



REPORT

Land use, forest cover change and historical GHG emission

From 1990 to 2010 Lam Dong province, Viet Nam Ha Noi, August 2013 This report has been produced by the USAID-funded Lowering Emissions in Asia's Forests (USAID LEAF) program in its support for the development of the Lam Dong Provincial REDD+ Action Plan (PRAP). It is one of five technical reports that have been developed to help the Lam Dong Department of Agriculture and Rural Development (DARD) in defining an appropriate Forest Reference Level (FRL) for the Province from which its policies and measures introduced to reduce emissions and increase greenhouse gas (GHG) removals from the forestry sector can be measured against. Specifically, the report assesses and quantifies historical changes in the forest and land use sectors in Lam Dong province from 1990 to 2010, and defines and evaluates the driving forces of the change. It also estimates historical GHG emissions and removal from these sectors over the same time period, and suggests preliminary REDD+ actions and areas to reduce future emissions and enhance removal, to be used as an initial source of information for the on-going development of the Lam Dong PRAP.

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Abbreviations

| CO ² | carbon dioxide |
|-------------------|--|
| CO ² e | carbon dioxide equivalent |
| DARD | Department of Agriculture and Rural Development |
| DoNRE | Department of Natural Resource and Environment |
| FLITCH | Forestry for Livelihood Improvement in the Central Highlands, Project |
| FREC | Forest Resources and Environment Center |
| GDP | gross domestic product |
| GHG | greenhouse gases |
| ha | hectare |
| LEAF | Lowering Emissions in Asia's Forests |
| NFIMAP | National Forest Inventory and Monitoring Program |
| NRAP | National REDD+ Action Program |
| PPC | People's Provincial Committee |
| PRAP | Provincial REDD+ Action Plan |
| RECOFTC | The Centre for People and Forests |
| REDD+ | Reducing Emission from Deforestation and Forest Degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries |
| SNV | Netherlands Development Organisation |
| UN-REDD | United Nations - Reducing Emission from Deforestation and Forest Degradation |
| USAID RDMA | United States Agency for International Development's Regional Development Mission for Asia |
| VNFOREST | Viet Nam Administration of Forestry |

Introduction

Over the past decade, various national and international organizations have made significant efforts to work out mechanisms to combat deforestation and reduce emissions of greenhouse gases (GHG) from the forest and land use sectors. They have attempted to quantify different values of forest resources and forest environmental services and propose workable market payment incentive mechanisms so as to effectively manage these valuable resources. Among these efforts, the most prominent initiative is the Reducing emissions from deforestation and forest degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries (REDD+) mechanism. This performance based mechanism is aimed at compensating developing countries for conserving and protecting their forest resources, thereby reducing GHG emissions and increasing GHG removals. REDD+ mechanisms also seek to generate additional social and environmental benefits. or 'multiple-benefits', which include biodiversity conservation, improvement of local livelihoods and gender equity.

The United States Agency for International Development (USAID) funded Program "Lowering Emissions in Asia's Forests" (LEAF) is being implemented by Winrock International in partnership with SNV Netherlands Development Organisation, Climate Focus and The Center for People and Forests (RECOFTC) in six countries: Viet Nam, Laos, Cambodia, Thailand, Malaysia and Papua New Guinea. The purpose of the program is to strengthen the capacity of developing countries in the Asian region to produce meaningful and sustained reductions in GHG emissions from the forestry and land use sectors, thereby allowing these countries to benefit from the emerging international REDD+ program framework.

In Viet Nam, the USAID LEAF program was approved by the Ministry of Agriculture and Rural Development (MARD). USAID LEAF will provide support for the successful implementation of the Vietnam National REDD+ Action Program (NRAP).

The province of Lam Dong has been selected as one of six pilot provinces under the NRAP to pilot REDD+. USAID LEAF is supporting the development of the Lam Dong Provincial REDD+ Action Plan (PRAP).

As support to the PRAP, this report provides an assessment of historical land use and forest changes, the identification of major driving forces behind these changes and an estimation of historical GHG emissions and removals. This information is critical in the development of the PRAP in Lam Dong province. It is also necessary for the Lam Dong Department of Agriculture and Rural Development (DARD) and the Lam Dong People's Provincial Committee (PPC) to determine and implement sound and convincing policy and mitigation measures to address the drivers of deforestation and degradation and substantially reduce the net GHG emission from the province.

1 Aims and Report Structure

The aim of this report is to:

- Assess and quantify historical change (1990 2010) in the forest and land use sectors in Lam Dong province.
- Define and evaluate the driving forces of forest and land use change between 1990 and 2010.
- Estimate historical emissions from the forest and land use sectors between 1990 and 2010.
- Suggest REDD+ mitigation actions and areas as an initial source of information for the on-going development of the Lam Dong PRAP.

The report is divided into five sections:

Section 1 is a brief introduction to set the context for the analysis.

Section 2 outlines the methodology used to collect and collate the necessary data and information upon which to track and evaluate historical land use and forest change over the four historical assessment periods: 1990 - 1995, 1995 - 2000, 2000 - 2005 and 2005 - 2010.

Section 3 reviews the key biophysical and socio-economic characteristics for the province.

Section 4 details the results from the analysis. The major result areas include:

- Area of forest and land use change for each of the four historical time series
- Reasons (or drivers) for this land use change and impacts
- Estimation of historical emission levels for the four historical time periods.

Section 5 summarizes the results and provides concluding comments, including known limitations and areas for further research and analysis.

2 Methodology

The step-wise process and methods used to collect and collate the necessary information to assess and quantify historical land use change and GHG emission and removals included:

- Gathering primary data from a number of different agencies and stakeholders at the provincial, district and commune levels
- A desk-top assessment of key policy decisions that have influenced, or are likely to influence, land use and land use change in the province
- Pairwise assessment of forest and land use change for each of the four historical time series periods to estimate activity data: 1990 - 1995, 1995 -2000, 2000 - 2005 and 2005 - 2010
- Determination of emission factors and, through the multiplication with activity data, an estimation of historical emissions.

The methodology presented here is only a summary. A full description of all methods used are presented in the supporting technical documents, which include:

- FREC (2013), Report on accuracy assessment for forest and land use maps in the period 1990 - 2010, Lam Dong province. Prepared for the LEAF project.
- FREC (2013), Establishment of forest status map during the period 1990 2010, Lam Dong province. Prepared for the LEAF project.
- Nguyen Dinh Hung (2013), Analysis of raw data of sample plots in NFIMAP-Cycle IV (2006 - 2010), Lam Dong province¹. Prepared for the LEAF project.

^{1.} Decision No. 280/QĐ-UBND, dated February 22nd, 2013, approved by Lam Dong province, related to project management and sustainable forest production of pine forest

2.1 Gathering primary data and information on major drivers of forest changes in Lam Dong province

2.1.1 Field survey

Surveys, interviews and workshops were held to collect information related to the changes in forests and forest land use between 1990 and 2010. The following agencies and stakeholders provided a wide range of data and information used in this analysis:

Provincial level

- DARD provided access to documents from 1990 2010, such as: maps, reports and data from programs to monitor forest changes every year in accordance with Directive No. 32/2000/CT-BNN-KL, reports and data related to forest protection and development and important socioeconomic data.
- The Department of Natural Resource and Environment (DONRE) provided 1:50,000 maps and relevant data and reports related to land use planning from 1990 - 2010.
- The Department of Commerce provided documents related to the development of hydroelectric projects, transport infrastructure and power lines from 1990 – 2010.
- The Provincial Forest Protection Department provided information on forest area and the drivers of forest change and likely future trends.
- The Department of Statistics provided information and data on annual demographics and agriculture and forestry production statistics from 1990 - 2010.

District level

- The Department of Agriculture and Rural Development and related departments allowed the gathering of information and data related to the monitoring of forest change and economic development, agriculture and forestry development and infrastructure and hydropower projects which have been, and are being, implemented in the districts of Lam Dong. Drivers of, and reasons for, forest change were also identified for the period 1990 – 2010.
- Forest organizations and forest owners (state forest enterprises, forest companies and management units for watershed protection and special use forest zones) allowed the collection of data and documents relating to forest management, protection and development at the district level. Problems in forest management and drivers of forest change were also discussed.
- The District Protection Department allowed the collection of information and data from programs to monitor forest change. Drivers and reasons for forest change for the period 1990 – 2010 were also discussed. Potential future forest change and trends were discussed, including which areas have a high risk of forest degradation and deforestation and the drivers of this potential change.
- A district meeting was held after the field survey and data collection process to present consolidated data and preliminary results as well as identified drivers of forest and land use change and forest quality changes across the province.

Commune level

Communes with a high level of forest change were identified and the chairman or deputy chairman of the Commune's People Committee in charge of agriculture and forestry were requested to fill in a questionnaire and provide information about forest change, drivers of this change and future trends that are expected to influence deforestation and forest degradation rates in the commune.

2.1.2 Review policy and projects, at all levels of local government, related to changes in forest and forest land use

The following policies and projects were assessed:

- The influence of Decree No. 163/1999/ND-CP on land and forest allocation and on the allocation and leasing of forest land to forestry organizations and households for the creation of stable, long-term forestry purposes.
- The influence of Decree No. 178/2001/QD-TTg on the interests, rights, obligations and benefits of households and individuals who are assigned or given a contract or lease for forest and forest land protection.
- The New Economic Zone program of the 1970s and 1980s: a program initiated by the Vietnamese Government to encourage transmigration of people from high density areas (such the Red River Delta) to lower population areas with surplus forest and agricultural land (such as the Central Highlands or the Northern Highlands of Viet Nam). The program provided these new citizens with permits to claim and clear forest land for agricultural production.
- The Housing Support program for ethnic minorities (Program 134), covering a number of policies to support production land, residential land, housing and clean water for households of ethnic minorities and living in difficult situations.
- The social-economic development program for the poorest ethnic minority communes in mountainous areas (Program 135), which aimed to improve the economic status of ethnic minority groups in mountainous and remote areas.
- The program supporting fast and sustainable poverty reduction under Resolution 30a/2008/NQ-CP. The program supports rapid and sustainable poverty reduction in 61 poor districts and narrowing the development gap between regions and localities through the allocation of resources for priority development areas and actions.
- The establishment of the 5 Million Hectare Program for new forest plantations in accordance with Decision No. 661/QD-TTg by the Prime Minister.
- A program of greening bare hills and bare land, under President of the Council of Ministers Decision 327/HDBT, including a number of guidelines and policies on the use of vacant land and hills, forests, alluvial land and coastal water.
- Hydropower dam and irrigation projects.

2.1.3 Workshop

In addition to the district and commune meetings outlined above, a provincial level workshop was held to get feedback from a range of stakeholders on a draft of this report. After the workshop, the report was edited by the Forest Resources and Environment Center (FREC) of the Forest Inventory and Planning Institute and the Lam Dong Agriculture and Forestry Consulting Company and sent to the Provincial Forest Protection Department, forest owners and the District Forest Protection Department to review and provide further comment.

2.2 Methodology to determine historical emissions from the forestry and land use sectors²

This analysis is only concerned with the estimation of historical emission and removals from 1990 - 2010. The approach followed is outlined in Figure 1 and provides the required data upon which a Reference Level of Lam Dong can be set.³

2. This section only provides a summary. For a description of the full methodology, see:

• FREC (2013), Establishment of Forest Status Map During the Period from 1990-2010, Lam Dong Province. Prepared for the LEAF project.

Nguyen Dinh Hung (2013), Analysis Of Raw Data of Sample Plots in NFIMAP-Cycle IV (2006-2010), Lam Dong Province. Prepared for the LEAF project.

3. The development of a Reference Level is outlined in the report by Grais, A., Petrova, S., Goslee, K. and Brown, S. (2014), *Establishing a Reference Level for REDD+ in Lam Dong Province, Viet Nam*, Prepared by the LEAF project for submission to Lam Dong DARD.

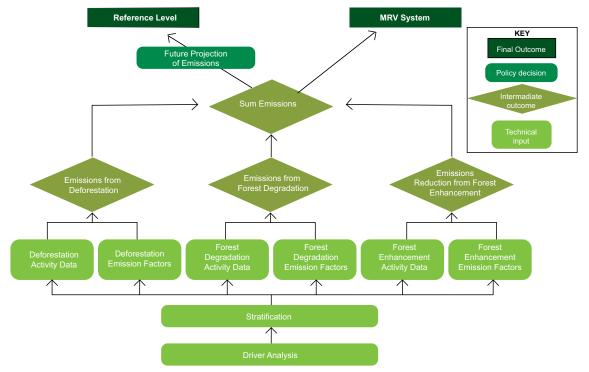


Figure 1: Approach to estimating historical emissions and the development of a Reference Level

Drivers' analysis: The analysis of drivers is outlined in the report and is based upon primary information collected through various stakeholder meetings (described in Section 2.1) and review of secondary data and project reports.

Forest stratification: The selected forest strata are based on Circular No. 34/2009/TT-BNNPTNT of June 10th, 2009 and are consistent with the national context and appropriate for the mosaic forest landscape found in Lam Dong. The process to determine the strata and location of NFIMAP Cycle IV permanent sampling plots within each strata is outlined in the report titled 'Analysis of the raw data of sample plots in NFIMAP-Cycle IV (2006-2010) in Lam Dong province, Viet Nam'.⁴ The 13 forest and land cover strata used for the analysis of this report are listed in Table 1.

^{4.} Nguyen Dinh Hung (2013), Analysis Of Raw Data of Sample Plots in NFIMAP-Cycle IV (2006-2010), Lam Dong Province. Prepared for the LEAF project.

| Forest/ land cover class | Description |
|-------------------------------------|---|
| Evergreen - Broadleaf - Rich | Forests that remain green throughout the year with timber reserve of standing trees between 201 and 300 m3/ ha * |
| Evergreen - Broadleaf - Medium | Forests that remain green throughout the year with timber reserve of standing trees between 101 and 200 m3/ ha * |
| Evergreen - Broadleaf - Poor | Forests that remain green throughout the year with timber reserve of standing trees between 10 and 100 m3/ ha * |
| Evergreen - Broadleaf - Regrowth | No clear definition |
| Deciduous | Forests with trees which shed leaves during certain season accounting for 75% or more of the total number of trees* |
| Bamboo forest | Forests consisting of tree species of the bamboo family * |
| Mixed wood and bamboo | Forests with timber trees accounting for more than 50% of their canopy * |
| Coniferous – Rich | Forests of these kind of trees accounting for more than 75% of total number of trees with timber reserve of standing trees between 201 and 300 m3/ ha * |
| Coniferous – Medium | Forests of these kind of trees accounting for more than 75% of total number of trees with timber reserve of standing trees between 101 and 200 m3/ ha * |
| Coniferous – Poor | Forests of these kind of trees accounting for more than 75% of total number of trees with timber reserve of standing trees between 10 and 100 m3/ ha * |
| Coniferous - Regrowth | No clear definition |
| Mixed broadleaf and coniferous | Forests of each kind of these trees accounting for between 25% and 75% of the total number of trees* |
| Plantation | Forests formed through plantation including (1) on land without forests; (2) on land after exploitation of existing plantations; (3) forest naturally regenerated after exploitation of forest plantations * |
| Bared land | Land without regenerated timber trees not planned for forestry purpose * |
| Agricultural and other land | Land for planting annual crop, perennial crop, aquaculture and other agriculture land stipulated by the Government ** |
| Water area | Area cover of water such as lake, reservoir, big rivers |
| Residential area | Land compromising residential land in rural and urban areas ** |

Table 1: Forest and land cover strata for Lam Dong

* Description based on Circular 34 on criteria for forest identification and classification (34/2009/TT-BNNPTNT)

^{**} Description based on Article 13 of the law on land use (No. 13-2003-QH11)

Activity data for deforestation, forest degradation and forest stock enhancement: The full methodology is outlined in the report 'Establishment of forest status map during the period 1990 - 2010, Lam Dong province'⁵. To summarize the process:

- Landsat satellite images for 1990, 1995 and 2000 and SPOT 5 satellite imagery for 2005 and 2010 were collected and processed for the creation of land cover maps.
- An accuracy assessment of all land cover maps was completed and documented in the report 'Accuracy assessment for forest and land use maps from 1990 to 2010, Lam Dong province, Viet Nam'6. For 1990, 1995, 2000 and 2005 forest status and land cover maps, the NFI permanent sampling plots were used as ground truth points to assess the accuracy of these maps. For the 2010 forest status and land cover map, a field survey of NFIMAP-Cycle IV permanent sampling plots was completed to assess accuracy of the map.

Accuracy varied considerably for each strata, but overall accuracy for each map was:

- 2010 map overall accuracy of 90%
- 2005 map overall accuracy of 85%
- 2000 map overall accuracy of 84%
- 1995 map overall accuracy of 84%
- 1990 map overall accuracy of 77%
- A pairwise comparison for each period of analysis, 1990-1995, 1995-2000, 2000-2005 and 2005-2010, was then completed to calculate area change due to deforestation, degradation (as calculated by a change from either rich, or medium, forest strata to a 'lower' quality strata) and forest enhancement (as measured by afforestation/reforestation to convert from either a medium or poor forest strata to a 'higher' quality strata).

The outcomes of this assessment are presented in this report.

^{5.} FREC (2013), Establishment of Forest Status Map During the Period from 1990-2010, Lam Dong Province. Prepared for the LEAF project.

^{6.} FREC (2013), Accuracy Assessment for Forest and Land Use Maps from 1990 to 2010, Lam Dong Province, Viet Nam. Prepared for the LEAF project.

Emission factors: Live tree carbon stocks were estimated from the NFIMAP-Cycle IV raw field data (2006 - 2010). The full methodology is outlined in the report 'Analysis of the raw data of sample plots in NFIMAP-Cycle IV (2006-2010) in Lam Dong province, Viet Nam'⁷. Estimates of below-ground live carbon are based on the ratio developed by Mokany et al. (2006)⁸ where the ratio of below-ground biomass to above-ground biomass for a specific vegetation type is either 0.235, if the above-ground biomass is less than 125 tons/hectare, or 0.205, if the above-ground biomass is greater than 125 tons/hectare.

Estimates for carbon stocks of litter, dead wood and soil were not included in this analysis (but for the creation of the Lam Dong Reference Level, IPCC defaults have been used). An accuracy estimate for all emission factors was also conducted, with uncertainty levels ranging from 11.7% for strata well represented in the NFIMAP-Cycle VI sample plots (i.e., Evergreen-Broadleaf Forest - Rich) to very high uncertainty for forest strata poorly represented in the NFIMAP-Cycle CI sample plots (i.e., 213% for bamboo forest).

Average carbon stocks used in this report are presented in Table 25.

Post deforestation land use was broadly classified as either agricultural land, bare land, residential land or waterbodies, with carbon stocks assigned, as per Table 25.

Sum of emissions: Historical emissions for each of the four time periods was estimated by multiplying the activity data for each forest strata by its relevant emission factor. The results are presented in Section 4 of this report.

^{7.} Nguyen Dinh Hung (2013), Analysis Of Raw Data of Sample Plots in NFIMAP-Cycle IV (2006-2010), Lam Dong Province. Prepared for the LEAF project.

^{8.} Mokany, K., Raison, J.R. and Prokushkin, A.S. (2006). Critical analysis of root:shoot ratios in terrestrial biomes. Global Change Biology 12:84-96.

3 Natural features and socio-economic condition of Lam Dong province

3.1 Natural features

3.1.1 Geographical position

Lam Dong is a mountainous province in the Southern Highlands and sits at 800 -1,000 m above sea level. Lam Dong province covers a total area of 9,772.19 km² and the geographic location of Lam Dong province is as follows:

Provincial coordinates:

- from 110 12' 47" to 120 19' 01"N
- from 107° 16' 23" to 108° 42' 11"E

Geographical position:

- · Khanh Hoa and Ninh Thuan provinces to the east
- Dong Nai province to the southwest
- · Binh Thuan province to the south and southeast
- Dak Lak province to the north.

Lam Dong is located on three plateaus and is drained by seven major river systems. It is a key economic region in southern Viet Nam, which is a dynamic area with high economic growth and large potential markets. The province can be divided into three regions with five strong areas of development: industrial plants, forestry, minerals, tourism-services and cattle breeding⁹.

Lam Dong Forest Department, 2012. Report notes designed to gather information on exploitation of wood and forest plantation area in 2012 on the area of complex bauxite-aluminium project in Bao Lam province (http://www.lamdong.gov.vn/vi-VN/congdan/thong-tin-can-biet/ NGTK2005/Pages/ktxh5nam/phan_1.htm)

3.1.2 Terrain topography

Lam Dong has a relatively varied terrain with mainly mountains and plateaus but also flat small valleys. These characteristics drive the climate, edaphology and fauna and flora of the province, as well as creating wonderful landscapes.

One notable feature of the topography of Lam Dong is how it varies across the province:

- In the north, the terrain consists of high mountains: Lang Bian plateau has high peaks from 1,300 m to over 2,000 m, for example, Mt. Bi Doup (2,287 m) and Lang Bian (2,184 m)
- In the east and west it has low mountain ranges (500 -1,000 m)
- The south covers the region between Di Linh and Bao Loc highland plateaus

Land with slope of less than 25 degrees accounts for more than 50% of the total area

3.1.3 Soil

Lam Dong has an area of 977.219,6 ha, consisting of 8 soil groups:

- Alluvium (fluvisols)
- · Grey soil
- Cambisols
- Luvisols
- Bazan soil (ferralsols)
- · Acrisols
- Alis developed on High Mountain (alisols)
- · Leptosols.

Soil in Lam Dong is generally of high quality.

3.1.4 Agricultural production and land use

The whole province has 225,400 ha of land which is suitable for agricultural production. 200,000 ha of land, mainly in Bao Loc-Di Nguyen plateau, is suitable for perennial plants with high economic value, such as coffee, tea and mulberry: the tea and coffee growing area accounts for around 145,000 ha, mainly in Bao Lam and Bao Loc, Di Linh and Lam Ha districts, and the vegetable growing area accounts for about 23,800 ha, mainly in Da Lat, Don Duong and Duc Trong districts.

The remaining agricultural land is not near residential areas and has limited potential for exploitation due to flooding or dry, thin or rocky soil.

The area of forest land accounts for 60% of the total land base

3.1.5 Climate

Lam Dong has a tropical monsoon climate varying with altitude, with two distinct seasons: rainy season is from May to November and the dry season is from December to April.

The average temperature ranges from 18 to 25°C but temperature differs by region: the higher the region, the cooler the weather.

Average rainfall is from 1,750 - 3,150 mm / year and average humidity is 85 - 87%. The average sunshine per year is 1,890 - 2,500 hours.

3.1.6 Hydrology

Lam Dong is located within the Dong Nai river system, with abundant water supplies, relatively dense stream network and large hydroelectric potential.

Rivers in this province are fairly evenly distributed, with average density of 0.6 km/km² and a bottom slope of less than 1%. Most rivers and streams run from the northeast to southwest.

Due to the mountainous and partitioned terrain, most river basins here are quite small with many rapids upstream.

The three major rivers belong to Dong Nai river system and include the:

- Da Dang River
- · La Nga River
- Nhim River

3.1.7 Water supply system

The water supply system is relatively well set-up. It includes: Da Lat Water Plant with a capacity of 35,000 m3/day; water supply systems in Bao Loc town with a capacity of 10,000 m3/day; Duc Trong district water supply system with a capacity of 2,500 m3/day; Di Linh District water supply systems with a capacity of 3,500 m3/day; and the water supply systems in Lam Ha district with a capacity of 6,000 m3/day.

3.2 Socio - economic characteristics

Population and ethnicity

In 2010, the provincial population was 1,204,869 people, of which 600,988 were female and 747,011 people were from rural areas (see Table 2). The average population density was 123 people/km². The densest area was Bao Loc city with 646 people/km² followed by Da Lat city with 532/ km². Lac Duong district had the lowest population density with 16 people/km² (see Table 3).

Gender Town and rural areas Year Population (people) Women Town **Rural areas** Men 1990 669,626 331,963 337.663 228.988 440.638 1995 820,530 407,574 412,956 297,961 522,569 2000 1,035,719 518,712 517,007 399,020 636,699 2005 1,157,147 722,523 578,805 578,342 434,624 747,011 2010 1,189,327 603,881 457,858 600,988

Table 2: Average population figures (1990 - 2010) by gender and location

Source: Lam Dong general statistics book 2005 and 2010

| District/city | Area (km2) | Average population (individual) | Density (Ind./km2) |
|-----------------------|---------------|---------------------------------|-----------------------|
| Total | 9,773.5 | 1,218,691 | 125 |
| 1. Da Lat city | 394.6 | 209,301 | 532 |
| 2. Bao Loc city | 232.6 | 150,202 | 646 |
| 3. Dam Rong district | 860.9 | 39,920 | 46 |
| 4. Lac Duong district | 1,263.5 | 20,235 | 16 |
| 5. Lam Ha district | 985.7 | 138,775 | 141 |
| 6. Don Duong district | 610.3 | 95,057 | 156 |
| 7. Duc Trong district | 901.8 | 168,355 | 187 |
| 8. Di Linh district | 1,614.6 | 155,908 | 97 |
| 9. Bao Lam district | 1,463.4 | 110,741 | 76 |
| 10. Da Huoai district | 495.3 | 34,077 | 69 |
| 11. Da Teh district | 524.2 | 44,667 | 85 |
| 12. Cat Tien district | 426.6 | 37,631 | 88 |

Source: Lam Dong general statistics book, 2010

According to the Viet Nam General Statistics Office, as of 1st April 2009, the province had 43 ethnic groups. Population figures for the main ethnic groups are shown in Table 4.

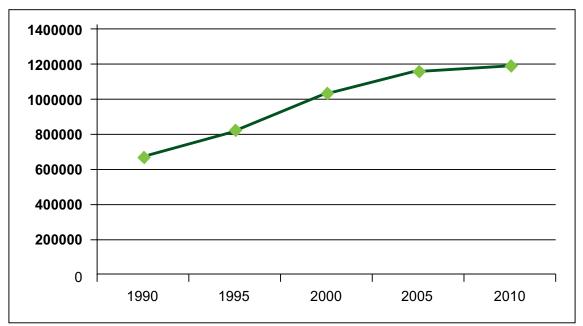
| Ethnic group | Population |
|--------------|------------|
| Kinh | 901,316 |
| Со Но | 145,665 |
| Ма | 31,869 |
| Nung | 24,526 |
| Тау | 20,301 |
| Chu Ru | 18,631 |
| Ноа | 14,929 |
| M'Nong | 9,099 |
| Thai | 4,445 |
| Muong | 4,445 |
| Mong | 2,894 |
| Dao | 2,423 |
| Kho Me | 1,098 |
| Others | <100 |

Table 4: Population figures for main ethnic groups in Lam Dong province

Source: Census of population and housing in Viet Nam in 2009, Viet Nam's General Statistics Office.

Over 20 years, the population of the province has increased by about 520,000 people. The population of the province increased notably from 1990 - 2000 due to the emigration from other provinces to Lam Dong (see Figure 2 and Section 2.1 and the discussion on the impact of the New Economic Zone program).

Figure 2: Population of Lam Dong province from 1990 – 2010



3.3 Forest management and development

Administration

The structure of forest management and development in Lam Dong province is separated into three levels: province, district and commune.

- Province level: The Department of Agriculture and Rural Development (DARD) is a specialized department assisting the People's Provincial Committee to manage forest lands. Under the management of DARD are the Forestry Department and the Forest Protection Department, which supports DARD in the management and protection of forests and forestry legislation.
- District level: The Department of Agriculture and Rural Department and the Forest Protection Department assist the District People's Committee in implementing activities related to the management of forests and forestry legislation at the district level.
- Commune level: Currently, the Commune People's Committee does not have a person in charge of forestry. For some communes, with a large area of forest, a forestry management board has been set up. Staff from state forestry enterprises, the Forest Management Boards, and forest rangers participate. At present, about 113 Commune People's Committees have been set up, with 1,263 participants.

Forest management agency / forest owner

At present, forest owners in Lam Dong province are Bi Dup National Park, Cat Tien National Park, 17 Forest Management Boards, 11 state forest enterprises, households and other forest management boards.

4 Results

4.1 Forest land use and forest status in Lam Dong province from 1990 – 2010

4.1.1 Area of land use in Lam Dong province, from 1990 - 2010

The total area of forest land of Lam Dong province in 1990 was 769,672 ha (78.7% of the total land area), of which area covered with forest was about 700,360 ha (90.9% of the total area of forest land) and bare forest land of 69,310 ha (approximately 9.1% of the total area of forest land).

In 1995, the total area of forest land of the province was 709,055 ha (72.5% of the total land area), of which the area covered by forest was around 646,379 ha (91.2% of the total area of forest land) and bare forest land was about 62,670 ha (approximately 8.8% of the total area of forest land).

The total area of forest land in Lam Dong province in 2000 was about 668,085 ha (68.4% of the total land area), of which area covered with forest was about 623,468 ha (93.3% of the total area of forest land) and bare forest land was 44,617 ha (approximately 6.7% of the total area of forest land).

In 2005, the total area of forest land in Lam Dong province was 634,819 ha (64.95% of the total land area), of which land area covered by forest was about 600,090 ha (94.53% of the total area of forest land) and bare land covered around 34,720 ha (about 5.47% of the total area of forest land).

The total area of forest land in 2010 was 582,290 ha (59.58% of the total land area) in which, forest land was 565,316 ha (97.1% of the total area of forest land) and bare land covered an area of 16,975 ha (about 2.9% the total area of forest land). Figure 3 summarizes these historic forest cover changes between 1990 and 2010.

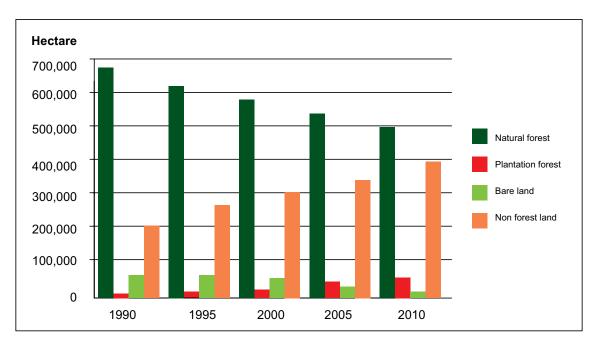


Figure 3: Land use types in Lam Dong province from 1990 - 2010

4.1.2 Changes in forest land and forest status in Lam Dong province from 1990 - 2010

4.1.2.1 Forest and land use change, 1990 – 1995

Table 5: Forest land and other land in Lam Dong province in 1990 and 1995

| Unit:h | Jnit:ha | | | | | | | |
|--------|--|---------|-------------------|---------|-------------------|---------------|--|--|
| | | 1990 | | | 1995 | | | |
| No. | Land use type | Total | Proportion (%) | Total | Proportion (%) | 1995- 1990 | | |
| I | Forest land | 769,672 | 78,8 | 709,055 | 72,6 | -60.617 | | |
| 1.1 | Forest land covered with forest | 700,362 | 91,0 | 646,380 | 91,2 | -53.983 | | |
| 1.1.1 | Broadleaf forest | 300,556 | 42,9 | 274,935 | 42,5 | -25.621 | | |
| - | Rich broadleaf evergreen forest | 59,962 | 20,0 | 44,639 | 16,2 | -15.323 | | |
| - | Medium broadleaf evergreen forest | 85,975 | 29,0 | 81,847 | 29,8 | -4.128 | | |
| - | Poor broadleaf evergreen forest | 110,781 | 37,0 | 102,199 | 37,2 | -8.582 | | |
| - | Regrowth broadleaf evergreen forest | 43,837 | 15,0 | 46,250 | 16,8 | 2.412 | | |
| 1.1.2 | Deciduous forest | 24,445 | 3,5 | 22,244 | 3.4 | -2,201 | | |
| 1.1.3 | Bamboo forest | 79,555 | 11,4 | 73,866 | 11.4 | -5,688 | | |
| 1.1.4 | Mixed wood and bamboo forest | 95,906 | 13,7 | 85,595 | 13.2 | -10,311 | | |
| 1.1.5 | Coniferous forest | 159,293 | 22,7 | 147,775 | 22.9 | -11,518 | | |
| - | Rich coniferous forest | 49,721 | 31,2 | 45,332 | 30.7 | -4,389 | | |
| - | Medium coniferous forest | 54,270 | 34,1 | 53,873 | 36.5 | -397 | | |
| - | Poor coniferous forest | 52,520 | 33,0 | 45,802 | 31.0 | -6,719 | | |
| - | Restoration coniferous forest | 2,781 | 1,8 | 2,768 | 1.9 | -13 | | |
| 1.1.6 | Mixed broadleaf and coniferous | 29,422 | 4,2 | 25,609 | 4.0 | -3,813 | | |
| 1.1.7 | Plantation | 11,186 | 1,6 | 16,355 | 2.5 | 5,170 | | |
| 1.2 | Bare land | 69,310 | 9,0 | 62,676 | 8.8 | -6,634 | | |
| II | Other land | 207,682 | 21,3 | 268,299 | 27.5 | 60,617 | | |
| 2.1 | Agricultural cultivation | 187,067 | 90,1 | 245,445 | 91.5 | 58,378 | | |
| 2.2 | Waterbody | 7,790 | 3,8 | 8,248 | 3.1 | 458 | | |
| 2.3 | Settlement | 12,825 | 6,2 | 14,606 | 5.4 | 1,781 | | |
| | Total | 977,354 | 100,0 | 977,354 | 100.0 | 0 | | |

Source: Data extracted from forest status maps in 1990 and 1995, Lam Dong province

Table 5 shows changes in land use and forest types in Lam Dong province between 1990 and 1995 and shows that the total area of forest land was reduced by 60,617 ha, within which forest land covered by forest fell by about 53,983 ha. Bao Lam, Dinh, Lam Ha and Duc Trong districts had the highest proportion of forest loss with 12,870 ha, 12,020 ha, 11,810 ha and 7,420 ha lost respectively.

Within this, broadleaf evergreen forest was reduced by 25,620 ha, mainly due to forest conversion and this was concentrated in Lam Ha, Bao Lam, Di Linh and Duc Trong districts. Rich evergreen forest was significantly reduced (about 14,210 ha), mainly due to human impacts such as logging, and overall there was a decline in forest quality with changes in forest status from rich to medium or medium to poor forest. The area of rich broadleaf evergreen forest declined most significantly in Bao Lam, Da Huoai and Lac Duong districts. Evergreen forest in poor condition was reduced by more than 9,350 ha, of which most was converted from poor forest to restoration forest, mixed bamboo or agricultural land.

The total area of deciduous forest decreased in this period by about 2,200 ha, particularly in the districts of Lam Ha (1,100 ha), Di Linh (more than 700 ha) and Duc Trong (510 ha). This forest was mainly converted to agricultural land (approximately 1,500 ha) and bare land (more than 730 ha). The main reason was forest exploitation by forestry enterprises and local people.

Bamboo forest declined by approximately 5,680 ha, mainly in Cat Tien and Bao Lam districts. Most of the area was converted to agricultural land, bare land or mixed bamboo forest. The main reason was forest exploited by state forest enterprises or used by local people.

Mixed wood and bamboo forest declined by more than 10,310 ha, concentrated mainly in Da Huoai, Bao Lam and Da Teh districts. This was mainly due to the conversion to agricultural land and commercial plantations.

Coniferous forest area fell by about 11,510 ha, concentrated mainly in Duc Trong and Bao Lam districts and Da Lat city. Most of this area was converted to agricultural crops and some shifted to bare land and plantation forests.

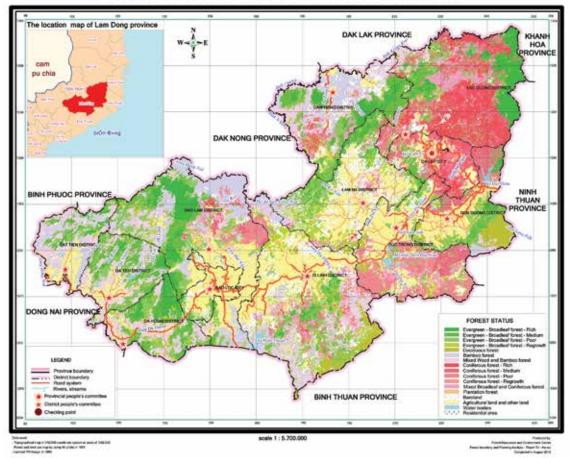
Mixed broadleaf and coniferous forest was reduced by about 3,810 ha, concentrated in Lam Ha, Duc Trong and Di Linh districts. This was due to conversion of forest land to agricultural land and bare land as a result of forest fires and over exploitation.

The area covered by plantations increased by about 5,170 ha and was concentrated in Cat Tien district and Da Lat city.

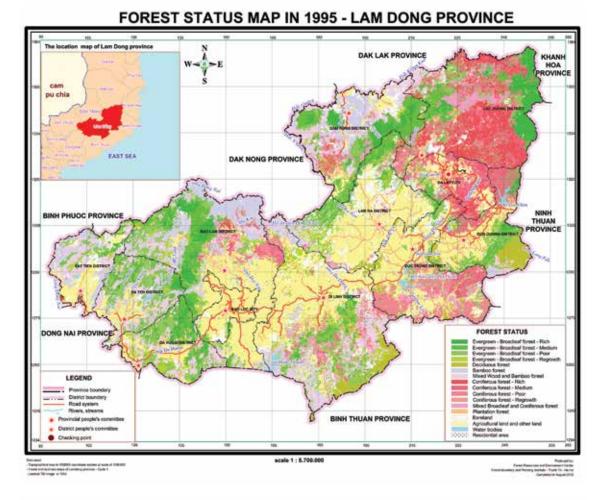
The area of bare land was reduced by about 6,630 ha and was concentrated mainly in Di Linh and Lam Ha districts. These areas consisted of poor forest and shrubs that switched to agricultural and industrial tree crops, commercial plantations or land that had been replanted.

Non-forestry land increased to 60,616 ha, with the biggest increases in Di Linh, Bao Lam, Lam Ha and Duc Trong districts. This was due to changes in land use, of which the most significant change was forest conversion to agricultural land and commercial crops.

The area of degraded forest was about 21,700 ha including: bamboo forest (11,470 ha), broadleaf evergreen forest (7,390 ha) and mixed wood and bamboo forest (nearly 7,000 ha).



FOREST STATUS MAP IN 1990 - LAM DONG PROVINCE



map of Lam Dong provis w-DAK LAK PROVINCE KHANH HOA ROVINCE -E cam pu chia EAST SEA DAK NONG PROVINC NINH THUAN PROVINCE BINH PHUOC PROVINCE G NAL P LEGEND rict box Road system Rivers, str. INH THUAN PROVINCE . Diatrict people's co scale 1 : 6.700.000

FOREST AND LAND USE CHANGE MAP OF LAM DONG PROVINCE 1990 - 1995

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Table 6: Conversion matrix of forest land in Lam Dong province between 1990 and 1995

Unit: ha

| Unit: na | | | | | | | | | | |
|-----------------------------------|----------------------------------|---------------------|------------------|-----------------------------|----------------------|---|------------|--------------|---------------------------------|-----------|
| 1995 1990 | Broadleaf evergreen forest | Deciduous forest | Bamboo forest | Mixed wood and bamboo | Coniferous forest | Mixed broadleaf and coniferous | Plantation | Bare land | Land area beyond forestry | Total |
| Broadleaf evergreen forest | 259,891.1 | 33.9 | 4.217.3 | 13,112.4 | 153.0 | 50.5 | 2,096.5 | 7,414.0 | 13,586.9 | 300,555.6 |
| Deciduous forest | 34.4 | 22,068.4 | 0.0 | 17.6 | 3.8 | 1.4 | 57.8 | 735.2 | 1,526.4 | 24,445.0 |
| Bamboo forest | 1,261.5 | 1.1 | 52,483.9 | 6,833.2 | 73.0 | 9.7 | 222.3 | 6,801.7 | 11,868.3 | 79,554.8 |
| Mixed wood and bamboo | 10,424.5 | 28.7 | 11,010.8 | 63,227,2 | 40,9 | 14.0 | 528,7 | 3,677.4 | 6,953.5 | 95,905.8 |
| Coniferous forest | 179.4 | 1.4 | 54.6 | 42.8 | 146,840.6 | 455.9 | 1,855,8 | 1,582.9 | 8,279.5 | 159,293.0 |
| Mixed broadleaf and coniferous | 141.1 | 2.0 | 12.1 | 14.8 | 484.4 | 25,025.1 | 110.7 | 2,008.4 | 1,623.8 | 29,422.4 |
| Plantation | 61.8 | 0.8 | 149.3 | 41.8 | 11.2 | 2.8 | 8,830.4 | 372.6 | 1,715.0 | 11,185.6 |
| Bare land | 2,467.0 | 88.5 | 3,691.1 | 1,822.0 | 125.3 | 39.3 | 1,539.8 | 37,607.7 | 21,929.4 | 69,310.1 |
| Land area beyond forestry | 473.9 | 19.2 | 2,247.3 | 483.3 | 42.8 | 10.3 | 1,113.3 | 2,475.9 | 200,816.3 | 207,682.2 |
| Total | 274,934.7 | 22,244.1 | 73,866.4 | 85,595.2 | 147,775.0 | 25,609.1 | 16,355.3 | 62,675.7 | 268,299.1 | 977,354.5 |
| | | | | | | | | | | |

Source: Overlaid data of forest status maps in 1990-1995 in Lam Dong province

4.1.2.2 Forest and land use change, 1995 - 2000

Table 7: Forest land and other land in Lam Dong province in1995 and 2000

Unit: ha

| No. | Type of land use | f land use 2000 | | 1995 | Changes 2000-1995 | |
|-------|--|-----------------|-------------------|-----------|----------------------|---------|
| | | Total | Proportion (%) | Total | Proportion (%) | |
| I | Forest land | 668,051.5 | 68.4 | 709,055.3 | 72.6 | -41,004 |
| 1.1 | Forested area | 623,399.3 | 93.3 | 646,379.6 | 91.2 | -22,980 |
| 1.1.1 | Broadleaf forest | 253,993.7 | 40.7 | 274,934.7 | 42.5 | -20,941 |
| - | Broadleaf evergreen forest (rich) | 32,609.7 | 12.8 | 44,639.1 | 16.2 | -12,030 |
| - | Broadleaf evergreen forest (medium) | 79,468.0 | 31.3 | 81,846.8 | 29.8 | -2,379 |
| - | Broadleaf evergreen forest (poor) | 97,301.3 | 38.3 | 102,199.1 | 37.2 | -4,898 |
| - | Broadleaf evergreen forest (restoration) | 44,614.7 | 17.6 | 46,249.7 | 16.8 | -1,635 |
| 1.1.2 | Deciduous forest | 20,416.9 | 3.3 | 22,244.1 | 3.4 | -1,827 |
| 1.1.3 | Bamboo forest | 71,473.5 | 11.5 | 73,861.5 | 11.4 | -2,388 |
| 1.1.4 | Mixed wood and bamboo forest | 88,813.5 | 14.3 | 85,600.1 | 13.2 | 3,213 |
| 1.1.5 | Coniferous forest | 139,291.3 | 22.3 | 147,775.0 | 22.9 | -8,484 |
| - | Rich coniferous forest | 35,718.8 | 25.6 | 45,332.1 | 30.7 | -9,613 |
| - | Medium coniferous forest | 55,763.5 | 40.0 | 53,873.2 | 36.5 | 1,890 |
| - | Poor coniferous forest | 44,850.6 | 32.2 | 45,801.6 | 31.0 | -951 |
| - | Restoration coniferous forest | 2,958.3 | 2.1 | 2,768.1 | 1.9 | 190 |
| 1.1.6 | Mixed broadleaf and coniferous forests | 23,488.1 | 3.8 | 25,609.0 | 4.0 | -2,121 |
| 1.1.7 | Plantation | 25,922.4 | 4.2 | 16,355.3 | 2.5 | 9,567 |
| 1.2 | Bare land | 44,652.2 | 6.7 | 62,675.7 | 8.8 | -18,023 |
| II | Other land use | 309,302.9 | 31.7 | 268,299.1 | 27.5 | 41,004 |
| 2.1 | Agricultural land | 282,270.5 | 91.3 | 245,445.2 | 91.5 | 36,825 |
| 2.2 | Water body | 9,779.2 | 3.2 | 8,248.0 | 3.1 | 1,531 |
| 2.3 | Settlement | 17,253.2 | 5.6 | 14,605.8 | 5.4 | 2,647 |
| | Total | 977,354.4 | 100.0 | 977,354.4 | 100.0 | 0 |

Source: Data extracted from forest status maps of Lam Dong province in 1995 and 2000

Table 7 shows changes in land use and forest types in Lam Dong province between 1995 and 2000. During this time the total area of forest land was reduced by about 41,000 ha, of which forest land covered by forest fell by about 22,980 ha. The districts with the most significant declines included Bao Lam (6,400 ha), Lam Ha (3,020 ha), Duc Trong (4,637 ha) and Di Linh (2,760 ha). However, the area of forest cover in Cat Tien district increased by approximately 1,000 ha.

Broadleaf evergreen forest was reduced by about 20,940 ha, particularly in the districts of Di Linh, Lam Ha, Don Duong, Lac Duong and Bao Lam. Rich broadleaf evergreen forest showed the biggest decline of 12,030 ha, mainly due to human impacts such as logging and the consequent conversion into different forest types, for example, the conversion from rich forest to medium or poor forest or restoration forest. Medium and poor evergreen broadleaf forests declined by about 6,120 ha, which was essentially a change in forest status from medium forest to poor forest, or to restoration forest and mixed wood and bamboo forest, as well as conversion to agricultural land.

The total area of deciduous forest declined in this period by about 1,820 ha, most notably in the districts of Duc Trong (740 ha), Don Duong (490 ha) and Di Linh (about 320 ha). The forest in these districts was mainly converted to agricultural land (about 1,300 ha) and bare land (310 ha) due to intensive logging by state forest enterprises and local people.

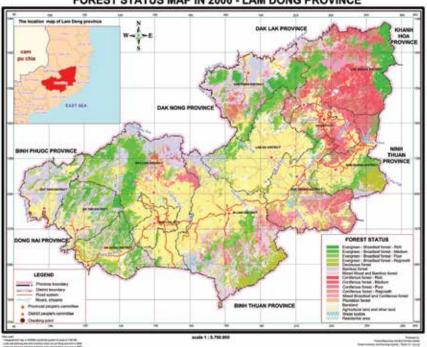
Bamboo forest area was reduced by over 2,388 ha, mainly in Bao Loc, Cat Tien and Di Linh districts.

Mixed wood and bamboo forest increased by about 3,212 ha, with increases in Lac Duong, Cat Tien, Di Linh and Bao Lam. This was due to conversion of large areas of broadleaf evergreen forest after selective logging (about 14,940 ha). However some areas of this forest type were converted to the other forest types, of which, approximately 8,310 ha of mixed forest suffered from the impact of cutting and subsequent conversion to bamboo forest. In addition, 1,860 ha suffered from exhaustive logging and conversion to bare land and some 580 ha converted to non-forestry land.

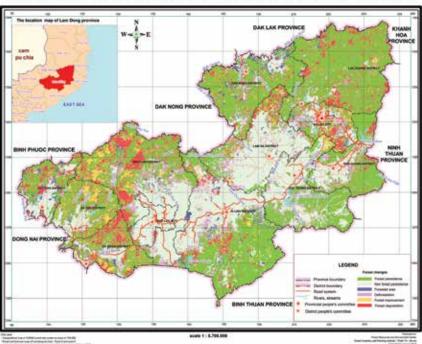
Coniferous forest area was reduced by approximately 8,483.7 ha, with decreases seen in all the districts that contained coniferous forest, but mainly concentrated in the districts of Duc Trong, Da Lat, Lac Duong and Bao Lam. Most of the area was converted to agricultural crops (around 5,100 ha), with the rest turned to bare land (about 2,090 ha) and commercial plantation forests (approximately 1,600 ha).

Mixed broadleaf and coniferous forest was reduced by 2,120 ha and was concentrated in Duc Trong and Di Linh districts. This reduction was primarily caused by conversion from forest to agricultural and bare land due to logging and forest fires. The area of plantation increased by 9,567 ha. *Pinus kesiya* was the most planted tree in this period. This forest type increased in most districts, but particularly in Cat Tien, Di Linh, Da Lat and Lac Duong.

The area of bare land was reduced by 18,023 ha, concentrated mainly in Di Linh and Lam Ha districts. This area comprises many different land use types, including poor forest, agricultural land (from bare land), industrial crops and commercial plantation forest.



FOREST STATUS MAP IN 2000 - LAM DONG PROVINCE



FOREST AND LAND USE CHANGE MAP IN LAM DONG PROVINCE 1995 - 2000

Table 8: Matrix of land use and forest type change in Lam Dong province between 1995 and 2000.

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| |

| 2000 | Broadleaf evergreen forest | Deciduous forest | Bamboo forest | Mixed wood and bamboo | Coniferous forest | Mixed broadleaf and coniferous forest | Plantation | Bare land | Land outside forestry | Tong |
|---|----------------------------------|---------------------|------------------|---|----------------------|---|-------------|--------------|-----------------------------|-------------|
| Broadleaf evergreen forest | 234,948.8 | 17.3 | 3,594.7 | 15,743.2 | 229.9 | 50.7 | 2,379.6 | 5,696.7 | 12,273.7 | 274,934.7 |
| Deciduous forest | 17.5 | 20,292.6 | 2.7 | 89.9 | 2.5 | 2.6 | 193.4 | 316.4 | 1,326.5 | 22,244.1 |
| Bamboo forest | 1,872.5 | 0.01 | 51,597.9 | 8,655.4 | 80.5 | 11.2 | 975.2 | 2,674.6 | 7,994.3 | 73,861.5 |
| Mixed wood and bamboo | 11,803.1 | 66.8 | 8,314.0 | 60,710.8 | 54.9 | 17.7 | 561.9 | 1,862.0 | 2,208.6 | 85,600.1 |
| Coniferous forest | 289.2 | 2.6 | 33.5 | 59.3 | 137,750.5 | 839.6 | 1,600.7 | 2,091.3 | 5,108.3 | 147,774.9 |
| Mixed broadleaf and coniferous | 100.3 | 1.4 | 6.3 | 13.4 | 405.7 | 22,424.8 | 197.8 | 358.6 | 2,100.7 | 25,609.0 |
| Plantation | 91.5 | 0.8 | 26.9 | 72.5 | 46.9 | 24.8 | 12,982.2 | 380.2 | 2,729.4 | 16,355.3 |
| Bare land | 3,500.6 | 31.8 | 5,368.3 | 2,885.9 | 615.1 | 93.8 | 3,283.8 | 26,001.8 | 20,894.4 | 62,675.7 |
| Land outside forestry | 1,370.1 | 3.4 | 2,529.1 | 283.0 | 105.2 | 22.8 | 3,747.9 | 5,262.7 | 254,674.9 | 268,299.1 |
| Total | 25,4041.3 | 20,445.2 | 71,473.5 | 88,813.6 | 139,290.8 | 23,481.7 | 25,922.5 | 44,617.1 | 309,268.8 | 977,354.4 |
| Source: Overlaid data of forest land use maps in 1995 - 2000. | f forest land u | se maps in 1 | | Lam Dong province non-forestry land increased by 41 350 ha with notable changes in Di | vince non-fore | estry land inc | reased by 4 | 1.350 ha wit | h notable ch | andes in Di |

Linh, Lam Ha, Bao Lam and Duc Trong districts. This land use type increased mainly due to conversion to other land use purposes, of which the most significant conversion was from bare forest land to agricultural and industrial tree crops.

4.1.2.3 Forest and land use change, 2000 - 2005

Table 9: Forest land use and forest status in Lam Dong province in2000 and 2005

Unit: ha

| | | 2000 | | 2005 | | Change in |
|-------|---|---------|-------------------|---------|-------------------|-----------|
| No. | Land use type | Total | Proportion (%) | Total | Proportion (%) | 2005-2000 |
| I | Forest land | 668,050 | 68.4 | 634,820 | 64.95 | -33,230 |
| 1.1 | Forested area | 623,398 | 93.3 | 600,099 | 94.53 | -23,299 |
| 1.1.1 | Broadleaf forest | 253,994 | 40.7 | 229,996 | 38.33 | -23,998 |
| - | Broadleaf evergreen forest (rich) | 32,610 | 12.8 | 29,295 | 12.74 | -3,315 |
| - | Broadleaf evergreen forest (medium)) | 79,468 | 31.3 | 74,026 | 32.19 | -5,442 |
| - | Broadleaf evergreen forest (poor) | 97,301 | 38.3 | 94,358 | 41.03 | -2,944 |
| - | Broadleaf evergreen forest (restoration) | 44,615 | 17.6 | 32,318 | 14.05 | -12,297 |
| 1.1.2 | Deciduous forest | 20,414 | 3.3 | 18,217 | 3.04 | -2,197 |
| 1.1.3 | Bamboo forest | 71,473 | 11.5 | 60,660 | 10.11 | -10,813 |
| 1.1.4 | Mixed wood and bamboo | 88,816 | 14.3 | 97,054 | 16.17 | 8,238 |
| 1.1.5 | Coniferous forest | 139,290 | 22.3 | 125,403 | 20.90 | -13,887 |
| - | Rich coniferous | 35,718 | 25.6 | 27,045 | 21.57 | -8,673 |
| - | Medium coniferous | 55,764 | 40.0 | 54,757 | 43.67 | -1,006 |
| - | Poor coniferous | 44,851 | 32.2 | 41,497 | 33.09 | -3,354 |
| - | Restoration coniferous | 2,958 | 2.1 | 2,103 | 1.68 | -855 |
| 1.1.6 | Mixed broadleaf and coniferous | 23,488 | 3.8 | 22,122 | 3.69 | -1,366 |
| 1.1.7 | Plantation | 25,922 | 4.2 | 46,647 | 7.77 | 20,725 |
| 1.2 | Bare land | 44,652 | 6.7 | 34,721 | 5.47 | -9,931 |
| II | Other land | 309,304 | 31.7 | 342,534 | 35.05 | 33,230 |
| 2.1 | Agricultural land | 282,418 | 91.3 | 311,591 | 90.97 | 29,173 |
| 2.2 | Water body | 9,633 | 3.1 | 9,609 | 2.81 | -24 |
| 2.3 | Settlement | 17,253 | 5.6 | 21,335 | 6.23 | 4,081 |
| | Total | 977,354 | 100.0 | 977,354 | 100.00 | 0 |

Source: Data extracted from forest status maps in 2000 and 2005, Lam Dong province

Within the forest estate, broadleaf evergreen forest was reduced by 23,990 ha, mainly due to human activities such as selected logging, clearcutting and exploitation of forest land for agriculture. The greatest reductions in area of evergreen forest were seen in Bao Lam, Da Teh and Da Huoai districts. The main reason for deforestation and forest degradation in this period was exploitation of forest land for agriculture, commercial plantation forest and rubber plantations. Within broadleaf evergreen forest areas, restoration broadleaf evergreen forest declined the most (about 12,290 ha), mainly due to the change from restoration forest to mixed forest (wood and bamboo) (approximately 7,360 ha) and the conversion to agricultural land (about 5,190 ha) and bare land (about 2,190 ha).

The total area of deciduous forest was reduced in this period by about 2,190 ha mainly in Lam Ha (approximately 990 ha), Duc Trong (approximately 750 ha) and Don Duong (approximately 510 ha) districts. During this period, deciduous forest was mainly converted to agricultural (about 1,540 ha) and bare land (about 650 ha).

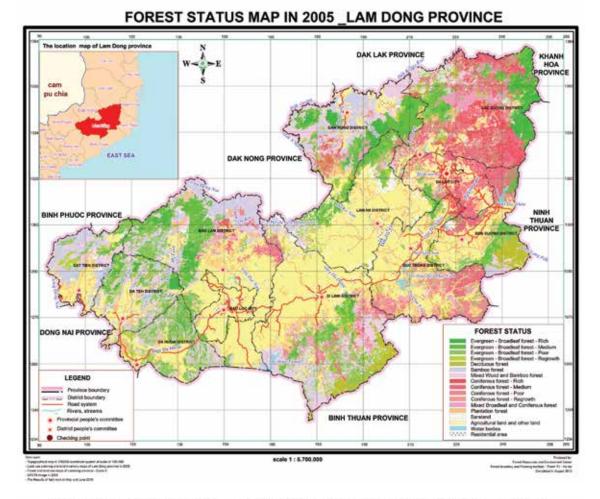
Bamboo forest decreased by about 10,810 ha, concentrated mainly in the districts of Bao Lam, Cat Tien and Da Teh. The majority of this forest type converted to mixed forest (about 10,650 ha), due to replacement of a number of fast-growing trees, and approximately 6,370 ha of bamboo forest was converted to agricultural land and bare land (about 3,540 ha) due to logging activity.

Mixed forest (wood and bamboo) increased by 8,230 ha, in particular across Da Teh and Bao Lam districts. The area of mixed forest (wood and bamboo) increased mainly due to the relatively large area of broadleaf evergreen forest which was logged leaving the mainly bamboo and mixed species forest (about 17,990 ha - see Table 10 Column 5). However, some mixed forest (wood and bamboo) was converted to other forest statuses, of which approximately 6,750 ha of mixed forest suffered from the cutting of selected trees and converted to mixed forest (wood and bamboo); about 3,140 ha was converted to bare land due to exhausted logging; and about 2,900 ha changed to non-forested land.

Coniferous forest was reduced by 13,880 ha across all the districts where coniferous forest grows, but concentrated in Lac Duong and Duc Trong districts and Da Lat city. Most of the area was converted to agricultural crops (about 7,430 ha), and the rest to bare land (about 4,460 ha) and commercial plantation forest (about 1,770 ha).

Mixed forest (coniferous and broadleaf) decreased by about 1,360 ha, concentrated in Lam Ha, Duc Trong and Di Ling districts. This was caused mainly by changes from forest land to agricultural land, shifting cultivation and bare land caused by logging and forest fires.

The area of forest plantation increased by 20,720 ha, with species composition as defined in the 661 Program and other reforestation projects. This forest type increased in the most districts, but mainly in Duc Trong, Bao Lam and Cat Tien districts.





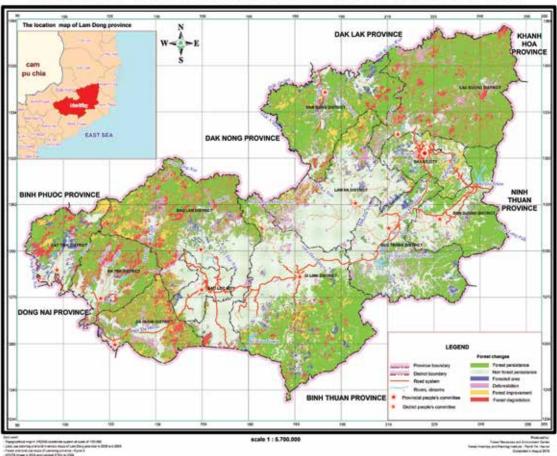


Table 10: Conversion matrix of land use and forest types in Lam Dong province between 2000 and 2005

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|---|----------------------------------|---------------------|------------------|--------------------------|----------------------|---|------------|--------------|-----------------------------|-----------|
| 2005 2000 | Broadleaf evergreen forest | Deciduous forest | Bamboo forest | Mixed wood and bamboo | Coniferous forest | Mixed broadleaf and coniferous forest | Plantation | Bare land | Land outside forestry | Total |
| Broadleaf evergreen forest | 216,353 | 27 | 3,068 | 17,991 | 143 | 56 | 2,811 | 4,490 | 9,055 | 253,993.7 |
| Deciduous forest | 6 | 17,914 | 0 | 14 | 4 | 9 | 277 | 640 | 1,546 | 20,414.2 |
| Bamboo forest | 881 | 0 | 46,738 | 10,654 | 46 | 6 | 3,234 | 3,542 | 6,370 | 71,473.5 |
| Mixed wood and bamboo | 9,540 | 24 | 6,749 | 65,643 | 22 | 6 | 784 | 3,141 | 2,904 | 88,816.1 |
| Coniferous forest | 176 | 9 | 41 | 51 | 124,519 | 717 | 1,779 | 4,561 | 7,439 | 139,290.2 |
| Mixed broadleaf and coniferous forest | 190 | 2 | 10 | 19 | 306 | 21,107 | 457 | 478 | 920 | 23,488.1 |
| Plantation | 186 | 3 | 176 | 117 | 82 | 14 | 22,056 | 512 | 2,776 | 25,922.4 |
| Bare land | 2,046 | 198 | 2,746 | 2,080 | 107 | 162 | 8,606 | 16,050 | 12,656 | 44,652.2 |
| Land outside forestry | 614 | 43 | 1,132 | 485 | 173 | 39 | 6,643 | 1,307 | 298,869 | 309,304.0 |
| Total | 229,995.9 | 18,217.2 | 60,660.1 | 97,054.0 | 125,402.8 | 22,121.8 | 46,647.2 | 34,721.0 | 342,534.4 | 977,354.4 |
| Service Outricity data of farmed atative mana in 2000 aver 2006 | of forcet of the | | | | | | | | | |

Source: Overlaid data of forest status maps in 2000 over 2005, Lam Dong province

The area of bare land was reduced by 9,930 ha, mainly in Di Linh, Duc Trong and Dam Rong districts. This was mostly due to poor forest and shrubland that had been converted to agricultural land, industrial crops and commercial plantations or land which was turned back into bamboo forest, mixed forest (wood and bamboo) and restoration broadleaf evergreen forest.

Non-forestry land increased by 33,230 ha, with the greatest changes in Di Linh, Lam Ha, Di Linh, Duc Trong and Da Huoai districts. This increased mainly due to changes in land use type, of which the most notable conversion was the area of bare land converted to non-forested land for agricultural-industrial crops (about 12,650 ha), broadleaf evergreen forest (about 9,050 ha) and coniferous forest (about 7,430 ha).

4.1.2.4 Forest and land use change, 2005 - 2010

Table 11: Forest land and other land in Lam Dong province in 2005 and 2010

| | | 2005 | | 2010 | | Change |
|-------|---|-----------|-------------------|-----------|-------------------|-----------|
| No. | Land use type | Total | Proportion (%) | Total | Proportion (%) | 2010-2005 |
| I | Forest land | 634,819.9 | 65.0 | 582,292.1 | 59.6 | -52,528 |
| 1.1 | Land covered by forest | 600,098.9 | 94.5 | 565,316.7 | 97.1 | -34,782 |
| 1.1.1 | Broadleaf forest | 229,995.9 | 38.3 | 208,787.4 | 36.9 | -21,209 |
| - | Broadleaf evergreen forest (rich) | 29,294.7 | 12.7 | 20,779.4 | 10.0 | -8,515 |
| - | Broadleaf evergreen forest (medium)) | 74,025.8 | 32.2 | 73,208.7 | 35.1 | -817 |
| - | Broadleaf evergreen forest (poor) | 94,357.7 | 41.0 | 87,240.7 | 41.8 | -7,117 |
| - | Broadleaf evergreen forest (restoration) | 32,317.7 | 14.1 | 27,558.6 | 13.2 | -4,759 |
| 1.1.2 | Deciduous forest | 18,217.2 | 3.0 | 15,622.9 | 2.8 | -2,594 |
| 1.1.3 | Bamboo forest | 60,660.1 | 10.1 | 50,030.0 | 8.9 | -10,630 |
| 1.1.4 | Mixed forest (wood and bamboo) | 97,054.0 | 16.2 | 93,960.9 | 16.6 | -3,093 |
| 1.1.5 | Coniferous forest | 125,402.8 | 20.9 | 114,418.4 | 20.2 | -10,984 |
| - | Rich coniferous | 27,045.1 | 21.6 | 25,342.6 | 22.2 | -1,702 |
| - | Medium coniferous | 54,757.5 | 43.7 | 45,596.0 | 39.9 | -9,161 |
| - | Poor coniferous | 41,497.1 | 33.1 | 42,835.2 | 37.4 | 1,338 |
| - | Restoration coniferous | 2,103.2 | 1.7 | ,644.6 | 0.6 | -1,459 |
| 1.1.6 | Mixed forest (broadleaf and coniferous) | 22,121.8 | 3.7 | 21,255.1 | 3.8 | -867 |
| 1.1.7 | Plantation | 46,647.2 | 7.8 | 61,242.1 | 10.8 | 14,595 |
| 1.2 | Bare Land | 34,721.0 | 5.5 | 16,975.4 | 2.9 | -17,746 |
| II | Other land | 342,534.4 | 35.1 | 395,062.3 | 40.4 | 52,528 |
| 2.1 | Agricultural land | 311,591.3 | 91.0 | 357,907.0 | 90.6 | 46,316 |
| 2.2 | Water body | 9,608.6 | 2.8 | 12,936.6 | 3.3 | 3,328 |
| 2.3 | Settlement | 21,334.5 | 6.2 | 24,218.7 | 6.1 | 2,884 |
| | Total | 977,354.4 | 100.0 | 977,354.4 | 100.0 | 0 |

Source: Data extracted from forest status maps in 2005 and 2010, Lam Dong province

Table 11 shows that, due to the impact of logging activities, around 13,880 ha of broadleaf evergreen forest was converted to mixed wood and bamboo forest. This mostly occurred in Da Teh (approximately 4,070 ha), Di Linh (approximately 3,140 ha), Da Huoai (about 2,300 ha) and Bao Lam (about 1,500 ha) districts. An additional 2,480 ha of bamboo forest was also converted in a number of districts, such as Bao Lam (approximately 770 ha), Di Linh (450 ha) and Da Teh (360 ha).

Also, about 14,110 ha of broadleaf evergreen forest was converted to nonforested land, mainly in the districts of Da Huoai (over 4,200 ha), Lam Ha (3,300 ha), Da Rong (1,600 ha), Di Linh (1,100 ha) and Bao Lam (990 ha). More than 2,750 ha of this forest type was replaced by plantation forest, in particular in the districts of Da Teh (approximately 600 ha), Di Linh (approximately 450 ha), Don Duong and Da Huoai (about 300 ha) and about 1,800 ha was converted to bare land, concentrated in Don Duong (approximately 380ha) and Lac Duong (approximately 530 ha).

The status of broadleaf evergreen forest varied in terms of quality due to selective logging and restoration occurring simultaneously. About 8,530 ha of rich evergreen forest was converted to medium evergreen forests, focused mainly in the districts of Da Teh (about 1,090 ha), Da Huoai (470 ha), Lac Duong (4,770 ha) and Lam Ha (790 ha) and about 2,270 ha was converted to poor forest, concentrated in Lac Duong (more than 1,000 ha) and Da Huoai (approximately 470 ha).

9,230 ha of medium forest was converted to poor forest due to the impact of illegal logging by local people, mainly concentrated in the districts of Da Teh (about 2,150 ha), Bao Lam (about 1,800 ha), Lac Duong (about 1,600 ha) and Di Linh (about 1,230 ha). Also about 3,150 ha of medium forest was allowed to grow and therefore move into the rich forest type. This was mainly concentrated in the two districts of Lam Ha (about 1,380 ha) and Di Linh (730 ha).

About 5,690 ha of poor broadleaf evergreen forest was converted to restoration forest, concentrated in Lac Duong (about 1,870 ha), Cat Tien (about 1,160 ha) and Don Duong (about 800 ha) districts. Due to intensive logging, about 7,600 ha of this forest type was converted to mixed wood and bamboo forest, focused in the districts of Da Teh (2,600 ha), Da Huoai (about 1,700 ha) and Di Linh (about 900 ha). In addition, and as a result of the implementation of forest protection and silvicultural measures, approximately 7,170 ha of poor forest changed to medium forest, including an area of 2,650 ha in Di Linh district, and about 1,630 ha in Lam Ha district.

Over 7,600 ha of poor forest was converted to agricultural land, mostly for perennial crops. The conversion area was mainly in the districts of Da Huoai (3,000 ha), Lam Ha (about 1,000 ha) and Bao Lam (about 900 ha). A further 1,600 ha of poor forest was also converted to plantation forest.

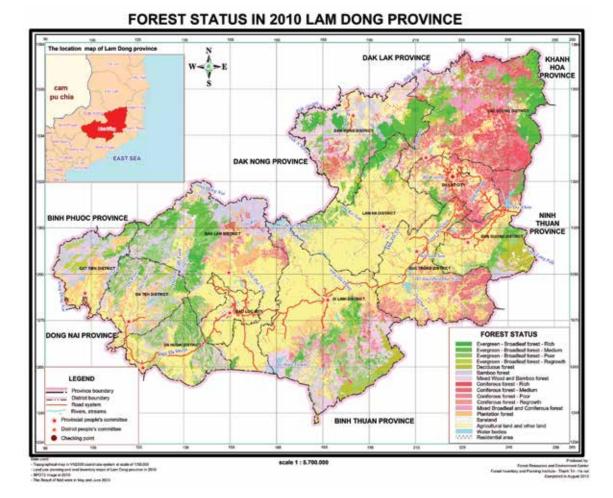
Restoration broadleaf evergreen forest was also subject to conversion. About 5,000 ha was converted to agricultural land, primarily in the districts of Lam Ha (about 1,400 ha) and Da Huoai (1,100 ha). Due to intensive logging, about 3,400 ha was converted to mixed wood and bamboo forest, focused in Di Linh district (about 2,000 ha). In addition, more than 5,200 ha of restoration forest grew into poor forest class due to the implementation of forest protection and silvicultural management systems. This was concentrated in Di Linh (about 2,800 ha) and Lam Ha (about 1,140 ha) districts.

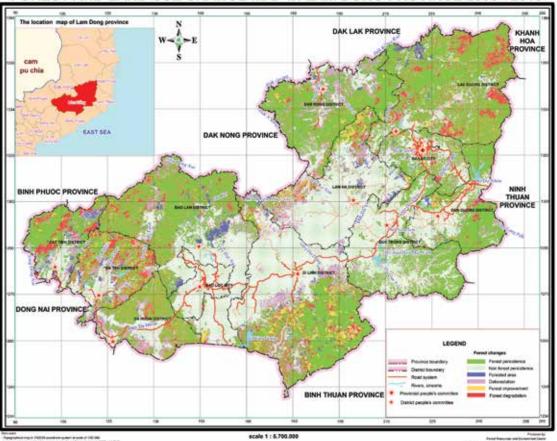
Deciduous forest was mostly converted into land for agricultural production (about 1,200 ha), with an area of about 640 ha converted to plantation and over 770 ha of bare land. The main reason for these conversions was extensive and exhaustive logging.

In this period, 7,400 ha of bamboo forest changed to mixed wood and bamboo forest and a further 700 ha became restoration broadleaf evergreen forest. In addition, an area of over 10,160 ha, where access was easy, switched to perennial crops. This was mostly in the districts of Dam Rong (4,400 ha), Bao Lam (about 1,700 ha), Di Linh (1,600 ha) and Cat Tien (1,100 ha). Finally about 3,400 ha was converted to commercial plantation.

Mixed forest (wood and bamboo) was subject to the most conversion. Due to forest restoration, approximately 10,460 ha of this forest type grew into the poor or medium broadleaf evergreen forest category (about 7,900 ha and 1,500 ha respectively). However, about 6,300 ha of mixed forest (wood and bamboo) was affected by continuous logging and therefore degraded to bamboo forest. A further 2,160 ha was converted to plantations, 7,460 ha was converted to agricultural land and 900 ha was converted to unused bare land as result of exhaustive cutting.

Coniferous forest mainly changed in terms of quality due to selective logging and restoration occurring simultaneously. About 7,950 ha of coniferous forest was converted to agricultural land and industrial crops like coffee and rubber and about 2,690 ha of rich coniferous forest was degraded to medium forest. About 7,160 ha of medium coniferous forest was degraded to poor coniferous forest, mainly concentrated in Lac Duong district (about 5,290 ha). In addition, after forest restoration, about 3,500 ha of poor forest changed to medium forest, concentrated in two districts: Lac Duong (2,500 ha) and Don Duong (480 ha). About 2,660 ha of this forest type was converted to agricultural land, mostly for industrial crops of coffee and rubber. The conversion areas focused mainly in the districts of Lac Duong (about 700ha) Duc Trong (500 ha) Bao Lam (510 ha) and Da Lat city (670 ha).





FOREST AND LAND USE CHANGE MAP IN LAM DONG PROVINCE 2005 - 2010

Franciscus en la 2000 construir quiera en una el 100 cm construir provincia en la 200 cm de la 200 cm de 100 el 100 el 100 cm de 100 cm de 100 el 100 el 100 cm de 100 Table 12: Matrix conversion area of forest land in the 2005 and 2010

Unit:ha

| 2010 2005 | Broadleaf evergreen forest | Deciduous forest | Bamboo forest | Mixed wood and bamboo | Coniferous forest | Mixed broadleaf and coniferous forest | Plantation | Bare land | Non- forested land | Total |
|---|----------------------------------|---------------------|------------------|-----------------------------|----------------------|---|------------|--------------|--------------------------|-----------|
| Broadleaf evergreen forest | 194,669.6 | 36.8 | 2,483.7 | 13,888.2 | 110.0 | 154.4 | 2,714.7 | 1,827.0 | 14,111.6 | 229,995.9 |
| Deciduous forest | 24.0 | 15,417.8 | 0.0 | 32.3 | 0.5 | 0.2 | 640.8 | 852.8 | 1,248.7 | 18,217.2 |
| Bamboo forest | 938.7 | 0.0 | 37,739.1 | 7,431.6 | 28.3 | 6.4 | 3,202.9 | 706.1 | 10,606.9 | 60,660.0 |
| Mixed wood and bamboo | 10,467.3 | 44.2 | 6,305.2 | 69,327.4 | 40.7 | 13.5 | 2,167.1 | 901.2 | 7,787.3 | 97,054.0 |
| Coniferous forest | 167.4 | 6.9 | 26.8 | 23.8 | 113,227.2 | 983.4 | 1,047.0 | 1,975.2 | 7,945.0 | 125,402.7 |
| Mixed broadleaf and coniferous forest | 193.0 | 1.3 | 7.6 | 15.0 | 412.3 | 19,936.5 | 353.2 | 202.8 | 1,000.1 | 22,121.8 |
| Plantation | 178.4 | 0.0 | 393.8 | 75.1 | 53.4 | 35.5 | 37,109.5 | 601.5 | 8,200.0 | 46,647.3 |
| Bare land | 1,884.5 | 107.0 | 1,963.4 | 2,604.2 | 344.1 | 92.0 | 4,491.5 | 9,407.2 | 13,827.2 | 34,721.0 |
| Non-forested land | 264.5 | 8.8 | 1,110.2 | 563.3 | 201.8 | 33.2 | 9,515.5 | 501.6 | 330,335.5 | 342,534.5 |
| Total | 208,787.4 | 15,622.9 | 50,030.0 | 93,960.9 | 114,418.4 | 21,255.1 | 61,242.1 | 16,975.4 | 395.062.3 | 977.354.4 |
| | | | | | | | c | | | |

Source: Data extracted from forest status maps in 2005 and 2010. Lam Dong province

New plantations, in this period, were mainly planted on non-forested land and some exhausted forests (very poor forests). Of those about 4,490 ha of bare land was afforested with plantation forest.

9,500 ha of perennial crops were afforested (converted to plantation forests) because the perennial crop had poor yield and farmers had difficulties with tending and harvesting the crops.

The exhausted forests were converted to plantation forests including: broadleaf evergreen forest of approximately 2,710 ha, bamboo forest about 3,200 ha and about 2,160 mixed forest (wood and bamboo). Additionally, about 8,200 ha of land for plantation changed to industrial crops with higher economic value

Bare land was the subject of a fairly complicated conversion process. A lot of forest land suffered excessive logging or was converted to bare land. Of this conversion to bare land, 6,400 ha was from natural forest, including evergreen forest (around 1,800 ha), coniferous forest (about 2,100 ha), deciduous forest (about 770 ha), bamboo forest (about 700 ha), mixed bamboo forest (about 900 ha) and coniferous forest (about 1,970 ha). Also, a portion of plantation area (approximately 600 ha) had not yet regenerated after harvesting and about 13,800 ha of unused bare land was targeted for industrial crops or slash and burn farming. In parallel with this negative trend, an area of about 6,800 ha of the bare land with scattered trees shifted to natural forest, of which bamboo forest (1,960 ha), mixed forest (wood and bamboo) (2,600 ha), restoration evergreen forest (1,880 ha) and new forests covered nearly 4,490 ha.

Non-forested land was subject to notable conversion. In particular, the conversion from forest to land for growing industrial crops or for agricultural cultivation, including bare land (about 13.820 ha), broadleaf evergreen forest (about 14,110 ha) and bamboo forest (10,600 ha).

4.1.3 Summary analysis of forest changes from 1990-2010

Between 1990 and 2010 the area and quality of forest in Lam Dong province changed significantly. The area of forested land reduced most between 1990 and 1995 with a total of 53,980 ha of deforestation. Deforestation in the other periods was: 22,980 ha (1995 – 2000), 23,290 ha (2000 – 2005) and 21,200 ha (2005 - 2010). During this time the area of plantation increased almost six fold, from 11,186 ha in 1990 to 61,242 ha in 2010.

Between 1990 and 2010 the main reason for the reduction in forest land was the conversion to agricultural land for perennial crop (such as coffee or tea) and annual crops. Some conversion to residential areas, plantation forest and rubber trees also occurred. During this period, the quality of the forest also declined with significant movement from rich to medium to poor to restoration forest classes. There were, however, some examples of forest enhancement and afforestation.

The drivers of forest change between 1990 and 2010 in Lam Dong province are examined fully in the next section, but include: conversion of forest land for agriculture expansion; conversion of exhausted forest to plantation forest or rubber trees; development of infrastructure and hydropower; selective logging by state forest enterprises; selected (planned) exploitation by local people and state forest enterprises; and forest fires.

4.2 Analysis of the causes of changes in forest and forest land in Lam Dong from 1990 - 2010

4.2.1 Direct causes of forest and land use change

4.2.1.1 Forest clearing for agriculture

A direct cause of the reduction of the forest resources in the Central Highland's region in general and Lam Dong province in particular is forest clearing for agricultural and industrial crops. This includes coffee, tea and pepper and fruit tree plantations. However, this differs by the forest type that has been logged as well as the factors that influence the deforestation conducted by local people.

Period from 1990 - 2000

Between 1990 and 1994, forest resources in the province were converted mainly because people lacked land for producing food crops. During this period, the country in general and Lam Dong province in particular had severe food shortages. The government encouraged the expansion of agricultural land to meet the needs of the communities. In fact, due to a lack of land for rice cultivation, people relied on slash and burn farming methods on steep areas. Also the yield of crops was low (average yield of rice in 1990 was 24.43 quintal/ ha compared to 41.90 quintal/ha in 2010¹⁰) as a result of poor quality plant seedlings and unsophisticated cultivation methods. So expanding the land used for growing food crops, and improving its productivity was urgently needed, hence forest cover shrunk.

Forest resources in the province were greatly impacted between 1995 and 2000. Most of the area deforested was replaced by perennial crops such as coffee, cashew, pepper and some other food crops as well as fruit farms. According to survey results at the commune level, the intense pressure caused by soaring coffee prices and population growth, mostly driven by free migration due to loose management by local government authorities -- which also affected forest management, resulted in a wave of deforestation for clear land to plant crops in most areas of the province. The main causes of deforestation during this period were: (i) lack of human resources and equipment for forest protection management, and (ii) lack of access, and therefore control, to the remote areas where deforestation mainly took place. This was the situation in Hoai Duc, Tan Ha, Nam Ha and Nam Ban communes of Lam Ha district and Hoa Ninh, Tan Nghia, Tan Chau, Hoa Trung and Di Linh in Di Linh districts. In general, forest loss in the province occurred rapidly and on a broad scale.

^{10.} Lam Dong statistical yearbooks 1995, 2000, 2005 and 2010.

Statistics show that from 1990 - 2000, the total area of crops increased by 124,885 ha, of which coffee trees were the dominant perennial industrial crop. Between 1993 and 2000, coffee prices increased from 42,000 to 45,000VND per kg so people rushed to purchase and illegally clear land for growing coffee, leading to much reduced forest cover. As of 2000, the area of industrial trees of the province had increased to 104,552 ha, more than three times more than in 1990.

Table 13: Area and yield of perennial crops in Lam Dong provincein 1990 - 2000

| | 1990 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|--------------------|-------------|---------|--------|---------|---------|---------|---------|
| Total area (ha) | 49825 | 91416 | 114751 | 129638 | 140693 | 149600 | 154377 |
| Теа | 11067 | 13970 | 18900 | 19998 | 20268 | 21021 | 21606 |
| Coffee | 38678 | 70104 | 87513 | 100970 | 111884 | 120015 | 124359 |
| Rubber | | | | | | | |
| Pepper | 80 | 27 | 46.3 | 65.7 | 129 | 190.3 | 263 |
| Cashew | | 7342 | 8338 | 8670 | 8412 | 8564 | 8149 |
| Yield of per | ennial tree | s (ton) | | | | | |
| Теа | 36,000 | 53,703 | 74,172 | 83,778 | 70,687 | 98,470 | 125,179 |
| Coffee | 25,460 | 61,656 | 91,761 | 129,249 | 103,670 | 139,337 | 167,360 |
| Rubber | | | | | | | |
| Pepper | 29 | 20.8 | 57.2 | 80.4 | 96 | 77.3 | 66.6 |
| Cashew | | 1,750 | 1,748 | 2,572 | 2,353 | 997 | 990 |

Source: Lam Dong statistical yearbooks 1995 – 2000

Period from 2001 - 2010

During this period, although government authorities at all levels had reflected upon the negative outcomes from poor forest management and protection in the previous decade, deforestation still continued due to ineffective law enforcement and monitoring; for example, local people were destroying forest to plant coffee trees and by the time the local authorities became aware of this it was too late to prevent it. In recent years, management of the protection of forests has been more focused but deforestation has still been happening. However, the area impacted and the number of violations have both significantly decreased

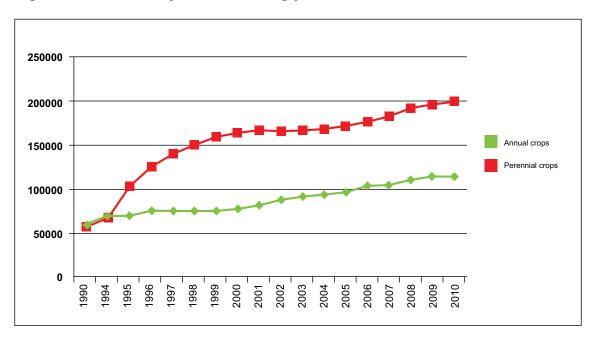


Figure 4: Area of crops in Lam Dong province, from 1990 - 2010

Another reason for the decline in deforestation rates between 2000 and 2010 was the reduced market demand and excess supply for coffee between 2001 and 2005 (see Figures 4 and 5 and Table 14). In 2001 and 2002 the coffee price was only 6,000 to 8,000VND/kg, which was less than the cost of the investment. Therefore the area under coffee production fell from 124,359 ha in 2000 to 117,538 ha in 2005. Since 2006, market demand has again increased leading to further expansion of the coffee estate (see Figure 5).

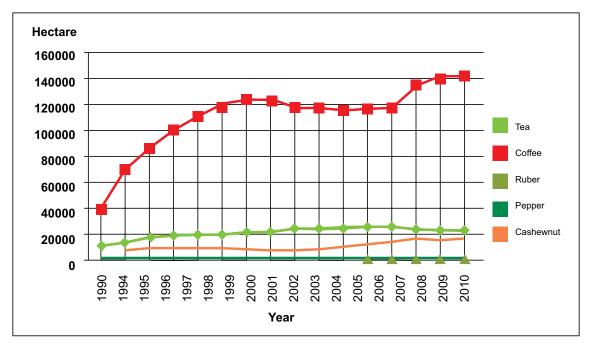
This decline in market conditions also coincided with further restrictions on the expansion of the perennial crop estate under the province's land use plan through to 2010.

| | 2001 | 2004 | 2005 | 2006 | 2008 | 2009 | 2010 |
|--------------------|-------------|------------|---------|---------|---------|---------|---------|
| Total area (ha) | 154,614 | 152,151 | 155,311 | 159,112 | 177,024 | 182,416 | 184,936 |
| Теа | 23,187 | 25,447 | 25,535 | 26,553 | 24,083 | 23,900 | 23,557 |
| Coffee | 123,739 | 116,740 | 117,538 | 118,788 | 136,142 | 141,100 | 143,212 |
| Rubber | | | - | - | 532 | 1,566 | 2,380 |
| Pepper | 386 | 390 | 403 | 390 | 304 | 284 | 280 |
| Cashew | 7,302 | 9,574 | 11,806 | 13,332 | 15,950 | 15,566 | 15,507 |
| Gross output | t of Pereni | nial crops | (ton) | | | | |
| Теа | 124,204 | 151,584 | 161,938 | 170,543 | 178,979 | 171,683 | 204,031 |
| Coffee | 178,394 | 205,227 | 211,804 | 244,152 | 282,587 | 304,715 | 332,036 |
| Rubber | | | - | - | 27 | 35 | 29 |
| Pepper | 189.2 | 696 | 744 | 725 | 572 | 513 | 519 |
| Cashew | 895 | 4,869 | 4,833 | 3,862 | 6,324 | 4,723 | 9,380 |

Table 14: Planted area and gross output of perennial crops from 2001 - 2010

Source: Lam Dong statistical yearbooks 2001, 2010





The areas of tea bushes slowly and steadily increased during this period. From 21,616 ha in 2000 up to 25,535 ha in 2005, an increase of 3,919 ha.

The area of cashews was relatively stable between 1995 and 2004, but had increased to 15,507ha by 2010.

4.2.1.2 Projects for planting new forest on poor forest land

From 2006 - 2012, a total of 106 forest conversion projects were implemented with a total area of 21,654 ha, accounting for 13.9% of the total area of forest conversion. Details for each district are shown in Table 15.

| District/city | Area | Location/commune/town |
|---------------|----------|---|
| Da Lat | 271.4 | Ward 5, 11, Ta Nung commune, lake Tuyen Lam |
| Lac Duong | 1,294.59 | Da Nhim; Da Chair; Lat and Lac Duong town |
| Don Duong | 2,732.63 | Lac Xuan; Ka Do; Tutra; Ka To; Lac Xuan; Tutra; Pro; Ka Do and Lac Xuan |
| Duc Trong | 2,047.53 | Hiep An; Hiep Thanh; Hiep An; Da Loan; Nang; Phu Hoi and Hiep Thanh |
| Lam Ha | 1,315.86 | Phu Tho; Tan Thanh; Lien Ha; Dan Phuong; Phi To |
| Dam Rong | 2,256.58 | Compartments: 188; 191B; 191; 210a; 174; 177. 178. 172. 187. 173. 186. 193. 200. 195. 176. 177 |
| Di Linh | 2,575.06 | Compartments: 618a; Gia Bac; Tan Thuong,Tan Chau, Tan Nghia, Dinh Lac, Gia Hiep, Son Dien, Dinh Trang Thuong, Hoa Bac |
| Bao Loc Town | 1.69 | Loc Chau |
| Bao Lam | 5,509.97 | B'la; Loc Thang; Loc Bao; Loc Phu; Loc Thanh; Loc Tan; Loc Ngai; Loc Bac |
| Da Huoai | 1,029.75 | Ha Lam; Mudagui town; Da Mri |
| Da Teh | 2,604.23 | Trieu Hai; Quoc Oai; An Nhon; My Duc; An Nhon |

Table 15: The area of natural poor forest converted to commercial plantation

Source: Circular No. 6690/UBND-LN lamdong. 27/11/2012

Private companies implemented the conversion projects but many companies implemented these ineffectively. For example, Don Duong district had 20 companies in 2010. Their business plans involved leasing land and converting exhausted forest to plantations with plant species such as keo (*Acacia*), xoan (*Melia*) and mit (*Artocarpus – moraceae*). However, some of the plans of Thien Quang Ltd., Hao Quang Sai Gon and Kim Phat companies were not completed because the companies cleared the forest without replantation and that led to large areas of cleared land being abandoned.

One measure for improving poor forests with low productivity is to turn the land into plantations with higher wood yields. This approach was detailed in Circular No. 99/2006/TT-BNN dated November 6th, 2006, issued by the Ministry of Agriculture and Rural Development for 2006 - 2012 and was implemented in Lam Dong province. A total of 53 projects were implemented, affecting 15,082 ha of forest and forest land (32.5% of

the total area of forest conversion), of which 13,991 ha was assigned to companies and organizations, including 13,900 ha of natural forest and 90.2 ha of bare land and non-forested land. Details for each district are shown in Table 16.

| District | Number of projects | Total area (ha) |
|-----------|--------------------|-----------------|
| Di Linh | 5 | 726.2 |
| Cat Tien | 2 | 178.4 |
| Da Huoai | 14 | 2,329.3 |
| Da Teh | 12 | 3,250.3 |
| Bao Lam | 14 | 6,389.1 |
| Dam Rong | 2 | 409.7 |
| Don Duong | 5 | 1,799.8 |
| Total | 53 | 15,082.7 |

Table 16: Conversion of forest and forest land to grow rubber trees

Source: Circular No. 6690/UBND-LN Lam Dong province. 27/11/2012

By 2010, 6,554 ha had been converted to rubber plantations and an additional 8,947 ha was in the process of conversion.

4.2.1.3 Infrastructure development

From 2006 - 2012, 73 infrastructure development projects were implemented across 1,954 ha of forest, accounting for 4.1% of the total area of conversion. These included:

- Construction on land leased to private enterprises: 36 projects with an area of 384.5 ha.
- Land area for: (1) offices and forest protection stations: 12 projects with an area of 388.2 ha; (2) construction of factories (three buildings) for processing forestry products: area of 3.6 ha; (3) road construction: seven projects with total area of 347 ha; (4) construction of rural development social welfare projects: area of 10.6 ha; (5) buildings related to religion and cultural purposes: two projects with total area of 26.4ha.

4.2.1.4 Hydroelectric projects

Construction of hydroelectric projects in the region also led to forest loss. Topographic features such as complex terrain, high annual rainfall and the density of streams and rivers create many advantages for hydropower development. From 2003 - 2010, 12 large and medium hydropower projects were implemented with 5,842 ha of forest land being converted for the construction, accounting for 4% of the total area converted during this period. A list of hydroelectric projects, their location and the area converted is shown in Table 17.

| Project | Year implemented | Location | Forest land converted (ha) |
|-------------------------|---------------------|--|----------------------------|
| Dong Nai 3 | | Bao Lam and Di Linh districts | 3,107.89 |
| Dong Nai 4 | | Bao Lam district | 831.45 |
| Dam Bor | | Bao Lam district | 14.93 |
| Dambri 2 | 2008 | Loc Tan commune, Bao Lam district | 372.79 |
| Da Khai | D | Da Khai stream, Dan Him river | 206.46 |
| Dong Nai 2 | 2008 | Tan Thuong commune, Di Linh district | 837.73 |
| Dong Nai 5 | 2009 | Dong Nai river in Dak Rap and Bao Lam districts | 232.63 |
| Da Cho Mo | 2009 | Lam Ha district | 12.6 |
| Da Dang | | Lac Duong district | 51.11 |
| Yan Tann Sien | 2009 | Yan Tann Sien stream, Dung Kno commune, Lac Duong district | 99.61 |
| Dak Me | 2009 | Da Long commune, Dam Rong district | 19.61 |
| Mang Linh (Cam Ly 3) | 2010 | Phuong 5, Da Lat city | 66.92 |
| Total | | | 5.842,56 |

Table 17: Hydroelectric projects and the conversion area of forest land

Source: Circular No. 6690/UBND-LN Lamdong province. 27/11/2012

Besides the direct impact caused by the construction of hydroelectric projects there were also indirect impacts, including:

- Roads constructed for transportation of raw materials to the hydroelectric projects created easy access to the forests for forest violators
- In the process of building the dams, the wood from forests near to these dams was exploited to provide raw materials, resulting in deforestation and forest degradation
- During the construction of hydropower plants, logging in the reservoir was allowed as part of the construction project, but forest violators could take advantage of this for illegal logging purposes.

• Rising water levels in the reservoir created favorable conditions for cutting forest near the lake to plant other crops.

4.2.1.5 Planned logging activity

Activities resulting in deforestation

Logging activities were one of the direct causes of forest degradation in Lam Dong province. According to the results of surveys and interviews, logging activities were highest between 1990 and 1995. During this period, agriculture and forestry state enterprises were established to carry out logging activities and reclamation of forest land. State forest enterprises conducted logging activities with a license, but illegal logging was also conducted by local people for construction of housing and to sell to generate additional income for the family.

Activities resulting in forest degradation

Legal logging based on the annual plan of the province as well as the illegal logging of local people was as follows:

- Annual volume of timber from exploitation of natural forests, according to approved quotas:
 - 2000 2005: 181,062 m³ over 4,895.2 ha. Approximately 30,000 m³/year
 - 2006 2010: 101,741m³ over 3,269.4 ha. Approximately 20,000 m³/year. This was a decrease compared to 2000 2005.
- Volume of timber product collected when forest land was converted for other projects:
 - **2000 2005:** 140,859 m³ over 4,707.9 ha. Approximately 28,000 m³/year
 - **2006 2010:** 191,365 m³ over 9,593 ha. Approximately 38,200 m³/year.

Timber volume from secondary logging increased by an average of 8,200 m3/year over the period 2006 - 2010. During this time, a large area of forest land was converted to land for buildings, commercial plantations and cultivation of rubber due to conversion of exhausted forest.

- Annual volume of timber from logging of plantation:
 - 2000 2005: 80,107 m³. Average: 13,300 m³/year
 - 2006 2010: 79,925 m³. Average: 16,000 m³/year.

Volume of timber extracted from plantations increased on average by

2,700 m³/per year, over the period 2000 - 2005. Plantation production increased due to a large area of plantation being ready for harvesting.

• Non-timber forest product (NTFP) extraction:

Deforestation through NTFP extraction mostly relates to bamboo which, in the years 2009 – 2010, was exploited for its resin.

• 2000 - 2005:

Volume of bamboo removed was 89,465 tons or an average of 14,910 tons/year.

Rattan production of 1,015 tons, average: 170 tons/year

• 2006 - 2010:

Volume of bamboo removed was 23,730 tons or an average of 4,716 tons/year.

Volume of bamboo exploited in 2006 - 2010 was much lower than in 2000 - 2005.

Rattan production of 1,082 tons, average: 215 tons/year.

Table 18: Exploitation of wood and forest product in Lam Dong province

| item | Unit | Total | 2000 - 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|--------------------------------------|------|-----------|-------------|----------|----------|----------|----------|----------|
| 1.Main exploitation | ha | 8,164.7 | 4,895.2 | 600.2 | 677.1 | 670.0 | 610.4 | 711.8 |
| Wood product | m3 | 282,803.2 | 181,062.4 | 16,913.1 | 18,062.6 | 25,210.7 | 20,339.0 | 21215.3 |
| 2.Extraction of wood and NTFPs | ha | 14,301.1 | 4,708.0 | 1,459.7 | 1,181.9 | 3,406.7 | 1,784.6 | 1,760.3 |
| Wood product | m3 | 332,224.0 | 140,859.0 | 34,392.0 | 28,149.0 | 40,309.0 | 39,484.0 | 49,031.0 |
| 3. Exploitation of plantation | m3 | 160,030.7 | 80,107.4 | 7,431.7 | 19,374.7 | 22,950.2 | 14,873.6 | 15,295 |
| 4. Non forest product | | | | | | | | |
| Pine resin | tons | 1,069.0 | | | | | 312.0 | 757.0 |
| Bamboo | tons | 113,195.0 | 89,465.0 | 8,676.0 | 7,969.0 | 42,30.0 | 1,869.0 | 986.0 |
| Rattan | tons | 2,097.0 | 1,015.0 | 581.0 | 330.0 | 76.0 | 70.0 | 25.0 |
| Stem. root | tons | 734.0 | | | 260.0 | 163.0 | 221.0 | 90.0 |
| Brush holders | tons | 8.0 | | 8.0 | | | | |
| Buong leaf | tons | 208.0 | | 75.0 | 55.0 | 30.0 | 33.0 | 15.0 |

Source: Lam Dong statistics year 1990 – 2010

4.2.1.6 Deforestation due to forest fire

Natural pine forest is very characteristic of Lam Dong province. As these are prone to fire, forest fire prevention has been a top priority for the forest protection management units.

As a result of good implementation of forest fire prevention, the incidence of forest fires in the province is very low (see Table 19), including both the number of fires and the area of burned forest.

For example, in 2005 the Forest Protection Department of Lam Ha and Di Linh reported a total of 21 cases of forest fires affecting 29.5 ha of forest, of which, Di Linh had 10 cases with 10.4 ha of forest lost and Lam Ha had 11 cases with 19.1 ha of forest lost.

Table 19: Forest fires and forest area burned from 2006 - 2010

| Land use and forest type | 2006 | 2007 | 2008 | 2009 | 2010 |
|-----------------------------|------|------|-------|------|-------|
| A. Land covered with forest | 0 | 0 | -4.17 | 0 | -1.97 |
| I. Natural forest | 0 | 0 | 0 | 0 | -1.97 |
| 1. Wood forest | 0 | 0 | 0 | 0 | -1.97 |
| II. Plantation | 0 | 0 | -4.17 | 0 | 0 |
| 1. Mature plantation | 0 | 0 | 0 | 0 | 0 |
| 2. Young plantation | 0 | 0 | -4.17 | 0 | 0 |

Source: Forest protection department, Lam Dong province

4.2.2 Indirect causes of forest and land use change

4.2.2.1 Infrastructure development

According to a survey among local officials and people about the influence of infrastructure development on the decline in forest resource, development of infrastructure does not lead to much forest loss. But in reality infrastructure development is one of the main indirect causes of forest loss as it allows easier access for illegal logging. The majority of communes in the province were only established between 1985 and 1990 and roads were also constructed at this time. The roads were primarily constructed for use by state forest enterprises for logging, as well as constructed by local people for transportation of agricultural products.

4.2.2.2 Spontaneous migration and re-settlement

Spontaneous migration was an indirect cause of forest and land use change. In fact, most of the communes in Lam Dong were established between 1985 and 1990 under a government program to develop a new economic zone. People were moved from to new areas to generate income from the land. Once households succeeded in cultivating the land they began to bring their relatives to the area, thus building settlements and creating spontaneous migration. According to interviews, spontaneous migration was heaviest between1993 and 1999: the population increased by thousands of people each year according to provincial statistics. However, the actual number of migrants was much higher than the statistics suggest because many migrants did not register with the local authority.

Interviews also showed that most respondents believed that the increase in population due to spontaneous migration was an indirect cause of forest loss. When migrants move in, forest clearance for agricultural production and house construction starts. In conclusion, large in-migration is a significant indirect cause of deforestation and forest degradation in the province.

In addition, development of hydropower plants, irrigation systems and road construction projects has both caused and contributed to the resettlement of ethnic minorities, who had to stay in planning before moving onto new areas. Although the amount of land they occupied was limited, the conversion of forest land for cultivation was inevitable.

The resettlement of the ethnic minority whose have shifting cultivation customs and resettlement of the family farming lands for irrigation hydropower projects, road – construction projects while the local's production land is limited so the conversion of forest lands to agriculture for people is inevitable.

4.2.2.3 Coffee price increases

Another important indirect impact on forest loss in the province was the increasing value of coffee. When the price increased it created a "coffee fever' with local people cultivating coffee on both agricultural land and land converted from forest land. The peak period of the conversion of forest land to coffee plantations was from 1993 – 2000, coinciding with the highest price of coffee, which reached a peak in 1994 of 45,000VND/ per kg.

The high coffee price also sped up spontaneous migration to the province, further impacting forest loss.

Analysis of coffee prices clearly indicates that when coffee price increased, the area of coffee plantations expanded and deforestation increased (see Section 3.2.2.1)).

4.2.2.4 Loose management policy at all levels of authority

The status of forest management at the local level also had an indirect impact on lost forest resources in the province. The major problem was that many communes were newly established so lacked effective officers and operations. Specifically:

- The capacity of rangers was still weak and had a corresponding impact on the ability to halt the decline of forest conversion. Rangers with a university degree were very limited, especially from 1990 - 2000 when the number of rangers who had graduated university was only 10 - 15% of the total number of rangers in the district Fire Protection Department (FPD).
- Checkpoints were also very sparse and staff in each station was limited; with only one to two staff per station to protect and control the 10,000 ha of forest area assigned to each station.
- Forest owners did not have enough support tools, competence or authority to support law enforcement. Most forest owners had not received enough training on using support tools from the police so could not effectively use them.
- State specific policies which applied to civil servant rangers had not been applied to forest owners.
- A large number of indigenous people in the central highlands are very poor and live in difficult circumstances, so even when they contravened forest law and regulations, forest owners and rangers could not force them to pay fines.
- Investment projects for forests and forest land were not yet under proper management or forest protection; forest guards for these projects lacked professional expertise and were unable to punish forest violators.

 Households with forest protection contracts were not confident or self-motivated enough to take full responsibility for forest protection, and there was a lack of legal frameworks for contracted households.

The impact of land trade and land speculation on forest and land use changes in Lam Dong province

Land trade also impacts on forest change. Indigenous people of ethnic minorities have been granted land advantages due to government policy and traders have often encouraged them to engage in deforestation for conversion to agricultural land and then sell the land to the traders. The lands are then used for growing coffee or sold to other people. According to Mr Dinh Cong Nhay, chairman of Hoa Nam commune, Di Linh district, land trade in the local area was a potential cause of forest loss. Specific management policies are now in place aimed at restricting the trade of land such as: every household is allocated only a specific area, land is not for commercial production and land is non-transferable.

Mr Nguyen Van Thong, head of resources and environment department, Lam Ha district, summarized the process of forest loss as follows:

Before the 1990s, state agriculture and forest enterprises had the mandate to exploit forests and reclaim land to plant industrial crops such as tea, mulberry, coffee, etc. This resulted in the loss of a lot of mature forest.

After this came the development of new economic zones and spontaneous migration. Each year, thousands of people moved to the province from the northern provinces and the southeast to reclaim land and settle in the region. This process took place over a long period of time, from 1990 – 2000, with an average increase of 500 to 1000 people per commune per year. This indirectly led to forest loss in the project region.

4.2.2.5 Socio-economic factors

Impact of economic development

According to statistics, the total production value of the agriculture and forestry sectors grew rapidly over this period: as of 2010, it was nearly 18 times higher than in 1995. Therefore, the pressure on the forest was inevitable: people will find any way to convert forest and other land in order to cultivate coffee. Consequently, the forest and forest land changes in the area were difficult to control.

Table 20: Gross output at current price

Unit: Millions VND

| | 1995 | 2000 | 2005 | 2010 |
|------------------------------|-----------|-----------|-----------|------------|
| Total | 2,237,033 | 2,676,108 | 6,939,094 | 48,541,711 |
| I. Economic element | | | | |
| A. Domestic sector | | | | |
| + State | 70,836 | 78,110 | 139,677 | 10,207,458 |
| - Central management | 29,953 | 12,812 | 42,272 | 6,527,598 |
| - Local management | 40,883 | 65,298 | 97,405 | 3,679,860 |
| + Collective economy | | 25,662 | 51,786 | 197,457 |
| + Private sector | | 3,336 | 34,049 | 6,520,185 |
| + Individual | 2,165,135 | 2,543,222 | 6,555,400 | 30,366,596 |
| + Mixed sectors | | 10,750 | | |
| B. Foreign investment sector | 1,062 | 15,028 | 158,182 | 1,250,016 |
| II. Agriculture sector | | | | |
| Agro-forestry sector | 876,172 | 2,631,286 | 7,408,779 | 23,659,823 |
| Aquatic sector / Fisheries | 12,317 | 32,069 | 57,742 | 227,220 |

Source: Lam Dong statistics book

In addition, due to the impact of economic liberalization, land and forest resources were exploited excessively and affected the sustainable development of these resources.

The influence of market mechanism

On the positive side, liberalized trade and investment meant local people were able to increase their income by exploiting the forest and the land. The area, yield and productivity of agricultural and forestry rose and drove conversion of forest land to agricultural crops.

However, cooperation between suppliers (farmers) and the business sector was not efficient. The value chain of perennial production was weak and products only achieved a low price and are were not competitive on the global market. In addition, the market coffee price fluctuated constantly, due to adverse weather and the increased prices of supplies, petrol, fertilizers and insecticides, and control by speculators, which caused further problems for producers. Local authorities (the Party and People's Committees) did not set out directives or specific measures to steer businesses and coffee growers to be production-oriented and to let the market regulate itself. As a result, coffee was grown in an unstructured way, having a huge impact on the management, protection and development of forest resources.

Impact of land use planning

Land use planning in the province had many inadequacies. Firstly, there was a lack of consistency between sectors in the province, especially between the Department of Environment and Natural Resources and the DARD. For instance, boundaries between forest land and land outside the forest estate were unclear. Reviewing and planning of forest management types was completed but the data and maps did not meet the required accuracy nor the needs of users. Therefore, those involved in the sustainable management and development of agriculture and forestry encountered many difficulties.

Secondly, the quality of planning was poor. The plan was inadequate in practice and was biased. The land use plans, even after approval, had many inadequacies leading to confusion, encroachment and unauthorized changes in land use by local people.

Influence of monitoring and assessment on forest change

The Forest Protection Department (FPD) is in charge of annual forest monitoring and gathers data on forest quantity and quality as well as distribution of forest to devise measures for forest protection and development. But there has not been close collaboration between forest owners, functional institutions and local authorities in collecting and updating data regarding forest development, conversion of forest uses, land use planning, assessing forest quality, monitoring forest fires, deforestation and mapping changes in forest and forest land. Therefore, it has been difficult to monitor and closely control the forest change.

4.2.2.6 Other indirect causes

A number of other factors led to the decline of forest area and quality, for example:

- The lack of staff dedicated to specific aspects of forest protection and development of the forest management units and a lack of suitable equipment. Forest owners, including limited companies (former state forest enterprises) and management boards of watershed protection forests, did not have the power and capabilities to fulfill their mandate.
- Much forest land has been encroached by local people. These lands were managed by locals, individuals, management units and forest owners but the process to deal with this situation was not strictly in accordance with the directions of the province.
- The boundaries of the three forest categories were not clear on the ground and boundary demarcations were incomplete.
- The follow-up monitoring of the implementation of projects related to conversion of forest land was not done properly in some places.

- Inaccuracy in terms of areas, forest type, boundaries and inventory programs were not thorough. This was a limitation of forest management.
- The illegal trade of forest land for cultivation was occurring and nothing was done to solve the problem.
- Some enterprises delayed afforestation or developing rubber after logging, as in their proposed conversion plan, because they had limited financial resources for implementing afforestation activities.

4.2.3 Forest enhancement

4.2.3.1 Reforestation and afforestation programs

1990 - 1999: Activities of reforestation in the province were limited and mainly conducted through Project 327 and afforestation programs, funded by the provincial budget. Only a small portion of the area was planted through joint capital investment. Also, according to interviews with forestry companies, due to the limitations of the techniques and seedlings used, the proportion of successful plantations was not high.

2000 - 2010: During this period (see Table 21) a number of projects and programs were implemented on a large scale, including: plantation of five million hectares (Program 661) under the provincial budget; Program 147, a plantation project for the production of paper; and, most recently, the FLITCH reforestation project. Programs like project 30A, supporting plantations by local people on a small scale, were also implemented.

In conclusion, over this period, afforestation programs were being promoted and made significant contributions to improving forest cover. The implementation of afforestation programs was carried out by forestry companies and forest management units. The selected tree species for plantations were mostly native species suited to the climate and soil of Lam Dong province. In the southern districts (An Huoai, Da Teh and Cat Tien) and Dam Rong district (at the border with Dak Lak and Dak Nong), the main species planted in watershed protection forest areas were Dipterocard mixed with Acacia; while in production forest, the selected species were Acacia spp, cashew and rubber. In the northern districts (including Bao Lam, Lam Ha, Da Lat, Dam Rong and Di Linh), in watershed protection forest areas, planted trees were Pinus khaysia and in production forest the species included ngan hoa (Grevillea robusta), muong den (Senna siamea) and xoan (Melia).

Table 21: Result of afforestation in Lam Dong province

| Item | Total | < 2000 | 2000- 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|--------|--------|---------------|------|------|-------|-------|-------|
| Total | 59,766 | 24,599 | 18,611 | 798 | 724 | 2,279 | 3,504 | 9,251 |
| Area planted by the state and central government and managed by forest owners | | | | | | | | |
| Capital from 661 | 10,422 | 5,252 | 3,386 | 393 | | 293 | 480 | 618 |
| Capital from sale of standing trees | 25,482 | 18,304 | 5,547 | 107 | 205 | 334 | 311 | 672 |
| Capital from 30A. CP | 1,901 | | | | | | 532 | 1,369 |
| Support capital in accordance with Decision 147 | 432 | | | 122 | | | 119 | 191 |
| Capital for afforestation in accordance with Decision 135. 178-CP (own) | 1,671 | 37 | 196 | 73 | 188 | 309 | 498 | 371 |
| Capital from exploitation of plantation for afforestation | 122 | | 4 | 13 | 13 | 26 | 35 | 30 |
| Capital for afforestation from exhausted forest | 190 | | | | | 52 | 99 | 39 |
| Capital from FLITCH project | 358 | | | | 35 | | 25 | 298 |
| Mobilised capital from forest owners for Acacia plantation | 311 | | 121 | 47 | 51 | 73 | | 20 |
| Joint-venture capital for rubber plantation | 474 | | 93 | | | 98 | 55 | 227 |
| Area planted by private companies, organisations and joint ventures for reforestation | | | | | | | | |
| Outside state capital (forest leased by business companies) | 9,201 | 683 | 670 | 43 | 232 | 985 | 1,313 | 5,276 |
| Joint-venture capital for forest enrichment T09 | 23 | | | | | | 16 | 8 |
| Joint-venture capital for paper materials | 8,780 | 323 | 8,194 | | | 109 | 22 | 132 |
| Capital of IPDP (hydropower plants) | 399 | | 399 | | | | | |
| Level I | 15,591 | | | | | | | |
| Level II | 15,224 | | | | | | | |
| Level III | 17,876 | | | | | | | |
| Level IV | 9,771 | | | | | | | |
| Level V | 1,305 | | | | | | | |

Unit: ha

Source: Report on forest protection and development planning of Lam Dong province, 2011 - 2015, vision to 2020

In recent years, successful projects and forestry development programs in the province have resulted in:

- Improved forest cover and quality: The forest cover of the province increased from 59.78% (1999) to 61.68% (2009) to a total of 602,757 ha, of which 545,244 ha was natural forest and 57,513 ha was plantation with a total standing volume of about 56 million m3 of timber and over 500 million bamboo trees. Forest quality also improved, with an increase in diversity of forest type and endemic flora and fauna. The improvement in forest cover and quality all had important economic, environmental and biodiversity values.
- Creation of raw materials for the development of the processing industry: Lam Dong province expanded its wood processing industry and rubber plantations. From 2011 – 2015, afforestation increased by an average 4,277 ha/year including: forest enrichment of 1,000 ha/year; rubber planting of 2,500 ha/ year; forest exploitation and logging: average of 38,000 m³/year; salvaged logging of 80,000 m³/year; logging from plantations of 38,000 m³/year; and trimmed plantation or 15,000 m³/year¹¹.
- Job creation and poverty reduction: The 5 Million Hectare Reforestation Program implemented in Lam Dong province involved local people, especially ethnic minorities, in forest protection contracts for the implementation of silviculture projects such as afforestation and plantation management. Enrichment of natural forest also contributed greatly to job creation and poverty alleviation, increasing income for families while at the same time encouraging local people to take greater responsibility for forest management and protection as well as increasing knowledge on techniques for growing and tending to plantation forests.

^{11.} Vo Van Hong and Tran Van Hung, 2006. Growth forest and forestry handbook.

4.2.3.2 Promotion of natural regeneration - forest enrichment

Along with forest planting, promotion of natural regeneration is another measure taken to increase forest area and quality. However, in the period from 1995 - 2000, not all measures to promote natural regeneration were fully carried out. According to interviews with officers and staff from local Forest Management Units, "the area of natural regeneration is only there as a result of forest protection and prevention of over-harvesting, as well as limited shifting cultivation. Silviculture measures such as additional planting, cutting lianas and trees with low value of timber have not been implemented".

During the period 2000 - 2010, the 5 Million Hectare Reforestation Program (Program 661) began promoting natural regeneration in 9,744 ha of watershed protection forest and in 1,770 ha of special-use forest. The area of natural regeneration has subsequently grown well and is now categorized as restoration forest (status IIA or IIB).

4.2.4 The impact of programs and projects for forest change

In the period 1990 - 2011, many forestry programs and projects were implemented throughout the province. Two time periods have been analysed for this report, based on the time of project implementation and the impact of changes in the forest estate.

1990 - 2000

The programs and projects investing in the forestry sector were limited. The two main projects were Program 327 and a reforestation project using provincial funds (running from 1976 to 2007). Most funds were invested in afforestation and did not really focus on forest protection and regeneration.

2000 - 2011

Before the year 2000, most projects invested in afforestation. However, in this period other goals, such as regeneration and forest protection, were also considered (see Table 22). The programs and projects in the forestry sector were also more diverse, such as:

- Project 661 or the 5 Million Hectare Reforestation Program: 1998 - 2010
- Project 147: 2006 2010
- Project FLITCH: 2007 2010
- Planting by the provincial budget: 1976 2007
- · Planting with Joint-venture funds: 1998 2007

More importantly, during this period, local governments issued many important policies which had a positive impact on the changes of forest resources.

| Afforestation | 8,953 |
|----------------|--------|
| Rehabilitation | 3,704 |
| Protection | 11,169 |

Table 22: Results of the implementation of projects in the period 2000 - 2011

Source: FLITCH project and forestry development department. Lam Dong province

The impact of programmes and projects

Positive aspects

The 5 Million Hectare Reforestation Program (Program 661) had notable advantages in its approach which attracted international funding from 21 donors to support the plantation of five million ha of forests. The project:

- Increased the forest coverage of Lam Dong province from 59,78% (1990) to 61,68% (2009)
- · Improved forest quality and diversity
- Created raw materials, through expansion of the forest plantation estate, for the development of the processing industry (described above in Section 4.1.1.1).

The 147 and FLITCH projects invested in afforestation on a large scale. In addition, smaller programs, like project 30A and other projects and programs related to the forest sector and rural development, supported activities in reforestation and forest protection on a small scale. As a result, increased forest cover resulted not only from the new forest plantings but also from forest rehabilitation programs. As well as forest protection, the project also helped maintain and develop existing forest area in an effective manner.

Economic and social development programs targeting ethnic minority communities in the most remote and mountainous areas also had a positive impact on the lives of ethnic minority communities and supported the forestry sector in building and protecting forest resources. There have been many positive activities related to forest protection, with the participation of nearly two million minority people. In addition, the forestry projects implemented from 2000 have brought many economic and social benefits. For local people, especially for ethnic minorities, participating in forest protection contracts and forestry/silviculture projects, such as reforestation, plantation care, rehabilitation of natural forest and nurturing and trimming plantation forests contributed greatly to job creation and poverty alleviation through increased income for local communities in the project region; at the same time participation enhanced the sense of responsibility in the management of forest protection and knowledge of techniques for growing and tending plantation forest. Annually, from 2005 to present, households who signed forest protection contracts under Decision 2005/304/QĐ-TTg or under resolution 30a/NQ-CP, have received more than 100,000 VND/ha/year and 10kg rice per month for six months. This helped to increase household income and encourage poor local communities to actively participate in forest protection and promote the efficiency of capital investment.

Negative aspects

Some general weaknesses of projects and programs:

Central level

The project cost norm for planting in watershed protection forest areas and special use forest areas, as referred to in Circular No. 28/1999/TT-LT dated February 3rd, 1999 of MARD and the Ministry of Finance, was too low compared to actual costs. For a poor province, matching funds were not available and therefore they had trouble in implementing the programs. These regulations (Circular No. 28/1999/TT-BTC, dated March 13th, 1999 and Circular No. 43/2002/TT-BTC, dated May 7th, 2002 of the Ministry of Finance) and implementation procedures were also highly complex.

The central government also issued and directed the implementation of many projects, such as forest protection contracts, in accordance with Decision 2005/304/QD-TTg, dated November 23rd, 2005, by the Prime Minister, and the program for accelerated and sustainable poverty reduction under resolution No. 30A/2008/NQ-CP, dated December 27th, 2008. These were implemented and integrated with the 5 Million Hectare Reforestation Program, but there was inconsistency in terms of cost norms across these programs, and that led to confusion and difficulties in implementing of the programs.

Local level

Projects related to reviewing and planning for the watershed forest basin in Lam Dong were implemented in 2003 (Decision No 1898/QĐ-UB, dated July 18th, 2003) and the results of were issued in 2008 (Decision No. 450/ QD-UBND, dated February 19th, 2008). The forest types covered were protection forest; special use forest and production forest.

4.3 Assessment of the impact of forestry policy on forest changes in Lam Dong province

The government has issued important legislation which has created a legal framework for forest management, protection and development, such as the Law on Forest Protection and Development (1991); Land Law (1993 and 1998); the Law on Environmental Protection (1994); decrees and resolutions by the Government; and decisions and directives by the Prime Minister. In addition, many other legal documents, such as tax exemption for plantation land and timber import duties, have been implemented to encourage all economic sectors, groups and individuals to be involved in forest production, processing, protection and development: Decision 178/2001/QĐ-TTg dated November 12th, 2001, regulated benefits and obligations of households and individuals who were assigned or rented forest and forest land and Resolution 30a/2008/NQ-CP dated December 27th, 2008, regulated rapid and sustainable support for poverty reduction in 61 poor districts.

In addition, the government has issued many policies which have only been applied in the Central Highlands region, such as Decision 132/2002/QD-TTg, dated October 8th, 2002, on the settlement of production and residential land by Central Highland ethnic minority communities.

• Re-arrangement of State Forestry Enterprises (SFE)

In 2005, Lam Dong province submitted to MARD a project proposal, which developed a scheme for the development of SFEs. The proposal was approved by the Prime Minister in Decision No. 296 / 2005/QD-TTg on January 14th, 2005.

Based on the approved project, the People's Committees of Lam Ha and Di Linh districts, in collaboration with the provincial departments, implemented a transformational plan. In the project area, Di Linh, Bao Thuan and Tam Hiep SFEs were changed to forestry companies. After the change, the companies actively added business lines, looked for joint-venture partners to enhance planting material for production and processing and improved and expanded production. These companies also pro-actively sought funds to turn forestry land into production land and mobilize funds from all sectors, including individuals, to accelerate afforestation.

· Payment for forest environmental services (PFES)

Decision No. 1574/QD-UBND, dated June 10th, 2008, of Lam Dong province, established a payment for forest environmental services (PFES) process (see Table 23). The outcomes from a pilot PFES included:

Socio-economic outcomes:

- Standard payment for forest protection households was 300,000 VND/ha/year, with each household protecting an average of 30 ha.
- Income of households tripled compared with households involved in the forest protection project 661.
- The pilot program contributed to poverty reduction and to stable and improved living standards for households.

Environmental outcomes:

- Forest environmental services were better protected.
- In the area of FPES, deforestation, forest encroachment and illegal harvesting of forest products fell 50% in terms of the number of violation cases compared with 2008.¹²

Table 23: Results of implementation of PFES in Lam Dong province

| Year | Total costs received (mil.VND) | Total expenses (mil.VND) | Total area for payment (ha) | Total household benefited |
|------|--------------------------------|-----------------------------|-----------------------------|---------------------------|
| 2009 | 55,328 | 23,504 | 98,732 | 4,014 |
| 2010 | 52,050 | 48,524 | 98,732 | 10,601 |
| 2011 | 71,417 | 69,702 | 272,559 | 10,601 |
| 2012 | 188,933 | 117,946 | 333,506 | 10,601 |

Source: Report on payment for forest environmental services. Workshop dated August 20th, 2013

• Result of forest protection contracts (summarized in Table 24)

Before 2000

Forest land was mainly managed by state forest enterprises. Protection and management contracts for households covered approximately 113,000 ha. Payment to contractors came from local budgets (balance from the sale of standing trees/timber) and government funds through the 661 Program. Remuneration paid during this period was 50,000 VND/ha/ year.

Businesses participated in forest management and protection on an area of only 660 ha of land.

^{12.} Vo Van Hong and Tran Van Hung, 2006. Growth forest and forestry handbook.

From 2000 to 2005

Forest land managed by state forest enterprises decreased as the area of forest protection contracts for households increased. The area of forest protection covered by contracts with households increased to over 270,000 ha per year. Funding for payment to contractors came from local government budgets and the central government as before, but additional funding for households who lacked land for agricultural production was mobilized in accordance with Decision 304/QĐ-TTg dated 23rd November, 2005. Remuneration paid during this period increased to 100,000VND/ha/ year.

Certifications of forest use rights were provided to local households. A total area of 8,696 ha of forest land was allocated to 1,767 households, including 1,389 Kinh households and 378 ethnic minority households. Red Books were issued through the project Forest Protection and Rural Development, funded by the World Bank. The project was implemented in 13 communes in the three districts of Bao Lam, Da Teh and Cat Tien, which are located in the buffer zone of Cat Tien National Park.

Forty-four private enterprises invested in forest and forest land.

From 2006 - 2010

A wide range of economic sectors participated in the allocation of forest land, forest protection contracts and forest leases. However, forest owners and state companies were key stakeholders. Results to the end of 2010 were as follows:

- The area covered by forest protection contracts allocated to local households was 341,032 ha, accounting for 57% of the total area of forest land in the province.
- The area covered by forest protection contracts for management and protection, but mainly covering afforestation for forest products, under the Decree 135, decision 178/QĐ-TTg and Decree 1/CP was 15,475 ha, accounting for 2.6% of the total forest land of the province.
- A total 8,696 ha of forest land was granted to households, accounting for 1.45% of the total area of forest land in the province. A further 2,621 ha of community forest was granted to nine communities of ethnic minorities in mountainous areas.
- 58,454 ha of forest land was leased by private companies until the end of 2010, accounting for 9.7% of the total forest land in the province (436 companies).
- 175,206 ha of forest land, accounting for 29.2% of the total forest land of the province, was managed by forest owners such as watershed forest protection boards, limited liability forestry companies, national parks, forest management units, districts PPC and cities.

Table 24: Situation of forest management and protection and forest land

Unit:ha

| Unit:ha | | | | | | | | |
|--|---------------------|----------------|----------------|---------|---------|---------|---------|---------|
| Item | Total up to 2010 | Before 2000 | 2000 - 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
| I. Forest protection contracts | | | | | | | | |
| Total | 341,033 | 113,737 | 269,514 | 313,644 | 323,151 | 297,327 | 335,906 | 341,033 |
| 1.Funds from 661 program | | 32,883 | 114,767 | 132,997 | 135,936 | 91,882 | 79,014 | 62,359 |
| 2.Funds from sale of standing trees (state) | | 80,854 | 148,592 | 173,925 | 167,411 | 192,249 | 133,141 | 121,005 |
| 3. Funds from PES | | | | | | | 103,961 | 122,666 |
| 4. Funds from IPDP (hydropower plants) | | | 5,414 | 5,850 | 5,986 | | | |
| 5. Funds as per Decision QĐ 4873 | | | | | | | 4,810 | 4,339 |
| 6. Funds as per Decision 240 | | | | | | | 379 | 320 |
| 7.Forest protection contract as per Decision 304 | | | 742 | 742 | 10,957 | 10,336 | 9,305 | 9,280 |
| 8.Forest protection contract as per 30a project | | | | 130 | 2,860 | 2,860 | 5,297 | 8,696 |
| 9.Forest protection from FLITCH | | | | | | | | 12,368 |
| II. Contract for reforestation and benefit sharing in accordance with policies | | | | | | | | |
| Total | 15,475 | 342 | 2,806 | 2,757 | 2,506 | 3,360 | 1,646 | 2,058 |
| 1. Reforestation as per Decree 135 | 7,437 | 108 | 1,219 | 962 | 982 | 2,052 | 820 | 1,293 |
| 2. Benefit sharing as per Decree 178 | 7,846 | 234 | 1,478 | 1,712 | 1,524 | 1,308 | 826 | 764 |
| 3. Decree 01/CP | 193 | | 110 | 83 | | | | |
| III. Land allocation, land lease and forest lease | | | | | | | | |
| Total investor | 436 | 2 | 44 | 41 | 82 | 130 | 76 | 61 |
| Total area | 58,454 | 321 | 10,277 | 3,536 | 8,345 | 16,220 | 11,415 | 8,340 |
| | | | | | | | | |

Source: Planning report of forest protection and development in period 2012-2020

4.4 Historical emissions and removals (t CO₂e) in Lam Dong province

As mentioned in the methodology section, the calculation of historical emissions and removals (t CO_2e) focuses on above- and below-ground average tree carbon stocks.

The average carbon stocks estimated for Lam Dong (Table 25) are based on the NFI conducted in Lam Dong province between 2005 - 2010, which provided estimates for the above ground, tree carbon pool¹³ and on the CDM A/R Methodological tool Version 03.0^{14} , which provided default estimates for the dead wood and litter carbon pool (tC/ha). Litter and dead wood, are equivalent to 6% and 1% of average tree carbon stocks, respectively, for each strata.

| Forest type | Sum (tC/ha) | Average tree carbon stocks based on NFI (tC/ha) | Default IPCC Dead Wood carbon stocks (tC/ha) | Default IPCC Litter carbon stocks (tC/ha) |
|--|----------------|---|---|--|
| Evergreen - Broadleaf forest - Rich | 132 | 124 | 7.4 | 1.2 |
| Evergreen - Broadleaf forest - Medium | 104 | 97 | 5.8 | 1.0 |
| Evergreen - Broadleaf forest - Poor | 60 | 56 | 3.4 | 0.6 |
| Evergreen - Broadleaf forest - Regrowth | 50 | 46 | 2.8 | 0.5 |
| Deciduous forest | 43 | 40 | 2.4 | 0.4 |
| Bamboo forest | 2 | 2 | 0.1 | 0.0 |
| Mixed broadleaf and coniferous forest | 77 | 72 | 4.3 | 0.7 |
| Coniferous forest - Rich | 86 | 81 | 4.8 | 0.8 |
| Coniferous forest - Medium | 72 | 68 | 4.1 | 0.7 |
| Coniferous forest - Poor | 51 | 48 | 2.9 | 0.5 |
| Coniferous forest – Regrowth(*) | 42.25 | 23 | 2.4 | 0.2 |
| Mixed wood and bamboo forest | 43 | 40 | 2.4 | 0.4 |
| Plantation forest | 24 | 23 | 1.4 | 0.2 |
| Agricultural land | 0 | 0 | 0 | 0 |
| Bare land | 0 | 0 | 0 | 0 |

13. Nguyen Dinh Hung (2013), Analysis of raw data of sample plots in NFIMAP-Cycle IV (2006 - 2010), Lam Dong province. Prepared for the LEAF project.

14. A/R Methodological tool: Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities Version 03.0 http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-12-v3.0.pdf. The default IPCC factors for the litter and dead wood carbon pools used to estimate EF/RF based on the CDM A/R Methodological Tool take into consideration the rainfall in Lam Dong exceeds 1600 mm.yr-1 on average and the vast majority of the forest in the province is found at an elevation under 2000m. (*) the data used to calculate volume and carbon stock for this kind of forest is based on research on young stands of Pinus kesiya in Don Duong district, Lam Dong province¹⁵. The average volume for this kind of forest is 76.5m3/ha and an average carbon stock for this kind of forest is 23.37 tC/ha.

Carbon stock data on post deforestation land was not measured and estimated for this report; we assume that all post deforestation carbon stocks for live trees, litter and dead wood to be zero. In the case of woody crops, the actual carbon stocks will not be zero; future analyses should identify post-deforestation land uses with more specificity and establish appropriate carbon stocks for each land use.

Changes in soil carbon stocks are related to the post deforestation land use. We estimate the changes by using the IPCC 2006 guidelines. The change in soil carbon stocks is assumed to occur over a 20 year time period, at which time a new steady state for a given land use is reached. However, as with the change in C stocks of vegetation, it is assumed that the total change in soil C occurs at the time of the event – that is committed emissions.

This IPCC method estimates the changes in soil carbon stocks based on the use of soil factors that account for how the soil is tilled, the method of management, and inputs in the post deforestation land use,

Soil carbon stocks for this study are derived from the Harmonized World Soil Database (HWSD). The soil carbon stock per each forest type represents the area weighted average value. Soil carbon stocks per forest type are summarized in Table 26 below.

| Forest Carbon Stratum/ Forest type | Soil Carbon Stock (tC.ha-1) |
|---|-----------------------------|
| Evergreen - Broadleaf forest - Rich | 43 |
| Evergreen - Broadleaf forest - Medium | 44 |
| Evergreen - Broadleaf forest - Poor | 43 |
| Evergreen - Broadleaf forest - Regrowth | 42 |
| Deciduous forest | 41 |
| Bamboo forest | 45 |
| Mixed Broadleaf and Coniferous forest | 43 |
| Coniferous forest – Rich | 40 |
| Coniferous forest – Medium | 39 |
| Coniferous forest – Poor | 40 |
| Mixed Wood and Bamboo forest | 43 |
| Plantation forest | 43 |

Table 26. Soil carbon stocks in t C.ha-1 estimated based on the HarmonizedWorld Soil Database

15. Le Van Cham, Tran Xuan Thiep, 1993. Report on sivicultural characteristics of natural forest in the Central Highlands.

The post deforestation land uses identified for Lam Dong in this study are agriculture land, settlements, and bare land. The appropriate stock change factors for each is summarized in Table 27 below.

Table 27: Values of F_{LU} , F_{MG} and F_{I} for the identified deforestation activities in Lam Dong¹⁶

| Post deforestation land use | F _{LU} | F _{MG} | F ₁ |
|---|-----------------|-----------------|----------------|
| Conversion to agriculture (assumes continuous cultivation for 20 years, full annual tillage, and <30% of ground covered with residues, and medium inputs typical of annual crops) | 0.48 | 1.00 | 1.00 |
| Bare land (assumes temporary set aside of annual cropland or other idle cropland that has been revegetated with perennial grasses, full tillage, and low inputs) | 0.82 | 1.00 | 0.92 |
| Settlements (assumes majority of settlement area is paved over) | 0.8 | 1.00 | 1.00 |

• Emissions from deforestation:

To account for total carbon emission from deforestation both activity data (AD) and emission factors are needed. AD are defined spatially, based on the post-deforestation land use class (e.g., agriculture, bare land and settlements) and forest carbon strata and is reported on an annual basis (ha yr^{-1}). Activity data for deforestation were derived from pairwise comparison between two land cover maps, to define the net area change from each forest type to agriculture, bare land and residential area for each time period.

An emission factor is an estimate of the change in carbon stocks in all carbon pools impacted by the land use change. The emissions resulting from deforestation in Lam Dong are expressed as emissions per unit area of change, i.e., tonnes of carbon dioxide per hectare (t CO_2e ha⁻¹).

The emission factors (EFs) from deforestation were developed for each relevant stratum by driver or cause of deforestation (i.e., conversion to cropland, conversion to settlement, and conversion to bare land) using the stock-difference method. Under the stock-difference method, carbon emissions are estimated as the difference between carbon stocks before deforestation and the carbon stocks following deforestation.

Based on the carbon stock for each forest type, emission factors of each forest type in each period is calculated by multiplying the area of each stratum of forest lost by the appropriate emission factor.

The total area of deforestation and total carbon stocks from deforestation are as shown below in Table 28.

^{16.} From Table 5.5 in IPCC 2006 GL, Vol. 4, Ch. 5 for agriculture and bare land and Ch. 8 for settlements.

Table 28: Area of deforestation (ha), emission factors per stratum (t $CO_2e.ha^{-1}$) and total CO_2e emission from deforestation in ton

| Foresthins | Post deforestation | Area of defor | estation (ha) | | |
|-------------------------------------|--------------------|---------------|---------------|-----------|-----------|
| Forest type | Post deforestation | 1990 - 1995 | 1995-2000 | 2000-2005 | 2005-2010 |
| Evergreen - Broadleaf - Rich | Agricultural land | 60 | 150 | 63 | 222 |
| Evergreen - Broadleaf - Medium | Agricultural land | 836 | 535 | 326 | 1,196 |
| Evergreen - Broadleaf - Poor | Agricultural land | 7,392 | 5,001 | 3,422 | 7,614 |
| Evergreen - Broadleaf - Regrowth | Agricultural land | 5,257 | 6,351 | 5,189 | 4,986 |
| Deciduous | Agricultural land | 1,523 | 1,316 | 1,544 | 1,205 |
| Bamboo | Agricultural land | 11,472 | 7,603 | 6,268 | 10,162 |
| Mixed broadleaf and coniferous | Agricultural land | 1,620 | 2,101 | 910 | 997 |
| Coniferous - Rich | Agricultural land | 249 | 245 | 663 | 730 |
| Coniferous - Medium | Agricultural land | 1,001 | 1,125 | 1,785 | 2,666 |
| Coniferous - Poor | Agricultural land | 6,665 | 3,506 | 4,746 | 4,040 |
| Coniferous - Regrowth | Agricultural land | 330 | 176 | 126 | 455 |
| Mixed Wood and Bamboo | Agricultural land | 6,936 | 2,124 | 2,892 | 7,467 |
| Plantation | Agricultural land | 1,710 | 2,725 | 2,712 | 8,105 |
| Evergreen - Broadleaf - Rich | Bare land | 93 | 89 | 40 | 39 |
| Evergreen - Broadleaf - Medium | Bare land | 852 | 406 | 373 | 250 |
| Evergreen - Broadleaf - Poor | Bare land | 4,017 | 2,060 | 1,886 | 931 |
| Evergreen - Broadleaf - Regrowth | Bare land | 2,452 | 3,142 | 2,192 | 607 |
| Deciduous | Bare land | 735 | 316 | 640 | 853 |
| Bamboo | Bare land | 6,802 | 2,675 | 3,542 | 706 |
| Mixed Broadleaf and Coniferous | Bare land | 2,008 | 359 | 478 | 203 |
| Coniferous - Rich | Bare land | 176 | 185 | 596 | 308 |
| Coniferous - Medium | Bare land | 397 | 364 | 1,778 | 833 |
| Coniferous - Poor | Bare land | 780 | 1,243 | 2,056 | 755 |
| Coniferous - Regrowth | Bare land | 230 | 299 | 131 | 80 |
| Mixed Wood and Bamboo | Bare land | 3,677 | 1,862 | 3,141 | 901 |
| Plantation | Bare land | 373 | 380 | 512 | 601 |
| Evergreen - Broadleaf - Rich | Settlements | 0 | 0 | 0 | 0 |
| Evergreen - Broadleaf - Medium | Settlements | 5 | 0 | 0 | 2 |
| Evergreen - Broadleaf - Poor | Settlements | 14 | 22 | 13 | 0 |
| Evergreen - Broadleaf - Regrowth | Settlements | 16 | 16 | 31 | 27 |
| Deciduous | Settlements | 1 | 10 | 2 | 3 |
| Bamboo | Settlements | 29 | 14 | 21 | 7 |
| Mixed Broadleaf and Coniferous | Settlements | 2 | 0 | 5 | 0 |
| Coniferous - Rich | Settlements | 0 | 0 | 5 | 4 |
| Coniferous - Medium | Settlements | 2 | 0 | 14 | 9 |
| Coniferous - Poor | Settlements | 20 | 7 | 20 | 10 |
| Coniferous - Regrowth | Settlements | 0 | 0 | 0 | 0 |
| Mixed Wood and Bamboo | Settlements | 7 | 6 | 6 | 0 |
| Plantation | Settlements | 3 | 3 | 59 | 73 |
| Total across land cover transitions | ; ; | 67,742 | 46,416 | 48,187 | 57,047 |
| Annual average across land cover | transitions | 13,548 | 9,283 | 9,637 | 11,409 |

| Emission | Total CO ₂ e emission | n (tonnes) | | |
|----------|----------------------------------|------------|------------|------------|
| factors | 1990 - 1995 | 1995-2000 | 2000-2005 | 2005-2010 |
| 567 | 33,999 | 84,998 | 35,699 | 125,796 |
| 466 | 389,210 | 249,076 | 151,773 | 556,813 |
| 303 | 2,238,232 | 1,514,259 | 1,036,151 | 2,305,452 |
| 262 | 1,375,505 | 1,661,752 | 1,357,712 | 1,304,597 |
| 237 | 360,558 | 311,552 | 365,529 | 285,274 |
| 94 | 1,079,764 | 715,607 | 589,955 | 956,464 |
| 365 | 590,859 | 766,293 | 331,902 | 363,634 |
| 393 | 97,773 | 96,202 | 260,335 | 286,644 |
| 340 | 340,176 | 382,315 | 606,607 | 906,002 |
| 265 | 1,764,009 | 927,924 | 1,256,112 | 1,069,257 |
| 243 | 80,069 | 42,703 | 30,572 | 110,398 |
| 239 | 1,659,934 | 508,319 | 692,118 | 1,787,014 |
| 172 | 293,572 | 467,827 | 465,595 | 1,391,464 |
| 523 | 48,675 | 46,581 | 20,935 | 20,412 |
| 421 | 358,942 | 171,045 | 157,142 | 105,323 |
| 260 | 1,042,522 | 534,627 | 489,469 | 241,620 |
| 219 | 537,955 | 689,337 | 480,913 | 133,172 |
| 195 | 143,685 | 61,775 | 125,114 | 166,753 |
| 49 | 332,248 | 130,662 | 173,011 | 34,485 |
| 321 | 645,500 | 115,406 | 153,660 | 65,257 |
| 346 | 60,848 | 63,960 | 206,055 | 106,485 |
| 294 | 116,748 | 107,044 | 522,867 | 244,965 |
| 218 | 169,833 | 270,644 | 447,662 | 164,389 |
| 196 | 45,161 | 58,709 | 25,722 | 15,708 |
| 239 | 879,985 | 445,617 | 751,709 | 215,629 |
| 172 | 64,037 | 65,238 | 87,900 | 103,179 |
| 516 | - | - | - | - |
| 414 | 2,070 | - | - | 828 |
| 252 | 3,533 | 5,551 | 3,280 | - |
| 212 | 3,398 | 3,398 | 6,584 | 5,734 |
| 189 | 189 | 1,886 | 377 | 566 |
| 41 | 1,198 | 579 | 868 | 289 |
| 314 | 629 | - | 1,571 | - |
| 346 | - | - | 1,729 | 1,383 |
| 294 | 588 | - | 4,117 | 2,647 |
| 218 | 4,355 | 1,524 | 4,355 | 2,177 |
| 189 | - | - | - | - |
| 189 | 1,322 | 1,133 | 1,133 | - |
| 121 | 364 | 364 | 7,152 | 8,850 |
| | 14,767,443 | 10,503,907 | 10,853,386 | 13,088,661 |
| | 2,953,489 | 2,100,781 | 2,170,677 | 2,617,732 |

• Emissions from forest degradation:

Activity data for forest degradation were derived from pairwise comparison between two land cover maps, to define the area change based on the quality for evergreen broadleaf and coniferous forest for each time period (Table 29). Degradation is defined here as the decrease of forest quality from rich to medium, medium to poor, and poor to regrowth.

Emission factors for forest degradation were estimated by calculating the difference in carbon stock in the live tree carbon stocks between different transitions within the evergreen broadleaf and within the coniferous forest types.

Table 29: Area of forest degradation (ha), forest degradation emission factors (t CO₂e.ha⁻¹) and total CO₂e emission from forest degradation area (t CO.e)

| | Doet foreet degradation | Area of fore | Area of forest degradation | n (ha) | | Emission | Total of CO ₂ e emission (tonne) | iission (tonne) | | |
|---|--|----------------|----------------------------|-----------|-----------|----------|---|-----------------|-----------|-----------|
| Forest type | rost lotest uegrauation stratum | 1990 - 1995 | 1995-2000 | 2000-2005 | 2005-2010 | factor | 1990 - 1995 | 1995-2000 | 2000-2005 | 2005-2010 |
| Evergreen - Broadleaf forest - Rich | Evergreen - Broadleaf forest - Medium | 15,005 | 15,318 | 5,746 | 8,532 | 96 | 1,444,333 | 1,474,462 | 553,092 | 821,263 |
| Evergreen - Broadleaf forest - Rich | Evergreen - Broadleaf forest - Poor | 2,039 | 1,810 | 1,662 | 2,279 | 247 | 502,813 | 446,342 | 409,846 | 561,996 |
| Evergreen - Broadleaf forest - Rich | Evergreen - Broadleaf forest - Regrowth | 378 | 698 | 203 | 259 | 283 | 107,074 | 197,718 | 57,503 | 73,365 |
| Evergreen - Broadleaf forest - Medium | Evergreen - Broadleaf forest - Poor | 14,360 | 16,096 | 10,406 | 9,237 | 150 | 2,158,897 | 2,419,889 | 1,564,449 | 1,388,700 |
| Evergreen - Broadleaf forest - Medium | Evergreen - Broadleaf forest - Regrowth | 3,142 | 2,031 | 1,835 | 1,546 | 187 | 587,576 | 379,811 | 343,158 | 289,113 |
| Evergreen - Broadleaf forest - Poor | Evergreen - Broadleaf forest - Regrowth | 5,801 | 7,471 | 5,668 | 5,696 | 37 | 212,699 | 273,931 | 207,822 | 208,849 |
| Coniferous forest - Rich | Coniferous forest - Medium | 4,419 | 9,352 | 7,219 | 2,712 | 48 | 210,296 | 445,053 | 343,545 | 129,061 |
| Coniferous forest - Rich | Coniferous forest - Poor | 1,379 | 2,016 | 2,462 | 1,333 | 120 | 164,958 | 241,157 | 294,509 | 159,456 |
| Coniferous forest - Rich | Coniferous forest – Regrowth* | 168 | 8 | 4 | 11 | 151 | 25,352 | 1,207 | 604 | 1,660 |
| Coniferous forest - Medium | Coniferous forest - Poor | 3,352 | 4,906 | 5,330 | 7,163 | 72 | 241,454 | 353,392 | 383,934 | 515,970 |
| Coniferous forest - Medium | Coniferous forest – Regrowth* | 149 | 65 | 52 | 13 | 103 | 15,394 | 6,716 | 5,373 | 1,343 |
| Coniferous forest - Poor | Coniferous forest – Regrowth* | 763 | 928 | 297 | 96 | 31 | 23,870 | 29,033 | 9,292 | 3,003 |
| Total across land cover transitions | ver transitions | 46,691 | 54,800 | 35,205 | 31,605 | | 5,694,716 | 6,268,710 | 4,173,124 | 4,153,780 |
| Annual average acr | Annual average across land cover transitions | 9,338 | 10,960 | 7,041 | 6,321 | | 1,138,943 | 1,253,742 | 834,625 | 830,756 |

• Removal carbon stocks by afforestation and reforestation:

Carbon dioxide removals through forest afforestation and reforestation (A/R) are presented in Table 30. The methodology for these calculations is based on the following:

Activity data for A/R were derived from pairwise comparison between two land cover maps, to define the area of agriculture and bare land converted to forest classes. The areas given are for net change not gross.

Removal factors for afforestation/reforestation were estimated by calculating the difference in live tree carbon stocks between transitions that we assumed were realistic (Table 30). Only carbon stocks for live trees were taken into account here as we assume other pools remain constant. For this section, it is assumed that only land change from agriculture land and bare land to the bamboo, mixed wood and bamboo, regrowth and plantation forest classes underwent an afforestation/ reforestation transition. We assumed that other A/R transitions (e.g. agriculture land to evergreen broadleaf rich forest) could not occur in the given timeframes and are attributed to remote sensing uncertainty.

Table 30: Area of A/R (ha), removal factors (t CO₂e.ha⁻¹) and CO₂e removals from A/R (t CO₂e)

| Forest carbon stratum/ Forest | Post A/R stratum | Area of fo | orest enh | Area of forest enhancement (ha) | ıt (ha) | Removal | Total CO ₂ e removal (tonne) | noval (tonne) | | |
|---|-------------------------------------|----------------|---------------|---------------------------------|---------------|---------|---|---------------|--------------|--------------|
| type | | 1990 - 1995 | 1995- 2000 | 2000- 2005 | 2005- 2010 | factor | 1990 - 1995 | 1995-2000 | 2000-2005 | 2005-2010 |
| Agriculture land | Evergreen - broadleaf - regrowth | 367.0 | 1171.0 | 398.0 | 146.0 | -182 | -(66,637) | -(212,621) | -(72,266) | -(26,510) |
| Agriculture land | Bamboo forest | 2238.0 | 2528.0 | 1120.0 | 1095.0 | ထု | -(18,624) | -(21,037) | -(9,320) | -(9,112) |
| Agriculture land | Mixed wood and bamboo forest | 479.0 | 582.0 | 481.0 | 548.0 | -283 | -(135,433) | -(164,555) | -(135,998) | -(154,942) |
| Agriculture land | Coniferous forest - regrowth | 0.0 | 0.0 | 0.0 | 1.0 | -155 | I | I | 1 | -(155) |
| Agriculture land | Plantation Forest | 1102.0 | 3724.0 | 6573.0 | 9494.0 | -90 | -(98,842) | -(334,017) | -(589,552) | -(851,546) |
| Bare land | Evergreen - broadleaf - regrowth | 2256.0 | 3303.0 | 1749.0 | 1675.0 | -182 | -(409,627) | -(599,732) | -(317,570) | -(304,133) |
| Bare land | Bamboo forest | 3691.0 | 5368.0 | 2746.0 | 1963.0 | 8- | -(30,715) | -(44,671) | -(22,851) | -(16,335) |
| Bare land | Mixed wood and bamboo forest | 1822.0 | 2886.0 | 2080.0 | 2604.0 | -283 | -(515,154) | -(815,991) | -(588,102) | -(736,258) |
| Bare land | Coniferous forest - regrowth | 94.0 | 476.0 | 47.0 | 79.0 | -155 | -(14,563) | -(73,745) | -(7,282) | -(12,239) |
| Bare land | Plantation forest | 1540.0 | 3284.0 | 8606.0 | 4491.0 | -90 | -(138,127) | -(294,552) | -(771,898) | -(402,811) |
| Total across land cover transitions | ver transitions | 13,589 | 23,322 | 23,800 | 22,096 | | -(1,427,722) | -(2,560,921) | -(2,514,839) | -(2,514,042) |
| Annual average across land cover transitions | oss land cover | 679.45 | 1166.1 | 1190 | 1104.8 | | -(285,544.4) | -(512,184.2) | -(502,967.8) | -(502,808.3) |

Result

Emissions from deforestation from 1990 - 2010 were 49.2 million t CO_2e , with an annual average of 2.46 million t CO_2e (Table 31 and Figure 7).

Emissions from degradation over the historical period were 20.3 million t CO_2e , with an annual average of 1.01 million t CO_2e (Table 31 and Figure 7).

Removals from A/R over the historical period were 9.0 million t CO_2e , with an annual average of 450 thousand t CO_2e (Table 31 and Figure 7).

Total combined net emissions for the province from 1990 - 2010 were 60.5 million tons CO_2e , with an annual average of 3.02 million t CO_2e . Emissions were highest in the period 1990 - 1995, then decreased in the next two 5-year periods and rose slightly in the period 2005-2010.

| | Total Emissio | ons and Remo | ovals (CO ₂ e) | | |
|---|---------------|--------------|---------------------------|-------------|-------------|
| REDD+ Activity | Historical Pe | riod | | | |
| | 1990-1995 | 1995-2000 | 2000-2005 | 2005-2010 | 1990-2010 |
| Deforestation | 14,767,443 | 10,503,907 | 10,853,386 | 13,088,661 | 49,213,398 |
| Forest Degradation | 5,694,716 | 6,268,710 | 4,173,124 | 4,153,780 | 20,290,329 |
| Total Degradation and Deforestation Emissions | 20,462,159 | 16,772,617 | 15,026,510 | 17,242,441 | 69,503,727 |
| Annual Degradation and Deforestation Emissions | 4,092,432 | 3,354,523 | 3,005,302 | 3,448,488 | 3,475,186 |
| A/R | (1,427,722) | (2,560,921) | (2,514,839) | (2,514,042) | (9,017,523) |
| Net Emissions | 19,034,437 | 14,211,696 | 12,511,671 | 14,728,400 | 60,486,204 |
| Annual Net Emissions | 3,806,887 | 2,842,339 | 2,502,334 | 2,945,680 | 3,024,310 |

Table 31: Total historical emissions across all activities andhistorical periods

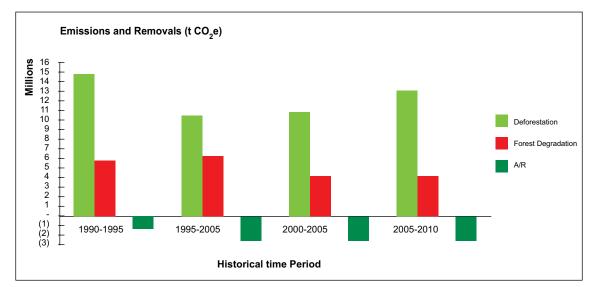


Figure 6: Emissions and removals of CO_2e in Lam Dong province in period 1990 – 2010 by activity class.

4.5 Preliminary actions to reduce future emissions and enhance removals

Various actions and policies are suggested that could reduce emissions and enhance removals from the forest sector in Lam Dong up to 2020. Some of the more important actions are listed below.

· Payment of forest environmental services

Implementation of a policy on payment of forest environmental services in Lam Dong province has had positive results. The positive perception of the local people toward forest conservation improved significantly, incomes stabilized and those receiving forest protection contracts gradually took more responsibility for forest protection and management. As well as these encouraging signs, forest quality, in the area where environmental services were paid, was also enhanced.

· Sustainable forest management for plantations

The implementation of sustainable forest management practices to achieve forest certification should be carried out in production forests. Reduced impact logging activities in production forests should be implemented to avoid unnecessary damage to forest stocks and avoid reducing forest quality.

• Implementation of suitable forestry and silviculture measures in forest protection contracts and forest fire prevention

Forestry and silviculture measures to promote forest regeneration should be carried out to increase forest quality.

Research should also be conducted into the use of clean-burning methods (controlled burning) to prevent fires in pine forest and to reduce the amount of carbon emissions from rotting forest debris.

Reforestation

As in the plan for forest protection and development, comprehensive reforestation should be conducted in the three forest categories: special use forest, watershed protection forest and production forest. This should be carried out in accordance with the development requirements of each forest category as follows:

Special use forest:

• Reforestation should be conducted in areas where shifting cultivation was once practiced.

Protection forest:

- Reforestation should be conducted on bare land (status la or lb).
- Afforestation should be conducted on areas of past shifting cultivation.

Production forest:

• Afforestation should be conducted on areas of bare land (status la or lb); old shifting cultivation land; harvested plantations; exhausted natural forest; and exhausted natural pine forest.

Reallocating forest conversions

Over the last few years, Lam Dong province has been relatively successful at reviewing and reallocating forest areas targeted for conversion. For example 351 ha of exhausted forest planned for conversion to rubber plantation and 43 ha of forest planned for conversion to agricultural land has remained as forest.

Institutional arrangements

- Speed up the re-structuring of the forestry sector in order to enhance performance, improve competency levels and understanding of the tools and processes necessary to execute management actions and improve operational efficiency.
- Establish binding legal coordination mechanisms between a number of stakeholders, including rangers, police, the army, border guards, communal police, internal affairs, inspectors, the courts, forest management units, forestry companies and residential communities to prevent and tackle forest violations.

• Supervision, monitoring and coordination

- Attach special importance to the supervision, monitoring and measurement of damaged forests and illegal encroachment and tackle those problems by preparing a plan for forest rehabilitation and replanting.
- The decision to convert forest must be scientifically based and contribute to broader economic, social and environmental goals, with MARD Circular No. 24/2013/TT-BNNPTNT, dated May 6th, 2013, related to the conversion of forest area for other purposes such as building hydroelectric plants and mining activity.
- Focus on solving conflicts of land encroachment between local people, forest owners, forestry companies and construction projects. Enhance supervision and monitoring and report forest loss statistics.
- Carry out monitoring and evaluation to assess forest conversion projects and conversion of forest use projects. Projects to convert natural forest into non-forestry land, especially special use and watershed protection forests, should be stopped, particularly if there will be negative consequences in the immediate and/or long term.

Mechanism, policy and communication

- Continue to review mechanisms for the implementation of forest protection and management contracts to create targeted and sustainable forest protection.
- Improve the effectiveness and efficiency of law enforcement for forest management units, especially rangers.
- Regularly conduct activities to raise awareness and education about policies and government guidelines on forest management, protection and development. Duplicate successful models for forest protection and management and criticize negative actions and behaviours. Enhance the communication and education on forest protection in local communities, including school children, students and government staff from provincial to local levels. This activity should also pay attention to ethnic minorities, with the aim of restricting shifting cultivation and illegal immigration. Measures should be put in place to help them stabilize their lives and jobs by granting agriculture land under appropriate local planning schemes.

Specific activities

- Continue to implement on the ground boundary demarcation of the three forest categories.
- Conduct a forest inventory of Lam Dong province, to record the exact area, status, timber volume and forest types in each forest management unit or for each forest owner.
- Continue enhancing the implementation of forest protection contracts for local people, especially ethnic minorities who are living near forests. Employ mechanisms to assess the implementation of forest protection contracts based on the area and forest volume after the inventory. Introduce relevant and motivating awards and commendations (spirit and matter) for achievements in forest management and protection.
- Ensure good planning, from master plan to agro-forestry planning and management of development plans, as a basis for immediate and long term management and development.
- Strengthen the capacity and enhance the effectiveness of forest owners. Strengthen the capacity of rangers to manage and strictly enforce the law.
- Closely manage areas used for coffee production to limit the expansion of coffee plantations on forest land.
- Strengthen the management of population growth, especially local population growth caused by spontaneous migration.
- Strictly enforce laws on illegal land encroachment, for example, eradicate all illegally planted crops on the area of encroachment.

- Collect statistics of households who lack sufficient land for production and promote agriculture and forestry programs to help them intensify production on their existing land to avoid encroachment of forest land.
- Upgrade and relocate forestry check points.
- Reclaim areas of land encroached by households and deal with households who make it difficult for state enterprises to do their job. Suspend and revoke investment licenses for agroforestry projects which are delayed. Strictly deal with organizations and individuals who cause forest loss and land loss or violate the rules of forest management and protection.
- Establish appropriate policies and mechanisms to encourage people who live near or in the forest to participate in forest management and protection, thereby contributing to poverty reduction and alleviation and development of the mountainous countryside.
- Continue implementing the payment for forest environment services (PFES).

Preliminary areas for actions to reduce emissions or enhance removals

The following suggestions for priority action are based on assessment of historical forest cover change, reviewing forest planning schemes and infrastructure developments, interviews with key stakeholders and field surveys.

Preliminary identification of areas with high deforestation rates

Results overlay maps forest cover over time and reviewing planning schemes in the province's forestry development, the plan/planning in infrastructural construction, interview survey of trends and changes in forest land use during the period from 2012-2020 at the level of the local organizations and branches, the forest owners in time of field surveys, has identified a number of potential areas of deforestation in the coming period as follows:

- Dam Rong district: including Da R'Sal and Dam Rong communes and areas of Da Tong, Ro Men, Da Long, Lieng Sronh and Da Knang communes
- Cat Tien district: including Gia Vien, Tieng Hoang, Nam Ninh, Dong Nai, Phu My, Tu Nghia and My Lam communes
- Da Teh district: including Da Lay, Huong Lam, An Nhon, Da The, Da Kho, Ha Dong, My Duc, Quang Tri, Trieu Hai, Quoc Oai and Da Pal communes
- Da Huoai district: including Da Huoai, Da Ton, Phuoc Loc, Ha Lam, Doan Ket and Madagouil communes and Madagouil town

- Bao Loc city: including Loc Chau and Dai Hoa communes
- Lam Ha district: including Phuc Tho, Tan Thanh and Phi To communes
- Lac Duong district: including the communes along national highway 723, such as Da Nhim and Da Sar
- Dong Duong district: including Dran town and a number of communes: Lac Xuan, Tu Tra, Ca Don, Ca Do and Pro
- Di Linh district: including Gia Bac and Son Dien communes, and areas of Rung Re, Lien Dam, Hoa Nam, Hoa Trung and Hoa Bac
- Bao Lam district: including Loc Nam, Loc Bac, Loc Bao and Loc Thanh communes.

These areas (see Figure 8) had significant forest loss in the period 2005 - 2010 due to the conversion of forest to rubber and other agricultural plantations (i.e., coffee, cashews etc.) by companies or other organizations. These areas are also near human settlements and roads and the terrain is relatively flat with good soils for the development of perennial and annual industrial crops. They are therefore under significant threat from future deforestation (see Figure 8).

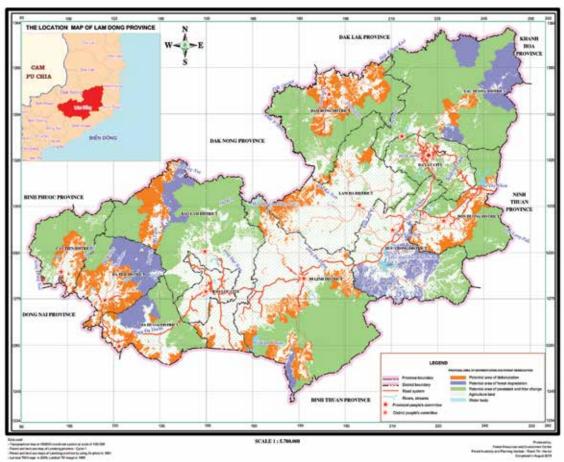
• Preliminary identification of areas with high forest degradation rates

The results of overlaid maps of forest changes over the periods and associated with reviewing planning schemes in the province's forestry development, construction planning and infrastructure and interview on forest land use trends in period 2012-2020 at all levels, the forest owners in the area during field surveys, have identified a number of potential areas of deforestation in future as follow:

- Bao Lam district: including Loc Bac and Loc Bao communes
- Da Teh district: including Quoc Oai, My Duc, Quang Tri, Dapal and Trieu Hai communes
- Da Huoai district: including Phuoc Loc commune, Dam Bri town, Da Ton commune and part of Dam Bri and Da Ploa communes
- Duc Trong district: including Phu Hoi, Ta Nang, Ninh Gia, Ta Hine, Ninh Loan and Da Loan communes
- Lac Duong district: including Da Chay, Da Nhim and Da Sar communes

These areas (see Figure 8) have seen significant historical degradation rates. Most of the areas are natural forest in the forest production category, some of which have been logged by forest owners and by local private companies without proper logging plans, management or design, leading to ongoing forest degradation.

Figure 7: Initially proposed map of potential areas of deforestation and forest degradation



PROPOSAL MAP DEFORESTATION AND FOREST DEGRADATION IN LAM DONG PROVINCE

• Initially proposed priority areas for implementing REDD+

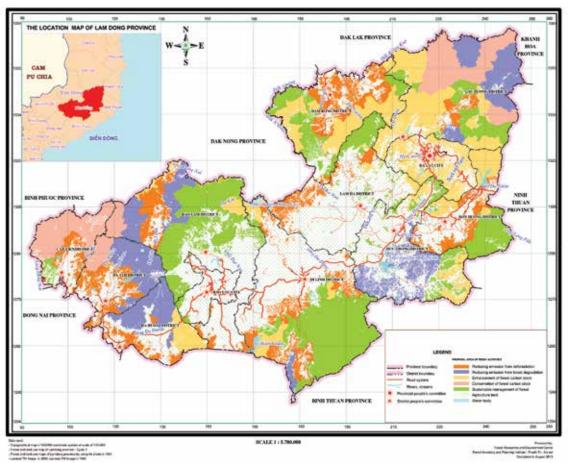
Based on the above assessment, the following is a list of priority districts for implementation of a range of REDD+ mechanisms (see Figure 9).

- **Reduction of greenhouse gas emissions from deforestation:** Focus mainly on forest production in the following districts:
 - Dam Rong district: including Da R'Sal, Dam Rong and Da Knang communes and areas of Da Tong Ro Men, Da Long and Lieng Sronh communes
 - Cat Tien district: including Gia Vien, Tien Hoang, Nam Ninh and My Lam
 - Da Teh district: An Nhon, Da Kho, Trieu Hai and Quoc Oai communes
 - Da Oai district: Da Hoai, Da Ton, Phuoc Loc, Ha Lam, Doan Ket and Madaguil communes and Madagoul town
 - · Lam Ha district: Phuc Tho, Tan Thanh and Phi To communes

- Lac Duong district: Dran town, Xuan Truong commune and the communes along road 723, such as Da Nhim, Da Sar, Da Chay and Ung Cno communes
- Don Duong district: Dran town
- Bao Lam district: Loc Nam, Loc Bac, Loc Bao and Thanh Loc communes.
- Reduction of greenhouse gas emissions from forest degradation: Mainly focussing on natural forest (both production forest and protection forest).
 - · Bao Lam district: including Loc Bac and Loc Bao communes
 - Da Tel district: Quoc Oai, My Duc and Dapal communes
 - Da Hoai district: Ha Lam and Phuoc Loc communes and Dam Bri town
 - Lam Ha district: Tan Thanh, Phuc Tho and Phi To communes.
- Conservation of carbon stocks: In Cat Tien and Lac Duong districts belong to management of Cat Tien and Bi Dup Nui Ba National Parks.

Figure 8: Preliminarily potential map for implementing REDD+ activities

PROPOSAL MAP FOR IMPLEMETING REDD+ ACTIVITIES IN LAM DONG PROVINCE



- Enhancement of carbon stocks: Areas of forest land for enhancement of carbon stocks are mainly in protection forest and are located as follows:
 - Dam Rong district: areas of communes such as Lieng Sronh, Phi Lieng, Ro Men, Dam Rong and Da Tong
 - Lac Duong district: areas of Lac Duong town and Lat, Da Sar and Da Chay communes
 - · Da Lat city
 - Don Duong district: areas of Dran and Thach My towns and Lac Lam and Da Ron communes
 - Duc Trong district: Ta Nang commune
 - · Di Linh district: Hoa Bac and Son Dien communes
 - Da Huai district: areas of Da Ploa and Dam M'ri communes and Dam M'ri town.
- Sustainable forest management: Mainly focus on production forest, which is located as follows:
 - Dam Rong district: area of Da Knang, Phi Lieng, Lieng Pronh and Da Long communes
 - Lac Duong district: areas of communes Da Nhim, Da Sar and Dung Kno
 - Don Duong district: areas of communes Lac Xuan, Ka Do and Pro
 - Duc Trong district: areas of communes Ta Nang, Ninh Gia, Tan Thanh, Phu Hoi, N'thon Ha, Tan Hoi, Lien Hop, Hiep Thanh and Lien Nghia
 - Lam Ha district: within Phu Son, Phi To, Me Linh, Dong Thanh, Gia Lam, Nam Ha and Dinh Van communes and Nam Ban town
 - Di Linh district: including Tam Bo, Bao Thuan, Gung Re, Hoa Bac, Son Dien and Gia Bac communes
 - Bao Lam district: including Loc Lam, Loc Phu, Loc Ngai, Loc Quang, Gia Bac, Loc Tan, Loc An and Loc Duc communes
 - Cat Tien district: areas of Phuoc Cat2, Phuoc Cat 1 and Pho Duc communes

5 Conclusion

Current status of forest changes

Based on the creation of the forest cover map and the estimation of the areas of land use and forest types in Lam Dong province, this analysis has determined that between 1990 and 2010 the area of forested land was reduced by approximately 134,950 ha, with an average of 6,747 ha lost per year.

From 1990 - 1995, forest area sharply declined and then declined more gradually from 1995 - 2005. However, forest loss was more dramatic again between 2005 and 2010, when forest cover of broadleaf evergreen forest was reduced by about 91,744 ha, including the following losses: rich broadleaf evergreen forest, 39,220 ha; deciduous forests, about 8,820 ha; bamboo forests, 29,520 ha; mixed forests (wood and bamboo), about 1,940 ha; coniferous forests, about 44,960 ha (mostly due to the loss of 24,300 ha of rich coniferous forest); mixed with broadleaf forest, approximately 8,060 ha; and bare land, 52,380 ha. During the same time period, plantations increased by 50,100 ha.

Most forest types in the period 1990 - 2010 declined due to deforestation for planting industrial crops and for agricultural production. Selected logging activities degraded forest quality and changed the forest status and condition. Several forest areas were restored after a period of forest enrichment and protection.

The drivers of forest change

Deforestation for agricultural and industrial crops was the main cause of forest change and directly led to the decline of forest resources in the province. In fact, the main cause of deforestation was for planting coffee. The most intensive deforestation for coffee plantations was from 1993 - 2000.

Forest exploitation is considered to be a direct cause of the decline of forest cover in Lam Dong province. While properly designed, managed and implemented forest exploitation practices may not actually reduce forest cover, current exploitation practices are leading to deforestation and conversion to agricultural crops by local people.

Afforestation, forest regeneration promotion and forest protection contracts are the main measures taken to increase forest cover in the province. However, increased forest area only accounts for a small proportion in comparison with the total area of forest lost annually.

Historical emissions and removals of CO₂e from forest changes in Lam Dong province from 1990 - 2010

Emissions from deforestation from 1990 - 2010 were 49.2 million t CO_2e , with an annual average of 2.46 million t CO_2e .

Emissions from degradation over the historical period were 20.3 million t CO_2e , with an annual average of 1.01 million t CO_2e .

Removals from A/R over the historical period were 9.0 million t CO_2e , with an annual average of 450 thousand t CO_2e .

Total combined net emissions for the province from 1990-2010 were 60.5 million tons CO2e, with an annual average of 3.02 million t CO_2e . Emissions were highest in the period 1990-1995, then decreased in the next two 5-year periods and rose slightly in the period 2005-2010

Proposed priority areas for implementing REDD+

Reducing emissions of greenhouse gases from forest loss should focus mainly on forest production in the districts Dam Rong, Cat Tien, Da Teh, Da Hoai, Lam Ha, Lac Duong and Bao Lam.

Reducing greenhouse gas emissions from forest degradation should be concentrated in the districts of Bao Lam, Da Tel, Da Hoai and Lam Ha.

Conservation of carbon stocks in special use forests should be in Cat Tien and Lac Duong districts.

Sustainable forest management should be implemented in some communes in Dam Rong, Lac Duong, Don Duong, Duc Trong, Lam Ha, Di Linh, Bao Lam and Cat Tien districts in production forest.

Enhancement of forest carbon stocks should be concentrated mainly in protection forests in Dam Rong, Lac Duong, Da Lat, Don Duong, Duc Trong, Di Linh and Da Huoai districts.

The proposed priority areas for the implementation of pilot activities in REDD + and areas of potential deforestation and forest degradation are initially proposed and should be further investigated in consultation with stakeholders.

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