, according to information from local government in the two districts, even though the migration trend has somewhat subsided, it still happens in some areas of province, especially in the remote areas. This is evidenced by the case of a group of 70 H'Mong ethnic households with 300 people migrated illegally to Phuc Tho commune, Lam Ha district. This group even demands local government permit to build a village at the primary forests. Therefore, the complete control of migration is still a challenge and requires more effort of the local government in the two districts.

The development of infrastructure

According to field surveys in local areas through interviewing local officials and residents about the impact of the development of infrastructure to deforestation and forest degradation shows that: The development of infrastructure only destroys very little area of forest to build roads or power lines. Nevertheless, in reality, it affects greatly the changes of forest resources and becomes an underlying cause to accelerate the process of forest loss. Most communes in the two districts were newly established from 1985 to 1990 and the roads have begun to expand since then. The roads were built mainly based on the logging roads of the State Forest Enterprises and were left when harvesting was finished. Those roads were then reopened by the local people themselves for transporting agricultural products (coffee, maize…).

The development of industrial crops

Having a lot of Bazan area, Di Linh and Ha Lam is a region favourable for the development of cash crops such as coffee and tea.

The surveyed data of the total area of cash crops in Di Linh and Lam Ha districts in 2005 was approximately 88,300 ha, accounting for 34.0% of natural land area. However, the percentage of cash crop planted area in each locality is very different. There are some communes with high percentage of area compared to the total natural area, such as Nam Ha, Tan Ha, Ha Lien in Lam Ha district; Di Linh town, Trung Hoa, Dinh Lac, Nghia Tan, Tan Chau, Tan Thuong Dinh Trang Hoa ... in Di Linh district. In fact, the area of planted cash crop according to the Social Statistical Yearbook is mainly for coffee plantations. Tea plantation accounts for only a very small percentage of the total area of industrial crops in each locality, even though Di Linh, Lam Ha and Bao Loc are the unique regions in the southern provinces with favourable conditions for growing tea.

With soil conditions suitable for many cash crops, coffee is still the main crop of this region. Coffee production (area) saw the largest increase between 1995 and 2000. Price of coffee also rapidly changed in this period. According to the survey by interviewing local officers showed that the coffee area reported is not all planted. Actually, on many small plots located away from residential areas, coffee was not detected. The massive development of coffee is the main cause leading to the loss of forests. Most of the coffee areas today were forests in the past.

The forest protection and development

In the two districts, the forest management and protection is still insufficient. With a vast forest region, rangers force is limited. Because one ranger is responsible for several communes, hence, the work efficiency is not high; deforestation and illegal forest exploitation still happen in many communes. According to the statistical results of the forestry law violations: in 2008, Lam Ha district has handled 172 cases including 90 cases of deforestation with an area of destruction of 38.5 ha, 31 cases of illegal forest exploitation and other related cases.

The forest management and protection activities were difficult to implement because of frequent changes in personnel. Under the regulation, each commune has a deputy director of the communal board of forestry, but due to limited allowances for staff, so they are not passionate about their work and work ineffectively.

The coordination between local governments and rangers force in forest management and protection is relatively good. Especially in the advocacy work of the people to strictly follow the state policy and law on forest protection. The result was that situation of forest burned for shifting cultivation is not happening anymore, and it is strictly controlled by coordination of the authorities with forest rangers. Specifically, a working group was established for advocacy, patrol, inspection and barricades at various places to control forest conversion to coffee plantation.

Regarding the forestland allocation:

Most of the area of forests in Di Linh and Lam Ha districts has been allocated to to State Forest Enterprises (SFE) and forest protection and management boards. The number of households or individuals who have been allocated forestland is very small. It is also a great influence to the management of local forests. In reality, forest management boards have been practicing forest protection through contracting residents living near the forest.

However, the contracted area is still limited, mainly concentrated in areas near residential areas and often assigned to groups of households.

5.2 Results on forest status mapping

5.2.1 Main Outputs

Forest status mapping in 2011 and forest change between 2005 to 2011 analysis and assessment has been conducted from July to September, 2011. The outputs include:

- ***SPOT5 images***

- The SPOT5 images were pre-processed based on the topographical maps of VN2000 projection covering the whole area of two districts (Di Linh and Lam Ha).

- ***A set of interpretation keys***

- A set of interpretation keys created for all forest and forest land types with at least 3 keys for each type.

- ***Maps***

All of the final maps have been edited on the topographical maps with the projection of VN 2000 in MapInfo formats, including:

- Forest status maps for 35 communes and towns at the scale of 1/10.000.
- Forest status maps for 2 districts at the scale of 1/25.000.

- **Report**

- Report on the results of Forest status mapping and forest changes assessment under the impact of socio-economic factors in two districts.

- **Area data**

- Statistical data sheet of the area of forest and land use types for 35 communes and towns.
- Statistical data sheet of the area of forest and land use types for 2 districts.
- Forest land change matrix over the period 1990, 1995, 2000, 2005 and 2011

5.2.2 Results on development of interpretation keys

Totally, 54 samples were developed for 18 existing forest and forest land status on the 2 district areas while making sure that every 3 samples reflect 1 status and are equally distributed on communes in the 2 districts.

Table 04: Interpretation key for medium evergreen forest

	
Image features	**Field photo**

In fact, there are 6 SPOT 5 scenes that cover the two districts. Hence, when developing photo samples, we identified sample points with much higher number than that of the photo key samples to ensure that each forest status on different photos has at least an observation point and site description so as to enable the in-door photo interpreters to come up with high precision and consistency on forest status for the same scene.

5.2.3 Classification system

Table 05: Harmonized classification system

No	Category	No	Category
A	**Forested Land**	*5.4*	*Coniferous forest - Regrowth*
1	**Evergreen - Broadleaf forest**	6	Mixed Coniferous forest
1.1	*Evergreen - Broadleaf forest - Rich*	7	Plantation forest
1.2	*Evergreen - Broadleaf forest - Medium*	**B**	**Non Forested land**
1.3	*Evergreen - Broadleaf forest - Poor*	1	Limestone area
1.4	*Evergreen - Broadleaf forest - Regrowth*	2	Grass and Shrub land
2	Deciduous forest	3	Fragmented wood land
3	Bamboo forest	**C**	**Non forestry land**
4	Mixed Wood and Bamboo forest	1	Industry tree plantation
5	Coniferous forest	2	Agricultural land
5.1	*Coniferous forest - Rich*	3	Water area
5.2	*Coniferous forest - Medium*	4	Residential area
5.3	*Coniferous forest - Poor*	5	Other land

On the basis of the standardized classification system (see table 05), historical forest and land use status maps have been established for the periods 1990, 1995, 2000 and 2005. All of the final maps are made by using MAP/INFO software includes:

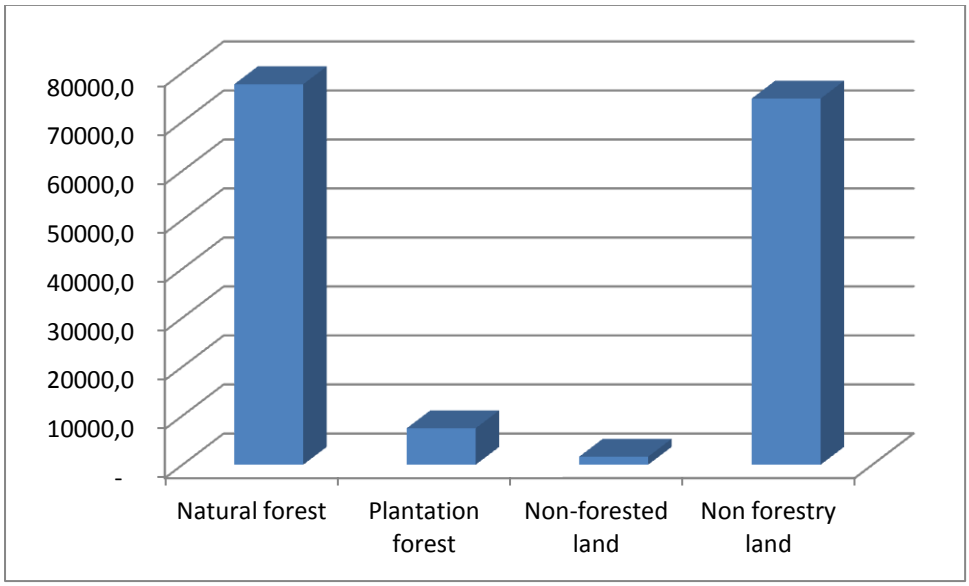
- Maps of the forest and land use for 34 communes and towns at the scale 1:10.000 with projection of VN2000, zone 3 degrees, longitude axis 107^0 45 '.
- Maps of the forest and land use of two districts at the scale 1:25.000 with projection of VN2000 zone 6 degrees, longitude axis 111^0.

5.3 Area of forest, forest land types

5.3.1 Area of forest, forest land types in Di Linh District in 2011

Area of forest, forest land types in Di Linh District is showing in the following chart:

Chart 01: Area of forest, forest land types in Di Linh District



Total forested land area: 85,097 ha (forest cover of 52.7%) of which, forests are mainly distributed in communes Tam Bo: 23,316 ha, Bao Thuan: 19,642 ha, Gia Bac: 11,671 ha, Son Dien: 8,869 ha, Gung Re: 7,148 ha, Hoa Bac: 6,351 ha, Dinh Trang Thuong: 4,406 ha.

In Di Linh district, a large number of communes have converted forests into agricultural and perennial plantation such as in Hoa Ninh, Dinh Trang Hoa, Tan Nghia, Di Linh town, Tan Chau, Dinh Lac communes.

In Di Linh district, evergreen broad leaved forest covers an area of 27,570 ha (32.4% of forest area), of which poor forest occupies the largest area, around 16,788 ha (61% of the evergreen broad leaved forest area). Medium and rich forest account for 7,339 ha (27%.)

There remain large area of mixed timber and bamboo, rattan forest in Di Linh district with the total area of 24,290 ha (28.5% of forested land). This forest type is mainly distributed on rehabilitated forest after considerable harvest with some mixture of bamboo, rattan and timber species.

Bamboo, rattan forests cover 6,207 ha, accounted to 7.3% forested land and could be found on high humidity area along streams or rehabilitated on unused cultivation area.

Deciduous forests occupy 7,402 ha, accounted to 8.7% forested land and are mainly distributed in communes that share the border line with Binh Thuan province as Tam Bo, Gia Bac, and Bao Thuan.

Coniferous forests spread an area of 8,060 ha (9.5% forested land) dominated by natural pine and could be found in communes as Tam Bo, Bao Thuan, Gia Bac, Gung Re, Hoa Bac. Of which, poor coniferous forest covers nearly 55% while rich coniferous forest only remains 10% and is mainly distributed on complicated, high elevation, slope and difficult to access areas.

Mixed broad leaved and coniferous forests spread an area of 4,131 ha, accounted to only 5% of the total forested land and are mainly distributed on area between coniferous and evergreen broad leaved forests.

Plantation forests make up an area of 7,437 ha (around 8.7% of forested land) and dominated by pine and some acacia. Majority of these plantation forests were planted by forest companies and protection forest management board on the areas. Part of the newly planted area was planted by FLITCH project.

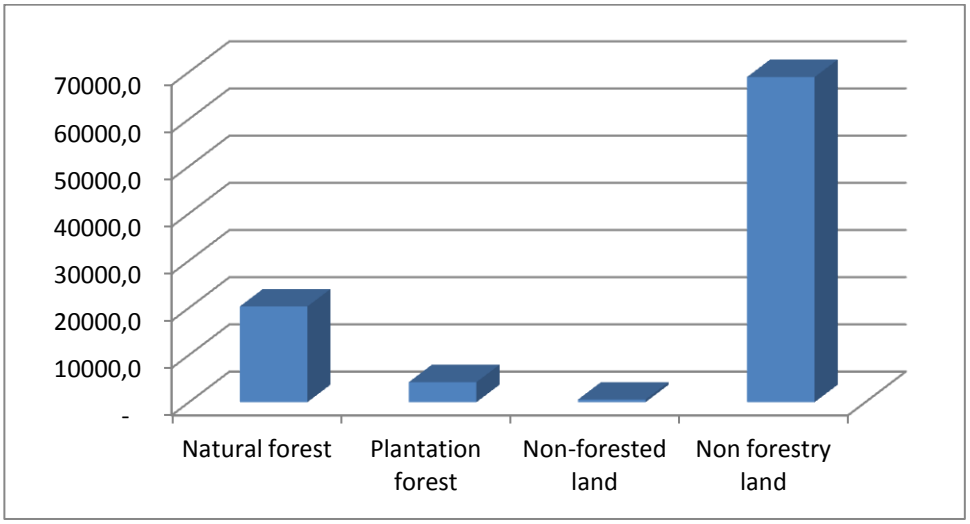
Non-forested land (lands not covered by forests, but within lands designated for forests) covers 1,638 ha, which used to be cultivated areas with unfavourable land conditions or difficult to access. These areas left unused due to low economic efficiency.

Non-forest land (areas not designated as forest lands) occupies 74,723 ha, accounted to 46.3% of the total natural area in the district. Of which, industrial plantation (mainly coffee) is dominated with an area 58.852 ha, occupied almost 80% of non-forest land and mainly distributed on area with suitable soil conditions and high accessibility. In many communes, most of natural area was converted into coffee plantation area as Ninh Hoa, Dinh Trang Hoa, Tan Nghia, Di Linh town, Dinh Trang Hoa, Dinh Lac.

5.3.2 Area of forest and land types in Lam Ha district in 2011

Area of different land types in Di Linh District is showing in the following chart 02:

Chart 02: Area of forest and forest land types in Lam Ha District



Total forested area is 24,532 ha (26.1% of forest cover) and mainly focus in Phu Son commune with 10,367 ha (over 42% of the total forest area in the district); besides this, forests area are also distributed in some other communes such as: Phi To, Phuc Tho, Dong Thanh. However, in many communes, forests have been converted into industrial trees plantation as Tan Ha, Lien Ha, Hoai Duc, Tan Van, Nam Ha and Dan Phuong.

Evergreen broad leaved forest has the largest area of 15,648 ha (63.8% of forested land). Of which, poor and medium forests are dominant, make up 74.8% of this forest type. The remaining rich forest is 2,144 ha and mainly distributed in difficult to access topography

such as blocks No. 220, 222, 219 and 229 of Phu Son commune and block 287 of Phuc Tho commune.

Mixed timber and bamboo, rattan forests spread an area of 2,654 ha (10.8% of the forested land) and are mainly distributed in Phu Son, Tan Thanh and Phuc Tho communes.

In addition, there exists some other scattered forest such as: bamboo and rattan forest: 959 ha mainly in Tan Thanh and Phuc Tho communes; coniferous forest: 789 ha and mixed broad leaved and coniferous forest: 233 ha, mainly distributed in Phu Son commune.

Plantation forests cover 4,249 ha (17.3% of the total forested land). This forest type is mainly distributed in Phi To, Phu Son, Gia Lam, Me Linh and Da Don Communes with pine as dominant species. This forest was planted by forest companies which were formerly called state forest enterprises. Besides, there are also some small areas of acacia forest that was newly planted by some households.

Non-forested land in the district covers approximately 550 ha, which used to be cultivated areas with unfavourable land conditions or difficult to access. These areas are left unused due to low economic efficiency. This land area is mainly distributed in communes such as: Tan Thanh, Phu Son, and Phuc Tho. Besides, due to favourable conditions for coffee development, barren land could no longer be found in many communes as Tan Ha, Dinh Van town, Nam Ban town and Lien Ha.

Non-forest land is 68,913 ha (73.3% of the total natural area in the district). Of which, industrial tree plantation covers the main part of 53.535 ha (77.7% of the non-forest land). There also exist 9.957 ha of land, which has just been converted from forested land but with no coffee planted yet or from forested land to shifting cultivation where land conditions are not favourable for coffee plantation.

5.4 Changes of forest, land types for 2005 - 2011

5.4.1 Changes on area of forest, land types in Di Linh district for 2005 – 2011

Findings from assessment of area changes of different forest and land types in Di Linh district for 2005 – 2011 have indicated that the total forested land reduced over 5,250 ha or roughly 6% of the original forest cover. Communes with sharp reduction of forested land are Tam Bo (over 1,330 ha), Son Dien (over 1,150 ha), Gia Bac (nearly 1,000 ha), Dinh Trang Thuong (nearly 8,500 ha).

Broad leaved forest reduced nearly 3,000 ha, of which rehabilitated broad leaved forest has the sharpest reduction. This forest type was destroyed to convert into cultivated or coffee plantation area and can be seen in Tam Bo, Gia Bac and Gung Re.

Bamboo and rattan forest also diminished considerably, around 2,550 ha and mainly happened in Son Dien, Hoa Bac, Gia Bac and Tam Bo communes.

Coniferous forest reduced more than 1,400 ha and mainly in Tam Bo and Dinh Trang Thuong communes.

Some other forest status has rather moderate changes due to parallel increment and reduction that took place in some communes on district area.

The changes on area of forest and forest land types in Di Linh district for 2005 – 2011 is as table 06:

Table 06: changes on area of forest, land types in Di Linh district for 2005 – 2011

Unit: ha

Type	2005	2011	Change
Total area	**161.464**	**161.464**	**0**
Forested land	**90.355**	**85.097**	**-5.259**
Evergreen - Broadleaf forest	30.545	27.570	-2.975
Deciduous forest	7.766	7.401	-365
Bamboo forest	8.756	6.207	-2.549
Mixed Wood and Bamboo forest	23.613	24.290	676
Coniferous forest	9.488	8.060	-1.428
Mixed Coniferous forest	4.327	4.131	-196
Plantation forest	5.860	7.437	1.577
Non Forested land	**5.795**	**1.639**	**-4.157**
Non forestry land	**65.313**	**74.729**	**9.416**
Industry tree plantation	49.704	58.852	9.148
Agricultural land	10.938	8.687	-2.250
Water area	1.544	2.991	1.447
Residential area	2.984	3.992	1.008
Other land	143	207	64

Increased forest area resulted from plantation with nearly 1,600 ha, mostly planted by the 5 mil. ha reforestation program and FLITCH project.

During this period, non-forested area has reduced sharply, over 4,150 ha and mainly in Bao Thuan, Tam Bo, Gung Re, Gia Hiep communes. These areas are mainly barren land and bushes that have been used by local people for cultivation or coffee plantation.

Non-forest land increased over 9,400 ha. This is the result of program on revision of the 3 forest types in 2007 and after being adjusted, some favourable forest land was shifted to coffee development in order to increase production value so as to minimize pressure on forests. Communes with large conversion include: Tam Bo, Son Dien, Gia Bac, and Dinh Trang Thuong. In addition, there seem not to be any considerable changes in some communes with favourable conditions for agricultural economic development due to limited forest land availability. Favourable areas were all converted before 2005 as in Hoa Ninh, Di Linh town, Hoa Trung, Tan Chau, Hoa Nam communes. Area with biggest changes was industrial plantation (coffee) with an increase of 9,150 ha. Besides, part of other forest land was converted into wetland due to being under flood during damp blocking process for hydro-power construction on the area. Furthermore, due to population growth pressure, residential land also increased to meet housing demands for local people.

Cultivated area also diminished sharply due to the increasing coffee value recently meanwhile prices of agricultural commodities such as corn, pastas without significant changes.

5.4.2 Changes on area of forest, land types in Lam Ha district for 2005 – 2011

Findings of the inventory for forest status mapping in 2011 and assessment of forest resources changes for 2005 – 2011 in Lam Ha district have indicated that:

Total forested land in the district reduced over 3,000 ha (reduced by over 10%). The highest forest area reduction was recorded in Tan Thanh commune, around 2,370 ha; Phuc Tho: nearly 1,170 ha and followed by Phu Son and Da Don commune. Nevertheless, a part from communes with large forest loss, some other communes with good forest plantation and rehabilitation campaigns have contributed to forest increase as Phi To, Dong Thanh and Gia Lam commune.

The changes on area of forest and forest land types for 2005 – 2011 is showing in table 06:

Table 06: changes on area of forest, land types in Lam Ha district for 2005 – 2011

Unit: ha

Type	2005	2011	Change
Total area	**93.994**	**93.994**	**0**
Forested land	**27.555**	**24.532**	**-3.024**
Evergreen - Broadleaf forest	19.749	15.648	-4.101
Deciduous forest	323	-	-323
Bamboo forest	1.290	959	-331
Mixed Wood and Bamboo forest	1.993	2.654	662
Coniferous forest	822	789	-34
Mixed Coniferous forest	381	233	-148
Plantation forest	2.997	4.249	1.251
Non Forested land	**8.921**	**549**	**-8.372**
Non forestry land	**57.517**	**68.913**	**11.395**
Industry tree plantation	38.188	53.535	15.348
Agricultural land	15.331	9.957	-5.375
Water area	653	1.141	489
Residential area	3.122	3.874	752
Other land	224	406	182

Evergreen broad leaved forest has the largest reduction of around 4,100 ha and mainly happened in Phuc Tho, Tan Thanh and Phu Son communes; of which rehabilitated and poor forest has had the highest reduction rate of 2,480 ha and 1,400 ha respectively. During this period, rich forest increased nearly 300 ha thanks to growth of medium forest.

By and large, other natural forest status also reflected changes but at a moderate scale of several hundred ha.

Plantation forest has increase tendency during this period with an area of over 1,200 ha and is mainly distributed in Phi To, Dong Thanh and Gia Lam commune.

Barren and non-forested land has sharply reduced, over 8,370 ha out of the total 8,900 ha of barren land in 2005. This was an obvious trend of this period due to high and stable coffee prices. As such, most of this barren land has been used by local people for coffee plantation in order to bring high economic value on utilization of the existing land availability.

Apart from the increased forest land of around 11,400 ha and mainly in some communes where large unused barren land as Tan Thanh, Phuc Tho, Phu Son, Phi To and Dan Phuong communes. In some communes, land use is rather stable due to limited land availability for possible conversion as in Nam Ha, Hoai Duc, Tan Ha and Tan Van commune. Industrial trees plantation area (coffee) has expanded over an area of 15,350 ha. Cultivation area was sharply reduced due to land conversion into coffee plantation because of the higher economic value of coffee.

5.4.3 Changes in forest statuses and soil types in Di Linh districts and for the period 2005 – 2011

The result of changes in forest and land use types in Di Linh districts and for the period 2005 – 2011is showing in table 08:

Table 08: Changes in forest and land use types matrix in Di Linh districts and for the period 2005 – 2011

Unit: ha

Năm 2011 / Năm 2005	Broadleaf forest	Deciduous forest	Bamboo forest	Mixed Bamboo forest	Coniferous forest	Mixed Coniferous forest	Plantation forest	Non Forested land	Non forestry land
Broadleaf forest	25.212	2	460	3.142		6	453	118	1.152
Deciduous forest		7.302					135	63	265
Bamboo forest	17		3.782	2.538			241	171	2.007
Mixed Bamboo fores	1.755		1.265	18.206			168	209	2.010
Coniferous forest	11				7.876	256	348	121	875
Mixed Coniferous fo	2				105	3.805	174	7	235
Plantation forest	2		24	8			4.359	28	1.439
Non Forested land	562	97	484	346	79	64	948	793	2.422
Non forestry land	9		183	58		0	612	128	64.324

The secondary study findings of forest status mapping in 2005 under program "mapping and analyzing forest resource developments during period 1990 - 2005 in Di Linh and Lam Ha districts of Lam Dong province were applied to assess the changes in forest status and land use. However, the findings were verified by existing baseline maps without field cross-checking. Consequently, there exist some discrepancies which are not in line with the forest resource developments when the map overlaying between 2011 and 2005 was done. However, this minor error is caused by the precision of the 2 different types of maps.

Evergreen broad-leaved forests are mainly converted into 3,150 ha of mixed timber, bamboo and neohouzeaua forests and approximately 460 ha of pure bamboo and neohouzeaua forests. In addition, more than 450 hectares of degraded poor forest with low economic value has been converted into land area for afforestation through a number of projects such as FLITCH. Furthermore, approximately 1,150ha of degraded poor forest land is converted into agricultural land, mainly for coffee plantations. The forests which are most affected are rehabilitated forests convenient to farming or industrial crop production.

More than 250 ha and 135ha of poor deciduous forests are respectively converted into agricultural land area and land area for new plantation. And more than 60 ha of such forest type is also to be converted to bare land. The phenomena mainly occur in extremely overexploited areas where big trees are cut down, leaving only some timber trees scattered.

Bamboo and neohouzeaua forests were transformed into to mixed timber and bamboo forests for this period due to the regeneration of some fast-growing timber species, covering an area of 2,500 ha. In addition, an area of 2,000 ha which is easily accessible was converted into land area for cash crop plantation and a part of newly-deforested area was became bare land where has not been used for cultivation yet.

Mixed bamboo and timber forest is the forest type which is mostly being converted, of which more than 1,750 ha with a high density of timber species was strongly rehabilitated for a while and then mainly transformed into evergreen broad-leaved forests. On the contrary, another part of this forest had bamboo and neohouzeaua faster growing after a certain period of harvesting. Therefore, this part was transformed into a new forest type with the remaining dominant species of bamboo. Over 2,000 hectares of this forest type was converted into agricultural land in order to bring in higher economic efficiency. In addition, another 200 ha of the deforested area became non-use bare land where has not been used for cultivation yet..

Coniferous forests mainly changed in terms of its quality since their selective harvesting and rehabilitation processes occur simultaneously. In which, after the harvesting operation, approximately 340 hectares of rich forests was transformed into medium forests and nearly 700 hectares of medium forests was transformed into poor forests. Besides, after the forest rehabilitation process, nearly 300 hectares of poor forest was developed into medium forests and nearly 100 per hectares of medium forests into rich forests. And over 250 hectares of the type of coniferous forests was transformed into mixed coniferous and broad-leaved forests. In addition, over 850 ha were converted into agricultural land.

New plantations for this period was mainly found on nearly 950 ha of non-use bare land and 600 ha of cash crop production land where accessible for tending, protecting and harvesting services as well as low economic efficiency. Furthermore, a high area of poor depleted forests and mixed timber and bamboo forests with low economic value was converted into plantations. In addition, more than 1,400 hectares of plantations in some favourable areas has been converted into cash crops with higher economic value.

Non-forest land has a quite complicated process of transformation. Many forested land areas have been over-exploited or newly destroyed and not yet been put to use, including nearly 700 ha of natural bamboo forests and mixed timber and bamboo natural forests. The land areas which are not used for the forestry purposes are mostly either land for cash crop production and farming cultivation located in the areas unfavourable to either cultivation or

transportation of agricultural products or unsuitable fallow land converted into bare land. Besides, a partial area of post-harvested plantation was not yet replanted, becoming fallow land area. In parallel with the negative changes as mentioned above, a part of barren land with the scattered distribution of timber trees has been developed into 1,650 ha of natural forests after the forest regeneration and restoration while approximately 1,000 ha of bare land with grasses and shrubs were afforested. In addition, over 2,400 ha of non-use bare land was used for cash crop production or farming cultivation, contributing to higher value of land use in the district.

Conversion to non-forestry purposes was most prominent. This reflects the complexity of land conversion both negative and positive under impacts of socio-economic factors in the district. It clearly reflects the conversion from forest land into cash crop production land, including mostly 4,000ha bamboo forests and mixed bamboo and timber forests with an area of approximately 4,000 ha. Plantations were also to be converted into agricultural land. However, nearly 2,400 ha of non-forest bare land were shifted into cash crop production area and subsistence farming land.

5.4.4 Changes in forest status and land use types in Lam Ha district the period 2005 – 2011

Based on the results of map overlaying, the matrix of forest and land conversion in Lam Ha district, for the period 2005 to 2011, the forest and forest land resource developments in Lam Ha district were not as dramatic and complicated as in Di Linh district.

The result of changes in forest status and land use types in Lam Ha districts and for the period 2005 – 2011is showing in table 08:

Table 08: Changes in forest status and land use types matrix in Lam Ha districts and for the period 2005 – 2011

Unit: ha

2011 / 2005	Broadleaf forest	Deciduous forest	Bamboo forest	Mixed Bamboo forest	Coniferous forest	Mixed Coniferous forest	Plantation forest	Non Forested land	Non forestry land
Broadleaf forest	14.538		193	1.271			237	153	3.357
Deciduous forest		3					39	4	278
Bamboo forest	0		357	184			49	53	646
Mixed Bamboo forest	465		152	974			12	35	356
Coniferous forest					781		3	6	33
Mixed Coniferous forest			2	3		233		11	132
Plantation forest			14				1.489	17	1.478
Non Forested land	637		219	220	8		1.162	206	6.469
Non forestry land	5		21	3			1.259	65	56.164

Broad-leaved forests have undergone changes in forest volume and forest status. However, the forest degradation happened drastically with many post-harvested rich and medium forests reduced to become 1,600 ha of degraded poor forests after selective harvesting of big trees. In many places, the depleted forests became mixed wood and bamboo forests or new pure bamboo forests after a period of rehabilitation of bamboo plants. During this

period, over 3,350 hectares of broad-leaved forests was converted into agricultural land and others.

Bamboo forests were mainly transformed into 650ha of agricultural land and into 200 ha of mixed wood and bamboo forests.

Mixed wood and bamboo forests were developed into timber forests after a period of rehabilitation of timber species covering an area of more than 450 hectares. A part of this area with favourable land conditions and convenient accessibility has been also converted into farming land.

Plantations have quite complicated developments, many new plantations which grown on more than 1,250 ha agricultural land and approximately 1,150 ha of non-forest bare land are not effective. A part of plantations which was converted from poor natural forests had a low economic value. In parallel with this conversion, many plantations were harvested and converted into nearly 1,500ha of farming land with aims to create higher economic efficiency.

During this period, non-forest land areas in Lam Ha district which is mostly used for coffee plantation and farming cultivation are newly formed from more than 6,450ha of un-used non-forest land and from 3,350 ha of evergreen forests as well as a part of plantations as analyzed above. The district hardly either abandoned any coffee production areas or changed such areas into other forms of land use.

5.5 Causes for forest resource developments for the period 1990 - 2011

5.5.1 Direct causes

5.5.1.1 Afforestation

Period 1990-1999, afforestation activities remained limited in the two districts, mainly through the Reforestation Program 327 and provincial budget-funded reforestation programs. A small area was afforested through a joint-venture. During this period, a total area of approximately 9,200ha plantations was dominated by such species as Eucalyptus and Pinus. According to interviews from forestry companies, due to limited techniques and seedling quality, the survival rate of plantations is not high.

The result of above projects is showing in table 10:

Table 10: Afforestation projects in 1990-2011

Project	**Area (ha)**		**Project duration**
	Di Linh	Lam Ha	
327 Project	420	1461	1993-1999
661 Project	324	1165	1999-2010
147 Project	120	464	2006-2010
FLITCH Project	120		2007-2010
provincial budget-funded	5262	3247	1976-2007
Small-scale reforestation	3420	2153	1998-2007

Source: Department of forestry, flitch PPMU

Figure 02: Pine plantation by provincial budget-funded – Dong Thanh – Lam Ha

For the period 2000-2011: A series of diversified reforestation projects and programs and different involvement from different sectors strongly promoted the planting operation in the two districts. During this period, six large-scale reforestation projects included provincial budget-funded reforestation program, Project 327; 5 Million Ha Reforestation Program, program 147 and wood pulp-based reforestation project and FLITCH- funded reforestation project. In addition, other integrated programs such as 30A project also supported local people in their small-scale reforestation activities. During this period, reforestation campaigns proliferated, contributing to expanding forest cover. The planting operation was locally carried out through forest companies and forest management boards. Dominant species are Pinus Kesiya and Acacia Hybrid

So far many typical organizations and individuals have been complimented for their outstanding achievements of reforestation activities. Especially, the Nam Ban Protection Forest Management Board was awarded for their excellent achievements in the project 661 implementation by the Ministry of Agriculture and Rural Development (MARD); Mr. Dang Van Loc bread-winner attained outstanding achievements in his forest protection and forest contract in Phu Son commune of Lam Ha district.

5.5.1.2 Natural regeneration

Along with the planting operation, regeneration is also a technical measure to increase forest area. However, ***for the period 1990 - 2000***, forestry programs and projects did not employ the technique of regeneration in Di Linh and Lam Ha districts. ***For the period 2000 - 2005***, the 5MHRP (Program 661) started applying the technique of regeneration, specifically as follows:

Table 11: Area of natural regeneration

Unit: ha

No	Forest managers	Area
	Hoa Bac- Hoa Nam Forest MGB	1.908
1	Nam Ban Forest MGB	1.320
2	Lan Tranh Forest MGB	476

Source: 661project management board of Lam Dong

The land area was directly assigned to forest owners for natural regeneration. The Hoa Bac and Hoa Nam Project Management Board conducted forest regeneration on a quite large forest area (1,908ha). It was the only unit to employ this technique in Di Linh district. The total area of 1,796 ha was regenerated by both forest owners in Lam Ha district. The entire areas which were regenerated in the two districts are protection and special-use forest land areas. To date, these areas have been well developed into rehabilitation forests (status IIA and IIB) and converted into a forest protection-contracted area (based on the results of Lam Dong management board of Project 661).

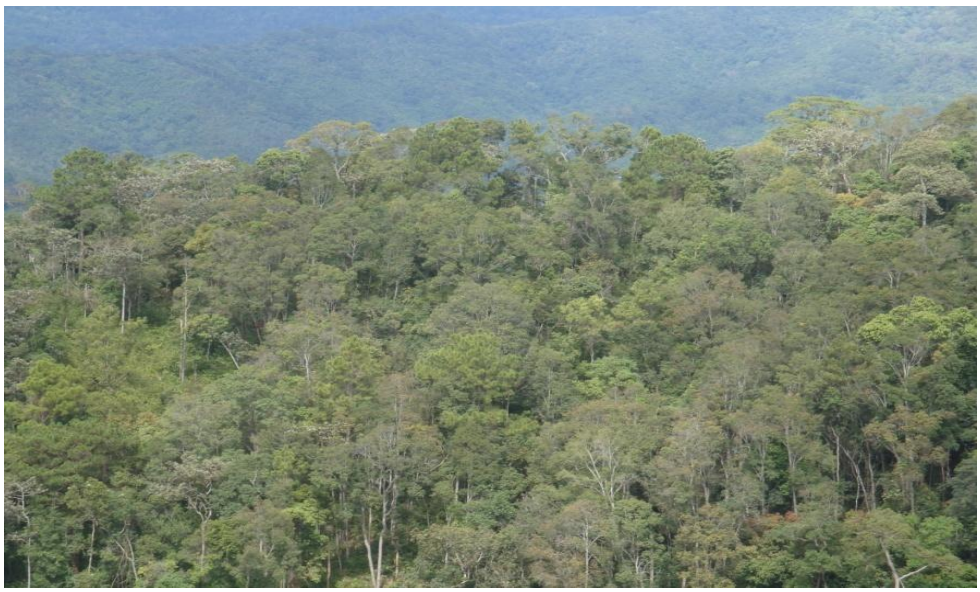


Figure 03: Forest regeneration in Son Dien – Di Linh

5.5.1.3 Deforestation for farming land

Direct causes for forest resource degradation in the Central Highland, in general, and Lam Dong province, in particular, cannot but mention deforestation for agricultural and cash crop production, specifically coffee production. Coffee was the most developed crop on deforested and converted forest areas in Di Linh and Lam Ha districts. In addition, some other crops such as tea, pepper, fruit trees etc were also planted. However, forests were logged depending on different stages while factors affecting local people's interventions in deforestation are very different.

Figure 04: Deforestation in Di Linh

For the Period 1990 - 2000 and before 1990, forest resources in Di Linh and Lam Ha districts were mainly converted mainly due to local people's inadequate availability of staple crop production land. During the period, the whole country, in general and local people in the two districts, in particular is in a serious shortage of food. The agricultural land expansion was encouraged by the Government of Vietnam to meet food demands there and then for local people and for the entire society. In fact, paddy cultivation area was very limited in the two districts. Because of poor knowledge of forest functions, local people mainly relied on deforesting to get more land for farming. They mainly developed the agricultural sector on a large scale while crop yield was not high because the quality of plant varieties has not yet been improved and the farming methods remain obsolete. Therefore, the natural forest contraction was unavoidable.

Between late 1995 and 2000, coffee price soared while the presence of engine-driven saws caused a serious and large-scale deforestation. Many communes completely lost their existing forest areas and replaced forests with coffee for only a very short time, for example, in Hoai Duc, Tan Ha, Ha Nam and Nam Ban communes of Lam Ha district; in Ninh Hoa, Nghia Tan, Tan Chau and Hoa Trung communes, or Di Linh township of Di Linh district... Most of the aforesaid communes still had forests left, even the total natural area was mainly occupied by forests until 1990 and before that, and then the forests completely disappeared in 2000 or if any, there were only plantations and extremely poor natural forests left. Deforestation aimed to grow different plant species, however, mainly to grow coffee since it is a coffee-growing area in Lam Dong province. However, local people living in Son Dien and Gia Bac communes of Di Linh district destroyed the forests mainly

for the purpose of their farming practice since soil conditions mainly including Aerosols are not suitable for coffee plantation.

For the period 2000 - 2010: Although the Party Commissions and local authorities draw out experiences in their management over last period, illegal logging was still happening. Forest resources were seriously devastated in the two districts in early years of the 21st century due to the authorities' undisciplined management and weak deterrence in hot spots. In many regions no sooner were forest destroyed, local people grew their coffee without notifying the local governments who could not promptly stop such action, for example in compartments No. 250 and No. 253 in Phuc Son communes. Over recent years, thanks to due attention paid to forest protection and management, illegal logging has been controlled remarkably in terms of the scale and number of violation cases. By 2010, 51 illegal logging cases caused damage to 13.69 hectares while there were 202 illegal trade and transport of forest products in Di Linh district; and these figures were 57 illegal logging cases (and area of 13.72 hectares damaged) and has 55 illegal trade and transport of forest products in Lam Ha district.

5.5.1.4 Forest logging

Logging is one of direct and important causes for forest degradation in Lam Dong province, in general and in Di Linh and Lam Ha districts in particular. The period which was considered the most flourishing period of forest exploitation was between 1990 and 1995 and the period before 1990. State Forest Enterprises (SFE) and agricultural farms were established with aims to perform their single task of forest exploitation during this period. In addition, another of SFE's tasks was to clear forests for developing cash crops. Along with the strong forest logging campaigns launched by forestry companies in all provinces with forest cover, local people also got involved in forest exploitation. During this period, it is said that "all individuals exploited forests, so did all households; the State and local people together exploited forests". In addition to legal logging, illegal logging was very prominent. Especially, local people's illegal logging usually occurred during the leisure time after their harvest time and between crop seasons. They often trespassed into the woods in order to cut trees for their house construction and generate additional income for their families.

As stated by Mr. Hoang Van Giang - Vice Chairman of Gung Re CPC who used to work in the forestry sector for many years before working as a civil servant in CPC, forests had been extremely exploited during the period before 1990, mainly focusing on rich forests and natural Pinus forests. Clear cutting was popularly applied. Between 1990 and 1995, SFEs moderately conducted harvesting operations whilst local people's illegal logging intensively occurred. According to Mr. Giang, logging by SFEs created a premise for local people's illegal logging in the forests. Moreover, fixed cultivation and resettlement projects caused a quite strong wave of deforestation during this period.

Figure 05: Forest logging in Hoa Bac- Hoa Bac, Hoa Nam Forest management board

5.5.1.5 Forest fires

Forest fires are a cause for forest degradation in 2 districts, in particular and in Lam Dong province, in general.

Di Linh and Lam Ha districts have many different forest statuses, including very distinctive and pure Pinus natural forests. Therefore, forest fire management is always the 1st priority given by relevant sectors and departments involved in forest protection at all levels. However, forest fires happen at different intensity and scale every year. They resulted in huge and serious consequences. Specifically, according to the review reports on forest fire management in 2005 developed by Forest Protection Units of Di Linh and Lam Ha districts, there were 21 fire cases, causing damage to 29.5 ha forest, of which 10 cases in Di Linh caused damage to 11.4 ha and 11 cases in Lam Ha destroyed 19.1ha forest.

Lam dong province's climate and forest conditions are very likely to cause fires since its dry season extends to 6 months without rain (from November of the previous year to April next year), or a very low rainfall if any, might kill the vegetation cover. On the other hand, because of being a densely-populated region, the slash-and-burn practice still persists, which also might easily cause forest fires. The survey findings showed that the former forests which caught fire were mainly natural forests; however, more plantations have been burnt over recent years.

Figure 06: Pine forest fire in Di Linh

Regarding the cause for recent fire cases occurring in plantations, some forest owners complained that competent agencies did not approve the funding for forest fire management plan when approving the reforestation project. However, according to some forest rangers, before the planting operation, the vegetative cover was supposed not to be well cleared up, leaving a high density of shrubs, reeds and weeds. Then when the dry season comes, the vegetation cover becomes dry and inflammable. Furthermore, reforestation usually takes place on the area where the population applies the slash-and-burn farming practice. Whenever the area is withdrawn for reforestation activities, many local people intentionally burn the existing plantations, unhappy with the revocation.

5.5.1.6 Hydro-power generation schemes

One of the causes for forest loss is hydro-power plant construction. Because of a strongly-fragmented terrain, high annual rainfall, high density of rivers and streams which are mainly tributaries of Dong Nai River and Luy River upstream, Di Linh and Lam Ha districts have many favourable conditions for hydropower development. Between 2005 and 2010, according to statistics, the two districts had 20 small and medium- sized hydropower plants which were projected and built. The list of hydroelectric power plants and their respective flooded area is as follows:

Small-scale hydro-power plants have reservoirs and dams located in the two districts. The number of hydro-power schemes which have reservoirs and dams located outside the region was not reckoned up. Typically, Ham Thuan - Da Mi hydropower plant which is located in Lam Dong and Binh Thuan provinces started operating in 1997. A part of Hoa Nam commune (in hamlet 11 and hamlet 13) in Di Linh district is situated in the reservoir bed; or Dinh Trang Thuong commune of Di Linh district and Tan Thanh commune of Lam Ha

district are also located in the inundation area of the hydro-power plant Dong Nai 3 (situated in Dak Nong province)

Table 12: List of Hydro-power and their area of reservoir up to the year of 2010

TT	Name of the project	Location		Total area of reservoir (ha)	Of which		
		Commune	District		Agriculture land (ha)	Forest land (ha)	Stream area (ha)
1	Bob La	Lien Dam	Di Linh	3,5	3,0		0,5
2	Da Riam	DinhTH.	Di Linh	39,0	36,1		2,9
3	Da Trou Kea	Lien Dam	Di Linh	8,6	6,4	1,0	1,2
4	Da Rium	Dinh Lac	Di Linh	2,5	2,0		0,5
5	Da Ke Trou 2	Tam Bo	Di Linh	27,5	0,7	25,0	1,8
6	Song Nhun	Gia Bac	Di Linh	25,0	2,2	21,3	1,5
7	Da Goub 1	Tam Bo	Di Linh	8,3		7,0	1,3
8	Ta Li	Tam Bo	Di Linh	2,8		2,3	0,5
9	Song Nhun 2	Gia Bac	Di Linh	41,5		39,0	2,5
10	Crom Luc	Son Dien	Di Linh	6,0		5,0	1,0
11	Da Dang 1	Phi To	Lam Ha	92,0	82,5	2,0	7,5
12	Da Cho Mo 1	Phi To	Lam Ha	29,0	8,0	18,5	2,5
13	Van Minh-Da Dang 2	Tan Ha	Lam Ha	31,0	28,7		2,3
14	Me Linh-Cam Ly	Me Linh	Lam Ha	32,3			
15	Nam Bang-Cam Ly	Gia Lam	Lam Ha	20,0	18,0		2,0
16	Da Cho Mo 2	Phi To	Lam Ha	16,9	8,2	5,7	3,0
17	Phu Son- Da Dang	Phu Son	Lam Ha	25,1	21,1	2,0	2,0
18	Da Dung	Phi To	Lam Ha	47,0	36,1	8,2	2,7
19	Da Dang A	Da Don	Lam Ha	33,0	30,5		2,5
20	Da Se Do 2	Phuc Tho	Lam Ha	25,0	1,0	21,9	2,1
Total				**516,0**	**284,5**	**158,9**	**40,3**

Source: Department of Commercial and Industrial of Lam Dong

The hydropower plant construction has direct and indirect impacts on forest resources. When the dam is closed, water level rising in the reservoir causes flooding in the surrounding area. Based on the above-mentioned table, we can see that the flooded forest area is 158.9 ha. Song Nhun 2 (39ha) and Da Ke Trou 2 (25ha) cause flooding on the largest forest areas. In addition to inundation areas, road construction and embankment etc. all have influence on forest resources. When road is opened through the forest, trees are cut

down, causing deforestation. In case where land compensation is required for power plant construction, land areas for housing and production could have negative impacts on forests, diminishing forest resources. Hydropower plant Dong Nai 3 flooded a wide area of Dinh Trang Thuong commune, forcing households to evacuate from the flood-stricken areas. The establishment of the resettlement site in hamlet 2 caused further deforestation.

Figure 07: Dong Nai 3 hydro-power

In addition to direct impacts, hydro-electric plant construction has indirect impacts on forest resources. The hydropower plant construction in densely-forested areas is required to build roads to transport construction materials, which facilitates illegal loggers (mostly individuals) to make easy access to forests. Since more construction materials are needed during the construction, timber logging in the surrounding area is unavoidable. The larger scale the power plants, the more forests are destroyed. Trees in the reservoir beds are allowed exploited during the dam construction, however, the actual harvesting volume was much higher than the figure as reported. Forest criminals use the permission as an excuse to exploit forests at the maximum level in surrounding areas where tree cutting is allowed for land compensation. In addition, while water level rising creates favourable conditions to irrigation services, trees located along lakes/reservoirs are often cut down by local people and replaced with other crops.

5.5.2 Indirect cause

5.5.2.1 Impacts of coffee plantation

Forest resources declined nation-wide between 1990 and 2010. Di Linh and Lam Ha districts were not exceptions. Deforestation for agricultural plant and cash crop production, especially coffee plantation in two districts was considered the 1st cause for forest deforestation.

Being situated in the basalt region with thick soil layer and high fertility as well as favourable climate conditions, Di Linh and Lam Ha districts are very attractive to immigrants. However, ***during the period 1990-1995***, forest resources were diminished mainly due to illegal logging for food crop production. The statistics also showed that staple crop production during this period was much greater than with other crops, including coffee. **For the period 1995 – 2005**, forest resource was also most severely damaged. Coffee price rose to VND40,000/kg in 1994, which was seen the heyday of coffee production. Di Linh and Ha Lam districts have strongly developed their coffee plantation since 1995. Di Linh district expanded up to 3,500 ha 4,000 ha of coffee in some years. Not only local people but also others gathered in the region for coffee plantation. The area of cash crop production (mainly coffee) was 2.240ha in 1987 in Lam Ha district, this figure increased to 24.264ha in 2000. The increase in coffee plantation means the decrease in forest area. The survey findings showed that the high pressure combined between a soaring coffee price and undisciplined management of local authorities created a "wave" of deforestation for coffee plantation throughout Di Linh and Lam Ha districts. Especially, between 1995 and 2000, many forests were replaced by coffee plantation. With a complicated terrain and a large area, local authorities in some regions could not control local people's forest destruction. No sooner were forest destroyed in many regions, local people did grow their coffee without a notice to the local governments who were not informed to promptly stop such action. As of 2005, natural forests were absolutely cleared in many communes of the 2 districts, namely Hoa Ninh, Nghia Tan, Tan Chau, Trang Dinh Hoa and Di Linh town of Di Linh district; and Hoai Duc, Tan Ha, Ha Nam, Nam Ban, Tan Van, and Lien Ha communes of Lam Ha district

Table 13: Statistics of the area, crop yields in the project area

District	Item	1995		2000		2005		2010	
		Area	yields	Area	yields	Area	yields	Area	yields
Lam Ha	Food crop	4.157	30.305	5.885	28.263	5.110	21.698	4.458	18.884
	Tea	578	2.990	509	2.070	706	3.922	369	3.096
	Coffee	4.532	3.600	24.264	26.868	34.630	37.731	39.445	94.237
	Peper					18	26	19	44
	Cashew	160							
Di Linh	Food crop	9.310	10.177	3.598	13.161	5.754	25.330	5.674	25.015
	Tea	878	3.255	695	2.245	2.015	10.350	886	5.640
	Coffee	22.260	7.268	27.388	40.264	25.794	32.514	41.527	96.800
	Peper	3		0	0	11	15	13	20
	Cashew	27							

Source: Statistical Yearbook of Lam Dong province

Period 2005 – 2010: a large area of remaining forests was also occupied for the purpose of coffee plantation. Di Linh District People's Committee (DPC) issued the Decision No. 1251/QD-UBND approving the adjustment of land use planning by 2015 and land use plan for the 1st phase" including 1,161ha of converted production forests in 2006. According to

the statistics, Di Linh and Lam Ha districts' coffee production area reached to nearly 81,000 ha with the total production of 191,000 tons in 2010. Thus, a larger coffee production area inevitably resulted in forest deforestation.

Figure 08: Coffee trees are planted on almost area of Tan Chau hills

5.5.2.2 Population growth pressure

Table 14: Census in the project through the periods.

Unit: person

District	Population 1990	Growth rate 1990-1995	Population 1995	Growth rate 1995-2000	Population 2000	Growth rate 2000-2005	Population 2005	Growth rate 2005-2010	Population 2010
Di Linh	81.102	21,7	98.675	42,2	140.344	6,6	149.551	5,6	157.906
Lam Ha	60.344	54,0	92.935	18,3	109.966	21,6	133.727	4,5	139.761
Project	141.446	35,5	191.610	30,6	250.310	13,2	283.278	5,1	297.667

Source: Statistical Yearbook of Di Linh and Lam Ha

For the period 1990 – 2000: Immigration into Di Linh and Lam Ha massively occurred, mainly including flows of Northern people who desired to do their business. The total population in two districts increased to 108,864 persons during this period (an average increase of 10.886 persons/year). In fact, immigrants into the two districts under the new economic development program for the period 1977-1986 were considered a bridge for subsequent flows of free immigrants. Most of them were identified as relatives of former immigrants. The rapid population growth and high land demands inevitably caused illegal logging for farming land.

For the period 2001 – 2010: Free immigration decreased but remained complicated. The total number of immigrants was 3,183 households or12.834 persons between 2001 and

2010, including 747 households or 2.771 persons in 2001 alone. Ethnic minority households from northern mountainous provinces often gathered and settled in watershed protection forests. Such phenomena as illegal logging for farming and illegal forest land encroachment remained very complicated, severely causing serious damage to forest resources and adversely affecting the local security and social order and local people's life who faced so many difficulties as hunger, illiteracy and disease.

Table 15: Immigration in the period of 2001-2010

Location	**Total**		**2001**		**2005**		**2010**	
	Household	Person	Household	Person	Household	Person	Household	Person
Lam Ha	1.845	7.546	90	337	101	381	71	325
Di Linh	1.338	5.288	657	2.434	83	481	16	55
Total	3.183	12.834	747	2.771	184	862	87	380

Source: DARD, Ethnic minorities Department of Lam Dong province

Under such context, Di Linh and Lam Ha DPCs issued written guidance on prevention and settlement of deforestation and illegal encroachment of forest land in such "hotspots" such as Tan Thanh and Phuc Tho communes (Lam Ha district) as well as provided direction on developing investment projects for free immigration statibilization in Tan Thanh commune (Lam Ha district), Hoa Bac - Hoa Nam (Di Linh) and many urgent migration projects, helping people escape from flash floods and landslides. It is notably that the fixed cultivation and resettlement project was implemented by Ethnic Minorities Committee of Lam Dong province.

Table 16: Sedentary scheme

Location	Amount	
	Household	Person
Lam Ha		
Buon Chuoi - Me Linh	36	200
Hang Ho - Me Linh	33	160
R'Teng - Phu Son	40	210
Cong Troi - Me Linh	41	210
Di Linh		
Ta Ly - Bao Thuan	50	255
Bao Tuan - Bao Thuan	65	320
Hang Lang - Gung Re	35	175
K'Long Trao - Gung Re	52	260
Thon 9 - Lien Dam	49	200

Source: DARD, Ethnic minorities Department of Lam Dong province

Under the project, most of stakeholders are ethnic minorities who are offered housing and production area as well as infrastructure investment such as roads and schools and clinics. The total budget for these activities reached up to 62,934 million dongs. This key program is expected to control the immigration and shifting cultivation in the future, contributing to restrict the pressure over existing forest areas in the province.

5.5.2.3 Inefficient management

Local authorities' forest management is one of indirect reasons causing to decline of forest resource in the two districts, particularly in period 1990 – 2005. The main reason is that most of communes were newly established thus staffs are few and activities implemented ineffectively. In addition, incentive policies for new economic zones, namely: people are allowed to exploit forest, to slash and burn. Such kind of policies creates conditions for people to deforest.

Forest protection units are understaffed and under-qualified, which cannot be able to control forest decline in the areas. Experienced forest rangers (Le Van Cong and Nguyen the Liem) in Lam Ha and Di Linh districts said that university graduated forest rangers account for 10 % to 15 % of total staff of forest protection units. Forest product control station is scattered and their team is understaffed (only 1 or 2 people/unit), which is not enough to control and manage their own forest management. Mr. Le Van Cong and Mr.Nguyen The Liem told that from 1990 to 1995 and before that time, forest rangers mainly took responsibility for issuing licence and managing forest exploitation for forest owners. Recently, districts' forest harvesting volume has gained by thousands of cubic meters of logs per year. The huge volume and understaffed team makes only licence issuing overloaded for local forest rangers therefore they found difficult to control and manage illegal forest exploitation.

5.5.2.4 Effects of land transaction and land accumulation to forest change in the two districts.

Land transaction is remarkable reason of forest change in areas. Land dealers approach local people particularly ethnic minorities who are entitled to state incentives programmes for land. They mobilise minority people to deforest and use land for production, afterwards when land is legally allocated they will buy land with high price and grow coffee seed or resell for others. Mr.Dinh Cong Nhay, president of Hoa Nam commune - Di Linh district said that land deal transaction is a hidden reason of forest loss. Each province has their own management policy to control land transaction, such as: each poor household without land will exploit specific areas and is not allowed to deal with land dealers.

5.5.2.5 Infrastructure investment

By conducting survey and interviewing local staff and people, during the recent years, infrastructure development accounts only for 3 – 5 % of commune forest removal. However, it is the fact that infrastructure investment has great impact on provincial forest resource development. This leads to deforestation more quickly. Most of communes in the two districts were established from 1985 to 1990. At that time, roads were built and enlarged. Mr.Le Van Cong, a Lam Ha district forest ranger, said: observing forest change

during last year shows that each new road drags on losing reducing quality of 2 forest lines along the road due to easy transportation of forest product.

5.6 Analysis of forest and forest land developments

5.6.1 Assessment of impacts of policies

Over recent years, the State has issued many important legal documents, creating a legal framework for forest management, protection and development as prescribed by the Law on Forest Protection and Development (2004), Land Law (1993, 1998), Environmental Protection Law (1994); Resolutions and Decrees by the National Assembly and Government of Vietnam; and Decisions and Directives by the Prime Minister. In addition, there are many other legal incentives mechanisms such as tax exemptions from reforestation land, tax exemptions from wood imports with aims to encourage economic sectors, organizations and individuals involved in forest protection and forest development, processing and production etc...

The current legal framework has reflected many positive aspects, for example, it enables farmers to secure their forest land use and enjoy more benefits from forests than ever before. A legal environment has been gradually established to encourage investors to invest their money in the forestry development. This is a basis to create equal conditions between forest enterprises and other economic sectors in forestry business activities. However, negative impacts which discourage forestry development still exist, for instance, forest land use rights and unsustainable forest land use planning, incentive policies, funding availability and technology for forest owners which is both subsidized and loosely linked with people's resource mobilization.

5.6.1.1 Policy on SFE reform

Lam Dong province developed a SFE renovation and development project in 2005 and submitted it to MARD for appraisal and got approval by the Prime Minister under the Decision No. 296/2005/QD-TTg dated 14/11/2005.

Based on the approved project, Lam Ha and Di Linh PCs collaborated with other provincial departments and competent agencies to implement the project. Di Linh, Bao Thuan and Tam Hiep SFEs in the two districts were transformed into forestry companies. After the restructuring, the forestry companies actively supplemented their business lines and sought partners for their joint venture in material-oriented plantation in combination with processing industry. They took initiative in increasing their investment in expanding wood production and trade activities of the wood processing establishments. So far, the forestry companies have actively mobilized investments in developing production forest land areas, mobilizing funds from different economic sectors to accelerate the intensive economic reforestation. Therefore, these forestry companies had their plantations improved both in terms of quality and quantity.

5.6.1.2 Policy on PFES

Aiming to implement the Decision No.1574/QD-UBND dated 10th June, 2008 by Lam Dong province on payment for environmental services. Di Linh and Lam Ha districts in collaboration with provincial authorities targeted at establishing an innovative financing mechanism which is directly constituted and contributed by forest environmental service users to the forest sustainable development. Local relevant departments, agencies, sectors, organizations and individuals were fully aware of the PFES policy

This policy has brought in practical efficiency and positive direct and indirect impact on forest resource developments. This is clearly shown during the PFES payment process in Dong Nai river basin (*Tan Thanh – Lam Ha report abstract):*

The pilot area of PFES of basin of Da Nhim and Dai Ninh hydropower plants is 121,024 ha; Dong Nai River Basin in the territory of Lam Dong is 395.803ha. In 2009, the forest Protection and Development Fund has contracted to pay for 3,342 households (including 2,694 ethnic minority households and 648 Kinh households) with total forest area of 112,208 hectares.

- Social-economic aspect: households who have forest areas contracted for their protection is paid 300,000 VND/ha/year as a PFES receivable, each household has an average of 30 hectares, this the total income of each household increased 3 times as much as the figure subsidized by the Project 661, contributing to poverty reduction and livelihood improvement among households having forest areas contracted for their protection (the number of poor local households in the PFES pilot areas decreased by 15%);
- Environmental aspect: Forest areas eligible for PFES was well protected. The reported cases of deforestation, forest encroachment, and illegal exploitation of forest products decreased by 50% compared to the figure of the previous years before PFES policy was piloted.

5.6.2 Assessment of impacts of forestry projects and programs on forest resource developments

Between 1990 and 2011, many forestry projects and programs were implemented in the two districts. Based on the time frame of such projects and the extent of project impacts on forest resource developments, the report analyzes the two following two periods:

5.6.2.1 For the period 1990-2000

The forestry investment programs remained limited, mainly including Program 327 and the provincial budget-funded reforestation project funded by the provincial budget. Most of funds were used for reforestation activities. Natural regeneration and forest protection were not reinforced. The total area of newly-established forests of Program 327 during this period was 9.203 ha.

The Program 327's advantage is to offer loans to households. This program also created many favourable conditions for project employers to disburse as well as a benefit-sharing mechanism applicable to all stakeholders. However, the program's weakness is not to precisely identify three types of forest on field, leading to a mis-use of funds because the rate of investment in reforestation on the production, special use forest land is different, so when the three types of forest boundaries are not clear, people will declare the type of forest plantations on investment rate high in order to take advantage of funds of the local forest. On the other hands, this program was seen a poverty reduction program in many areas, resulting in a fragmented investment and average investment rate, slow capital disbursement, undisciplined and unclear capital withdrawal regulations.

5.6.2.2 For the period 2000-2011

In case where projects only invested in forest plantations, for this period, other objectives of forest regeneration and protection was also highly emphasized. Forestry programs and projects were more diversified. More importantly, local governments promulgated and enforced a series of key policies to positively affect forest resources during this period.

5.6.2.3 Project/program impacts

- **Positive aspect:**

The 5 Million Ha Reforestation Program (Program 661) has more outstanding advantages. It took a program-based approach which attracts more donor countries and international organizations to involve in this program, ensuring a legal basis for the implementation. However, the project also has shortcomings such as unclear investment policy, benefit-sharing mechanism and credit incentives applicable to production forests, mortgage requirements, land rental etc...

Projects 147 and FLITCH have been investing in large-scale reforestation activities. The Project 661 had other silviculture activities including forest regeneration and protection, apart from a number of integrated programs such as Project 30A with the main objectives is "To support development of agriculture, sustainable forestry, in the direction of commodity production, exploiting the strengths of the locality. Building infrastructure - economic and social conformity with the characteristics of each district economic restructuring and other forms of organizing production according to plan effectively and build a stable rural society, rich cultural and ethnic identity; enhanced intellectual, ecological environment protection and ensuring strong security and defence."; the fixed cultivation and resettlement program also supported the province in small-scale reforestation and forest protection. Therefore, forest cover increased not only thanks to the presence of newly-planted forests but also regenerated forests. Furthermore, forest protection with support from different projects helped maintain and develop the existing forest areas in an effective way.

The fixed cultivation and resettlement program and the socio-economic development program in extremely difficult remote and isolated areas had positive impacts on the life quality of ethnic minorities living in mountainous areas as well as supported the forest sector in forest establishment and conservation. The main objectives of this program are "To focus on the basic situation of migrants currently living freely in project area.

Propagating and educating and mobilizing people to arrive at new guidelines implement the Party's guidelines, policies and laws of the State. Concentrate on building a work item of essential importance in a number of places allocated conditionally stable population to gradually improve the material life and spiritual life and long-term stability people. Combined with the armed forces in the area to strengthen and build the political system, solid base, improve the quality focus of the system operation facilities from villages to create security posture, national defence." A series of good models which combined between fixed cultivation and forest protection practices with the participation of nearly 2 million ethnic minorities have been developed. In addition, forestry projects which have been implemented in the province since 2000 has created many socio-economic benefits. Attracting local people, especially ethnic minorities to take part in forest protection contracts and annual silvicultural services such as planting, tending, assisted natural regeneration, enriching and thinning has greatly contributed to job creation, poverty reduction and higher income as well as improvement of local people's awareness and their responsibilities for forest management, planting and tending techniques in the two districts.

Having integrated the annual budget for households having forest areas contracted for their protection as stipulated by the Decision No.304/2005/QD-TTg and Resolution No. 30a /NQ-CP into the budget for the forest area under Project 661, each household have been offered additional 100,000 VND/ha/year since this project was launched and provided a rice subsidy with the rate 10kg/head/month during consecutive 06 months, contributing to higher income for household assignees as well as encouraging poor ethnic minority households actively involving forest protection and investment promotion since 2005

Table 17: The total area of the project implementation period 2000-2011

Unit: ha

Project	Forest Plantation	Forest Restoration	Forest Protection
661	1489	3704	11169
147	584		
FLITCH	120		
Provincial budget	6760		

Source: Department of Forestry, PPMU of FLITCH

- **Shortcomings:**

The following shortcomings are commonly confronted by the projects, especially state budget-funded programs:

At the local level:

Some existing legal documents and policies promulgated by the local level had negative effects on the forestry project implementation in certain areas:

- Reviewing the catchment planning and watershed protection forest area in Lam Dong Province in 2003 (under the Decision No. 1898/QD-UB dated 07/18/2003) and three forest type re-classification (under the Decision No. 450/QD-UBND dated 19/02/2008) has

adjusted structure and area of protection, special-use and production forests, leading the adjustment of some grassroots-level projects, including annual production plans with aims to attain the project objectives

- Some legal documents related to decentralization and authorization, some regulations on tendering procedures for infrastructure construction projects (under the Decision No. 10/2006/QD-UBND dated 22/02/2006), still had discrepancies, when applied

At the national level:

The investment rate of planting operation of protection and special-use forests as stipulated in the Joint Circular No. 28/1999/TT-LT dated 03/02/1999 by the Ministry of Agriculture and Rural Development, the Ministry of Planning and Investment and the Ministry of Finance applied for 661 project is much lower than the cost norm, unit price and actual investment cost in provinces. In case of poor provinces, counterpart capital contribution was not available, causing difficulties during the implementation.

Records and procedures for capital administration, allocation and disbursement as prescribed in the Circular No. 28/1999/TT-BTC dated 03/13/1999 and Circular No. 43/2002/TT-BTC dated 07/05/2002 by the Ministry of Finance remain complicated compared to other programs and projects;

Over recent years, GOV launched and steered the implementation of various programs and projects, for instance, forest assignment under the Decision No.304/2005/QD-TTg dated 23/11/2005 of the Prime Minister; the rapid and sustainable poverty reduction program under the Resolution No.30a/2008/NQ-CP dated 27/12/2008 by the Government etc... These programs were integrated with the 5MHRP; however, the higher cost norms of these programs caused difficulties in implementing the 5MHRP.

5.6.3 Assessment of socio-economic impacts on forest resource developments

5.6.3.1 Economic development impacts

According to statistics, the total production value of the agriculture and forestry sectors in 2 districts has increased rapidly. By 2010, this figure was nearly 18 times as high as it was in 1995. Coffee plays a major role in increasing the total economic value of these sectors. In fact, the more the economy develops, the higher investment capital for coffee plantation is, and the better farming facilities, techniques and seedlings are improved. This led to higher demands for larger production expansion. Therefore, the pressure over forest resources is inevitable. Local people shall try their best to seek ways to convert forests and other land areas into coffee. Therefore, the changes in forests and forest land very difficult to control.

Table 18: Total value of production in the area at current prices

Unit: Million VND

Items	1990	1995	2000	2005	2010
ECONOMIC SECTORS	**147.168**	**260.445**	**771.370**	**1.814.015**	**2.820.301**
Domestic economic sector			**765.987**	**1.767.000**	**2.362.142**
Government			110.421	269.836	1.170.985
Collective			14.968	19.340	253.061
Private			22.664	106.453	917.924
Individuals			617.934	1.371.371	20.172
Foreign invested regions			**5.383**	**47.015**	**458.159**
BY ECONOMIC SECTOR	**147.168**	**260.445**	**771.298**	**1.814.015**	**5.851.637**
Agriculture and Forestry		198.848	579.920	1.282.367	3.503.396
Fisheries			490	800	1.150
Industrial		41.021	88.167	243.656	1.399.956
Others		20.576	102.721	287.192	947.135

Source: Statistical Yearbook of Lam Dong province

In addition, due to impacts from a strong economic liberalization, land and forest resources are being over-exploited, affecting sustainable national economic development. The main cause is human interventions in irrational exploitation and use to meet their immediate needs and improve their income livelihood without emphasis on sustainable forest resource use. With focus on short-term economic development, local people are willing to exploit forest resources and convert them into farming land without considering environmental consequences in the future.

5.6.3.2 Impacts of market-oriented economy

Regarding positive aspects, it is certain that the liberalization of trade and investment have huge impacts on land and forest use and exploitation. This liberalization has increased local people's income. It made labourers have a stronger connection with land resources. As a result, they shall highly respect the land resource, contributing to increase the wealth generated from land and forest. Therefore, agricultural and forest area, productivity and production were all improved, which accelerates the quick land conversion from forests into cash crop plantations in the two districts.

However, unclose cooperation among economic sectors and enterprises and poor concern over business mechanism development have weakened the competitiveness during the international integration. Coffee prices constantly fluctuate without following any market trends and under the context of harsh weather conditions and higher cost of supplies, gasoline, oil, fertilizers and pesticides. On the other hand, coffee price is often controlled by speculators, causing more inherent difficulties to provinces in their coffee production and trade. In addition, local authorities have not yet determined specific directions and measures in steering enterprises and local people to expand their demand-oriented coffee production.

Market self-regulating and spontaneous coffee production expansion has adversely affected forest resource management, protection and development.

5.6.3.3 Impacts of land use planning

The land-use planning in Lam Dong province in general and in the two districts in particular remains inconsistent among relevant sectors, especially between DONRE and DARD. The real situation is that the boundaries of land use planning inside and outside of forestry sector have not yet been clearly identified. The 3 forest type re-classification has been completed, however, the database and baseline maps failed to reach the necessary accuracy and meet local demands for land use. Therefore, there are many difficulties in sustainable forest management and development, forest resource protection and sustainable development.

The quality of the land use planning is still low. The planning fails to precisely forecast and reflect actual situation. It is still heavily subjective. The administration of the approved land use planning remains weak, leading to encroachment and illegal forest land conversion.

In addition, due to local people's low awareness and participation level in the planning process, the land use planning is not adhered to, particularly in protection forests.

5.6.3.4 Impacts of forest changes monitoring and assessment program

Forest and forest land changes monitoring and assessment is annually mainly conducted by forest protection sub-department. However, this program is mainly carried out by statistical data collection, while the GIS and remote sensing technique has not been applied yet. This causes difficulties in regular monitoring and evaluation of the developments of forest quantity, quality and distribution for the purpose of forest management, protection and development measures... There have not yet been close cooperation among forest owners, competent agencies and local authorities in periodically collecting and updating data on forest development, land conversion, land-use planning, forest quality assessment, forest fires, illegal logging, mapping and monitoring of forest and forest land developments... Therefore, it is difficult to strictly monitor and control the forest resource developments which have been inherently very complicated over recent years in 2 selected districts.

6 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusion

6.1.1 Forest area

Remote-sensing image and GIS technologies in close collaboration among local relevant organizations and agencies were used to develop forest baseline maps in communes, ensuring the details of the classification scale to precisely and objectively reflect current status of forests and forest land for 2011. This will be very important database serving as a basis for identifying critical areas to implement REDD+ and integrate REDD+ into the land use planning at the district level.

The baseline maps and data for 2011 on forest land area in Di Linh and Lam Ha districts have identified as follows:

- Total forested land area in Di Linh district is 85,097 ha, equivalent to a forest cover of 52.7%

- Total forested land area in Lam Ha district is 24,532 ha, equivalent to forest cover of 26.1%

6.1.2 Changes in forest types and land use types in the period of 2005-2011

- Forested land area in Di Linh district decreased by 5,250ha, equivalent to 3.3% decrease in forest cover.
- Forested land area in Lam Ha district decreased by 3,024ha, equivalent to 3.2% decrease in forest cover.

The changes in forest and land use types for 2005 and 2011 are not as complicated as in 1990 to 2005. The area of cash crop production which is mainly converted from hilly land and un-used land increased, largely from land conversion for cultivation and unused lands. Forests are less affected despite the existence of illegal logging, land conversion into cash crop production and farming cultivation. Some forest areas have been restored after a period of efficient regeneration and protection. Plantation area has significantly increased compared to the previous period.

6.1.3 Forest resource developments

Reforestation and regeneration are two major measures in increasing forest area in certain localities. However, the additional increase in forest area is a smaller percentage compared to forest loss.

Deforestation for agricultural land and cash crop production is the most important direct cause for deforestation in Di Linh and Lam Ha districts. In fact, in both districts, the main aim is to grow coffee. The largest deforestation caused by conversion to coffee plantation happened between 1993 and 1997, which coincided with rising of coffee prices.

Forest degradation is directly attributed to forest exploitation. Although forest exploitation as designed will not shrink the forest area as much as it is caused by deforestation for production land, it is a precondition for subsequent deforestation among local people. The most serious forest exploitation happened between 1990 and 1995 and before 1990.

Indirect cause for negative forest changes was immigration. Another large factor contributing to forest loss was jump in value of coffee plants. Since the coffee price soared, local people constantly expand coffee production area, resulting in a movement of forest destruction for coffee plantation. Higher coffee price also affected the free immigration which was, in turn, the main cause for deforestation.

6.2 Recommendation

The study findings consist of forest mapping surveys and data on forest types and land use in communes of the 2 districts. The forest map development and data calculation for local forest owners such as forest companies, forest management boards and private enterprises have not been conducted. The results can be used as baselines for planning REDD+. Therefore, our recommendation is that reviewing boundaries of forest owners is necessary for serving as a tool to build a mapping system and calculate forest current status database for individual forest owners in the 2 pilot districts.