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Rural livelihoods in the buffer zone of Lo Go-Xa Mat National Park and their impacts on local forest biodiversity

**Impacts of rural livelihoods on forest
biodiversity**

Dang Thi Kim Phung

Supervisor

Suzanne Von Walter

CBM MASTER THESES SERIES



Swedish Biodiversity Centre



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Abstract

Located in Tay Ninh province (South Vietnam), Lo Go-Xa Mat National Park is famous for its wealth in diversity of flora and fauna. The Park is considered to harbour some threatened lowland habitats in Vietnam with species of great national and global conservation importance. There are about seven thousand farmer households living in the buffer zone. Policies of land and forest allocation have allowed local people to develop their household economies through farming or other livelihood activities. However, there are still conflicts between local livelihoods development and forest biodiversity conservation and gaps exist between policies and realities for development of land-use and forest conservation programs. The objectives of the study were to gain understanding of rural livelihoods in the buffer zone of The National Park and their impacts to forest biodiversity. The research employed a combination of methods to crosscheck data. Primary information was gathered through different tools of Participatory Rural Appraisal (PRA), standardized questionnaires in households' surveys and medicinal plants inventory. Results of the study indicated that though there was a livelihood diversification in the four villages surveyed, agriculture appeared to be the main trait in the livelihood of villagers and their main strategy for the future with a great focus in expansion of agriculture land for cash crops. Poor people accounted approximately for 70% of the population and livelihoods of all wealth status groups appeared to be unsustainable. Threats ranking revealed that since 2002, collection of non-timber forest products, forest encroachment, illegal cutting, hunting & trapping, and grazing have become five major threats to forest biodiversity in the National Park. The study identified three major impacts of local activities to forest biodiversity in the Park: (i) habitat loss through forest degradation and conversion of natural forest into agriculture land; (ii) decline in wild populations of fauna and flora and (iii) an existing trend in reduction and transformation of rich-biodiversity natural forests and wetlands into poor-species richness forest plantations and agriculture landscapes. Population growth, poverty, land scarcity, trade-off between rural development and forest conservation, high economic benefits from cash crops, preferences of urban dwellers for bush meat and medicinal plants, low education levels and awareness on the importance of forest and biodiversity are factors driving existing local threats to forest biodiversity in the National Park. Recommendations for threats mitigations includes improving the sustainability of local livelihoods, education and training, local awareness raising, local participation in forest conservation, and better policy making in rural development.

Key words: Biodiversity, conservation, driving forces, human impacts, livelihood, rural sustainability, threats, tropical forest

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Introduction

Established in 2002 from a nature reserve, Lo Go-Xa Mat National Park is one of the most densely forested areas in Tay Ninh Province, South Viet Nam. The Park is famous for its wealth in diversity of flora and fauna and is considered to harbour different threatened lowland habitats in Vietnam with populations of a number of species of great national and global conservation importance. There are about seven thousand farmer households living in the buffer zone. Policies of land and forest allocation have allowed local people to develop their household economies through farming or other livelihood activities. However, there are still conflicts between local livelihoods development and forest biodiversity conservation. Livelihood activities, including agricultural production, illegal timber extraction, over exploitation of non-timber forest products (NTFPs) are considered the main driving forces of biodiversity loss in the National Park. Existing policies of rural development are focusing on the integration of local livelihoods and forest conservation. However, there are many issues relating to land and forest use that have not been studied, and gaps exist between policies and realities for development of land-use and forest conservation programs. Increased understanding of livelihoods and the driving forces behinds the conflicts between local communities and forests, therefore, is extremely important to devise better strategies and to avoid policies failures in both rural development and forest biodiversity conservation.

The aim of the study is to understand the existing livelihood systems in the buffer zone of Lo Go-Xa Mat Nation Park in Tay Ninh province-south Viet Nam with a view to assessing their threats and impacts on forest biodiversity, and to formulate recommendations for threats mitigation.

The results of this study contribute to understanding of existing livelihoods of people associated with forests in the tropical rainforests, and also in other forest areas of similar conditions in Viet Nam. The study findings also give rise to further examination of other important issues of forest biodiversity conservation and are useful to policy makers and other relevant parties involved in rural development and nature conservation in the province.

To achieve this objective, the following research question is advanced for the study:

What are the existing livelihood systems in the buffer zone of Lo Go-Xa Mat Nation Park in Tay Ninh province, South Vietnam and their threats to local forest biodiversity?

Subsidiary questions include:

1. What type of existing livelihood systems are there? Which is the major?
2. What are the main assets of local livelihoods, livelihood outcomes and strategies?

3. How do local communities in the buffer zone depend on forest resources?
4. How is forest resources exploited and used by local people?
5. Are existing livelihoods sustainable? Why and why not?
6. What threats are local peoples' livelihoods posing to local forest biodiversity?
7. What are the proximate and ultimate causes of threats?
8. What are local impacts on forest biodiversity in the National Park?
9. What solutions are possible in order to mitigate the threats?

The thesis consists of 6 chapters. The first chapter, the Introduction formulates the problem statement, research objectives and research questions. The second chapter provides detailed descriptions on the study site: the National Park Lo Go-Xa Mat and its buffer zone. The third chapter defines some key concepts for the study and presents research methodology. The fourth chapter provides study results on local livelihoods, threats to forest biodiversity and local impacts on forest biodiversity. The fifth chapter discusses on the representativeness of sampling, threats ranking, inference of human impacts on forest biodiversity, sustainable livelihoods, local dependence on forest resources, factors involved in biodiversity loss and local awareness on forest conservation. The final chapter makes conclusion and formulates recommendations for threats mitigation and further research.

Study Area Descriptions

Located 96 kilometres northwest of Ho Chi Minh City, Tay Ninh province has a total area of 4,029 sq km and a population of 908,000, 80% of which live on agriculture. After the war, Tay Ninh had 147,000 ha of forest (covering 36% of the provincial total area), most of which were rich natural close forest in the north of the province and were exposed to human disturbances due to their accessibility sites and suitability for agriculture. A sharp decline in the province forests occurred during the 10 years after reunification both quantitatively and qualitatively: the forested areas went down to 44,500 ha (only 11% of the provincial total area) and most of rich natural forest became poor and exhausted. The economic development policies made a serious impact on the province forests through timber over-exploitation, forest clearance for the national border claim, agriculture, settlement and infrastructure.

In 1989, recognizing the situation, the provincial authorities banned all natural forest from exploitation and started forest rehabilitation and plantation programmes (under the national programme 327 and then the Five Million Hectares Reforestation programme ¹). Since the early 1990s, there have been three major changes in the provincial forest management. First came the shift from a concentrated planning mechanism with subsidies and bureaucracy towards using the market mechanism. Second were the policies of land and

forest allocation to households. And third was the changes in targets, tasks, project scales, approaches of forestry sector from a 'state forestry' towards a 'people forestry' with focus on protecting and promoting the regeneration of existing forest with more local involvement and more investment on rural development. The changes have had effect: the area of disturbances and the rate of forest degradation have been considerably reduced.

However, there are still conflicts between local livelihoods development and forest biodiversity conservation. The conflict is especially tense and serious in the buffer zone of Lo Go-Xa Mat National Park- one of the most important forested area of Tay Ninh province.

Lo Go- Xa Mat National Park

Locality and history

Located in Tan Bien district, southeast of Vietnam and 30km northwest of Tay Ninh town (Figure 1), Lo Go-Xa Mat was declared a nature reserve in 1993 for its historical importance as a revolutionary base during the Vietnam-America War. Due to the biodiversity values of the site, Lo Go-Xa Mat was officially upgraded to a National Park in 2002 ². The Park has a total area of 18,765 ha, comprising a core area of 8,594 ha, a forest rehabilitation area of 10,084 ha, and an administration and services area of 87 ha. Besides this, there is also a buffer zone of 18,600 ha (BirdLife International 2004).

Biodiversity values

The National Park has a great biodiversity importance not only at the provincial and national scales but also at regional and global levels. Firstly, it contains the single largest forested area in Tay Ninh province, accounting for 26% of total natural forest cover of the province with a mosaic of lowland habitat types ³ which have almost got lost throughout the country. Secondly, the Park covers approximately 50% of all protected evergreen forest within The Eastern Indochina Moist Forests Ecoregion (EIMFE) ⁴ and plays a significant role in the conservation of the transitional ecosystem between the Mekong Delta and the Eastern Cochinchina (Vietnam, Lao, and Campuchia). Thirdly, the area is considered to support populations of a number of species of national and global conservation importance such as *Afzelia xylocarpa*, *Dipterocarpus alatus*, *Hopea odorata*, *Shorea roxburghii*, Pygmy Loris *Nycticebus pygmaeus*, Northern Pig-tailed Macaque *Macaca leonina* and Long-tailed Macaque *M. fascicularis*, Silvered Leaf Monkey *Semnopithecus cristatus* and Black-shanked Douc *Pygathrix nemaus nigripes*. Furthermore, Lo Go-Xa Mat National Park qualifies as an Important Bird Area for offering habitats for globally threatened and restricted-range bird species including Woolly-necked Stork *Ciconia episcopus*, Lesser Adjutant *Leptoptilos javanicus*, Asian Openbill *Anastomus oscitans*, Germain's Peacock Pheasant *Polyplectron germaini*, Siamese Fireback *Lophura diardi* and Grey-faced Tit Babbler *Macronous kellei*. The Park also appears to be a stop-over area for Sarus Cranes *Grus antigone* in their migration journey between the Mekong Delta of Vietnam and their breeding areas in Campuchia. (Le & Tran 2000; Tordoff *et al.* 2002)

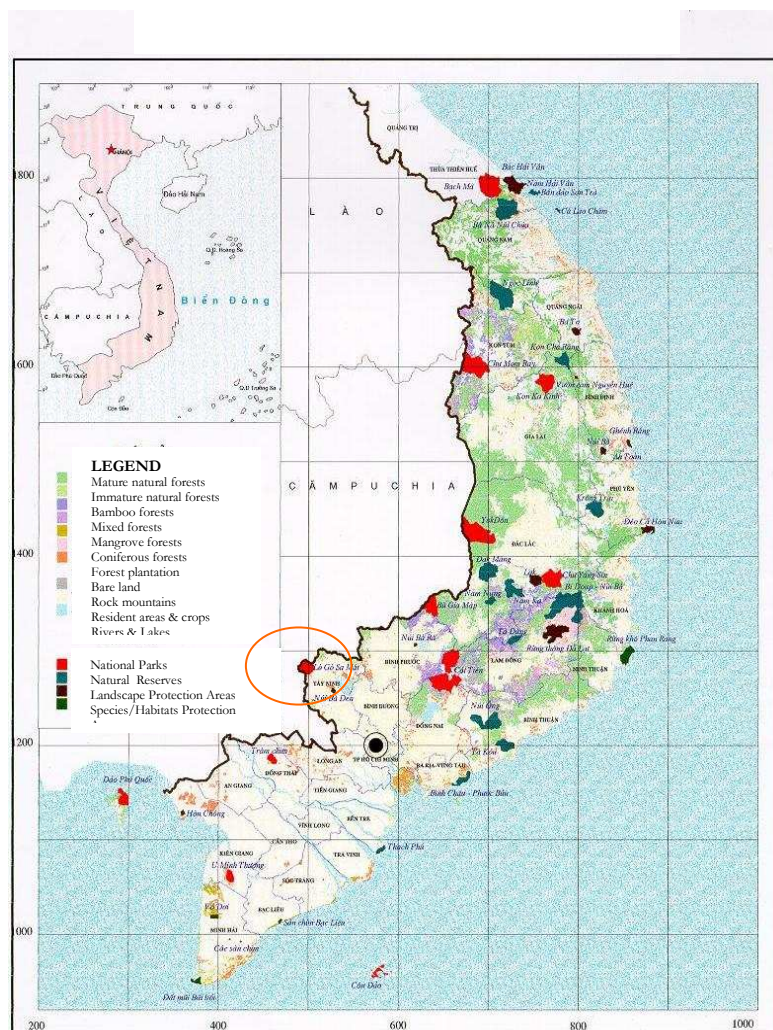


Figure 1. Location Lo Go- Xa Mat National Park (Birdlife International 2004)

The Buffer Zone of Lo Go- Xa Mat National Park

Locality

The buffer zone of Lo Go-Xa Mat National Park has a total area of 18,600 ha and covers the administration areas of 4 communes of Tan Bien District, Tay Ninh Province (South Vietnam): Thanh Tay, Hoa Hiep, Tan Binh and Tan Lap. The communes include altogether 17 villages.

Physical conditions

The buffer zone is a relatively flat area with the gradient $<3^{\circ}$, soils in the area mainly belong to the group Acrisols with light physical component and poor nutrients. The buffer zone is characterized by distinct tropical dry and wet seasons with medium rainfall, average annual temperature is 27.7°C and average annual precipitation is around 1.800 mm. There are only two main rivers in the area- Ben Da and May. The low density of rivers and streams and seriously disturbed forest cover at the source of these rivers together explain low water

flow in the dry season, leading to insufficient supporting capacity for agriculture and human consumption. Most of the agricultural fields in the buffer zone therefore are rain fed (HCMC SFIPI 2003)

Demographics

There is a total population of 26,574 people - 6,707 households living in the area. Local residents in the buffer zone belong to four ethnic groups Kinh, Kh'me, Hoa, and Muong of which Kinh is the biggest group being 99.8% of the population. Villages' history revealed that the first group to settle in the area was The Kh'me (prior to 1975). After the country reunification, The Kinh began settling in the area either through the Programme of Development of new economy zone (from 1985-1990) or free migration in search for land. Other ethnic groups came later. Population density in the buffer zone is 143 people/km², relatively high in comparison with the figure of the district (91 people/km²).

Infrastructure

The buffer zone has 187 km of roads, only 31% of which is asphalted. Road density in the area (1,005 km/km²) is rather high in comparison with the figure for the total district (0.597 km/km²). There are only 7 km of irrigation canals and 1 km drainage canals in the buffer zone. Besides one hospital in Tan Bien district, each commune has its own infirmary but all of these health centers are in shortage of medical equipment and medical staff. Three traditional medicine clinics in Thanh Tay, Hoa Hiep and Tan Lap also provide health care to local habitants. Each commune has at least one kindergarten, 2-3 primary schools and 1-2 secondary schools. Pupils at tertiary level have to go to the tertiary in the district town. Reports of local authorities show that the average level of education varies among the four communes, Thanh Tay and Tan Lap are at the level of tertiary school, and the two others are reported at the level of secondary school. However, the illiteracy rate, especially among the ethnic group Kh'me in the buffer zone is rather high. Explanations can be the poor- equipment and the insufficient staff and equipments of most of schools in the area. Each commune has one postal and one cultural point; Thanh Tay and Hoa Hiep also have their cultural house. In all communes, there are social associations and organizations at commune level such as Farmer Association, Women Association, Youth Association, Veteran Organization, Red-cross and Motherland Front. Thanks to rural development programmes in recent years such as the programme 135 and the Programme for clean water and rural sanitation, more than 80% of households of the buffer zone has access to electricity and clean water mostly in the form of drilled wells. Having large areas of sugar cane, cassava and rubber production, the buffer zone is one of the important areas for supplying raw materials for processing factories in the province. In the four communes, there are 21 small and medium processing factories mostly for cassava and rubber, 6 grain mills, 2 small handicraft units. Number of service units are rather high (957 units) but most of them are small and mainly grocery stores, coffee shops and eateries.

Economics

80% households in the area are living from agriculture. Poor households ⁵ are officially reported to be nearly 10% of the population. 91% (16,853 ha) of the buffer zone is agricultural land. Annual crops such as rice, cassava, sugar cane comprise 67% of the total cultivated area. Other crops are vegetables, water melon, peanut and tobacco. Due to the lack of irrigation, most rice fields are rain-fed with low productivity (1-1.5 tones/ha). Rice is the crop cultivated by most poor villagers for their subsistence use. Perennial crops, are mainly grown by wealthy villagers and outsiders are increasing in recent years with 78% of its area is rubber. Cattle and pigs husbandry is very developed in the buffer zone, especially in Thanh Tay and Hoa Hiep. Poultry is favoured by villagers in Thanh Tay commune where there is limited land for grazing.

Land-use change

Before 1975, 80% of the buffer zone area was forested. During the Vietnam-America war, there were few households living in the area, most inhabitants were soldiers. After the country reunification, some Cambodian-Vietnamese from Cambodia came back and established new settlements. Most of the settlers lived from forest and shifting cultivation. Forests were cleared out significantly in the 1980s under intensive logging of State Enterprises, the programme development of new economic zone, conversion to agriculture and infrastructure. To date most of the communes (especially Thanh Tan) are nearly deforested (Figure 2), the area of remaining natural tropical forest of Hoa Hiep, Tan Lap, Tan Binh now is managed by the National Park.

Rural development projects and programmes in the buffer zone

Rural development projects and programmes carried out in the buffer zone are listed below (HCMC SFIPI 2003):

- Programme 135:

Targeting poor communes in the remote and border areas, the programmed aimed to develop and improve rural roads and other infrastructure. In 2002, the programme built unsurfaced roads in Tan Binh (1,785 m), Tan Lap (2,598 m) and Hoa Hiep (2,080 m). It also offered medical insurance to all villagers in the buffer zone.

- Programme of hunger elimination and poverty reduction:

The programme offers favourable credits for poor villagers for investment and development. Funds for hunger elimination and poverty reduction have offered 1,933 households in Tan Bien district with 2.5-3 millions/household for production and livelihood improvement. National Funds for investment and development has offered 9 projects with 900 Million Vietnamese Dong (VND) to create jobs for 4,000 villagers. In general, in Tan Bien district and the buffer zone, no hunger is now reportedly.

- Programme for clean water supply and rural sanitation:

Operated in the buffer zone from 1995, the programme supplied each commune with 20-30 drilled wells, 10 self-discomposed toilets and 1-2 biogas

bags for production of gas from waste treatment. It also established a small station for clean water supply.

- Programme for agricultural extension and veterinary:

Every commune has a co-worker of The Provincial Extension Office working in coordination with an extension officer in the district. There are Farmer Associations and Women Associations to provide demonstration of new varieties and techniques, training courses for farmers and distribution of leaflets on agriculture knowledge. There is also a co-worker of The Provincial Veterinary Office who works under assistance of a veterinarian in the commune to provide vaccines, medicine, vaccination and treatment for domestic animals.

- Programme for free vaccination for cattle in border areas:

The programme is carried out by The Provincial Veterinary Office through a network of veterinarians in district and communes to provide free vaccination for all cattle in communes in the border area with Cambodia in order to prevent the spread of foot-and-mouth disease.

- Breeding programmes for meat-oriented beeves:

The programme provides small credits from 8-10 Million VND per household for breeding meat-oriented beeves, extension services and technical assistance to selected poor farmers.

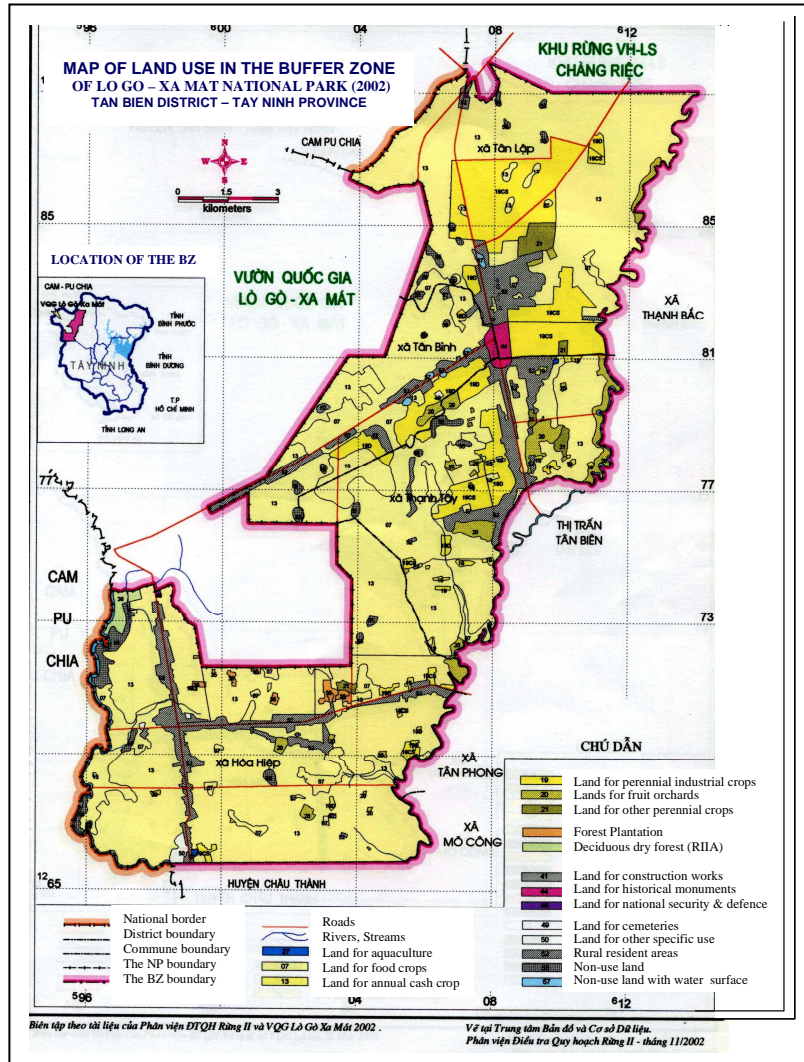


Figure 2. Map of land use in the buffer zone (HCMC SFIPI 2003)

Materials and Methods

Key concepts and theoretical framework

In term of a theoretical context, my understanding of the component of livelihood systems and human impacts on forest biodiversity is based on the following key concepts:

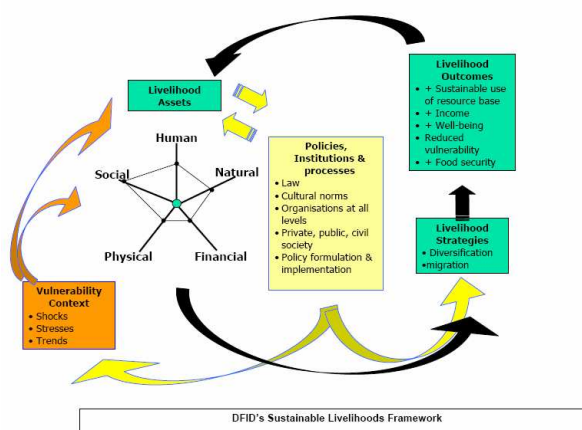
Livelihood

The concept 'Livelihood' was first defined by Chambers (1989) and then by Chambers and Conway (1992) as "adequate stocks and flows of cash to meet basic needs". However, this definition 'fails to address how these adequate stocks and flows of cash come about' (Niehof 2004). Carney (1998) provided a more comprehensive definition about livelihood when he put it "A livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a mean of living". The development of the concept by Ellis (2000) put livelihood in the complicated linkages with economic and social context under which livelihoods activities occur: "A livelihood comprises the assets (natural, physical, human, financial and social capital), the activities, and the access to these (mediate by institutions and social relations) that together determine the living gained by the individual or households". Taken together, Niehof (2004) confirmed that 'livelihood is a multi-faceted concept, being both what people do and what they accomplish by doing it, referring to outcomes as well as activities. The livelihood is seen as an open system, interfacing with other system and using various resources and assets to produce livelihoods, with the households as the locus of livelihood generations'.

Livelihood Assets

The United Kingdom Department for International Development (DIFD 2001) identified five following assets (capital) of livelihood, which are all inter-related in the sustainable livelihood framework (Figure 3).

- Human capital: includes the skills, knowledge, ability to labor and good health that enable people to pursue different livelihood strategies and achieve their livelihood objectives.
- Natural capital: the natural resource from which livelihoods are derived.
- Financial capital: the financial resources (flows/stocks) that people use in production or consumption to achieve their livelihood objectives.
- Social capital: the social resources upon which people draw to pursue their livelihoods.
- Physical capital: consists the basic infrastructure and goods producer necessary for helping people to meet their basic needs and pursuing their livelihoods.



Sustainable Livelihood

Carney (1998) said that: 'A livelihood is sustainable when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base'. Based on this definition, different

Figure 3. DIFD Sustainable Livelihood framework (DIFI 2001)

authors formulated different criteria for sustainable livelihood in specific contexts. In Vietnam, a previous research 'Forestry, Poverty reduction and Rural livelihoods in Vietnam' defined the following criteria for sustainable livelihood: food security, natural environment improvement, community environment improvement, material condition improvement, and protection from shocks and risks (Dinh 2005).

Biodiversity

Biodiversity is the short form of biological diversity. 'Biological diversity' means the variability among living organisms from all sources including, inter alia, terrestrial marine and other aquatic ecosystems and the ecological complexes of which they are part, this includes diversity within species, between species and of ecosystems (CBD 1992).

Biodiversity Impacts

Changes in ecotype, vegetation, animal or plant types and species observable over relatively short period (Vayda 1983).

Human impacts on biodiversity

Modification of species diversity and composition result from a variety of human induced environmental changes, including changes in land use, nutrient availability and cycling, atmospheric composition, climate, the introduction of exotic species, and over exploitation by humans (Hooper 2005).

Proximate threats to biodiversity

Species losses, and other declines in biodiversity, result from the "evil quartet" (Diamond 1984) namely: (i) direct exploitation (over-harvest); (ii) habitat loss and degradation; (iii) introduced species; and (iv) extinction cascade or chains of extinction (Gaston & Spicer 2005).

Ultimate threats to biodiversity

Indirect causes of biodiversity loss and decline such as population growth, scarcity of land, poverty, market demand on certain forest products and the like.

Types of factors involved in biodiversity impacts

In analyzing biodiversity impacts, some authors (Vayda 1983; Geist & Lambin 2002) prefer the following terms:

- Drivers of impacts: activities that directly affect the environment or specific component of biodiversity.
- Underlying factors: factors are causally related to drivers of impacts.
- Triggers factors: factors that operate at a specific period of time, and are 'trigger events' that lead to other factors coming into operation.
- Contributing factors: especially at the site-specific level, a complex array of biophysical, socio-economic and cultural factors may all play a part in determining a particular outcome.

Empirical studies (Vasquez & Gentry 1989; Sinha & Bawa 2001; Chidumayo 2002; Kaimowitz *et al.* 2003; Veach *et al.* 2003; Xu & Wilkes 2003; Shaanker *et al.*

2004; Suderlin *et al.* 2005) identified the following numerous driving forces and other factors involving in human impacts on forest biodiversity loss:

- Drivers: timber procurement, hunting, non-timber forest products collection, food production, livestock grazing, agriculture encroachment and intensification.
- Underlying factors: demographic changes; market demand, prices and regulation mechanism, land and resource tenure policy and practices, development policies and interventions.
- Triggers: political movements, tenure policy reform, infrastructure development, forest fire and pest.
- Contributing factors: technology levels and dissemination of new technologies, new markets for crops and livestock and certain improvement in agricultural productivity, resource and tenure policies (government allocation of forest, land and minerals to large companies), household structure, altitude and climate, population migration.

Research Methods

Scope of Study

The study was carried out in four communes (Thanh Tay, Hoa Hiep, Tan Lap and Tan Binh) in the buffer zone of Lo Go-Xa Mat National Park in Tan Bien district, Tay Ninh province, south Vietnam. The research attempted to get insight in relevant socio-economics contexts that influence rural livelihoods in the area, mainly at local and provincial levels. During fieldwork, when necessary relevant information was also collect at the national level. Local threats and impacts on forest biodiversity were considered at the species and landscape levels. Time for assessing impacts from 1991 after the logging ban and when the National Park was still a nature reserve.

Data Collection

To achieve the aims of the study, both quantitative and qualitative data are needed:

- Data on local livelihoods and their socio-economic context.
- Data on local livelihoods impact on forest biodiversity.

The nature of these two types of information made it necessary to combine different sources of information to obtain and cross-check data. Besides this, the combination of different data collection methods is also extremely crucial to provide reliable findings and convincing conclusions on the issues (Yin 1994; Lindberg 1996; White 2002; Nachmias 2005; Punch 2006). In the study, data collection comprised of seven steps to gather both archived and primary information.

Secondary Data Collection- Literature Study

The study started with step 1-literature review from books, previous and existing governmental documents of relevant organizations and previous studies in the area ⁶. The aim of this step was to get the background information in socio-

economic and natural characteristics of the study area, changes in land use pattern and human impacts of biodiversity ⁷.

Field Data Collection

Primary data on local livelihoods and local threats to forests was gathered through informal and formal observations, Participatory Rural Appraisals (PRA) ⁸ tools (village visit and history, village mapping, seasonal calendars, threats ranking, informal and formal interviews with key informants) and standardized questionnaire survey with five other steps of field data collection:

- Step 2: the reconnaissance visit and discussion with key local agencies in the four communes to make informal observation; meet local key persons to get background information ⁹ and discuss issues on local livelihoods systems. In the end of the first visit, four villages within the four communes were selected to conduct households survey: Thanh Tan (Thanh Tay), Hoa Dong A (Hoa Hiep), Tan Tien (Tan Lap) and Tan Nam (Tan Binh). These villages were chosen based on the following criteria: (1) having the typical characteristics of villages in the commune; (2) being of various locations to the National Park ¹⁰; and (3) The intensity level of activities causing forest disturbances ¹¹.
- Step 3: formal meeting with the village leaders to introduce the study, to obtain the households list and to make transect walks through the villages for deeper information through seasonal calendar, participatory social and resource mapping. Information was gathered to form the baseline village and households profiles for household survey.
- Step 4: In each selected villages, 10% of the households were interviewed following a standardized questionnaire (Appendix 1) which was organized according to the DFID (2001) sustainable livelihood framework. The sample of households survey comprised of 162 households. The research team included the author and four other interviewers, two from the Tay Ninh Provincial Department of Agriculture and Rural Development and the others from Tan Bien Division of Economics. A training for these enumerators was carried in advance of the survey to make sure all interviewers understand all the questions and requirements of answers (Table 1).

Table 1. Sampling of Households Survey

Communes	Villages	Total number of households	No of respondents	%	
1	Thanh Tay	Thanh Tan	339	40	11.80
2	Hoa Hiep	Hoa Dong A	573	59	10.30
3	Tan Lap	Tan Tien	466	47	10.00
4	Tan Binh	Tan Nam	153	16	10.45
Total		1,531	162	10.58	

- Step 5: Wealth ranking and group discussions on threats ranking

Wealth status was first identified by the households themselves, the results then was combined with wealth ranking from some key informants in the villages. For threats ranking, 25 villagers in two villages (Tan Nam and Tan Tien) were selected for the discussion in 5 groups. The groups included men and women with different ages who were knowledgeable of various aspects of the village life. The discussion began with making consensus on a list of local threats to forest. Every participant then gave two scores for each threat, one for the period before 2002 (the time the Park was officially established) and another for the period after 2002. All scores of a group were counted and calculated to produce the two average scores for each threat. Scores of all groups were combined later to get the final results. The aim of threat ranking is to gain the overview of threats through villagers' awareness and perception of human impacts on forest biodiversity.

- Step 6: Intra-household deep interview and formal key informants' deep interviews were carried out after households survey. The key informants included commune and village staff, National Park staff, local forestry protection agencies, some household representatives (rich, medium, poor men and women, the elderly and the young), sedentary and mobile villagers, different ethnic and religious groups, former hunters, NTFPs collectors, animal herders, forest contractors. These semi-structured interviews were made in order to get deeper insight in underlying drivers of local threats to forest biodiversity.

From literature review, households surveys, group discussion and key informants interviews, evidence and data of forest loss, illegal hunting, illegal hunting and trapping, grazing were sufficient. For exploitation of NTFPs, especially medicinal plants which was considered the most serious threat to forest in the Park, there was not much available information of impacts. Therefore, the seventh step of data collection was a forest survey in the abundance of medicinal plants collected by villagers. To assess changes in number of species and density of medicinal plants in the National Park under local exploitation, systematic random sampling was employed: 52 plots of 20*20m (0.01% total area of natural forest in the National Park) were distributed systematically in all forest blocks and forest categories of the Park (Table 2). In each block, the plots were placed randomly and all medicinal plants in the plots were surveyed in numbers and their status of growth (Appendix 2).

Data Analysis

Most livelihood studies based on participatory methods with which data collected was largely qualitative in type. Therefore, analyses and interpretations in these studies have to be based largely on inferences (Mbile *et al.* 2005). In this study, the analysis of livelihood assets, activities and threats involved comparisons between the four wealth groups. Non-parametric test for differences (The Kruskal-Wallis) and Pearson correlation with Minitab 14.0 were conducted for local collection of NTFPs and income from forest among villages and wealthy groups to determine local dependency on forest resources.

Proximate cause of biodiversity impacts were identified by examining local people's activities which are affecting biodiversity at the four study sites. The investigation was first carried out from secondary literature review of previous rapid surveys, records of forest violations and governmental reports. It was then combined with local perception, observation in households' interviews, key informants and group discussions in PRA. Threats were also inferred from ways of living, preferences, strategies, and awareness of villagers. The impacts on biodiversity were specified from empirical data (previous studies, previous forest inventory and medicinal plants inventory) and local observation of the

Table 2. Distribution of sampling plots of medicinal plants survey in natural forest blocks in The National Park

Block	Area (ha)	No of sampling plots (20*20m ²)
16	442	2
17	787.5	3
18	861	3
19	1,015	4
20	1,116.5	4
21	1,245	5
22	570	2
23	445	2
24	480	2
25	833	3
26	879	3
27	990	4
28	1,029	4
29	987	3
30	1,281	5
31	675	3
Total	13,636	52

decline in wild populations. Biodiversity loss was also inferred from data of habitat loss through the loss of forest cover and land-use change. To determine changes in number of species and density of medicinal plants in forest blocks of different distances to the buffer zone, Non-parametric test for differences (The Kruskal-Wallis) and Pearson correlation with Minitab 14.0 were conducted. The variable *Distances* here was used to confer effects of villages on the abundance of medicinal plants in the National Park with assumption that the closer to the Park, the more exploitation of medicinal plants from villagers.

For analysis of the sustainability of existing LHs in the buffer zone, some of the criteria of the study 'Forestry, Poverty Reduction and Rural Livelihoods in Vietnam' (Dinh 2005) were adopted such as food security, material condition improvement. Besides this, other criteria were derived from villagers' suggestion

in the households survey focusing on livelihood assets and outcomes, livelihood strategies to cope with shock and surprises, effects of livelihood activities on forest biodiversity and participation in local social organizations. Evaluation was done on the basis of a sustainability matrix with scores ranging from 0 (no), 1 (low), 2 (medium), 3 (somewhat high) to 4 (high). Results of livelihood analysis helped to name the ultimate causes of biodiversity loss in the area. Further key informants' interview confirmed the findings.

Research Duration and Constraints

Field work and data collection were carried out from July 2006 to December 2006. From January to April 2007, data was processed and analyzed for thesis writing in April and May 2007.

There were some constraints in conducting the thesis. First, in records of forest violation cases provided by Tan Bien Forest Protection Sub-Division, data on hunting and trapping cases was recorded mainly since 2002 and the destroyal and removal of traps were only carried out since 2004. The reason was that before this time, forest protection focused only on timber extraction, there was not much attention on wildlife and NTFPs. Second, some medicinal plants were not yet identified. Some were reported to be abundant 10 years ago but now could not be found or scientifically identified based on descriptions from traditional healers and villagers. Others, mostly climbers though presented in sampling plots but were difficult to be identified. In these cases, only common names were given.

Results

Local livelihoods

Households characteristics

The average age of respondents was 48.6, the oldest was 81 and the youngest was 19. In most of the cases, the households' heads were the interviewees because the villagers saw that the interview dealt with important issues of the family (main occupation, income, strategy etc). Due to the tradition in Vietnam culture, most of households' heads were male, female households' heads only found in families where the

husbands passed away or left for one or another reason. 82% of the respondents, therefore were male, the female interviewees were either wives or the oldest

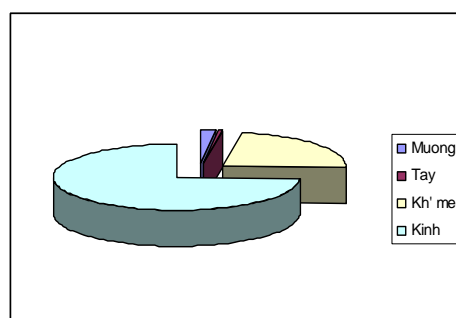


Figure 4. Composition of Ethnic groups in the sample

daughters who took part in the survey because the households' heads were absent. Due to the dominant of men presence in the respondents, we carried out intra-household interviews after the questionnaire survey. All households' have permanent residence in the area and 74% belong to the Kinh, the major ethnic group in Vietnam (Figure 4). 83% of respondent were farmers, 14% were wage labourers in agriculture.

Main Livelihoods

There were 23 livelihood activities pursued by the households in the survey with 5 on-farm activities and 18 off-farm jobs. However, among the 4 main occupations, three (cultivation, husbandry, wage labour) related to on-farm activities. Wage labours appeared to be the main occupation of villagers in Tan Tien village while cultivation, husbandry were more common in 3 other villages (Table 3).

Livelihood diversification

Villagers in Thanh Tan had the most diversified livelihoods and Tan Nam had the least. Most of villagers pursued from 2 or 3 occupations, 3% of the interviewees even had 4 employments. 81% of villagers had only on-farm activities. There were 34 types of livelihood diversifications in which the 4 most popular ones were combinations of cultivation; husbandry and wage labour. The poor were the most active in diversifying their livelihoods with 28 types of work combinations, and second were the poor escapers with 13. However, all groups had 2-4 common combinations of livelihoods which all related to on-farms activities (Table 4, Figure 5).

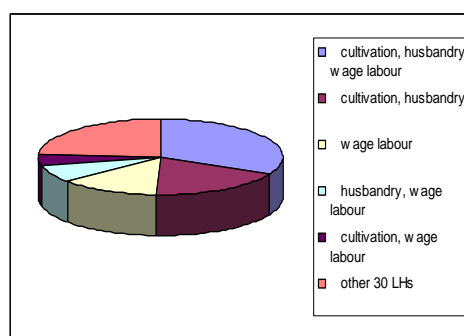


Figure 5. Livelihood diversification

Table 3. Types of livelihoods in the four villages

	Livelihoods	Total	Thanh Tan	Tan Nam	Hoa Dong A	Tan Tien
A	On-farm activities					
1	Cultivation	114	35	13	43	23
2	Husbandry	112	35	10	46	21
3	Wage Labour	105	21	10	41	33
4	Fish farming	4	1		1	2
5	Collecting remain of cassava crop	1			1	
B	Off-farm jobs					
6	Seller	17	5	4	5	3
7	Construction worker	4			1	3
8	Rice-wine maker	3				3
9	Agricultural truck driver	2			2	
10	Mini-taxi driver	2			1	1
11	Tailor	2				2
12	Teacher	1				1
13	Post office clerk	1			1	
14	Pensioner	1				1
15	Well driller	1	1			
16	Traditional healer	1	1			
17	Truck driver	1			1	
18	Children support	1			1	
19	Carpenter	1	1			
20	Cattle trader	1	1			
21	Bank clerk	1	1			
22	Rubber worker	1				1
23	Hair dresser	1	1			

Table 4. Livelihood diversification in the four villages

	Livelihoods (LHs)	Total	Thanh Tan	Tan Nam	Hoa Dong A	Tan Tien
1	No of LHs	23	12	5	11	10
2	No of LHs' combinations	34	9	9	15	14
3	No of main LHs' combinations	4	3	3	3	3
4	No of Households (HHs) with farming & wage labour	53	16	6	24	7
5	No of HHs with cultivation & husbandry	29	14	1	10	4
6	No of HHs with husbandry & wage labour	12	2	2	5	3
7	No of HHs with cultivation & wage labour	8	2	1	1	4
8	No of HHs with 1 LH	29 (18%)	1 (3%)	2 (13%)	9 (15%)	17 (36%)
9	No of HHs with 2 LHs	62 (38%)	20 (50%)		19 (32%)	17 (36%)
10	No of HHs with 3 LHs	66 (41%)	18 (45%)	8 (50%)	29 (49%)	11 (23%)
11	No of HHs having 4 LHs	5 (3%)			2 (3%)	3 (6%)
12	No of HHs with only on-farm LHs	132 (81%)	35 (88%)	12 (75%)	50 (85%)	35 (74%)
13	No of HHs with only off-farm LHs	4 (2%)			1 (2%)	3 (6%)
14	No of HHs with both on and off farm LHs	26 (16%)	5 (13%)	4 (25%)	8 (14%)	(19%)

Wealth status

Results of wealth ranking showed that among 162 households surveyed, there were 112 poor households, taking 69%, the medium households (the poor escapers) accounted for 14%, rich and well-off families made the remain 17% of the total (Table 5). Local criteria on wealth status based on area of cultivation land, investment in cash crops, animals, houses, machines and equipment, income and ability to send children to school. The poor were locally defined as landless people or villagers having area of cultivation land less than 1.5 ha, growing rice for subsistence, having no animals or only some poultry, and living mainly on wage labour. The poor escapers had small land around 2-2.5 ha and besides rice, they also grew cash crops, they also could have one cattle or some

pigs. The well-off were villagers who had around 4-5 ha of cash crops, they also could have some cattle. The rich were the ones having large area of cultivation land (>5 ha) with agriculture machines and equipment or having large herd of cattle. They certainly enjoyed better houses and could send their children to secondary school and even university. Wealth status varied among villages. In term of the distance from the National Park to the villages, the farthest one (Thanh Tan) had the greatest percentage of poor households, households in the closest village (Tan Nam) appeared to be more wealthier and had the high percentage of poor escapers.

Table 5. Wealth status of households in the sample

Wealth status	Unit	Total	Thanh Tan	Tan Nam	Hoa Dong A	Tan Tien
Number of Households (HHs)	HH	162	40	16	59	47
Rich	"	14 (9%)	3 (8%)	1 (6%)	7 (12%)	3 (6%)
Well-off	"	13 (8%)	2 (5%)	3 (19%)	5 (8%)	3 (6%)
Poor escapers	"	23 (14%)	3 (8%)	5 (31%)	4 (7%)	11 (23%)
Poor	"	112 (69%)	32 (80%)	7 (44%)	43 (73%)	30 (64%)

Livelihood assets

In general, physical conditions in the buffer zone offer some advantages in land and climate. Relatively large land stock with flat terrain and typical tropical climate with high temperature around the year, high rainfall and no disasters such as tropical storms or flooding are suitable for agriculture development. However, the typical soil of the area (Acrisols) is not very fertile and there is insufficient water supply for agriculture, especially in unirrigated area. The natural forest is strictly protected, but collection of fuel wood, mushrooms, medicinal plants and fruits is not considered too serious violations.

Average family size was about 4-5 people. Average number of labourers was 3 per family, not varying much among wealth status. Average age of households' heads was around 50 and their education levels lowered with lower wealth status: 46% of the rich and 33% of the well-off had gone to secondary school while only 23 % of the poor had done so. Illiteracy was very high among the poor (32%) and even the poor escaper (20%) and well-off (17%). The highest education level of households' heads was tertiary schools mainly in the rich and well-off groups. Education levels of other labourers in the families also revealed the gap between wealth status groups. The poor still got the highest level of illiteracy among their other labourers (10%) and the majority of their labour force had only primary school level. Education of the labour force of the poor escapers was better with 52% at secondary school level. More than 10% of other labourers in rich and well-off families had university level. Most children of the poor had the highest level of education at primary school while other groups (the rich and well-off) could send their children to secondary and even university.

Only 6% of households' heads had off-farm skills mostly in the well-off and poor escapers. 36% of the households' heads were in bad health in which the poor and poor escapers made of nearly 93.1% of this figure. The other labourers appeared to be healthier because most of them were sons or daughters in the families (Appendix 3).

Land owning reflected the disparity among wealth status groups with landholding by the rich was 3-4 times larger than the poor and the poor escaper. There were 53 landless villagers (33%) in the sample, most of which were in Hoa Dong A (19) and Tan Tien (24) and Thanh Tan (10). These villagers lived on wage labour and animal husbandry. The wealthier groups invested more capital in production and also had larger capital shortage than the poor. All groups appeared to have money constraints for their way of living. The poor also were disadvantageous than other wealthier groups in accessing to bank loan because their lack of property (land) for deposit requirement. They therefore relied on small credits from poverty reduction programmes and other rural development programmes. These programmes with resource limitation appeared to be insufficient for the big numbers of poor villagers who had to compete in the selection of candidates. The poor therefore had to find support from private credits which certainly had higher interest (10% in comparison with 1.2% of bank loan and 0.6% of poverty reduction programmes). Most of the poor escapers were benefited from poverty reduction programmes or they also could access loan from the bank with their small land as deposit. Households' saving also declined with lower wealth status but not linear. The rich had capacity to have the average biggest saving in all groups, second were the poor who often felt insecure and tried to set aside a small amount of money in case of bad luck. Most of the two groups: well-off and poor escapers invest all money in production (Appendix 4)

Difference land and capital led to the disparity among groups in crops and domestic animals. Due to food security, rice is still the main crop for even the rich and well-off households. The average cultivation areas of rice were not different among wealth groups, varying from 1-2 ha. Cash crops such as sugar cane, cashew, and rubber appeared to be crops of wealthy villagers due to the high investment in capital and labour that the poor were not capable to achieve. They instead grew cassava, vegetable, maize which required less capital investment.

Most of the rural roads were unsurfaced and often became bad during the rainy season, making travelling and transporting of agricultural products difficult. 84% of the poor, 83% of the poor escapers and 54 % of the well-off were living in temporary houses which were uncomfortable and not good for their health. Even, most of houses of the rich were still in class IV ¹². households' appliances, televisions, videos, electric fans were common for all groups while only the rich could enjoy comfort from fridges, hot water suppliers, telephones and computers. Motorbikes appeared to be the most common vehicle used by the villagers. The wealthy households were also distinguished from the poor by their

ox carts and tractors. Wells were the main source of water, drilled wells and pumping machines were established in most rich and well-off houses. Even 69% of poor households could afford for this source of clean water. Due to rural development programmes, especially the programme 135, more than 90% of villagers can have access to electricity supply and clean water, improving not only life activities, entertainment but also condition for productions.

Villagers were looking mainly for information on high yielding breedings and new techniques in agriculture. The existing extension service was carried out mostly through the coordination with local non-governmental organizations (NGOs) such as Farmers' Association and Women's Association. Information on agriculture offered by agricultural extension service was limited. The poor learned from their neighbours or other successful farmers. The main sources of information for the wealthy villagers were through televisions and radios. (Appendix 5).

Only 33% of households surveyed participated in rural development programmes in which the poor escapers got the highest numbers and then the well-off. The poor due to the lack of some resources such as minimum land and capital for the requirements of participation had lower involvement and were mainly involved in poverty reduction programmes. Only 11% of participants of these rural development programmes showed their satisfaction. Common complaints were insufficient capital support, complicated procedure and unfair selection of candidates. 19% of households surveyed escaped from poverty of which 26% received financial support from these rural development programmes and 55% became better-off. 58% of respondents were members of one or more local NGOs, mostly Women Association, Farmer Association or Veteran Association in which poor escapers and well-off villagers took the majority. 27% of these members got support from the organizations in terms of small credits or information on agricultural practices. 15 % of households surveyed, mostly the rich did not want to be involved with these NGOs but 27% of respondents, mostly the poor complained that they were not invited to participate (Appendix 5).

Livelihood outcomes

Income of households included both cash and goods the households get from different activities. Average income per person per year of the poor was around 4,365,005 VND (around \$273), of the poor escapers 6,927,866 VND (around \$433), of the well-off 9,172,528 VND (around \$574), of the rich 15,006,392 VND (around \$937). We can see that average income of the poor in the sample under local wealth ranking was higher than the national poverty line. Besides this, income of the poor escaper and the well-off were still under the poverty line defined by The World Bank (less than \$2/day) ¹³. In the same wealth status, income also varied, income of the poor in villages closed to the National Park (Tan Nam, Tan Tien, Hoa Dong A) appeared slightly higher than farther village (Thanh Tan) but income of wealthier groups were higher in villages whose distance to forest were medium and far (Thanh Tan, Hoa Dong A) (Table 6).

80% of the poor, 74% of poor escapers and 38% of the well-off still collected fuel woods, mushrooms, fruits and medicinal plants. Income from these NTFPs made up 57%, 23% and 5 % of total income of the poor, poor escapers and well-off respectively (Table 7).

Table 6. Incomes of households in different wealth status groups

Average income	Unit	Average	Thanh Tan	Tan Nam	Hoa Dong A	Tan Tien
Rich	VND	15,006,392	15,164,524	13,500,000	17,194,879	14,166,167
Well-off	"	9,172,528	9,487,500	8,715,556	9,771,500	8,715,556
Poor escapers	"	6,927,866	6,493,571	7,265,202	6,841,023	7,111,667
Poor	"	4,365,005	2,966,137	5,959,405	3,988,305	4,546,172

Table 7. NTFPs collection in different wealth status

Wealth status	Unit	Total	Thanh Tan	Tan Nam	Hoa Dong A	Tan Tien
-Well-off households (HHs)	HHs	5 (38%)	1 (50%)	1 (50%)	2 (40%)	1 (33%)
-Poor escapers	"	17 (74%)	1 (33%)	4 (67%)	4 (100%)	8 (80%)
-Poor		100 (80%)	21 (66%)	7 (100%)	41 (95%)	31 (97%)
Average income from NTFPs collection						
-Well-off HHs	VND	460,000		600,000	300,000	480,000
% total income	"	5		7	3	6
-Poor escapers	"	1,640,625	485,000	2,272,500	1,718,750	2,086,250
% total income		23	7	31	25	29
-Poor	"	1,873,746	1,320,000	2,718,571	1,481,759	1,974,655
% total income	"	57	45	46	37	43

Sustainable livelihoods and livelihood trends in the past ten years

Results of sustainability matrix indicated that all wealth status groups had not achieved sustainable livelihoods with low scores in criteria for relatively stable income, livelihood strategies and social support (Table 8). Only 26% of respondents improved their income and 40% even had declining income in the year of the study. Around 30-50% of the poor and poor escapers could not improve their income due to limited land, difficulties in finding jobs, low productivity resulted from low investment, pest and disease and low prices of agricultural products. Most wage labours in the four villages could find jobs for only 6-7 months per year. They blamed this situation on the wide use of pesticide which reduced the numbers of labours needed for weeding and the drought that made many field abandoned. There were several off-farm activities in the buffer

zone but the poor were disadvantageous in the competitions with workers from outside due to the lack of necessary skills.

However, nearly 48% of the poor and 65% of poor escapers did get better income in the past 5 years. For the past ten year, 68% of the poor and 100% of poor escapers really improved much their incomes. The rich and well-off with larger areas of cultivated land and high input in production had gotten a steady increase in income the last 10 years. Beside land and houses, better education for the children was the third indicator that both the rich and the poor meant for a better life. Some rich villagers claimed that their life were significantly improved with the help of their mature educated children in both farm and off-farms activities. Capital for production remained the most difficult for all groups and limited land was a constraint for most of the poor and poor escapers.

Table 8. Sustainability matrix for sustainable livelihoods analysis

Criteria	Rich	Well-off	Poor escapers	Poor
1. Livelihood assets & outcomes				
-Food security	4	4	2	1-2
-Shelter	3	2-3	1	1
-Water/Electricity access	4	4	4	4
-Relatively stable income & job around the year	3	3	2	0-1
-Children education	3	3	2	1
2. Livelihood strategies				
-Saving, insurance	1-2	1	1	1
-Capacity to cope with drought, falling price and crop failures	1-2	1-2	0-1	0
3. Effects of livelihood activities on forest biodiversity	3-4	3-4	3	4
4. Participation in local social organizations	2	2	2	2

Livelihood strategies

Agriculture remained the main future livelihood strategy for villagers of all wealth status groups who explained that this activity brought them good income and was all what they knew to do. The poor who worked as wage labours also hoped to get a small plot or one or two cows as a better way of living. All the rich and well-off were farmers with capital and large plots of land. The poor combined more livelihoods than the well-off for earning their living just because they did not have much investment in each livelihood, all in small scale. Off-farm activities appeared not to improve villagers' wealth status because they could only do tenuous jobs.

Expanding or buying new cultivation land for cash crops therefore appeared to be the common strategy for villagers to improve their livelihoods. Insurance was unfamiliar to the villagers except the medical insurance offered to all villagers from the programme 135. Due to the lack of capital for production, saving was only adopted by 22% of households mostly the rich and well-off. Nearly 20% of

the poor had small saving for cases of illness or bad luck. 25% of respondents with off-farm activities (mostly as small sellers and construction workers) also practiced cultivation or husbandry. 46% respondents adopted selling property (mostly land) for investment in agriculture or in case of debt. Migration for jobs was not favored by villagers (Appendix 6).

Local dependence on forest resources

Villages' history revealed that local residents were highly dependent on forest resources, especially during the period of 1980s (Appendix 7) From 1990s and onwards, with the strict protection of forest and increasing price of cash crops such as cassava, sugar cane and rubber, local residents turned into agriculture and the dependence of local people on forest resources seemed to be less significant. Illegal cutting decreased but collection of NTFPs still occurred because the villagers saw that it was not a serious violation in the eye of forest rangers. For most villagers who even got land for agriculture, NTFPs extraction was seen as coping strategy and diversification strategy to get supplementary income. Seasonal calendar of activities in the four villages (Appendix 8) revealed that NTFPs collection, hunting and trapping appeared to be high in slack labour period and in agricultural off-season. The survey indicated that 80% of the poor and 74% of poor escapers still collected fuel wood, mushrooms, fruits and medicinal plants. There was a statistical significance in NTFPs collection between economic status groups (Kruskal- Wallis, DF=3, P=0.000) with a strong correlation (Pearson correlation =-0.672, P-value=0.006). Income from these NTFP made up 57%, 23% of total income of the poor and poor escapers respectively. Engaging in NTFPs collection was significantly differently between villages (Kruskal- Wallis, DF=3, P=0.004) with a strong correlation (Pearson correlation =-0.216, P-value=0.006). The nearer the village to forest, the more respondents collected NTFPs (Kruskal- Wallis, DF=1, P=0.031) with a high correlation (Pearson correlation =0.214, P-value=0.004). 38% well-off families especially in Tan Nam, the closest village to the National Park also gathered firewood though this activity contributed only 5% to their income.

Dependence on forest resources for consumption appeared to be high, especially in villages close to forest. 90% of households surveyed still depended on fuel wood which came from farms by-products, litter fall of rubber plantations and forest (Appendix 9). A part of the villagers also lived on fishing on rivers and wetlands in the National Park by electricity, dynamite and poison, on collecting honey, tree resin and scraps from the remaining bombs of the Second Indochina War. They also dugged up some specific forest trees for horticulture. With the existing scarcity of NTFPs in natural forest, there was a trend to domestication of some NTFPs, especially medicinal plants such as Kim Tien Thao *Desmodium styracifolium*.

Human threats to forests

Previous studies¹⁴ and governmental records emphasized that conversion of seasonally inundated grasslands to agriculture, illegal timber extraction, hunting and trapping wild animals, over-exploitation of NTFPs and forest fires were among the potential and existing greatest threats to forest biodiversity in the National Park (Birdlife International 2004).

Local perception on threats through households survey listed illegal cutting, forest encroachment, NTFPs collection, hunting & trapping, forest fire, drainage and grazing as the existing activities threatening forest biodiversity (Figure 6). Records of forest violation cases from forest rangers confirmed the mentioned of proximate causes of biodiversity loss in the National Park except drainage and revealed that the closer the communes, the more violation cases (Figure 7).

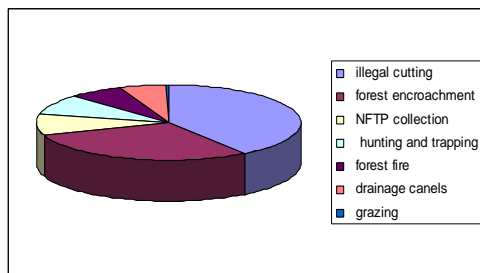


Figure 6: Local perception on threats to forest

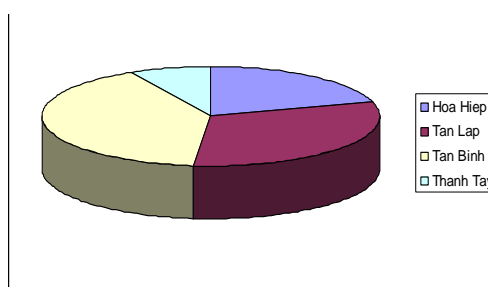


Figure 7. Forest violation cases by communes

Illegal cutting

Local forest rangers confirmed that illegal cutting was the most common violation from local people, taking nearly 50% of cases detected. Due to the facts that the National Park covers a large area accessible for villagers, the records probably only reflect a small percentage of this activity. The illegal cutting is for households needs of wood for construction and animal shelters, but mostly for commercial selling. Illegal wood extraction focused on certain target species of Dipterocarpaceae such as *Dipterocarpus alatus*, *D. intricatus*, *Hopea odorata*, *Shorea cochinchinensis* and some other hardwood species such as *Azizia xylocarpa*, *Pterocarpus naccarpus*, *Diospyros mollis* which are listed in the Red Data Book of Vietnam (Anon 1996). Besides this, it also damaged the neighboring trees and seedlings.

Forest Encroachment

Local encroachment into the core of the National Park, especially into the wetlands is a serious problem. 84% of violators were villagers in the buffer zone (Table 9). Fertilizers and pesticides polluted the wetland, agricultural practices made great disturbances to wildlife and the tendering practice of certain crops such as removing and burning leaves of sugar cane in the dry season to prevent pest also caused forest fire. Offenders also tried to drain the wetland for more

favourable conditions for cash crops. Besides this, forest encroachment made forest more accessible to hunters and poachers.

Table 9. Records of forest encroachment by communes (2006)

Blocks	Areas (ha)	No of cases	Violators from the buffer zone	Thanh Tay	Tan Lap	Tan Binh	Hoa Hiep	Violators from other places
16	198.9	95	74	12		1	61	21
23	78.6	21	19	2	12	4	1	2
24	191.3	42	40	7	18	15		2
29		9	9			9		
30	25.2							
31	47.9	13	10			10		3
Total	541.9	180	152	21	30	39	62	28

Illegal hunting and trapping

Hunting and trapping of wild animals was difficult to halt. The methods of trapping were diversified and detrimental to species from snare to more complicated traps that can kill any animals which got in. The number of traps discovered and destroyed by forest rangers was around 1000 units per year. Targets were small wild animals such as wild pigs, primate, birds and reptile.

Collection of Non-Timber Forest Products

Products from wetlands in the National Park have been a source of living of poor villagers in the buffer zone. Products collected were medicinal plants, leaves for handicraft, rattan, honey, tree resin and gum, fish from wetlands and rivers in the National Parks. The methods of harvesting were detrimental to species: removal of the reproductive parts or the whole plants in medicinal plants, over-exploitation in harvesting rattan, leaves, resin and use of dynamite, poison and, electricity in fishing.

Grazing

More than 1000 cattle from the communes in the buffer zone are frequently grazing in the National Park. Previous study indicated that the large number of cattle and herders gave serious disturbances to wildlife. Cattle's trample on soils affect the fauna and give good condition for invasive plants species. Grazing has also changed and increased nutrients to soils, leading to the change in fauna composition and the disappearance of other soils species which adapted to the poor condition of wetlands (Tran *et al.* 2005).

Threats ranking

Group discussion of key informants on threats ranking in Tan Nam and Tan Lap communes showed that before 2002, illegal cutting, forest encroachment, hunting & trapping, shifting cultivation, and NTFPs collection were among the serious threats to forest biodiversity. After 2002 when stricter protection on timber extraction has been introduced, there were changes in local disturbances

to forest: shifting cultivation decreased but collection of NTFPs and hunting & trapping become greater threats than before; forest encroachment and timber extraction were also the main threats to forest from local livelihood activities. (Table 10).

Local impacts on forest biodiversity

The survey yielded evidence for the following human impacts on forest biodiversity in the National Park.

Loss of habitats due to forest fragmentation and deforestation

Satellite photos showed that the coverage of forest in the National Park decreased significantly since 1989. Most of forest in the south of the National Park had become agriculture land (Tran *et al* 2005). Forest area in the National Park was changed significantly in 2 periods after the ban of logging in 1989:

Table 10. Threats ranking in group discussions of key informants

	Ranks	Average scores	Tan Nam	Tan Tien
1 Before 2002				
. Illegal cutting	1	6.7	7.2	6.2
. Forest encroachment	2	6.1	5.4	6.8
. Hunting & trapping	3	6.0	6	6
. Shifting cultivation	4	5.9	6.8	5
. NTFPs collection	5	5.5	4.8	6.2
. Grazing	6	4.5	5.4	3.6
. Metal scraps collection	7	3.7	3.8	3.6
. Forest fire	8	2.8	1.8	3.8
. Detrimental fishing	9	1.6	2	1.2
2 After 2002				
. NTFPs collection	1	7.3	7.4	7.2
. Hunting & trapping	2	6.0	5.8	6.2
. Forest encroachment	3	5.9	6	5.8
. Illegal cutting	4	5.4	5.5	5.2
. Scraps collection	5	5.3	5	5.6
. Grazing	6	4.8	5	4.6
. Forest fire	7	4.4	4	4.8
. Detrimental fishing	8	3.3	3	3.6
. Shifting cultivation	9	2.3	2	2.6

Table 11. Change of forest resource in the National Park from 1991-2006

Year			change		change		
	1991	1996	1991-1996	2006	1996-2006		
1	Natural forest	ha	28,545	24,267	-4,278	13,636	-10,631
	-Rich and medium forest	"	15,081	12,562	-2,519	855	-11,707
	-Natural forest in rehabilitation	"	13,464	11,705	-1,759	12,781	1,076
2	Plantation	"	55	420	365	1,134	714
3	Degraded forest land	"	8,813	4,162	-4,651	3,032	-1,130
	IC	"				963	963
	IB	"		2,159		22	-2,137
	IA, IA-TR (wetlands)	"		1,242		2,047	805

Source: The National Park Lo Go- Xa Mat, Report of forest inventory in Tay Ninh Province in 1992, Project of Lo Go Xa Mat special- use forest (period 1997-2005)

1991-1996 and 1996-2006. From 1991-1996 natural forest loss was 4,278 ha and from 1996-2006 the figure was 10,631 ha. In the two periods, the process of forest loss was in the same pathway: illegal extraction degraded natural forest, deforested areas then was converted into agriculture lands or was removed from the protected areas for other purposes of economic development which focused on seeking new arable land for landless villagers or new settlers (Table 11).

Decrease in the abundance of wild populations

Due to illegal extraction of target species, hardwood such as *Albergia sp*, *Sindora siamensis*, especially *Azela xylocarpa*, *Diospyros mollis* and *Pterocarpus marcocaropus* which were listed in the Red Data Book of Vietnam and were abundant before 2000 nearly disappeared in the National Park. Targets of illegal timber extraction then turned into Dipterocarps and as results the once-dominant tree species in the National Park including *Anisoptera coastata*, *Dipterocarpus alatus*, *D. costatus*, *D. intricatus*, *Hopea odorata*, *Shorea roxburghii*, *Shorea cochinchinensis* also decreased in the abundance (Le & Tran 2000).

About wildlife, the National Park harboured a fauna of nearly 104 species of 86 genera and 55 families in which there were 57 species of birds, 23 species of reptiles, 14 species of mammals and 10 species of amphibian. Rivers, streams and wetlands were also home to 86 high economic value species of fish and water mammals which belonged to 42 genera, 24 families (HCMC SFIPI 2003). Former hunters, old villagers and senior forest rangers confirmed that big games such as elephants and tigers disappeared during the war with intensive bombing. Hunting and intensive logging in the 1970's and 1980's removed most of other big games from the forest. From 1990's to 2000, target species of hunting and trapping were small mammals such as wild pigs *Sus scrofa*, deer *Cervus unicolor*, muntjacs *Multiacus muntjak*, primates *Semnopithecus critatus*, *Macara variegatu* and hedgehogs *Hytrix hodgsoni* which also became rare. Hunters and poachers now turned into small snakes, water birds, reptiles and rodents. Local residents and

forest rangers confirmed the decrease in population of most of wild species in The National Park. Respondents in HHs surveys said that some common bush meat such as deer, wild pigs, snakes, hedgehogs and mouse-deers became scarce and expensive in the black markets and local eateries. Unfortunately, this was not an indicator of a better forest protection in the National Park but the declining of wild populations. Informal interview of some former hunters in Hoa Dong A village revealed that even the stocks of small reptiles, rodents and forest birds were decreasing. Seriously, wild animal captured by local forest rangers in recent years included species of global and national conservation importance such as *Pygathrix nemaneus nigripes*.

Decline in the abundance of NTFPs appeared to be the most visible impact from local over-exploitation. Respondents from households survey and key informants (NTFPs collectors, traditional healers, forest rangers, old villagers) offered information that some NTFPs such as rattan, leaves for handicraft, roofing and packaging, honey, medicinal plants and fruits which were abundant 5-10 years ago has become scarce now (Table 12).

Local traditional healers confirmed that there used to be nearly 150 species of medicinal plants collected by villagers in the buffer zone (Appendix 10). Our inventory in the abundance of medicinal plants in 52 sampling plots in 16 forest blocks of the National Park did not find the presence of 19 species (13%) of the 149 medicinal plants that used to be collected by villagers (Table 13). Only 8 species (6%) could be found in more than 50% of sampling plots. More than 50% of the species of high medicinal value had the plot frequency less than 10%. 8 of 11 species with high density (80->100 plants/ha) were in low value and most of high value medicinal plants such as Day Dau Xuong, Day Kim Luong, Day Huyet Dang... had low density of only 25 plants/ha (Appendix 10). Forest inventory also observed that most of medicinal plants in forest blocks near the buffer zone were in the status of being over harvested with detrimental methods of collection. Statistics tests indicated significant differences and strong correlations in number of species and density of medicinal plants under different forest categories and different distances to villages (Table 13).

Over-exploitation of wetland resources resulted in serious impacts to freshwater species. To get more products, villagers were not reluctant to employ methods of exploitation which were detrimental to species population such as electricity shocks, use of dynamite and toxic substances, net with small meshes, killing everything not only the target species. As a result, there was concern of the rapid exhaustion of the resources. Interviews with key informants such as fishermen and old villagers gave at hand that fish catches were decreasing. A recent study on wetland resources confirmed that some high economic value fish such as Gudgeon *Oxyeleotris marmorata*, Hemibagrus *Mystus nemarus* nearly disappeared in the area. The high value Leaf fish *Nandus nandus* which was believed to be a good medicine for many illnesses disappeared in Da Ha stream where they were abundant 5 years before. Freshwater prawns *Machrobrachium rosenbergii* and

Pignose turtle *Carettocheyls* spp. were also threatened with over-exploitation (Tran *et al.* 2005).

Transformation of natural landscape in The National Park

Illegal cutting and forest encroachment fragmented, degraded and deforested the natural tropical forest which was rich in biodiversity, giving way to conversion of large areas into agriculture land especially the area near roads and villages. Even when practices of forest rehabilitation were adopted; areas of former natural forest mostly became monoculture plantations with exotic and fast growing species such as Khasya or Acacia. There was an attempt to establish forest plantations with native species but in most of the cases, only some native species such as *Dipterocarpus alatus*, *Hopea odorata*, and *Anisoptera cochichinensis* were intercropped with fast growing and exotic trees.

A recent study in wetlands showed that some important wetlands of the National Park such as Trang Ba Diec, Trang Tan Thanh, Trang Ta Not were much drier than before and the changes were in both the time period and the level of inundation. There was growing concern that this trend of drying was affecting the wetland ecosystems. It can be observed traits of change in composition of plants in some areas such as Trang Dat Den, Trang Dau Bo with the absence of many species adapted to wet conditions and the appearance of some species of dry environment. A preliminary study of the soils discovered that dry conditions changed the soils physicals properties and there may be a trend toward irreversible and undesirable status such as laterization (Tran *et al.* 2005). As a result, if such trends were not controlled and monitored, there would be a risk of transforming wetlands in the National Parks into typical dry landscapes and ecosystems.

Table 12. Households' perception on changes in the abundance of some forest products in The National Park in the last 10 years

Forest products	No of respondents	%	Now	5 years ago	10 years ago
Fuel wood	152	84.57	S	H	H
Mushroom	132	72.22	S	H	H
Fruits	143	78.81	S	H	H
Tree resin	124	67.08	N	M	H
Rattan	129	70.37	S	M	H
Honey	131	71.60	S	M	H
Leaves	127	68.93	N	H	H
Medicinal plants	151	83.74	S	M	H

N: not available, S: scare, M: medium, H: high

Table 13. List of medicinal plants not found in sampling plots.

	Common names	Scientific names
1	Bach Dong	<i>Calotropis gigantea</i> (Linn) R. Br. (Asclepidaceae)
2	Cat Canh	<i>Platycodon grandiflorum</i> A. DC. (Campanulaceae)
3	Cau Dang	<i>Uncaria rhynchophylla</i> (Miq.) Jacks. (Rubiaceae)
4	Chap choa	<i>Beilschmiedia sphaerocarpa</i> Lec. (Lauraceae)
5	Cong Cong	NI
6	Danh Danh	<i>Gardenia jasminoides</i> Ellis (Rubiaceae)
7	Day Coc	<i>Menispermum crispum</i> L. (Menispermaceae)
8	Day Hoang Dang	<i>Fibraurea tinctoria</i> Lour. (Menispermaceae)
9	Duoi	NI
10	Dia Lien	<i>Kaempferia galanga</i> C. (Zingiberaceae)
11	Gang Gai	<i>Gardenia tomentosa</i> Wall (Rubiaceae)
12	Lim	<i>Erythrophloeum fordii</i> Oliv. (Caesalpiniaceae)
13	Long Mang	<i>Pterospermum heterophyllum</i> Hance (Sterculiaceae)
14	Ngai Den	NI
15	Nhan Den	NI
16	Phen Den	<i>Phyllanthus reticulatus</i> Poir. (Euphorbiaceae)
17	O Duoc	<i>Lindera myrrha</i> (Lour.) Merr. (Lauraceae)
18	Thuoc Doi	<i>Pouzolzia zeylanica</i> L. Benn. (Urticaceae)
19	Xa Can	<i>Pardanthus sinensis</i> Ker. (Iridaceae)

Table 14. Statistics tests on results of medicinal plants inventory

Variables	Kruskal-Wallis		Pearson correlation	
	DF	P	Pearson correlation	P-value
No of species vs. forest categories	4	0.006	-0.477	0.000
No of species vs. distance	2	0.000	0.682	0.000
Density vs. forest categories	4	0.006	-0.477	0.000
Density versus distance	2	0.000	0.636	0.000

** Correlation is significant at the 0.01 level (2-tailed).

Discussion

Representativeness of samples in households survey

Random selection of respondents helped to ensure the representativeness of the sampling to the population. Composition of ethnic groups in sampling was rather compatible with most of respondents belonged to the Kinh (70% in the sampling in comparison with 79% in the buffer zone) and the presence of the three other ethnic groups: Kh'me, Tay, and Muong. The missing of respondents from the ethnic Hoa was compensated with some interviewees in intra-households interview belonging to this group. The main occupations of the households sample were also compatible with more than 80% were on-farm activities. Intra-households deep interviews also complemented to the findings from households survey in which most of respondents were men.

Threat Ranking

Statistic tests showed that scores of different threats in threat ranking were significantly different (General Linear Models, DF=8, P=0.000) and there appeared to be no effect of villages on the scores of group ranking (General Linear Models, DF=1, P=0.588). Therefore, it is possible to make the average from scores of the two villages (Tan Tien and Tan Nam) to rank the threats. Threats ranking from local perception and observation were compatible with information from previous studies and governmental records.

Use of local perception and observation and inference of human threats and biodiversity impacts

The proximity of local people to the resource confer an ability observe of day-to-day changes. Local knowledge, therefore based on accumulation of observation through daily life and experience of what happening in the area (Berkes *et al* 2000). Due to this reason, the combination of local perception and observation on forest changes with empirical data and governmental records were justifiable and crucial in investigating human impacts on forest biodiversity in the buffer zone.

Besides this, studies of human threats to forest biodiversity and biodiversity impacts require comprehensive research with long time period, intensive labours and expertise. However, in most of the cases, policy makers, especially in developing countries cannot always wait for the results of such research to develop and formulate intervention because of the urgent situation of realities. In the lack of elaborate and comprehensive studies on biodiversity impacts, identification of human impacts on forest biodiversity through the use of inferences from surrogate or proxy measures provides a useful way to get an overview of the situation and to provide necessary input for policy development in forest conservation.

With limited time and resource, the study could not be able to quantify biodiversity loss in the area under human disturbances. However, if considering the much quoted rule of thumb which holds that a 90 percent reduction in the area of a given habitat will result in the immediate loss of about half of the species contained in the habitat (Wilson 1992; Terborgh *et al* 1997), nearly 21% of the species of the forest in 1991 might be lost through the deforestation of 10.631 ha natural tropical forest during this period. Forest rehabilitation by forest plantation can recover forest cover but can not compensate to the loss of biodiversity from the vanishing natural forest because in such mix plantations, the number of species of trees was limited and due to intensive weeding and ploughing to prevent forest fire in dry season, it was hard to think of these frequently disturbed areas to be as good a home for wildlife as the replaced natural forests. A study on medicinal plants in the central highland of Vietnam showed that the number of species declined significantly with the forest categories (Bao *et al.* 2004). Medicinal plants survey in the National Park revealed the same results: numbers of species in 'medium' forest IIIA2, IIIA3 were much

higher than in ‘rehabilitating’ forest IIA and IIB (Appendix 12). So this fact was a clear example for the loss of forest biodiversity due to the degradation of natural forest in The Park.

Sustainable livelihoods

It is easy to see that the poor and poor escapers in the survey were having unsustainable livelihoods with poor and unstable income from low productivity agriculture and wage labours. Poor soil conditions and shortage of water for agriculture in the area, low education and skills, lack of financial and social assets together prevented them from well-paid job that may help them to have a good living condition and capacity to send their children to school for a better future. Poverty drove them to over-exploitation of the resources, declining resources provided them with less income and this in turn fuelled more over-exploitation. Low livelihood assets also made the poor more vulnerable not only to falling prices of agricultural products, drought, pest and disease but also to cases of bad lucks, illnesses and other unexpected situations in life. Significant diversification of livelihoods in the poor and poor escapers was observed in the surveys and appeared to be their coping strategies for daily survival and really to help them employ better households’ labour surplus in agricultural off-season. However, there were few off-farms jobs in the buffer zone and due to the lack of working skills; villagers were able to seek only odd jobs with low incomes even when migrating for work. With the poor human assets, non-farm employment did not help them much in improving their livelihoods.

The rich and well-off seemed to have a better life but still with low livelihoods assets and their livelihoods were not more sustainable. Their income was mainly based on agriculture of cash crops which had ‘burst and down’ cycles which could be noticed in the past ten years. High investment by better-off households in agriculture relied on big loan from the banks with property deposit. With insufficient information about market trends, they were then prone to bankrupts after several crop failures or falling prices. The price crises of cassava in 1995 and of sugar cane in 2001 were among sad memories of villagers. Besides this, agriculture practices of many better-off households based on agricultural encroachment and grazing, making negative impacts on the environments and therefore certainly were not a sustainable way of living. This fact implicated that existing rural development policies in the area which focused only on agriculture development especially cash crops as a mean to improve rural livelihoods could not reduce but expands more the trade-off between rural development and conservation.

Local dependence on forest resources

Due to the restriction of forest access and use by regulations, activities relating to forest extraction without permission were considered ‘illegal’, and all respondents denied they lived on forest extraction. However, because the collection of some NTFP such as fuel wood, medicinal plants, leaves, mushrooms and fruits were given much ‘tolerance’ from forest rangers, villagers felt comfortable to mention

to these activities though the information given by forest rangers was that many villagers also engaged in wild animal trapping. Income sources of villagers, therefore only revealed what villagers considered as 'acceptable': to get supplementary income from collection of fuel wood, mushroom, leaves fruits and medicinal plants in certain months of the year. However, from the survey this supplementary income revealed that 80% of the poor and 74% of poor escapers still collected fuel wood, mushrooms, fruits and medicinal plants. Income from these NTFP made up 57%, 23% of total income of the poor and poor escapers respectively. Though they claimed that incomes from forest were supplementary to their main livelihoods just in the slack labour period or off-season of farming, they admitted that incomes from NTFPs were important to them.

About dependence on forest resources for consumption, villagers claimed that their fuel came from farms, litter fall in rubber plantations and in forest. If we notice that the litter fall in rubber plantations could only be collected in rainy seasons and with limited access from the owners in order to protect the latex. Trees around home yards and by-products of agriculture could satisfy only a part of the fuel demand. Forest, especially forest plantations are therefore still an available source for fuel wood. With average amount of consumption of 26 sters fuel wood per households per year, more than 158,000 sters of fuel wood were needed every year and if only 30% was derived from forest according to the respondents, 48,000 sters of fuel wood would be collected from forest in the National Park every year! Moreover, most of houses in the buffer zone were wooden temporary houses. If assuming that only 30% of the wood needed for this come from forest, nearly 52,000m³ of wood would be needed every year. Fuel wood and wood for construction are not the only most needed NTFPs. According to the traditional healer in Tan Tien village, every month, a traditional medicine clinic in the area consumed nearly 1ton of dry medicinal plants of which 50% was derived from forest. With 3 clinics in the buffer zone, the demand every year is nearly 18 tons of dry medicinal plants (equivalent to 72 tons of fresh medicinal plants). This figure certainly does not include the amount of medicine plants which villagers sold to outside traders from big cities. Local preferences on forest products also reveal that this trend will still last longer (Appendix 9)

Dependence on forest resource also could be seen in a different form. With the scarcity of land, villagers saw forest land as a potential source for agriculture land. Shifting cultivation was halted after the National Park established but encroachment to forest, especially for the wetlands for cultivation of cash crops has become a serious problem. 27% of households surveyed are cultivating in the core of the National Park and 7% households used to do it. It is important to notice that 83% of the well-off and 31% of the rich are having agriculture land in the National Park and these figures are greater than the numbers of poor and poor escapers in forest encroachment (Appendix 9). Therefore, though incomes of these better-off groups seemed to come from agriculture, they did depend on forest land.

These mentioned activities were only the upper part of the iceberg which could be seen and recorded. Nearly 75% of respondents claimed that illegal cutting, hunting and trapping from villagers in the buffer zones still occurred. Certainly, it was difficult to get the true answers from interviewees if they themselves involved in such forest violations. From the survey, more than 40% of respondents admitted that they sometimes cut trees for repairing houses or tools and that they in the past hunted or trapped wild animals for food or sell but only around 10% of violations had been caught and fined by forest rangers due to the large area of forest and insufficient of forest staffs. If we considered this ratio when looking at the records of forest violation cases from 2000 to 2006 supplied by Tan Bien Sub-Department of Forest Protection: there were in average 167 cases per year with breakers mostly from communes near the National Park (Tan Lap and Tan Binh), we could see that the real number was must be much higher

Factors involved in biodiversity impacts

From the households survey and key informants interviews and secondary information about natural, socio-economic contexts of the buffer zone, the following factors of impacts on forest biodiversity in the National Park were identified:

Drivers of impacts

Local activities that directly affected the environment or specific component of biodiversity in the National Park were illegal cutting with certain targets species, hunting & trapping of wildlife especially endangered species, over-exploitation of NTFPs both in natural forests and wetlands with methods detrimental to species population, agriculture encroachment and grazing. All these drivers were interrelated: illegal cutting and forest encroachment fragmented, degraded and deforested the natural tropical forest which was rich in biodiversity, giving way to conversion of large areas into agriculture land especially the area near roads and villages. Illegal cutting and agricultural encroachment also opened the forest, making it more accessible to hunters and poachers. They also transformed the landscapes, leading to the loss of habitat for wildlife. The declining resources of wild population and high market demand for bush meat fuelled more local over-exploitation which then led to greater decrease in wildlife population, making it more vulnerable to trapping and hunting.

Underlying factors

One of the underlying factors was land scarcity which was rather serious, for example, in Tan Lap communes; average agriculture land was only 0.43ha/person. Migration from other provinces to the buffer zone made land scarcity more severe (Tran *et al* 2005). Information from the National Park revealed that there were at least 937 poor households living on forest resources, most of them were landless villagers or farmers with small plots. Besides this, poverty forced the poor villagers and landless farmers engaged in over-exploitation of NTFPs, hunting and trapping, illegal cutting. Some rural development programmes which aimed to develop agriculture as the only

income generating activity in the buffer zone also fuelled for forest encroachment. Local consumption need of wood and other forest products also posed a pressure on the forest. This may still last longer with villagers activities, strategies and preferences relating to land and the use of forest products (Appendix 9)

Triggers

The buffer zone was no longer a remote area; it has the link with urban market and can be seen as an intermediate zone¹⁵ with mixed vegetation types between forest area and urban area. The high economic benefits of cash crops such as sugar cane, cassava, rubber etc. and cattle husbandry in the past five years and the increase in agricultural consumption played the roles of triggers for local encroachment and grazing into forest in the National Park. Besides this, the high demand and prices of bush meat as exotic food, the tendency to favour medicine which originated from forests and wildlife for urban dwellers also made the problem worse.

Contributing factors

Contributing factors can be seen in the low productivity of small farms due to low fertile of soils, dependable on rainfalls due to shortage of irrigation systems. Low education level of villagers and lack of skills prevented villagers from on off-farm activities and forced them to seek for supplementary income from over-exploitation of forest resources. Low awareness on the importance of biodiversity of both villagers considered as contributing also factors for existing problems. 91% respondents have not heard of the term biodiversity, for the other 9% who once heard of biodiversity but could not understand what it meant. 43% of respondent saw nothing important in the protection of wetlands which they preferred to converse into farming land for cash crops. 41% wished to harvest products and to get more land for agriculture from forest. Nearly 10% still saw forests as trees only, thus hunting animals and over-exploitation of NTFPs did not violate forest protection. Respondents from households survey also showed a disadvantageous perception to forest and the National Park: 49% claimed that they did not know that they were living in the buffer zone, 51% stated they had no rights and responsibilities at all on forests because forest belonged to the state, forest protection thus was the State's business, 25% thought that they should not make any suggestions because there would be no improvements from their suggestions. Most respondents emphasized the roles of forest rangers for forest law enforcement and indicated that there should be improvements not only in forces but also in professional ethics and responsibilities. They much concerned about what they called the unfair treatments to different violators in which some serious breakers were still not punished appropriately to their offence. Poverty reduction, rural development and local participation were also mentioned by villagers. 13% of respondents had contracts with the National Park and 37% wished to do so because of the opportunity to get jobs and income from this. Most of forest contractors did not satisfy with the contracts mainly in the low payment they received for their work.

Awareness on forest and biodiversity among policy makers was not better. Many rural development programmes in the area focused only on economics aspects. One important reason was that forest resources especially, forest biodiversity was underestimated. Visions of policy makers and local authorities to forest resources still focused mostly on the production functions, little or even no attention was paid on the regulation, carrier and information functions of forest ¹⁶. As a result, forests appeared to have insignificant contribution to public budgets in comparison to agriculture and other economic activities because of insufficient estimation of the direct value and the unrecognizing of their indirect use values and intrinsic values ¹⁷.

Awareness raising and forest conservation

It was widely assumed by most conservationist and policy makers in Vietnam that poverty alleviation can help to achieve better forest conservation. This assumption seemed to be proved truthful through the surveys with the facts that most forest violators were poor villagers. However, the study also revealed that even local better-off who were lifted from poverty were engaging in activities threatening forest well-being such as encroachment or intensive grazing. Therefore, poverty alleviation only, could not help to protect the forest because different wealth status groups were driven by different factors to be 'bad doers'. Awareness of the importance of forest and biodiversity and also of law abiding therefore should be paid equal attention to poverty reduction in policy development and conservation programmes. Local low awareness on forest biodiversity and the way of thinking that forest belonged to the 'public' as a whole made villagers find no responsibility for the loss and degradation of forest. The National Park with large and accessible area of forest and insufficient resource for protection has indeed become a 'common pool resource' with the attributes of non-excludability and extractability. Low awareness thus could explain why The 'Tragedy of Common' existed and forest resources were over-exploited. Low awareness also prevented further local participation in forest conservation.

Conclusions and Recommendations

Conclusions

Villagers in the buffer zone of The National Park Lo Go-Xa Mat had diversified livelihoods but most of them were based on agriculture. There was a few off-farm activities in the area but most of the villagers could not get jobs from these sources due to lack of necessary skills required. An existing social disparity can be observed among local people with nearly 70% considered in poverty. Dependence on forest resources was reduced in comparison to the level of five and ten years ago but it was still the coping strategy for local dwellers and can be found in all groups of different wealth status. The poor engaged in NTFPs over-exploitation, illegal timber cutting for outsiders, hunting and trapping while many wealthy households increased their income from agriculture encroachment and

grazing in the Park, making these activities main human threats to forest biodiversity in the National Park.

Impacts of local threats to forest biodiversity in the National Park emerged mainly in habitat loss for wildlife through forest degradation and conversion to agriculture or other types of land –use. Other impacts were the decline in wild populations and transformation of rich-biodiversity natural forest and wetlands into poor- species richness agriculture landscape.

Existing local livelihoods appeared to be unsustainable due to poor livelihoods assets and under other socio-economic triggers and underlying factors. These proximate causes of biodiversity loss were driven by population growth, poverty and trade-off between rural development and forest conservation policies. Increasing economic benefits of cash crops from expanding markets, high prices of bush meat due to changes in ‘urban consumers’ preferences also triggered forest violations. Poor and insufficient awareness of the importance of forest and biodiversity contributed to the problems.

Recommendations

Improving sustainability of local livelihoods should be the main target of rural development and biodiversity conservation programmes. Expanding of beneficiaries to the one with income over the national poverty line at a level appropriate to local socio-economic context is necessary for successful poverty reduction and mitigation. Promoting and strengthening of effective agricultural extension services should help farmers increase productivity without expanding their land. Besides this, rural development programmes should provide alternative income generating activities through small projects and credits to help the poor and landless villagers change into new livelihoods without over-exploiting the resources. Handicraft, husbandry with self-supply fodder, services for industries in the areas and the new border markets are worth paying attention to. Forestry sector and the National Park with the help of research institutes should develop agro-forestry models that can help villagers practice a more sustainable agriculture and produce necessary wood and fuel wood for their needs. Domestication of some high value medicinal plants should also be encouraged.

Human capacity building is very important to improve local livelihoods . Rural development programmes should also focus on improving the level of education of local people and training of off-farm skills for the young villagers. More investment on health services and communication services providing information for villagers should also be important.

A comprehensive and long time of awareness arising on the importance of forest biodiversity and on law abiding is crucial to reduce forest violations and to involve local participation in forest conservation. It must be part of the National Park annual and long-term planning and investments. Besides this, the forest

rangers should be strengthened for forces and professional ethics as well as responsibilities. Fair treatments in violation cases would help the Park gain trust from villagers in law enforcement. There should be appropriate mechanisms to promote local participation in forest protection and more emphasises should be paid in benefit sharing to attract villagers to the process. Employment of local people in forest rehabilitation and protection, development of eco-tourism from diverse forest landscapes in the Park are among several ways for such participation.

Local NGOs proved to be helpful in rural development and poverty reduction programmes. Local authorities and the National Park should co-operate and facilitate local NGOs in their efforts to combine rural development and forest conservation.

The forestry sector and the National Park should play stronger roles in providing input to rural developments and poverty reduction programmes in the buffer zone to avoid policy failures that lead to serious biodiversity loss in the Park. Strong collaboration with relevant sectors and local authorities is necessary. Besides this, more scientific research should be carried out to convince decision makers on the biodiversity values of the Park.

Further research

Because this research studied the human impacts on forest biodiversity mostly through proxy measures, further research with quantitative measures on the impacts of habitat loss, landscape transformation to species composition and richness in the National Park are necessary to get a deeper insight of the process. Studies on population dynamics of some key species are also crucial to formulate conservation programmes.

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Appendix 1. Questionnaire for rural livelihoods survey in the buffer zone of Lo Go-Xa Mat National Park, Tay Ninh Province, South Viet Nam.

Commune:-----Village:-----Date:-----
 Interviewer's name: -----
 Household's head name:-----
 Respondent's name: -----
 Age:-----Gender: male female Marital status: single married widowed Ethnic -----

A) Household general descriptions

1-Household economic status: poor poor escaper well-off rich

2-Type of dwelling: permanent impermanent

Year of settlement:-----Place of previous settlement:-----

B) Livelihoods

2. On-farm activities:

*Cultivation:

Crop	Area (ha)	Outputs (tons/ha)	Time of cultivation	No of crops/year	Price	Income/year	Problem, if any
rice							
sugar cane							
cassava							
peanut							
...							

*Husbandry:

Animals	Heads	Time of raising	Selling weight	Price	Income /year	Problems, if any
pig						
milk cow						
beef						
ox						
...						

*Aquaculture

	Area (m2)	Time of culture	Outputs	Price	Income/ year	Problems, if any
fish						
shrimp						
...						

3. Off-farm activities:

Jobs	Working days/month	No of working month	Wages	Income/year	Problems
Carpenter					
Artisan					
Day-labour					
...					

4. Involvement in Non-timber forest product collection? Yes No

If Yes:

Type of forest products collected	How often/month	How many months/year	Amount	Use/sell	Price	Abundance H/M/S/N:
firewood						
mushroom						
fruit						
resin						
...						

H: high, M: medium, S: scare, N: not available

5. How about your opinion about the abundance of some forest products?

Type of forest products	Abundance H/M/S/N		
	now	5 years ago	10 years ago
firewood			
mushroom			
fruit			
resin			
rattan			
leaves for handicraft			
honey			
medicinal plants			
wild animal			
Timber			

H: high, M: medium, S: scare, N: not available

6. Do you use fuel wood? Yes No

If yes, amount fuel wood used per month?-----From:-----Price:-----

Available or scare?-----What fuel wood do you often use?-----7.

Are you in need of wood for house repair? Yes No

If yes, how much do you need?-----What timber?-----

Source: -----Price:-----How often do you repair your house?-----8.

Are you in need of wood for animals' shelters? Yes No

If yes, how much do you need?-----What timber?-----
 Source: -----Price:-----How often do you need wood for animal
 shelter-----

9. What kind of forest products your family consume/month?

Type of forest products	Amount	Price	Species	Easy /difficult to get	Reason
firewood					
mushroom					
fruit					
resin					
rattan					
...					

10. Do you know how many villagers still involving in timber extraction? Yes No

If yes, how many people?-----How often they do?-----
 What is the average amount they can get each time?-----

11. Do you ever make timber extraction for the last 10, 5 years? Yes No

If yes, when did you last do it? -----How often did you do it?-----
 How much did you get each time?-----

Have you ever had to work with forest ranger?-----
 What was the penalty?-----

12. Do you have land in the National Park? Yes No

If yes, where is it (what block)?-----How large is the area?-----
 How long have you got it?-----How can you have it?-----

What crops you are cultivating in this area?-----

13. Do villagers still make hunting in the National Parkin the last 10, 5 year? Yes No

If yes, how many people?-----How often they do?----What
 is the average amount bush meat they can get each time?-----Do they
 sell or consume the bush meat?-----Where do
 they sell bush meat?-----

14. Do you
 ever make a hunting for the last 10, 5 years? Yes No

If yes, when was the last time? -----How often did you do it? ----
 Where did you do it?-----

What species?-----How much did you get each time?-----
 Did you sell or use?-----If
 selling, where did you sell?-----Price:-----

15. Have you ever had to work with forest ranger? Yes No

If yes, what was the penalty?-----
 Do you sometimes do it? Why/ Why not?-----

16. Have you ever practiced shifting cultivation in the forest area for the last 10,5
 years? Yes No

If yes, where did you do it?-----How large was the area?-----
 How long have you done it?-----What kind of crop?-----

Do you still do it? Yes No Why/ Why not?-----

17. Do you want to get more land? Yes No

- If yes, how do you intend to do?-----Why?-----C.
 Livelihood Assets
18. No of member in the family:-----in which adults:-----
 children:-----number of labours:-----19.
- Occupation of:
 HH head:-----Other:-----
20. Do you have a link to off-farm activities? Yes No
 If yes, please specify-----
21. Education and working skill of household's head:
 -Education: illiterate primary , secondary , University
 -Skills: -----
22. Education and working skill of other labours:
 -Education: illiterate primary , secondary , University
 -Skills: -----
23. How is your working ability? Very well Good Medium , Bad
24. How is the health status of labours in household ? (healthy, medium, weak)
 Household's head-----Other labours-----
25. Area of land: own -----, rent----- in which
 residential area----- Cultivation area:-----
26. House (own, rent):
 class II :-----m²
 class III:-----m²
 class IV:-----m²
 temporary house:-----m²
- Class II: houses with concrete foundation and frame, brick walls, concrete/metal/tile roof, flowered brick/enamel floor, ceiling, complete and painted front, relatively completed systems of electricity and water supply, bathroom with ashlar walls and flush toilet.
- Class III: houses with stone and brick foundation, concrete/brick frame, brick walls, metal/tile roof, flowered brick/enamel floor, ceiling, complete and painted front, indoor bathroom and toilet.
- Class IV: houses with stone and brick foundation, brick frame and walls, metal/tile roof, cement/flowered brick floor, ceiling, lime-washed front.
- Temporary house: houses structured by thatch, bamboo, leaves, wood or brick wall without cement cover, no ceiling, floor with samel brick or cement.
27. Car and machines
 Motorbikes:----Carts:----Agricultural machines:----Tractors:----Ploughing machines:----Seeders:----Harvesters:----threshers:-----Others-----
28. Access to electricity: Yes No
29. Water source: Running water normal wells Drilled wells River, stream Others -----
30. Entertainment and house appliances:
 Television:-----Radio:-----Video:-----Mobile: -----Telephone:-----Fridge:-----
 Water heater-----Electric fan:-----Computer:-----
31. How much do you need to invest in your livelihood activities?

Cash-----Labour-----Fertiliser-----Pesticide-----Seeds-----

32. Do you have enough capital for livelihood activities? Yes No

If no, how do you lack? -----

Where can you get this capital?

Banks: -----(interest...%) Relatives: -----(interest..%)

Private credit :----- (interest...%) Others-----

33. Where do you sell your agricultural products? -----

Favourable conditions:-----

Problems:-----

34. Where do you sell your products from forest? -----

Favourable conditions:-----

Problems:-----

35. How do you gather information necessary to your livelihoods?

36. What kind of knowledge you have that can help you in livelihood?

cultivation-----

Livestock raising-----

D. Household economic status

37. Household income/month:

Source	In farm activities	Off-farm activities			
Total					

38. Activities can bring non-cash activities:

If yes, specify----- estimation goods in cash:-----

Do you get food aid in the last 5 years? Yes No

39. Has your income increased, decreased or stayed the same last year?

-----why/why not?-----

40. Has your income increased, decreased or stayed the last 5 years?

why/why not?-----

41. Has your income increased, decreased or stayed the last 10 year?

why/why not?-----

42. Has your family escaped poverty? Yes No

why/why not?-----

43. Does your family have any saving? Yes No

If yes, how much?-----What do you intend to use this saving?-----

44. What are improved in your family in the last 5 years?

Children education Property Livestock Machine Land

House Others -----

45. Do you have any problems? If yes, specify-----

E.Livelihood Strategies

46. Do you have insurance: Yes No

If yes, what type of insurance?-----what level of insurance?-----

47. How long are you free from agricultural activities/year?

During that time, can you get well-paid non-farm activities? Yes No

- If yes, please specify-----
48. Have you ever sold your possessions for cash? Yes No
If yes, reasons-----
49. Have any members of your household left the area for work in the past 5 years? Yes No If yes, how long have they left?-----
What jobs are they doing?-----
Do they still make end meet or become better off?-----
Do they support the family?-----F.
- Social support
50. Is your family member of the poverty reduction or rural development programmes: Yes No
If yes, give the names of the programmes:
Other (please specify) -----
51. Do you satisfy with the support from these programmes? Yes No
why/why not?-----
52. What would you like to change in current rural development programmes in the area?-----
53. Do you need any help from local authorities?-----
- G. Social relation:
54. Do you belong to any social associations? Yes No
If yes, give the name of the association(s):-----If
no, what is the reason?-----55.
- Do you get any support from this/these organisation (s)? Yes No
If yes, please specify-----H.
- Perception and awareness in forest, forest biodiversity and threats
56. Do you know anything about forest biodiversity? Yes No
If yes, what is it?-----How do you know it?-----
57. Do you think forest biodiversity is important? Yes No
Why/why not?
58. Do you think forest is important for your life? Yes No
Why/why not?
59. Do you think local use of fuel wood has negative impacts on the forest in the National Park ? Yes No Why/why not? -----60. Do you want to change the type of fuel? Yes No Why/why not?-----If yes, please specify the new fuel you prefer-----61. Do you think local hunting and trapping have negative impacts on the forest in the National Park? Yes No Why/why not?-----62. Do you think local collection of non timber forest products has negative impacts on the forest in the National Park? Yes No Why/why not?-----63. Do you think wet lands in the National Park are important? Yes No
Why/why not?-----
64. What do you think we should do with wet lands in the National Park?

65. What you can do with the forest in the National Park?

66. What you can not do with the forest in National Park?

67. What would you wish to do with the forest in the National Park? Why?

68. Do you think the national park is important? Yes No

Why/why not?-----

69. How do you think we should do to protect forests in the National Park?

70. What would you think the National Park should do for local people?

72. How do you think about the National Park operation?

73. Are you a forest contractor with the National Park? Yes No

If yes, do you satisfy with the contract? Yes No

Why/why not?-----

77. If no, would you like to be forest contractors for reforestation or protection with the National Park?

Yes No Why/why not?-----

78. What do you think the threats to forest in the National Park?

-----I.
Individual preferences and priorities:

79. How do you think about cremation?

80. Do you prefer wooden furniture? Yes No

Why/why not?-----

If yes, where do you get them?-----what wood do you prefer?-----Are they available or scare?-----

82. Do you prefer bush meat? Yes No Why/why not?-----If yes, where do you get them?-----Are they available or scare?-----

83. Do you prefer traditional medicine Yes No Why/why not?-----

If yes, where do you get them?-----

84. If you can have enough condition and capacity, what kind of livelihood activities would you like to do?-----

Why?-----

85. What you would purchase your property to improve your family life?-----

Why?-----

86. What you would do if you got success in your livelihoods?

Why?-----

87. What you would do if you got failures/bad luck in your livelihoods?

Why?-----

Appendix 2. Inventory form for medicinal plants survey

Date:

Number sign of the sampling plot:

Block:

Forest Category:

Names:

Investigator:

Traditional Medicine Healer:

Forest Ranger of the National Park:

Ordinal Number	Medicinal Plants					
	Common names	No of plants	Growth status			
			young	juvenile	harvested	
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						

Appendix 3. Human capital in different wealth status

	Unit	Total	Rich	Well-off	Poor escapers	Poor	
1	Average family size	person	5	5	4	5	
2	Average number of labourers	labour	3	3	3	3	
3	Age of households (HHs) heads		50	51	48	50	
4	Ethnic	person	162	14	13	23	112
	-Kinh		124 (77%)	10 (77%)	13 (100%)	19 (76%)	82 (7%)
	-Kh' me	"	34 (21%)	4 (31%)		4 (16%)	26 (23%)
	-Muong	"	3 (2%)				3 (3%)
	-Tay	"	1 (1%)				1 (1%)
4	Education level of HHs' heads	level	162	14	13	23	112
	-illiterate	"	44 (27%)	1 (8%)	2 (17%)	5 (20%)	36 (32%)
	-primary school	"	71 (44%)	5 (38%)	5 (42%)	13 (52%)	48 (43%)
	-secondary school	"	41 (25%)	6 (46%)	4 (33%)	5 (20%)	26 (23%)
	-tertiary school	"	6 (4%)	2 (15%)	2 (17%)		2 (2%)
5	Labourers' education level	level	261	19	18	41	183
	-illiterate	"	19 (7%)			1 (3%)	18 (10%)
	-primary school	"	140 (54%)	7 (41%)	2 (13%)	20 (61%)	111 (61%)
	-secondary school	"	80 (31%)	6 (35%)	9 (60%)	17 (52%)	4 (26%)
	-tertiary school	"	17 (7%)	3 (18%)	5 (33%)	3 (9%)	6 (3%)
	-college, university	"	5 (2%)	3 (18%)	2 (13%)		
6	Education level of children	level	164	13	14	25	112
	-illiterate	"	3 (2%)			1 (8%)	2 (2%)
	-primary school	"	78 (48%)	3 (23%)	4 (29%)	9 (36%)	62 (55%)
	-secondary school	"	62 (38%)	7 (54%)	8 (57%)	9 (36%)	38 (34%)
	-tertiary school	"	18 (11%)	2 (15%)	2 (14%)	6 (24%)	8 (7%)
	-college, university	"	3 (2%)	1 (8%)			2 (2%)
7	Connection to off-farm activities	HHs	36 (22%)	4 (31%)	3 (25%)	8 (22%)	21 (19%)
8	HHs' head with off- farm skills	"	9 (6%)		3 (25%)	3 (13%)	3 (3%)
9	Working skill of HHs' heads	person	162	13	12	25	112
	-good	"	11 (7%)	4 (31%)			7 (6%)
	-fairly good	"	36(22%)	5 (38%)	3 (25%)	4 (16%)	24 (21%)
10	Health of HHs' heads	person	162	14	13	23	112
	-good	"	43 (27%)	4 (31%)	7 (58%)	6 (50%)	26 (23%)
	-medium	"	61 (38%)	8 (62%)	4 (33%)	8 (32%)	41 (37%)
	-bad	"	58 (36%)	2 (15%)	2 (17%)	9 (36%)	45 (40%)
11	Health of other labourers	labor	262	24	16	41	181
	-good	"	110 (42%)	12 (50%)	5 (42%)	19 (76%)	74 (41%)
	-medium	"	129 (49%)	10 (42%)	8 (67%)	19 (76%)	92 (51%)
	-bad	"	23 (9%)	2 (8%)	3 (25%)	3 (12%)	15 (8%)

Appendix 4. Resource capital in different wealth status

	Total	Rich	Well-off	Poor escapers	Poor	
A. Land						
1	Average area	ha	5.12	4.51	2.30	1.22
2	Average area of land owned	"	3.70	3.00	1.91	0.95
3	Average agricultural area	"	4.72	4.18	2.15	1.08
4	Average residential and garden area	"	0.04	0.03	0.02	0.02
B. Capital						
1	Average investment capital	Millions of VND	77	45	41	20
2	Average amount of capital shortage	"	75	31	24	17
3	No of households (HHs) in shortage of investment capital	HHs	11 (79%)	12 (100%)	23 (100%)	112 (100%)
4	No of HHs accessed to financial support	"	8 (57%)	7 (58%)	15 (65%)	61 (54%)
5	No of HHs offered loan from The banks in which from poverty reduction programmes	"	7 (50%)	4 (31%)	11 (48%)	46 (41%)
6	No of HHs offered private credits	"	2 (15%)	5 (22%)	22 (20%)	2 (15%)
7	No of HHs offered small credits from NGOs	"	1 (7%)	1 (8%)	2 (9%)	10 (9%)
8	No of HHs offered credits from Companies	"			1(4%)	
9	No of HHs offered small credits from relatives	"				1 (1%)
C. Saving						
	No of HHs having savings	"	6 (43%)	2 (15%)	2 (9%)	22 (20%)
	-average	Millions of VND	16	8	1	1

Appendix 5. Social support for livelihoods

	Total	Rich	Well-off	Poor escaper	Poor
1 No of households (HHs) participating in	54 (33%)	3 (21%)	5 (38%)	13 (56%)	33 (30%)
. Poverty reduction programme			2	5	22
. Breeding programmes	12	1	2	4	5
. Programme for development of villages in the border area.	3				3
. Agriculture extension programmes	5	1	1	2	1
. Animal vaccination programmes	5	1		2	2
2 No of participants showed	25	3	3	8	11
. satisfaction with the programmes	17 (11%)	3 (21%)	3 (23%)	5 (22%)	6 (5%)
3 No of HHs escaped from poverty	31 (19%)	9 (64%)	8 (61%)	14 (61%)	
-with poverty reduction programmes	8	2	1	5	
-with loan from banks	1	1			
4 No of HHs are members of local NGOs	94 (58%)	6 (43%)	10 (77%)	17 (74%)	61 (54%)
5 No of HHs are members of					
.Farmer Association	46	4	6	9	27
.Veteran Association	22	1	4	2	15
. Women Association	54		4	15	35
.Young Association	3		1		2
.Red- Cross Association	5	1			4
.The Motherland Front	1				1
6 No of HHs got support	48 (27%)	3 (21%)	5 (38%)	8 (35%)	32 (29%)
7 No of HHs did not want to participate in these organizations	25 (15%)	7 (54%)		2 (9%)	16 (14%)
8 No of HHs told that they were not invited to participate in these organizations	43 (27%)		2 (15%)	6 (26%)	35 (31%)
9 No of HHs getting necessary information for livelihood from					
.Public Media	28 (17%)	7 (50%)	1 (8%)	5 (22%)	15 (13%)
. Agriculture Extension service	36 (22%)	3 (21%)	3 (23%)	5 (22%)	25 (22%)
.Neighbors	82 (51%)	3 (21%)	9 (70%)	12 (52%)	58 (52%)
10 No of HHs are looking for information on					
.Cultivation	28 (17%)	2 (14%)	2 (15%)	4 (17%)	20 (18%)
.Husbandry	39 (24%)	8 (57%)	2 (15%)	4 (1%)	25 (22%)
.Cultivation and husbandry	61 (37%)		8 (61%)	11 (48%)	42 (38%)
11 No of HHs had medical insurance	128 (79%)	13 (100%)	12 (100%)	22 (96%)	103 (92%)

Appendix 6. Livelihood strategies in different wealth status

	Unit	Total	Rich	Well-off	Poor escaper	Poor
1	No of households (HHs) received medical insurance	HHs 162 (100%)	14 (100%)	13 (100%)	23 (100%)	112 (100%)
2	No of HHs had savings	" 35 (22%)	6 (43%)	5 (38%)	2 (9%)	22 (20%)
	.average	Million VND 21	18	1.5	2	
2	No of HHs have off farm jobs	HHs 41 (25%)	4 (29%)	7 (54%)	7 (30%)	23 (21%)
4	No of HHs selling their assets in the last 5 years	" 74 (46%)	4 (29%)	6 (46%)	12 (52%)	52 (46%)
5	No of HHs have members migrating for livelihoods	" 18 (11%)	2 (14%)	3 (23%)	3 (13%)	10 (9%)
6	If having sufficient conditions, No of HHs wish to follow	" 162	13	12	25	112
	.agriculture	" 123 (76%)	10 (71%)	7 (54%)	21 (91%)	85 (76%)
	.husbandry+driver of agricultural machine	" 1 (1%)				1 (1%)
	.trade and agriculture	" 30 (19%)	2 (14%)	2 (15%)	2 (9%)	24 (21%)
	.driver of agricultural machines	" 3 (2%)	1 (7%)	1 (8%)		1 (1%)
	.traditional healer+agriculture	" 1 (1%)				1 (1%)
	.no reply	" 4		2	2	
7	If getting success, No of HHs wish to	" 162	13	12	25	112
	.continue agriculture practices	" 123 (76%)	10 (71%)	10 (77%)	23 (100%)	80 (71%)
	.sawn mill	" 23 (14%)	1 (7%)	1 (8%)		21 (19%)
	.trade+agricutulture	" 14 (8%)	2 (14%)		2 (9%)	10 (9%)
	.buy pedicab, truck to serve farmers	" 2 (1%)		1 (8%)		1 (1%)
8	If getting failure, No of HHs prefer to	" 162	14	13	23	112
	.be wage laborers	" 81 (50%)	7 (50%)	6 (46%)	9 (39%)	59 (52%)
	.sell property	" 38 (23%)	2 (14%)	4 (31%)	5 (22%)	27 (24%)
	.get loan from the banks	" 35 (22%)	4 (29%)	3 (23%)	3 (13%)	25 (22%)
	.migrate for work	" 5 (3%)			4 (17%)	1 (1%)
	.trade	" 2 (1%)	1 (7%)			
	.no reply	" 1 (1%)			1 (1%)	

Appendix 7. Village history

Appendix 7.1. History of Thanh Tan village

Date	Landmark Events	Area of natural forest	Agricultural Area	Wildlife	Abundance of wildlife
1973	Village was named Tan Trung and then Tan Lap commune of Tan Bien District. It was a liberated area from Saigon Government. 100% habitants were Vietnamese-Cambodian from Bien Ho, Cambodia escaping from the genocide targeting Vietnamese by Lon Nol government in 1972.	90%		There were big games such as Tiger, Elephant, wild animals	*****
1973	It was named Tan Trung village of Thanh Tay commune (area from Thien Ngon military airport to The Big Can Dang bridge). 50% of the population was Vietnamese repatriates from Cambodia and 50% were migrants from other provinces.	90%			
1975	After country reunification, there were increasing settlers from other part of the country. Becoming crowded, the village was divided into 2 villages in: Thanh Trung and Thanh Tay	80%	10%		
1976-1977	With the policy of food self -supply, the government allowed villagers to clear forest for food crops	60%	30%		
1978-1979	Village was deserted because of the border war.	60%	abandoned	Wild pigs, mouse deer, hedgehogs,	
1979-1990	Villagers came back and migrants increased. Shifting cultivation was common during 1979-1982. Intensive logging by State Enterprise Tan Bien	30			
1993	After the logging ban in 1989, The 327 Lo Go- Xa Mat project established. Villagers turned into agriculture		80%		**
2002	The National Park established, the village was included in the buffer zone	deforested			

Appendix 7.2. History of Tan Tien village

Date	Landmark Events	Area of natural forest	Agricultural Area	Wildlife	Abundance of wildlife
1973	Vietnamese-Cambodians in Bien Ho, Cambodia escaped from the genocide targeting Vietnamese by Lon Nol government in 1972 and formed a settlement in forest of liberation area.	90%		There were big games such as Tiger, Elephant, wild animals	*****
1975-1978	After country reunification, it was named Tan Hoa village of Tan Lap commune. In 1978, the village was attacked by Pon Pot Forces in locations that are hamlet 7 and hamlet 8 nowadays.	80%			*****
1978-1989	After the war, villagers came back and there were increasing settlers from other part of the country. Becoming crowded, hamlets Tan Minh and Tan Khai were separated from Tan Hoa village and became Tan Tien village with 8 sub-hamlets. Villagers mainly lived on forest. High deforestation under shifting cultivation and intensive logging of State Enterprises.	80%	10%		*****
1993	After the logging ban. The 327 project of Lo Go- Xa Mat established. Villagers turned into agriculture	45%	50%	Wild pigs, mouse deer, hedgehogs,	***
2002	The National Park established, the village was included in the buffer zone of The Park.	Nearly deforested			

Appendix 7.3. History of Hoa Dong A village

Date	Landmark Events	Area of natural forest	Agricultural Area	Wildlife	Abundance of wildlife
1948	Village was named Soc Thiet. Inhabitants were mainly soldiers of Division 302 in the war against French colonialists, there were only 5 households of villagers	100%		There were big games such as Tiger, Elephant, wild animals	*****
1973	It was named Tan Phu village of Tan Thanh commune. 50% of the population was Vietnamese repatriates from Cambodia and 50% were migrants from other provinces	90%			*****
1975	After country reunification, it was renamed Hoa Dong village	80%	10%		*****
1978	During the Border War with Cambodia, villagers were evacuated from Kh' me Rouge attack, whole village deserted	60%			
1979-1990	After the war, villagers came back and there were increasing settlers from other part of the country. Becoming crowded, the village was divided into 2 villages in 1981: Hoa Dong A and Hoa Dong B. The policy of new economic zone development led to deforestation in large scale for settlement, infrastructure and agriculture. 80% of villagers lived on forest from 1980 to 1985	45%	50%	Wild pigs, mouse deer, hedgehogs,	*****
1993	After the logging ban, The 327 project Lo Go-Xa Mat established. Villagers turned into agriculture		80%		***
2002	The National Park established, the village was included in the buffer zone of the Park.				
2003	The village formed 4 new sub-hamlets from the residential area of Rubber Enterprise Tan Bien, making a total 12 sub-hamlets.	Nearly deforested			

Appendix 7.4. History of Tan Nam village

Date	Landmark Events	Area of natural forest	Agriculture Area	Wildlife	Abundance of wildlife
1973	Vietnamese-Cambodians in Bien Ho, Cambodia escaped from the genocide of Vietnamese by Lon Nol government in 1972 and formed a settlement belonged to Tan Lap Commune.	90%		There were big games such as Tiger, Elephant, wild animals	*****
1975	After country reunification, it was one of three villages of Tan Binh Commune, which was separated from Tan Lap commune. The village was thinly populated.	90%			*****
1978-1979	During the Border War with Cambodia, villagers escaped from Kh' me Rouge attack, the village was deserted.	80%	10%		*****
1980-1990	After the war, villagers came back and there were increasing migrants from other part of the country. Villagers mainly lived on forest. Forest sharply declined by shifting cultivation and intensive logging by State enterprise Tan Binh.	60%			****
1993	After the logging ban. The 327 project Lo Go Xa Mat established.	45%	50%	Wild pigs, mouse deer, hedgehog,	****
2002	The National Park established, the village was included in the buffer zone of the Park.	Nearly deforested			**

Appendix 8. Seasonal calendar of activities in the four villages

Activities	Month											
	1	2	3	4	5	6	7	8	9	10	11	12
Temperature	****	****	**** *	***	***	***	***	***	***	**	**	***
Rainfall	*	*	*	**	**	**	***	***	****	**	*	*
Rice							Sowing	Tending				Harvest
Sugar cane	Harvest											Planting
Cassava	Harvest winter-spring crop				Planting summer-autumn crop			Harvesting Ummer-autumm crop			Planting winter-spring crop	
Peanuts		harvesting					Planting			Harvesting	Planting	
Maize												
Water melon	Planting		Harvesting							Planting		Harvesting
Tobacco	Planting			Harvesting								
Forest Plantation						Planting						
Rubber Plantation	Tending			Harvesting			Planting Harvesting		Tending the newly established plantation, Harvest the mature plantation			Tending
Hunting and Trapping	***		**	*	*	*	*****			**	**	**
Firewood collection	Around the year											
NTFPs Collection	medicinal plants, honey, resin, leaves, ****			mushroom **	fruits, mushroom **	fruits **	medicinal plants, resin, leaves, fruits *****					
Demand of Labours	***	***	***	*****	*****	*****	**			*****		****

Notice: * no **low ***medium ****high ***** very high

Appendix 9. Households activities relating to forest in different wealth status

		Total	Rich	Well-off	Poor escapers	Poor
1	No of households (HHs) using fire wood	146 (90%)	7 (54%)	11 (92%)	19 (76%)	109 (97%)
	-average		3	1.92	2.30	1.89
2	No of HHs are in need of woods for house repair	115 (71%)	7 (54%)	11 (92%)	14 (56%)	83 (74%)
	-average		4.4	5.0	2	2
3	No of HHs are in need of woods for animal shelter	59 (36%)	5 (38%)	4 (33%)	10 (40%)	40 (36%)
	-average		2	0.7	0.6	1
4	No of HHs are having upland farming	78 (48%)	10 (77%)	7 (58%)	17 (68%)	44 (39%)
5	No of HHs used to have upland farming	40 (25%)	1 (8%)	3 (25%)	3 (12%)	33 (29%)
6	No of HHs wanting to expand their agricultural land	102 (63%)	10 (77%)	7 (58%)	22 (88%)	63 (56%)
7	No of HHs wanting to buy agricultural land	49 (31%)	3 (23%)	4 (33%)	7 (28%)	35 (31%)
8	No of HHs used to have agriculture land in the Park	11 (7%)	2 (15%)		3 (12%)	6 (5%)
9	No of HHs are having agriculture land in the Park	44 (27%)	4 (31%)	10 (83%)	7 (28%)	23 (21%)
10	No of HHs used to cut trees in the national park	71 (44%)	1 (8%)	2 (17%)	10 (40%)	58 (52%)
11	No of HHs used to hunt or set trap	76 (48%)	5 (38%)	12 (100%)	13 (52%)	46 (41%)
12	No of HHs told that illegal cuttings were still happening	121 (74%)		12 (100%)		109 (97%)
13	No of HHs told that that illegal hunting and trapping were still happening	122 (75%)		1 (8%)	22 (88%)	99 (83%)
14	No of HHs were fined by forest rangers	16 (10%)	1 (8%)		1 (4%)	14 (13%)

Appendix 10. List of medicinal plants collected by villagers in the National Park

	Common names	Scientific names
1	Bach Dong	<i>Calotropis gigantea</i> (Linn) R. Br. (Asclepidaceae)
2	Bach Bo	<i>Stemona tuberosa</i> Lour. (Stemonaceae)
3	Binh Linh	<i>Vitex pubescens</i> (Verbenaceae)
4	Bi Bai	<i>Evodia lepta</i> (Spreng.) Merr. (Rutaceae)
5	Bo Huc	NI
6	Bo Cong Anh	<i>Lactuca indica</i> L. (Asteraceae)
7	Bua	<i>Garcinia oblongifolia</i> Champ (Guttiferae)
8	Cam Thao Nam	<i>Scoparia dulcis</i> L. (Scrophulariaceae)
9	Can xen	<i>Xanthophyllum</i> sp. (Xanthophyllaceae)
10	Cat Canh	<i>Platycodon grandiflorum</i> A. DC. (Campanulaceae)
11	Cat Loi	<i>Costus speciosus</i> (Costaceae)
12	Ca Duoi	<i>Streblus asper</i> Lour. (Moraceae)
13	Ca Dam	<i>Mitrogyna diversifolia</i> (G. Dan) Havil (Rubiaceae)
14	Cau Dang	<i>Uncaria rhynchophylla</i> (Miq.) Jacks. (Rubiaceae)
15	Cay Cay	<i>Irvingia malayana</i> Oliv. ex Benn. (Simarubaceae)
16	Chanh Rung	<i>Citrus limonia</i> Osbeck (Rutaceae)
17	Chap choa	<i>Beilschmiedia sphaerocarpa</i> Lec. (Lauraceae)
18	Chieu Lieu (Kha Tu)	<i>Terminalia chebula</i> Retz. (Combretaceae)
19	Chum Bao Lon	<i>Hydnocarpus anthelmintica</i> Pierre (Flacourtiaceae)
20	Chum Goi	<i>Hoya oblongacutifolia</i> Cost. (Asclepiadaceae)
21	Chum Hoi	<i>Micromelum falcatum</i> (Lour.) (Rutaceae)
22	Chum Moi	<i>Antidesma buniis</i> Spreng. (Euphorbiaceae)
23	Co Hoi	<i>Eupatorium odoratum</i> (Asteraceae)
24	Co May	<i>Chrysopogon aciculatus</i> (Retz.) Trin. (Poaceae)
25	Co Muc	<i>Eclipta alba</i> (L.) Hassk. (Asteraceae)
26	Co My	<i>Pennisetum polystachyon</i> (L.) Schult (Poaceae)
27	Co Tranh	<i>Imperata cylindrica</i> (L.) Beauv. (Gramineae)
28	Co Xuoc (Nguu Tat)	<i>Achyranthes bidentata</i> Blume (Amaranthaceae)
29	Cong Cong	NI
30	Cu Den Long (Cay Thuoc Moi)	<i>Croton poilanei</i> Gagnep (Euphorbiaceae)
31	Cu Den (Cu Lan)	<i>Croton budopensis</i> Gagnep. (Euphorbiaceae)
32	Cut Cu (Rung Ruc)	<i>Berchemia lineata</i> (L.) DC. (Rhamnaceae)
33	Co Xen 3 Lá	NI
34	Danh Danh	<i>Gardenia jasminoides</i> Ellis (Rubiaceae)
35	Day Ba Benh	<i>Eurycoma longifolia</i> Jack (Simarubaceae)
36	Day Bung	<i>Crateva</i> sp. (Capparaceae)
37	Day Buom	NI
38	Day Bong Bong	<i>Lygodium flexuosum</i> (L.) Sw. (Lygodiaceae)
	Common names	Scientific names

39	Day Cam	<i>Sarcolobus globosus</i> Wall (Asclepiadaceae)
40	Day Chieu	<i>Tetracera scandens</i> L. (<i>T. loureiri</i>) (Dilleniaceae)
41	Day Che Long	<i>Symplocos Racemosa</i> Roxb (Symplocaceae)
42	Dây Co Bong	NI
43	Day Coc (Day Ky Ninh, Sot Ret)	<i>Menispermum crispum</i> L. (Menispermaceae)
44	Day Co Rua	<i>Derris elliptica</i> (Sw.) Benth (Fabaceae)
45	Day Cu Chi	<i>Strychnos nux- vomica</i> L. (Loganiaceae)
46	Day Cut Ngua	<i>Albizzia turgida</i> Merr.ex Chun (Mimosaceae)
47	Day Cut Qua	<i>Gymnopetalum cochichinense</i> Kurze (Cucurbitaceae)
48	Day Dau Xuong	<i>Tinospora sinensis</i> Merr. (Menispermaceae)
49	Day Do Trong	<i>Eucominia ulmoides</i> Oliv. (Eucommiaceae)
50	Day Gam	<i>Gnetum montanum</i> Mgf. (Gnetaceae)
51	Day Guoi	<i>Willughbeia cochinchinensis</i> Pierre (Apocynaceae)
52	Day Dac	<i>Tetrastigma strumarium</i> (Planch) Gagnep (Vitaceae)
53	Day Kim Cang (Tho Phuc Linh)	<i>Smilax china</i> L. (Liliaceae)
54	Day Kim Luong	NI
55	Day Hoang Ba	<i>Phellodendron amurense</i> Rupr var. <i>sachalinense</i> F. Schmidt (Rutaceae)
56	Day Huyet Rong	NI
57	Day Huyet	NI
58	Day Huyet Dang	<i>Sargentodoxa cuneata</i> (Olivier) Rehder et E.H. Wilson (Lardizabalaceae)
59	Day Hoang Dang	<i>Fibraurea tinctoria</i> Lour. (Menispermaceae)
60	Day Linh (Day A Rac, Day Tim)	NI
61	Day Mam	NI
62	Day O Qua	NI
63	Day Quan Mao	NI
64	Day Ran Bay	<i>Polypodium fortunei</i> O. Kuntze (Polypodiaceae)
65	Day Guoi	<i>Willughbeia cochinchinensis</i> Pierre (Apocynaceae)
66	Day Rom	NI
67	Day Song Ran	<i>Acacia pennata</i> (L.) Willd (Mimosaceae)
68	Day To Hong	<i>Cassytha filiformis</i> L. (Lauraceae)
69	Day Trung Quan	<i>Ancistrocladus extensus</i> Wall (Ancistrocladaceae)
70	Day Vu Bo	<i>Ficus heterophyllus</i> L. (Moraceae)
71	Dau Dat	NI
72	Dau Rai Trang	<i>Dipterocarpus alatus</i> Roxb (Dipterocarpaceae)
73	Dua Gai	<i>Pandanus tectorius</i> Sol. <i>P. Odoratissimus</i> L. (Pandanaceae)
74	Duoi	<i>Streblus asper</i> Lour (Moraceae)
75	Dia Lien	<i>Kaempferia galanga</i> C. (Zingiberaceae)
76	Doc Cho	<i>Ficus heterophyllus</i> L. (Moraceae)
77	Dung Dinh	<i>Caryota</i> sp. (Palmeae)
78	Gam Do	NI
	Common names	Scientific names

79	Gao Long	<i>Sarcocephalus cordatus</i> Miq. (Rubiaceae)
80	Gao Vang	<i>Neonauclea sessilifolia</i> Merr. (Rubiaceae)
81	Gang Gai	<i>Gardenia tomentosa</i> Wall (Rubiaceae)
82	Gang Tu Hu	<i>Randia dumetorum</i> Lam. (Rubiaceae)
83	Giang Huong	<i>Pterocarpus pedatus</i> Pierre (Papilionaceae)
84	Gung	<i>Zingiber</i> sp. (Zingiberaceae)
85	Ha Thu O	<i>Apocynum juvenas</i> Lour. (Asclepiadaceae)
86	Hau Phac	<i>Magnolia officinalis</i> Rehd. et Wils (Magnoliaceae)
87	Huynh ky Nam	NI
88	Ke Huyet dang	<i>Mucuna birdwoodiana</i> Jutcher (Fabaceae)
89	Kim Vang	<i>Barleria lupulina</i> Lindley (Acanthaceae)
90	Kim Tien Thao	<i>Desmodium styracifolium</i> (Osb.) Merr. (Fabaceae)
91	Ke Dau Ngua	<i>Xanthium strumarium</i> L. Compositae (Asteraceae)
92	Lau	<i>Psychotria montana</i> Bl. (Rubiaceae)
93	La Lot	<i>Piper lolot</i> C. DC. (Piperaceae)
94	La Dong	<i>Phrynium parviflorum</i> Roxb (Marantaceae)
95	Lim	<i>Erythrophloeum fordii</i> Oliv. (Caesalpiniaceae) <i>Eichhornia crassipes</i> (Maret.) Solms. (Pontederiaceae)
96	Luc Binh	
97	Long Mang	<i>Pterospermum heterophyllum</i> Hance (Sterculiaceae)
98	Ma Tien	<i>Strychnos nux-vomica</i> L. (Loganiaceae)
99	Mac Co	<i>Mimosa pudica</i> L. (Mimosaceae)
100	Mo Cua (Sua)	<i>Alstonia scholaris</i> (L.) R. Br. (Apocynaceae)
101	Mo Vang	NI
102	Mong Bo	<i>Bauhinia monandra</i> Kurz. (Fabaceae) <i>Melastoma saigonense</i> (Kuntze) Merr. (Melastomaceae)
103	Mua Long	
104	Muong Trau	<i>Cassia alata</i> L. (Caesalpinaceae)
105	Muop Rung	<i>Hodgsonia macrocarpa</i> (Blume) Cogn. (Curcubitaceae)
106	Nap Binh	<i>Nepenthes mirabilis</i> (Lour.) Bruce (Nepenthaceae)
107	Nganh nhanh (Do Ngon)	<i>Cratoxylon Prunifolium</i> Dyer (Hypericaceae)
108	Ngai Den	NI
109	Nhau Go	<i>Morinda citrifolia</i> L. (Rubiaceae)
110	Nhau Nuoc	<i>Morinda persicaefolia</i> Ham. (Rubiaceae)
111	Nhan Den	NI
112	No (Bong No)	<i>Fluggea virosa</i> Roxb. ex Willd (Euphorbiaceae)
113	Nhan Chai	NI
114	Nhan Long	<i>Passiflora foetida</i> L. (Passifloraceae)
115	Phen Den	<i>Phyllanthus reticulatus</i> Poir. (Euphorbiaceae)
116	Ot Rung	<i>Capsicum annuum</i> L (Solanaceae)
117	O Duoc	<i>Lindera myrrha</i> (Lour) Merr. (Lauraceae)
118	Rieng Rung	<i>Alpinia conchigera</i> Griff (Zingiberaceae)
	Common names	Scientific names
119	Sam Cat (Day Xanh, Xanh Cat	<i>Milletia Speciosa</i> Champ (Papilionaceae)

120	Sam Dat	<i>Boerhavia repens</i> L. (Nyctaginaceae)
121	Sam Lang	NI
122	Sam Cau (Ban Long Sam)	<i>Spiranthes sinensis</i> (Pers.) Ames (Orchidaceae)
123	Sam Mem	NI
124	Sam Nhon (Tho Cao ly sam)	<i>Talinum crassifolium</i> Willd. (Portulacaceae)
125	Sam Nam	<i>Boerhaavia repens</i> L. (Nyctaginaceae)
126	Sai Ho Nam	<i>Pluchea pteropoda</i> Hemsl. (Asteraceae)
127	Sim	<i>Rhodomyrtus tomentosa</i> Wight. (Myrtaceae)
128	Sang Da	<i>Canescens</i> Lour. (Myrtaceae)
129	So Dat	<i>Dillenia hookeri</i> Pierre (Dilleniaceae)
130	Sung	<i>Ficus glomerata</i> Roxb. var. <i>Chittagong</i> (Miq) King (Moraceae)
131	Tai Nghe (Vo Dut)	<i>Hymenodictyon excelsum</i> Wall (Rubiaceae)
132	Tam Lanh	NI <i>Rhamnus crenatus</i> Sieb. et Zucc. var. <i>cambodianus</i> Tard (Rhamnaceae)
133	Tao Rung	
134	Thanh Nganh	<i>Cratoxylon prunifolium</i> Dyer (Hypericaceae)
135	Thuoc Doi	<i>Pouzolzia zeylanica</i> (L.) Benn (Urticaceae)
136	Trau Ba	<i>Scindapsus</i> sp. (Araceae)
137	Trau Rung	<i>Piper bettle</i> L. (Piperaceae)
138	Trai	<i>Fagraea fragans</i> Roxb. (Loganiaceae)
139	Tre	<i>Bambusa</i> sp. (Poaceae)
140	Truong	<i>Pometia pinnataa</i> (Sapindaceae)
141	Trang Bong Trang	<i>Psychotria reevesii</i> Wall. (Rubiaceae)
142	Tu Hu Cay	<i>Canthium parvifolium</i> Roxb (Rubiaceae)
143	Xa Can (Re Quat)	<i>Pardanthus sinensis</i> Ker. (Iridaceae)
144	Xich Dong Nam (Mo Do)	<i>Cleradendron infortunatum</i> (Verbenaceae)
145	Bach Dong Nu	<i>Cleradendron squamatum</i> (Verbenaceae)
146	Xam Loc	NI
147	Xuong Dung	NI
148	Vong Nem	<i>Erythrina indica</i> Lamk (Fabaceae)
149	Tai Chua	<i>Garcinia pedunculata</i> Roxb. (Guttiferae)

NI: not identified

Appendix 11. Medicinal plants density

Variables	Frequency
No of plots	
>50%	8
25% - 50%	18
<25%	104
Density (plants/plot)	
30-40	1
20-<30	0
10-<20	4
>1-<10	57
1	68
Density (plants/ha)	
>900	1
400-500	1
>100	3
80-100	6
60-<80	10
40-<60	20
20-<40	89

Appendix 12. Forest categories in Lo Go–Xa Mat National Park (adapted to HCMC SFIPI, 2003)

IIIA2: Medium forest

Natural forest with medium volume was harvested many times and become multi-layer forest. The canopy is dominant by *Dipterocarpus sp.* There is still abundance of species in other layers. The forest height is about 14-16cm, average diameter is about 25-30cm and average wood stock is about 136m³/ha.

III A1: Poor forest

Exhausted and multi-layer natural forests with low wood stock. Due to over-exploitation, the canopy was broken with *Dipterocarpus alatus*, *D.costata*., *Lagerstroemia sp.*, *Anisoptera costata*, *Heritiera cochinchinensis* and *Vitex pubescens*. The forest height is about 12-14m, average diameter is about 18-20cm, average tree density is about 400-500 tree/ha, average wood stock is about 78-85m³/ha.

II B Regenerating forest

Regenerating multi-layer forest with most trees occupy in the medium layer of 8-10cm. The canopy is thin with *Syzygium sp.*, *Dipterocarpus sp.*, *Vitex pubescens*, *Pterospermumheterophyllum*. Average height is about 11-12.5, average height of the main tree layer is about 8-9m, is about 15-17cm, tree density is about 500-600 trees/ha, average wood stock is about 30-40m³/ha. Number of regenerating seedlings is about 3000-5000 seedlings/ha

IIA: Regenerating forest

Regenerating multi-layer forest, most trees occupy the medium layer. The canopy is thin with *Dipterocarpus sp.*, *Syzygium sp.*, *Vitex pubescens*, *Hymenodictyon excelsum*, *Cratoxylon sp.*, *Pterospermum heterophyllum* at the height of 8-9m. There are scattered trees at the height 30-40m out of the canopy but they are often in low economic value such as *Irvingia malayana*, *Lagerstroemia sp.*, and *Anisoptera costata*. Average height is about 10-11m, average diameter is about 10-12m, tree density is about 400-600 trees/ha, average wood stock is about 20-22m³/ha.

RIIA: Deciduous regenerating forest

Open regenerating forests with low density, dominant trees are *Dipterocarpus obtusifolius*. They also appear along inundated grasslands such as Tan Thanh (Tan Binh), Ba Su, Ba Diec (Hoa Hiep). Average height is about 6-9m, average diameter is about 8-15m, tree density is about 200-400 trees/ha and average wood stock is about 16m³/ha. These forests are considered having low economic value but they have extremely high value in the aspects of environmental protection and landscape.

IA

Bare land with scattered scrubs, regenerating from damaged and fired forest with fast growing and shade intolerant species which have low economic value such as *Cratoxylon sp.*, *Peltophorum pterocarpum*, *Grewia sp.* and the ground is covered by *Imperata cylindrica*, *Pennisetum polystachyon*.

IB

Bare land with scattered scrubs on former fallows with *Cratoxylon sp.*, *Hymenodictyon excelsum* and *Syzygium sp.*

IC

Bare land with scattered trees from overexploited natural forests or former fallows with fast growing and shade intolerant species such as *Syzygium sp.*, *Cratoxylon sp.*, and *Grewia sp.* with scrubs and grasses such as *Rhodamnia dumetorum*, *Melastoma saigonense*, *Imperata cylindrica*. Regeneration is rather high

IA-TR

Seasonally inundated grassland with *Fimbristylis miliacea*, *Imperata cylindrica*, *Syzygium sp.*, *Cratoxylon sp.*, and *Peltophorum pterocarpum*.

Notes

1. Programme 327 is a Government-sponsored programme that started in 1993 and terminated in 1998, aiming to re-green baren land and hills. It included protection of existing forest areas, natural regeneration and forest plantations. forest;aquaculture, resettlement and new economic zones. Endorsed by The Prime Minister Decision 661/QĐ-TTg (1998), The Programme of Five Million Hectares of Reforestation is a continuation of Programme 327 on the objectives, tasks policies and organisations for the establishment of 5 million hectares of new forests as well as for the protection of the existing forests (Wunder *et al.* 2005).
2. Following Decision No. 91/2002/QĐ-TTg of the Prime Minister issued on 12 July 2002.
3. Lowland habitat types include lowland semi-evergreen forest, lowland deciduous forest and lowland evergreen forest (Le & Tran 2000).
4. The Eastern Indochina Moist Forests Ecoregion (EIMFE) is situated within Vietnam, Laos, Campuchia and Thailand. The natural vegetation of the Eastern Indochina Moist Forests Ecoregion is characterized by evergreen forest and semi-deciduous forest. The total area of the ecoregion in Vietnam is 2.9 million ha, including 789,000 ha of natural forest. (Wege *et al.* 1999, cited in Le & Tran 2000).
5. According to Decision No 170/2005/QĐ-TTg of The Prime Minister of Vietnam, dated 8 July 2005, the national poverty line of Vietnam defines the poor in rural areas are people with income less than 200,000VND/month (Vietnam Government 2005)
6. They included:
 - Relevant Provincial Departments of Tay Ninh province: Agriculture and Rural Development, Forest Protection (and its sub-divisions), Environmental and Natural Resources, Technology and Sciences, Veterans and Social Affaires, Statistics Office, Health service, Education and Training, Transportation Service, Information and Culture, Trade and Tourism ...)
 - Tay Ninh Electricity Company, the National Park Lo Go-Xa Mat.
 - The local authorities of Tan Bien district, Tan Binh, Hoa Hiep, Thanh Tay, Tan Lap communes and selected villages in the study.
 - The Institute of Forest Inventory and Planning, the Institute of Agriculture Planning and Projects.
 - Different libraries (Tay Ninh Libraries, Library of HCMC University of Agriculture and Forestry).
 - Websites of The Ministry of Agriculture and Rural Development, of The Central Department of Forest Protection, and of some international NGOs in Forest Conservation: IUCN Vietnam, BirdLife International Vietnam Programme, WWF Indochina programme.
 - Non-Government Organizations (NGOs) such as Women Associations, Farmer Associations at provincial, district, commune and village level.
7. Information collected in literature review:
 - Geography, topography, hydrology (information, maps)

- Demography: population (age, sex, birth and death rate, ethnics, religions, standard of education, rate of illiteracy, unemployment and poverty).
 - Infrastructure (road, irrigation system, electricity and water supply, health and education centers, post and communication, markets, cultural places...)
 - Services (health, education, entertainment, farming, agriculture extension...)
 - Organizations systems.
 - Custom and tradition
 - Existing policy in rural development and forest conservation (poverty reduction, land tenure reform, forest allocation, fiscal and taxation policy, good governance...).
 - Projects in poverty reduction and rural development, their effectiveness.
 - Other social resources.
 - Land-use change in the buffer zone
 - History, biodiversity values and conservation issues of Lo Go - Xa Mat National Park.
 - Awareness, attitude and behaviors in connection with biodiversity resources and use
 - Records of local violations on forest resources in the NP including records of confiscated forest products and wildlife at local forest rangers.
 - Data on wildlife populations and their decrease
 - Information on medicinal plants in the National Park.
8. PRA is the common technique to study local livelihoods and assess their impact on tropical forest from the rural people. It is based on the principle that local people are creative and capable to do their own investigations, analysis, and planning. The basic concept of PRA is to learn from rural people. PRA closely involve villagers and local officials in the process (Chamber 1980).
9. Main livelihoods, poverty status, policy and programs of rural development, forest policy and management, forest violation cases and existing human threats to local forest biodiversity.
10. Average distances from residential areas in Thanh Tay, Hoa Hiep, Tan Lap, Tan Binh communes to the nearest forest in The National Park are 9km, 5km, 4 km and 3km, respectively.
11. Tan Lap, Tan Binh communes are considered the two communes of high levels of forest violation cases to The National Park. Hoa Hiep is at the level somewhat high and Thanh Tan is at low levels (Tan Bien Sub-Department of Forest Protection 2006).
12. Classification categories of houses:
- Class II: houses with concrete foundation and frame, brick walls, concrete/metal/tile roof, flowered brick/enamel floor, ceiling, complete and painted front, relatively completed systems of electricity and water supply, bathroom with ashlar walls and flush toilet.
 - Class III: houses with stone and brick foundation, concrete/brick frame, brick walls, metal/tile roof, flowered brick/enamel floor, ceiling, complete and painted front, indoor bathroom and toilet.

- Class IV: houses with stone and brick foundation, brick frame and walls, metal/tile roof, cement/flowered brick floor, ceiling, and lime-washed front.
 - Temporary house: houses structured by thatch, bamboo, leaves, wood or brick wall without cement cover, no ceiling, and floor with samel brick or cement (Tay Ninh Department of Construction 2006).
13. When estimating poverty worldwide, the same reference poverty line has to be used, and expressed in a common unit across countries. Therefore, for the purpose of global aggregation and comparison, the World Bank uses reference lines set at \$1 and \$2 per day (more precisely \$1.08 and \$2.15 in 1993 Purchasing Power Parity terms). It has been estimated that in 2001, 1.1 billion people had consumption levels below \$1 a day and 2.7 billion lived on less than \$2 a day. These figures are lower than earlier estimates, indicating that some progress has taken place, but they still remain too high in terms of human suffering, and much more remains to be done (WB 2007).
 14. Rapid survey conducted in 2000 by Forest Inventory and Planning Institute in cooperation with Birdlife International, Operational Management Plan for Lo Go Xa Mat National Park, Tay Ninh Province, Viet Nam 2004-2008 prepared by BirdLife International in Vietnam (2004)
 15. Intermediate zones are the areas between urban and forested area where forest extraction is supplementary source of livelihoods and forest activities oriented towards established markets and urban demand (Wiersum 2007)
 16. Production functions are functions based on the provision by nature of a variety of resources such as food/agriculture, fish, energy,...Regulation functions are functions provided by the capacity of ecosystems to regulate essential ecological processes and life support systems such as climate, habitat for birds, animals, storage, pollution...Carrier functions (habitat functions) are functions provided by ecosystems through space and a suitable substrate or medium for the systems itself as well as for many human activities. Examples of carrier functions are drinking, recreation...). Information functions are functions which do not involve a physically measurable effect or output from an ecosystem but contribute to human well being by their importance for religion, culture or individual well-being. Examples are cultural or artistic information, educational and scientific information, aesthetic, spiritual, (Lette 2007).
 17. The indirect use value includes the benefits derived basically from functional services that the environment provides to support production and consumption. Environmental resources often provide value without being consumed, traded in the market place, or reflected in national income accounts. These values correspond to regulation and carrier functions. The intrinsic value or existence value is the value attached to nature by people without considering benefits or use of it. The character and magnitude of the existence value is determined by religious and cultural perspective. Peoples may find satisfaction in knowing that certain ecosystems or species exist, even though they do not intend to visit or otherwise use these ecosystems or species. The existence value is connected to the information functions of nature (Lette 2007).