Thi Phuong Mai Nguyen

Local People´s Demand for Forest Ecosystem Services and Drivers of Change in Vo Nhai District, Northern Vietnam

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Dissertation

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By

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Dedicated to

My parents, my husband and my son

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Summary

Originally defined as "*the benefits people obtain from ecosystems*" by The Millennium Ecosystem Assessment in 2003 based on Daily (1997) and Costanza et al (1997), ecosystem services (ES) includes provisioning services, regulating services, supporting services and cultural services. The ES concept was considered to be a mainstream in natural management at all levels of decision-making and it was applied in forest management in some countries. In Vietnam, ES related researches and programs have increased only during the recent five years, most of them focusing primarily on the evaluation of some marketable goods that can undergo economic assessments. The non-marketable values of ES and the social and cultural factors behind, receive inadequate attention.

From the framework of Ecosystem services and the context in Vietnam, the present study focuses on local people´s demands for forest ecosystem services (FES) and on drivers of changes that impact the forest - local people relationship in the Nghinh Tuong and Vu Chan communes, northern Vietnam. The research aims at identifying the local FES demand and the drivers of changes to support and optimize forest management and policy decision-making at the local scale. The demand of local people for FES refers to what they want and need (could be accessible or not due to some reasons) from local forests to serve their life. The requirements for forests depend on local social and cultural characteristics that may change over time by the changes in socio-economic development and management policies. FES supply assessment will based on the satisfaction of local people for these FES and their perception of ecosystem changes over time to refer the match or mismatch between supply and demand at the research area.

After finding FES relevance and indicators for FES and drivers of change, both qualitative and quantitative data were collected through group interviews, household survey, individual expert interviews; and observations. The study showed the local people´s demand for FES at current time and their demand change over time. They have high demands of water supply, construction wood and fire wood. The FES supply, followed their assessment, has been reduced although supply of some FES still meet the local demand like water supply, medicinal plants and some non-timber forest products (NTFPs). FPES usages between communes or between the poor and the non-poor are not much different. In contrast, a Dao family consumes fewer wood for construction and fuel wood than a Tay family, while it require more NTFPs than the Tay. The forests have more effects on the local cultures, but forest cultural services received inadequate attention from local people. The research also indicated the mismatch between the local people demands and the governmental demands at national and local scale for FES.

Regarding to indirect drivers of change, government policies of forestry and rural development have great impacts on the forest ecosystems. People´s awareness, which influenced by their social-economic backgrounds, also have effected on forest use and protection. Additionally, economic development and some social factors such as population growth, local customary and labour allocation were considered as internal indirect drivers of changes in the research areas. Besides all these mentioned endogenous drivers, external demands create pressure on forest resources rather than internal demand for some NTFPs.

From the findings, the research gave some recommendations that are followed three major issues (decision making, forestry economic development and local awareness improvement of FES) for sustainable forest management at local scale.

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Abbreviations

ES:	Ecosystem Services
FES:	Forest Ecosystem Serivces
FPES:	Forest Provisioning Ecosystem Services
MA:	Milliennium Ecosystem Assessment
NTFP:	Non-timber forest product
TS-PH:	Than Sa - Phuong Hoang Natural Conservation Area
TSPHMB:	Management board of Than Sa - Phuong Hoang natural conservation area

CHAPTER 1: INTRODUCTION

1.1. Forests and forest management in Vietnam

1.1.1. Current state of forests

Vietnam is situated along the eastern coast of the Indochina Peninsula in Southeast Asia with the territory of 330 972 km^2 (FAO 2014; World Bank 2016). On the map, Vietnam is an S-shaped strip of land, elongating 1650 kilometres from the northernmost point to the southernmost point. The country's diverse topography consists of hills, mountains, deltas, the coastline and the continental shelf, reflecting the long history of geology and topography formation in a monsoon, humid climate with strong weather exposure.

For forest management, forests in Vietnam are classified according to forest functions: production, protection, and special-use, as defined by the 1991 Forest Protection and Development Law. *Production forests* are used mainly for production and trading of wood, non-timber forest products, and for purposes of protection and regulation. *Protection forests* are used primarily for protection of ecosystem services, natural disasters prevention, and environmental protection. Unlike production or protection forests, *special-use forests* are designated to the goals of nature conservation, the protection of historical and cultural relics, and environmental protection. (The criteria of this classification are shown in appendix 4).

In 2014, Vietnam had 13.8 million hectares of classified forests including over 6.7 million hectares of production forests (approximately 49%), 4.56 million hectares of protection forests (33%), and about 2.1 million hectares of special - use forests (15%) (MARD 2015) (table 1.1). The national territory under forest cover increased from 27.8% in 1990 (Vu et al. 2011) to over 40% at current time (MARD 2015) as a result of the expansion of forest plantations and regeneration forests in the past two decades (de Queiroz et al. 2013). However, most of this area is plantation forests accounting for about 26.8% of forestry land. Natural forest rehabilitation has grown rather slowly (Vu et al. 2011). Indeed, "natural forests" occupy 73.2% of the total forest cover, but mostly are naturally regenerated forests rather than pristine forests. Primary forests are estimated to represented just 1% of the total forest cover (de Queiroz et al. 2013). Nonetheless, Vietnam has established 128 protected areas accounting for 11.7% of the total forest area. There are 30 national parks, 60 nature reserves and 38 landscape protection areas in the special use forest system (FSIV 2009).

Table 1.1: Forest composition in Vietnam, 2014, by type and use category (in ha)

Forest land type	Total	By use category			
		Special-use	Protection	Production	Other
A. Natural forest	**10 100 186**	**2 008 254**	**3 938 689**	**4 059 302**	**93 941**
1. Timber forests	8 305 870	1 603 909	3 196 969	3 435 391	69 601
2. Bamboo forest	397 199	46 095	115 094	231 395	4 615
3. Mixed forest	658 294	136 398	210 097	303 964	7 790
4. Mangrove	33 441	973	30 985	1 325	157
5. Limestone forest	705 426	220 878	385 544	87 226	11 777
B. Plantation forest	**3 696 302**	**76 878**	**625 848**	**2 692 621**	**300 973**
1. Stocked forest[b]	2 034 212	56 206	412 352	1 416 555	148 098
2. Unstocked forest[c]	1 047 297	13 800	146 629	813 019	73 850
3. Bamboo	99 360	200	7 308	90 935	917
4. Industrial trees (e.g. rubber)	464 390	2 900	34 513	350 039	76 939
5. Mangrove	51 061	3 772	24 047	22 073	1 170
Total	**13 796 506**	**2 085 132**	**4 564 537**	**6 751 923**	**394 914**

a. With hardwood forest stock (diameter of breast height ≥ 10 m^3/ha)

b. With hardwood forest stock (diameter of breast height ≥ 10 m^3/ha)

(Source: (MARD 2015)

The biodiversity of the Vietnam ´s forests is ranked very high, both in the region and worldwide due to the geographic position, the complicated topography and climate condition (Vu et al. 2011; de Queiroz et al. 2013). The biodiversity in Vietnam´s forests includes the variety of natural forest ecosystems and their diversified composition of plant and animal species. In terms of flora, the abundance of plant species has created great economic and scientific values with hundreds of trees for commercial timber production; at least 40 bamboo species having commercial value; and there are thousands of herbal plants and hundreds of discovered species for producing myrrh, tannin and oil (MARD 2006; Vu et al. 2011). Regarding the fauna, Vietnam´s forests have quite rich species compositions and a high level of endemism compared to neighbour countries (Vu et al. 2011). Besides their diversified species, Vietnam´s forests do also have diversified forest ecologies. Following their ecological characteristics, natural forests are classified into eight major forest groups (MARD 2006), including (1) Evergreen closed tropical rain forest, (2) Semi-deciduous closed tropical humid forest, (3) Evergreen broad leaved forests on limestone, (4) Natural needle leaved forests, (5) Dry dipterocarp forests, (6) Mangrove forests, (7) Melaleuca cajuput, and (8) Bamboo forests (Vu et al. 2011).

1.1.2. Forest management system in Vietnam

Administratively, the forest management system in Vietnam is stratified into four levels, which are (1) central/national level, (2) provincial level, (3) district level, (4) commune level (see table 1.2). The tasks of government agencies and ministries in these different levels are regulated in a legal framework defined by Decree 23/2006/NĐ-CP. Tran et al. (2005) showed two basic kinds of institutions in the management system "*directing organizations*" and "*implementing organizations*". The directing organizations establish general or on-paper plans while the implementing organizations including professional or special institutions practice the plans that the directing organizations appointed. It means that at the same level of the management system, the directing organizations have a slightly higher position and direct the implementing organizations. All administrative levels are under the control of the state (directing organizations).

Table 1.2: Different organizations of Vietnam´s foresttry and forest land management system

Level	"*Directing organizations*"	"*Implementing Organisation*"
The 1st level: Center	Government and National Assembly	Ministry of Agriculture and Rural Development (MARD) Director General of the Vietnam Forestry Administration (VNFOREST) Ministry of Natural Resources and Environment (MONRE)
The 2nd level: Province	Provincial People´s Committee (PPC)	Department of Agriculture and Rural Development (DARD) *Division of Forest Protection* *Division of Forests* Department of Natural Resources and Environment (DONRE)
The 3rd level: District	District People´s Committee (DPC)	Forest Protection Station Division of Agriculture and Rural Development Division of Natural Resources and Environment
The 4th level: Commune	Commune People´s Committee (CPC)	Forestry and Agricultural staff Land management staff

(Source: Tran et al. 2005; Pham et al. 2011)

Below the commune level is the informal system of villages or hamlets that combine households in a single village which are led by the heads of the villages who are important connectors between national laws and existing customary law. The local organizations (such as associations of farmers, veterans, women, elderly, youth, etc.), groups of local households, particular households and individuals are the forestland recipients and directly work on protecting, conserving, and developing the allocated forests (Tran et al. 2005).

1.1.3. Forest development in Vietnam

Vietnam is a repository of global biodiversity, but also still contributes to the heavy losses of biodiversity that are caused by illegal trade and consumption of wildlife as well as forest degradation. To respond to the forest degradation and the serious decreases of forest cover to the lowest level in 1990, the Government has paid much attention to the development of forest resources and biodiversity conservation since then. Besides restricting the forestry sector, a series of laws and legal documents was promulgated relating to forest management and development, in which the Government gave high priority to forest rehabilitation. Vietnam also participates in most international agreements and conventions relevant to biodiversity and tropical forest conservation.

Concurrently with the efforts to develop forests and forestry, the Government focused on the socio-economic development for mountain communities, especially minority ethnic people, whose livelihoods depend on the forests and whose living standards are low. The policies of forest land allocation have given the rights of decision and management to local people motivating forest owners to use forest land in a sustainable way, increase forest-related income and support environment protection (Bui 2006). Land allocation also contributed to the sedentary livelihood for shifting farmers and reduced slash and burn forests for cultivation (Castella et al. 2006). Vietnam has received many financial and scientific supports from international and non-government organization for the conservation of biodiversity and forests (de Jong et al. 2006; Vu et al. 2011), of which, the protected area system has received the majority of investment (Vu et al. 2011).

1.2. Mountain forests and their relevance for local people

1.2.1. Mountainous areas and people in Vietnam

Vietnam has 63 provinces and cities, 19 of which are highland and mountainous provinces and other 23 provinces have mountains (CEMA 1998). Mountain areas occupy three quarters of Vietnam´s territory. The Northern Mountains include the Northeast region, formed primarily by uplifted limestone ranging in altitudes, from 300 to 700 meters and the Northwest complex, dominated by the steep topography of the Hoang Lien mountain range, with the highest point, Fan Si Pan (3143m). The Truong Son range runs along the country's western border with Laos. Its complex geology gives rise to a diverse landscape and ranges mostly between 500 and 1500 meters. The Central Highlands, also known as *Tây Nguyên*, consist primarily of a series of plateaus and hills ranging in elevation from 500 meters to 1500 meters. These mountainous areas that comprise 90% of national forest land, over 70% of plants and animals species and over 90% of precious species, provide water, hydraulic power, timber, fuel wood, wild species, medicinal plants and many minerals for the whole country (Vo 2001; Vu 2001).

Mountainous areas are also the habitats of about 25 million people (Le 2001). More than 10 million mountainous residents (over 13%) are estimated to be ethnic minorities, representing 75% of the 53 ethnic minorities population in Vietnam (World Bank 2009). Living in complicated and diversified terrains, the mountainous population in Vietnam has some main features of residential distribution. Ethnic diversity is usual in many mountainous communes or districts (Le 2001; Ngo 2001). Mixed ethnic residence creates cultural exchanges and influences. However, each ethnic has developed in specific geographic areas. For example, *Viet Bac* (in the Northeast) is the residential place of the Tay and the Nung; The Central Highland is the main habitat of the Kho Me and the Nam Dao. Another important feature of ethnic people´s distribution is that the development of each ethnic group is related to determined ecological spaces, called "*ethnical ecology*" (*sinh thái tộc người*) (Ngo 2001). Certain minorities, like the Tay, the Thai, the Nung, and the Muong in particular, more commonly live in the valleys within the mountain areas, and thus, have greater access to flat land and to reliable water supply. Other groups, such as the Mong and the Dao in particular, are often associated with higher altitudes and more mountainous slopes (Le 2001; Ngo 2001; World Bank 2009).

Distribution of many minority ethnic groups and sub-groups with their specific social and cultural features adapting to their natural living environments creates cultural diversity for mountainous areas in Vietnam. Cultural variety is represented through traditional social structures (like family, lineage and parentage, village, cultural landscape, etc.), physical and spiritual life, languages, traditional knowledge, adaptive strategies, social institutions, ethical norms and beliefs (Ngo 2001). The culture differences between ethnic groups create also the differences in economic development and integration (Le 2001). Some ethnic groups (especially groups of less than 1000 people) still depend on self-sufficient cultivation methods while some others adapted to new developments as in the lowland areas.

1.2.2. Forest dependency

There is rich evidence in the literature concerning the relations between forests and people. The forests provide multiple products and benefits such as land for cultivation, food, materials, medicine, etc., which are important for day-to-day living. Humans, especial forest people, exploit these products to meet essential parts of their nutritional, energy, and primary health needs and use them in different ways such as direct consumption, inputs for agricultural production, and materials for house construction. Doubtlessly, the forest is a key element of the habitat and of the social and cultural structure of those living within it. For example, the Khasis in India consider forests and every part of their natural produces as the central place into the sanctum of the Khasi religious rites, rituals and social ceremony besides being useful in their daily needs (Shangpliang 2010). Thus, the forest is also a dominant factor that shapes the physical

materials, the economic circumtances, and the spiritual life of the people who are living in or close to it. Vice versa, local people´s culture have powerful influence on forests and forestry development as well (Jamieson et al. 1998; Le 1999; Rambo and Tran 2001; Vuong 2012).

The existence of productive edible and medicinal species in the forests is a pillar for human health protection. Forest foods are additional nutrient sources of diets or do meet dietary shortfalls during particular seasons and during emergency periods such as floods, famines, droughts or wars (Byron and Arnold 1999). In the process of adaptation and independence on forests for sustenance since a long time, indigenous people have accumulated a wealth of indigenous knowledge. The Yanomami in Brazil, as a good example, shares extensive ethno-botanical knowledge of forest species and their uses for food, drugs, body adornment, constructions, etc. (Milliken et al. 1999). The ethnic people in Vietnam's mountainous areas also own a treasure-trove of local knowledge, in which knowledge of medicinal plants and traditional disease treatment is the most conspicuous.

The forest-people relations are usually manifested in human´s dependence on the forests which differs among forest users based on the engagement of forests and their communities (Byron and Arnold 1999). The forest dependency ranges from choices of economics (for both livelihood and income) (Sato 2000) to non-monetary benefits (cultural or spiritual elements) (Byron and Arnold 1999). The dependency levels reply on different factors that are usually interlinked, such as the ability of accessing markets or forests; the wealth of households (poor or non-poor); good roads; etc. One evidence is that poor people depend more on forest products as a source of income than others, because they have limited opportunities (land, capital, accessibility) to generate income and secure food (Sato 2000; Kalaba et al. 2013a).

1.2.3. Forests and local peoples´ livelihood

Forest resources are essential for the livelihood of people in rural mountainous areas. Hunting and gathering forest fauna and flora as a food source are basic livelihood strategies for populations living within forests like the Yanomami in the Brazilian Amazon (Milliken et al. 1999) or the Khasis in India (Shangpliang 2010, 2013) that have retained predominantly subsistence and self-reliant ways of life. Shifting cultivation in the cleared forest and the bush fallow has been recognized as a basic transition of forest-dependant livelihoods (Sunderlin et al. 2005), supplemented by gathering and hunting (Byron and Arnold 1999). Forests also generate income for local households from selling forest products. About 200 million people in the Asia-Pacific region are estimated to depend on NTFPs for their income and subsistence needs, including medicine, food, fuel and construction materials (FAO 2010). Forest-related income may contribute considerably to the total income of households, like in Stung Treng province, Cambodia (Bühler et al.

2015) or in Chilimo, Ethiopia (Mamo et al. 2007). According to the Forestry Science Institute of Vietnam (FSIV), forest-related income accounted for 10-20% of the total income of rural households in 2009, most of them belonging to ethnic minorities. Income from NTFP may also reduce idiosyncratic shocks and seasonal food stresses for rural households in Miambo, Zambia (Kalaba et al. 2013a, 2013b). By functioning as a source of livelihood diversification, forests help has contributed considerably in poverty reduction (Wunder 2001; Sunderlin and Huynh 2005; Sunderlin et al. 2005; Mamo et al. 2007; Lee et al. 2009; World Bank 2012).

1.2.4. Forests and the poor

In the tropics, extensive forest areas often coincide geographically with the large number of poor people that depend on forests for their livelihoods (Wunder 2001). Vietnam is not an exception concerning this correspondence between the poverty at district level and areas of remaining natural forests (Sunderlin and Huynh 2005). The mountain areas are living places of most poor people in Vietnam with high poverty proportion. The people here are facing many difficulties of households´ economic development. Household´s income from forest products are low because the private-managed forests are just small area and have not much valuable forest products. Other activities like forest protection contracts and plantation of commercial forests, etc. have not produced considerable income for the mountainous people in compared with agricultural cultivation (Sunderlin and Huynh 2005). Only adequate benefits will motivate the local people to protect and develop the forests.

However, the lifestyle based on the forest exploitation of many indigenous people has been formed since a long time. This lifestyle can only meet the people´s demands as long as the natural resources are plentiful. If they get scare, due to internal or external increase of demands, this will easily become "*poverty trap*" perpetuated by "*nature-dependant-thinking*" of mountainous residents, which is still quite popular in many upland and remote areas in Vietnam (Vuong 2012).

1.2.5. General socio-economic development in mountainous area

In general, the socio-economic conditions in Vietnam´s mountainous areas have been developed considerably in recent years; however, they still lag behind other regions. The share of agriculture and forestry still dominates the economic structure in rural mountainous areas (Chu 2001; GSO 2012). Agriculture and forestry are considered to be important sectors in mountainous areas, however sustainability of these economic sectors has strong interrelations with the forest resources that are being degraded and the environment dependence of people (Chu 2001). Vietnam has achieved remarkable economic growth and poverty reduction during the past two decades (World Bank 2012), however, the number of poor households in highland areas is still high and based mainly

on ethnic minorities (ADB 2006). Constituting less than 15% of the total national population, ethnic minority people in Vietnam represented 47% of the total poor and 68% of the extreme poor in 2010 (World Bank 2012).

Infrastructure improvements as a result of the 135[1] program and the program of Hunger Eradication and Poverty Reduction investments opened access to social services and markets for the mountainous people, especially ethnic minorities in geographically remote areas (World Bank 2009). The expansion of road systems, electricity network, healthcare system, and schooling has dramatically increased the number of ethnic households with access of these services. The development of rural infrastructure created favourable conditions for facilitating production, accessing outside markets, attracting investors to mountain areas and resolving many social and economic issues. However, there are still many villages and communities where roads, electricity and schooling has not yet reached. While nationally more than 95% of the rural villages had access to the electricity grid in 2011, only 89.19% of the rural villages in the Northern Mountains did (GSO 2012).

1.3. The ecosystem service concept and its application

While most ecological researches focused on the natural ecosystems without explicit attention to human impacts on the biotic world (Liu 2001), like other living organisms, *Homo sapiens* has to be considered as part of the global ecosystems and has - directly or indirectly - affected almost every corner of the earth, through various activities (Liu 2001; MA 2005d; Liu et al. 2007). Humans have always extracted and benefited from ecosystems, using water, food, medicines, and materials etc. for their living. They developed techniques and mechanisms to adjust to specific ecosystem conditions. On the other hand, they influenced and changed site conditions and processes of nature that they depend on. While human demands for natural resources grew, and human technologies to exploit them improved, human interventions tended to reduce or threaten the capability of ecosystems to meet all these demands (MA 2005b).

People and their surrounding natural environment interact reciprocally and form complex feedback loops (Liu et al. 2007). In the human - nature relationship, both human and nature do adapt or re-adapt to their mutual changes. Thus, it is necessary to study not only the biosphere and physical environments, but to include human societies with their direct and indirect impacts (Rambo 1980) in order to clarify the human - ecosystem interactions and to manage the social-ecological systems sustainably.

During the past two decades and based on conceptualizing *ecosystem services* (ES) by researchers like Costanza et al. 1997; Daily 1997; Shelton et al. 2001; Nasi et al. 2002

[1] Program of socio-economic development for difficult minority ethnics and mountain areas

and others, the significance of ecosystems for human well-being has gained rapidly increasing political and scientific attention. The Millennium Ecosystem Assessment (MA), a scientific program commissioned by the United Nations in 2001, involve over 1300 experts from 95 countries (Fisher et al. 2009; Meijaard et al. 2011). Originally defined as "*the benefits people obtain from ecosystems*" (MA 2003 based on Daily 1997 and Costanza et al (1997)), ES includes provisioning services such as food and water; regulating services such as regulation of floods, drought, land degradation and disease; supporting services such as soil formation and nutrient cycling; and cultural services such as recreational, spiritual, religious and other nonmaterial benefits (figure 1.2). In this respect, the concept offers a framework for considering the provision of life-support and life-fulfilment to people by nature (Cork et al. 2001). Since then the term "ecosystem service" has been used, discussed, completed and redefined with an exponential increase in scientific paper (Fisher et al. 2009).

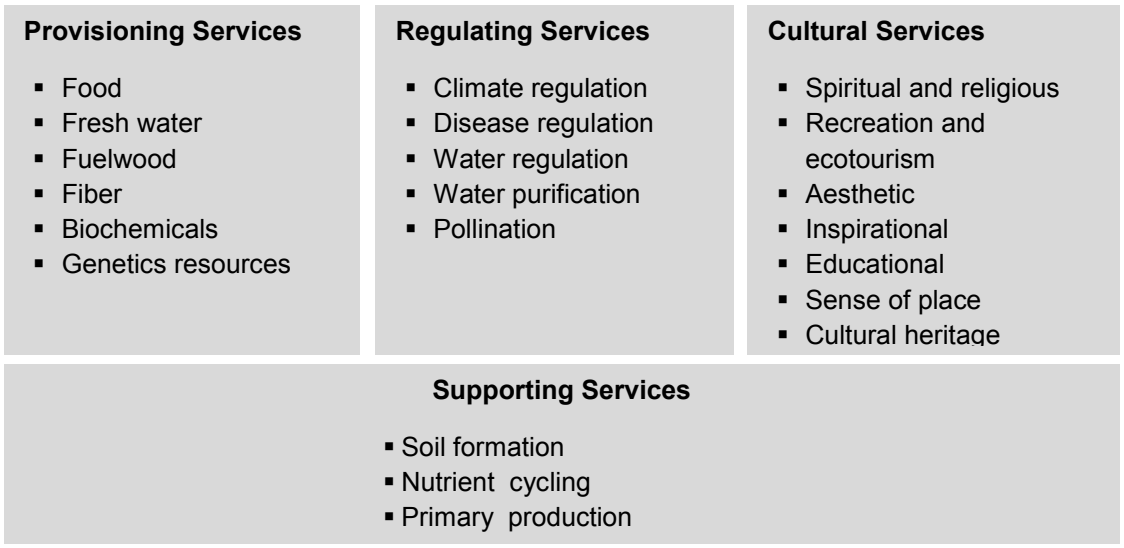


Figure 1.1: Ecosystem services categories (Source: MA 2003)

In any case, the ES conceptual framework emphasizes the linkage between ecosystems and humans, in which human well-being is at the centre focus concerning the assessment of ecosystem services and benefits. Thus, the ES conceptual framework emphasizes on:

- Ecosystem´s functioning and use potential (ES supply)
- ES demand and access of different stakeholders
- Realised benefits and respective beneficiaries
- Impacts of human activities on ecosystems and ecosystem change
- Direct and indirect drivers of change concerning natural conditions, ecosystems, landscapes etc.
- Relevance of ecosystem changes for people and societies
- Spatial localisation and illustration of ecosystem services supply, demand and flow on different scales or for different ecosystem types

A multiple assessment of the human-ecosystem interactions may:

(1) demonstrate the relevance of ecosystems and their biodiversity for the quality of human life
(2) improve the awareness of the dependence of humans on nature and
(3) illustrate the importance for nature protection and sustainable use.

Identifying the relevant services provided by an ecosystem in a specific place and assessing both, their economic and non-economic values illustrates the importance of ecosystem for human well-being. Simultaneously, it contributes to raising human awareness of the human-nature reliance. Increased public awareness and appreciation of ES may also have the potential to change consumption patterns and the kind and quantity of goods and services demanded (Patterson and Coelho 2009). The evaluation and assessment of ecosystem services could also help to enhance sustainable management and conservation or acquire budgets from payments for ecosystem services (PES). PES are an attempt to harness market forces to provide ecosystem services, which is viewed as an innovative approach towards improving natural resource management and providing opportunities for enhancing incomes and livelihoods (Suhardiman et al. 2013).

The ES framework further pays attention to the direct and indirect drivers of changes in ecosystems to show that ecosystem protection and sustainable use are essential to maintain their potential and provide welfare on the long-term. By considering the dynamic interactions between people and ecosystems and understanding the causes of changes, the ES conceptual framework may provide essential decision-making support at all levels (Everard 2009; Lara et al. 2009; Smith et al. 2011) and lead to suitable strategies and interventions for sustaining ecosystem services for human well-being.

Due to all these advantages, the ES concept has been proposed or even launched as a meaningful framework for future natural resource management in many countries. For example, ecosystem services are supposed to provide useful information and to be relevant for policy and decision-making regarding forest conservation and management in Chile (Nahuelhual et al. 2007; Lara et al. 2009). The Australian Ecosystem Services Project applied the concept of ES on management of natural resources. From identifying the ES around Australia and analysing the ecological, social and economic problems and opportunities, innovative ways are explored to encourage investment in the full range of services for maintaining them (Cork et al. 2001). Incorporating the concept and language of ES in the US national forest management involves implementing a comprehensive strategy for evaluating, describing, and monitoring the outcomes of management over time and communicating it to the public (Kline and Mazzotta 2012). According to Smith et al. (2011), articulating forest service management objectives and accomplishments in terms of ecosystem services marks a shift in perspective and could provide the necessary information for forest managers to set of management activities to manage the ecological

functions and processes in addition to outputs. In so far, the ES framework is considered as a tool for guiding forest management, and better illustrate the concept for policymakers, managers, and potential national forest partners (Kline et al. 2013)

1.4. Ecosystem service - related researches in Vietnam

Human-ecology relations have been concerned in Vietnam since the late 1980s through the application of human ecology theory as a powerful conceptual framework for researches of tropical agroforestry ecosystems (e.g. Rambo 1980, 1983; Cuc et al. 1990; Jamieson et al. 1998) and rural resource systems analysis (Jamieson et al. 1998). Human ecology is based on the assumption that there are systemic relations between human society (the social system) and the natural environment (the ecosystem). These relations involve the ability of humans to obtain needed resources as well as the environmental impacts generated by human activities.

Recognizing the roles of forests and their biodiversity for human life, Vietnam has substantially increased its efforts in natural conservation has and thus received many supports and donations from international organizations. Despite increasing national and international attention, biodiversity in Vietnam still faces threats from deforestation and illegal trading. In 2007, a conference on: “Biodiversity and Human well-being”, held by The Centre for Natural Resources and Environmental Studies (CRES), Vietnam National University, assembled scientists from northern Vietnam to discuss current issues of biodiversity as well as appreciate its relevance for human well-being.

To respond to global climate changes and forest degradation, Vietnam is one of the first countries piloting the Reducing Emissions from Deforestation and Forest Degradation program of the United Nations REDD and the REDD+ scheme, which continues expanding with enhancement of forest carbon stocks in developing countries. REDD+ activities are incorporated into forestry strategies. They are expected to provide financial incentives for environmental protection and to ensure co-benefits, such as poverty reduction, when combined with other Payment for Ecosystem Services (PES) schemes (Pham et al. 2011b).

Vu (2006) mentioned the following environmental values and key ecosystem services of forests for Vietnam: watershed protection; biodiversity conservation; carbon sequestration and climate regulation; recreation and landscape amenity. Their option and existence values are represented by willingness to pay for ecosystem services. He also suggested that developing payment mechanisms would create an outlook for the management of forest environmental services. Payment for forest ecosystem services (PFES) has been developed since 2007 when Vietnam had chosen to develop a respective pilot project in two provinces, namely Lam Dong in the Central Highland and Son La in the North Mountains, funded by the United State Agency for International

Development (USAID). The payments were collected from hydroelectric power plants and water supply plants. It revealed that there are some shortcomings in the implementation process and benefit sharing mechanism (Hoang et al. 2008; Jourdain et al. 2009; Nguyen et al. 2013; Pham et al. 2013; Suhardiman et al. 2013), while the positive results from the pilot project show the possibility of implementing the program in more than 20 provinces. The payment scheme has been complimented and expanded to other ecosystems such as mangrove (see Kuenzer and Tuan 2013; McDonough et al. 2014; Orchard et al. 2015), marine and coastal (see Brown et al. 2008); while the program shall include other industries, such as ecotourism (Hoang et al. 2008). Overall, PES is considered as a potential economic tool and policy to raise financial supports for ecological restoration and conservation as well as local people´s livelihood improvement. The Vietnamese Law of Biodiversity 2008 also mentions to these proceeds from biodiversity-based environmental services.

In addition, some further ES-related programs and scientific conferences have been activated just recently. The “Forest Certification of ES” project (ForCes) valued provisioning and regulating services in the Quang Tri and Ha Tinh provinces. SNV - Netherlands Development Organisation is the implementing partner for these two project sites over four years (2011 - 2015). The Southeast Asia regional training worked on the Economic of Ecosystems and Biodiversity on March 29-30, 2012 in Tam Dao; and the project of “Integration of ES in the process of decision making” was implemented by Institute of Strategy and Policy on Natural Resource and Environment (ISPONRE) for mangrove ecosystems in the Ca Mau province in 2011- 2014. This project is part of the “Project for Ecosystem Services” (ProEcoServ) launched in 2010 by the United Nations Environment Programme (UNEP) with funding from the Global Environment Facility (GEF). It is a global, four-year initiative that is researching how to integrate ecosystem assessment, scenario development and economic valuation of ecosystem services into national sustainable development planning, and decision-making. Integrating ES in mangrove management and conservation shall create chances for better generating and maintaining benefits of this ecosystem. It will also designs strategies of sustainable mangrove ecosystem management and conservation avoiding the cost caused by the losses of biodiversity and mangrove ecosystem services (Kim 2014). In April 2013, the Ministry of Natural Resources and Environment (MONRE) in collaboration with the People’s Committee of Ca Mau Province and World Wildlife Fund (WWF) organized the 5th Forum in “Conserving Natural and Cultural Values for Sustainable Development in the Mekong Delta Region” under the theme of “Maintaining ecosystem services in Mekong Delta”. It was part of a project to integrate ecosystem-based approaches to climate change adaption and to preserve biodiversity in Vietnam.

The trade-offs between ecosystem services and development have been discussed by some authors like (Le 2008; Hoang et al. 2009; Jourdain and Dinh 2010; Ayanu et al. 2011; Nguyen 2015) This topic was also discussed in a sub-committee on “Trade-offs

between conservation and development" in the fourth National Environment Conference in Hanoi in August 2015. Considering trade-offs between ecosystem services or between conservation and development need to be careful in decision-making to get the immediate benefits and long-term benefits.

1.5. Research motivations

The prospect of the ES concept as a mainstream in natural management at all levels of decision making has been predicted by de Groot et al (2010) and its application in forest management has been demonstrated in some countries around the world. Forest management for multiple function objectives is a current trend as a consequence of broadening social and environmental issues (Sayer et al. 2004). Besides concentrating on the integration of economic and ecological values, considering the social and cultural dimensions of ecosystem changes is essential for sustainable resource management (Burkhard et al. 2014; Retallack and Schott 2014).

The ecosystem services differ, not only between ecosystem types and locations but also vary over time (de Groot et al. 2002; Costanza 2008; Fisher et al. 2011), due to their differences in geography, relief, history and socio-economics patterns. These patterns will affect the ecosystem´s functioning and use potential (ES supply), the appreciation and valuation by surrounding communities and the nature of related management challenges (Smith et al. 2011). Thus, the services delivered depend not only on the capacity of the ecosystem but on the demand of beneficiaries also. The integration of societal needs for goods and services in management strategies reveals the full application potential of the framework (de Groot et al. 2010; Chan et al. 2012).

In Vietnam, ES related researches and programs have increased only in the recent five years, most of them focusing primarily on the evaluation of some marketable goods that can undergo economic assessments such as: wood and NTFPs provision; water supply and regulation; climate regulation such as carbon sequestration; and landscapes and amenity for tourism. The non-marketable values of ES and the social and cultural factors behind, receive inadequate concerns, although the local socio-cultural features are considered and mentioned whenever the causes of deforestation and degradation are analysed. However, looking at the interactions between mountainous communities and forest ecosystem as mentioned in section 1.2 of this chapter, studying socio-cultural impacts and benefits of local communities is essential for sustainable forest development in Vietnam.

Local people lived within the context of a particular forest ecosystems for generations, thus the respective interrelations each represent a specific case of ecosystem services - well-being relation (MA 2005b). Local communities are considered as locally focused groups of civil society and as the managers of the local common property and natural

resources. As far as they are empowered, they are beneficiaries of forests, as well as forest managers to sustain benefits at the same time (Michon 2005). On the other hand, they also have to cope with the external impacts of the global and international and local changes which sometimes mismatch with their own valuation at local scale (Sayer et al. 2004). Thus, forest management should pay attention to the local human demands for FES. To communicate the concepts at the local scale, the ES concept should adapt to the local terms and conditions (MA 2005b). In addition, internal changes at the local scale do have impacts on the ES supply. The local demand for ecosystem services is often shaped by shifting socio-economic and political trends (Grêt-Regamey et al. 2012). The demand side in the ecosystem service framework needs to be sufficiently investigated (Burkhard et al. 2014) to support policy makers to respond to the local stakeholders (Casado-Arzuaga et al. 2013)

Keeping all these consideration in mind, the presented study focuses on local people´s demands for forest ecosystem services and on drivers of changes that impact the forest - local people relationship in the Nghinh Tuong and the Vu Chan communes, as examples of two mountainous communes in the Northeast of the Vo Nhai district, Thai Nguyen province, northern Vietnam. These communes have protected forests that nowadays belong to the Than Sa - Phuong Hoang natural conservation area[2] (abbreviated TS-PH). The respective limestone forest ecosystem keeps a high level of biodiversity with many valuable species (TSPHMB 2012a; Nguyen 2014). However, the natural forests have degraded by activities of the communities living in and near the areas like hunting, logging, and shifting cultivation (Do 2012; TSPHMB 2012b; Nguyen 2014). The indigenous population consists of Tay and Dao ethnic minorities. Since time immemorial, they have extracted forest products for their welfare and have developed their own customs. The most important forest products are timbers for construction, fuel and cultivation tools as well as various NTFPs for medicine, handicraft, food etc. Most of them are poor, while economic effectiveness from agroforestry and plantation forests is still limited. Thus, managing natural forests for biodiversity conservation as well as maintaining the forest integrity are considered as an important issue.

1.6. Research questions and objectives

Objectives

The presented study serves theoretical as well as practical goals. It focuses on the socio-cultural aspects and their assessment within the Ecosystem Services Framework. More

[2] Than Sa - Phuong Hoang nature conservation area is a forest ecosystem on limestone which includes six communes (Than Sa, Thuong Nung, Sang Moc, Vu Chan, Nghinh Tuong, Phu Thuong) and Dinh Ca town.

precisely, it aims at identifying the local FES demands and the drivers of changes to support and optimize forest management and policy decision-making at the local scale.

This includes:

- To determine the demand of local people for forest ecosystem services and their changes in demands over time.
- To reveal their assessment of recent and former forest ecosystem service supply.
- To learn about the forest ecosystem services use and linkage to the local cultures.
- To analyse driving forces that might affect the local forest ecosystem services and people demands.
- To propose recommendations for appropriate sustainable forest management that meets the FES demands of the local people while respecting binding national and international conventions and obligations.

Research questions

More specific research questions are as follows:

- What do people demand from the local forests to fulfil their welfare (including their awareness and priorities)?
- How do local people assess the capacity of the local forests to provide services and its changes?
- What kinds of factors are influencing forest ecosystem services and local people´s demands?

1.7. Research structure and contents

Making the attempt to apply the ES concept in to the assessment of local people´s demand for forest ecosystem services and of identifying drivers of change in two mountainous communes in Thai Nguyen province, northern Vietnam, this study is composed of seven chapters.

The thesis begins with *Introduction*, which presents the underlying motivation, questions and objectives of the study. The following chapter, *Literature review and conceptual framework*, gives an overview of ecosystem system services and derives the theoretical framework for the research. The chapter also discusses the ecosystem services framework more in detail considering concepts, supply and demand side, drivers of changes, indicators and the goods and services of forest ecosystems. The conceptual research framework is based on accessing theoretical of forest ecosystem services and social demand, following the research questions and propositions. Chapter 3 introduces *the research area* with general descriptions of the essential natural and social-economic features as well as the forests in the study area. Chapter 4, *Methodology*, covers the identification of relevant subservices and indicators for the research issues and the

elaboration of appropriate methodology combining quantitative and qualitative approaches for data collection and analysis.

Chapters 5 and 6 present the results of the empirical analysis at the local scale. Chapter 5, *Forest ecosystem services in the research area,* analyses and discusses the local demand for FES over time at household and community level; the FES supply assessed by local people´s perception and their satisfactions concerning the services supply; as well as the uses of some provisioning and cultural services in the areas. This chapter also discusses the match or mismatch between local demand and governmental demands inferred from policy documents at both national and local scales. Chapter 6 looks into some indirect *Drivers of changes* and their effects in the study area concerning forest ecosystem services and the local demand for these services. The final chapter, *Main results and Recommendations*, summarizes the major findings and offers some suggestions for sustainable forestry development in the research area.

CHAPTER 2: LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

2.1. Ecosystem services and human well-being

2.1.1. Concepts of ecosystem services

The term of ecosystem services was used and defined in the last decades with exponential increase of scientific papers (Fisher et al. 2009). According to documents of the Millennium Ecosystem Assessment, various scholars have developed or conceptualized ecosystem services, such as Fisher et al. 2009, Boyd & Banzhaf 2007, TEEB 2010 (see box 2.1). The conception of ecosystem services is variously worded and still being discussed with different viewpoints and arguments from ecologists and economists. In short, the ecosystem services concept comprises two main aspects, namely (1) ecosystems potiential to provide goods and services for human beings and societies, based on their functioning and (2) human needs, demands, expectations and appreciations facing these potientials and their options and assertiveness to realize them. In other words, an ecosystem contains a dynamic complex of living and the non-living components (biophysical structure) whose interactions and processes constitute the ecosystem´s functioning. Quite a substantial part of ecosystem functions and the related natural processes and components they involve determines the ecosystem services potential of the respective ecosystem (de Groot 1992). However, this potential is only acknowledged as goods and services where people can access, utilize or benefit from it directly or indirectly to satisfy their needs (Nasi et al. 2002; Fisher et al. 2009; de Groot and Van der Meer 2010; Bürger-Arndt 2012). This means that benefits are provided only by human appropriation of ecosystem services, including processes to transform raw materials into useful products (Spangenberg 2014).

Ecosystem services have been categorized in a number of different classification schemes. Norberg (1999) classified ecosystem services into three general types, based on organizational criteria namely: services related to the maintenance of population density; services related to processing and transforming of external inputs; and services related to biological organization. Wallace (2007) proposed ecosystem services classification according to human values, including adequate resources, benign physical and chemical environment, protection from predators, deseases and parasites, and sociocultural fulfilment. De Groot and his colleagues classified ecosystem services related to a range of 23 ecosystem functions into four main groups: regulation function (maintenance of essential ecological processes and life support systems), habitat function (providing suitable living space for wild plant and animal species), production function (providing natural, renewable resources), and information function (providing opportunities for cognitive development) (de Groot et al. 2002). He developed his

previous researches further and added the carrier function that provides a suitable substrate or medium for human activities and infrastructure (de Groot 2006).

Box 2.1: Ecosystem services definitions

- Ecosystem services are the conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfil human life. They maintain biodiversity and the production of ecosystem goods, such as seafood, forage timber, biomass fuels, natural fibre, and many pharmaceuticals, industrial products, and their precursors (Daily 1997)
- Ecosystem goods (such as food) and services (such as waste assimilation) represent the benefits human populations derive, directly or indirectly, from ecosystem functions (Costanza et al. 1997).
- Ecosystem services as "transformations of natural assets (soil, water, atmosphere and living organisms) into goods and other products (including experiences) that are valuable to people" (Shelton et al. 2001).
- Ecosystem services are the outcomes from ecosystem functions that benefit human beings (Nasi et al. 2002).
- Ecosystem services are the benefits people obtain from ecosystems (MA 2005d)
- Ecosystem services are the aspects of ecosystems utilized (actively or passively) to produce human well-being (Fisher et al. 2009).
- Final ecosystem services are components of nature, directly enjoyed, consumed, or used to yield human well-being (Boyd and Banzhaf 2007)
- Ecosystem services are the contributions of ecosystem structure and function - in combination with other inputs - to human well-being (Burkhard et al. 2012a)
- Ecosystem services as the direct and indirect contributions of ecosystems to human well-being (TEEB 2010).

Finally, the MA (2003) classified ecosystem services along functional lines into four categories for operational purpose, including provisioning, regulating, cultural and supporting services. This classification has been used the most popularly in recent researches with the categories being defined succinctly as:

- *Provisioning services* are the products people get from ecosystem such as food and water, fuel, fibre, genetic resources.
- *Regulating services* are the benefits obtained from regulation of ecosystem processes, including air quality maintenance, regulation of floods and drought, erosion control, disease regulation and water purification.
- *Cultural services* are non-materials benefits which people obtain from ecosystems through recreational, spiritual, religious and other nonmaterial enrichment.

- *Supporting services* are structures and processes which are necessary for the supply of all other ecosystem services, such as soil formation, nutrient cycling and primary production.

While humans can directly harvest and consume the outcome of provisioning services, regulating services, generated from ecosystem processes and functions, are considered as intermediate ecosystem services (Fisher et al. 2009; Pradhan et al. 2010). Cultural services mainly depend on social perception, cultural and moral value and available technology. Supporting services do not directly provide benefits for people but are a part of the complex mechanisms and processes that generate the other three types of services (MA 2003; Pradhan et al. 2010). These are often indirect or occur over the long-term (Washington 2012). There are relationships among ecosystem services categories (Bennett et al. 2009; Pradhan et al. 2010). Thus the changes of one service do impact on another. For example, supporting services are essential to keep an ecosystem running (Washington 2012) and provide other services whereas overexploitation of provisioning services will cause depletion of supporting services for regulating services which will affect cultural services (Pradhan et al. 2010).

2.1.2. Ecosystem services and human well-being

Human well-being has multiple constituents, many of which are provided by ecosystems. However, well-being includes components that are experienced and perceived differently across cultures and socioeconomic gradients (MA 2005b). The five key constituents of well-being are (MA 2003, 74):

- *the necessary material for a good life* (including secure and adequate livelihoods, income and assets, enough food at all times, shelter, furniture, clothing, and access to goods);
- *health* (including being strong, feeling well, and having a healthy physical environment);
- *good social relations* (including social cohesion, mutual respect, good gender and family relations, and the ability to help others and provide for children);
- *security* (including secure access to natural and other resources, safety of individuals and possessions, and living in a predictable and controllable environment with security from natural and human-made disasters);
- *freedom of choice* (including having control over what happens and being able to achieve what a person values doing or being).

Ecosystem services have recently become a key concept to understand the reciprocal interaction between humans and their natural environment. Humans do rely completely on ecologies. Although the ecosystems deliver goods and services of enormous value to human life, goods and services are not just a gift of nature. Humans have to invest labour,

time, energy, resources and often money as well to obtain the benefits for their survival and well-being (Braat 2014; Spangenberg 2014). For a basic provisioning service such as food, people have to spend time and labour in gathering, hunting or harvesting them. All cultural services involve the activity of human sensory organs and brains to absorb and process the information provided by the components, structures and dynamics of ecosystems. This is not exactly the same concerning regulating services, which work directly without human labour or perception (Braat 2014). Therefore, ecosystems do provide a high potential for services, while humans have to make their choice which services should be realized. This choice depends on the outcome of social discourses, conflicts compromises, which may change over time. Changes in the composition and functioning of ecosystems are often due to societal decision and intervention and the resultant flows of ecosystem services have effects on human well-being.

2.2. Goods and services provided by forests

Forest ecosystems do provide multiple benefits to human society, which can be direct or indirect (table 2.1). *Forest provisioning services* sustain various aspects of human well - being. Forests provide timber, fuel, energy and other NTFPs such as mushrooms, fruits, leaves, plants and animals, which are used as food, folder, medicine and raw materials. They have significances as sources of income, human health protection and cultural objects. Forest ecosystems also provide various and useful sources of genes for biotechnology. *Forest regulating services* include purification of air and fresh water; reduction of flooding, drought or soil erosion; mitigation of local and global climate changes; biological control and balances. Regulation functions of forests maintain the health of both ecosystems and human beings through regulation of essential ecological processes and life support systems. *Forest cultural services* involve aesthetic and recreational use, spiritual and religious services and cultural heritage; as such, they contribute to human mental well-being. *Forest supporting services* are not just related to the forest ecosystem´s integrity but also to the ecosystem significance to provide habitats for various stages in the life cycles of wild plants and animals. The maintenance of healthy habitats is a necessary requirement for the supply of all ecosystem goods and services, directly or indirectly.

Beside natural forests, plantation forests have increased around the world recently, supplying a considerable human demand for goods and services as well. Their main services are production of resources (e.g. round wood, fibre and raw materials) and regulation (e.g. carbon sequestration, clean water production, regulation of the hydrocarbon cycle). However, compared to natural forests, the supply of most other service is reduced (de Groot and Van der Meer 2010) (see table 2.1).

Table 2.1: Overview of forest ecosystem services and comparison between natural and plantation forests

Main category	Goods and services provided by forests	Ecological processes and/or components providing the services	Natural forest (1)	Plantation forest (2)
Provisioning services	**Food** (from harvesting forest wildlife or gathering forest products)	Presence of edible plants and animals	high	0
	Raw materials (e.g. timber, fuel)	Presence of species or abiotic components with potential use of timber, fuel and raw material	low	+
	Energy resources (e.g. fuel wood, biofuels)		medium	+
	Folder and fertilizer (e.g. leaves, other organic matter)	---	low	0
	Genetic resources (genes and genetic information used for animal and plant breeding and biotechnology)	Present species with (potentially) useful genetic material	high	-
	Natural medicines and pharmaceuticals (e.g. drugs, models, tools, essay org.)	Presence of species or abiotic components with potentially useful chemicals and/or medicinal use	medium	-
	Bio-chemicals (non-medicinal) (e.g. for dyes, biocides, food-additives)		medium	-
	Ornamental resources: wildlife used in e.g. fashion, handicraft, jewellery, worship, souvenirs, decoration, as pets and in landscaping	Presence of species or abiotic resources with ornamental use	medium	-
Regulating services	**Air quality regulation** (e.g. capturing dust particles, NO_x fixation, etc)	Capacity of ecosystems to extract aerosols and chemicals from the atmosphere	medium	-
	Climate regulation Including carbon sequestration and storage	Influence of ecosystems on local and global climate through land cover and biologically mediated processes	medium	-
	Water quality regulation (filtering of rainwater and run-off water)	Role of biota and abiotic processes in removal or breakdown of excess amounts organic matter, nutrients and polluting compounds	medium	-
	Water regulation (buffering of extremes in run-off and river discharge)	Role of forests in water infiltration and gradual release of water	medium	-
	Natural hazard regulation (reduction of storm and flood damage)	Role of forests in dampening extreme events (e.g. protection against flood damage)	low	0

Table 2.1. (Continued)

Main category	Goods and services provided by forests	Ecological processes and/or component providing the services	Natural forest (1)	Plantation forest (2)
Regulating services	**Erosion prevention** (soil retention and prevention of landslides/siltation) and **Maintenance and restoration of productive soils**	Role of vegetation and biota in soil retention	high	-
	Biological control (reduction/prevention of crop, livestock and/or human diseases by providing a barrier or habitat for control of vectors)	Control of pest populations through trophic relations; role of biota in distribution, abundance and effectiveness of pollinators	low	- -
	Pollination (providing habitat for pollinators of crops and wild plants)		high	-
Cultural services	**Aesthetic information** (non-recreational enjoyment of scenery)	Aesthetic quality of the landscape, based on e.g. structural biodiversity, "greenness", tranquillity	medium	-
	Recreation and nature-based tourism	Landscape features Attractive wildlife	medium	-
	Cultural heritage and identity (many people value a 'sense of place' which is often associated with forests)	Culturally important landscape features or species	medium	-
	Inspiration (e.g. for art, folklore, national symbols, architecture, design, advertising)	Landscape features or species with inspirational value to human arts and religious expressions	medium	-
	Spiritual and religious information (many individuals and religions attach spiritual values to forests and/or individual species)		medium	-
	Educational information (both formal and informal education in nature)	Features with special educational and scientific value/interest	medium	- -
	Science (ecosystems, incl. forests influence the type of knowledge system developed by different cultures)		medium	- -
Supporting services	**Refugium** (provide habitat for resident plants and animals and migratory species and thus contribute to maintenance of biodiversity and evolutionary processes	Importance of ecosystems to provide breeding, feeding or resting habitat to resident or migratory species (and thus maintain a certain ecological balance and evolutionary processes)	high	- - -
	Nursery (provide reproduction habitat for species with commercial value that spend their adult life elsewhere)		?	?

(1) Qualitative scales (high, medium and low) indicate relative performance of natural forests in providing services

(2) Difference in services provision between natural and plantation forests: (+) = services is enhanced, (0) = remains the same, (-) = services is reduced

(Source: de Groot and Van der Meer 2010)

2.3. Ecosystem service supply and demand

2.3.1. Ecosystem service supply

Generally, ecosystem service supply refers to the capacity of an ecosystem to provide goods and services. The capacity depends on existing ecosystem properties, processes and functions. Burkhard et al. 2012b, 2014; Albert et al. 2015 defined ecosystem service supply as *actual supply* referring to the capacity to generate *used services* in a specific area. Actual supply is distinguished from *potential supply*. *Ecosystem service potential* refers the *total capacity* for service delivery (Bastian et al. 2012; Villamagna et al. 2013). In different way, potential supply is the *hypothetical maximum yield* of selected optimized services (Burkhard et al. 2012b, 2014). Burkhard et al. 2014 argued that ecosystem potentials could be compared to natural capital stock, yielding flow of ecosystem services in the future.

Concerning the supply side, a transformation of ecosystem structures and processes into ecosystem functions has to take place to provide ecosystem services (de Groot et al. 2002; Fisher et al. 2009; Haines-Young and Potschin 2010; Müller et al. 2010). The potential service supply is based on ecological characteristics and their functionalities (Van Oudenhoven et al. 2012; Geijzendorffer et al. 2015). Consequently, ecosystem health and integrity effect ecosystem service supply (Pradhan et al. 2010). Alterations of ecological integrity caused by external drivers of change have affected ecosystem´s abilities to supply services, on which human societies depend (Geijzendorffer et al. 2015). The capacity to provide certain services may be increased or decreased depending on the forest ecosystem management and conservation. Thus, ecosystem capacity provides service potentials on the long term through sustainable ways of ecosystem use and managment (Schröter et al. 2014).

The actual generation of ecosystem service supply is not only based on the ecosystem service potential (as natural contribution) but also on human input (as anthropogenic contribution) (Albert et al. 2015). The societal demand for services and their realization converts them into real ecosystem services (Burkhard et al. 2014). Thus, a distinction between potential and actual supply is necessary to develop practically and politically relevant measures of sustainable use (Schröter et al. 2012), and support finding relevant indicators for ecosystem services (UNEP-WCMC 2009; Burkhard et al. 2014; Albert et al. 2015). However, in some cases, it is difficult to determine indicators for actual and potential supply.

2.3.2. Societal demand for ecosystem services

Demand for ecosystem services has been approached and defined differently depending on the authors (Baró et al. 2015) (see box 2.2). While Burkhard et al. (2012b) and

Geijzendorffer et al. (2015) defined societal demand for ecosystem services as actual use and consumption of ecosystem goods and services, other authors (UNEP-WCMC 2009; Villamagna et al. 2013; Schröter et al. 2014; Albert et al. 2015) stated that demand for services should be understood as the requirement or search for ecosystem goods and services no matter whether it can be satisfied or not.

Box 2.2. Definition of demand for ES

- The need for specific ecosystem services by society, particular stakeholder groups or individuals (Albert et al. 2015)
- Ecosystem goods and services currently consumed or used in a particular area over a given time period, not considering where ecosystem services actually are provided (Burkhard et al. 2012b)
- Expression of demands by stakeholders in terms of actual allocation of scarce resources (like money or time to travel) to fulfil their demand for services in a particular area and over a specific time period (Geijzendorffer et al. 2015)
- Expression of individual agent's preferences, for specific attributes of the service, such as biophysical characteristics, location and timing of availability, and associated opportunity costs of use (Schröter et al. 2014)
- The demand for a service is considered as the requirement a population has for service delivery, and is influenced by changes in economic and social circumstance (UNEP-WCMC 2009)
- The amount of a service required or desired by society (Villamagna et al. 2013)

Concerning the first way definition, demand is measured and indicated by existing consumption; considering only those cases where human demand meets service supply (Wolff et al. 2015), while the second definition keeps in mind that demand may be greater than the current ecosystem services supply or flow (Albert et al. 2015; Wolff et al. 2015), putting pressure on the respective services generation. In this respect, the second definition reflects also unsastified human desires that influence human behaviours in services utilization, consumption and generation. Therefore, it can influence to the willingness to preserve or improve services for both current and future generations (Wolff et al. 2015).

Based on the different approaches of defining ecosystem service demand, Wolff et al. (2015) classify demand into four demand types (figure 2.1). This classification supports for finding appropriate indicators and suitable methods to quantify the demand for ecosystem services. If demand for provisioning services is calculated by the direct use or consumption of goods (Burkhard et al. 2012b; Wolff et al. 2015), population sizes and average consumption rates are often combined to produce indicators (Zhao and Sander 2015). For example, the quantification of demand for energy provisioning services is based on statistical data on the energy consumption per area unit and associated with

different land cover types (Burkhard et al. 2012b; Kroll et al. 2012). Most cultural services demands are assessed based on social preferences and valuation of intangible ecosystem services (Plieninger et al. 2013; Wolff et al. 2015) or as the direct use of recreational and cultural sites (Wolff et al. 2015). Demand for regulating services is most often expressed in terms of the social desire or need to reduce and prevent risks or increase service benefits (Nedkov and Burkhard 2012; Stürck et al. 2014). The human demand can also be valued by non-monetary indicators such as people´s perception of the importance of different services (Burkhard et al. 2012b; Quintas-Soriano et al. 2014).

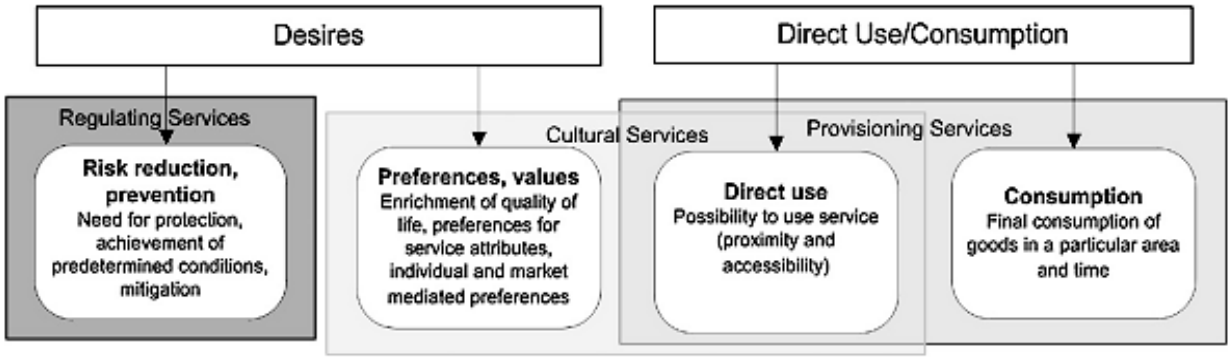


Figure 2.1: Classification of demand types (Source: Wolff et al. 2015)

However, human demands for ecosystem services do change over time (Müller et al. 2010; Villamagna et al. 2013). For example, the demand for nature has changed from basic needs, such as food, to services which improve the perceived quality of life, such as recreation, nature experience or perception of aesthetic and beautiful landscapes in Western societies (Nelson et al., 2006). The demand for ecosystem services also differs between stakeholders and thus can be a cause of conflict between different beneficiary groups (Geijzendorffer and Roche 2014). Finally, demand is also differing across service categories. For example, people in remote mountainous areas do often have high demand for forest provisioning services to elevate poverty (e.g. Sunderlin and Ba 2005; Sunderlin et al. 2005; Kalaba et al. 2013). Logging and deforestation for agriculture on upstream areas can impact on water supply and water regulation for downstream communities. These examples highlight that societal demands for ecosystem services are different at spatial scales for different ecosystem potentials (Villamagna et al. 2013; Geijzendorffer and Roche 2014; Yahdjian et al. 2015). They are driven by socio-economic conditions, demographic changes, human perceptions and technological innovations (Pradhan et al. 2010; Villamagna et al. 2013; Wolff et al. 2015). Thus, ecosystem service trade-offs should be taken into account in decision making for the sake of ecological benefit optimization and sustainable ecosystem management.

2.3.3. Supply - demand relations

Due to ecosystem supply and human demand, people access ecosystem to benefit and improve their well-being. The benefits of ecosystems do depend on both. The services and benefits that people actually receive or use in a particular area, within a given period of time are defined as *ecosystem service flow* (Villamagna et al. 2013; Burkhard et al. 2014) that integrates biophysical and beneficiary components (Villamagna et al. 2013). The actual benefits from an ecosystem service represent the match between ecosystem services supply and respective human demand (Geijzendorffer et al. 2015). However, in practice, not all human demands are fulfilled by the existing service supply. Ecosystem service demand and consumption can also be limited by accessibility (Albert et al. 2015) or by societal exclusion, or if the natural capital stock gets depleted or degraded (Burkhard et al. 2012b; Nedkov and Burkhard 2012; Villamagna et al. 2013; Schröter et al. 2014).

Ecosystem services supply and demand have got increasing attention in recent scientific researches, either separately or together, to serve for developing strategies of service management on the long term. The supply - demand relations are often visualized by mapping to demonstrate match or mismatch between the ecosystem´s capacity for services provision and the services that people desire. Mismatch occurs where the demand is not met by supply (Baró et al. 2015). Thus, supply-demand mismatch reflects the dissatisfaction of stakeholders´ demand for ecosystem services (Geijzendorffer et al. 2015). The unsatisfied demand was addressed in many research papers of ecosystem services such as Burkhard et al. 2012b; Kroll et al. 2012; Nedkov and Burkhard 2012 and Bagstad et al. 2014.

2.4. Drivers of changes

2.4.1. The MA definition and categories

The capacity to provide ecosystem services is determined by many different factors that directly or indirectly drive the ecosystem health and integrity. Changes of ecosystem services depend on changes in these factors that could be induced by natural or human impacts. The factors which are causing such changes of ecosystems and their ability to deliver services for human well-being are called *drivers of (ecosystem services) change*. Several typologies of drivers of change have been developed such as primary versus proximate, anthropogenic versus biophysical, dependent versus independent, primary versus secondary. The MA´s distinction between direct and indirect drivers of change provides one more classification and seems to be acceptable to most policy, planning and managing issues.

Direct drivers of change are human or natural - induced direct impacts on ecosystems, including climate change; land use and thus land cover changes; use of input of fertilizers and pesticides; invasive species and diseases; natural disasters etc.

Indirect drivers of change are social circumstances that influence (either encourage or discourage) human actions and impact on ecosystems including:

- Demographic (such as population size, age and gender structure, and spatial distribution);
- Economic (such as national and per capita income, macroeconomic policies, international trade, and capital flows);
- Socio-political (such as democratization, the roles of women, of civil society, and of the private sector, and international dispute mechanisms);
- Scientific and technological (such as rates of investments in research and development and the rates of adoption of new technologies, including biotechnologies and information technologies); and
- Cultural and religious (such as choices individuals make about what and how much to consume and what they value).

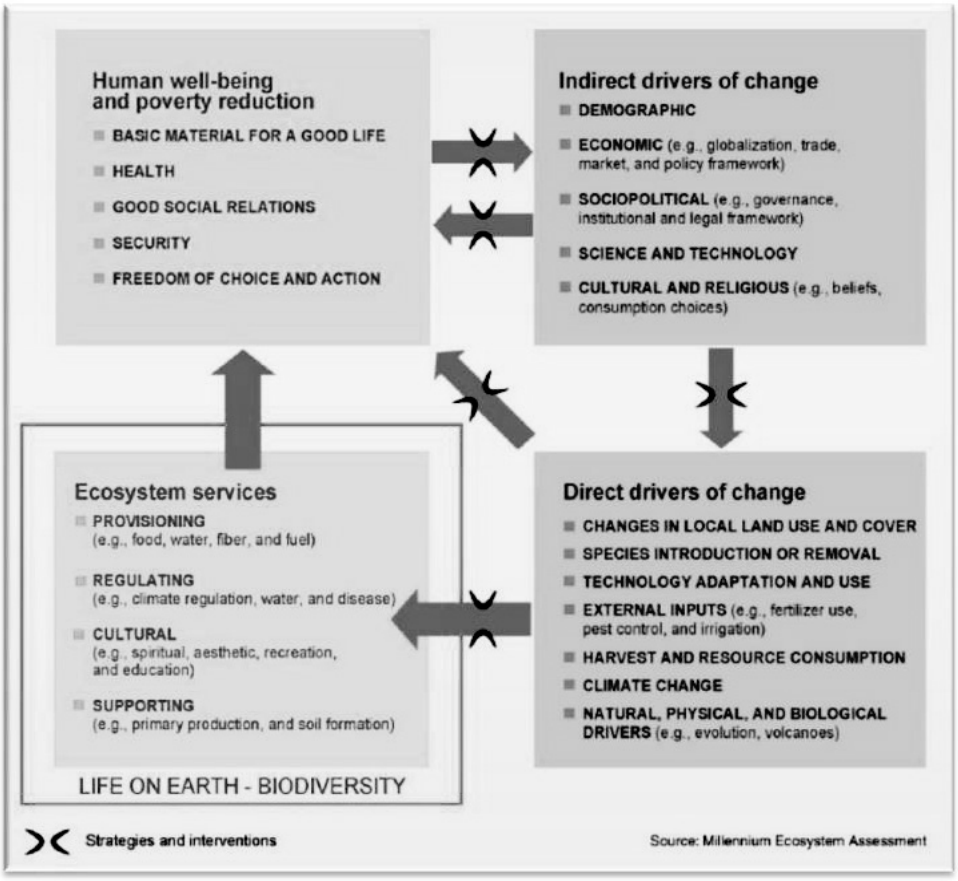


Figure 2.2: Millennium assessment conceptual framework of interactions between biodiversity, ecosystem services, human well-being and drivers of change
(Source: MA 2003)

Drivers of change do always interact across spatial and temporal or organizational levels (MA 2005a). In addition, they do not operate separately, but interact with other drivers. Therefore, the change of a single driver can effect on the others or on the entire interaction leading to unforeseen changes of ecosystem services as well as human well-being (figure 2.2). Due to population growth, for example, the higher demand for forest conversion into agriculture lands causes losses of forest ecosystem services. The human impacts on ecosystems can often be recognized at different scales, but are most obvious at the local level (MA 2003).

Understanding the drivers of changes, their origin and context, and their interactions with ecosystems is very important for decision makers and mangers (MA 2005a; Bennett et al. 2009) to design effective responses to enhance positive and minimize negative impacts. However, a full assessment of the interactions between people and ecosystems would require a rather complex multi-scale approach in order to reflect the multi-scale nature of decision-making, allow the examination of driving forces that may be exogenous or endogenous and to provide appropriate means of examining policy responses.

2.4.2. Some main drivers of changes in tropical forest ecosystems

Forest degradation and conversion to other land uses are considered as the two main processes of recent changes occurring in natural tropical forest ecosystems (MA 2005a). Based on the MA categories of drivers of changes, this part analyses more details of some main driving forces for those changes.

Indirect drivers of change in tropical forest ecosystems

Demographic factors including population size and growth, population distribution and other demographic variables such as age or gender, influence forest ecosystems in complex ways. Relations between population increase and deforestation have been demonstrated by many researches, such as Allen and Barnes (1985); Myers (1995); Angelsen and Kaimowitz (1999); or Laurance (2007). The population growth increases the consumption of food, fibre, timber, clean water, and of a wide range of forest ecosystem goods and services. Consequently, increasing the demand for food creates pressure for forest conversion to agricultural expansion (including slash and burn cultivation, permanent agriculture and livestock). While populations in tropical forest countries expanded by amounts ranging from 15 - 36% during the 1980s, deforestation reached almost 70% (Myers 1995). Due to population growth and off-farm unemployment, the surplus rural labours are available for forest extraction (Panayotou and Sungswan 1995).

Economic drivers consist of some subcategories such as economic growth, market growth and commercialization, or spatial economic structure. Since income received by individuals and families determines their level and nature of consumption (MA 2005e),

economic growth will also shape human consumption patterns. When per capita income grows, the consumption will shift from satisfaction of basic needs to improvement the quality of life. After basic food needs have been met, for example, the human desires a dietary diversity with less starchy staples (e.g. rice, wheat) and more fat, meat and fish, fruit and vegetables. However, income growth reduces the pressure on forests due to increasing off-farm employment opportunities (Angelsen and Kaimowitz 1999). In the context of market growth and commercialization, the growth of some specific sectorial production industry goes along with the increase of demand for consumer goods and services (Geist and Lambin 2001). For instance, the demand for raw materials in the wood industry sector in general and in the domestic wood consumption in particular strongly affected natural forests in Northwest Ecuador in the 1980s and 1990s (Sierra 2001). Accordingly, Angelsen and Kaimowitz (1999) argued that the market prices for agricultural products and timber have effects on deforestation. Higher prices for agricultural products could either stimulate forest clearing for cultivation or reduce deforestation because people meet their basic consumption needs. On the other hand, higher prices for timber promote deforestation by making logging more attractive (Angelsen and Kaimowitz 1999) or exacerbate illegal logging activities like they did in some Asian countries (Laurance 2007). Additionally, the increase of market accessibility, especially from rural areas to urban markets, through transport infrastructure development, influences forest resource extraction and deforestation for agricultural production (Angelsen and Kaimowitz 1999; Geist and Lambin 2001). In this respect, the spatial economic structure has also to be considered as a driving factor for deforestation apart from indebtedness, poverty or economic crisis (Geist and Lambin 2001).

Cultural factors encompass public attitudes, values and beliefs on the one hand, and individual and household behaviour on the other. Culture may influence on decision making at all levels (public or individual) that people concern or consider as important and where they suggest appropriate actions toward forest environments. Cultural factors, for example, can influence consumption behaviour (what and how people consume) and thus may be a particularly important driver of ecosystem change (MA 2005a). The public values and beliefs also shape individual and household behaviour. For example, the appreciation of sacred forests drives local people to protect them.

Technological factors are mostly related to technological applications in the wood sector and in agro-technological change. The technological development in the wood industry requires more timber materials for production, which may enhance the timber logging or conversion of poor natural forests into product oriented plantation forests. In this context the development of agricultural technologies and its impact on deforestation needs to be considered as well. The technological progress in agriculture drives the change of ecosystems and their services in two different ways. On the one hand, the increase of agriculture yields and land use intensification may reduce the pressure on the forests (Angelsen and Kaimowitz 1999; Geist and Lambin 2002). On the other hand,

technological changes can also be expected to extend forest clearance for agriculture commerce. Besides, different technological developments also determine the accessibility through the way people obtain the ecosystem services and how sustainable they use these services.

Socio-political factors include (formal and informal) policies and governance related to forests and forestry development, economic development (agriculture, agroforestry, land use, or infrastructure), finance, investment, trade, or population policies (migration or resettlement).

Direct drivers of change in tropical forest ecosystems

This part considers the human-induced factors that directly cause deforestation and forest degradation, in which changes of forest covers are key driving forces. Changes of land use cover are mostly due to human activities or immediate actions at the local level that affect forest covers by agricultural expansion, wood extraction, or infrastructure extension.

Agricultural expansion is the main direct driver that causes deforestation in many tropical countries (accounting up to 96% of the case studies presented by Geist and Lambin 2002). Agriculture expansion includes shifting cultivation, permanent agriculture intensification for either subsistence or commercial purposes, creation of grazing land. Quite commonly, it may follow indirect drivers of change like population growth and migration or targeted programmes which aim at converting forests to agriculture or timber plantations. In Asia, shifting cultivation with slash and burn accelerated deforestation considerably in the 1980s (Myers 1995) and more widespread than in Afica and Lantin America (Geist and Lambin 2002).

Wood extraction includes commercial extraction, round wood logging for construction, fuel wood gathering for both domestic and industrial uses. Illegal logging is also a major concern in many tropical countries (MA 2005a).

Infrastructure extension, particularly road extension, was found to be a direct driver of deforestation in many case studies (Geist and Lambin 2002).

Forest plantation, besides all above mentioned drivers, can cause forest cover change as well as species introduction. Plantation forests (including species mixture and monoculture) have often been introduced for restoration of the productive capacity of the land (Lamb 1998) and to improve the ecosystem service production (de Groot and Van der Meer 2010). Although forest plantation does little to recover biological diversity, it allows for some of the former forest species and yields the timber need if indigenous species and species mixtures are used (Lamb 1998). However, the introduction of exotic species for economic purposes causes considerable changes in the services supply potentials of the ecosystems.

2.5. Ecosystem service indicators

In order to assess services and benefits of an ecosystem on the local scale, it is necessary to compile and rate indicators, which provide insight into the specific conditions, trends and changes of the respective ecosystems, their services and human well-being (MA 2005a). Ecosystem service indicators are defined as “information that efficiently communicate the characteristics and trends of ecosystem services” (Layke 2009). They are very practical items expected to provide quantitative information via relatively simple measures and quantifiable variables (Jørgensen et al. 2013). Therefore, ecosystem service indicators can be used to show positive or negative changes (Dandeneau 2008) or to monitor the progress of ecosystem services provision (van Oudenhoven et al. 2012). Based on the provided information, decision-makers and managers can identify, prioritise and execute the intervention to sustain the ecosystem (Layke 2009; TEEB 2009; UNEP-WCMC 2009a).

Indicators are not new to policy-makers, however, ES indicators were scarce (UNEP-WCMC 2009) and have been developed from indicators of other related fields such as biodiversity, ecology, climatology, and from economic sectors like forestry, agriculture, and fishery (Layke 2009). Since the publication of the MA, scientists and policy-makers have attempted to develop ecosystem service indicators proceeding from the Convention of Biological Diversity as well as the Millennium Ecosystem Assessment (TEEB 2010a).

When some ES can not be measured directly or are difficult to monitor, or when sufficient data is not available, it may become necessary to use proxy indicators (Layke 2009; Burkhard et al. 2014). A proxy indicator, also named an indirect or secondary indicator (Egoh et al. 2012), can be understood as an indicator that indirectly measures one aspect and provides sufficient information to allow the assessment of that aspect. In the context of cultural ecosystem services, for example, proxy indicators like land cover, visitor numbers or to the accessibility to a natural site are commonly used (Egoh et al. 2012). The number of people visiting a natural site is supposed to be a proxy measure for spiritual services, although the number of visitors does not the directly measure the spiritual benefits people get from an ecosystem (Layke 2009). Economic losses associated with natural disasters are another example of proxy indicator that provides an insight into regulating services. Proxy indicators can provide similar information for evaluators to assess a given interest. Thus they have been used as a common approach to ecosystem service assessment (Seppelt et al. 2011).

The process of indicator finding is flexible but consistent depending upon some criteria such as: the framework and management purposes (Müller and Burkhard 2012; Van Oudenhoven et al. 2012), the characteristics of the investigated ecosystem (MA 2005b; Müller and Burkhard 2012), the ability to convey information, data quality and availability (Layke 2009; TEEB 2010a; Layke et al. 2012). The Economics of Ecosystem and Biodiversity (TEEB), for example, focuses on the economic consequences of biodiversity

changes, so their indicators were converted into economic terms and suitable for economic analysis (TEEB 2010a). Numerous recent studies have placed on monetary and biophysical values to assess on ecosystem services, categorical indicators were frequently used as well (Seppelt et al. 2011; Egoh et al. 2012). The workshop on ES indicators, involving 16 experts from all over the world in the fields of indicators and ecosystem services, reviewed and further developed a framework and established a set of ecosystem service indicators following the 5-step classification (condition-function-service-benefit-impact) (UNEP-WCMC 2010). The indicators in the Sub-Global Assessment (SGAs) Reports have been assessed by ecosystem services types (provisioning, regulating, cultural and supporting services) and it has then been identified whether they represented ecosystem services supply or demand (UNEP-WCMC 2009). Developing ES indicator sets that considerate supply-demand relations allow for the best description of gains and losses in human well-being (Albert et al. 2015). In turned out that provisioning service indicators were dominated by those that indicate the supply of a service while cultural service indicators include many that reflect the demand for a service rather than the overall total supply.

Layke et al. (2012) found out that indicators of benefits that people actually received (flow of ecosystem services) are more common than indicators of the capacity of the ecosystem to provide services (stock of an ecosystem). While the flow indicators demonstrate how effectively the contribution of an ecosystem is to human welfare, the stock indicators measure the ecosystem condition to continue providing services. Both stock and flow indicators are needed in decision-making (Layke et al. 2012). However, the measurement of ecosystem service flows is challenging (UNEP-WCMC 2010).

The flow of many of the provisioning ecosystem services, such as timber provision from a stock of trees in a forest, can relatively easy be measured (Burkhard et al. 2014), whereas identifying relevant indicators and getting data for regulating services, for cultural and for supporting services is increasingly challenging (Layke 2009; UNEP-WCMC 2010; Burkhard et al. 2014). This can be explained by the clear and immediate contribution of many provisioning services to people. This led to a long history of measuring, communicating and trading such services, which is why respective data are readily available and easily quantified. Moreover, many regulating and cultural services are intangible, and strongly correlated with the perception of people (UNEP-WCMC 2009; Layke et al. 2012). Thus, definitions and robust measurements of the importance of these services have been recognized as elusive (Hernández-Morcillo et al. 2013).

The assessments of some cultural services, such as aesthetic and spiritual services, rely on descriptive information rather than on quantitative data and the services are experienced differently across cultures and individuals (UNEP-WCMC 2009). Recreation and tourism services, for example, may depend on a large collection of indicators because they can be attributed to existing markets. Regulation services, that are traded

or objects of government regulations are better supported by indicator findings than those which are not (Layke 2009). Climate regulation, as an example, is indicated and avaluated by willingness to pay for the benefits. Supporting services received the least attention within four the ES categories which can be explained by the lack of information about primary indicators.

According to Layke et al. (2012), the main limitations for using ES indicators are:

1. The overall ability of indicators to convey information is low. This ability varies widely among services, but is consistent across scales.
2. The indicators available for most ecosystem services are insufficient to communicate the quality and quantity of benefits provided by many ecosystem services completely.
3. Data limitations make it difficult to apply ecosystem services indicators.
4. Indicators for regulating and cultural services lag behind those for provisioning services in each of the limitations identified above.

2.6. Conceptual framework and process of the research

2.6.1. Conceptual research framework

The generation of ecosystem services has been structured and described as a cascade, connecting ecosystems, their structures, processes and biodiversity with specific relevant functions and human individuals social groups and societies by providing benefits according to their needs and values (figure 2.4). The ecosystem structures and processes stipulate the specific functions of an ecosystem. These functions present a potential that humans find useful and mobilize it to contribute to their life, such as cleaning the air or mitigating climate change. The ecosystem services provide benefits resulting in socio-cultural or economical welfare, such as health, employment and income (Van Oudenhoven et al. 2012).The value of ecosystem services is determined depending on the benefits people get from the ecosystem. In so far, what is to be an ecosystem service depends on human desires or needs and their activity to appropriate or obtain. Therefore, the determination of benefits and beneficiaries will help to determine the service.

It can be seen in the cascade illustration that - per definition - ecosystem services do not exist isolated from people´s needs (Haines-Young and Potschin 2010) but are components, or better to say interfaces of the social - environmental system (Müller et al. 2010). This mutual rather than mono-directional interrelation between ecosystem conditions and human society requirements has been emphasized by Bürger-Arndt (2012) (figure 2.5). The ecosystem services are derived due to the ecological functioning (natural side or supply side) and human demand and accessibilities (societal side or demand side). The changes of the social side drive the changes of the ecosystem side

(Pradhan et al. 2010) and vice versa. Due to population growth, for example, increase of human demands for forestry lands causes decrease of forests and loss of habitats of some species. Consequently, this change will affect ecosystem service supply to fulfil human demand. Understanding the linkages of services supply and social demands for ecosystem services and their changes is necessary to apply the ES concept to ecosystem management.

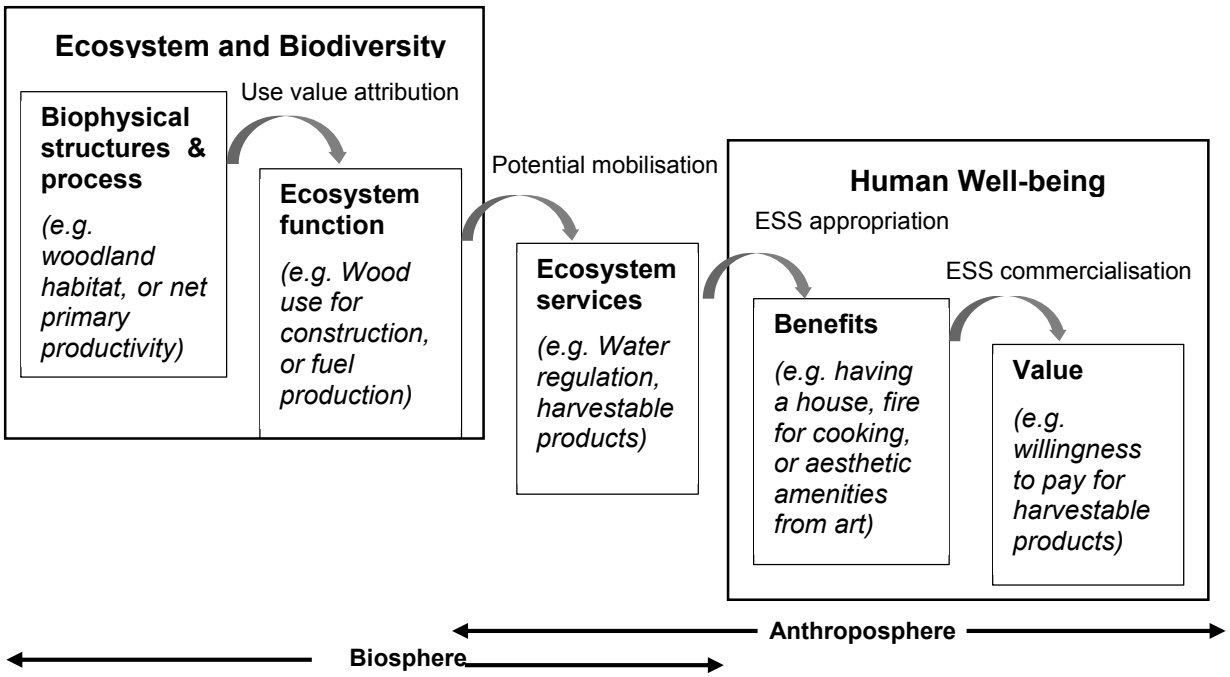


Figure 2.3: Ecosystem service cascade
(Source: Haines-Young and Potschin 2010; Spangenberg 2014)

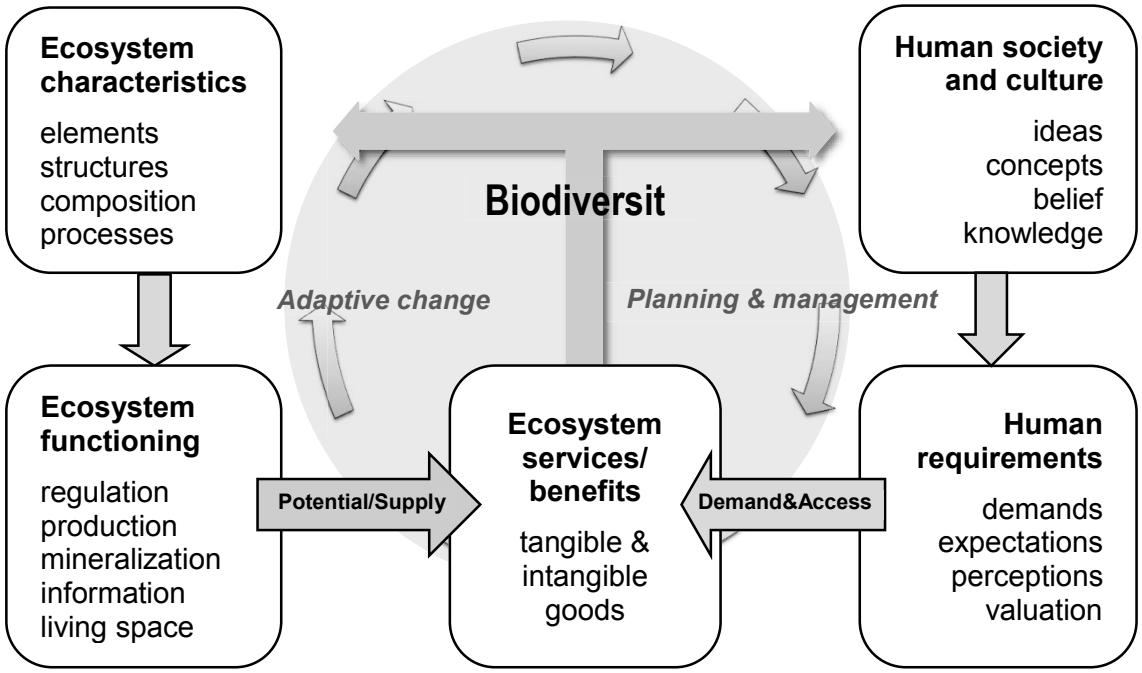


Figure 2.4: Mutual relationship between human and their environment
(Source: Bürger-Arndt 2012)

Considering the unavailable forest inventory data and keeping in mind the rareness of demand studies, the presented thesis focuses on the demand side and on drivers of change within the ES framework, approaching the social side in Bürger-Arndt´s scheme (2012). The demand of local people for FES refers to what they want and need, to what they may access and realize or are excluded from concerning the local forests to serve their life. These requirements depend on local social and cultural characteristics that may change over time by the shifting of socio-economic development and management policies. Accordingly, the assessment of FES supply is based just on the satisfaction of local people concerning the forest services they require and on their perception of ecosystem changes over time. This assessment also refers the match or mismatch between supply and demand in the research area. By definition, people do not use supporting services directly. Consequently, they are not aware of the respective benefits nor do they express such kind of demand. Thus, supporting services are not considered in this research.

2.6.2. Research process

The step-by-step research process is illustrated in figure 2.6. The preparation phase started with reviewing publications to understand the ES concept and framework as well as to get an overview of different viewpoints and current trends in ES researches. Based on the specific conditions and backgrounds of the research areas, the research issue was identified. Series of discussion with the supervisor encouraged critical thinking concerning the conceptual framework used in the research. In the inventory phase, the indicator set was conducted from referring different indicator sets from other authors and considering the local context realities. The suitable methods and the techniques were chosen and designed to match with oriented contents and local respondents. A series of interviewing individuals, households and focus groups in different fieldtrips collected both quantitative and qualitative data and helped cross check the information. After the completion of the fieldwork, the collected data was organized and analysed to reach the results that are discussed to draw conclusions.

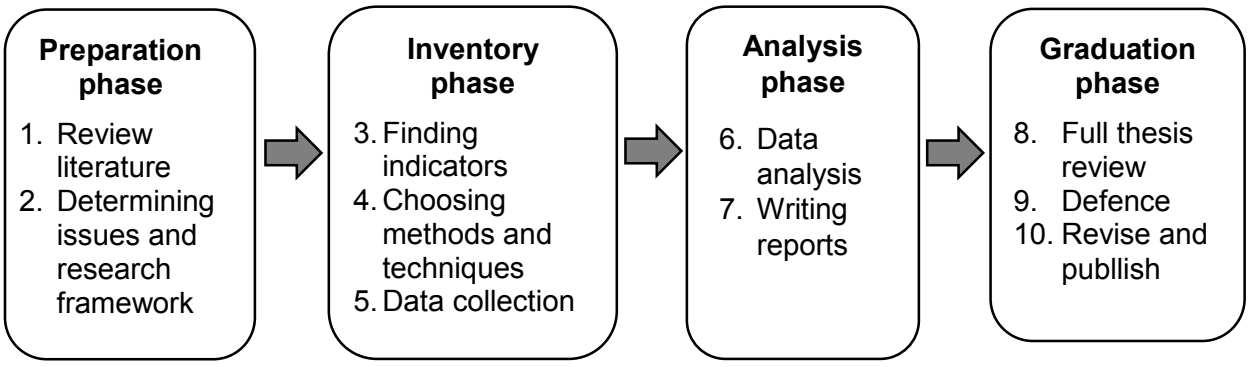


Figure 2.5: Process of the research

CHAPTER 3: RESEARCH AREA

3.1. Location and natural features

The research was conducted in Vu Chan and Nghinh Tuong, two adjacent mountainous communes in the Vo Nhai district, which is located in the Thai Nguyen province, northern Vietnam. The district is situated within the latitude of 105:58:00E - 106:08:00E and longitude of 21:46:00N - 21:56:30N (figure 3.1). The chosen communes are located in the northern area of the district which are the final southern part of the Ngan Son range of mountains from the Bac Kan province with the North East - South West direction. The altitude of most areas ranges from 500 to 1000 meters and the slope inclinations from 10^0 to 20^0, which makes them difficult to cultivate. The ***topography*** dismembered by small valleys alternating with zonal and limestone mountains creates a beautiful landscape in the areas (Photo 3.1).

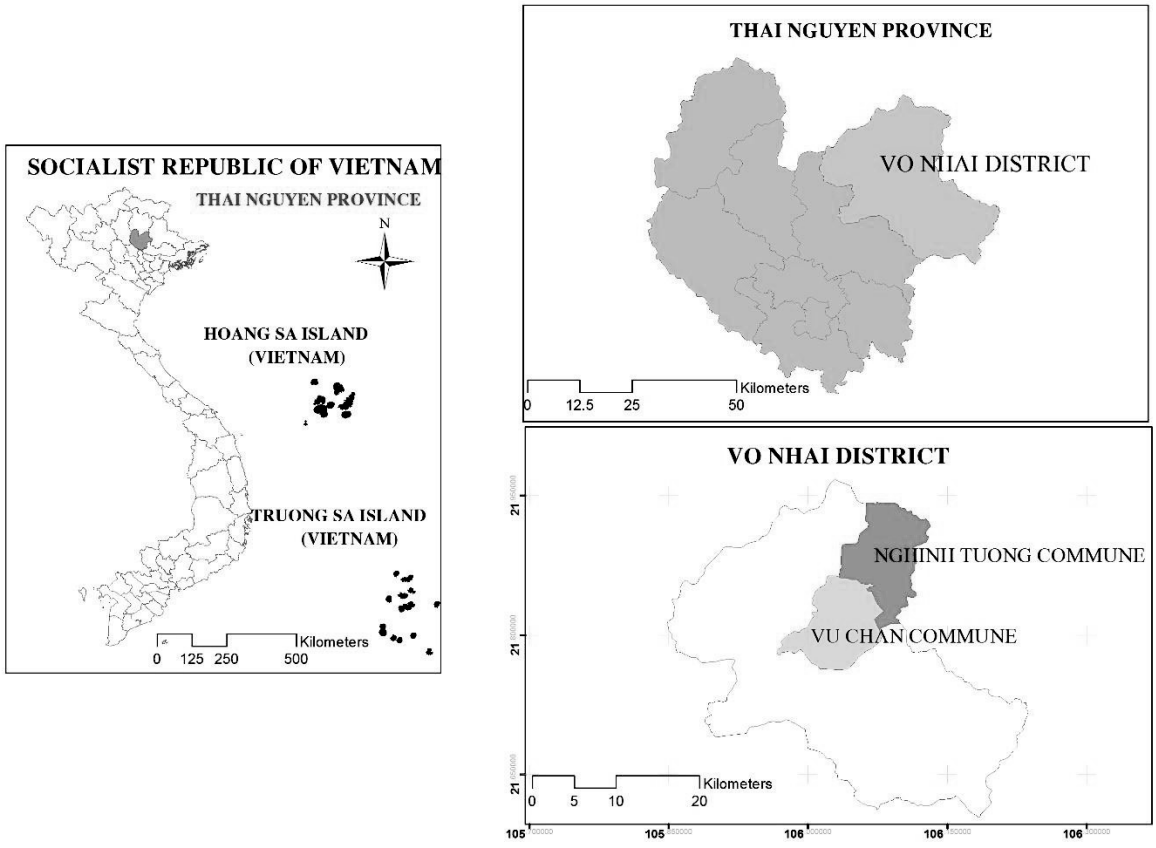


Figure 3.1: Location of research areas

Photo 3.1: Landscape in the research area (Source: Fieldwork - taken by the author)

The ***climate*** in the area is similar to the mountainous climate in northern Vietnam, namely tropical monsoon climate with four distinct seasons. The spring is cool and drizzly, the summer is hot and dry westerly winds, the autumn is cool and the winter is cold and wet. Following statistics of National Resource Centre of Hydrology and Meteorology, the mean annual temperature is 24^0C. The warm months are from May to September with the highest temperature up to 40^0C. The cold months are from October to March, when the lowest temperatures reach around 6^0C (figure 3.1-a). The difference in temperature between day and night is about 7 - 8^0C. The average annual rainfall is 1650 mm, with about 85 - 90% of precipitation occurring in the rainy season. The rainy season lasts from May to October, with the heaviest rainfall in July and August (about 300 mm) (figure 3.1-b). In recent years, average temperature has increased while precipitation has reduced (figure 3.1-c and d). The annual mean humidity is 80%. The dry season lasts from November to April with the lowest rainfall, the lowest temperature and fog that often appear. The evaporation during this time is higher than the precipitation that is another disadvantage in cultivation.

The ***stream network*** is dense with narrow and relatively steep flows of low water level. In some places, ground water streams create fulminating surface water flows. A small river of 46 km length, namely Nghinh Tuong originates from the arc mountain range of the Bac Son district (the Lang Son province) to supplies water for the Nghinh Tuong commune and three others. This river flows mainly through limestone areas (about 40% of length) with a deep narrow basin between steep cliffs. Water supply in the research area comes from surface water from small streams. However, these water sources flow unevenly depending on rainy water in seasonal.

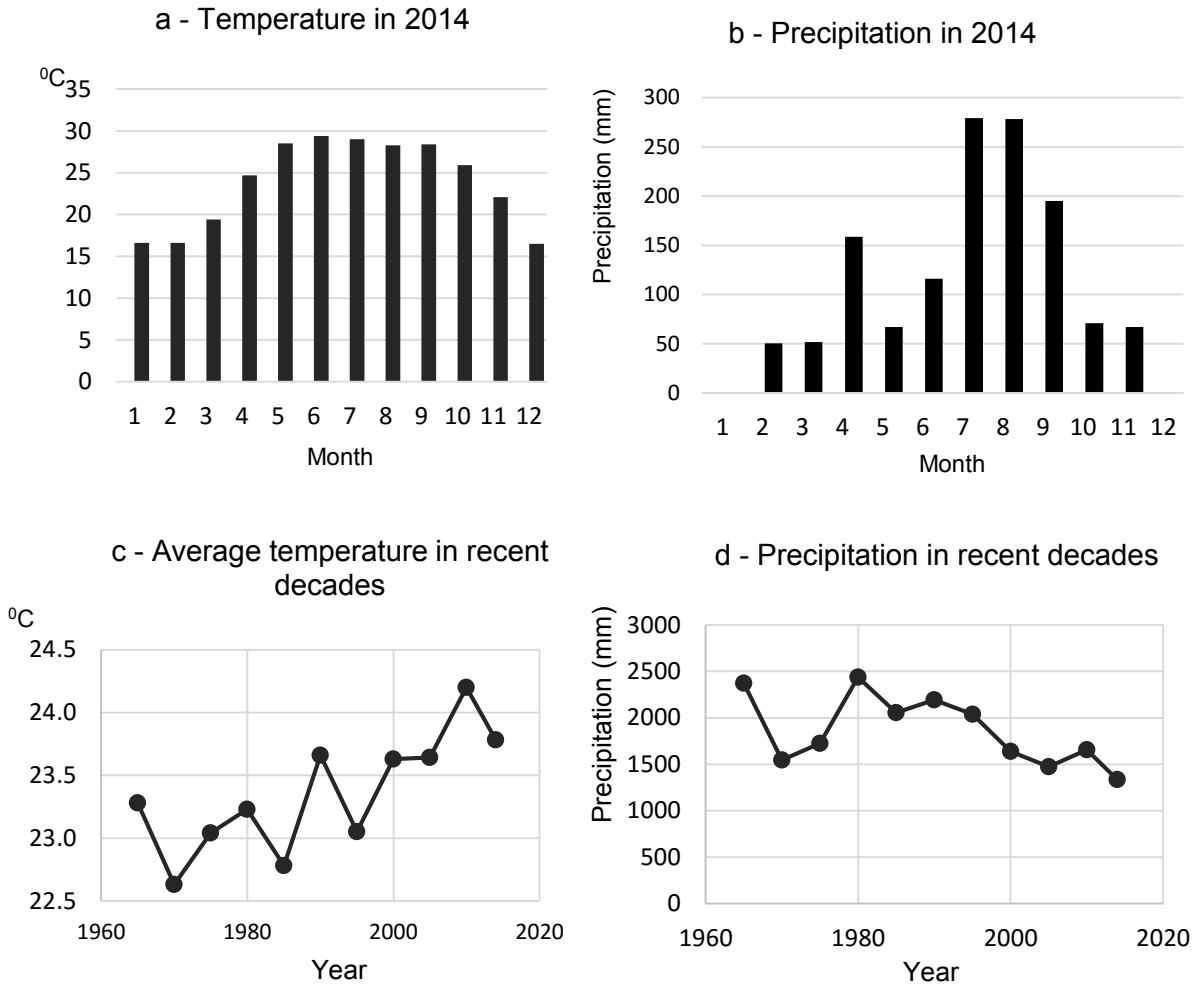


Figure 3.2: Temperature and precipitation data in the research area

(Source: Data of the National Resource Centre of Hydrology and Meteorology, the Thai Nguyen province station)

3.2. Soil and land use

There are different types of ***soils*** in the areas including (TSPHMB 2012b):

- *Hyperdystri-Haplic FERRALSOLS* (FRha.dyh): distributes in limestone mountains with high fertility and fine texture that are good for agriculture cultivation. Thus, many forest plots with this kind of soil got slashed and burned for swidden cultivation.
- *Hyperdystri-Haplic ACRISOLS* (ACha.dyh): among hills and mountains at the altitude of 300-600m. The soil texture varies depending on parent materials.
- *Areni-Haplic REGOSOLS* (RGha.ar): scattered in the foot of low hills; suits for growing fruit and tea trees.
- *Eutri-Haplic FLUVISOLS* (FLha.eu): along the rivers, suitable to cultivate main annual crops in the area.
- *Areni-Haplic FLUVISOLS* (FLha.ar): as small strips along streams. This soil has light texture, acidic and poor humus that suits for cultivating wet rice and other crops.

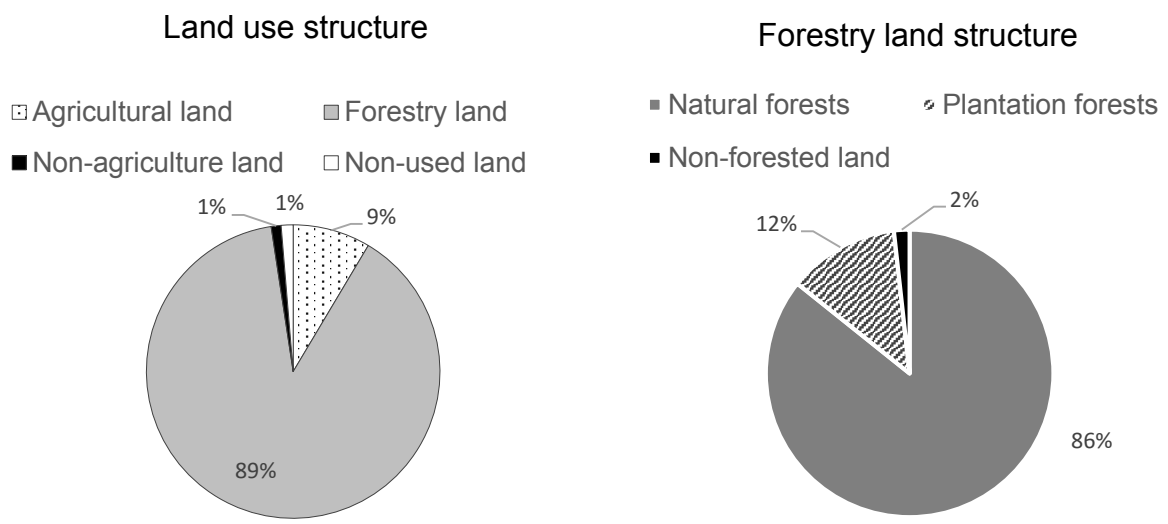
In the system of ***land use*** classification in Vietnam, agriculture land encompasses land for agriculture production, land for forestry and land for aquaculture. Non-agriculture land is land used for non-agricultural purposed such as residential land, land for special use purposes like official building and land for public purposes like roads, markets, meeting houses at villages, etc., land for cemeteries, land for special use water bodies like rivers, streams, irrigation systems, etc. The land use data of the Department of Natural Resources and Environment (DONRE) in the Vo Nhai district calculated and published the different land use areas as presented in table 3.1 (state: end of 2011).

Table 3.1: State of land use in two research communes in 2011 (in ha)

Land use type	Vu Chan	Nghinh Tuong	Total
Agriculture land	**7 645.08**	**8 164.56**	**15 809.64**
Agriculture production land	1 025.67	345.35	1 371.02
Annual crop	*783.22*	*200.02*	983.24
Rice	*302.16*	*154.45*	456.61
Other annual crop	*481.06*	*45.57*	526.63
Perennial crop	*242.45*	*145.33*	387.78
Forestry land	6 607.01	7 816.67	14 423.68
Forested land	*6 485.50*	*7 685.00*	*14 170.50*
Natural forests	*5 330.00*	*7 037.00*	*12 367.00*
Plantation forests	*1 155.50*	*648.00*	*1 803.50*
Non-forested land	*121.51*	*131.67*	*253.18*
Aquaculture land	12.4	2.54	14.94
Non-agriculture land	**103.09**	**73.37**	**176.46**
Residential land	20.47	19.92	40.39
Special-use land	36.77	29.85	66.62
Cemetery land	1.00	1.20	2.20
Special use water body	44.85	22.4	67.25
Non-use land	**20.83**	**191.72**	**212.55**
Flat un-used land	3.95	6.62	10.57
Hilly un-used land	16.88	182.91	199.79
Rocky mountain un-used land		2.19	2.19
Total area	**7 769.00**	**8 429.65**	**16 198.65**

(Source: DONRE of Vo Nhai, 2012)

Most land in the research communes is forestry land that accounts for 89% land; while land for agriculture production accounts less than 9% (figure 3.3). Natural forests do cover more than 12 thousand hectares, accounting for 86% of the forested land, while plantation forests do less than 2 thousand hectares (12%) so far. The average forest cover is 89.5% in Nghinh Tuong and 82.36% in Vu Chan (DONRE 2012). Over 250 ha (2%) forestry land is still bare land. Non-use land is scare and occurs and mostly in hilly areas.



Note: None-agriculture land includes residental land, special-use land, and others land uses. Agriculture land includes forests and aquaculture land.

Figure 3.3: Structure of land use and forestry land in 2012
(Source: DONRE Vo Nhai, 2012)

3.3. Forest types and their functions

3.3.1. Forest status and function types

Based on forestland utilization purposes, forests are divided in three function types, namely special-use forests, protection forests and production forests. The criteria for forest function classification are given in the appendix 4. Apart from the criteria and indicators for their delimitation, the forest status[3] and the classification of its productivity may play an important role, particularly in the case of production forests (see table 3.2). The *North-West Sub Forest Inventory and Planning Institute* and *Thai Nguyen provincial Forest Protection Unit* provided respective statistics and maps of forests classification in the research communes (see figure 3.5 and figure 3.6).

The special-use forests are managed by the management board of TS-PH (abbreviated TSPHMB). The forests in this nature conservation area stand for poorly productive limestone forests (representing over 85% of special-use forests) of the Ngan Son mountain range. Thus they have many common features of limestone mountain ecosystems in Vietnam. They are home to a large diversity of flora and fauna. Following report of TSPHMB (2012), most of this forest area has average and low quality[4] (table

[3] These forests are distinguished by the level of former disturbance, potential regeneration, species, maximum diameter class, etc.

[4] Classification of forest productivity for timber forest are: a) Very rich forests: standing volume of 300m ^{3}/ ha; b) Rich forest: standing stocks from 201-300m ^{3}/ ha; c) Average forest:standing stocks from 101-200m

3.3). Average forests account for 19% of total forestland with average wood reserves of 138.16 m^3/ha, mostly distribute in Nghinh Tuong commune.

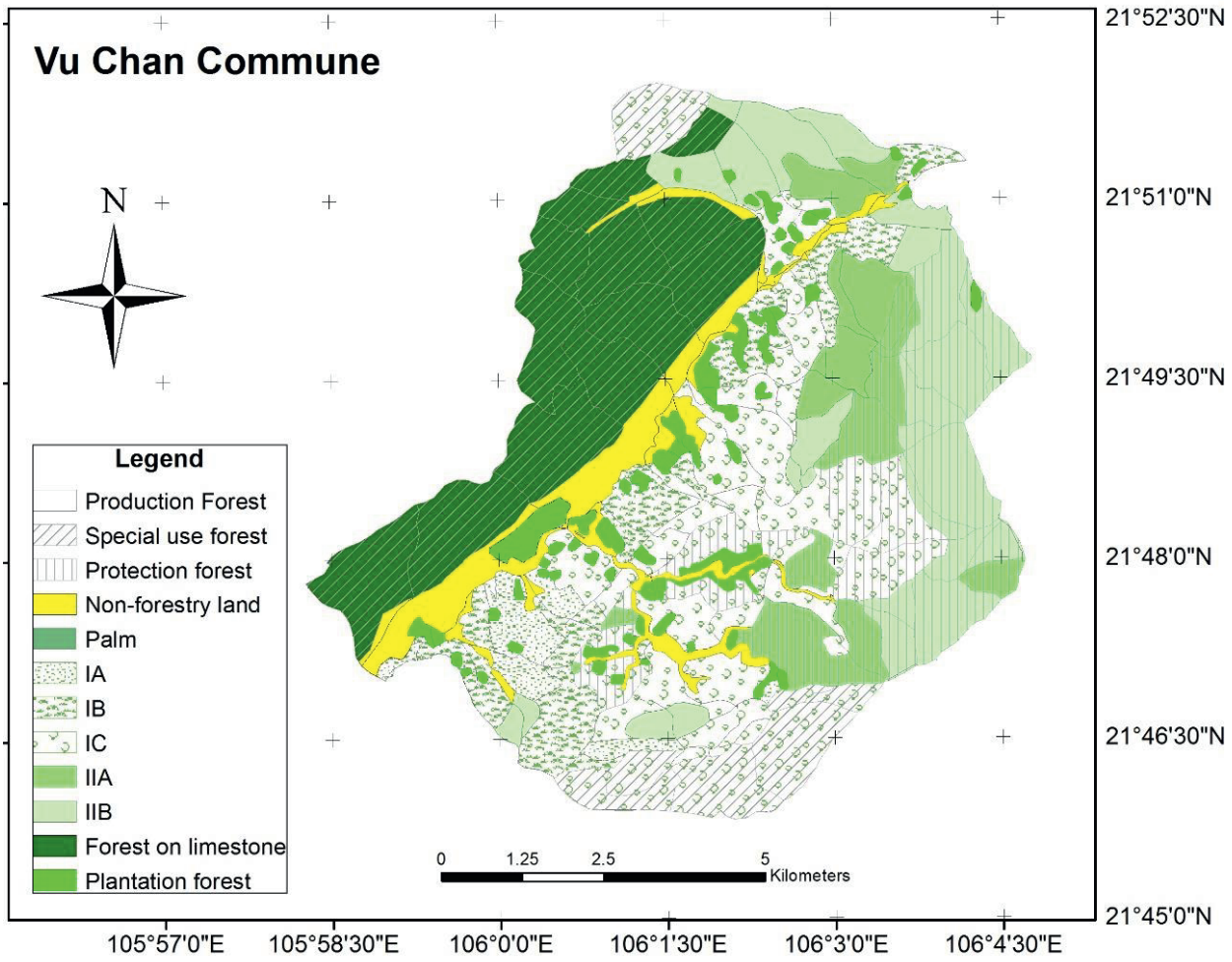
Regeneration forests are mainly forests that recovered after overexploitation or slash-and-burn cultivation and still stay in poor stand. The average wood reserve is just 77 m^3/ha. However, biodiversity and forest quality in these regeneration forests after exploitation is better than in the forest restored after swidden cultivation. Thus these forests will have potential values for both environment and economy in the future if they are well protected during their natural regeneration process.

Table 3.2: Status of three forest function types in 2013 (in ha)

Types of land	Commune		Total
	Nginh Tuong	Vu Chan	
1. Special-use forests	***2301.00***	***1852,70***	***4153.70***
Forested land	2125.00	1852.70	3977.70
Natural forests	2120.00	1852.70	3972.70
Plantation forests	5.00		5.00
Non-forested land	176.00		176.00
2. Protection forests	***4400.60***	***1432.60***	***5833.20***
Forested land	3940.10	1422.70	5362.80
Natural forests	3862.10	1344.20	5206.30
Plantation forests	78.00	78.50	156.50
Non-forested land	460.50	9.90	470.40
IA	36.00		36.00
IB	424.50		424.50
IC		9.90	9.90
3. Production forests	***2889.80***	***1746.60***	***4636.40***
Forested land	2778.80	1.646.35	4425.15
Natural forests	2055.30	1.167.65	3222.95
Plantation forests	723.50	478.70	1202.,20
Non-forested land	111.00	100.25	211.25
IA	47.50	100.25	147.75
IB	63.50		63.50
Total forest land	***9591.40***	***5031.90***	***14623.30***

(Source: FPD 2014)

[3]/ ha; d) Poor forest: standing stocks from 10 to 100m [3]/ ha; e) No reserve forest: forest and average diameter <8 cm, volume of standing trees less than 10m^3/ha (Circular No. 34/2009/TT BNNPTNT issued by the MARD)



Note: IA, IB, IC, IIA and IIB are subclasses in Vietnamese Forest Classification by MARD, in which, each subclass refers:

IA: Bare land characterized by grasses, bushes and wild bananas

IB: Bare land characterized by bushes, scattered trees and bamboos

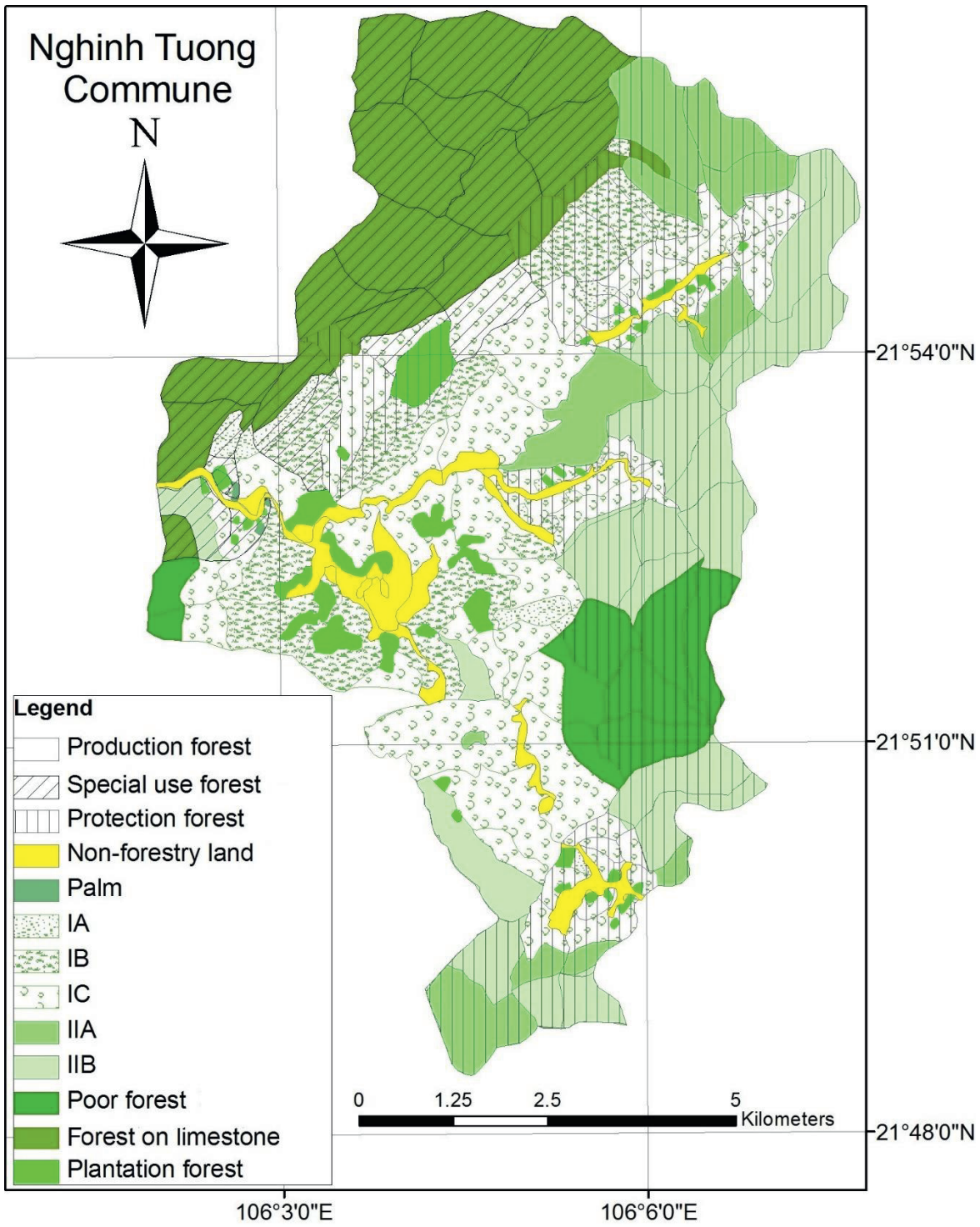
IC: Bare land characterized by high density of regenerating trees (trees of over 1m height and with more than 100 stem per ha)

IIA: Regeneration forest after shifting cultivation

IIB: Regeneration forest following heavy exploitation for timber

Figure 3.4: Map of three forest function types and their status in Vu Chan in 2008

(Source: Division of Forest Protection, DARD of Thai Nguyen province)



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IIB: Regeneration forest following heavy exploitation for timber

Figure 3.5: Map of three forest function types and their status in Nghinh Tuong in 2008

(Source: Division of Forest Protection, DARD of Thai Nguyen province)

Table 3.3: Forest status and reserve of special-use forests in the research area

Forest status	Area (*ha*)		Reverse (m^3)	
	Nghinh Tuong	Vu Chan	Nghinh Tuong	Vu Chan
Forest land	***1 897.0***	***2 051.1***	***189 775.9***	***158 044.8***
Average forest	740.0	7.4	102 238.4	1 022.4
Poor forest	829.0	377.0	62 490.0	28 418.3
Regeneration forest	314.1	1 644.1	24 239.1	126 875.2
Mixed forest	3.4	22.0	262.4	1 697.7
Plantation forest	10.5	0.6	546.0	31.2
Non-Forest land	***142.9***	***52.2***		

Source: (TSPHMB 2012b)

Mixed forests are reported in documents of TH-PH management board in small area (about 25ha in special use forests) (table 3.3). However, it is not found in the maps of 2008. These forests were described as mixed of bamboo species and wooden trees. The density of wood plants is over 600 plants per hectare, reserves 7.17 m^3/ha. Bamboo species includes *Neohouzeau nadullooa (Nứa), Arundineria callosa (Sặt), Idosasacras angustata (Vầu), Dendrocalamus patellaris (Giang).* These species grow alternatively with timber plants or in small mono-plant association.

Protection forests are supported to serve for watershed protection. Most of them are natural regeneration forests in the state of IIA and IIB[5]. This also includes small area s of plantation forests.

Production forests include natural regeneration forests and plantation forests. However, the quality of regeneration forests is lower than that on the protection forests. Plantation forests, which were converted from bare forest lands and poor regeneration forests, are almost pure stands with dominating *Acacia hybrid* spp.

3.3.2. Natural forest vegetation

“Natural forests” dominate in the research areas. However, due to intensive human impacts in the past (timber extraction and slash and burn cultivation), the forest vegetation shows various stages of degeneration and regeneration with successional phases, which are often difficult to distinguish. In the research areas, limestone forests occupy 25% of the forest lands (about 3.5 thousand hectares). Due to an initiative of the management board, the forests in TS-PH have been studied more in detail, which led- for example - to a classification, description and quantification of the mentioned natural forest regeneration types (see table 3.4).

[5] The characteristics of these forest states are detailed in Appendix 3

Table 3.4: Natural forest vegetation classification of special used forests in research area

Vegetation classification	Nghinh Tuong (ha)	Vu Chan (ha)	Total (ha)	(%)
Tropical vegetation				
Evergreen closed tropical rain forest	1386.15	2 053	3 439.15	83.01
Limestone forest	*1328.96*	*1 834.1*	*3 163.06*	*76.34*
Zonal forest[6]	*57.2*	*218.9*	*276.10*	*6.66*
Broad leaved open tropical woodland on limestone		235.52	235.52	5.68
Tropical scrub and grassland	60.34		60.34	1.46
Subtropical vegetation				
Evergreen closed humid sub-tropical limestone forest	367.35	40.8	408.15	9.85
Total	**1813.84**	**2 329.32**	**4 143.16**	**100**

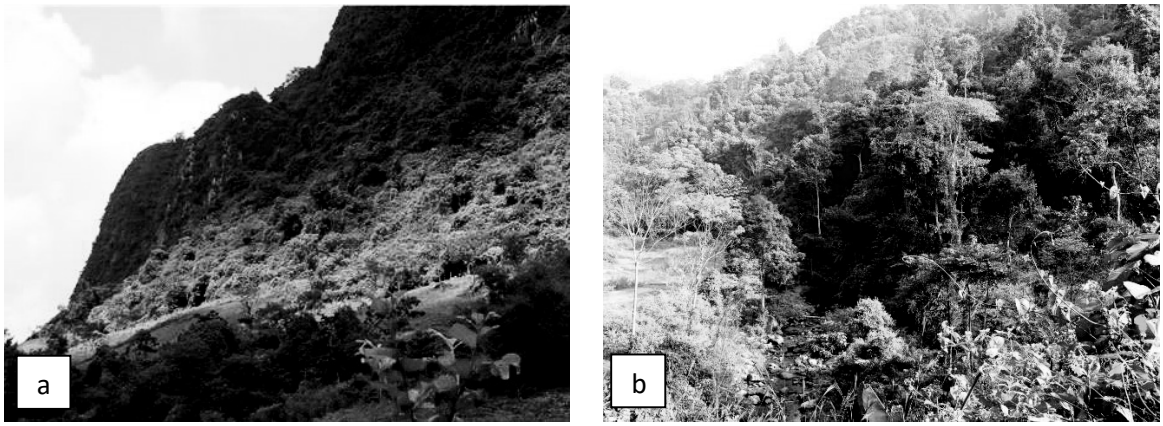
(TSPHMB 2012b)

Stands of primary e*vergreen closed tropical limestone* forests*,* which used to be the dominating natural forest type in the protected area, have survived only on a few scattered high and steep slopes, which are too difficult to access. The secondary forests are regenerating naturally after exploitation. The forest structure consists of tree layers, 3-4 m high shrub layer and ground vegetation. The tree layer encompass 78 woody plant species. Many trees have over 10 m height and about 22 cm diameter. The tree layer is acomplicated plant association with one or two dominant tree species. Timber species include *Excentrodendron tonkinense (Nghiến), Markhamia stipulata (Đinh), Chukrasia tabularis (Lát hoa), Garcinia fragraeoides (Trai lý), Tetrameles nudiflora (Thung), Streblus macrophyllus (Mạy tèo), Pterospermum heterophyllum (Lòng mang), etc*.

In the low mountain areas (<500m)**,** *the zonal evergreen closed tropical forest* (later refered to as “zonal forests”) has been completely devastated due to timber over-extraction and slash-and-burn cultivation. It is followed by early stages of natural regeneration. Regenerating after overexploitation, these forests are still keeping 5-layer-forest structure (i.e. 3 tree layers, shrub layer and ground cover vegetation), and hosting over 70 woody tree species. The forests being in process of natural regeneration after slash and burn comprise only three layers of woody trees (10-15m height), some bushes (3-5m height) and ground vegetation. These forests have quite high woody tree density (510 stems per hectare), but smaller wood reserves. They are still influenced by fuel wood extraction of local people. The plant species are *Castanopsis indica (Dẻ gai), Vaticache valieri (Táu muối), Trám trắng (Canarium album), Đa cao (Ficusal tissima), Styrax*

[6] To distinguish from limestone forests

tonkinensis (Bồ đề), Liquidambar formosana (Sau sau), Peltophorum tonkinensis (Lim xẹt), etc.



a) Limestone forests b) Natural regeneration forests

Photo 3.2: Landscapes of forest ecosystem (Source: Fieldwork, taken by the author)

Broad-leaved open tropical evergreen limestone forests constitute the more advanced stages of succession after exhausted exploitation with many photophilic pioneer species. The species composition depends on the level of harvesting and forest recover time. Density and volume of trees are poor. This sub-formation has 30 woody species, in which, five dominant tree species are *Streblus macrophyllus (Mạy tèo, Excentrodendron tonkinense (Nghiến) Pterospermum heterophyllum (Lòng mang xanh), Machilus grandifolia (Kháo lá to) and Antidesmapaxii (Chòi mòi).*

Furthermore, *evergreen closed humid sub-tropical low limestone forest* was listed as forest vegetation of the TS-PH (e.g. TSPHMB 2012a, 2012b), however, there is no any description of this forest type available.

Tropical scrub and grassland do also regenerate after slash-and-burn cultivating or clear cutting and occure in different altitudes. The species components and dominant species vary according to the topography, soils, humidity, etc. Dominant species are *Phyllanthus reticulatus (Phèn đen), Randia spinosa (Găng), Melastoma* sp. *(Mua), Maesa perlarius (Đơn nem) Saccharum spontaneum (Lau), Musa acuminata (chuối rừng), Dicranopteris linearis (Guột).*

3.3.3. Species diversity

There is also information about the forest´s diverse and precious fauna and flora. The flora includes multi-layered canopy; timber species; flowers, including, orchids; ferns; and an abundance of liana and caulis. The area also hosts quite a number of plants, which are used for medicines as well as edible fruit, nuts, and shoots (table 3.5). Furthermore, many valuable and specious timber species still exist in the research areas from group II

to group VIII[7], however the reserves are not much. The fauna includes mammals, birds, reptilian species, fishes and insects (table 3.6). Many species in the conservation area are listed on Vietnam Red Data Book 2007 or the Decree 32/2006/ND-CP of endangered, precious and rare forest species (See more in appendix 6).

Table 3.5: Number of flora species and the utilization of flora in Than Sa- Phuong Hoang natural conservation area

Phylum	Ultilization			
	Timber	Medicine	Food	Ornamentation
Lycopodiophyta		1		2
Polypodiophyta		8	4	6
Gymnospermae			2	
Angiospermae	319	565	156	76
Dicotyledonae	*311*	*510*	*144*	*55*
Monocotyledonae	*8*	*55*	*12*	*21*
Total	***319***	***574***	***162***	***84***

Source: (TSPHMB 2012b)

Table 3.6: Number of assured vertebrate species in the two research communes

Class	Order	Family	Species
Mammalia	7	18	29
Eves	12	29	50
Reptilian	2	5	10
Amphibian	1	2	2
Piset	4	12	29
Total	**26**	**66**	**120**

(Conducted part from TSPHMB 2012b)

3.4. Available forest inventory data concerning FES supply in the research area

The process of elaborating forest statistics, forest inventory and forest resource monitoring in Vietnam was stipulated in the Law of Forest Protection and Development in 2004. It states that forest statistics, inventory and forest resource monitoring have to be done directly by forest owners namely individuals, households and organizations, in

[7] The wood classification in Vietnam is based on:
- Decision number 2198/CNR of 26/11/1977 of Ministry of Forestry on temporal classification table of wood used consistently in Vietnam.
- Decision number 334/CNR of 10/5/1988 of Ministry of Forestry on classification adjustment of 4 types of wood.
- Decision number 3341/NN-PTLN/QD of 22/12/1997 of Ministry of Agriculture and Rural Development on temporal supplement of 8 types of wood in table of wood classification.

prescribed forms and under the guidance and control of forestry organizations (The Law No. 29/2004/11th Parliament Session). The forest statistics are done annually, forest inventory is done once in five years and forest resources are monitored regularly. The People´s Committee is responsible for synthesizing and reporting the data to the Commission at the next higher level.

In the research area, special-use forests are managed by the management board of TS-PH (TS-PHMB). This organization inventories and monitors the forest biodiversity and the changes of forest resources in details and reports once every five years (Article 13, item 1, Decree 08/2001/ QĐ-TTg). The forest management board of the natural conservation area has an overall report about the forest status and biodiversity for the entire area including six communes, but no separate report has been prepared for single communes.

Box 3.1: Some definitions used in forest inventory in Vietnam

- *Forest statistics* is the synthesis and assessment on the cadastral documents about area and quality of forests at the time of statistics and the changes of the forest between the two successive statistics. (Article 3, The Law No. 29/2004/11th Parliament Session)
- *Forest inventory* is the synthesis and assessment on cadastral documents and in the field in terms of area, reserve and quality of the forests at the time of inventory and the changes of the forests between two successive inventories. (Article 3, The Law No. 29/2004/11th Parliament Session)
- *Monitoring changes of forest resources* includes changes of forest area, forest reserves, forest quality, quantity and constituent of flora and fauna. Changes of forest resources are annually monitored and declared once in 5 years. (Article 40, Decree No. 23/2006/ NĐ-CP)

Protection forests and production forests are mostly allocated to individuals and households; Parts of these forests are managed by the Communal People´s Committee. Because those individual or community forest owners do not sufficient abilities (knowledge, finance, tools and time) to realize forest inventories in terms of forest biodiversity or reserves, especially in natural forests, parts of the forests are managed by the Communal People´s Committee. However, the forest owners do report data like the total forest area, area changes, and the planted or logged forest area each year to the Communal People´s Committee that then synthesizes and provides the data bases for forest inventory of these forest types.

However, the information compiled in the forest inventory in the research areas is insufficient to evaluate FES potential supply. This shortage is caused by the poor conditions for doing an inventory and storing the collected data, especially in remote and poor mountainous areas. All available information that could be relevant with respect to

FES supply in the research was presented in section of forests and biodiversity in this chapter and in the appendix of fauna and flora species.

3.5. Socio - economic conditions

Since Program 135[8] of the Government was executed, socio-economic conditions have been improved dramatically. **Infrastructures** were transformed and improved by many projects of building, transportation and irrigation. By the year 2011, 88% of the households were provided with electricity. Some villages located in the very steep areas are still living without electricity from national sources. Both two communes have asphalted auto roads to the centre and auto ways to some villages. The pathways in the villages are small and poor quality, causing difficulties, especially during the rainy season.

Table 3.7: Background information of socio-economics in the research areas

Items	Unit	Vu Chan	Nghinh Tuong
Number of villages		10	12
Population	people	2689	2795
Number of households		654	621
Poor households	%	50.61	55.71
Medical stations	station	1	1
Doctors	people	1	2
Nurses	people	2	5
Medical collaborators	people	10	12
Schools		3	3
Pupils		539	541
Teachers		73	64

Source: (General Statistic Office of Vo Nhai district 2015)

The **economics** of the areas is dominated by agriculture cultivation. Both Nghinh Tuong and Vu Chan are poor communes with the poor accounting for over 53% of the total households. Although agriculture land occupies small proportion, mainly on slopping land, livelihoods of over 90% of the local people are based on agriculture cultivation. In 2014, the two communes cultivated 300 ha of paddy with average yields of 48.1 quintal/ha (General Statistic Office of Vo Nhai district 2015). The paddy yield of the area is lower than the usual yield of paddy in the whole province (50.8 quintal/ha (GSO 2015)). Perennial crop lands are mainly for green tea growth, however, tea has not developed as

[8] Socio-economic development programs for extremely difficulty communes in ethnic minority and mountainous areas (program 135) are programs of national poverty alleviation of Vietnamese Government.

commercial crop. The area of tea cultivation increased from 14 hectares in 2005 to 37 hectares in 2014 (General Statistic Office of Vo Nhai district 2010, 2015).

The **healthcare services** have been improved in recent years with a medical station in the centre of each commune and a network of 22 collaborators in 22 villages. The maternal health has also improved with a decrease of morality of under-five-year old children. Under 6-year old children have received the free medical treatment card. Two national Programs: *Malaria* Prevention and Expended Vaccination have been realized in the entire areas. The **education system** has been improved with respect to the facilities for kindergarden, primary and secondary schools. Classrooms of kindergardens and primary schools have been built in some villages (as branch or sub-school) to reduce the distance for pupils and encourage children´s application of the public education systems. Despite increased of attention in schools, the education of local people is still at low levels. Most of them are only at literate.

The **demographics** in 2011 showed that the total population in Vu Chan and Nghinh Tuong was 5480 people (49.3% male and 50.7% female) in more than 1270 households (General Statistic Office of Vo Nhai district 2010). Population is distributed in 22 villages and hamlets located in valleys or near water sources or along transport ways. Population density is 34 people/km^2. The Tay and the Dao are two dominant ethnics in the areas constituting 56% and 41% of population respectively, while other ethnic group make up the remaining 3% (General Statistic Office of Vo Nhai district 2010). Each ethnic group has a separate culture, language and customs.

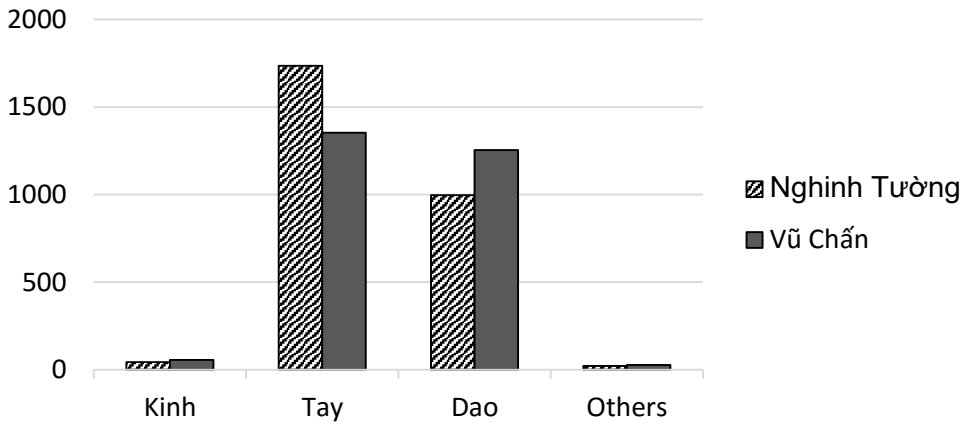


Figure 3.6: Distribution of ethnic groups in the study communes
(Source: Department of Ethnic Minorities Vo Nhai dictrict and Nhai 2011)

The Tay is an ethnic community belonging to the Tay -Thai language group, the second population ethnic group in Vietnam (following the Kinh or Vietnamese) with 1.626.392 people (GSO 2010). Most of the Tay live by the valleys and low mountains in midland and mountain provinces in the northeastern part of Vietnam. Their villages are characteristically large and crowded. The Tay traditional house is built on stilts with a frame of rafters and 4, 5, 6, or 7 rows of columns. A house has from 2 to 4 roofs made from tiles, straw, or palm leaves.

As they live on the fertile fields in the valleys, the Tay follow traditional agriculture, which is fairly developed. They earn their living mostly by wet rice cultivation. They also raise livestock and poultry and grow vegetables, fruit trees and medicinal herbs. Beside craftwork, such as cloth weaving, cloth dying and knitting to make items for daily uses, they also knit fine-art products from different kinds of bamboo.

The Tay have many traditional folk activities, with poems, singing, dancing, and music. Their spiritual and cultural life is abundant with traditional singing known as *Then, Sli* and *Lượn*, as well as traditional festivals, and unique folk games played during traditional ceremonies. It can be said that these occasions are the festivals of a community based on wet rice cultivation, because they are closely associated to it, and are full of the colors of folk beliefs. The biggest special occasions include the Long tong festival and the *Nàng Trăng* (Moon Lady) festival.

Many ancient documents and ethnological data show that **the Dao** in Vietnam originated from China. Due to historical up and down, they gradually migrated southwards and have entered Vietnam in different periods and along different routes (Vu 2006a). The Dao in Vietnam encompass 751067 people, which is 0.87% of the population of Vietnam (GSO 2010) and consists of many sub-groups: Red Dao, Coin Dao, Tight-trousers Dao, Dao Lo Gang (or Dao Thanh Phán), White-trousers Dao, Long-dressed Dao. The culture of the Dao expresses ethnic similarities and unity, reflecting the distinctions and diversities of all subgroups.

Due to their traditional method of production, their hamlets are usually established at the forest edge or the mountain foot or hillsides to have enough cultivated land as well as water supply for daily life and farming on terraced fields. At present, many Dao hamlets still preserve their tradition: there are few households, only around 30 houses in maximum; the territory is quite large but the residential quarter is small (Vu 2006a; People´s Commitee of Thai Nguyen Province 2009). Their houses are mainly scattered in harmony with the terrain. Up to now, the organization of hamlets in the form of subgroups and clans has remained quite popular among the Dao community. The Dao people have many family surnames, the most popular being *Bàn, Triệu*. Each lineage or each branch possesses its own genealogical register and a system of different middle names to distinguish people of different generations. Dao religious beliefs include traditional practices and agricultural rituals mixed with elements of Confucianism, Buddhism and Taoism. In some subgroups, there is a common ancestral altar in the clan head´s house, where the clan´s ceremonies are carried out. This is also the place where ceremonial instruments (music instruments, painting for worship, religious books) are kept. Each hamlet has a chief to deal with all hamlet affairs. He is assisted by clan-heads and shamans.

The Dao sub-group in the research area is Dao Lo Gang. Dao Lo Gang wears many layers of square scarves piled up on each other, forming a cylindrical bonnet hemmed with red cloth. In other localities, they wear long scarves that can be folded into seven

layers of square shape. A stick is put it to create two acute angles on the head. Jackets worn by women are richly embroidered with decorate patterns and yellow tassels along the rims of collar and front opening. Brassieres are a piece of indigo or black, long, wide-bottomed trousers of which the lower part is decorated with many or few embroidery motifs (depending on each locality). The leggings are of triangular shape, with embroidered patterns.

a) An old Tay couple with their daily clothes. The traditional clothes have not existed in the daily life of the Tay in this area.

b) The Dao Lo Gang women in a family. An old woman (on the right side) and her three daughters-in-law. The young Dao women only wear the traditional clothes in the wedding or in some special spiritual activities.

Photo 3.3: Ethnic people in the research area

Source: Fieldwork (photos taken by the authors)

CHAPTER 4: METHODOLOGY

4.1. Identification of relevant forest ecosystem services (FES) and their indicators

Possibly relevant FES and their indicators were identified based on reviewing literatures about ecosystem service categories and their indicators (like Layke 2009; UNEP-WCMC 2009, 2010; Tyrrell et al. 2010) as well as local fact-finding. In addition to that, the literature research also helped to find relevant indicators for drivers of changes. The table 4.1 summarizes the number of indicators that were used for each content group. The indicator findings are presented in details in the appendix 1.

Provisioning services were by far the most elaborated, in which, more indicators (for food, timber and water supply) could be selected than for other services. It is notable that water supply is understood as a provisioning service and that relies on water regulation. Water regulation in turn depends on ecological the processes that regulate or control both water quality and quantity through which water becomes available, while water supply is water that is already available for use. The indicators for provisioning services do not only dominate the indicator compilations of many institutions and scholars (e.g. UNEP-WCMC 2009a; Egoh et al. 2012; Layke et al. 2012) but also turned out to be of major interest for the local people in the research area. Usually they are easy to quantify.

Table 4.1: The number of indicators used in the research

Indicator Categories	Number of indicators
Forest ecosystem services	**63**
Provisioning services	33
Food	*7*
Timber	*6*
Fuel wood	*4*
Water supply	*7*
Ornamental species	*2*
Medicinal plants	*3*
Land use	*4*
Cultural services	24
Spiritual and religious life	*3*
Knowledge system	*13*
Social relation	*1*
Aesthetic	*5*
Inspiration	*2*
Regulating services	6
Drivers of change	**19**
Total	**82**

In contrast, information on ***cultural services*** is scarce and rather uses qualitative indicators. However, they turned out to be rather unspecific or irrelevant for the people in the research area. For example, recreation or landscape-perception-related indicators, which dominate in cultural service studies (like Boyd and Wainger 2003; Burkhard et al. 2009; Schaich et al. 2010; Tengberg et al. 2012; Szücs et al. 2015); are irrelevant in the research area and of least interests to the local people. Thus, the presented research focuses for the indicators of the local knowledge system (13 out of 24 of total indicators) rather than on other cultural service sub-categories.

Regulating services are the fewest indicators in this research (only 6 indicators). Regulation services get more attention at global and sub-global scales, especially water and climate regulation (Seppelt et al. 2011). Some indicators may be relevant at large scale but not available on the local scale. The benefits of regulating services of an ecosystem seem to be clearly realized and recorded at global, national and regional rather than on local scales. Moreover, when focusing on local demand, the assessment of these services relies on people´s awereness. The limitation of data and information for regulating services causes these services to be not fully perceived and appreciatedby local people.

Since the entire study focuses on the social system or - better to say - on local people´s demands, expectations, awareness and appreciations toward forest ecosystem services, the chosen indicators for **drivers of changes** focus on those that impact on the local community and their demands (indirect drivers) rather than on drivers that impact directly on the ecosystem (direct drivers).

In the research, both quantitative and qualitative indicators were needed to look what is being used and measured. Quantitative indicators usually quantify provisioning services with the quantitative measures such as number of people, cubic meters, percentages, etc. Qualitative indicators are people´s judgments and perceptions about a subject, normally used for cultural and regulating services. The study focuses on people´s demand for forest ecosystem services, thus, indicators for local people´s demand account for 75% of the total indicator number for these services. The indicators presented in this research follow non-monetary assessment of forest ecosystem services and the compiled information was gathered through conventional and participatory social science methods and through examination of written documents.

4.2. Data collection

Data were collected from secondary documents (annual reports, project reports, local statistic data, etc.), focused group interviews, household surveys, individual interviews and direct observations. The mixture of qualitative and quantitative approaches shall facilitate capturing vary perspectives and cross-check the results to support each other

as well as strengthen in data analysis (Dey 1993; Carpenter et al. 2006; O'Leary 2010). Qualitative information is supposed to add more depth and insights to quantitative data that create a broader picture of situation (O'Leary 2010).

4.2.1. Focus group interviews

Group interviews were used as a data collection method to give an overview of issues and related opinions or views within a population in a short time (Creswell 1997; Marck et al. 2005). **Group discussions** were added order to encourage dialogue among the respondents. The views differ from informants in ages, genders, educations, experiences, resource assess, etc. of the informants. Thus, various viewpoints were expressed during the discussions.

A variety of different techniques was used in the interviews depending on the given issues and the addressed groups of respondents (table 4.2). Such variety was thought to capture information most effectively, avoid boring participation but rather motivate respondents to express their views or opinions. We focused on eight major issues and two types of informant groups, namely key informant panel (KIP) and local people.

Table 4.2: Contents and techniques of group interviews

Interview content	Technique	Informants
1. Local history	Timeliness	KIP
2. Forest benefit ranking over time	Matrix Ranking	KIP Local people
3. Participation in forest extraction	Matrix scoring	
4. Forest types and benefits	Matrix scoring	Local people
5. Cultivation Calendar	Seasonal diagram	
6. Economic activities	Discussion	
7. Ecosystem changes	Discussion	
8. Village demands for FES	Matrices	

KIP informants are local authorities, representatives of local organizations, and some local village leaders having a thorough knowledge of their homeland. In each commune, a KIP group encompassed 12 to 15 people. The contents focused the local history, forest benefits and scoring and local forest management.

Local people are villagers including men and women, elderly and youth and both ethnic groups, the Dao and the Tay. They discussed the economic structure and conditions; their livelihoods and their time schedules in agriculture cultivation during the year; their perception of FES changes, and other forest-related changes with relevance for their daily life over the last 20 years up to now, and finally their prediction of changes for the next 10 years.

The group interviews were conducted in meeting rooms of either the communes or the villages. Participants discussed warmly and friendly. My co-operators and I rather acted as learners and others gave their ideas or additional information they knew. In each part of the discussion, we gave some questions or suggestions to the informants talking about our interests. Besides the final discussion results, we also listened, observed and took notes of all discussions of informants in each issues or contents to get extra information data supporting for main results. Overall results of the discussion were represented in tables, figures or brief texts, which helped participants to avoid getting bored. At the beginning of the consultations, some people hesitated to talk. However, active participation of others removed the hesitations of all participants. Every discussion took longer than the expected time.

The following parts will go into details concerning some of the used techniques and the content captured through the group interviews.

Matrix ranking and scoring

Ranking and scoring mean placing something in order that reveals the participant's choices and priorities (Cavestro 2003). Based on people´s preference or some given criteria, the method give a relative comparison between different options for a specific issue or how much preference of one option to the other. The discussions would come to a decision about the final score of each option (as well as on settling on the criteria for scoring). The reasons for preferences and rejection of options also emerged. The objective is to find the priority between problems and select the most feasible alternative solution suitable with the local conditions. This research used (1) *preference ranking* to scoring importance of forest benefits overtime and (2) *matrix ranking* to gain information about *forest types and benefits* and *participation in forest extraction.*

Ranking forest benefits over time: Firstly, participants are asked to think about the various benefits that they can get in the local forests at present. Then these benefits are listed and categorized in groups follows: timber and fuel wood, NTFP, medicinal plants, hunting products, regulation and cultural benefits. In the next step, the participants ranked a list of benefit groups in priority of importance level over time: in the past, at present and in the future. The ranking refers to the relative importance of each benefit group based on informant´s preference and priority. In discussion, the informants also revealed the reasons for the preferences between the items of interest and the change over time.

Forest types and benefits: The participants had to judge the different forestland categories in their areas with respect to the main benefits that they got from them, following their personal perception. For this purpose, a matrix that linked ten ecosystem services to six forestland types was drawn on an A0-paper. At the intersections, capacities of each type to support ecological integrity or to provide particular services were assessed through distributing the peanuts. The number of peanuts expressed the perceived capacity of the

particular forestry land type to support the selected ecological integrity component or to supply the selected ecosystem service on a scale between: 0 = not relevant, 1 = low relevant capacity, 2 =relevant capacity, 3 = medium relevant capacity, 4 = high relevant capacity and 5 = very high relevant capacity. The quantification of matrix value bases on experience and knowledge of the local people about the respective forest ecosystem.

Participation in forest extraction: Participation of local people in forest product extraction was rated with respect to people´s gender and age. Local people could give their judgement in the following four levels: unimportant (-), less important, (+), important (++), very important (+++).

Village demands

The annual village demand for FES was estimated, asking questions about the requirement per unit products in a Tay and in a Dao village. Each forest product was presented in words and simple drawing on an A0-paper sheet, allowing participation by illiterate people. Everybody discussed and recorded results in Vietnamese language paper, then the information was translated in English to show in this thesis.

The use of tools and indicators that local people are familiar with is inevitable to make the issue simple and vivid. Examples, the quantity of wood needed for manufacture of various products, estimation of respect volumes is in m^3, unit of fuel wood consumed daily is in pack, etc. The annual demand was roughly calculated based on the demands per a unit product, per year and the total number of households in the villages.

The annual village demand for timber and non-timber forests products was calculated based on the quantity of wood which is needed for building a unit of houses, stalls, fences and other products. Based on the demand for each product, participants then had to access how many units of each product the village is usually consuming annually. At the end of this exercise, the entire annual village demand for timber and NTFPs is approximated. Because the method has not yet been extended to yield accurate data about the quantities of bamboo or other NTFPs, the respective annual village demand was not estimated. Instead it was just recorded if the present supply was perceived as being sufficient or insufficient.

Seasonal diagram

Seasonal diagramming is a participatory rural appraisal (PRA) method that determines the patterns and trends throughout the year (Cavestro 2003; Cornwall and Pratt 2011; PAEX 2012). In this research, seasonal diagram was carried out to collect information on the cultivation calendar (e.g. period of cropping, tillage, conservation practices, labour demand, etc.). The sketches were drawn on the paper with a time scale in lunar months on the horizontal axis, and the type of the activities and their duration within the year on the vertical axis of the chart. The diagram is useful to indicate the time distribution in year

of farmers undertake the various farming activities in a year (Cavestro 2003). The purpose of cultivation calendar was to illustrate (1) the cultivation experience of the local people depending on the seasonal change of weather in a year and (2) the available period in a year farmers could spend more time with forest related activities.

a) Discussion of KIP group in Vu Chan

b) A KIP informant´s Participation in Nghinh Tuong

c) A group discussion in the Tay village

c) A group discussion in the Dao village

e and f) Participation of local people in focus group interviews.

Photo 4.1: Some images of group discussions

Source: Fieldwork (photos taken by the authors)

Historical profile diagram

Historical profile diagramming was undertaken in the two communes to obtain insight in the events that had an effect on forest ecosystem use and management. Participants traced back past and current time (Tesfai and De Graaff 2000) to define the major agents (policies, projects, activities of local people) and factors (forest cover, forest quality such

as timber, non-timber, the number of species) of changes. The participants also analysed and described the reasons and changes of forest ecosystems.

4.2.2. Household surveys

Questionnaire design

Based on the identified relevant services and indicators, a questionnaire was designed to survey the FES used and demanded by local households; local individual awareness and assessment of the recent FES supply - demand and local impacts were added. The questionnaire contains both open and closed questions. *Closed questions* are questions in which all-possible answers are identified and the respondent is asked to choose from a list of answer choices. *Open questions* are questions that allow the respondent to answer in any way they wish, give their opinions and feelings. An opened question asks the participant to formulated his own answer, where as a closed question constrains the participant to a greater extent (Phellas et al. 2012). Some questions are 'mixed', containing both open and closed answer choices. In "Others" option in the list of answer choices, respondents can add their own answers excluding as options in the questionnaire. They also have to elaborate the reasons underlying their answers to the closed-form questions. This is better approach to avoid an overly restrictive questionnaire or one that is too open and difficult to analyse. *Likert scale questions* ware used to scale responses for FES importance and effectiveness of forest-related information sources. Scaling was used to evaluate ecosystem services in some researches such as (Morhardt 2006; Burkhard et al. 2012b; Nedkov and Burkhard 2012)

Finally, a six-page questionnaire for household survey was conducted following the formatting options of the Evasys software. Each questionnaire has a barcode for each page used for the software-driven data input process. The questions were put in order of following content groups:

- General information about the household
  - Personal information concerning the respondents and family
  - Forest plantation and management activities in the household
- Forest ecosystem services related to the household (following consumption - demand - supply - impact - assessment) including
  - Timber for construction
  - Fuel wood
  - Other forest products
- Other information
  - Information-received sources and influences
  - Local awareness and assessment

The Vietnamese language was used to develop the questionnaire because it is the mother tongue of the interviewees. This made it easy for the respondents to understand the questions and explicitly express their opinions and concerns. Additionally, words and concepts in the questionnaire have the same meaning for both respondents and questionnaire designer and conform to the local context and respondent´s background. The questionnaire was translated into English for non-Vietnamese speaking readers and the scientific community (*see in the appendices*).

Household interviews

The survey was carried out in the communes of Vu Chan and Nghinh Tuong. After explaining the purpose of the surveys, selected villages were determined with the help of consultants of the local government. The interviewers also met and informed the leaders of selected villages about the survey. A sample of Tay and Dao households was selected for the interview. In some cases, the village leader went with the research group as a guide and worked as an interpreter during the interviews. Targeted respondents of the survey were defined to be adults (both male and female) and belonging to one of the two most important ethnic groups (Tay and Dao) but not necessarily the household head.

The local people were hesitant to read and answer the questions by themselves because they afraid of wrong answers or bad handwriting. The interviewers had to make a friendly conversation and help them fill in the questionnaires. There were more men willing to participate in the interviews than women, who refused interviews because they were not head of the households and not confident to answer. In some cases, it was observed that the women were a little informed about the forest resources and use. This made it difficult to achieve gender balance with respective number of respondents.

Photo 4.2: Household interviews with questionnaires

Source: Fieldwork (taken by the author)

Another difficulty was to meet the respondents. Because of the dissected terrain and scattered residential areas in some remote hamlets, families live alone on a hill or in a small group in remote mountains. To get from one house to another, people have to take a long time on foot across streams or following a small path around the mountain, which becomes slippery and muddy after rainfalls. People usually go to work in their upland

fields or go to forests early in the morning, and they come back when it is dark because their fields and their forests are not situated close to the houses. If the interviewers did not visit interviewees at the right time, they met only children and elders at home.

Characteristics of respondents

All in all 195 face-to-face interviews have been performed in Vu Chan and Nghinh Tuong (53% and 47 % respectively) with 52% the Tay and 47% the Dao ethnic group. Gender of respondents was unwell balanced with 73% men and 27% women. Household leaders achieved 67%, in which only 5.3% were women. Poor respondents accounted for 43.5%. Almost of interviewees (97%) gain their main income from on-farm activities, only meagre 3% of their income came from off-farm sources. More than half of the interviewees had below secondary school level education, while a quarter of them had finished secondary schools. After secondary school education, the local people have to move to another area to apply for high schools and higher education levels, that is why only 5% of them finished high school program and less than 5% attended vocational schools and universities (figure 4.1). The age of interviewees ranged from 20 to over 60 years old, in which the age of 30 to 50 dominated the approximately 60% in total (figure 4.2). Four-person family including a couple and their two children is popular family size (40%) in research areas (figure 4.3). In some family, there are three or four generations living together, because parents usually live with a son and his own family when they get older.

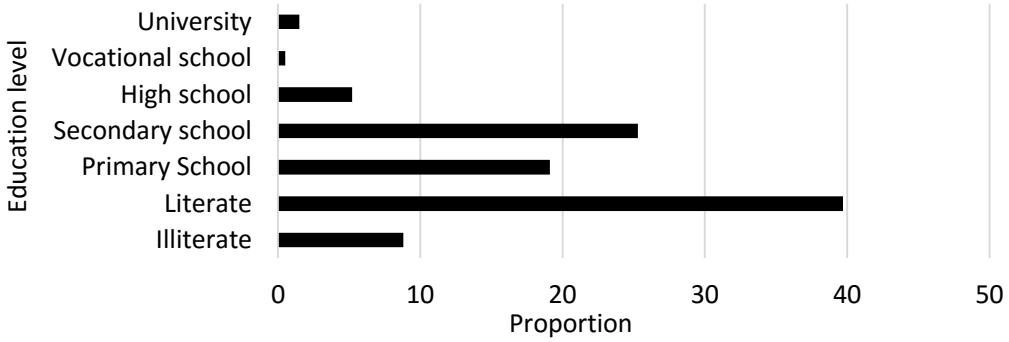


Figure 4.1: Distribution of people in education level (n = 195)

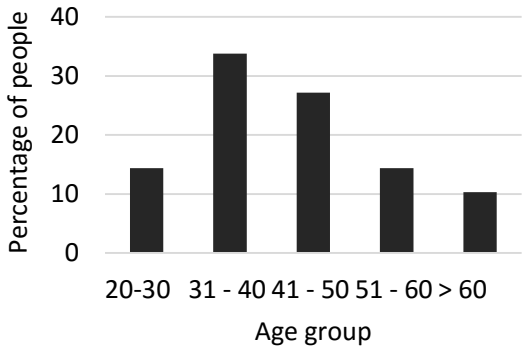


Figure 4.2: Distribution of interviewees in age groups

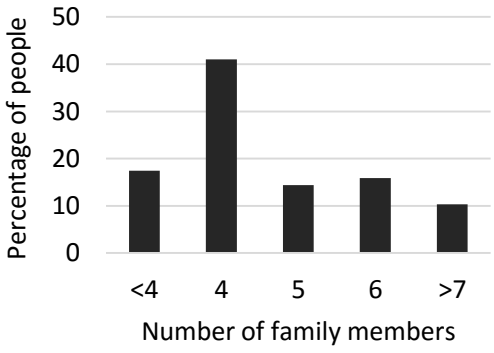


Figure 4.3: Size of family

4.2.3. Individual expert interviews

Expert interviews usually collect qualitative data of the research issue, such as cultural services or forests management. In some sections, this qualitative information supported or further clarified the information gained from the household surveys and the group interviews. Face-to-face interviews seem to be the best way in the areas, where internet and telephone do not offer good services and thus are still unpopular. Moreover, through direct interviews, interviewers could gain the interviewees´ confidence and observe their behaviours as well.

Semi-structured interview guidelines were prepared for the interview session, where only some of the questions are pre-determined and new questions may arise during the interview, in response to preceding answers from the interviewed (Bhandari 2003). The interviews were conducted with individuals using ***open-ended questions,*** which have the potential to evoke responses that are meaningful and culturally salient, unanticipated by the research, rich and explanatory in nature (Dey 1993; Flick 2009; Fish et al. 2011). This question type will encourage informants to manifest their answers freely and follow their personal beliefs, conception and experience of the questioned issue. ***Qualitative interviews*** allowed the researchers feel flexible to probe initial participant response by why and how questions (Dey 1993; Flick 2009). All interview information was recorded by notes, recorders and transcribe verbatim. The informants were identified based on the purpose of interviews or required content (table 4.3).

Some respondents accepted the interview with pleasure, while others did not agree to take an interview with recorders, especial local people. They were afraid because recording a talk intimidated them and took their confidence to answer freely. Moreover, some people thought that the talk relating to forest product themes is more sensitive. Thus, recording is not good for them. Although researchers explained with interviewees' purposes and contents of interviews, some people still refused with recorders. In some cases, we approached them by friendly talking about marginal things before go to the main goal of meeting. In some interviews, we did not recode the talk by recorders because we would like interviewees feel free and safe with their answers, and they will talk truthfully. This approach is very effective with some sensitive issue such as situation of illegally extracting forest products or evaluating the role of some stakeholders in forest management.

Besides face-to-face interview, informal talking with local people during field trips provides marginal information that could help researcher partly understand local life and social context.

Table 4.3: The respondents and the corresponding interview contents

Who?	What?	How many?
Foresters	- State of forests and forest management - Cooperation of local people - State of forest product extraction	3
Local government officers *(chairman and specific staffs of CPC)*	- Local forest management and impact of forest policies and institution on local forests and community - Local socio-economics development - Benefits as well as influences of development projects in the areas - Local land use	6
Local medical officers	- The local healthcare services in the area - The information popular diseases related forests in the past and at present	2
Timber traders	- The journeys of local wood (where and for what?)	1
Local healers	- The availability of medicinal plants - The knowledge of medicine collection, treatment	4
Rector of secondary schools	- Official and in-official education programs relating to forest resources and forest protection in schools - How do pupils´ responds with these programs	1
Forest management board of TS-PH	- Forest biodiversity - Local people´s responds to establishing conservation area and planning special-used forests	2
Local people *(villages´ leaders, older people,etc.)*	- Forest-related culture and stories - Local knowledge - Impacts of local activities on forest quality and quantity - Participatory forest management in the area - Changes of forests and landscapes over periods	>15

a) A Dao shaman and a family header; b) An old man with experiences of hunting; c) A forest owner in his forests.

Photo 4.3: Some informants in individual expert interviews

Source: Fieldwork (taken by the author)

4.2.4. Direct observation

Direct observation is a technique to collect informal data in field research that might give an overview of physical and social features of a study area or a group of individuals and help design questions and structure for the following approaches to give the best understanding of the study issues. It relies on direct presence of the researcher who provides direct and reliable research data (Talja 1999)

Observation can be used during the time of interviews, group discussions, village visits and travelling or even informal conservation. For example, an interviewer could observe some forest products used in local households, such as ornamental plants or handicraft products. He or she could also seek human behaviour or perception (Talja 1999; Marck et al. 2005) of research issues. All direct observations have to be put on appropriate record, for example by taking field notes or exemplifying photographs as an illustration of the research.

The data of observation can be checked against local people´s subjective reporting of what they use, believe or do through their usual context. It may also help to check or support formal data that have been collected by other methods or suggest new questions or ideas for further semi-structured/qualitative interviews (Marck et al. 2005).

For the presented study, the author did many field trips in different periods of time during four years of research to do research phases and combine with observation. Information that observers could focus on criteria:

- Physical or ecological information of the villages: terrain, infrastructure, landscape, resident sites.
- Social and cultural information, such as the habits or customs of local people, their behaviours and perceptions, the differences between from ethnic groups, the social relations as to be observed in community meetings or in a big event of a household.
- Local cultivation systems and livelihood
- Forest product collection and storage in the homes: the amount of wood stored in the homes or vehicles, etc.

4.3. Data analysis

For data of the household surveys, the filled out questionnaires were scanned into the Evasys software. After coding all variables, the data was transferred into Excel and SPSS for further descriptive analysis. Multiple linear regression analysis was used as an analytical tool to explain the influence of respondents' backgrounds on their evaluation of forest´s importance for household´s incomes, water supply, water regulation, climate regulation, soil nutrients and local culture as *the dependent variables*. The *independent*

variables are respondent's age, gender, ethnics, educational level, family size, economic status of households, commune where they live, respondent´s position in the family.

The model of multi linear regression has the formula (Landau and Everitt 2004):

$$\hat{Y}_i = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + ... + b_nX_n$$

Where $\hat{Y}$ is a dependent variable

b_o is a constant value

b_i is the regression coefficient for each corresponding explanatory variable X_i

n is the number of independent variables

The study encompasses thirteen independent variables and six regression models which correspond to the six dependent variables. The selected variables are described in table 4.4.

Table 4.4: Selected variables in the multi linear regression model

Variables	Description	Unit/grading
Independent variables		
Age 1	Respondent's age in group of 20-30 years old	1 = from 20 to 30 years old; 0 = other
Age 2	Respondent's age in group of 21-40 years old	1 = from 31 to 40 years old; 0 = other
Age 3	Respondent's age in group of 41-50 years old	1 = from 41 to 50 years old; 0 = other
Age 4	Respondent's age in group of 51-60 years old	1 = from 51 to 60 years old; 0 = other
Gender	Gender of respondent	1 = male; 0 = female
Economic	Economic status of family	1 = poor; 0 = non-poor
Commune	Commune that respondent is living	1 = Nghinh Tuong; 0 = Vu Chan
Ethnic	Respondent´s ethnics	1 = Tay; 0 = Dao
Family´s leader	Position of respondent in the family	1 = leader; 0 = non-leader
Education 1	Education background of respondents who has not finished primary school (include illiterate and literate)	1 = under primary school; 0 = other
Education 2	Education background of respondents who finished only primary school	1 = primary school; 0 = other
Family size 1	Size of respondent´s family	1 = 4 people and less; 0 = over 4 people
Family size 2	Size of respondent´s family	1 = from 7 people ; 0 = Less than 7 people
Dependent variables		
Forests and household income	The role of forests with incomes of respondent´s household	
Forests and water supply	The role of forests with water supply	
Forests and water regulation	The role of forests with water regulation	1 = unimportant 2 = less important 3 = neutral
Forests and climate regulation	The role of forests with climate regulation	4 = important 5 = very important
Forests and soil nutrients	The role of forests with soil nutrients	
Forests and local culture	The role of forests with local culture	

The *backward selection method* was used to provide an initial screening of the independent variables when a large number of variables is to be considered (Landau and Everitt 2004). This is one of several computer-based iterative variable-selection procedures. It starts by developing a full model containing all the potential explanatory variables. Then, based on coefficient significance $\alpha = 0.05$, at each step the variable with the highest *p*-value greater than 0.05 is removed from the model, and another regression model is developed with the remaining independent variables. The backward elimination continues until all remaining independent variables have *p*-values less than 0.05. The advantage of backward elimination is that the decision maker has the opportunity to look at all the predictors in the model before removing the insignificant variables. The correlations of determination (R^2) were computed. This measures the strength of the linear relationship between the dependant and independent variable(s).

Qualitative data was transferred from interview recordings into transcripts. Those were read carefully and notes were written to describe all aspects of content. Information categorization is necessary to be done follow the aspects of each issue that will be analysed (Bhandari 2003).

With reference to theoretical and conceptual framework, background knowledge, the synthesized results are finally shown in tables, graphs, diagram and texts.

4.4. Limiting factors

Apart from limitations that are stated in each section, the following difficulties were encountered during the research:

- *Language difficulties*: The research group faces with some difficulties related to local languages. Local people have their own languages. In some conversation, they discuss each other in local language that making interviewers do not catch up with or understand their dialogs. In some rare cases, it is difficult to explain the requirements or situations follow their dialects and understanding ways leading to misunderstanding between interviewers and interviewees as well as spending more time of interviews.
- *Reliability*: Although all the interviews were conducted in a conversational manner, and ‘sensitive’ questions about forest product harvesting such as wildlife hunting or logging were integrated into other sections, some villagers were clearly reluctant to provide truthful responses because of their inherent fear of legal punishment. Therefore, under reporting, illegal activities by community member are probable. A similar situation was observed concerning the report of local knowledge of hunting skills.

- *Data gaps*: Some data or information is not available such as:

- Data on demography or land use change in previous periods is unavailable or insufficient to analyse the drivers of changes on the forest ecosystems. Storing primary data of social and economics is not good and adequate at commune level in rural areas of Vietnam as well as in the research areas.
- The units of measurements for the data on resource uses were not uniform among interviewees because of locality´s features or the respondents´ interests. For instance, the measurements used to calculate the amount of consumed fuel wood differed from household to household. Some of them used the unit of “pack per day” while others estimated in m^3 per month or year. Another example is the area of forests owned or controlled by each family. Some respondents knew the size of the forests they were allocated to in ha, but some others only knew where their forest are located or how many plots they had, but not the exact size.
- In most interviews, the author could not get accurate information about the annual income or expenditures, etc. because a part of the income was illegal (i.e. from wood extraction or transportation). Moreover, the daily life of local people was mostly based on agriculture and NTFP exploitation that could not be measured in cash.

CHAPTER 5: FOREST ECOSYSTEM SERVICES IN THE RESEARCH AREA

Forest ecosystem services (FES) are recognized by service supply of forests and human demand for these services. This chapter analyses the FES in the research areas based on the local people´s demand for FES and their assessment of local forest supply. The demands of households and villages are analysed to indicate the different demands between Tay and Dao people and demand changes over time. This chapter will present the detail results of the uses of some provisioning services and some culture services in this area. Besides local people´s demands for FES, the governmental demands are analysed to indicate the match or mismatch with local demands. The governmental demands were indentified by inferences from legal acts of national and local forestry organizations.

5.1. Local people´s demand for forest ecosystem services (FES)

5.1.1. Awareness and importance ranking of current forest benefits

The current benefits that people can get from the local forests were surveyed in focus group interviews. First of all, participants thought of tangible goods and benefits as provisioning services that they could use directly. Only few people did also consider regulation services, in particular the role of the forests with respect to water sources and local climate; while the intangible socio-cultural services of forests, i.e. their inter-linkage with local culture and social life, were only acknowledged after having been suggested by the interviewer.

The mentioned benefits of forest ecosystems were divided into the following six groups: i) timber products and fuel wood; ii) non-timber products including wild vegetable, bamboo, and honey; iii) medicinal plants; iv) hunting products; v) regulation with respect to water, climate and soil nutrition; and vi) culture. The participants appreciated the importance of these forest benefits with respect to their current daily life. Table 5.1 illustrates the results of interviews and discussions in the two research communes concerning the benefits of forests and their importance. Ranking levels range from 6 indicating the most important benefits to 1 indicating the least important benefits.

There was no difference between local authorities and residents concerning the most important level of forest benefits. Vu Chan (VC) people thought that timber products and fuel wood are indispensable to their lives because they needed wood for building stilt houses and for daily cooking and heating in winters. These benefits were rated at second importance level, following the most important regulation benefit in the Nghinh Tuong (NT) commune where people considered water-related benefits as very significant for their lives and their cultivation. Many people said that, the amount of water had diminished in recent years, and that shortages of water for cooking and washing occurred in some places during the dry season. Hunting products became less important in people´s lives due to the reduction of wild animals and a better availability of protein food in the markets. However, according to NT1 and VC2, it is considered

to be more important than cultural benefits. As an overall result, cultural benefits are not highly appreciated in the research area.

Table 5.1: The importance level ranking of forest benefits with respect to local people´s daily lives

Benefits	OR	NT 1	NT 2	VC 1	VC 2
Timber and fuel wood	**5**	5	5	6	6
Medicinal plants	**4**	4	4	3	4
NTFPs	**3**	3	3	3	4
Hunting products	**2**	2	1	1	2
Regulation (*)	**6**	6	6	5	5
Culture	**1**	1	2	2	1

Ordinal numbers from 1 to 6 refer to the order of importance levels, in which 6 indicates the most important level and 1 means the least important level.
(*) Regulation (with respect to climate and water resources)
NT 1: the group discussion of KIP in the Nghinh Tuong commune
NT 2: the group discussion of locals in the Nghinh Tuong commune
VC 1: the group discussion of KIP in the Vu Chan commune
VC 2: the group discussion of locals in the Vu Chan commune
OR: Overall result as a synthesis from all group discussion results

5.1.2. Changes of FES demands over different periods

The local demands of FES have changed over time. The results of this change indicated by the group discussions are presented in table 5.2. Timber and fuel wood are considered essential in every period because they are necessary for construction, cooking and heating. Hunting products and non-timber products such as vegetables or bamboo shoots used to be highly appreciated in former time because they were the main sources of nutrients for the local people in their self-sufficient economy. At present they have dropped to a lower position and they are expected to drop further in the future. The significance of forests in regulating water resources and climate was accessed to be very high at present and in the future, although this benefit had been almost ignored in the past. This can be explained by the shortage of water in dry seasons in recent years which directly affected the life and cultivation of local farmers whose water resources originate from forests. The cultural services are predicted to get more attention in the future although only in forth position. The relevance of medicinal plants was rated as slightly increasing compared to the past and expected to remain at a medium level in the future.

Table 5.2: Use of forest ecosystem services and changes in the course of time

Benefits	Past	Present	Future
Timber and fuel wood	6	5	5
NTFPs	4	3	2
Medicinal plants	3	4	4
Hunting products	5	1	1
Regulation	1	6	6
Culture	2	2	3

Note: Ordinal numbers from 1 to 6 refer to the order of importance levels, in which 6 indicates the most important level and 1 means the least important level.

5.1.3. Local village demand

The annual demand for FES was estimated for two villages, one of the Dao people and one of the Tay people. Based on the demands per unit, per year and the total number of households, the village demand was roughly calculated (table 5.3). The amount of timber needed for a house was quantified based on the medium size of houses in the village and the dimensions of each part of them. Then it was converted into cubic meters of wood. The calculation was done in a similar way with livestock stalls. As the methodology has not yet been extended to yield accurate data about the quantities of bamboo, firewood, and other NTFPs, the annual village demand for those commodities was not estimated. Instead, participants were asked if respective resources could be obtained in sufficient quantities from their forests at present. Regarding firewood, the amount of backpacks per household per day as well as the respective annual village demands were recorded.

The house of Dao people is usually smaller than that of Tay people. Therefore the Dao needed a smaller amount of wood, although two new houses were built every year in both villages. This result also matches with the result of the household interviews. Since the Tay do not raise buffalo any longer, they have no demand for wood to construct pens. The pigpens of the Dao are normally made of wood while the Tay use non-wood materials. The Tay raise pigs as a livelihood while the Dao consider them as an extra food source. Therefore, the number of pigs in a Tay household is normally bigger than that in the Dao household. Cooking food for domestic livestock is a reason why the Tay have higher annual firewood demands than the Dao. Tay people were satisfied with all NTFPs while the Dao were not content with the availability of bamboo and bamboo shoots. The Tay grow bamboo culms around their houses to meet their demands for mature bamboo and bamboo shoots. But this is not the case for the Dao.

Table 5.3: Annual village demand for FES in a Dao village and a Tay village

a) Annual demand in the Dao village

Product	Requirement per unit of product	Annual village requirement (62 households)
Stilt house	24 - stilt house: 15 m^3	Two new houses every year
Buffalo pens	1.29 m^3	One new stall every two years
Pigpens	1.53 m^3	Two stalls every year
Firewood	1 pack every two days	11315 packs/year
Coffin	5 planks: (2.20 x 0.5 x 0.05) = 0.275 m^3	One coffin every 10 years
Medicinal plant	→	Enough to satisfy village demand
Bamboo	→	Unsatisfying village demand
Bamboo shoot	→	Unsatisfying village demand
Wild vegetable	→	Accounting 20% of total amount

b) Annual demand in the Tay village

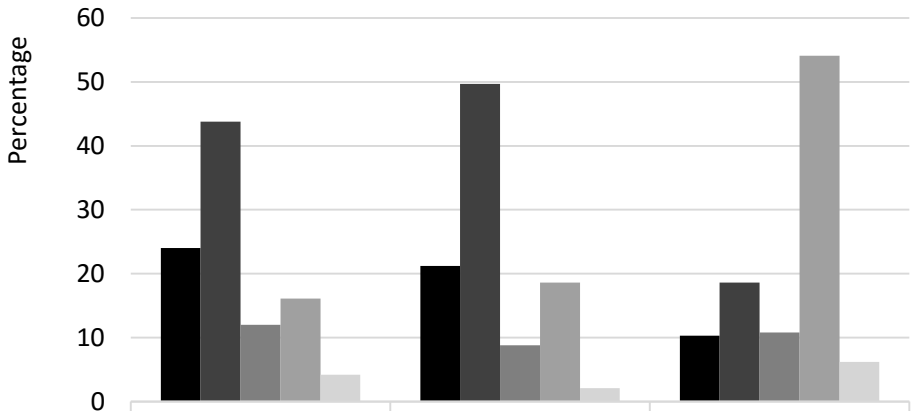
Product	Requirement per unit of product	Annual village requirement (57 households)
Stilt house	36 - stilt house: 25 m^3	Two new houses every year
Buffalo pens	No	
Pigpens	Non - wood material	
Firewood	1 pack per day	20805 packs/year
Coffin	5 planks: (2.20 x 0.5 x 0.05) = 0.275 m^3	One coffin every 3 years
Medicinal plant	→	Enough to satisfy village demand
Bamboo	→	Enough to satisfy village demand
Bamboo shoot	→	Enough to satisfy village demand
Wild vegetable	→	Enough to satisfy village demand

5.2. Local people`s assessment of FES supply

5.2.1. Satisfaction with recent supply

The assessment of FES supply is based on local people´s perception. The evaluation of their satisfaction with water supply or with certain provisioning services gives information about their availability. Another assessment regards the ability to provide goods and services of some forestland types in the area.

As can be seen in figure 5.1, two thirds of the respondents were highly satisfied with their domestic water supply in both quality and quantity, although they claimed that the amount of water has declined recently. However, more than 60% of the interviewees were displeased with the agriculture water supply. They complained that their fields did not receive enough water to growth two paddy crops a year. Thus, the fields either produced other types of farm crops or lay fallow during the dry season. The shortage of water in the dry seasons has affected the life of local people whose water resources originate from the forests and depend on annual precipitation.



	Domestic water quality	Domestic water quantity	Agriculture water quantity
Completely satisfied	24	21.2	10.3
Satisfied	43.8	49.7	18.6
Neutral	12	8.8	10.8
Unsatisfied	16.1	18.6	54.1
Completely unsatisfied	4.2	2.1	6.2

Figure 5.1: Satisfaction of local people with water supplies

In another FES assessment (table 5.4), local people had to compare the availability of various provisioning services at present with that in the past. In general, the evaluation shows that most tangible goods have become scarcer than before. Especially, wild animals and wild honey were considered extreme shortage levels by approximately 98% and 95% of the respondents respectively. Nowadays, local people do not see or meet the trace of wild animal species in the local forests any more. Some kinds of wild animals seem to exist only in the books or the stories of old people. Sources of wood, bamboo, bamboo shoots, ornamental species and wild vegetables were also evaluated at scarce level by more than 70% of the respondents. However, the supply of medicinal species was still rated as plentiful by 34% and as neutral by 21.4%. Finally, fuel wood supply was estimated less than before, but still meeting local requirements, due to the growth of plantation forests.

Table 5.4. Local people's assessment of FES supply (by %)

Services	Very plentiful	Plentiful	Neutral	Scarce	Very scarce
Wood	1.8	12.6	15.0	47.3	22.8
Fuel wood	12.9	17.7	22.0	42.5	4.8
Vegetable	3.3	8.8	13.3	56.4	18.2
Bamboo shoot	1.6	5.4	10.3	48.9	33.7
Bushmeat	-	1.1	1.1	16.8	81
Wild Honey	-	4.6	0.6	36.6	58.3
Medicinal plants	5.0	34.6	21.4	34.6	4.4
Bamboo	2.2	8.7	16.9	48.1	24.0
Ornamental species	1.2	7.3	4.2	33.3	53.9

Regarding the local evaluation of the capacity of different forestland types to provide goods and services (table 5.5), natural forests were considered to be highly relevant, especially for regulation services. This is also the case with natural rehabilitation forests because most of them are not strictly protected. Thus, local people have access to both provisioning, and regulation services from these forest areas. Natural forests on limestone and zonal forests also have high potential in providing regulation and provisioning services but they are irrelevant for grazing or as a place of graves. Even plantation forests were supposed to be of very high relevance for erosion prevention and climate regulation although they will be clearcut and replanted every 7-10 years. They are also highly relevant for grazing, but they have only limited capacity with respect to provisioning services or water regulation because they are usually monoculture plantation forests with simple vegetation structure and low biodiversity. Finally, non-forested land and upland fields are of minor relevance or even irrelevant for most services. Nonetheless they are considered to be the best places for grazing and graves. Overall, forest lands with forest vegetation were expected to supply a higher number of services than others.

Table 5.5: Local people's assessment of local forestland type's capacity to provide goods and services

Land types	Timber	Fuel wood	Medicinal plants	NTFPs	Grazing	Grave place	Water supply	Water regulation	Climate regulation	Soil protection
Natural limestone forest	5	5	2	4	0	0	5	5	3	5
Natural zonal forest	5	1	5	5	0	0	5	5	5	5
Secondary forest	3	5	5	3	5	4	5	5	5	5
Pure stand plantation forest	2	0	0	2	5	2	1	2	5	5
Non-forested land(*)	0	0	3	0	5	5	0	0	5	0
Upland field	0	0	3	0	5	5	0	0	0	0

(*): Forestry land with only grasses or bushes but very few trees.
Local people evaluated capacity to provide the forest ecosystem services based on their own empirical perception and their accessible ability these benefits. Scale from 0 = no relevance; 1 = low relevance; 2 = relevance; 3 = medium relevance; 4 = high relevance; and 5 = very high (maximum) relevance.

5.2.2. Perception of changes of forest ecosystems and their services supply

Following local people´s description (table 5.6 and box 5.1), the ecosystems are deemed to have changed over time. Before the 1990s, forests were the primary land cover with high quality. Forest species (both fauna and flora) were distributed widely with a high number of individuals, including valuable species. Big and durable timber species were

plentiful to support local construction. In local people´s narrations, many big trees with a diameter over one meter, enough for a whole pillar set for a house, could be found. At that time, the tools for logging were still manual and simple, and burning the basis of big trees was a good way to fall them down. Wild big animals appeared frequently in the forests or around the areas where people lived. Sources of medicinal herbs were available for local traditional health care. Agriculture cultivation was poor with low yields and productivity, thus the people almost lived in starvation. A document of Vu Chan[9] recorded that the average food productivity in 1986 was 160 $kg.person^{-1}.year^{-1}$, which was already an improvement compared to the previous years. Starvation and poverty caused local people to enhance slash and burn cultivation, wild food gathering and hunting from forests. However, they seemed satisfied with the availability of food supply from the forests during that period.

Forests degradation increased as a result of deforestation and shifting cultivation. Thus primary forest areas shrunk while the population and distribution of animals and big trees declined. At that period, agricultural development, such as the application of new varieties or the cultivation of rice and maize in lowland fields partly solved food insecurity issues in the area. This reduced the pressure on forest land due to shifting cultivation which has been prohibited since 1992.

During the last decades, afforestation policies have affected a change in the landscape. Forest plantation has greened almost all barren lands and mountainous areas. However, biodiversity in natural forests has decreased. Some species even disappeared and only small or invaluable timber trees have remained.

All in all, the local people seemed to be nostalgic about an abundant forest ecosystem that used to be a good supply for their life previously. They did not know when this ecosystem could be restored.

[9] Cited in “History of Communist Party Committee in Vu Chan”- this book is editing for publication.

Table 5.6: Synthesis of local people´s descriptions of forest ecosystem changes over time

Items	More than twenty years before (before 1992)	Twenty years before (1992- 2002)	Recent ten years (2002-2012)
Forests	- Primary forests had a good quality with a variety of valuable and large timber trees in high density	- Primary forests quality had been reduced - Shifting cultivation was banned and abolished - Forests were allocated under restoration - oriented protection	- Primary forests degradation continued - Secondary forests and plantation forests developed - Forest Biodiversity declined
Wild animals	- There were precious and big wild animals such as deer, wild boars or monkeys - Wide spread and in high number of individuals	- Precious species had been reduced - Distribution and numbers of individuals declined	- Animal wildlife diversity and habitat ranges decreased further - Some precious and big species disappeared - Only small species such as squirrels, weasels survived
Woody plants	- Many big and precious timber trees of high economic values, such as *Madhuca pasquieri*, *Vatica* sp., *Markhamia stipulata*, *Michelia balansae* (*Giổi) and others were available*Wood extraction for construction was usual	- Valuable wood became rare: only vestiges remained *- Melia azedarach (xoan), Canarium sp., Cinnamomum iners (De)* were popular species - Pruning and logging wood of *Styrax tonkinensis (bồ đề)* was permitted	- Big and valuable wood trees were minimized - Small and less valuable trees started to dominate - Non indigenous tree species such as *Acacia* spp. or *Canarium* sp. were planted
Medicinal plants	- Plentiful medicinal plants, including specious medical species like Lingzhi mushroom (*Ganoder malucidum*) were available - Some common medicinal plants occurred abundantly around the homes	- Abundance of medicinal plants still existed inside the forests - But shortcomings had developed around the houses - The Lingzhi mushroom had become scarce	- Abundance levels were reduced further, leaving only few common species - The natural Lingzhi mushroom disappeared

Agriculture yield and productivity	- Wet rice was cultivated with just one crop per year - Up-land field crops (rice and maize) had rather low productivity	- Wet-rice was cultivated with two crops per year in some fields. - Paddy and maize was cultivated on both, upland and lowland fields. - New varieties of maize were planted while up-land rice cultivation was reduced	- Productivity and cultivation scales of wet rice have been extended with an increased extent of two-rice-crop cultivation - Shifting cultivation was completely abolished - New varieties of crops got cultivated with higher yield

Box 5.1: Verbal descriptions concerning the changes of forests (from interviews)

Forest ecosystem

- "The mountains and forests were dense and interminable with many big timber trees. In this side (*pointing to the front of the house*) there were primary forests, but now they became "*rừng ót*" (*means poor forests*). The limestone mountain had valuable and durable wood such as *Excentroden drontonkinense (nghiến), Vatica sp. (táu), Markhamia stipulata (đinh), Madhuca pasquieri (sến), Chukrasia tabularis (lát),* nevertheless, they are gone out at the present. (….) Forests have been degraded by deforestation". (Interviewee)
- "There were primary forests with many big trees that could not be taken in someone´s arms round (…) there were many big trees of *Excentroden drontonkinense* (*nghiến*) and other big wood trees in the limestone mountains in front of my house, but now there are invaluable trees that are only used for fuel. It looks green but there are just invaluable things in side". (Interviewee)

Fauna

- "Formerly, birds and wild animals like monkeys and wild boar were abundant. In this season, I´ve never seen deer in the upland fields. In the recent five years, animals have gone out". (Interview
- "When I was young, there were many wild animals like herds of wild boars and deer. Now, there is not any footprint of them". (Interviewee)
- "When I was a child, the old people said that deer and wild boars destroyed some low land field so that they could not harvest their crops. At that time, old forests were in this area and I still saw wild boar when I was an adult". (Interviewee)
- "Deer once came and shouted behind my house, but now it is impossible to find out traces of their foot. (…) At that time, we could hunt many animals in the forests behind the house. We have always caught golden turtles (*Cuora trifasciata*). Up to now, even other turtle species have disappeared because of local people catching turtles to sell them". (Interviewee)

- "In old times, there were hundreds of wild boars. We could hunt even two to three boars a day. When boars became rare, we hunted monkeys. (….) Hunting made wild animals not existed anymore". (Interviewee)

Flora

- "Recently, exploitation for selling outside has caused the depletion of some kinds of medicinal plants. Some species decreased about 60%, compared to the previous state, some species cannot even be found at all nowadays". (Interviewee)
- "Mass of *Neohouzeau nadullooa* had flowered, followed by the death of adult plants since several years. Thus the bamboo shoots of *Neohouzeau nadullooa* have become extinct in this area. People must wait at least four years for this species to regenerate naturally and to get the shoots". (Interviewee)
- "All fourtytwo stilts of my house are *Shorea chinensis (chò chỉ)* timber. We make five sets of stilt house from a *Shorea chinensis* tree that was 1.6 meters in diameter and hundred meters in height. (…) We logged it near my house. At that time, we had to burn the foot of the tree to make it fall down. The burning took more than a month". (Interviewee)
- "Previously, there used to be many trees of *Peltophorum dasyrachis* (lim vang) and *Vatica sp.* species (*táu*) on the mountain. (…) Now, timber species are sparse in the forests and only to be found in high mountains". (Interviewee)
- "There were many big trees of *nghiến* on the limestone mountains growing over generations. However, now they are exhausted". (Interviewee)
- "Many houses in this area were built on stilts of *nghiến*. Now, a tree of *nghiến* that is big like this one (shows a stilt of the house) does not exist anymore. I do not know how many thousand years are needed for an immature tree to grow to this size". (Interviewee)
- "It is difficult to expect that the forests will be restored like they have been before. No one knows how many hundred years are needed to get to that forest state". (Interviewee)

5.3. Forest provisioning services (FPES)

5.3.1. Present use of FPES

The following survey results give the proportion of people who are beneficiaries of forest-provisioning services considering the commune, the ethnic group and the economic status of the households, i.e. poor or non-poor (table 5.7). It reveals that there are not much different in the forest product usage between the two communes and the household economic situations, in contrast to the ethnic groups.

In general, a large number of households (over 96%) utilised *construction wood and firewood*, whereas *bush meat, ornamental species or wild honey* were only used by a minority of households with 4%, 14% and 18% respectively. Approximately three quarters of the people applied *bamboo shoots and wild vegetable* as a kind of food. The

percentage of households using bamboo accounted for 79% in total. Finally, more than half of the interviewees said that their family used *medicinal plants*.

In terms of the ethnic group, the proportion of the Dao people who consumed NTFPs for food and healthcare was higher than that of the Tay people. The Dao people also may have more knowledge and experiences concerning traditional medicines: While over 75% of the Dao families applied medical plants in healthcare, there were just two fifths of the Tay people who did. Although the number of people who employed forest species as ornamentation was meagre of 14.4% in the overall statistic, the number of the Tay was almost four times more than of the Dao. This can be explained by the differences in the residential positions and customary laws. The Tay lives in lower areas, where cultivation lands are flatter and easier for managing paddy fields and their irrigation. While the Dao live in high positions and close to the forests where land sources are limited and steeply sloping. They live separated from other communities and their life is closely connected to forests.

Table 5.7: Percentage of households using forest provisioning services

FPS	Commune		Ethnic group		Economic status		Overall
	Nghinh Tuong	Vu Chan	Tay	Dao	Poor	Non poor	
	n = 103	n = 92	n = 101	n = 94	n = 83	n = 112	**n = 195**
Fuel wood	98.1	100.0	98.0	100	98.8	99.1	**99.0**
Wood	99.0	93.5	99.0	93.6	97.6	95.5	**96.4**
Bamboo	87.4	68.5	79.2	75.5	79.5	75.0	**78.5**
Bamboo shoots	78.6	72.8	69.3	72.0	68.7	70.5	**75.9**
Wild vegetable	62.1	79.4	57.4	84.0	67.5	71.4	**70.3**
Medicine	57.3	57.6	40.6	75.5	57.8	55.4	**57.4**
Ornamental species	13.6	13.0	20.8	5.3	10.8	15.2	**14.4**
Bush meat	2.9	5.4	3.0	5.3	3.6	4.5	**4.1**

The following parts will describe more in details some main provisioning services local people have used or had demands.

Wood

Wood was utilised mainly for the purpose of construction (66%) and for furniture making (26%), but hardly for selling %). Local people have high demands of wood for construction and sub-construction. They live in a stilt house, a typical architecture of northern mountainous areas in Vietnam. Stilt houses are made of wood and bamboo, with a roof of palm leaves or tiles. The frame structure of a stilt house is a system of beams and stilts, which are connected to each other and made of strong and durable wood. The number of pillars which normally ranges from 24 to 52, measures the size of a house. Other structures of the house are made of normal wood; for example, the walls are made of wood planks while the floor is made of either bamboo or wood planks. Before it gets used,

the normal wood is soaked under water in a pond or stream for one year or more in order to prevent termite and woodworm infestation.

From the results of the household interviews, 95% of households live in wood-made houses, in which 86% are stilt houses. The average size of a house is around 32 stilts. Stilt houses of Tay people are bigger than those of the Dao with the mean numbers of stilts being 33.4 and 29.9 respectively.

Over three quarters of the interviewees said that their family needed more wood. Nearly a half of these people required the wood to widen their old houses, whereas a quarter of the people desired to build a new house for their children or repair/complete their own house (figure 5.2).

Wood is used to build stilt houses (a), pens of livestocks (b,c), or make production tools (d-h)

Photo 5.1: Wood ultilization of local people (Source: Fieldwork, taken by the author)

Looking at the results of the local demand survey for altering house materials (figure 5.3), only one third of the total interviewees wanted to change the material of their house because of current shortages in the wood supply (23%). They rather think brick houses look more beautiful (14%) and are more convenient (14%) than stilt houses (figure 5.4). They also said that the brick houses keep warmer than the stilt houses.

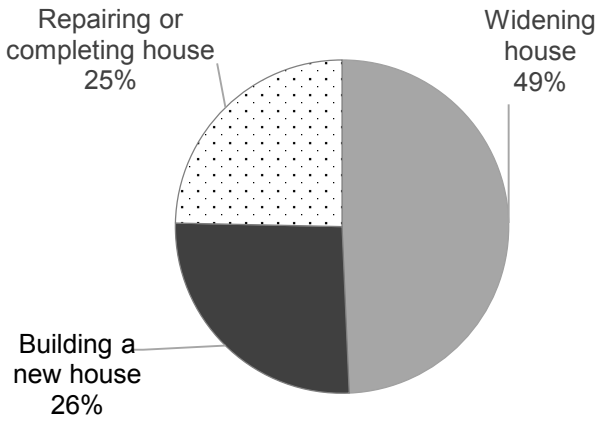


Figure 5.2: Reasons for further wood demands

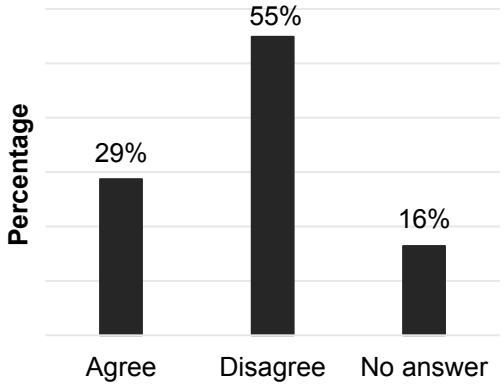


Figure 5.3: Demand for changing house materials (n = 195)

Almost two thirds of the interviewees had no intention to change their house materials because they still appreciated stilt houses. For example, a meagre of 5.6% wanted to build stilt houses because they had the needed materials available (see figure 5.5). More than a quarter (28%) asserted that stilt houses do suit the local landscape and weather. So, local people feel more comfortable to live in a stilt house. Over 12% of the respondents who disagreed to change the construction material justified their choice with cultural aspects. In their opinion, stilt houses have been part of their custom and culture for a long time and they would like to keep it. Some people also claimed that using other building materials requires good financial preparation. They explained further that they could log wood from forests and store it year by year. These results reveal that local people expect and demand wood for construction.

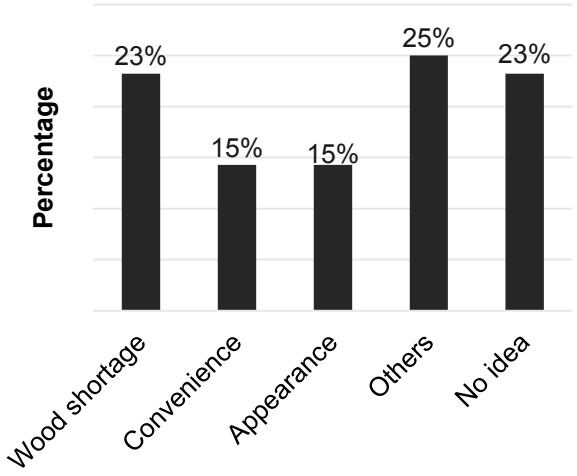


Figure 5.4: Agreement with reasons for house material change (n = 57)

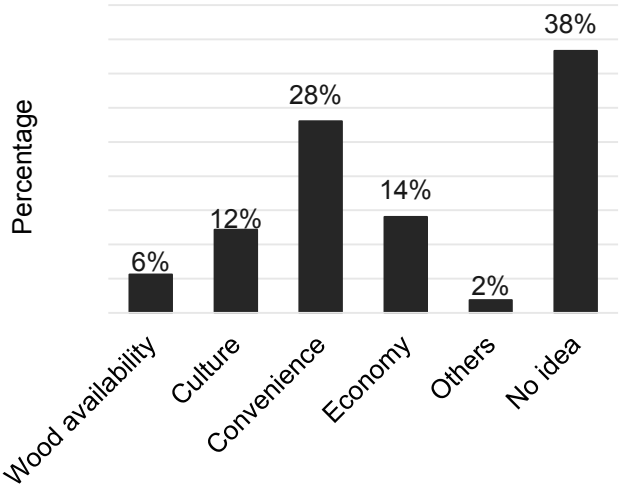


Figure 5.5: Disagreement with reasons for house material change (n = 107)

Besides the main house, there are sub-constructions like kitchen; sheds; courts for drying agricultural products; pens for livestock and poultry. Local people also required wood to build their furniture (tables, chairs, wardrobes) as well as production tools (mortars, winnowing machines, and textile-making tools). However, some production tools have fallen into oblivion due to mechanization.

Firewood

Firewood is the main fuel for cooking and heating in the area. Local people consume a big amount of fuel wood to cook mash for feeding pigs. The statistic data show that, normally, each household spent one backpack of firewood every one or two days, with an estimation of about eight to twelve cubic meters of firewood per year. People collected and logged from forests around their houses. They also salvaged small branches of pruned trees in their plantation forests. Some of them even collected firewood from parts of big trees, which were cut down for timber. They stored firewood in the ground or under the floor of their stilt houses. In the winter, big firewood logs were burned to heat the whole houses. Firewood demand also increased in late winter and early spring when big festivals are celebrated in the area, where more fuel is needed to cook traditional food.

Bamboo

People used bamboo for sub-construction (house´s floors, drying courts, fences, pens) and for tool and furniture production (tables, chairs, shelves, tool´s handles). The Tay and the Dao are also good in bamboo knitting. They can knit bamboo baskets, wattle, and lattice as partition. Knitters are usually women who are skilful and precise. They make knitting products in their free time between the two cropping seasons or on rainy days. Knitting products are kept dry above cooking fires for a long time before they are used.

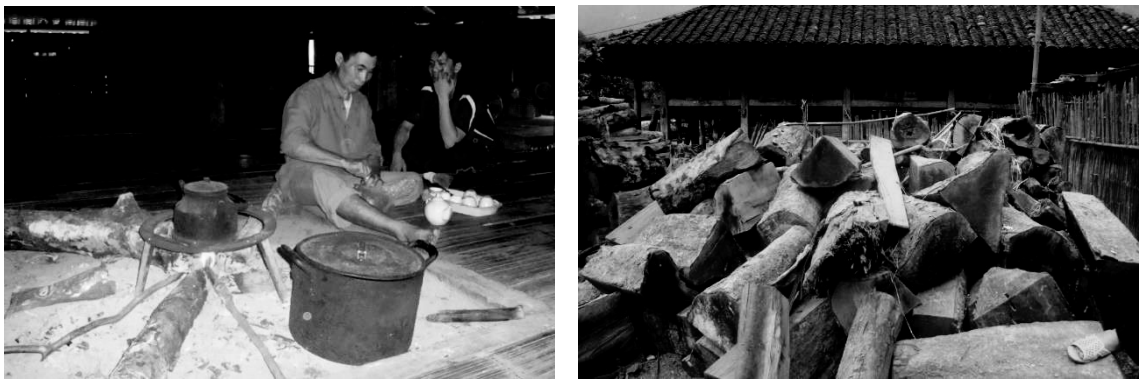


Photo 5.2: Firewood is major fuel for cooking and heating
Source: Fieldwork (taken by the author)

Medicine

With indigenous knowledge of traditional medicine, local people can produce many drugs from various forest floras to treat diseases. In some cases, the traditional drugs are even

more effective than modern medicine but no one can explain how and why. Local people use different parts of plants and herbs (flowers, leaves, barks, roots, seed and fruits) and animal viscera. Medicine can be applied as fresh or dry materials. Besides producing tonic medicaments for people, the local people do know how to produce toxic drugs for hunting.

Photo 5.3: Images of medicinal plants and using them
Source: Fieldwork (taken by the author)

Freshwater

Surface water from forests is the main water supply for over twelve thousand households in Vu Chan and Nghinh Tuong. Almost 90% of the interviewees obtained waters from rivulets or small streams for cooking and washing (table 5.8). Water is conducted directly from the forests through a pipe system made of bamboo, rubber or plastics. Around 12% of the correspondents, in which the Tay people were more than the Dao people, obtained water from dug-wells or deep wells equipped with a pump.

Table 5.8: Household proportion use of water sources for drinking and cooking (%)

Water source	Commune		Ethnic group		Economic status		**Overall** *n = 195*
	NghinhTuong *n = 103*	Vu Chan *n = 92*	Tay *n = 101*	Dao *n = 94*	Poor *n = 83*	Non poor *n = 112*	
Ground water	14.6	10.5	22.9	2.1	14.5	11.5	**12.7**
Surface water	82.5	88.4	72.9	97.9	85.5	84.6	**85.2**
Both	2.9	1.2	4.2	-	-	3.9	**2.1**

Water for agricultural cultivation

Irrigation water supplies are very important for the farmers, whose main subsistence is paddy cultivation. 203 ha of paddy fields in NghinhTuong and 196 ha in Vu Chan need irrigation each year. Water provision comes from streams, rivers and rainwater. The Tay is rather skilful in designing irrigation systems to carry water in various terrains such as ditches or trenches. Traditional irrigation tools to lead water into fields, for example, water wheels, are made of wood or bamboo, simple and available materials in the region.

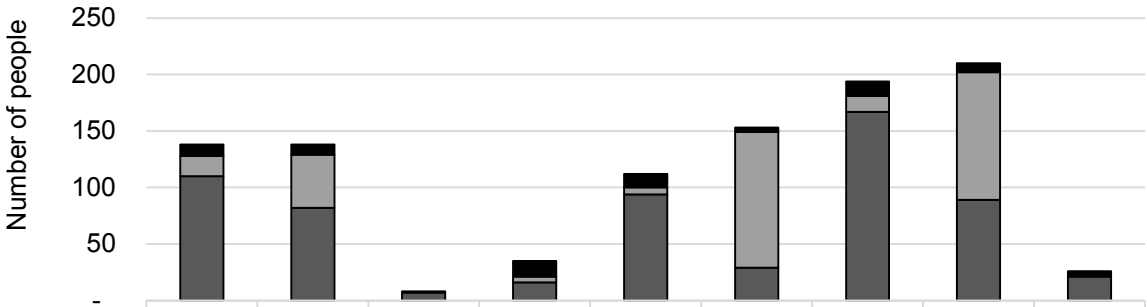
Photo 5.4: Simple irrigation tools made of bamboo and wood
Source: Fieldwork (taken by the author)

5.3.2. Present sources of FPES

The sources or places where people obtained FPES were given by the people themselves (figure 5.6). According to them, most of FPES were obtained from natural forests where the majority took wild vegetable and wood [10] from. The wood they used to build their houses had often been logged already in the past and then stored. Recently, plantation forests have been developed in both qualitative and quantitative. However, local people do not appreciate this source of wood for construction because the quality does not meet their requirements. Thus, plantation forests wood is rather sold outside the areas to provide materials for wood processing or for fuel. However, local people are only interested in the economic benefits, but not concerned about how to use plantation wood to fit their own demands.

[10] Wood includes wood that they extracted and stored since many years

Hunting products, medicine and ornamental species mostly came from natural forests but the total amount of consumers was rather small. In contrast, the majority of fuel wood and bamboo originated in plantation forests. On the other hand, natural forests do supply a wide variety of bamboo shoots that are good for food, thus a higher percentage of people get them from there or buys them on the local markets. However, the survey in general revealed that the purchase of FPES in the area is rather unpopular and only happens at the community scale.



	Vegetable	Bamboo shoot	Bush meat	Honey	Medicine	Bamboo	Wood	Fuel wood	Ornametal species
Buying	10	9	-	14	12	4	13	8	4
Plantation forests	18	47	1	5	6	120	14	113	1
Natural forests	110	82	7	16	94	29	167	89	21

Figure 5.6: FPES supply sources according to local people's information

5.4. Forest related cultural services

5.4.1. Local knowledge system

Local people have accumulated and formed their own knowledge systems to exist and adapt to their natural environment due to having a strongly forest-attached life since generations. Some ancient knowledge still exists until today and is being transferred orally in the communities or families, while others have disappeared with time. In this section, we describe the empirical local knowledge system related to the forests and the life in mountain areas as cultural services of forest ecosystems.

Knowledge about forest flora and fauna

Local residents gain knowledge about the flora and fauna that they come across regularly in the local forests. Their species-focused empirical knowledge (knowledge of form, physiology, behaviour, feeding habits, interrelations with other species, the activity of predators and diseases) is applied in various fields of their lives, for instance, finding food, hunting, choosing construction timbers and healthcare.

Local people are experts in timber identification and classification through their ethno-botanical knowledge about the flora. A man said that he could determine *Excentroden drontonkinense* (*Nghiến*), a popular plant species in the limestone forests area from long

distances, based on the canopy shape and growth position. The wood chosen for construction reveals local knowledge on timber qualities. For stilts or beams hard and durable timbers are used. They do not use the trunk with many roots, nor liana or timber with ant-heaps or woodworms inside (Ma 2004; People´s Commitee of Thai Nguyen Province 2009; Vu 2009). There is also a taboo to use plants that have had the top cut off; or trees struck by lightning for building a house. Besides spiritual reasons[11], these plants are known to be brittle or damaged in side, which is why they are weak or unattractive for building (Ma 2004).

Box 5.2: Verbal descriptions concerning local knowledge about flora and fauna

Flora

- "There is a variety of plants from the forests so for timbers. We have to learn the names of trees, which kind of trees are valuable and durable, which trees can resist to termites. […] Basically, we have to determine characters of leaves, wood grain, bark, wood type" (Interviewee).
- "Bamboo shoots that have bitter taste usually grow in spring (the first and second month of the lunar year) while shoots of *Neohouzeau nadullooa* (Nứa) grow profusely in summer (in the fifth and sixth month of the lunar year), shoots of *Macharochloan affmontana (*Giang) grow in autumn (the ninth and tenth month of the lunar year)".
- "*Phryrium*[12] grows near the wetlands along the streams or rivulets in the forests" (Interviewee) or "Medical plants distribute more in low areas and mountain forests. They grow in limestone forests also, but with low quantity" (Interviewee).

Fauna

- "We often lurked outside the cave and waited for *cắng* (the common local name of monkeys and gibbons) to come back to their habitats" (Interviewee)
- "Honey-bees usually make their nests in big branches of tall trees in the forests that have good terrain" (Interviewee)

Knowledge transparence

- **"**The mountain people going to the forest since childhood learnt from the experiences of the elderly people (referring to previous generations)". (Interviewee)
- "Nowadays, when I talk about wild animals, some of my children still know what the deer is, but my grandchildren do not know any more"- An old man regretfully said.

[11] Will be presented in another section.

[12] Leaf of *Phryrium* (*lá dong*) is used as a cover layers for some kind of Vietnamese traditional food that made of rice or sticky rice. Local people highly extract these leave extraction in the winter to use in their own family or sell outside to meet human demand in Vietnamese traditional festivals.

Knowledge about local forest species is also used for finding food and medicine. In this respect, the whole tree or only parts of it (leaves, fruits, flowers, roots, nuts, etc.) may be used. Residents have a firm grasp on growth seasons of trees to extract them, especially when bamboo shoots grow rapidly. The Book of Thai Nguyen Geography (2009) records the kinds of vegetables, bamboo shoots, and mushrooms collected in the spring-summer season and the kinds of tubers and fruit found in the autumn-winter season. Moreover, local people are very familiar with the ecological distribution of these trees in the forests.

The knowledge of fauna, such as behaviour and habitats, helps the hunters to be highly successful in their hunting activities. In relation to finding honey, they have the experience where honey bees do nest. The local people have accumulated ethno-biological knowledge from their practices and experiences as well as from previous generations, untutored by sciences. However, nowadays, they are losing the local knowledge about the fauna and flora because (1) the traditional knowledge is not written but transferred orally from generation to generation and (2) some of the species do not exist in the area any more.

Knowledge about forest soils in shifting cultivation

Knowledge about the soil and site conditions of forestland that had been accumulated in the process of using the land and selecting suitable crops was revealed in site selection for shifting cultivation. People selected areas for slash-and-burn cultivation by considering soil colour, abundance of organic matter, or porosity (box 5.3).

Do (1994) mentioned that mountain inhabitants determined soil texture by lightly throwing a pointed knife into the soil: “If it goes deep into the soil, this shows that the soil is good because it is porous. Loam or clay soils are identified if earth sticks to the knife when it is withdrawn from the soil”. An eighty-year-old man shared his experience in choosing soil for cultivation: “The fine-grained soil is good for upland rice; soil consisting of a mixture of sand and gravel is suitable for maize”. Soil is also checked by tasting (People´s Commitee of Thai Nguyen Province 2009): If it is good, it tastes a bit acrid, salty but not sour.

Box 5.3: Verbal descriptions concerning forest soil selection for shifting cultivation

- “To select a site for upland fields, we relied on soil colours to determine whether it is suitable to grow maize or upland rice (…) Soil for maize is usually located in limestone mountains and has dark brown colour. Red coloured soil under the forest is suitable for upland rice growth”. (Interviewee)
- “Soil for upland rice has red colour, while soil for maize and cassava has porous characteristic and dark colour. If cassava is grown on soil for maize, it will have poor quality and become inedible” (Interviewee).

The forest vegetation cover is considered as one indicator for soil fertility. Soils under old forests are thought to be fertile for planting crops (Tran 2007a). Some groups prefer primary forests while others prefer secondary forests. For example, "*Neohouzeau nadullooa forest land is believed to be the best choice because the ashes of this species provided much fertility for soil*" (Interviewee)

Skills for self-protection in the forests

Resulting from their experiences and knowledge about the local forests people have the necessary skills to save them in some situations such as losing way, thirst or anticipation of dangerous animal. The results in this section were drawn from qualitative interviews with some elder people. Usually they go to the forests in groups of at least two people. In serious cases, two people can support each other. When going into the forests, a knife is indispensable and most useful. With a knife, people can open the path; whittle small logs or trees into necessary tools and weapons or use it as a weapon in serious situations.

In order to avoid losing their way, people have to know about specific characters of the forest. They reply on special things, sounds, and signs around them as indicators to determine where they are and then they do find the right direction. They use the shade of trees to identify the direction of the sun. The determination of east and west is based on sunrise and sunset, although it is only relatively exact and depends on the weather conditions and the season. During the night when they cannot use sunshine and direction of tree shades, they locate the direction of water flows and go follow it. The water will flow to downstream areas, where people usually live close to. It means that people who get lost can find someone for help. The knowledge of vegetation in the forests can help local people finding food or water when they are hungry and thirsty. Additionally, when going to the forests, people take precautions of dangerous snakes or have suitable protection when harvesting beehive.

Box 5.4: Verbal descriptions concerning skills for self-protection in the forests

- "Determining the direction needs to realize the characteristics of topography, objects around us, and know the direction of them (refer to around objects). We have to know that forest precisely; if we do not, we should go follow the way the water flows (…) because water will flow from upper to lower terrain (…) and people usually live near the water source. Besides, we can see the sun to determine the east or the west. (…) Based on the shade of trees and sunshine, we should know the time at least approximately." (Interviewee)
- "I live near and usually go to the forests. I can find water in some kind of trees or in roots of trees. If I am thirsty, I can have water for drinking even in the high mountains. (…) There are various edible and drinkable trees in the forests such as *Hó*, tree or roots of *Sấu* tree, just cutting a small piece produces enough water. I must not find streams (…). However, I have to learn from elder people to avoid toxic trees*."* (Interviewee)

Hunting experiences

In the past, hunting was one necessary way to adapt to living in mountain areas. Due to shifting cultivation, the ethnic people used to move with their family and house to a new forest area where they started to cultivate a new upland field. Their semi-nomadic life taught them to drive away and chase wild animals that might attack people and crops. That was the way to protect themselves and their crops. Moreover, hunting added protein sources to their diets before domestic breeding was developed.

They hunted wild game like tigers, panthers, bears, stags, deer, civets, foxes, porcupines and forest rooster. For the successful hunt, men had good knowledge about animals´ appearance or habits that helped to trace them. The experienced hunters could detect the presence of wild animals through footmarks or traces at place where they went through. They knew the favourite food of animals, the places where they lived and found food and the suitable time for hunting different species. For example, Tran (2007) wrote, "*The season of hunting herbivores, such as roe deer and chamois, took place in May and lasted until July annually when grass has just grown"*. In this time, herbivorous animals usually come to regenerating forests near residential areas to forage and could easily be trapped. A local hunter said: "*On a time, we lurked from 3 to 5 nights in the forests to wait for an herb of Cắng coming back to their cave*". Since local hunters knew the wild animals´ living habits in groups or individuals, they relied on this knowledge to decide about the appropriate size of hunting groups.

Box 5.5: Verbal descriptions concerning local hunting experiences

- "When I was a child, I saw that deer went down to the fields to eat paddy" (Interviewee)
- "When I was a child, my father said that our lower fields were destroyed by deer and wild boars. We did harvest a few crops". (Interviewee)
- "Hunting weapon was flint-locks. I did not make these traps, but I know that Mán (other name of Dao ethnic) often made the traps. They caught herbs of Cắng and wild boars too, but not many. (Interviewee)
- "I heard that, a long time ago, people used saps to synthesize toxics and poisoned arrows. But in my generation, I have never seen that" (Interviewee)
- "In my father´s time, there were poisoned arrows. A prey was killed instantly when its wound, even light wound, contacted with that toxic. Today, I do not know which trees can be used to compound that toxic" (Interviewee)

The main hunting weapons were flintlocks and crossbows. Locals also used various kinds of traps including underground traps, clip traps, traps with knots, cage traps to trap birds and wild animals. The local people produced these hunting gears with available materials around them. Some documents also indicate that ethnic people could produce toxic

chemicals from some kind of plants to poison arrows in hunting. However, local people in the research areas did not know about it and had never used it. Some people just heard about it from their predecessors.

All in all, the knowledge of animals and forests made hunting more effective and saved time. It was built up over a long period of time, during the process of living and cultivation in the forests. Today, people practice little hunting; on the one hand, because of forest decrease and animal depletion, on the other hand, because hunting is strictly forbidden by law. Thus, skills to create and use the developed hunting methods are only known by several elder people.

Residential experiences

The Tay often resides in areas that are bordering forests and paddy fields. Tay hamlets lean against mountains and look over fields or valleys. Nowadays, Tay people rather tend to live nearby the main transport ways. The Dao often lives near forests or on the foot of high hills where they have the water sources for living and cultivation. The natural forest resources decided their living level as well as the residential time in the villages (in the nomadic period). The Dao language has a saying: "*Chảm mải kềm lải mài miền*", which means that wherever is the forest, there are Dao people living (People´s Commitee of Thai Nguyen Province 2009). This saying reflects not only the residential custom depending on the forests, but also the significance of forests for the Dao´s economy. Even their names like *Kềm Miền, Kìm Mùn*, *Dìu Miền* or *Yu Miền* reflect these residential customs (Vu 2006a). In Dao language, *Kềm* and *Kìm* both mean "forest", *Miền* or *Mùn* "people", and *Dìu* or *Yu* "Dao". So *Kềm Miền, Kìm Mùn* refers to the people living in the forests while *Dìu Miền* or *Yu Miền* refers to the Dao people

The selection of an area to build a house is mostly based on feng-shui. Thus people avoid places with high mountains in front of the house, and they avoid strange and odd objects that look straight into the house. They believe that a mountain peak is like an arrow which if pointed at a house and might injure its residents. Ideally, the front of the house should overlook the fields while its back should point to the mountain. It is also believed that the location for the house facing the confluence of rivers and streams will bring good and thriving business for the house owners. Choosing the direction for the house is also based on the age of the house owner. The direction should suit his age and the house should be built following that direction. The time it takes to build houses should also be in harmony of the age of the house owner (Vu 2009).

As Ma (2004) stressed all materials of the traditional house used to come from the local tropical forests with high flora diversity, which indicates that local people used to depend on their natural environment. However, the structure of a stilt house had to suit both, the natural environment as well as cultivation. The three-floor structure of stilt houses creates more space for people's activities and for storing agriculture products (Vu 2009). Level

one, under floor, stores production tools and shelters livestock and poultry. Level two (a broader floor) serves as living quarters, cooking and worshiping space. It is an airy and cool space in the summers and dries in humid days, which are quite a popular weather phenomenon in the north of Vietnam in spring. Level three, the boarded attic shelf, stores rice, maize, and other agricultural products. The invention of stilt houses provides safe and strong accommodation that suits high humidity and hot weather, resists wild beasts and fits to cratered terrain (Ma 2004). The structure and function of stilt houses are in harmony with the natural environment creating a beautiful landscape. Indeed, stilt houses or houses on stills do reflect the natural conditions and environment of local people.

Cooking and food preservation

A fundamental part of indigenous knowledge is concerned with food. Due to hunting and collecting forest products, mountain people know what types of plants and animals are edible and tasty and what kinds are maleficent. They also know what part of plants can be eaten, how they should be prepared and where and when they can be found.

The type of foods and cooking recipes vary from areas, and between different ethnic groups, depending on available food sources and cooking habits. Local people have their own features in cooking and eating creating their own cultural characters of areas or ethnic groups.

The Tay, for example, is famous for their five-colour steamed sticky rice, also called *Đăm đeng* steamed sticky rice. Five colours (red, violet, yellow, black and white) are made of different kinds of forest leaves and depend on the materials that have been used. For red and violet steamed sticky rice, they use crushed red and black leaves (called *bẩu khẩu đăm đeng*) that are mixed with boiling water to soak the rice. After five or six hours, the strained rice is put in a rice steamer to cook, so the rice will have very beautiful red or violet colour. If *Cẩm* leaves are crushed with a little lime, and then soaked with sticky rice, the sticky rice will have an attractive bottle-green colour after being steamed. If they crush the leaves and soak with ash water of sticky rice straw, they will get dark green sticky rice. The Tay women are considered skilful and it is their duty to make the steamed multi-colour sticky rice to decorate their food trays during festivals and Lunar New Year[13] festival. The ancient people believed that, if they eat five-colour steamed sticky rice, they will have a lot of good luck and happiness. (Vu 2009)

From available cereals cultivated in upland fields such as rice, sticky rice or some types of bean, the Tay and the Dao make a variety of food such as *Bánh dày, bánh chưng,*

[13] Called *Tết Nguyên đán*, begins from the eve of the last day of the old year, and lasts until noon of the second or the third day of the first month (of the lunar calendar) of the year. This is the most important festival of the year, because it marks the end of a production circle, and the beginning of a new circle. This is also an opportunity for the family to reunite, look back to their original and commemorate their ancestors

bánh dợm that are packed by *Phryrium* or banana leaves and then are tired by bamboo strings. Some kinds of bamboo shoot can be cooked instantly extracting or after been sun-dried. Fresh bamboo shoots can either be boiled and eaten with salt or are fried with lard and salt. Sun-dried bamboo shoots are cooked with pig´s trotters' soup. It is a traditional and special food in lunar New Year festival of many ethnics in Vietnam.

The local people do also have their own way to preserve their food in case they want to keep it for a long time. For example, bamboo shoots are sun dried and kept above the cooking fire to be used in out of the growth season. The Tay soak pieces of pork inside a jar containing liquid lard. The Dao preserve pork in salt or dry it by smoke of firewood. These ways can preserve pork for several months.

Photo 5.5: Pork was smoked to preservation of the Dao
Source: Field work (taken by the author)

Land cultivation

Shifting cultivation

People living in mountainous regions have adapted their cultivation methods to the terrain and other natural conditions. Shifting cultivation is the most suitable agricultural practice in the uplands of Vietnam (Tran 2007a) where much of the forest still remains and the population density is low (Do 1994; Tran 2007a). Shifting cultivation or 'slash and burn' cultivation refers to the practice of cutting down the vegetation on a plot of forestland, allowing it to dry, then burning it and planting crops in the ashes. Like other ethnic people living in mountain regions of Vietnam, Tay and Dao people in Vo Nhai have their own knowledge of shifting cultivation techniques revealed in phases of the shifting cycle.

Apart from the determination of the site conditions, farmers have to follow definite regulations: Forest areas which serve to protect the environment and watershed for the community should not be cultivated (Do 1994), and the forest should not contain too many big trees, because they are difficult to log. These criteria protect big trees for timber and prevent "*water competition between the stump and agriculture crops*" (Interviewee). Other criteria for selecting sites include available labour of the family; distance from a house or village; the species and variety to be planted; and the topography (Tran 2007a).

After selecting the appropriate forest area for cultivation, cutting plantation cover and clearing are realized in February and March, following the lunar calendar. The field is slashed with simple tools such as knives to clear small trees and liana or axes to cut down bigger trees. Cut-down plants are dried naturally on the field before burning. The Dao

used to clear in the following order: weeding, cutting small trees and vines, then felling big trees, finally cutting fallen trees and drying them before burning.

Burning should be done at a sunny day in April or May in the lunar calendar, before the rainy season or after the dry season (from lunar October). In humid weather, the process does not spread forest fires, but during the dry season, careless burning can set nearby woods ablaze. Cleaning the boundary of upland fields before burning is one way to prevent fire spreading to the surrounding areas. Scientifically, burning is a highly efficient means of reducing labour needs and obtaining high crop yields (Tran 2007a). Ramboo (1981) names six benefits of burning in shifting cultivation: It

- turns clearing above-ground vegetation unnecessary
- changes soil texture for easier planting;
- improves soil fertility (with ashes);
- reduces soil acidity;
- increases soil nutrient availability;
- sterilizes the soil and decreases populations of soil microorganisms, insects, and weeds that reduce crop yields.

In the research area, the major swidden crops are upland rice, maize, cassava, peanut and bean. The suitable time for planting new crops is the later part of lunar May and early lunar June at the beginning of the rainy season in the North of Vietnam. Following the local farmers experience, "*it is difficult to sow seeds in July and August because then the weather in this mountain area is drought*" (Interviewee). The most common method of sowing in shifting cultivation was to poke a hole in the ground with a stick, then drop in seeds. The tool was a pointed stick with 2 to 2.5 metres length. One person (normally a male) pricked a hole in the ground, followed by another (normally a female) who dropped the seeds in that hole and fill it by foot. The Tay usually poke from the bottom to the top of the field (People´s Commitee of Thai Nguyen Province 2009).

The crops are planted on the same spot for several consecutive years with no application of fertilizer. After two or three crop cycles, when the soil is depleted of nutrients the farmers moved to a new plot. The old field was thus left fallow for natural forest regeneration. Rehabilitation of bamboo forests is rather faster. Soil fertility under bamboo forests is better than else were (Do 1994). As long as the human population was low, the fields were cultivated for two or maximum three years and then were abandoned without interference for ten to fifteen years. During the last decades, the fallow period has been reduced to three or four years. The regenerated forests in this curtailed fallow phase do not contain big trees but consist of mainly just bushes and grass. The local people call it "rừng ót" indicating scrub forests.

Shifting cultivation is part of the Tay and Dao traditions. It is not easy to leave a cultivation habit that has been practiced for generations. They also used to live in the surrounding forests. Therefore, they have the tendency to retreat further to be near the forests and

practice shifting cultivation (Mai 2003). However, this form of cultivation is unsustainable and ill-suited for the current socio-economic and environmental conditions of mountainous regions (Tran 2007a). Due to the government´s policies in agriculture and economic development as well as new cultivation techniques, agricultural productivity has increased. Shifting cultivation was instead of intensive cultivation and agro-forestry models. Although shifting cultivation has not been practiced in the area for the recent ten years, it is undeniably the master knowledge system of local farmers in their environment and slopping land cultivation.

Soil erosion prevention

A major concern of local farmers living in mountain areas of tropical regions is soil erosion. Besides adapting cultivation methods that do not disturb the ground surface, such as poking holes to sow seeds in shifting cultivation, farmers also transform the terrain to suit their cultivation. They create terraces to reduce the slopes in the high lands. The terraced paddy fields are built into steep hillsides or infertile shifting lands that have gentle slopes, near the water sources. They use very rudimentary tools (such as hoes, pickaxe or rakes) and intense physical labour, and sometimes they use farm animals like water buffalo to do the ploughing and terracing. The terraces function as dams by retaining rainwater, which slowly weeping underground and gently flows on the hillside´s surface. Therefore, it prevents landslide and soil erosion. Thus, terrace fields help to cultivate more effectively. Additionally, the terraces blend in with beauty of majestic mountainous landscapes and give viewers a great sense of peace and comfort.

Photo 5.6: Terrace fields, an advantage model of cultivation and irrigation on sloping land

Source: Fieldwork (taken by author)

Irrigation

Water supply is very important for the local people, whose main livelihood is paddy cultivation. For many years, they have extracted water from forests and have applied several methods to lead it into their rice fields, like digging canals, laying water pipes, building dams, and making wood water reels. The Dao build their fields downstream the

water source while the Tay are good at leading water from streams to upper paddy fields through a system of water reel machines and ditches.

In general, both the Tay and the Dao use the same methods of irrigation. They dig trenches from forests or subterranean sheets of water in the forests into the fields. The width and length of trenches depend on the terrain and its topography. When the terrain is inconvenient for trenches digging, they use conduits made from bamboo. From the fields, water is distributed in two ways. First, it is lead into the highest field, and then flows through interstices opened in the field edge and staggered positions from field to field. This is used popularly in terraced fields on high slopes. Second, the farmers dig drainage along the fields´ benches, even along each plot of fields in different positions. It means that many cross drainage gullies are created to lead water from trenches to fields. Building and conserving the irrigation system is done together by those households that are using the same system. Households having separated fields actively maintain their irrigation system by themselves.

Health care

The local people that live in close connection with nature have acquired knowledge about medicinal plants for the maintenance of their health. With respect to their useful or harmful properties, plants are categorized into three groups: (1) plants used to produce tonics that improve general health; (2) plants for the treatment of diseases and (3) toxic plants used for producing poisons. For the first group, suitable plants are used depending on human demand and constitution. For instance, stew of chicken with *Artemisia vulgaris* (*Ngải cứu*) - a kind of herbs - or roots and young leave of *Tòm địa nọng (in Dao language)* is supposed to be good for a woman who has given birth recently. Weak pregnant women will take a bath in which a selection of fresh plants has been boiled. Some plants are used to fortify the kidneys or lungs, strengthen the heart, or treat anaemic people. People also use tonic medical herbs as a kind of food, boil them with drinking water or soak wine with medicinal herbs. For the second group of plants the healers combine different medicinal herbs to cure ailments. Concerning the third group, experienced people know about the harmfulness and toxic level of relevant species. The ancient people applied toxic chemicals in plants to synthesize poison used in insect prevention and hunting. However, nowadays, almost nobody knows how to synthesize those poisons.

Therapeutic methods vary depending on the disease and the medicinal herbs. To treat internal organ-related diseases such as renal calculus (kidney stone), heart attack, *gastrodynia*, hepatitis, *arthrodynia*, herbal medicines are used as food or drink. To treat skin diseases, herbs are boiled and decanted to get water for washing, bathing or soaking affected parts. To treat cuts and wounds, freshly crushed leaves, some having been chewed or heated before, are applied on the cut or wound for rapid healing. To treat back ache, head ache or general body ache, patients drink medicinal infusion and lie down on a layer of crushed and heated herbs. The medicine decoctions also differ from plant to

plant, and disease to disease. Some are cut into small pieces and sun dried naturally, then processed on fire before being boiled to get infusion. Some others are boiled in fresh state or dehydrated on fire before use. The medicine concoction can combine herbs with liquids as alcohols, water of rice-wash or clear limewater, or with organs of living species.

Box 5.6: Verbal description concerning local healthcare knowledge

- "Medicine can be fresh or dry herbs, in fact, dried herb medicine dominates. They (dried herbs) are decocted or soaked in alcohol in a certain time to drink or massage". (Interviewee)
- "In case I see some medicinal plants in forests on limestone mountain, I will collect and dry them to store for necessary case in the future".(Interviewee)
- "My experiences were taught by my father. I can treat diseases related to liver, kidney (…) There are a few traditional healers in my region. The ancient people did hide their light under a bushel and only transferred their knowledge orally to their descendants. Therefore, some indigenous therapies get lost" (Interviewee)
- "Some time, when I found and collected medicinal herbs, I met the Dao and the Mong healers. We shared information about medicinal plants and the disease they treat" (a Tay healer)
- "I recognized the parts or trees that seniors used to treat certain disease and I used the same", a Tay healer said
- "The previous generation said that exploiting medicinal herbs should be done in the morning before 12 o´clock and in the afternoon after 14 o´clock, because at that time, quintessence of trees or good quality of medicine was collected. (…) For extracting roots of plants, we dug around the tree and cut a half of lateral roots or rootlets. This method keeps the main root of a tree stable and its function persistent in order to let the trees grow after that. For extracting bark and trunk parts, we cut only part of the tree. For extracting leaves, we only pick leaves, do not break branches or sprigs, thus, the trees can grow continuously. We seldom use the foot of trees for herbal medicine". (Interviewee)

Overall, the Dao people are more famous in using medicinal herbs for the treatment of diseases than the Tay people. Some of the Dao healers even go to other localities or communities to treat diseases. Women usually play an important role in gathering food and medicine for curing simple ailments such as fever orheadache. Such knowledge is often passed on from mothers to daughters. In addition, certain special persons, such as herbal doctors, have elaborated skills regarding medicinal properties and potencies of certain herbs. They may also be well versed in matters concerning incantations, sorcery and health treatment methods which involve the use of herbs and incantations (Santasombat 2003). With respect to genders, the Dao women have a greater and better

knowledge about medicinal plants than the men, while in the Tay ethnic group, there are more male healers than females.

The knowledge of traditional medicine goes along with sustainable methods in extracting medicinal herbs. Some of the medicinal plants only grow rapidly in a certain time of the year. Therefore, healers pick and dry them to be kept for necessary cases. Some other medicines are only used after sun dried or dehydrated on fire. Nowadays, many medicinal herbs for treating common diseases are grown in family gardens.

Despite their huge treasure of medicinal knowledge, the local people do not have any written documents about it. The knowledge is transferred orally from generation to generation in the family. Some therapies even were passed to only one person who had the highest reliability or respect in the family. Normally, each healer will be good in the treatment of certain diseases and keep the therapy as a family secret. Because of oral transfer of medicinal knowledge, the younger healers only know about the remedy through the morphology of plants and experiences. Nonetheless, seeking for medicinal evidence, local healers of different ethnics might meet each other and exchange their knowledge of plants used as a medicine.

Craft production experiences

Carpentry

Carpentry by the Tay and Dao ethnic groups has been developed to meet the daily needs of the households. With basic tools of carpentry (saws, shaves, knives, hammers, chisels,etc.), they produce wooden furniture such as wooden boxes, cooking steamers, chopping boards, feed troughs and tools for cultivation like rice mortars, ploughs, winnowers, rakes, harrows, etc. At present, some wood works are superseded by modern and non-wood products. Thus, they are just merely produced and used nowadays.
Building a house on stilts is considered as a process of absorbed work and creativity of both, the house owner and the assistants. The process can last for several years, even a decade with many steps and different procedures. This includes the preparation of construction materials, the selection of a suitable area, choosing the direction for the house, study the age of the man who will head the construction of the house, set up the frame of the house, make the roof and organise the house warming ceremony.

Selecting enough good timber to build a house also takes time. People have to go to the forests, normally limestone forests. When they find a suitable tree, the tree is marked on the foot to inform other people of the ownership. Wood extraction is done either when enough trees for one house have been found or immediately when a suitable tree has been found. Logged trees are sawed and spit in to square stilts, and then dried naturally in the forests before being transported to the villages. Beside sawing pillars, the house owner has to find more wood and other materials. It takes much time and needs supports from other people in the community to prepare the construction material. This also means

expenditure of time and costs for meal-and-local-wine for helpers. Consequently, it is impossible to do this work continuously. One has to take advantage of leisure time after harvest month.

The house owner can hire a group of professional carpenters who build stilt houses in their community or for other communities. There is at least one carpenter group in each community. Based on demands of the house owner, carpenters sketch out, measure and calculate for the house frame. However, the calculation of the structural frame has a formula conducted from traditional experiences of ancient people. The measurement parameter, position and direction of mortises on the pillars are done very accurately to ensure the proper construction of the house.

Bamboo weaving

The Tay and the Dao are good at weaving. They can weave bamboo baskets, closely woven baskets, winnow, wattles, panniers, and lattice used as partition. Artisans are usually older women who are skilful and precise and do this work between harvests. Bamboo is cut down after winter solstice (Be et al. 1992), and then split into tapes which are knitted or dried on the shelf above cooking fires. Knitters can use dried bamboo tapes whenever they want. Bamboo products are kept dry above cooking fire for a long time before being used. This is a way of preserving knitting products to avoid damage by mould or termites as well as a means to create beautiful golden colour. The size of bamboo tapes depends on the knitting products. Some tapes are dyed with different colours to design patterns on the products. Weaving techniques include square weaving, cross weaving, rectangular weaving, and V-shape weaving.

Photo 5.7: Baboo weaving products (Source: Fieldwork. taken by the author)

Cloth weaving, dyeing and embroidering

Brocade has been the quintessence of a mountainous region where people from various groups grew cotton by themselves and weaved nice traditional clothes and brocade textiles. The traditional clothes of local people are made of indigo-dyed cotton. Indigo harmonises with nature in the green forests (Vu 2010). The Tay wears long self-made woven clothes with indigo colour and not much of embroidery or other decoration, while costumes of the Dao women are embroidered with colourful patterns and many turbans.

The cotton seeds are sowed in spring when the terraced fields are soaked with rainwater. This is a good time for cotton plants to grow well; avoiding both harmful mist and early season torrential rains. After 4 months, farmers harvest the cotton fruits, and bring them home to process for cotton yarns for weaving. While weaving, the women have to synchronize their eyes, their hands and their feet nicely. Weaving is a complicated work that requires many details. To weave a piece of cloth, the weaver should spend a lot of time and energy. The product normally included 4 pieces, each 40-50 cm wide.

Indigo dyeing is a traditional method that helps keeping the colour for long, even if clothes are worn out. Besides cropping cotton, the local people grew indigo trees as materials for dyeing clothes. Indigo trees grow easily and quick to be used, just after a short period of time. Clothes were dyed and dried three times. In the third dyeing, a certain root (*củ nâu*) was added into the mixture so that the colour of the product could be durable and never faded.

a & b) Dao women emboider in their free time. c) They can buy accessories and materials to decorate their clothes in the local market. d & e) emboidering parterns on Dap people´s clothes

Photo 5.8: The Dao women and their emboidering products

Source: Fieldwork (taken by the author)

The Dao create patterns on their cloth by embroidery based on their memories. They embroider on one side of the cloth in a way that the design was seen on the other side. They have several pattern designs such as letter "*vạn*", the pine tree, animals, birds, humans or leaves. The young Dao girls are taught how to make clothes and needle works by their mothers. It is a very important duty of the Dao females who have to make clothes for preparing their marriage. In the wedding, the Dao bride wears all clothes she saw and embroidered. The Dao think that the bride that wears the most clothes is also the most beautiful. Nowadays, cloth weaving and indigo dyeing does no longer exist in the research areas, but embroidering is still maintained in the Dao community. One can buy colour threads in the local flea market for embroidery.

5.4.2. Social relations

Social relations are affected by the surrounding ecosystem (MA 2005d), creating representative features of particular cultures. The natural landscape influences the residence characteristics of local people. Hamlets or villages [14] (*bản*), rudimental residential units of the Tay and the Dao societies, represent communities with rural communes´ features (People´s Commitee of Thai Nguyen Province 2009; Vu 2009). The name of a hamlet is often related to the landscape: rice fields, valleys, mountains or mountain passes. Each hamlet has its own territory, defined by a natural boundary, such as mountain ranges, or streams, which are conceded and respected by other hamlets (People´s Commitee of Thai Nguyen Province 2009). Dao hamlets are normally located in higher terrain than Tay hamlets, because of the residential customs. Most of the Tay and the Dao live in separate hamlets. There are few hamlets being home to both, Tay and Dao people, who live in groups of the similar ethnic background.

The social structure of the Tay and the Dao is based on hamlet and family[15]. In a hamlet, there are different families, some of which may have larger numbers of inhabitants and more influential social power than others (People´s Commitee of Thai Nguyen Province 2009; Vu 2009). The Dao residences are dispersed. Each house is located on a hill. Due to population growth, both the Tay and the Dao live in small family groups. Some family groups may live separately and quite far from other groups but still belong to the same hamlet. Originally, the population distribution was influenced by the natural fragmentation of mountain topography and by characteristics of shifting cultivation.

[14] Hamlet- *bản*, a term that refers to an administrative unit of a minority ethnic community in mountainous areas; village - *làng or xóm*, a term that refers to an administrative unit of a community in lowland areas. Village and hamlet are the same level that is the lowest position in administrative management system in Vietnam.

[15]Family in this case refers to a collection of nuclear families and extended families that have the same consanguinity and family name.

Each hamlet has its own governance and management institution and a leader or a chief, called *trưởng bản* or *trưởng xóm*. This prestigious person usually has good knowledge of hamlet culture and situation as well as good education. People in the hamlet elect a chief who represents the hamlet´s governance and institution, reflects the will of the community, and takes care of the internal and external affairs of the hamlet. In administration, the chief has the responsibility of governmental management at the hamlets scale and under the leadership of Communal People's Committee. The voice of a chief has vital influences on other people in the community.

Each family has its own family name and ancestor. Patriarchy is shown quite clearly in the family of both the Tay and the Dao. Males are more esteemed than women because they have the duty for ancestor worship and family reproduction. Each family has a chief of the fathers, who does ritual activities in the family and has most power and influence on other members. In the Tay family, members of closer blood relationship have a higher social position, regardless of their age. In contrast, the Dao stipulate that someone who has seen the sun for a longer time must have a higher position in the family, no matter the degree of family relationship. It means that someone´s position in the family is based on age.

Neighbour relations are also very important in both, the Tay and the Dao communities (People´s Commitee of Thai Nguyen Province 2009). Apart from kinship, the local people highly appreciate good neighbourhood relations. Residing in groups in or near the forests, mountain people need to be solidly united against wildlife attacks and help each other in shifting cultivation. They have the same rituals and spiritual life, so they feel the urge to celebrate ritual events together. These are reasons why they tend to close coordination in all their life features, from cultivation to spiritual and ritual activities.

Thus, in daily life, neighbourhood relations are also expressed in helping each other whenever a family has a big event like a funeral, a wedding, building a house etc. The number of participating guests indicates the quality of the relationship between the host and the neighbours. The below idiom of the Tay reflects the mutual assistance when families have special events that can be done with only family members:"*Vàn phi vàn rườn, nọi cần bố mà tươi hắt ngải* - Funeral and house building needs help of neighbours, since it is not easy to do these works with a few people" (Ma 2004).

Also in cultivation and production, social relationships are expressed through mutual help between groups of several households.

> "*When sowing seed, dozens of people were mobilized for helping. Someone used a wooden stick to poke holes followed by another to sow the seed. (…) We must exchange labours among families when sowing*". (Interviewee)

Hunting as well used to be an activity that united people in a community (Tran 2007b). In the hunt, especially when being done collectively, hunters shared all the works and achievements. They were coordinated with each other in any action to get success in the

hunt. The party after the hunt and the sharing of the hunting "booty", gave to them joy and closeness.

Building a house is considered a big deal which needs the support of others in all steps, from timber logging, timber transportation, building to celebrating a new house.

> *"I must ask my relatives and neighbours for timber carriage to the villages and building the house. At that time, building a new house required participation of dozens of people"* (Interviewee)

Therefore, it depended on friends and neighbours to help and the host provides meals and rice wine to thank all helpers. In the past, local people only did these works as support and took the meals as a repayment from the host. Therefore, the house owners had to feed pigs and chickens to prepare food for thanking meals. The meals with many people and new house celebrations are social occasions for local people to meet, exchange information and from this, consolidate their neighbour relations.

Neighbourhood relations are not only important between different people, but also between different communities or hamlets.

> "*Bản tẩu mà hưa, bản nưa mà chòi* - people in the lower villages come to help, people in the higher villages also come to help" (Ma 2004).

The community activities are considered as good opportunities to tighten the neighbourhood and hamlet cohesion (People´s Commitee of Thai Nguyen Province 2009). Good social relations will lift the spirit of local people in their work and their daily lives.

Photo 5.9: Neighbourhood relations in working and daily life

Source: Fieldwork (taken by the author)

5.4.3. Spiritual and religious life

Although the Tay and the Dao have different spiritual and religious lifes, both ethnic groups do share some similarities in their conception and imagination of the universe and the supernatural world. They believe that the universe has three layers (heaven or upper layer; earth or middle layer and water or under layer) and two worlds (the real material world of humans and the intangible world of the divinities and ghosts). The intangible world of genii and ghosts includes benign ghosts such as ancestral spirits, ghost of kitchen, the soil and wicked ghosts like those of rivers and streams as well as spirits of

people who suddenly passed away. The benign ghosts sometimes make difficulties to humans. For example, the spirits of dead people are believed to have close linkage with family members in the real world so that the ancestors may bless or impede living descendants based on their behaviour. Therefore, ancestor worshiping is an important service in the spiritual life of the Tay and the Dao. Before doing anything important, people often make offerings to the Genii and ancestors as a report to them and pray for their support.

In the past, people worshiped the Earth Genie (*Cốc Bản*) and local gods in their villages. The Earth Genie is the god who protects the village and the crops. People worship the God twice during the lunar New Year festival and the mid-Autumn festival, or in other important events in the year. The Earth Genie has his own temple, built under a big tree or among the ancient trees in front of the village. Each village or several villages have a communal house to worship many different gods and saints, who live in a forest on a mountain, called sacred forest or sacred mountain (Vu 2009). However, there is no relevant evidence of the existence of any sacred forests in the research area. Local people affirmed that they heard about sacred forests but never knew about any in their areas. People in Vu Chan commune stated that there used to be a communal worshiping house in their area, which unfortunately had been destroyed a long time ago.

The belief in the intangible world is shown in many aspects of daily lives. For example, it is a taboo to select a tree with the top cut off by a stroke of lighting for construction. People believe that these kinds of trees are damaged by the deity of trees or by magic forces. If the timber is used for house construction, the home will be faced with disasters and bad luck in business while people and livestock will be unhealthy and catch diseases. Before moving in a new house, local people always choose an auspicious day and organise the ceremony "*phạt mộc*" which aims at inviting the God of Trees to go back to the forests. In the ceremony, the wizard carves on the stilts in the four corners of the house and mumbles some magic words. After that, an elder man who is considered the embodiment of happiness and virtue brings a "scared flame" to light the kitchen fire. On the day the owner moves into the new house, he must keep the fire burning through the night till the next morning, because the Tay believe that as the fire blazes through the night, the family can live in peace and happiness (Vu 2009).

The Tay also believed that the spirit of a new born baby is as weak as its body. Therefore in the first month after birth, Tay people do not allow strangers to see the baby, especially those who are considered to be unusual, have a bad reputation, or chicken demons. Right after the baby has been born, the family ties a bunch of special forest leaves by the staircase or beside the door to warn others. They also hang a straw broom (if the baby is a girl) or a half-burned piece of firewood (if the baby is a boy) on the entrance. These are considered able to ward off bad spirits.

Local people do use various forest products to support the spiritual life and rituals. For instance, the Tay use the flowers of wild banana *(Musa acuminata)* are as an indispensable feature, symbolizing a cock (People´s Commitee of Thai Nguyen Province 2009) while *Sớ* is indispensable in the Dao rituals. It refers to a special paper like a letter that people used to send their confessions or petitions to the Jade Emperor. *Sớ* paper is a raw paper (locally named *giấy bản*) made of bamboo. The young *Neohouzeauna dullooa* is crushed into small particles, and then boiled for several hours before the pulp is spread thinly on bamboo lattices in the size of 40 cm x 60 cm and sun dried. Formerly, local Dao people produced *giấy bản* themselves, but now, they can buy it in the local market. Thus *giấy bản* production has been exited.

People also use incense, an aroma smoke made from forest plants, in divine being or ancestor rituals. In Vietnamese conception, incense burning is a bridge to connect the tangible and intangible world. It is a way to contact with the divine being. The materials and the way to use incense by the Dao differs from that of the Tay. The Dao people use barks of a special trees and burn dried pieces of that bark in a small bowl or ceramic plate on the altar. The Tay people make their incense from leaves called *"bơ bìa"* and *"bơ hắt"* as agglutinative substances and decayed-wood particles of *Canarium* spp. They grill sun-dried leaves and make a compound in a special recipe, then roll inflammable sticks in the mixture and dry them.

5.4.4. Inspiration

Pleasure activities and mental health

Local hunters considered hunting as a pleasure activity. They felt happy and proud about their hunting successes. The hunter who shot or caught a prey would be considered having the main contribution to the hunt´s achievement. Therefore, he got the biggest part of the prey. Hunters usually kept a part of the prey in the house, for example the head or horn of dears, teeth or claws of tiger, wild boars, tails of wild boars as a sign of success in the hunting and pride. It is not difficult to see various hunting trophies hung on stilts or kept in the kitchen area in some local people´s homes. This also gives evidences that some wild animal species did exist in the local forests. In qualitative interviews, some local people said that they felt excited with the hunt, even if not for food purpose.

After hunting, participants and their families made a party together to celebrate their achievement. The leftovers from the hunted animals were shared among the hunters, and the bigger part being provided for the main contributor to the hunt. Celebrating together did not only improve close relationships between hunting participants and neighbours, but also created excitement for local people in life and work.

Hunting is forbidden since several decades in favour of wildlife conservation. However, when talking about hunting, some old people felt regret for what they had to give up. Local

people also felt pleasure when they went to the forest for NTFP foraging or gathering, or just diversion. They usually did muilti-purposes gathering whenever they went to the forests, such as for timber or honey.

Box 5.7: Verbal descriptions concerning forests and pleasure activities

- "At those days[16], we went to the forests for hunting whenever we wanted or had stimulation. Sometimes, there was a profusion of meat for food, but we still went hunting when someone informed us that there were wild boars or chamois in a specific forest area" (Interviewee)
- "Sometime I miss the days of hunting and forests. (…) If I had enough strength and hunting was legal, I would like to go for it, only for food, not for economic purpose". (Interviewee)
- "I will feel sad if I cannot go to forests anymore. I find some interesting things when I go into forests. For example, when I walked leisurely into the forests, I can find out beehives and enjoy the fresh and cool air. This activity is recreation and refreshment" (Interviewee)

Human feelings when hearing nature sounds

A small survey was done with 107 local people about their feelings when they hear the sounds of nature such as singing birds or the lapping of running water. More than half (58%) of them felt relaxed and comfortable, 15% felt quite normal while 26% people said that they did not pay attention to these sounds and only one person (1%) felt uncomfortable with the sound of nature. It can be seen from the survey, that nature sounds do mostly have positive effects on local people´s feeling.

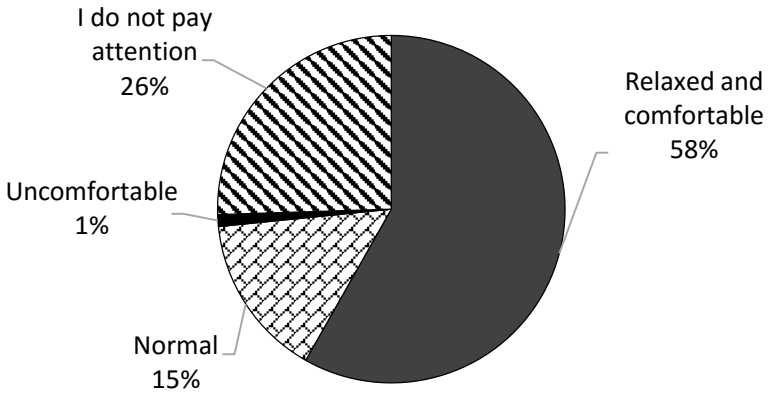


Figure 5.7: People feelings when hearing nature voice

[16]Some decades ago when hunting was not banned

5.4.5. Aesthetics

Architecture of stilt houses

The stilt house is a special architecture of the Tay and the Dao, which has been generated to adapt with the natural environment and socio-economic conditions in mountain areas. The traditional structure of the Tay stilt houses has the ollowing main features: a house consists of five, three or one compartment(s) and two lean-tos; a diagonal roof having axe shapes in the corners; wall made of wood or bamboo-wattle; trusses[17] with 3,5,7 stilts; the total number of stilts has to be even (normally from 24 to 52 stilts). The original house of the Dao in the area was half-ground half-stilt house. The ground-floor leaned against the mountain whistle a wooden floor was erected above the slope. In process of resident, the Dao imitated the structure of the Tay stilt houses. Their stilt-houses are built in the same way and with the same materials as the Tay.

Currently, the stilt house structure is affected by the architecture from communities in lowland area, creating variants of the house and changes some parts. Concerning the truss structure, the odd number of stilts (5 or 7) in which one pillar is on top of the roof has been changed into 4 or 6 stilts. The centre stilt is omitted and instead by a short logs from the rooftop to the cross-beam. This beam is bigger in size and made of durable timber because it has to bear the entire weight of the roof that used to be pillared by the omitted column. The new structure is not as strong as the old one but it widens the space of the house, and simplifies the building process. Formerly, stilt was fixed in the ground. Currently, it is put on a carved stone. Systems of beam and trusses create the stability of the house. The height of the houses has also increased to get more air and cooling.

> *"The wall of this floor (*referring living floor*) was only around 1 and 1.1 meter high; now, it is higher because of airy*". (Interviewee)
>
> *"In the past, main stilts were only 6 meters high. These stilts are now 7 meters long. The first floor of the house is built higher than it was before."*(Interviewee)

The space inside the stilt house is divided into functional areas. They include a place to worship ancestors, a fireplace and cooking are, sleeping places for the family members and guests, places for storing agriculture products, a place for grinding and pounding rice, a place for the water container, one for the kitchen cupboard and food, and finally a floor to dry unhusked rice (Vu 2009)

Ma Ngoc Dung - an ethnologist of the Tay - affirmed in his study (2004) that the stilt house is an art product of folk architecture that is revealed in harmony with the local natural

[17]a framework of beams (rafters, posts, struts) forming a rigid structure

landscape, a utility for its users and an individual personality expression. The art of house architecture is both pragmatic and ethical, representing the spirit of the Tay.

Materials for music instruments

The art of the *Then* folk singing and the *Tinh* guitar playing do represent important features in the Tay's spiritual and cultural life, and are preserved since many generations till now. The art is unique within Vietnam's traditional folk music heritage. *Then* folk singing and *Tinh* guitar playing have become indispensable in the Tay's festivals, Lunar New Year days and community cultural activities.

The materials to make the *Tinh* guitar are simple, because they are connected to people's daily life. The most difficult and important thing is to choose a gourd which is round, big, and beautiful. The peel should be thick so it has a sharp sound when beaten. An old gourd is hollowed out and soaked in water for ten days. It is then smoothed out and pricked with holes. The front of the guitar is made of *Erythrina variegata* (*Vông)* timber. In the past, the strings were made of silk cords but today they are made of nylon threads. The long neck of the guitar is made of *Dâu* or *Wrightia* spp. wood. It should be light and straight with its length being nine times the length of the player´s fist. According to folk experiences, the size of the instrument fits the singing voice of the musician. The Tay use brown tubers, found in forests, as glue to attach the neck of the guitar with gourd.

Photo 5.10: The *Tinh* guitar

Source: Fieldwork (taken by the author)

5.5. Synthesis of local FES supply, demand and benefits

Based on the available information and local assessment, an overview of local FES supply, demand and benefit is given in table 5.9. Regarding local benefits, the overview focuses on the benefits that local people may get now from their forests. The table also considers the supply and demand in the past and at present to indicate changes in local demand. Those will be linked to drivers of changes in chapter 6. Due to lack of data and information available to assess the trends of FES supply (increase, constant or decrease), the research only can give the recent state. Regarding local benefits, the overview focuses on those benefits that local people can get currently from their forests.

In terms of provisioning services, the trend of local demands has changed with respect to several subservices. The availability of bush meat and forest honey has not been predicted because wild animals have become scarce and hunting is prohibited. However, the local demand for wild food has also decreased because of available alternative

sources in the market. Additionally, people do domestic livestock breeding which does not only serve as a source of food but for cash income as well. The demand for construction wood is persistently high while the demand for agriculture tool production has decreased, but wood demand for furniture has increased following the improvement of local living standards. The wood supply for processing has been developed parallel with the initiation of plantation forestry. However, local people are solely interested in monetary benefits from wood selling rather than in environmental services.

In general, the local demand for herbal medicine has dropped due to the introduction of western-medical treatment. However, the external demand for some kinds of common medicinal plants encourages people to collect and sell them, causing degradation. Local people did not require expanding their land for agriculture by converting forestry land. They rather wanted to improve the economic effects of their forest land. In former times, hydraulic power used to be converted to mechanical energy to run rice mortars. At present, hydraulic power is used to generate electric energy in some villages.

In terms of regulating services, the forests in the areas should still have a good regulation capacity and local people are benefiting from these services, however without being aware of them. At the local scale, nature hazards are not a big problem. In general, local people are less concerned about this regulating service because they do not face the effects of climate change yet nor of flooding.

In terms of cultural services, local knowledge has declined considerably due to several factors. First, the materials or contexts to use the knowledge do not exist anymore. Therefore, the young generation does not face the necessity to learn or to improve this knowledge. Second, some of the traditional knowledge does not suit the current social contexts or has become out of date. Consequently it disappeared or the young local people are not interested in it any longer. However, some aspects, like the experiences for choosing house sites and directions have been maintained and still create a feature of local customs. On the other hand, local forests increasingly serve as a source of scientific knowledge and education and local people can get the benefits from researches relating to forest biodiversity conservation or agroforestry development from the universities and research institutes.

According to our surveys, the local demand for good social relations and inspiration seems to continue because these services give mental health benefits. Degradation of spiritual and religious forest related demands, however lead to the decrease of respective local arts and traditional spiritual and religious activities. The aesthetic value of stilt house architecture is regularly appreciated by outsiders, but, the local relevance and demand of this service has not been evaluated sufficiently.

Overall, local people do get benefits from most of the FES categories, although their accessibility or availability is not as plentiful as in the past. Moreover, the local demand is decreasing due to both, internal and external drivers of change (see in Chapter 6).

Table 5.9: Local FES supply, demand and benefit according to local people's judgement

Category	Service sub-category	Supply		Local demand		Local benefit
		a	b	a	b	b
Provisioning services						
Food	Wild vegetable	+	+	+	↘	+
	Bush meat	+	?	+	↘	O
	Honey	+	?	+	↘	+
Wood/Timber	Construction wood	+	+	+	→	+
	wood for tools and furniture production	O	+	+	+	+
	Wood for further processing	?	+	O	O	+
Fuel wood		+	+	+	→	+
Bamboo	Construction	+	+	+	↘	+
	Handicraft production	+	+	+	↘	+
Ornamentation		+	+	?	+	+
Medicinal plants		+	+	+	↘	+
Forest land	Construction	O	?	+	+	+
	Agriculture	+	+	+	O	O
Water supply	Fresh water	+	+	+	↗	+
	Aqua-cultivation	+	+	+	↗	+
	Power generation	+	+	+	+	+
Regulating services						
Air quality regulation		+	+	?	↗	+
Local climate regulation		+	+	?	↗	+
Water regulation		+	+	?	↗	+
Water purification		+	+	?	↗	+
Soil quality regulation		+	+	?	↗	+
Cultural Services						
Local knowledge system	Ethno-botanical knowledge	+	+	+	↘	+
	Forest soils assessment	+	+	+	↘	O
	Skills in self-protection	+	+	+	↘	+
	Hunting experiences	+	+	+	O	O
	Residential experiences	+	+	+	→	+
	Food cooking and preservation	+	+	+	↘	+
	Slopping land cultivation	+	+	+	↘	+
	Healthcare	+	+	+	↘	+
	Craft production experiences	+	+	+	↘	+
Scientific knowledge and education		+	+	?	?	+
Social relations		+	+	+	→	+
Spiritual and religious life		+	+	+	↘	+
Inspiration		+	+	+	→	+
Aesthetics	House architecture	?	?	?	?	+
	Materials of arts	+	+	+	↘	+

Note:

a = former b = recent

+	relevant	↘	decreasing
O	irrelevant /awareness	→	continuing
?	uncertain	↗	increasing
+	relevant but trend evaluation impossible		

5.6. Governmental demand for forest ecosystem services

5.6.1. Governmental FES demands on the national scale

As already mentioned shortly in chapter 3, forests in Vietnam are divided into three different “forest function types” and some further sub-types which shape forest management and development. These forest sub-types, their expected services and the criteria and indicators which are used to classify them have been analysed in detail, based on a review of forestry legal acts in the appendix 5. The respective results and a summary are given in table 5.10. They served as the basis to finally derive the official FES demands for each forest type.

Concerning special-use forests, the main required services are biodiversity conservation, scientific research and tourism (The Law No. 29/2004/11th Parliament Session). This forest type provides high biodiversity (including genetic, species and habitat diversity).Thus it has important values with respect to conservation and education. Furthermore, the variety of landscapes, climate, and historic sites is an advantage of forest-related tourism development and neighbouring areas of high cultural value. Special-use forests are usually located in remote upland areas or in significant areas for national security. Thus, on the national scale, the official FES demands for regulation or cultural services are dominating those for provisioning services. The latter do focus on genetic resources and fresh water supply. Timber demand in special-use forests is salvaged (1) in cases where the trees are dead or felt down by natural hazards or forest fires and (2) only in the special-use forests for conservation of cultural - historical monuments and environment (follow Decision Nr. 80/2011/QĐ-TTg and Decision Nr. 186/2006/QĐ-TTg).

Apart from the designated special use forest areas and according to Decree No. 32/2006/NĐ-CP, it is prohibited to extract timber or other goods in any type of forest wherever it concerns the habitats of valuable and endangered species as assigned in that decree.

Protection forests are expected to provide regulating services as an outcome of the forest intrinsic ecological functioning and integrity. Depending on the forest locations and the objects to be protected, forests may provide various protective functions: Watershed forests regulate the flow of water; mangroves prevent waves to threaten production sites on coastal areas, while - at the same time - satisfying national demands for tourism or provisioning services such as timber, fuels, medicine etc. The extraction of these goods and services accords with the law and legal regulations as long as it does not harm the regulation services of the forests (Decision No. 17/2015/QĐ-TTg, Decision No. 08/2001/ QĐ-TTg).

Table 5.10: Governmental demand for forest ecosystem services at the national scale

Service category[18]	Special use forests	Protection forests	Production forests	In General
Provisioning services				
Wood	+	+	+	+
Bamboo[19]	-	+	+	+
Food and fibre	-	+	+	+
Fuel	-	+	+	+
Genetic resources	+	+	+	+
Bio-chemicals, natural medicines, and pharmaceuticals	-	+	+	+
Ornamental resources	-	-	-	?
Fresh water	+	+	+	+
Land use	-	+	+	+
Regulating services				
Air quality maintenance	+	+	+	+
Climate regulation	+	+	+	+
Water regulation	+	+	+	+
Erosion control	+	+	+	+
Water purification and waste treatment	+	+	+	+
Regulation of human diseases	-	-	-	?
Biological control	+	+	+	+
Pollination	-	-	-	?
Storm protection	+	+	+	+
Cultural Services				
Cultural diversity	-	-	-	-
Spiritual and religious values	+	-	-	+
Knowledge systems	+	+	+	+
Educational values	+	+	+	+
Inspiration	+	-	-	+
Aesthetic values	+	-	-	+
Social relations	-	-	-	?
Sense of place	+	-	-	+
Cultural heritage values	-	-	-	?
Recreation and ecotourism	+	+	+	+
Supporting services				

Note:

+ relevant
- irrelevant /awareness
? uncertain

[18] Following MA categories of ecosystem services
[19] Bamboo is not included in ES categories of MA concepts, but is a typical forest product in Vietnam, thus, it is mentioned separately.

Production forests shall fulfil the national demands for provisioning services without affecting their regulating services. However the use and protection regulations for natural production forests are more stringent than those for plantation forests. Concerning possible provisioning services, the main focus is on timber for construction and for the wood processing industry. Regarding bamboo and other NTFPs, the legal act system focuses on forests that have the capacity to become providing areas. Therefore, the demands for forest products depend on the forest´s characteristics and local social contexts

The national demand for cultural services clearly focuses on knowledge, education and recreation considering all three types of forests, while other cultural values seem to be neglected. At least services like inspiration, sense of place or cultural heritage are not explicitly mentioned in the regulations for recreation and ecotourism while the assignment and thus understanding of others (like ornamental resources, cultural diversity, social relations, cultural heritage or regulation of human diseases) is unambiguous.

5.6.2. Governmental FES demands in the research areas

All three mentioned forests types are represented in the research area. Protection forests have been designated for watershed protection which does not restrict local people´s accessibility to FES in principle; while special use forests shall guarantee the conservation of limestone forest ecosystems; habitats of endemic, rare and valuable species (Decision No. 1604/QĐ-UBND); and the landscape. It is necessary by restricting to the access to provisioning services. As it has been demonstrated in chapter 3.3, this restriction involves a considerable proportion of the forest area in both communes. Production forests encompass natural as well as plantation forests that shall serve for timber production in combination with further protection services. On so far they do support local provisioning and regulating services, but no necessarily cultural services. Since a few years, the local government and the local forest administration have started to consider plantation forests to green the land for the purpose of environment protection as well as to improve economic forest values. Plantation forests shall supply materials for wood industry and economic development of local households

Government organizations in the research area have to follow the national regulations concerning FES in vertical linkage[20] of national - provincial - district - communal levels. They have to localise and specify the official demands for FES (table 5.11) corresponding to local forest characteristics and social contexts and they have to provide guidance how to implement the regulations.

[20] The vertical linkage is a link either among directing organizations in different levels or among implementing organization different levels

Table 5.11: Governmental demand for forest ecosystem services in the research area

Service category	Special use forests	Protection forests	Production forests	In General
Provisioning services				
Wood	-	+	+	+
Bamboo	-	+	+	+
Food and fibre	-	+	+	+
Fuel	-	+	+	+
Genetic resources	-	-	-	-
Bio-chemicals, natural medicines, and pharmaceuticals	+	+	+	+
Ornamental resources	-	-	-	-
Fresh water	+	+	+	+
Land use	-	+	+	+
Regulating services				
Air quality maintenance	?	?	?	?
Climate regulation	+	+	+	+
Water regulation	+	+	+	+
Erosion control	+	+	+	+
Water purification and waste treatment	+	+	+	+
Regulation of human diseases	-	-	-	-
Biological control	-	-	-	-
Pollination	-	-	-	-
Storm protection	?	?	?	?
Cultural Services				
Cultural diversity	-	-	-	-
Spiritual and religious values	-	-	-	-
Knowledge systems	+	+	+	+
Educational values	+	+	+	+
Inspiration	?	?	?	?
Aesthetic values	-	-	-	-
Social relations	+	+	+	+
Sense of place	-	-	-	-
Cultural heritage values	-	-	-	-
Recreation and ecotourism	-	-	-	-
Supporting services				

Note:

+ relevant
- irrelevant /awareness
? uncertain

Some possible services may not exist or be irrelevant on the local scale, thus there is no governmental demand for safeguarding them. In the research area there is no need for air quality maintenance or storm protection since it is not affected by industry or traffic pollution nor does it face storm events. The air is quite fresh and clean and local people said that the natural hazards like storm, drought or flood have not happened since quite

long time. This might also indicate that the forests are doing well with respect to regulation services in the area.

5.6.3. Comparison with local people's demands

The main concerns of governmental forestry organizations are the management and conservation of forests and forest resources. Most legal documents are related to the extraction, utilization, protection and management of forest products and forest ecologies. National forestry organizations require FES generally in all kinds of forest ecosystems and in the whole country for strategic management. Local official organizations have more specific demands that are considering of management aspects to maintain the services of the local ecosystem, whereas local people's demand for tangible forest products do have practical significance for their personal lives. The demand for FES of local people and official organization is synthesized in table 5.12 that was conducted from the results of table 5.9, 5.10 and 5.11.

Concerning provisioning services, local people do need various kinds of forest goods, mainly for their domestic utilization and subsistence. Most of these forest products have no potentials to be developed as commercial products. In spite of high species diversity the relevant forest species are distributed dispersedly in only small quantities. Only timber from plantation forests is sold outside for commercial purpose. Local governments have supported and encouraged plantation forests as a source of local economic development.

Concerning regulating services, both local people and local governments are interested in those which have direct effects on their areas and thus are related to climate, water and erosion, official demands on the national scale are clearly broader.

When it finally comes to cultural services, the demand for each specific service sub-category differs between local people and governmental organizations. For instance, forest related spiritual and religious activities of local people do still exist as remnants of traditional culture in the area. However, since they are no salient specificities of ethnic cultures, government organizations do not care much about them. To give another example, local people focus on empirical education in natural forests while government organisations are rather interested in scientific education.

Overall, it is difficult to compare the demands for FES of local people with those of local and national government organizations because of the differences in geographic scales, their concerns, and their purposes. Additionally, the research results depend on scales with a growing number of subservices demand but a decreasing detail level in each service from the local to the regional and the national level (see also table 5.12). In so far the demands for specific sub-services depend on the characteristics of the ecosystems as well as on socio-cultural characteristics and on the economic situation a in the respective research area.

Table 5.12: Recent demand for FES of local people and government organizations

Service category	Local people	Governmental demand	
		Local scale	National scale
Provisioning services			
Wood	+	+	+
Bamboo	+	+	+
Food and fibre	+	+	+
Fuel	+	+	+
Genetic resources	o	o	+
Bio-chemicals, natural medicines, and pharmaceuticals	+	+	+
Ornamental resources	-	-	?
Fresh water	+	+	+
Land use	+	+	+
Regulating services			
Air quality maintenance	o	?	+
Climate regulation	+	+	+
Water regulation	+	+	+
Erosion control	+	+	+
Water purification and waste treatment	+	+	+
Regulation of human diseases	-	-	?
Biological control			+
Pollination			?
Storm protection	o	+	+
Cultural Services			
Cultural diversity		?	?
Spiritual and religious values	+	+	+
Knowledge systems	+	+	+
Educational values		+	+
Inspiration	+	?	+
Aesthetic values		?	+
Social relations	+	+	?
Sense of place		?	+
Cultural heritage values		?	?
Recreation and ecotourism			+
Supporting services			

Note:

+ relevant
- irrelevant /awareness
? uncertain

The result is summary from results of table 5.9, 5.10 and 5.11 to show different demands for FES between official and non-official respondents as well as among different scales

CHAPTER 6: DRIVERS OF CHANGE

There are many factors that impact on an ecosystem directly or indirectly and may be from internal or external the ecosystem. To focus on societal side in the ES framework, the thesis continues to analyse indirect drivers of change, which impact on human activities making change forest ecosystems in the research areas. This chapter analyses indirect drivers of human activities and their effects on local forests and people´s demand for FES. They are both interal and external drivers, including governmental policies of forests and rural area development; local economy and livelihoods; people awareness; some social factors and external demands.

6.1. Policy

6.1.1. National forest policies and their implementation in the research area

Forestry policies and institutions have changed since 1950 with regards to the development and management of forest resources in accordance with the social-economic contexts over different periods in Vietnam (table 6.1). This chapter presents the main national forestry policies and programmes to halt deforestation and foster upland development that have effects on the forest ecosystems in the research areas. Some of the policies and programmes in recent years relate to forest land allocation; forest rehabilitation and afforestation.

Forest land allocation policies have been implemented in Vietnam since the 1980s (de Jong et al. 2006; Tran 2012) and have been strengthened further after the promulgation of the Land Law 1993 that gave farmers the right to inherit, mortgage, transfer, exchange, and lease land. Before land allocation, forests could be used by all villagers. Anyone who came first could log a specific tree first; who came later had to find another tree. The regulation in selection of forest plots for slash-and-burn cultivation was similar.

Forestland allocation has been implemented in the two research communes since 1994 including all three types of forests.

Table 6.1: Fundamental changes in forest institutions since 1950

Period	Management system	Business and service system	Key mechanisms and policies
1955-1975	• Establishment of Ministry of Agriculture • Establishment of agriculture companies and state forest enterprise (SFE)at local level • Establishment of People's Forest Protection Forces (1973) • Local forest management, especially in poor communes	• Forest product exploitation (mainly timber) serving war and national construction efforts • Private enterprises excluded from involvement in timber processing • Cooperatives worked closely with SFE to harvest timber.	• Nationalization of forest resources • Swidden cultivation minimize • Resettlement programs combined with establishment of cooperatives • Late in the period, a shift from forest exploitation to protection.
1976-1986	• Establishment of Ministry of Forestry • Reinforced forest protection forces • Ministry of Forestry and PPC manage SFE • Overlaps in management and performance between SFE and forest protection forces • The forest sector faced a crisis; numerous SFE failed to operate, funds from forestry and the state declined sharply due to decreased revenue.	• Timber exploitation continued for export and national restructuring • Timber was over-exploited, leading to exhausted forests • Forest land was converted into agricultural land and new special economic zones	• Continued resettlement programs • Emigration from lowlands to mountainous areas, building up new economic zones • Continued shift from forest exploitation to protection.
1986 until now	• MARD manages forestry issues • Establishment of FMB to manage protection and special-use forests • SFE manage production forest • Households, individuals, and communities are involved in production forest use and management	• New emphasis on the importance of forest environmental services and biodiversity • Forest value is not just economic (i.e. land for production) but also tied to environmental services	• Priority has been given to forest protection and biodiversity conservation through policies/mechanisms on protection and special-use forest management. • Applying market-oriented mechanisms for full exploitation of forest environmental services (PES, REDD+). • Decentralization has proceeded through improved land access for households, individuals, and communities (Land Law/Forest Protection and Development Law).

(Source: To and Tran 2014)

The establishment of a special-use-forest management board, which became the forest management board of TS-PH[21] in 2008 was needed to protect special-use forests and prevent over-exploitation in natural forests in the six communes. Their responsibilities include the 2.35 thousand ha special-use forests in Nghinh Tuong and the 1.85 thousand ha in Vu Chan. According to the chief of Vu Chan ranger station, Mr Nguyen Thai Son, "*the quality of special-use forests has been improved after the implementation of forest land allocation. People can see monkeys and gibbons on the mountains near the office of the Communal People´s Committee*."

Production and protection forests were allocated to households or individuals who were given long-term rights[22] to lease, transfer, inherit mortgage and exchange land. In Nghinh Tuong, in 2015, 2.5 thousand hectares of forest land marked for protection and production were devolved to 363 households to manage. The Nghinh Tuong Communal People´s Committee control 4.7 thousand hectares of protection and production forests[23]. In Vu Chan, protection and production forests were allocated to local households. The Communal People´s Committee only manage about 200 ha of protection forests. In the fact, the forests that the Communal People´s Committee manage are devolved to villages near those forests and they are considered as community forests of the whole villages. Each village have a team for forest protection that leader is village leader who is responsible to the Communal People´s Committee for forest protection.

To devolve forest management authority from the state to the local users and their responsibilities is for quite a radical policy. Land property became stronger and more individual, consequently, disputes of forestland ownership and use were inevitable. As to be expected, there have also been some inadequacies in the implementation process of forest land allocation (Sikor 2001; Sunderlin et al. 2005; Sikor and Nguyen 2007; Tran 2012). However, it has shown successes (figure 6.1): Endured private land use rights encourage local people invest in protection and restoration of their forest land (Sikor 2001; Sunderlin and Huynh 2005; Castella et al. 2006) as well as the development of perennial plantation in the upland (Castella et al. 2006) which improve household income (de Jong et al. 2006; Tran 2012; To and Tran 2014). Forest land allocation also contributed to the sedentary settlement and cultivation program that reduced shifting cultivation and

[21] The forest management board has co-operated with the local people in forest protection and conservation; in economic developments to reduce forest dependence; and education concerning forest functions.

[22] Decree 164/CP, issued in 1993, promulgated a long-term land tenure program for households: 20 years for annual crops and 50 years for perennial crops with upland areas given longer tenure privileges.
Decree 02/CP, passed in January 1994 and a revision of Decree 163/ND-CP allocated forestlands to upland households for periods of 50 years. (Vien et al, 2005)

[23] Cited from Report Nr. 08/BC-KDB, Report of ranger´s responsibilities of forest protection and development at communal level in Nghinh Tuong in 2015.

promoted paddy land intensification in mountain areas (Castella et al. 2006; To et al. 2013).

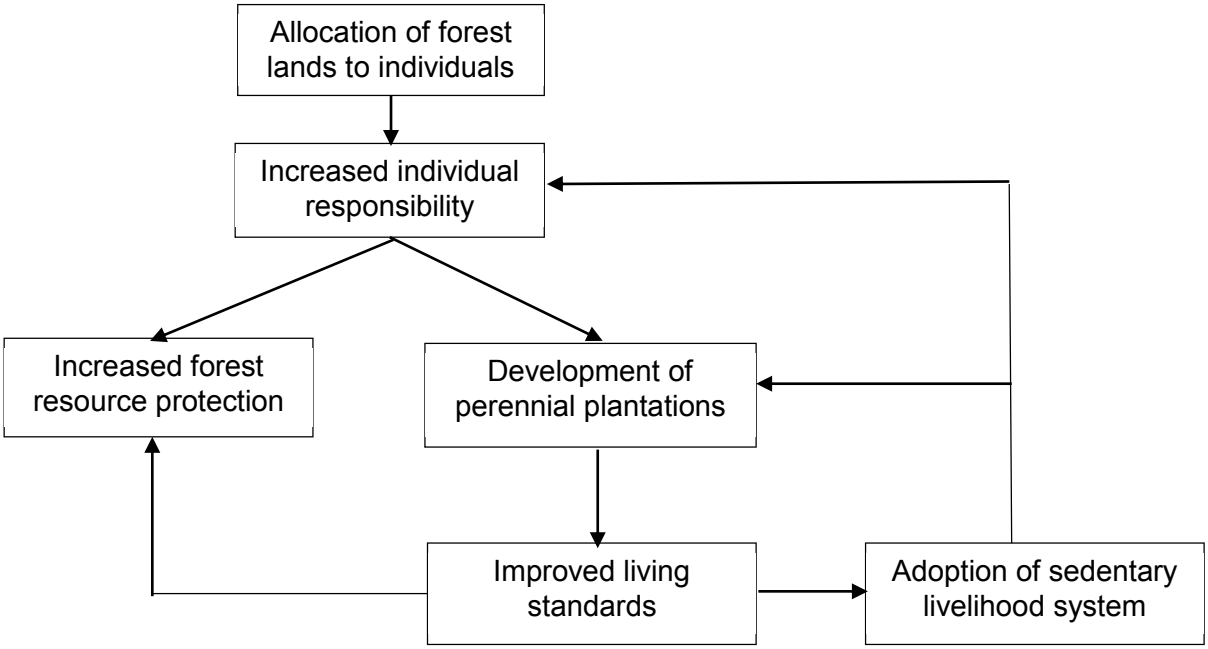


Figure 6.1: Rationale for forestland allocation
(Source: Castella et al. 2006)

The government of Vietnam has also carried out forest rehabilitation programs since the mid-1950s (de Jong et al. 2006), with increasing efforts since the early 1990s (Clement and Amezaga 2009). The two national large-scale aforestation programs, namely i) The 327 Program (known as 'Greening the Barren Hills' program) was implemented between 1993-1998 and ii) the Five Million Hectare Reforestation Program, also known as The 661 Program, between 1998 - 2010. Both have been the most significant initiatives in terms of objectives, size of investment and magnitude of political and international support (de Jong et al. 2006).

The 661 program was promulgated under Decision 08/1997/QH10 issued in December 1997 and Decision 661/QD-TT issued in July 1998. The program´s concretely named taks and responsibilities are (1) plantation of 5 million hectares of new forests and (2) protection of existing forests and stimulation of natural regeneration in order to increase the forest cover to 43% of total land area and reach some other socio-economic objectives. In this period, the three before mentioned types of forests (special-use, protection, and production forests) were determined to support the implementation of the 661 program.

People in Vu Chan and Nghinh Tuong participated enthusiastically in this program. Local households had Forest Protection Contracts to protect existing forests and to stimulate natural rehabilitation through payment of 50,000 VND (just over 3USD at the current exchange rate) per hectare per year. In areas requiring ecological restoration or new establishment of plantation forests, households received saplings, fertilizers and two

million VND/year/ha during the first 2 years. The species for new forest plantations were *Acacia hybrid* spp. In some plots, anise (*Illicium verum*) was planted together with *Acacia hybrid* spp. alternatively following the hypothesis that, mature *Acacia hybrid* sp. trees would shaded young anise trees, until *Acacia hybrid* sp. could be logged (in 7-10 years old), while anise raised as a forest. In fact, anise has been stunted or died because of high density and leaf canopy of *Acacia hybrid*.

Box 6.1: The 661 program

Goals

- Establish 5 million ha of new forests as well as protection of existent forests in order to increase the forest cover to 43% of total land areas for 1998 - 2010
- Use bare lands as a production tool to create jobs, contributing to famine eradication, poverty alleviation, sedentary livelihood, rural economic development.
- Supply wood for industrial purpose, firewood and other forest products for both domestic consumption and export.

Planning

- To plant 2 million hectares of protection forests and special-use forests in which, one million ha of restoration - oriented protection in combination with supplemental plantation and one million ha of new plantation associated with sedentary agriculture and settlement.
- To plant 3 million hectares of production forests, in which, about 2 million hectares of woods for industrial raw materials, pit-props, growing specialty and specious wood plants; one million hectares of perennial plants and fruit trees.

In our household surveys, we investigated the factors that motivated local people to engage in forest plantation. The results are illustrated in figure 6.2. The biggest motivation for afforestation with half of the respondents´ approval is the expectation of economic benefits. About 13% of the interviewees participated because they saw the environmental benefits coressponding to this activity. The portion of households that planted forests because they received good supports from the afforestation program accounted for nearly 30%. Some households (14%) also said that their neighbours´ successes of forest plantation motivated them to plant their own forest. Around 10% gave other reasons for planting forests and a very small number of people (less than 1%) did because of coercion.

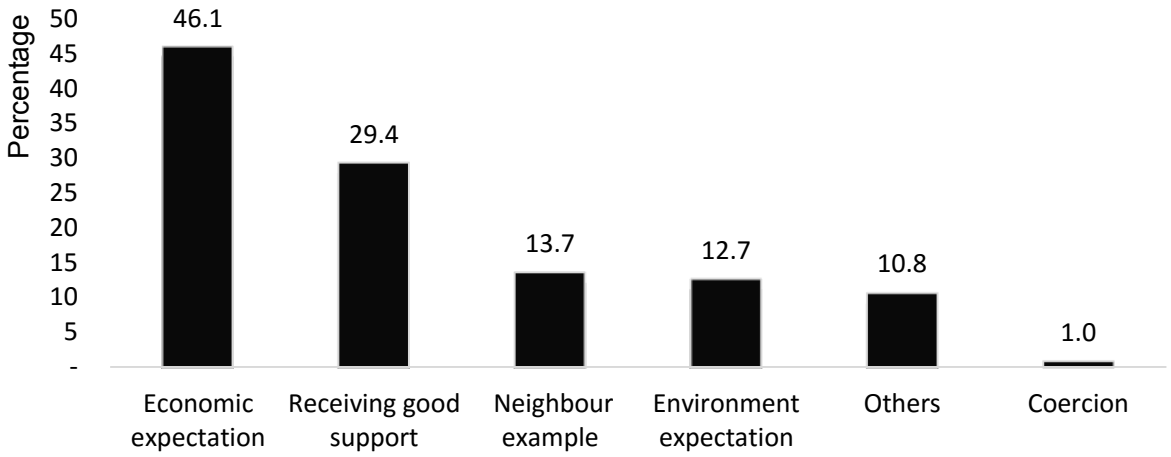


Figure 6.2: Motivation of forest plantation (n = 102)

Many people said that they recognized the good effects of afforestation after several years since the national program has been implemented. They decided to invest by themselves to expand the areas of their plantation forests. Mr. Ha Van Ninh, chair of Nghinh Tuong commune, said that local people were highly enthusiastic about the afforestation program. They carried baskets of nurslings into the high forests disregarding the difficulty of the ascent. Due to the afforestation program, the bare forestlands have been greened and the landscape has become more beautiful.

In this respect, the 661 program has achieved certain success in the research area with thousands hectares of planted forests by *Acacia hybrid* sp. since 2002. Local people have invested continuously in forest plantation after they realized the economic benefits of the first wood harvesting. This enhances the forestry development in the local economic structure. Another indirect benefit of the afforestation program is the upgrading (widening) of many roads for logging. This will also support transporting agricultural products and travelling. So far, owners of remote forests were obliged to sell wood at low prices in order to encourage traders to built or widen forest roads for wood transport.

Beside the 661 program, the above mentioned project of anise (*Illicium verum)* plantation for commercial purposes was also implemented in Vu Chan commune between 2002 and 2007. However, after more than 10 years, anises did not blossom and the effort turned out to be economically inefficient in the area

6.1.2. National rural development policies and their implementation in the research area

The Vietnam government has many rural development policies and programs for mountain areas in order to reduce the various dependencies of local people on forests and promote local economics, secure local livelihoods and residences, and stabilize the population. In this part, some policies and programs of rural development that influence

the forest resources indirectly and induce changes of local demands for FESs in the research areas will be analyzed

The program of sedentary life and cultivation for nomadic ethnic communities intends to reduce slash and burn forests for cultivation. Shifting cultivation, which creates nomadic life styles of minority ethnic people in mountain areas changed the forest cover and put pressures on forests, especially with the growth of the nomadic population. The Tay and the Dao have always lived in the surrounding forests. Therefore, they still tend to move further into the forests and practice shifting cultivation (Mai 2003). In the research areas this cultivation method increased considerably during the 1960s and 1970s (interview). The government has then exerted great efforts to remove shifting cultivation that had already been practiced for generations. The main issue was to persuade farmers to transform shifting farming into sedentary cultivation and settlements. The programs of sedentary life and cultivation for minority ethnic groups were implemented in combination with others programs of land allocation, poverty reduction, socio-economic development for rural communities adapting fixed cultivation practices, and forestry development. Nomadic communities were supported with land, finance and technologies to settle and cultivate more intensively in lowland fields. Due to the successes of settled agriculture and sedentary residency, nomadism could be eliminated in both two communes in the 1990s.

Nomadic existence always goes with famine because the farmers only cultivated upland rice with lower productivity on soils with rather limited plant nutrient conditions. However, permanent settlements with fixed cultivation practices suffered from inevitable poverty as well, if they could only cultivate one crop annually. Planting soybean in Vu Chan in the earlier 1990s contributed significantly to the reduction of cereal scarcity at that time. Since the development of irrigation and the application of new rice varieties with higher yield and better drought tolerance, farmers are able to cultivated two rice crops each year (summer and winter rice crops). Maize as well is cultivated in lowland fields with new kinds of seeds that have higher productivity. Food shortage was solved and famine was overcome in the 1990s in these mountain communities. Since then, local governments and people have started the fight against poverty with many supportive policies and programs.

The program of socio-economic development for difficult minority ethnics and mountain areas**,** called the 135 Program[24], is one of the Government programs for poverty reduction in northern Vietnam, which was implemented in 1998 under decision 135/1998/QD-TTg

[24] According to the original plan, the program was implemented in 7 years with 2 phases: Phase I of the fiscal year 1998 to 2000 and Phase II in 2001 to 2005. However, the Government of Vietnam decided to extend this program with phase III in 2006 to 2010 and phase IV in 1012-1015 and to continue with period 2016-2020.

of the Prime Minister of the Government of Vietnam. With its support infrastructure and the economy have been developed in Vu Chan and Nghinh Tuong. Communal asphalt roads and electricity gave impulses to the development of the local socio-economic situation. The rehabilitation and construction of the irrigation systems have contributed to increase agricultural productivity. The improvement of the road system has improved the chances for commercial plantation wood extraction and goods exchange between the lowlands and the upland areas. In the past, for instance, local people needed half a day walking to the markets to sell their agriculture and forest products or buy something, while now, they can easily purchase on their local market. With the good road system, traders easily go to the villages to bring goods to the local people as well as to buy local products. Local farmers can buy agricultural inputs (like fertilizers, seedling, seeds, cultivation tools, etc.) in their areas to grow their agricultural products. The application of electric machines enhances the productivity and reduces human labour forces in cultivation. The social and cultural aspects of the local communities have been improved with these economic developments.

Box 6.2: Verbal descriptions concerning the infounces of intensive agriculture on up-land field cultivation

- "Nowadays, since the government invested in fertilizer, people can grow crops in low-land fields with higher yield. No one has to grow maize in the forests any more"(Interviewee)
- "When agriculture sciences were not yet developed, people used to clear forests to grow upland rice, maize, cassava and sweet potato" (Interviewee)
- "About recent ten years, local people have not cultivated shifting fields because the field´s soils run out of nutrients and the new crop varieties can only be growth in low land fields" (Interviewee)

Some programs and policies that encouraged agriculture expansion, supported seeds or seedlings, trained cultivation techquiques or loaned for poor households and women, encouraged local people develop agricultural economics and apply new plants (green tea, *Morindae officinalis - ba kich)* (Photo 6.1). The policies of rural development have contributed directly to the local socio-economic development and indirectly to forests and forest cover. Changes in structure and variety of crops have increased productivity and economic benifits leading to reduced shifting cultivation, and illegal forest-based activities. In other words, they reduced the demands for FPES and thus the pressure on natural forests.

a) Morindae officinalis- a medicinal plant is planted for commerce
b) Green tea has been grown as a product
c) Bananas is planted around the foothill.

Photo 6.1: Images of agroforestry in the research area
(Source: Fieldwork, taken by the author)

6.2. Local economy and livelihood

Considering the perception of local people, livelihood is the sources that provide long-term food or cash for their family. In this respect, most local people reply on on-farm activities such as cultivation and livestock husbandry. More than 90% of the interviewed households cultivate paddy fields and it is significant in farmers' life because it is the main source of food. Only 3% of the respondents considered livestock husbandry as the first source of their households´ income, while a large numbers of local families breed livestock (pigs and poultry) just to provide food for their families and an additional income source.

Accordingly, the main livelihood of local people is agriculture, and their schedules depend on the cultivation calendar as presented in figure 6.3. Rice is the main crop in the areas and most on-farm activities occur in summer and winter. Rice is cultivated mainly in summer because rainfalls provide enough water for the paddy fields and the natural condition is suitable for the crops. In winter time, the fields that do have enough water are also cultivated with winter rice crop. Additionally, some annual crops such as cassava, maize, bean or soya bean are planted on upland fields or in the dry fields. Cassava is planted in February and harvested from October to the end of year. Domestic livestock and fowls are raised in the whole year to get eggs or meats for the households. In the cultivation process, transplanting and harvesting are steps that require more labour in a short period of time (normally just for one or two weeks). The process of weeding and tending crops are not done frequently and therefore does not need more labour. Thus, farmers have free time after transplanting or harvesting, when they wait and prepare for the next cultivation season. In this time only, people usually generate benefits from the forests. Women usually gather NTFPs for food or for selling them depending on the

amount they can harvest. They also collect fuel wood for winter and available food for their families. The cultivation schedule indicates that people impact on the forests frequently during lunar October and December. In these months, they have also higher demands on fuel wood and NTFPs to prepare for their traditional new year and other festivals than during other periods in the year.

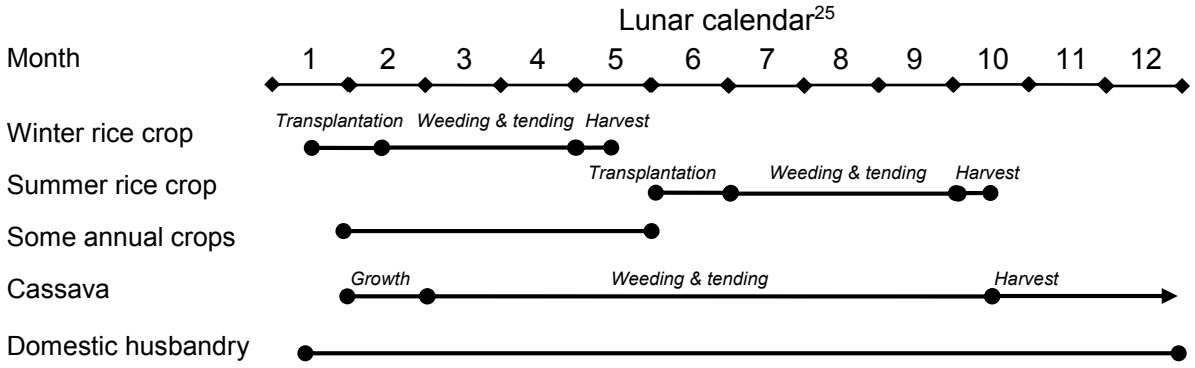


Figure 6.3: Agricultural time schedule in a lunar year

However, forests do only contribute a small and decreasing part to their livelihood. Forest products like food, medicine, or fuel wood are rather perceived as a supplement to their entire consumption but not as a considerable source of income. Local people do not even quantify the amount of NTFPs they consume in a year. Thus, the calculation of the consumption in cash money is impossible. Nonetheless, the extraction of fuel wood and other NTFPs from forests can save a considerable amount of money which otherwise had to be spent to buy these products from the local markets. Therefor it remains relevant for the poor households. In recent years, plantation forests started to give monetary benefits to the owners. However, following local people, the price of this wood is low, keeping in mind that they have to invest during a 5-7 years period, and spend for road widening to access the wood. Furthermore, the small monetary benefits they get per year are usually reinvested in afforestation.

At the time of the survey, forest-based employment activities (both legal and illegal) were not popular, and in some cases considered even to be an irregular and sensitive issue. Local people avoided talking about this. Nonetheless off-farm and forest-related activities account for a small proportion of first income in the areas with 4% and 1% respectively. In some families, the money from off-farm activities may sometimes even surpass those from agriculture. However, this income is ussually not stable nor permanent and thus, not considered as the main pillar of livelihood. Some households have also small stores to sell groceries to their neighbours. The benefits of such kind of small businesses are supportive sources of incomes. Some other households gain additional money from

[25]Lunar calendar or the moon calendar is calculated based on observation of changing position of the Moon and the Sun relative to the Earth. In many part of the world including Vietnam, lunar calendars serve to determine the holidays and cultivation schedule.

aquaculture, pensions, salaries, allowances for poor households or local collaborations in social fields, but also these sources are not their main income.

Many researches have shown the relation between poverty and resource degradation such as Khan & Khan 2009; Duraiappah 1998; Scherr 1999; Malik & Nazli 1998; Barbier 2000; IFAD 2012. This seems to be due to the fact that the poor households do lack in land and ready cash to generate income from agriculture (Asfaw et al. 2013) and commerce. In so far, they depend just on the natural resources around them (IFAD 2012) and tend to extract these sources to serve their basic needs. This is definitely the case in the research area. Due to poverty, no extra jobs, labour redundancy in given periods, and low agriculture-based income, local people depend essentially on forests which according to Thoa (2014) can lead to illegal or excessive extraction of forest products. However, the results of household surveys given in table 5.8 demonstrate that the less poor households consume more forest products than the poor households do although the differences in consumption percentage are small (around of 2%). This situation is similar to a case study in Zimbabwe (Cavendish 2000), Pakistan (Khan and Khan 2009) and Zambia (Kalaba et al. 2013)

In fact, economic growth leads to changing consumption patterns (Nelson et al. 2006). People change their demands for forest provisioning services from just basic needs into goods (and services) which improve their quality of life. For example, while the poor need enough wood to build their house, the rich want valuable and durable wood for their building or intend making it more beautiful and bigger. Another relevant evidence of changing demands is the trend of furniture use. Traditionally, local people spread sedge mats on sleeping places when they went to sleep; they sat on the floor when they received visitors, and there was almost no timber furniture in the stilt house. Nowadays, it is popular to use beds, wardrobes, tables and chairs. Valuable wood furniture or big wood planks manifest the wealth of the owners. Following a study of Nguyen Thi Yen and her partners (1994), some collected NTFPs such as vegetable, bamboo or mushroom were consumed in richer households while in poorer households these forest foods were sold to buy rice (cited by/in Arnold & Pérez 1998, 34). Consequently, poverty reduction does not necessarily translate into noticeable improvements in sustainable resource management (Hazell & Wood 2008; Kalaba et al. 2013).

To sum up, local people tend to extract or collect forest products (NTFPs) during their free periods in the year for selling and for consumption in order to save money for their family instead of spending it in the markets. Nevertheless, it is difficult to delineate clearly whether the poor or the non-poor do have more effect on the forest ecosystem, although the impact level on forests differs marginally with respect to their wealth levels.

6.3. Local people´s awareness

People´s awareness can influence their attitude and participation in natural resource use and management (Arjunan et al. 2006; Heinen and Shrivastava 2009; Sirivongs and Tsuchiya 2012; Tesfaye et al. 2012; Nelson et al. 2014). Thus, this research considers human awareness as a factor that affects forest ecosystems as well as changes people´s demand for FES. Accordingly, the following section analyses local people´s awareness of human activities influencing on forests; special-use forests; the relevence of forests as well as factors that influence human awareness of forest importance. The sources of forestry-related information were shown in this section with the purpose of finding out the most effective approach of information that could have effects on local awareness and may change their attitude towards forests positively

6.3.1. People´s awareness concerning different human impacts on forests

Human awareness of impacts on forests was assessed through local people´s evaluation of the impact levels of thirteen activities on forests, following five levels from very positive to very negative. The results are presented in figure 6.4, in which, the increase in negative influence matches with the increase of darkness in the bar chart.

Most respondents agreed that wood logging, ornament-related business and hunting influence negatively on forests. Fuel wood extraction, a regular activity of local people, was not thought to degrade forests because it only affects branches, small or fallen trees. Collecting NTFPs such as medicine, honey and mushroom was considered as highly neutral impacts on forests. Local people said that they only extract small amounts to be used directly in their families, but not for commercial purposes. Moreover, they believed that their extraction methods do not damage the forest ecosystem. Contrary, around 15% of the interviewees claimed that collecting these products could damage forests directly, for example, because big trees are cut down to create habitats for mushroom or to obtain honey and medicine. A few people argued that extraction should be encouraged in some case to reduce nutrient competition between individual trees and that trees also die themself as a final term in the growth cycle.

Half of the respondents did not give positive or negative viewpoints about the impact of grazing in forests whereas more than 40% thought that grazing caused some disadvantages for the forest ecosystem. Some people also explained that livestock grazing has not developed in the area, therefore they could not estimate its effects on the forest system. At the time of the survey, grazing was practiced on small scale only, with one or several buffalos in some households which should not have much effect on forests.

Regarding the activities related to ornamental species, collecting and selling these forest products was highly criticized by almost two thirds of interviewees. Hence, the number of people who thought that using plants and keeping animals for ornamental purposes had negative influences on forests was reasonably higher than of those who thought it had positive impacts. However, it was still lower than of those who were neutral or did not

express any opinion. Some people said that growing ornamental plants at home was not negative because these plants still grow up in other places. In any case, they considered keeping wild animal species to be more negative than using plant species as ornaments. In fact, moving a species out of its environments disturbs the ecosystem.

Bee keeping was assessed to be the most positive activity, with 44.6% of positive and 52.3% of neutral judgements, and only 2% negative opinions.

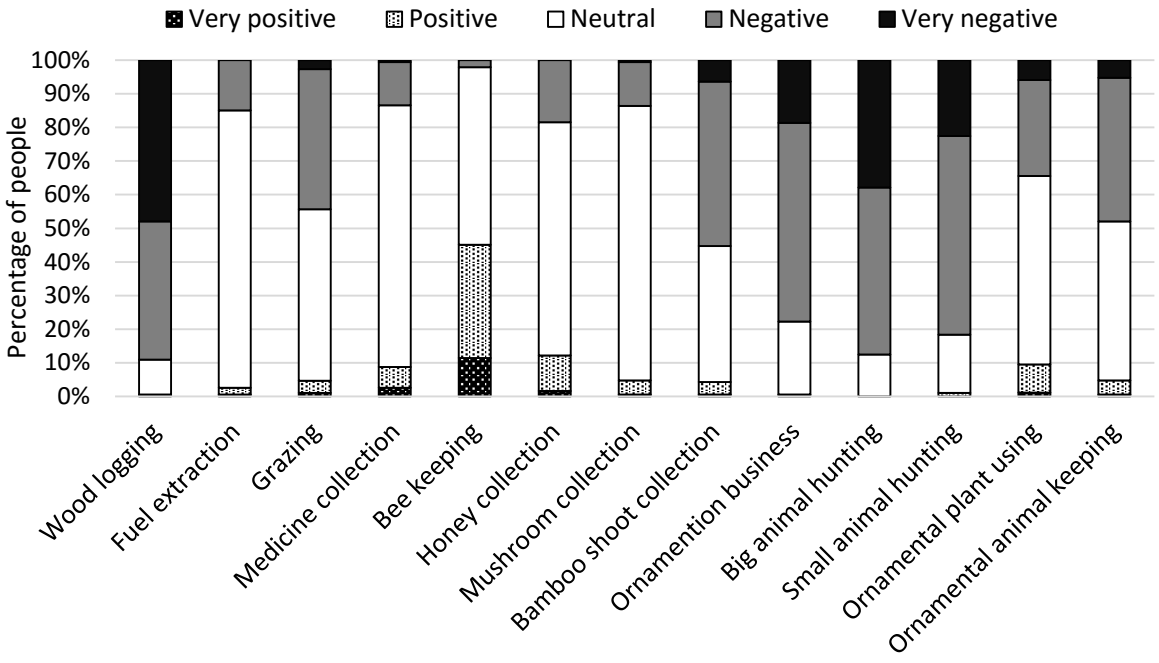


Figure 6.4: Local people perception on the forest influence of some activities

6.3.2. Local awareness concerning the necessity of special-use forests

Since the Than Sa - Phuong Hoang forest conservation area was established in 2008, following the government regulation in natural conservation, a main part of the natural forests has become special-use forest and thus has been strictly protected. Mr. Nguyen Van Thu, Deputy Chief of the TSPHMB, said that, when special-use forests had been established, foresters and forestry officers had to disseminate regulations on using and protecting these forests and persuade local people not to extract any more. However, they also faced disagreement of some local residents with special-use forest establishment.

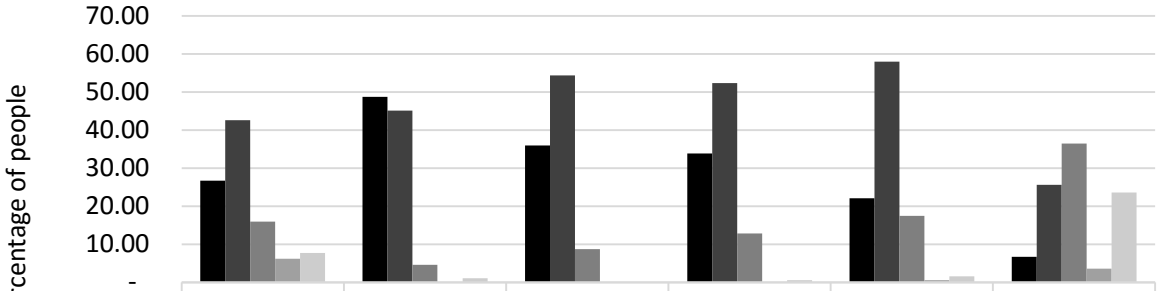
A small survey related to this issue was done with 50 people in the phase of questionnaire testing. A significant majority thought that their lives and income did not change after a major part of natural forests had become special-use forests. Less than a fifth said that their incomes had decreased because they would not be able to extract wood in the protected forests for trading or building. The percentage of people who were aware of the border of the protected forests was 40%, most of whom were males. A large number of

female interviewees did not know the boundary of the protected forest areas and considerably fewer females than males knew about forest-related projects or programs in their area (with 36.4% and 50% respectively). Obviously, women are ill-informed about the local forests.

Legally, it is forbidden to take or extract whatsoever from protected forests (Article 13, Decision No. 08/2011/QD-TTg). Some people said that they knew the regulation but they still extracted something in special-use forests because of their needs. Some others thought that they can extract non-timber products such as medicinal plants, vegetables or firewood in special-use forests and their extraction would not affect the natural forests.

6.3.3. Local awareness of forest services importance

Local people´s perceptions of forest importance were evaluated using six different sectors, including their household income, water supply, water regulation, climate regulation, soil nutrition and culture (figure 6.5). Forests were considered to be of high importance with more than 90% of agreements, as a source of water supply and for their regulation function. The proportion of respondents who gave neutral answers or evaluated at low level was below 10% in total. The role of forests for climate regulation and soil nutrition were also highly appreciated, though not as high as for water. About 70% of the interviewees agreed that forests were important for their income while 16% were neutral and about 14 % indicated minor importance. Some people said that the forests had no effects on their home income because their livelihoods were not dependent therefrom. Following the surveys, about 33% of respondents thought that forests were important with respect to their cultures. However, culture was perceived as the least depending issue. Basically, cultural services were of no interest in these areas and do not seem to be noticed adequately with respect to their dependancy on forests.



	Income	Water supply	Water regulation	Climate regulation	Soil nutrition	Culture
Very important	26.67	48.72	35.90	33.85	22.05	6.67
Important	42.56	45.13	54.36	52.31	57.95	25.64
Neutral	15.90	4.62	8.72	12.82	17.44	36.41
Less important	6.15	-	-	-	0.51	3.59
Unimportant	7.69	1.03	-	0.51	1.54	23.59

Figure 6.5: Importance level of forests with respect to different ecosystem services

However, all interviewees said that it was necessary to protect the forests for their descendants. They also realized forest degradation through scarcity of resources stating that it has become increasingly difficult to find particular species in the forests. In an open question about the reason why to protect forests for following generations, local people gave various answers that are grouped and quantified in figure 6.6. The most popular reason (23%) is preservation of forest resources for the future descendants. The reasons for environment, wood and water are 17.3%, 15.4% and 12.3% respectively.

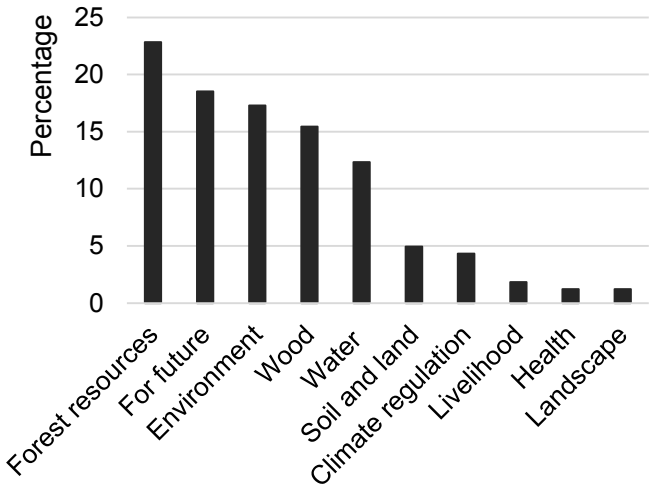


Figure 6.6: Reasons for forest rotection

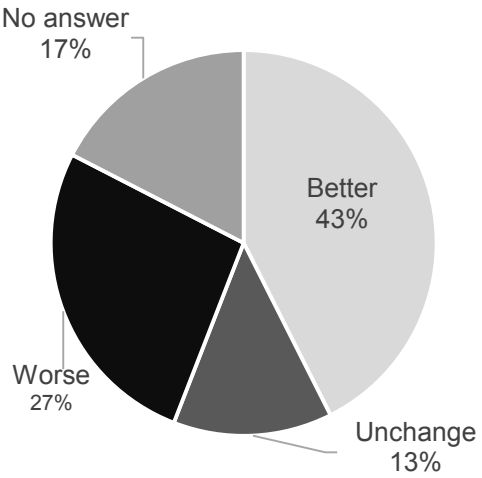


Figure 6.7: Prediction of local forest quality in next decade

In predicting the quality of local forest for the next 10 years (figure 6.6), more than two-fifths of the respondents had positive expectations that the forests will be in better state due to forest protection and afforestation at present, while a quarter of respondents forecasted negatively. The proportion of those who forecast that the forests will remain unchanged is 13%, however, some of them still worry about the quality of natural forests because of illegal forest extraction.

Box 6.3. Verbal descriptions concerning change of forests and effects

- If forests are destroyed, drought and flood will influence agricultural production, climate will change. (Interviewee)
- We should think how to plant and protect forests better to regulate weather, reserve water sources and provide forest products as well. (Interviewee)
- If we can plant forests, some natural factors/conditions will recover. For example, if forest quality recovers in good condition, honeybees will return and make their beehives. They have gone out because of the poor condition of their habitat in the forests. (Interviewee)

6.3.4. Factors influencing local people´s perception of forest importance

In assessing the influence of the respondents´ backgrounds (such as gender, age, ethnicity, education, economic family status , commune, family size or the respondents´ position in the family) on their perception of the forest importance level for the income of their family, water, climate, soil and culture, a backward linear multiple regression analysis was used. We considered six regression models matching with predictions for six dependent variables and the same independent variables.

Indeed, the multiple regression analyse results (Table 6.2) reveiled relations between the respondents' awareness and some of their socio-economic backgrounds: A multiple linear regression was calculated to predict respondents´ perception of the contribution of forests to their income, based on gender, ethnicity, family size and the household economic status. Gender and family size have highly positive significant influences on the dependent variables with < 0.01 level of significance. Ethnic and economic status have negative effects on the dependent variables at a significance level of less than 5%. The model fits with $R^2 = 0.133$.

The highly significant effect of gender on respondents´ awareness of forests importance to family income can be attributed to the labour distribution in forest-related employment in the research areas. Males usually participate in timber-related employment which fetches more money than the subsistent livelihoods undertaken by females such as firewood and NTFP collection and gathering. Therefore, men appreciated the important role of forests to their families´ income significantly more than the women.

Respondents in families with 7 or more people have highly positive perception of forest importance to their income because these big size families need to vary the sources of their income. While there are some limitations concerning on-farm activities, forest-related incomes are good source for these families.

The negative significant effect of ethnicity on respondents´ attitude towards the importance of forests to household income could be explained by the fact that the Tay cultivates wet rice and agriculture better than the Dao. They are also good in doing business or other activities to improve their economic situation.

Age and home commune do have positive effects on respondents´ attitude toward forest importance with respect to water supply at a significancelevel of >0.01; while the respondents´ educational background had negative influence on this evaluation (at p=0.003). The coefficient of determination (R^2) of the model is 0.313.

When the respondents´ perception of forest importance to water regulation was predicted, it was found that the place they live (Beta = 0.372, p = 0.000), and their education level (Beta = -0.285, p = 0.001) were significant predictors. The overall model fit was $R^2 = 0.17$.

Table 6.2: Effect of some selected variables on the respondents´ evaluation of forest importance

Dependent variable	Independent variable	Regression coefficient	SE	t	P
Forests and family´s income R^2=0.133 F (4, 188) = 7.187	(Constant)	3.648	.199	18.353	.000
	Gender (1 = male)	.477	.179	2.669	.008
	Ethnicity (1 = Tay)	-.328	.160	-2.047	.042
	Economic status (1 = poor)	-.354	.160	-2.206	.029
	Family size 2 (1 = from 7 people)	.764	.259	2.951	.004
Forests and water supply R^2=0.313 F (4, 189) = 21.541	(Constant)	4.194	.087	47.954	.000
	Commune (1 = Nghinh Tuong)	.612	.083	7.372	.000
	Economic status (1 = poor)	-.149	.084	-1.774	.078
	Age 2 (1 = from 31 to 40 years old)	.249	.087	2.847	.005
	Education 1 (1 = under primary school)	-.252	.083	-3.027	.003
Forests and Water regulation R^2=0.170 F (2, 190) = 21.541	(Constant)	4.219	.075	55.976	.000
	Commune (1 = Nghinh Tuong)	.372	.082	4.527	.000
	Education 1 (1 = under primary school)	-.285	.082	-3.473	.001
Forests and climate regulation R^2=0.177 F (4, 189) = 21.541	(Constant)	4.056	.111	36.583	.000
	Gender (1 = male)	.240	.106	2.260	.025
	Commune (1 = Nghinh Tuong)	.338	.095	3.553	.000
	Age 2 (1 = from 31 to 40 years old)	-.167	.097	-1.724	.086
	Education 1 (1 = under primary school)	-.318	.094	-3.400	.001
Forests and soil nutrient R^2=0.047 F (3, 190) = 21.541	(Constant)	4.308	.118	36.416	.000
	Ethnicity (1 = Tay)	-.258	.114	-2.267	.025
	Economic status (1 = poor)	-.203	.108	-1.883	.061
	Education 1 (1 = under primary school)	-.199	.113	-1.753	.081
Forests and local culture R^2=0.097 F (3, 183) = 21.541	(Constant)	3.647	.197	18.470	.000
	Family´s leader (1 = leader)	-.500	.195	-2.561	.011
	Commune (1 = Nghinh Tuong)	-.354	.182	-1.946	.053
	Ethnicity (1 = Tay)	-.470	.180	-2.613	.010

Furthermore, respondents´ gender and place they are living were found to have positive effect on their awareness of forest importance to climate regulation ($p<0.05$). The educational level has negative influence on the dependent variable at 0.001 significance level. The explanatory power (R^2) of the model is 0.177.

The educational level proved to have highly negative influences on the perception of forests with respect to water supply and climate regulation. This could be explained by their perception of these forest ecosystem services. The respondents having higher education level have more knowledge about the forest functions to reserve and regulate water and climate. Respondents with at least primary school education highly appreciated the role of forests in these services and considerably more than respondents who did not finish primary school.

By examining the effect of these independent variables on respondents´ perception of forest importance with respect to soil nutrients, the regression analysis showed that the ethnicity of respondents had negative effects on the dependent variable ($p<0.05$) with explanatory power (R^2) equal to 0.17.

Regarding the evaluation of forest importance to local culture, the regression results show that ethnicity and the position of respondents in their family have negative effects on this dependent variable. The coefficient of determination (R^2) of the model is 0.097. The influence of ethinicity could be explained by the retained cultural features of the two ethnic groups. The Dao have been keeping more of their traditional cultural features concerning their material and spiritual life and their relation to nature. Thus, forests play a more important role in their culture than they do in the Tay's.

6.3.5. Information approach

Assessment of how local peole approach forest-related information and the effectiveness of information transfers indicated that people-to-people or two-direction communication transfers information more efficiently than one-way-interactive methods in the rural mountain areas (table 6.3).

Talking with local authorities turned out to be the most effective and popular way to transfer knowledge and information about forestry to local people, followed by sources of television and talking with neighbours. Local authorities have specific knowledge of forestry and government policies. They also understand the local contexts and local people's daily lives. Therefore, they can transmit information briefly in simple ways to locals in the communities' own language through regular village meetings or by talking to groups of locals. Foresters have a neutral role in information transfer to local people. In local people´s opinions, talking with neighbours was also an effective way to exchange information related to forests. Talking with other people at leisure or in working together

is another affecting way to get information and it is suitable for rural areas where social relationships are is tidy and neighbourhood relationships are intimate and friendly.

Table 6.3: Efficiency level of different forest-related information sources
(lowest value = 1, highest value = 5)

Information source	Mean ± SD	Number of respondent (n)
Local government talking	3.56 ± 1.1	169
Television	3.40 ± 1.2	126
Neighbour talking	3.34 ± 1.1	144
Information board	3.01 ± 1.4	126
Forester talking	2.89 ± 1.4	128
Radio	2.58 ± 1.5	88
Newspaper/magazine	2.27 ± 1.4	63
Leaflets	1.82 ± 1.2	45
Internet	1.21 ± 0.6	43

Local people may also get the news and information through television programmes, although this mean is not effective in some villages because electricity has not been available. The communitcative effectiveness of the information board was valuated at the forth position, however, some forest information boards have been deteriorated. Magazines, newspapers, leaflets and radio seem to be inefficient to transmit information in the research area. This is a pretty common situation in rural and mountain areas in Vietnam, because farmers can not afford to buy newspapers or magazins. Only few local government officers and villages' leaders receive the newspapers freely.

The research also considered the knowledge transfer about forest protection and natural environment for children in local schools. The administrators of primary and secondary schools in two communes said that, topics of nature conservation were taught in some social and natural modules. Besides, nature education was given in extracurricular activities through games and plays, in which, pupils acted as characters. During the extracurricular courses, pupils enjoyed and participated actively and enthusiastically. The lectures and extracurricular activities in school enhance the perception of nature´s importance for children, who may popularize forest conservation for their familmembers or become forest protectors in the future.

6.3.6. Resume

Local people did recognize the impacts of some activities on forests, especially the negative activities that happened in the research areas, such as logging and hunting. To some uncommon activities such as using and dealing in ornaments, grazing and bee

keeping, local people attributed a neutral level of impacts because they could not appraise the exact impact level. Although they did not know the exact boundary of the protected forests, local people were aware of the regulations concerning special-use forests. Nevertheless, they still extract some NTFPs in these forests to meet the demand of their families.

They also had a good perception of the importance of forests regarding provisioning and regulating services that do not only benefit their current lives but also the life of their descendants. Respondents´ awareness of the importance of forests was affected by their social-economic backgrounds. Educating and popularizing information about forest functions and their relevance seem to be factors that may improve local people´s knowledge and perception to protect and develop forests. The role of local government officers is important in this educative duty.

Understanding local people´s awareness of forests and their services is essential in changing their behaviour and commitment (Tesfaye et al. 2012) towards FES management and conservation. It could even influence demands for forest services and attitudes towards forest utilization and thus improve the effectiveness of forest management and FES. Besides, local foresters have to work more strictly to prevent illegal forest extractions.

6.4. Some social factors

6.4.1. Population growth

In the areas, the Tay resided first, and then the Dao with their former nomadic life settled in the remote villages close to the forests. Several decades ago, there were only few dozen households in the areas. The population has increased year by yea. In the last 20 years, the success of the family planning program has kept the birth rate and population size stable. The population in each commune was over 2.7 thousand people (table 3.7, chapter 3) and the rate of birth constantly kept below 2% during the last ten years (General Statistic Office of Vo Nhai district 2015). The rate of population growth has been quite similar in both communes since 2010 (figure 6.8). Although the number of people in Nghinh Tuong is higher than in Vu Chan, the population density in Vu Chan is slightly higher than in Nghinh Tuong (0.35 and 0.33 people/km^2 respectively). In general, the population density in both communes is low and the distribution is dense only in some villages that offer convenient transportation.

Demographic data for more several decades is unavailable. Therefore it is difficult to estimate the increase in population for the whole areas. However, through the narations of older people, it can be seen that population growth is considerable in comparison with previous decades. Following Hoang Van Khuyen, an 82-year-old man in Ban Cai village,

Nginh Tuong commune, there were about 15 households in his villages about 40 years ago. Now, the number of families in his village has increased to over 90 making it the most crowded village in Nghinh Tuong. An unpublished document of history of Vu Chan Communist Party shows the population of this commune in different periods. Before the Revolution in August 1945, there were seven villages with 76 household and 837 people in Vu Chan. This number developed to 93 households with just 708 people in 1954. In the 1970s, Vu Chan had 1427 people. This number increased to 1789 people, living in 367 families in 1985. Since then, the population has increased by another thousand living in 670 households. All in all, the population has more than tripled within the last 70 years, while the number of houshoulds has grown almost ninefold. Insofar, households became continuously smaller.

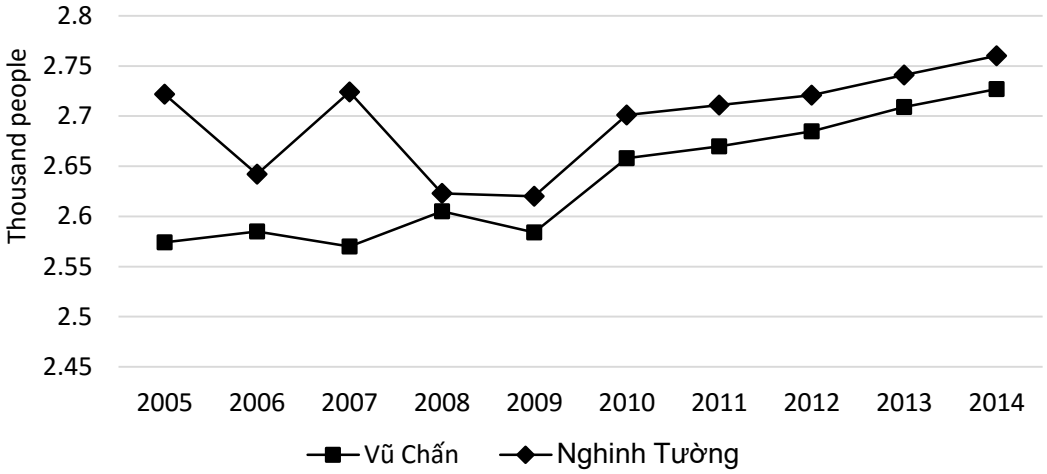


Figure 6.8: Population development in the research areas between 2005 and 2014
(Source: General Statistic Office of Vo Nhai district 2010, 2015)

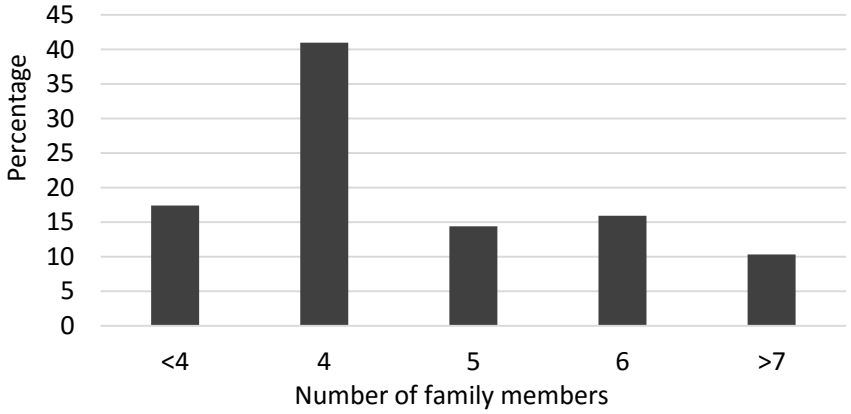


Figure 6.9: Family size of respondants (n = 193)

In the early second half of the 20th century, the average family size was around ten people with many children. Recently, the family size has shrank to four people. In the household survey, the four-person families accounted for more than 40%, while the households with seven or more people were only 10% (figure 6.9). Nuclear families with parents and two

children are dominant. Some families live with grandparents and other few families have four generations living together. Reduced family sizes are often accompanied by a larger number of households (MA 2005e). This explaines the dramatical increase of famillies in the research communes. There is evidence that the number of households drives environmentally significant consumption, for example by requiring more wood to build adequate stilt houses to accommodate them.

Population growth does also increase the consumption of food, fibres, energy and other essential resources. People usually reply on part of local ecosystem to meet their consumption requirement (MA 2005e), for example, a part of forests and forest land is instead for cultivation and house building. Thus, it is not just the population size but also the family size which impacts on the forest ecosystems and in fact, the forests have been degraded rapidly in the past 20 years. However, population growth seems to be a less important driver compared to other recent drivers.

6.4.2. Local people´s handling of natural resources

The forest-related cultural features of local people have been presented in detail in section 5.5. Self-subsistence and self-protection of life by hunting and gathering forest products in the forest have created particular mountainous people, who live in stilt-houses, use medicinal herbs in disease treatments or specific forest products for their ritual activities. Nowadays, hunting has been banned, whereas gathering forest products still practiced as a local custom, not only for subsistence. To some extent, this has an impact on the forest ecosystem.

Collecting forest food (like wild vegetable, or bamboo shoots), medicinal herbs and other NTFPs is a habit or regular activity when people go to the forests for buffalo grazing. Besides, some forest products serve for ritual activities in the local community. Thus, the forest extraction is unavoidable in mountainous areas because of local customs as well as due to the availability of these forest products. Table 6.4 illustrates forest extraction participation and frequency of local people as gathered from household interviews.

In terms of participating in forest extraction, a remarkable number of people (around 70%) collected bamboo and food (vegetable and bamboo shoot), while just a small number of people (under 5%) joined wild animal hunting and ornamental species extraction. Half of the respondents collected medicine from forests and alsmost 10% extracted wild honey while 19% went for logging wood.

Table 6.4: Participation and frequency of FES extraction

FES	Number of participants		Frequency (%)				
	n	%	Seasonal	Several/year	Monthly	Weekly	Daily
Wood	37	19.0	13.5	81.1	2.7	2.7	-
Fuel wood	189	96.9	0.5	7.9	15.9	45.0	30.7
Vegetable	134	68.7	28.4	38.8	14.9	7.5	10.4
Bamboo shoot	134	68.7	3.0	96.3	0.7	-	-
Hunting	8	4.1	87.5	12.5	-	-	-
Honey	19	9.7	89.5	10.5	-	-	-
Medicine	106	54.4	94.3	4.7	0.9	-	-
Bamboo	141	72.3	85.8	12.1	1.4	-	0.7
Ornamental species	9	4.6	77.8	11.1	11.1	-	-

In terms of extraction frequency, most of the mentioned forests were extracted seasonally, based on the growth cycles of the plants (medicine, bamboo shoot) as well as on the availability of free time of the local people (in hunting, collecting honey, bamboo and ornamental species) during the year. Almost one fifth of the respondents logged wood, mostly (81 %) several times per year, and a small proportion (13.5%) just seasonally. The proportion of people logging every month and week was 2.7%. Firewood was extracted frequently with 45% weekly and 30.7% daily. Some households extracted a large amount of firewood per time which was enough for a whole month or even several months. Vegetables were obtained for food in season when the respective species grow or reproduce rapidly. Some types of vegetable grow allthrough the years while some others only grow rapidly once in a year. However, local people do not depend on wild vegetable from forests because it is easy to buy them in the local market or grow them in gardens to support daily meals. Concerning frequency levels the proportion of people collecting vegetable is evenly distributed (table 6.4). Bamboo and bamboo shoots were also harvested seasonally, i.e. normally in the winter, when bamboo shoots grow fast and abundantly, and local people have free time between two crops. They also have good experiences of growing periods of each kind of bamboo.

Overall, the frequency of extraction is mainly seasonal or several times a year. This means that the impact frequency on forests is not the same over the year. However, the extration of NTFPs is rather individual, so that it is difficult to estimate the amounts as well as its management.

Local people have the custom of keeping the fire burning continuously day and night. Therefore big and firm firewood that catches fire easily is chosen for fuel. Thus, local people do cut big dried braches or parts of woods that have been logged for timber. In some cases, they even extract standing trees for fuel wood (Nguyen 2014). Firewood is the most important and irreplaceable fuel in the area. Since most local people are poor, they do not have any financial reserves to use substitute fuel like gas or coal. Local people

have a high demand for fuel wood and the extraction is done frequently throughout the year. However, their use of firewood is ineffective and uneconomical. They often burn many trees at once and keep the fire for the entire day, even when not cooking. The structure of cooking fire also does not trap the heat. Due to the abundance of fuel wood, people exploit and use it arbitrarily, with little concern on sustainable use for the long-term (Do 2012). The forests will lose huge amount of fuel wood if people do not save firewood or use other fuels.

6.4.3. Labour allocation in rural mountain areas

Labour distribution in rural areas is also a social factor manifesting the human impact on local forests. The participation varies by age and gender in using and extracting forest goods. Women and men who frequently collected and utilized different forest products represent the working-age group. Participating in forest resource extraction by gender and age is summarized in table 6.5. Labour allocation in a family follows traditional conventions. Males participate mainly in logging (timber and firewood) and hunting both, illegally and legally. Young men log wood to prepare for building their house in future. Some people are employed in illegal logging and wood tranporting and their income is higher than from agriculture but infrequent. Besides, men also hunt small animals in their free time either for food or for selling. Women collect firewood and NTFPs for their daily lives because, traditionally, their responsibilities are related to organizing and providing food and fuel for the families, which are heavy and unpaid works. The elderly people and children have less impact on the forest. The elders collect medicinal plants, mainly because they are more experienced in identifying different plant species and their uses. Children may participate in collecting firewood, hunting and collecting NTFPs.

Table 6.5: Gender and age in forest resource extraction

Activity	Female	Male	Elderly	Children
Wood logging	+	+ + +	-	-
Wood transporting	+	+ + +	-	-
Firewood logging	+ +	+ +	-	-
Firewood collecting	+ + +	++	+	+
Medicinal collecting	+ + +	+	+ + +	-
Hunting	-	+ + +	-	+
NTFP extracting	+ + +	+	+	+

Frequency: (-) never (+) rarely (++) sometimes (+++) often

In a study of Do (2012), families whose leader was female had more forest exploitation because usually, these families were poor. Allthough women extract more frequenly from forests, men seem to have more serious impact on forests because they usually have work arrangement and do work in a team. Participation of children in forest extraction will

have future effects on their forest perspective because they will be either forest protectors or destroyers, depending on how they have been educated. If they did collect forest products freely, it will be difficult to persuade them to not extract from the forests when they mature.

6.5. External demands

The external demand for NTFP encourages local people to collect such products in the local forests and sell them for their income. Over harvesting of some species, even high density species, may cause negative impacts or even degradation of the respective ecosystem (Arnold and Pérez 1998) and disminishing or even locally extincting some species (Nguyen 2014).

Commercial demand for NTFPs in the area, originating from big cities, has been recorded by some researchers, such as Thoa (2014) and Do (2012). It could be confirmed by own observations in the local flea market or on village trips. Urban traders can buy forest goods from either local people in open-days of the flea markets or from local intermediaries. Due to massive exploitation by local people in a short time to be sold to outside traders, tortoises, snakes and some valuable medicinal herbs, such as *Fibraurea tinctoria (hoàng đằng), Stephania rotunda (bình vôi)*, *Morinda officinalis (ba kích)*, etc. have becom scare in nature (interviews, Thoa 2014; Do 2012) (see box 6.4).

Box 6.4: Verbal descriptions concerning outside demands

- "One tortoise was paid from 5 to 10 thousand VND (about 0.3-0.5 USD at that time). People rushed to catch terrestrial tortoises so that they have been exhausted" (Interviewee)
- "Several years ago, people caught snakes so much days and nights. It is difficult to see snakes nowadays". (Interviewee)
- "They (timber traders - author's words) bought wood for making beds and cabinets. They bid 400 thousand VND (20 USD) for one round wood slice with 20cm or 40 cm of diameter and 4 cm of thickness to make boards. This demand encouraged people logging, even cutting big branches as well." (Interviewee)

Another example of impacts on forest ecosystems, generated by external market demands is over harvesting leaves of *Phryrium* (*lá dong*) in the last quarter of the year (see photo 6.1). Vietnamese people use this kind of leaf for their traditional food at the end of the lunar year which they prepare for the Tet festival. High demand for this forest product in a short time caused over harvesting by local people for commercial purposes. They often collect and store *lá dong* from October or early November and sell it to traders in their villages from mid November to December. However, due to competition between harvesters in recent years, they harvest *lá dong* earlier than usual, even in early September, including small leaves.

a-b) Medicinal herbs were collected to sell to ousite traders in the Nghing Tuong market
c) Illegal-logged wood before tranporting
d) The ledder was made by illegal loggers to climb up rocky mountains
e) This woman collected lá dong in the forests for selling

Photo 6.2: Forest products extracted for selling outside

Source: Fieldwork (taken by the author)

Trends of using forest products (plants and animals) as ornamentation and timber furniture by urban people encourage forest extraction in the rural areas. Favouring of hard and valuable timbers for furniture and construction create pressure on the natural forests in the research areas. Wood smugglers abused the local custom of buiding stilt houses for commercial purposes. They pay high prices for wood, depending on the size and kind of wood. Besides, illegal loggers pay money to local people who log or transport wood outside the forests, based on participation stages. A person is paid between 200 and 500 thousand VND (from 9 to 22 USD) for a day of logging and 70 thousand VND (around 3 USD) for one turn of transporting wood. Illegal logging has become a serious problem that threatens the timber resources as well as the habitats of forest species (Nguyen 2014). Besides using wood with beautiful grain, some people grow wild animals and plants for decoration. Many wild forest orchids, squirrels or kinds of birds are sold on the weekend flea markets in Thai Nguyen city. According to the interviews, trees with beautiful wild orchids growing on their branches are cut down to get the orchids. The exteral demands for ornamental wild species can be observed in the weekend flea market in the center of Thai Nguyen city where wild species and forest orchids are sold openly attracting a crowd of buyers and sellers (photo 6.3).

Photo 6.3: Some images of ornamentation market in Thai Nguyen city

Source: Fieldwork (taken by the author)

6.6. Chapter synthesis

From all mentioned drivers of changes, the exteral indirect drivers such as the Government´s policies and demands from outside have more effects on forests than the internal drivers of changes like local economy and livelihood, human awareness and social factors. Concerning exteral drivers, the government policies have created positive effects on the forests while outside market´s demand has accelerated forest degradation. These drivers originate partly from interal factors. For example, the living standard of ethnic minority communities in mountain areas has been improved, however it is still considerably lower than that of ethnic majority communities (Pham et al. 2011a). The economic benefits from illegal wood logging and NTFPs selling to satisfy external demands are many times higher than those from agriculture cultivation. This motivates local people to participate in such kind of activities and ignore the local ecological benefits.

Understanding the indirect drivers of change could motivate the decision making process, in which, the decision makers can control the internal drivers but not the exogenous ones (MA 2005c). The local people are considered as decision makers when they impact on the forests or have demand for FES. Thus, the internal driver analyses indicated the current issues of local people that support for policy makers in making suitable decisions for the local context.

CHAPTER 7: MAIN RESULTS AND RECOMMENDATIONS

7.1. Main research results

The research was set out to explore the ecosystem services framework and its application in natural resources management. From the theoretical framework and their practional context in Vietnam, the study focuses on local people´s demands for forest ecosystem services and on drivers of changes that impact the forest - local people relationship in the Nghinh Tuong and Vu Chan communes, northern Vietnam. With the goals of identifying the local FES demand and the drivers of changes to support and optimize forest management and policy decision-making at the local scale, a set of indicators was found out to provide information to seek the answers for the research´s questions. The research leads to the following main results:

1. *Local people´s demand* for forest ecosystem services changed over time, depending on the services importance and their availability in each period**.** Provisioning services have always been regarded as the most important, while regulating services started being appreciated only in recent years. However, they are expected to receive increasing awareness and attention of local people in the future. Likewise, the cultural services are predicted to get growing attention in the future, although they still receive inadequate appreciation at present.

2. In general*, FES supply* is recognized as having been reduced, due to the former degradation of the forest ecosystems. However, the supply of some important FES, like water supply, medicinal plants and some NTFPs still meets the local demand.
   Regarding FES supply sources, natural forests are appreciated to have a high potential to provide both numbers and qualitative of services. Although being degraded, natural forests still do supply a wide variety of wood and NTFPs, as well as regulation services, while the majority of fuel wood and commercial wood is provided by plantation forests, which have been developed just recently. However, plantation wood is sold outside the area for economic benefits rather than meeting the local demand for wood because of low quality.

3. Regarding *the utilization of some FPES*, there are no big differences between communes, or the poor and the well-off households, but some differences between the considered ethnic groups. A Dao family consumes less wood for construction and fuel wood than a Tay family, but instead requires more NTFPs than the Tay.

   However, local people have high demands of wood for construction and firewood. More than three quarters of the respondents state that they need more wood to widen

their old houses or to build a new house. They still do appreciate the traditional stilt house and do not want to change the materials of their houses. Firewood is the main fuel for cooking and heating in the area. The firewood demand increases in late winter and early spring when big festivals are celebrated in the area, and more fuel is needed to cook the traditional food. Surface water from forests is the main water supply in the Vu Chan and Nghinh Tuong communes with almost 90% of the respondents using waters from rivulets or small streams in the forests directly for cooking and washing.

4. As revealed in the local knowledge system, social relations, religious and spiritual life, inspiration and aesthetic values, the forests do also the considerable and clear effects on *the local cultures*. The treasure of local knowledge includes the knowledge about forest species; soils and land use systems, including slopping land and cultivation; hunting; residental experiences in the mountainous area; cooking and food preservation; health care and handicraft. The life in the mountainous area creates specific features of social relations, as part of the local culture. These are intimate engagement and relationships in families, clans and villages. The signififcance and influence of forests is also reflected by the spiritual and religious life of the local people, namely by their belief in the God of Trees, the God of Forests, or in their use of some indispensable forest products for their spiritual activities. Inspiration services, such as pleasure activities and feelings of relaxation, and aesthetic services were also appreciated to be offered by the local forests.

5. The research also assessed *the governmental demand for FES* at national and local scale based on forestry policies and legislations, which has to be considered as one essential indirect driver of change. The main concern of governmental forestry organizations is the conservation and respective management of forests and forest resources. Most legal documents are related to the extraction, utilization, protection and management of forest products. National forestry organizations require FES at a stratergical and comphrehensive level, considering all kinds of forest ecosystems in the whole country. Local official organizations formualate more specific demands and management aspects to maintain the services of localized-forest ecosystems. This is mismatch with the demand of local people who have requirement of tangible forest products that have practical significant for their lives.

6. *As indirect drivers of change*, government forestry and rural development policies have great impacts on the forest ecosystems. Regulative policies like for forestland allocation and forest rehabilitation motivated forest owners not only to invest in forest management and plantation, but contributed to the success of the sedentary settlement and cultivation program that reduced deforestation also. With respect to forest development, the major successes of forestry policies and programmes are i)

natural regeneration of thousands of hectares of degraded forests after over-exploitation and slash-and-burn cultivation; and ii) the regreening of thousands of hectares of bare former forest lands by plantation forests that enhances the forestry development in the local economic structure. Many other rural development policies and programs for mountain areas contributed directly to the local socio-economic development and indirectly to the improvement of forest status and cover by reducing local people´s dependency on forests and their demands for FES.

People´s awareness also influences on forest use and protection. Local people do recognize the impacts of their former activities on forests, especially the negative activities that happened in the research areas. They are also getting more sensible for the relevance and importance of forests concerning wildlife and certain regulating services that benefit their life of them and that of their descendants. The research also shows that this awareness is influenced by their social-economic backgrounds like ethnic, gender and education level.

However, local economy and household income development can impact on forests not only positively but also negatively because the impact level differs - at least marginally - according to the wealth levels. The local people tend to extract or collect forest products (NTFPs) during their free periods in the year both for selling and consumption in order to to save money for their family instead of buying in the markets. Additionally, some social factors such as population growth, local customs and labour allocation in rural mountain areas has to be considered as indirect drivers of changes in the research areas. Besides all these mentioned endogenous drivers, while further external demands may create more pressure on forest resources rather than internal demands for some NTFPs.

7.2. Recommendations

Considering the main results of the presented research, the author gives the following recommendations for sustainable forest management improvement at the local scale.

a. Recommendations for decision-making

- In decision-making for forest management, local societies and their demands for forest ecosystem services should be considered and balanced more specifically and explicitly, in order to encourage their participation in forest protection and development as well as to match between the demands of different stakeholders (farmers, the Government, investors, etc.) for forest use.

- Site-specific forest inventory data should be provided and unified between different "*implementing organizations*" in order to provide sufficient and adequate information that can support decision-making in forestry planning and development.

b. Recommendations for economic forestry improvement

- Forest lands have been allocated to local households, but most of forests are either protection forests or natural production forests, where local people have rather limited rights in forest using and development. Thus, the forest owners should be more empowered in the use of the production forests which they manage concerning conversion of the plant composition in production forests to improve economic efficiency and value of these forests.

- Although forestland occupies a high proportion of the area, the forestry sectors does not receive proper appreciation by local people and forestlands are not developed to their optimum economic efficiency. Thus, the economic value of the forests should be improved carefully, f.e. as an economic opportunity that will encourage more local people to participate in agroforestry. This could reduce their free time, increase economic benefits and thus minimize their impacts on the recovering natural forest. In this respect, the following specific suggestions could be considered:

    - Plantation forests should be improved in quality and extended futher
    - Different options for the diversification of plantation species should be considered and tested with respect to their suitability for the local site conditions and the annual activity cycle of the people. Plantation tree diversification creates various sources and gets cash income in different time in the year. To do these suggestions, it is necessary to get the supports from scientists in finding suitable species and training local farmers for suitable silviculture technique.

c. Recommendations for the improvement of local people's awareness about FES

- The local people´s perception of forest ecosystem services should be improved, especially awareness of intangible benefits and the forest benefits for beneficiaries in other areas. For example, their perception of regulation services is still on a rather general level that forests are important for the climate, or for their water supply. While the services of climate regulation are directly experienced and recognized by the fresh and cool air where they live, the mechanism of carbon sequestration can not be realized. The ES framework explicitly considers such kind of ES flows between supply and benefit areas, thus sustaining these services needs to be based on adequate perception of them (Cork et al. 2001). FES-related training programs for local people,

both formal and informal, should be encouraged to improve their perception and change their actions.

- Gender equality is considered as an essential factor in awareness improvement for local people. In the research areas, women are forest users but in their families they have only little power in decision making for forest management and development. The experience of IFAD (2004) indicates that the roles of indigenous womenin sustainable development and biodiversity conservation should be strengthened because they keep valuable indigenous knowledge related to the management of natural resources.

- The roles of some important or key persons in community and households like village´s leaders, shamans, family´s leader should be appreciated in improvement of local perception. Because of specific characters of local social and family relationships mentioned elswhere in the research, these people have more effects on other people and their voices have more empowers in the community. If these key persons have a good appprication and knowledge about forest services, they could be good disseminators of forest conservation and development in the community.

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Appendix 1: Indicator finding for forest ecosystem services, drivers of changes

A- Indicator for Forest Ecosystem Services

Category	Sub-category	Indicators	Supply or Demand	Unit
Provisioning Services				
Food		Local assessment of availability of wild plants as food sources	Supply	
		Percentage of food from forest/in total of a household	Supply	%
		Number of people want to buy NTFPs in the local market for food	Demand	people
	Wild vegetation	Number of household use wild plants for food	Demand	people
		Amount of wild vegetation for food they get in the meal		flexible
	Bush meat	Local assessment of availability of wild animals as food sources	Supply	
		Number of people hunting for food	Demand	people
Timber products		Species for wood	Supply	
		Numbers of houses in the past and at the moment	Demand	houses
		Quantitative of wood cubic meters for each house	Demand	m^3
		Numbers of houses in the past and at the moment	Demand	houses
		Tools and furniture are made of wood	Demand	
		Quantitative of wood for other construction (stalls)	Demand	m^3
Fuel wood		Average annual firewood consumption in a household	Demand	m^3/ year
		Amount of firewood was collected	Supply	m^3/ year
		Ratio between wood and non - wood fuel in a household each year	Demand	%
		Ratio between fuel wood from plantation and natural forests	Demand	%
Water	Fresh water	Satisfaction of local people for water supply	Supply	
		Amount of water using	Demand	m^3/cap/mth.
		Drought months in a year	Supply	
		Number of households use water directly from forests	Demand	%
		Population growth	Demand	
	Water for agriculture	Total area of agriculture land need water each years	Demand	ha
		Amount of hydro power generators	Demand	
Ornamental resources		Number of people use wild species as a ornamentations	Demand	People
		Number of people employ in collecting, hunting or selling ornamental species from forests	Demand	People
Medicinal plants		Number of households using medicinal plants	Demand	People
		Frequency of collecting medical plants	Demand	People
		Number of people work as traditional doctors	Demand	People
Land use		Forest land for road in recently and in planning	Demand	ha
		Forest land for other local infrastructures	Demand	ha
		Forest land for agriculture cultivation (land area for shifting cultivation)	Demand	ha
		Local demands in expanding land for cultivation (Yes/No; Why?)	Demand	

Cultural services				
Spiritual and religious life		Position for burying dead people or spiritual activities (e.g. secret forests)	Supply	
		Spiritual and religious activity/belief relates to forests	Demand	
		Forest products are used in spiritual activities	Supply	
Local knowledge System	Knowledge of species	Species-focused empirical knowledge of local people	Demand	
	Forest soils	Experiences in soil choosing in shifting cultivation	Demand	
	Self-protection skills	Skills to self-protection in forests	Demand	
	Hunting experiences	Experiences in hunting skills (e.g. making traps, or tracing animals)	Demand	
	Residential experiences	Experiences to choose position for living and building house	Demand	
	Cooking and food preservation	How to cook some kinds of wild food	Demand	
		Forest food preservation methods	Demand	
	Slopping land cultivation	Knowledge about soil erosion prevention, irrigation and shifting cultivation	Demand	
	Heath protection	Knowledge of medicinal plant function and usage	Demand	
		Traditional therapeutic treatments	Demand	
		Sustainable medicinal plant extraction	Demand	
	Handicraft production experiences	Experiences in carpentry and building houses	Demand	
		Experiences of domestic handicrafts (e.g. bamboo weaving, cloth weaving, dying and embroidering)	Demand	
Social relation		Social relation in community, hamlet or ethnic groups	Demand	
Aesthetic	Architecture	Architectures of stilt houses	Demand	
		Local demand to change materials of house	Demand	
		Landscape harmony of stilt house		
	Art	Music instruments made of forest products	Demand	
		Embroidering motifs originated from forests	Supply	
Inspiration		Pleasure activities	Demand	
		Human feeling when hearing nature sounds	Demand	
Regulation services				
		The nature hazards in the areas in recent decades	?	
Erosion regulation		Areas with exposed soil		
Water regulation		Local satisfaction of water distribution in a year	Supply	
		Local satisfaction of water quality in a year		
Climate regulation		Changes of temperature and precipitation		
		Carbon sequestration of plantation forests	Supply	

B- Indicators for divers of change

Direct drivers			
Category	***Sub-category***	***Issue***	***Unit***
Changes of land use	Agriculture extension	Forest land area for shifting cultivation land in recent year	ha
		Forest land area for permanent cultivation land in recent year	ha
	Infrastructure extension	Forest land area for infrastructure in recent year	ha
		Forest land area for infrastructure in planning	ha
Wood extraction		Amount of wood was extracted each year (in production forests)	m^3/ year
		Forest land was logged	ha
		Illegal logging	m^3
		Amount of fuel wood gathering for domestic use	m^3
Indirect drivers			
Categories	***Sub-categories***	***Issue***	***Unit***
Demographic	Population growth	Population in recent years	people
		Number of households in recent years	
Economics	Local economic structure	Proportion of livelihood related forest	%
	Cultivation schedule	Schedule of cultivating some major crop	
	Poverty	Proportion of poor households	%
		Dependence of poor people on forests	
	Market growth and commercialization	Growth of demand for forest-related consumer goods due to rise in well-being	
		Increased market accessibility	
	Transportation	Increase accessibility for forest-related consumer goods	
Information accession		Means and time for getting forestry-related information	
Perception/Awareness	Indigenous knowledge	Local knowledge of forest management and protection	
	Awareness	Locals´ awareness of forest´s importance	
		Social factors that influence on local people´s awareness	
	Cultural factors	Individual and household behaviour	
Policy and institution	Agricultural and economic development	Land use intensive	
		Productivity of agriculture per year	Tan/ha/year
		Rural economic development	
	Forestry policy	The area of plantation forests	ha
		The area of forest land allocated	ha

Appendix 2: Questionnaire

A - Vietnamese version of Questionnaire

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ĐH Khoa học Thái Nguyên — Đại học Goettingen

Mark as shown: ☐☒☐☐☐ Cách đánh dấu phương án lựa chọn
Correction: ☐■☐☒☐ Cách sửa khi đánh dấu sai

1. Thông tin của người được phỏng vấn

(Những nội dung phỏng vấn trong phiếu này chỉ được sử dụng cho mục đích học tập và nghiên cứu khoa học, vì vậy rất mong sự hợp tác từ phía bà con)

1.1 Họ và tên

1.2 Tuổi
☐ 20 - 30 ☐ 31 - 40 ☐ 41 - 50
☐ 51 - 60 ☐ > 60

1.3 Giới tính ☐ Nam ☐ Nữ

1.4 Dân tộc
☐ Tày ☐ Dao ☐ .....

1.5 Nghề nghiệp
☐ Nông dân ☐ Cán bộ địa phương ☐ Giáo viên
☐ Buôn bán nhỏ ☐ Lao động tự do ☐ Khác.....

1.6 Trình độ học vấn
☐ Mù chữ ☐ Biết đọc, biết viết ☐ Đã tốt nghiệp tiểu học
☐ Đã tốt nghiệp THCS ☐ Đã tốt nghiệp PTTH ☐ Học nghề, trung cấp
☐ Cao đẳng, đại học

1.7 Ông/bà có phải là chủ hộ không?
☐ Có ☐ Không

1.8 Gia đình ông bà có bao nhiêu người?
☐ < 4 ☐ 4 ☐ 5
☐ 6 ☐ ≥7

1.9 Gia đình ông bà có phải hộ nghèo không?
☐ Có ☐ Không

1.10 Nguồn thu nhập chính của gia đình là gì?
☐ Canh tác nông nghiệp ☐ Chăn nuôi ☐ Nuôi trồng thủy sản
☐ Săn bắn ☐ Thu lượm và bán các lâm sản ngoài gỗ ☐ Khai thác và vận chuyển gỗ
☐ Kinh doanh buôn bán ☐ Khác:.....

2. Thông tin về quản lý và trồng rừng

2.1 Hiện nay gia đình ông/bà đang quản lý bao nhiêu ha rừng? (Đề nghị ông bà liệt kê chi tiết theo loại rừng: rừng sản xuất, rừng phòng hộ, rừng trồng, rừng tự nhiên).

2. Thông tin về quản lý và trồng rừng [Fortsetzung]

2.2 Nếu gia đình có rừng trồng, xin mời ông/bà trả lời câu hỏi: Tại sao gia đình ông/bà lại trồng rừng?

- ☐ Nhận được nhiều hỗ trợ từ chính quyền
- ☐ Có lợi về kinh tế từ việc bán gỗ trong tương lai
- ☐ Nhận thấy các lợi ích môi trường từ trồng rừng
- ☐ Bắt buộc trồng rừng theo chương trình chung
- ☐ Học tập theo các gia đình khác ở địa phương
- ☐ Nguyên nhân khác: .....

3. Thông tin về khai thác gỗ và nhà ở

3.1 Gia đình ông bà sử dụng gỗ có nguồn gốc từ đâu?

- ☐ Mua lại từ người khác
- ☐ Tự khai thác trong rừng tự nhiên
- ☐ Tự khai thác tại rừng trồng của gia đình

3.2 Gia đình ông/bà có thường xuyên khai thác gỗ không?

- ☐ Không khai thác
- ☐ Khai thác theo mùa
- ☐ Vài lần trong năm
- ☐ Hàng tháng
- ☐ Hàng tuần
- ☐ Hàng ngày

3.3 Gỗ mà gia đình ông/bà khai thác được sử dụng cho mục đích gì?

- ☐ Đóng đồ dùng trong gia đình
- ☐ Dựng nhà sàn
- ☐ Bán cho người khác

3.4 Ông/bà nhận thấy nguồn cung cấp gỗ ở rừng hiện nay như thế nào?

- ☐ Rất nhiều
- ☐ Nhiều
- ☐ Bình thường
- ☐ Ít
- ☐ Rất ít

3.5 Loại nhà ở của ông/bà hiện nay là gì?

- ☐ Nhà sàn
- ☐ Nhà gỗ
- ☐ Nhà xây

Nếu đáp án câu 3.5 là nhà sàn hoặc nhà gỗ thì xin mời ông bà trả lời các câu hỏi 3.6, 3.7, 3.8. Nếu đáp án câu 3.5 là nhà xây thì xin trả lời tiếp câu 3.9.

3.6 Ông/bà cho biết độ lớn của ngôi nhà gia đình đang ở?

3.7 Tỷ lệ gỗ quý hiếm của ngôi nhà là bao nhiêu?

- ☐ 0%
- ☐ < 30%
- ☐ 30-50%
- ☐ 50-70%
- ☐ >70%

3.8 Ông/bà có muốn dựng nhà bằng vật liệu khác (không phải bằng gỗ) không? Tại sao?

3.9 Gia đình ông bà có cần thêm gỗ để dựng nhà không?

- ☐ Có
- ☐ Không

Nếu Có, xin mời trả lời câu tiếp theo

3.10 Nếu Có, Tại sao?

- ☐ Bản thân người phỏng vấn chưa có nhà ở riêng
- ☐ Muốn dựng nhà mới tốt hơn/ lớn hơn
- ☐ Dựng nhà cho con cái/thành viên trong gia đình ở riêng
- ☐ Lý do khác: .....

4. Thông tin về khai thác củi đun

4.1 Củi mà gia đình ông/bà đang sử dụng có nguồn gốc từ đâu?

- ☐ Mua từ người khác
- ☐ Khai thác từ rừng trồng
- ☐ Khai thác từ rừng tự nhiên

4. Thông tin về khai thác củi đun [Fortsetzung]

4.2 Gia đình ông/bà có thường xuyên lấy củi trên rừng không?
- ☐ Không khai thác
- ☐ Khai thác theo mùa
- ☐ Vài lần trong năm
- ☐ Hàng tháng
- ☐ Hàng tuần
- ☐ Hàng ngày

4.3 Ông/bà nhận thấy nguồn cung cấp củi hiện nay như thế nào?
- ☐ Rất nhiều
- ☐ Nhiều
- ☐ Bình thường
- ☐ ít
- ☐ Rất ít

4.4 Ông/bà sử dụng củi khai thác được cho những mục đích nào sau đây?
- ☐ Đun nấu và sưởi ấm
- ☐ Bán cho người khác
- ☐ Cả hai mục đích trước

4.5 Hàng năm, gia đình ông bà sử dụng bao nhiêu củi?

☐

4.6 Ông/bà cho biết tỷ lệ củi gỗ mà gia đình sử dụng là bao nhiêu?
- ☐ < 25%
- ☐ 25 - 50%
- ☐ 50 - 75%
- ☐ > 75%

5. Thông tin về các nguồn lâm sản và các hoạt động khác

5.1 Nguồn nước của gia đình ông/bà đang sử dụng là gì?
- ☐ Nước giếng khoan
- ☐ Nước giếng khơi
- ☐ Nước sông/suối
- ☐ Nước mưa
- ☐ Nước ao/hồ
- ☐ Nước khe

5.2 Ông/bà có hài lòng về chất lượng nước sử dụng cho sinh hoạt không?
- ☐ Rất hài lòng
- ☐ Hài lòng
- ☐ Bình thường
- ☐ Không hài lòng
- ☐ Rất không hài lòng

5.3 Ông/bà có hài lòng về khối lượng nước cung cấp cho sinh hoạt không?
- ☐ Rất hài lòng
- ☐ Hài lòng
- ☐ Bình thường
- ☐ Không hài lòng
- ☐ Rất không hài lòng

5.4 Ông/bà có hài lòng về khối lượng nước cung cấp cho nông nghiệp không?
- ☐ Rất hài lòng
- ☐ Hài lòng
- ☐ Bình thường
- ☐ Không hài lòng
- ☐ Rất không hài lòng

Nguồn gốc của các lâm sản mà gia đình ông bà sử dụng từ đâu? (Xin mời ông/bà trả lời từ câu 5.5 đến câu 5.11)

	Không sử dụng	Mua ở chợ	Rừng tự nhiên	Rừng trồng
5.5 Rau rừng	☐	☐	☐	☐
5.6 Măng	☐	☐	☐	☐
5.7 Thịt thú rừng	☐	☐	☐	☐
5.8 Mật ong rừng	☐	☐	☐	☐
5.9 Cây thuốc	☐	☐	☐	☐
5.10 Cây tre, nứa	☐	☐	☐	☐
5.11 Sinh vật rừng (cây, con) làm cảnh	☐	☐	☐	☐

5. Thông tin về các nguồn lâm sản và các hoạt động khác [Fortsetzung]

Mức độ thường xuyên mà gia đình ông/bà khai thác các loại lâm sản trên (xin mời ông bà trả lời từ câu 5.12 đến 5.18)

	Không khai thác	Theo mùa	Vài lần/năm	Hàng tháng	Hàng tuần	Hàng ngày
5.12 Thu lượm rau rừng	☐	☐	☐	☐	☐	☐
5.13 Lấy măng	☐	☐	☐	☐	☐	☐
5.14 Săn bắt thú rừng	☐	☐	☐	☐	☐	☐
5.15 Lấy mật ong rừng	☐	☐	☐	☐	☐	☐
5.16 Thu lượm cây thuốc	☐	☐	☐	☐	☐	☐
5.17 Khai thác cây tre, nứa	☐	☐	☐	☐	☐	☐
5.18 Khai thác, tìm kiếm các sinh vật rừng làm cảnh	☐	☐	☐	☐	☐	☐

Ông/bà đánh giá thế nào về mức độ có sẵn của các loại lâm sản? (Xin mời ông bà trả lời từ câu 5.19 đến 5.25)

	Rất nhiều	Nhiều	Bình thường	Ít	Rất ít
5.19 Rau rừng	☐	☐	☐	☐	☐
5.20 Măng	☐	☐	☐	☐	☐
5.21 Thú rừng	☐	☐	☐	☐	☐
5.22 Mật ong rừng	☐	☐	☐	☐	☐
5.23 Cây thuốc	☐	☐	☐	☐	☐
5.24 Tre nứa	☐	☐	☐	☐	☐
5.25 Cây làm cảnh	☐	☐	☐	☐	☐

Gia đình ông/bà đã sử dụng lâm sản như thế nào? (Xin mời ông bà trả lời từ câu 5.26 đến 5.32)

	Sử dụng trong gia đình	Để bán lấy tiền	Cả hai mục đích trước
5.26 Rau rừng	☐	☐	☐
5.27 Măng	☐	☐	☐
5.28 Thú rừng	☐	☐	☐
5.29 Mật ong	☐	☐	☐
5.30 Cây thuốc	☐	☐	☐
5.31 Tre nứa	☐	☐	☐
5.32 Sinh vật rừng làm cảnh	☐	☐	☐

5. Thông tin về các nguồn lâm sản và các hoạt động khác [Fortsetzung]

5.33 Nếu đánh giá theo tỷ lệ phần trăm thì bình quân lượng thức ăn từ rừng (các loại rau rừng và thịt thú rừng) trong bữa cơm của gia đình ông/bà chiếm tỷ lệ bao nhiêu?

☐ ≤ 10% ☐ 11- 20% ☐ 21 - 30%
☐ 31 - 40% ☐ 41 - 50% ☐ > 50%

5.34 Ông/bà hãy lựa chọn các hoạt động dưới đây mà gia đình có tham gia:

☐ Chăn, thả gia súc trong rừng ☐ Thu, lượm cây cỏ và thức ăn chăn nuôi trong rừng

5.35 Gia đình ông/bà có nhu cầu chuyển đổi đất lâm nghiệp sang mục đích sử dụng khác không? Vì sao?

6. Thông tin về hiệu quả của các phương tiện truyền thông

Ông/bà đánh giá về hiệu quả của các tiếp nhận các thông tin về quản lý và bảo vệ rừng như thế nào?

	Rất hiệu quả	Hiệu quả	Bình thường	Kém hiệu quả	Không hiệu quả	Không biết
6.1 Vô tuyến	☐	☐	☐	☐	☐	☐
6.2 Đài	☐	☐	☐	☐	☐	☐
6.3 Báo chí	☐	☐	☐	☐	☐	☐
6.4 Internet	☐	☐	☐	☐	☐	☐
6.5 Bảng tin, biển báo	☐	☐	☐	☐	☐	☐
6.6 Tờ rơi	☐	☐	☐	☐	☐	☐
6.7 Nói chuyện/họp dân với cán bộ địa phương	☐	☐	☐	☐	☐	☐
6.8 Kiểm lâm địa bàn nói chuyện và tuyên truyền	☐	☐	☐	☐	☐	☐
6.9 Trò chuyện với hàng xóm	☐	☐	☐	☐	☐	☐

7. Thông tin về nhận thức của người dân

Ông bà đánh giá thế nào về tầm quan trọng của rừng đối với những yếu tố sau? (Xin mời ông bà trả lời từ câu 7.1 đến 7.6)

	Rất quan trọng	Quan trọng	Bình thường	Ít quan trọng	Không quan trọng	Không biết
7.1 Thu nhập của gia đình	☐	☐	☐	☐	☐	☐
7.2 Cung cấp nước	☐	☐	☐	☐	☐	☐
7.3 Điều hòa nước	☐	☐	☐	☐	☐	☐
7.4 Điều hòa khí hậu	☐	☐	☐	☐	☐	☐
7.5 Dinh dưỡng đất	☐	☐	☐	☐	☐	☐
7.6 Các phong tục, tập quán của cộng đồng	☐	☐	☐	☐	☐	☐

7. Thông tin về nhận thức của người dân [Fortsetzung]

7.7 Ông/bà cảm thấy thế nào khi nghe âm thanh của tự nhiên (tiếng nước chảy, tiếng chim hót, ...)?

☐ Thư thái và thoải mái ☐ Bình thường ☐ Không thoải mái
☐ Không quan tâm

Ông/bà đánh giá thế nào về mức độ ảnh hưởng của các hoạt động sau đây đến rừng? (xin mời ông/bà trả lời từ 7.8 đến 7.20)

	Không biết	Rất tốt	Tốt	Bình thường	Xấu	Rất xấu
7.8 Khai thác gỗ	☐	☐	☐	☐	☐	☐
7.9 Khai thác củi đun	☐	☐	☐	☐	☐	☐
7.10 Chăn thả gia súc	☐	☐	☐	☐	☐	☐
7.11 Lấy cây thuốc	☐	☐	☐	☐	☐	☐
7.12 Nuôi ong	☐	☐	☐	☐	☐	☐
7.13 Lấy mật ong	☐	☐	☐	☐	☐	☐
7.14 Lấy nấm	☐	☐	☐	☐	☐	☐
7.15 Lấy măng	☐	☐	☐	☐	☐	☐
7.16 Khai thác, buôn bán các sinh vật rừng làm cảnh	☐	☐	☐	☐	☐	☐
7.17 Săn bắn các loài thú lớn (hươu, nai, khỉ,...)	☐	☐	☐	☐	☐	☐
7.18 Săn bắt các động vật nhỏ (chim, rùa, sóc ...)	☐	☐	☐	☐	☐	☐
7.19 Sử dụng các loài cây rừng làm cảnh	☐	☐	☐	☐	☐	☐
7.20 Nuôi nhốt các loài động vật rừng làm cảnh	☐	☐	☐	☐	☐	☐

7.21 Ông/bà có thấy cần thiết phải giữ rừng cho con cháu mai sau không?

☐ Cần thiết ☐ Bình thường ☐ Không cần thiết
☐ Không biết

7.22 Xin mời ông/bà đưa ra lý do cho câu trả lời câu hỏi trên.

7.23 Ông/bà dự đoán thế nào về chất lượng rừng trong 10 năm tới?

☐ Tốt hơn ☐ Không đổi ☐ Xấu hơn
☐ Không biết ☐ Không trả lời

7.24 Ông/bà có thể mô tả chi tiết hơn cho dự đoán của mình.

7.25 Ông/bà có thể đưa ra những ý kiến, gợi ý để việc quản lý và phát triển rừng được tốt hơn?

Xin chân thành cảm ơn sự cộng tác nhiệt tình của ông/bà!

B - English version of Questionnaire

FOREST ECOSYSTEM SERVICES AND FOREST MANAGEMENT

Case study in Vo Nhai, northern Vietnam

(Questionnaire for local people)

Information in this questionnaire is used for scientific purpose, therefore, your cooperation highly is expected and appreciate

Questionnaire ID: …… Date of interview: ……

Village…… Commune……..

Personal and household background

1. Name: …… 2. Age: ……

3. Gender: □ Male □ Female

4. Ethnic group: □ Tay □ Dao □ Others……

5. Occupation: ……..

6. The highest level of education you have completed:

□ Illiterate □ Literate □ Primary school □ Secondary School

□ High school □Vocational school/technical institute □ University

7. Are you a leader of your household? □ Yes □ No

8. How many people are there in your family?

□ < 4 □ 4 □ 5 □ 6 □ ≥7

9. Is your family poor? □ Yes □ No

10. Which activities bring your family the most income?

□ Agriculture cultivation □ Animal husbandry

□ Aquaculture □ Collecting and selling NTFPs

□ Timber product extraction and transportation □ Hunting

□ Commerce, small business □ Others ……..

11. How many hectares of forest does your family manage?

Protection forests	……..	ha
Natural forests	……..	ha
Plantation forests	……..	ha
Production forests	……..	ha
Natural forests	……..	ha
Plantation forests	……..	ha

Forest ecosystem services

12. Where does your family get these things from?

	Market	Natural forests	Plantation forests
Timber	□	□	□
Plants for food	□	□	□
Bamboo shoot	□	□	□
Plants for medicine	□	□	□
Firewood	□	□	□
Hunting products	□	□	□
Honey	□	□	□
Bamboo	□	□	□
Ornamental plants	□	□	□

13. What does your family collect from forests and frequency?

	No	Seasonal	Several/year	Monthly	Weekly	Daily
Timber	□	□	□	□	□	□
Plants for food	□	□	□	□	□	□
Bamboo shoot	□	□	□	□	□	□
Plants for medicine	□	□	□	□	□	□
Firewood	□	□	□	□	□	□
Hunting products	□	□	□	□	□	□
Honey	□	□	□	□	□	□
Bamboo	□	□	□	□	□	□
Ornamental plants	□	□	□	□	□	□

14. What does your family use them for?

	Household consumption	Selling	Both two these purposes
Timber	□	□	□
Plants for food	□	□	□
Bamboo shoot	□	□	□
Plants for medicine	□	□	□
Firewood	□	□	□
Hunting products	□	□	□
Honey	□	□	□
Bamboo	□	□	□
Ornamental plants	□	□	□

15. How are their supplies?

	Very plentiful	Plentiful	Neutral	Scarce	Very scarce
Timber	□	□	□	□	□
Plants for food	□	□	□	□	□
Bamboo shoot	□	□	□	□	□
Plants for medicine	□	□	□	□	□
Firewood	□	□	□	□	□
Hunting products	□	□	□	□	□
Honey	□	□	□	□	□
Bamboo	□	□	□	□	□
Ornamental plants	□	□	□	□	□

16. What kind of your house? How big is it?

□ Stilt house (….. stilts; ……..m^2)

□ Wooden house (……..m^2)

□ Brick house (……m^2; …… floor(*s*))

17. How many percents of valuable wood of your house?

□ 0% □ < 30% □ 30-50% □ 50-70% □ >70%

18. Does your family need more wood for house building? □ Yes □ No

If Yes, Why?

□ You do not have your own house

□ Your family want a new bigger and better house

□ One of your family member need her/his own house

□ Others……

19. Do you want to change the materials of the house? (non-timber materials)

□ Yes □ No

Why?.....

.....

.....

20. How much fuel wood does your family use per year? …… m^3 or …… packs

21. Where does the fuel wood come from?

□ State natural forests

□ Natural forest which your family manages

□ Plantation forest which your family manages

□ Others……

22. How many percent of wood fuel which your family uses each year?

□ < 25% □ 25-50% □ 50-75% □ >75%

23. Water resources used in daily life come from:

□ Well-water □ A deep well equipped with a pump

□ Streams/rivers □ Rivulets or small streams from the forests

□ Rain water □ Ponds/ reservoirs

□ Others: ……

24. Does your family sastisfy with water sources?

	Completly satisfied		Neutral		Not sastified at all
Water quality	□	□	□	□	□
Water quantity	□	□	□	□	□
Water quality for cultivation	□	□	□	□	□

25. Which below activities does your family do?

	Yes	No
Grazing cattles in the forests	□	□
Collect forest plants for livestock grazing	□	□
Decorating your house by forest plants (orchis, ...)	□	□
Decorating your house by grazing wild animals	□	□
Decorating your house by a body part of wild animals	□	□
Having a member collecting and selling wild species for ornamental purposes	□	□

26. Proportion of food from forest plants in the meal of your family:

□ < 10% □ 10-30% □ 30-50% □ >50%

27. Proportion of food from wild animals in the meal of your family:

□ >10% □ 10-30% □ 30-50% □ >50%

28. Does your family need to extend the land for agriculture cultivation from forest land?

□ Yes □ No

Why?.....

.....

.....

29. Why did your family plant forests? (You can choose more than one answer)

□ Good supports from governments

□ Economic benefits in the future from wood selling

□ Environmental benefits □ Coercion

□ Imitating neighbors □ Others……

30. How do you feel when you hear the nature voice (e.g. voice of singing birds, voice of running water …)?

□ Relaxed and comfortable □ Uncomfortable

□ Normal □ I do not pay attention

Awareness of local people

32. To what extent do you think forests are important for?

	Very important		Neutral		Not important
Your family´s income	□	□	□	□	□
Water supply	□	□	□	□	□
Water regulation	□	□	□	□	□
Climate regulation	□	□	□	□	□
Soil nutrition	□	□	□	□	□
The culture of your community	□	□	□	□	□

33. How do these activities affect on forests?

	Very positive		Neutral		Very negative
Wood logging	□	□	□	□	□
Fuel wood collecting	□	□	□	□	□
Shifting cultivation	□	□	□	□	□
Animal husbandry	□	□	□	□	□
Medicinal plant collecting	□	□	□	□	□
Bee keeping	□	□	□	□	□
Honey extraction	□	□	□	□	□
Mushrooms collecting	□	□	□	□	□
Bamboo shoot collecting	□	□	□	□	□
Forest vegetable collecting	□	□	□	□	□
Bamboo collecting	□	□	□	□	□
Ornamental plant extraction	□	□	□	□	□
Insect collection	□	□	□	□	□
Large animal hunting (bears, monkeys, deer…)	□	□	□	□	□
Small animal hunting (turtles, birds, fogs…)	□	□	□	□	□
Using wild plants as an ornamentation	□	□	□	□	□
Using wild animals as an ornamentation	□	□	□	□	□

34. What are means you get information of forest conservation? To what extent do you think which mean communicates more effectively than others?

	Strongly efficient		Neutral		Strongly inefficient
□ Television	□	□	□	□	□
□ Radio	□	□	□	□	□
□ Magazines, newspapers	□	□	□	□	□
□ Information boards	□	□	□	□	□
□ Leaflets	□	□	□	□	□
□ Local government officer talking	□	□	□	□	□
□ Forester talking	□	□	□	□	□
□ Talking with neighbors	□	□	□	□	□
□ Others……	□	□	□	□	□

35. Do you need to protect forests for your descendants?

1. Yes 2. No 3. Other ideas ……

36. What do you think about forest quality in next 10 years?

1. Better 2. Unchanged
3. Worse 4. No answers

Give more details of description:

……
……
……
……
……

37. Please you give any suggestion of forest management and conservation?

……
……
……
……

Thank you for your answers.

Appendix 3: The classification systems of forest in Vietnam (Nguyen 2009)

"Several classification systems have been applied to Vietnamese forest during the past century. The vegetation of Vietnam has been studied and classified from the beginning of the last century.

1. Several forest classification systems before 1975

In 1918, Chavalier[26] performed the first classification system for the forests in the North of Vietnam based on vegetation types. By 1943, Maurand [27] divided vegetation in Indochina into three vegetation zones including North Indochina vegetation, South Indochina vegetation and an intermediate one.

In the south of Vietnam, a particular classification system of forest was proclaimed by Maurand in 1953[28].

Using the classification system of UNESCO (1973)[29], Vietnamese vegetation exists in four formations of which two are related to forest. They are dense forest and open forest. Each of these two is divided into several sub-formations, and some different classes are divided from the sub-formations.

2. The developed classifications in the post-war period

The above classification systems were performed separately in two parts of Vietnam. Hence, there had not been any common system for the whole country until after 1975 when Thai[30] (1978) developed the classification of forests based on site condition for the whole country.

2.1 The forest classification system developed by Thai Van Trung

Thai[31] (1978, 1998) classified the vegetation of Vietnam based on the viewpoint of ecological factors of phytocoenosis of vegetation. According to this view, in a specific ecological environment they can appear only in a given intact vegetation type, in which the various forest characteristics such as species composition, physiognomy, and structure are decisively affected by five ecological groups e.g. physic-geographic, climate,

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[26] Chevalier, A. 1918. Premier inventaire des bois et autres produits forestiers du Tonkin.

[27] Maurand, P. 1943. L'Indochine forestiere. BEI, Ha Noi.

[28] Maurand, P. 1953. Considerations sur les formations vegetation denomees "forest Claire" et les principle essences composant. 14 p.13 pl. Center de research science. Et techn. Saigon.

[29] UNESCO. 1973. International Classification and Mapping of vegetation, Paris.

[30] Thai, V.T 1978. Vietnamese forest vegetation. Science and Technique Publishing House Hanoi.

[31] Thai, V.T 1999. Ecosystems of tropical forests in Vietnam. Science and Technique Publishing House. Ha Noi.

edaphic, floristic and bio-anthropogenesis. Accordingly, Thai Van Trung (1978, 1998) divides the forests of the entire country into five main types with 14 subtypes as table below:

Types of lowland closed rainforest:

1. Humid tropical evergreen closed rainforest.
2. Humid tropical semi-deciduous closed forest.
3. Deciduous tropical forest.
4. Hard leaf, dry closed tropical forest.

Types of open forest

5. Broadleaved open tropical forest.
6. Needle-leaved evergreen slightly open dry tropical rainforest.
7. Needle-leaved evergreen open slightly dry semitropical rainforest in lower montane.

Steppe

8. Bushes, dry tropical tall-grass.
9. Thorn scrubs

Closed montane rainforest

10. Humid evergreen semi-tropical rainforest in lower montane.
11. Humid mixed broad-needle leaved lower montane evergreen rainforest.
12. Closed needle-leaved temperate forest.

Cold-dry montane formation

13. Montane dry formation.
14. Montane cold formation.

2.2. The forest classification according to forest status

In order to put the suitably silvicultural treatments into practice for different forest stands, the Department of Forest Planning Inventory applied hierarchical classification to categorize the forests. Accordingly, the forest is divided into 4 main classes with several subclasses each. These classes are distinguished by level of disturbance, potential regeneration, species, maximum diameter class and so forth. The criteria of the system are detailed in table 1. This system is simple, easy to recognize in the field, hence it has been broadly used by forest rangers. However, according to Thai (1978), the basic weakness of the system is although the three criteria used for classification are tree composition, ecological characteristics and structure, in reality the forests are categorized based mainly on forest status with different disturbances. Therefore, it is not possible to distinguish among the pristine forest and secondary forest and their complex successional periods.

Table 1: Class definition for Vietnamese Classification of Evergreen Natural Wooden Forest (Source: MARD)

Group I: **Non-forest**. Only grasses, bushes with very few trees, scattered bamboos; coverage index is under 0.3 (full coverage is 1.0). This group has 3 sub-groups:

- IA: Characterized by grasses, bushes or wild bananas.
- IB: Characterized by bushes, scattered wooden trees and bamboos.
- IC: Characterized by high density regenerating wooden trees. Trees of over 1 meter height and with more than 1000 stems per hectare.

Group II: **Regenerating forest** with pioneer species that have a smaller diameter. Based on status and origin, there are 2 sub-groups:

- IIA: Regenerating forest after shifting cultivation, characterized by pioneer species that are fast growing and prefer light. Trees are of similar age and with only 1 layer.
- IIB: Regenerating forest following heavy exploitation for timber. Young community with species preferring light; diverse species composition; trees of different ages; unclear dominance. There may be some big trees remaining, but the numbers are not relevant with bad quality. Forest is only classified into this group if the community with the most common diameter equal to or less than 20cm.

Group III: **Degraded forest**. Communities have been exploited, and changed the stand structure of the forest. Depending on exploitation levels and potential stand volume, two sub-groups are recognized:

- IIIA: Communities with heavy exploitation; present potential for exploitation of timber is limited. The structure of the forest is significantly changed. There are 3 sub-groups:
    - IIIA1 (Poor Forest): Most heavily exploited forest. The upper storey may have some large trees, but generally the forest is of low quality with numerous vines, bushes, and bamboos, and has a defragmented canopy.
    - IIIA2 (Medium Forest): Heavily exploited, but significant time for regeneration. Characterized by middle storey that becomes dominant with the majority of trees of 20-30cm diameter. The forest has at least 2 stories; the upper storey coverage is not continuous, and mostly previously established by the trees from the lower storey; there are a few large trees.
    - IIIA3 (Rich Forest): After selecting cutting with low intensity or forest developing from IIIA2. The communities have a relatively closed coverage, with at least 2 stories. The main difference from type IIIA2 is that the number of trees are higher with some trees with having diameter of more than 35cm.
- IIIB: Characterized by communities that have low levels of selective logging, with few valuable wooden species exploited. The stable structure of the forest has not changed; biomass is high with a high percentage of large trees.

Group IV: **Primary forest**, stable forest. Pristine forest or matured secondary forest that has not yet been exploited. The forest has a stable structure, multi-storey, diverse diameter sizes, but sometimes lacks a lower storey.

There are 2 sub-groups:

- IVA: Primary forest
- IVB: Regenerating secondary forest.

In addition, several classification systems of forest have been used for different purposes such as:

- Classification based on forest functions (forestland utilization purposes)

This classification system was specifically regulated upon Decision 08/2001/QD-TTg dated 11 January 2001 by the Prime Minister. Under this decision, natural forest has been classified in three categories for the following utilization purposes:

  - Production forest: this kind of forest is used for commercial purposes. It supplies timber and non-timber forest products (NTFP). In addition, it provides environmental protection
  - Protection forest: the forests used to protect water resources, soil, and to prevent from land erosion, desertification, or to regulate climate and so on.
  - Special use forest: the forests used mainly for natural conservation, genes, historical/cultural monument protection, scientific research, and ecologically environmental protection. This classification is employed for long term forestry strategy in the entire country.
- Classification based on stand volume: the forests are distinguished by their volume. Accordingly, volume categories are:
  - Little affected natural forest with three-storey tree structure, unclear vestige of ravaged forest, and timber stock of 300 - 400 m3/ha;
  - Medium-level affected natural forest with three-storied tree structure and timber stock of 200 - 300 m3/ha;
  - Exhausted forest with timber stock of 120 - 200 m3/ha;
  - Exhausted forest with timber stock of 80 - 120 m3/ha; and
  - Exhausted forest with timber stock of 50 - 80 m3/ha

However, such classifications only provide generally indicative information and criteria description in the forest without using remotely sensed data for interpretation during forest inventory. Whereas, forest inventories, particularly in the rainforest, are both time consuming and expensive if they are conducted using the pure terrestrial approach only. Monitoring and management of tropical rainforest is of paramount importance to many countries in the tropical regions because it is essential for economic reasons to establish a sustainable process of exploitation of the timber resources in the forests. There is a pressing need for low cost and effective inventory and monitoring" (cited after Nguyen 2009).

Appendix 4. Forest functions and Criteria of forest classification by function

Forest Type	Sub-types	Functions	Classification criteria and indicators
Protection forests	Watershed forest	To enhance the capability of regulating the flow of water and water reservoirs in order to limit flooding, reduce erosion, protect soil, and limit the river-bed and lake sedimentation.	Area, rainfall, slope, relative height, body composition and thickness of the soil layer (Depending on this criteria, they determine the area need to protect in three levels of high, medium and low risk)
	Forest for windbreak and sand break	To prevent wind damage, sand mobility; to protect agricultural production; to protect residential areas, urban areas, production areas and other works	Area, sandy coastal terraces, climate and economic status characteristics and social areas.
	Forest protection for wave break and reclamation	Wave prevention, erosion control, and protection of production and works on coastal and riversides	Size, location, hydrology, erosion and protected works
	Protection forests for environmental protection	To regulate the climate; to prevent environment pollution in residential areas, urban and industrial areas; to combine with tourism, leisure, protection of national and border security.	Area; factors of the environment, pollution, toxic due to social - economic activities in the region; or requirements for security and defence
Special-use forests	National Park	Conservation of forests and forest ecosystems; scientific research; environmental education and ecotourism	The characteristic of ecosystems; endemic species; the natural area of the park; and the proportion of agricultural land, residential land compared to the natural area of the park
	Nature reserve includes nature reserves and protected areas species - habitat	To protect ecosystems and species that should be conserved; to serve for environmental research, monitoring, education; to enhance awareness about the environment and eco-tourism.	Endemic, rare and endangered species and their natural habitat; the natural area of conservation areas; and the proportion of agricultural land, residential land from areas of natural conservation areas.
	Landscape area protection	To protect, maintain and develop the traditional relationship between the human nature to serve for religious activities, recreation, entertainment, sightseeing, education and ecotourism	History; traditional culture; landscape; and the area of natural landscape protection as well as the ratio of agricultural land, residential land from the areas

	Forest for scientific research and experiment	To serve for scientific research and experiment; education and vocational training in forestry.	The requirements of the organization of scientific research and technological development, vocational training in forestry
Production forests	Natural forests and natural regeneration forests	Production and business timbers and NTFPs; combination with protection functions	The derived form
	Plantation forests		
	Seed stand forests		

Details of classification criteria are on these follow legal acts:

Code	Original Title in Vietnamese	Title Translated into English	Issuing Institutions
1	Luật số: 29/2004/QH11, ngày 3 tháng 12 năm 2004 „***Luật bảo vệ và Phát triển rừng***“	Law No.: 29/2004/11th Parliament Session, date 3rd, Dec 2004 “Forest Development and Protection Law“	Parliament
2	Quyết định số 61/2005/QĐ-BNN của Bộ NN&PTNT ngày 12 tháng 10 năm 2005 về “Việc ban hành quy định về tiêu chí phân cấp rừng phòng hộ’’	Decision No. 61/2005/QĐ-BNN of MARD on 25th October 2005 on “Promulgating the regulation of classification criteria for protection forests’’	MARD
3	Quyết định số 62/2005/QĐ-BNN của Bộ NN&PTNT ngày 12 tháng 10 năm 2005 về “Việc ban hành quy định về tiêu chí phân cấp rừng đặc dụng’’	Decision No. 62/2005/QĐ-BNN of MARD on 25th October 2005 on “Promulgating the regulation of classification criteria for special use forests’’	MARD
4	Quyết định 186/2006/QĐ-TTg của Thủ tướng chính phủ ngày 14 tháng 8 năm 2006 về “Việc ban hành quy chế quản ly rừng”	Decision No. 186/2006/QĐ-TTg on “Promulgating the regulation of forest management’’ issued by Vietnam Prime Minister on 14th August 2006	Prime Minister
5	Quyết định 17/2015/QĐ-TTg của Thủ tướng chính phủ ngày 9 tháng 6 năm 2015 về “Việc ban hành quy chế quản ly rừng phòng hộ”	Decision No. 17/2015/QĐ-TTg on “Promulgating the regulation of protection forest management’’ issued by Vietnam Prime Minister on 9th June 2006	Prime Minister
6	Nghị định 117/2010/QĐ-CP của Thủ tướng chính phủ ngày 24 tháng 12 năm 2010 về “Việc tổ chức và quản lý hệ thống rừng đặc dụng”	Decree No. 117/2010/QĐ-CP on “Organizing and managing system of special use forests in Vietnam”, issued by Vietnam Prime Minister on 24th December 2010	Prime Minister

Appendix 5. List of Legal Act

Nr.	Original Title in Vietnamese	Title Translated into English	Issuing Institutions
1	Luật số 29/2004/QH11, ngày 3 tháng 12 năm 2004 „***Luật bảo vệ và Phát triển rừng***“ của Quốc hội khóa 11	The Law No. 29/2004/ QH11 on December 3rd 2004 “***The Law of Forest Development and Protection***“ by The 11 Parliament Session	Parliament
2	Luật số 20/2008/QH12, ngày 13 tháng 11 năm 2008, “***Luật đa dạng sinh học***” của Quốc Hội khóa 12	The Law No. 20/2008/QH12 on November 13th 2008 “The Law of Biodiversity” by the 12th Parliament Session	Parliament
3	***Nghị định 32/2006/NĐ-CP của Thủ tướng chính phủ ngày 30 tháng 3 năm 2006 về “***Quản lý thực vật rừng, động vật rừng nguy cấp, quý, hiếm***”***	Decree No. 32/2006/NĐ-CP on “***Managing endangered, rare and valuable plant and animal species in forests***”, issued by Vietnam Prime Minister on 30th March 2006	Prime Minister
4	Nghị định số 23/2006/NĐ-CP ngày 3 tháng 3 năm 2006 về việc “***Thi hành luật Bảo vệ và Phát triển rừng***” của Chính phủ	Decree No. 23/2006/NĐ-CP on “***Executing the Law of forest protection and development***”, issued on 3rd Mar 2006 by Vietnam Prime Minister	Prime Minister
5	Nghị định số 119/2006/NĐ-CP củaThủ tướng Chính phủ về “***Tổ chức và hoạt động của Kiểm lâm***” ngày 16 tháng 10 năm 2006	Decree No. 119/NĐ-CP, 16th Oct 2006 of Prime Minister on “***Structure and Activity of the Forest Ranger***”	Prime Minister
6	***Nghị định số 02/CP của Thủ tướng Chính phủ ngày 15 tháng 01 năm 1994 “***Ban hành quy định về việc giao đất lâm nghiệp cho tổ chức, hộ gia đình, cá nhân sử dụng vào mục đích lâm nghiệp”	Decree No. 02/CP on “***Promulgating the regulation of forestry land allocation to organizations, households, individuals used for forestry aim***”, issued by Vietnam Prime Minister on 15th Jun 1994	Prime Minister

7	Nghị định số 163/1999/NĐ-CP của Chính phủ về ***"Giao đất, cho thuê đất lâm nghiệp cho tổ chức, hộ gia đình và cá nhân sử dụng ổn định, lâu dài vào mục đích lâm nghiệp"*** ban hành ngày 16 tháng 11 năm 1999	Decree No. 163/1999/NĐ-CP on "***Allocating and leasing forestry land to organizations, households and individuals for long-term utilization for forestry purpose***" issued on 16th Nov 1999 by Vietnam Prime Minister	Prime Minister
8	Nghị định số 99/2010/NĐ-CP ngày 24 tháng 9 năm 2010 của Thủ tướng Chính phủ "***Về chính sách chi trả môi trường rừng***"	Decree No. 99/2010/NĐ-CP on September 24th 2010 by Vietnam Prime Minister on "***Policy of payment for forest environment services***"	Prime Minister
9	Quyết định 186/2006/QĐ-TTg của Thủ tướng chính phủ ngày 14 tháng 8 năm 2006 về "***Việc ban hành quy chế quản ly rừng"***	Decision No. 186/2006/QĐ-TTg on ***"Promulgating the regulation of forest management***" issued by Vietnam Prime Minister on 14th August 2006	Prime Minister
10	Quyết định số 61/2005/QĐ-BNN của Bộ NN&PTNT ngày 12 tháng 10 năm 2005 về "***Việc ban hành quy định về tiêu chí phân cấp rừng phòng hộ''***	Decision No. 61/2005/QĐ-BNN of MARD on 25th October 2005 on "***Promulgating the regulation of classification criteria for protection forests''***	MARD
11	Quyết định số 62/2005/QĐ-BNN của Bộ NN&PTNT ngày 12 tháng 10 năm 2005 về "***Việc ban hành quy định về tiêu chí phân cấp rừng đặc dụng''***	Decision No. 62/2005/QĐ-BNN of MARD on 25th October 2005 on "***Promulgating the regulation of classification criteria for special use forests''***	MARD
12	Quyết định 17/2015/QĐ-TTg của Thủ tướng chính phủ ngày 9 tháng 6 năm 2015 về "***Việc ban hành quy chế quản ly rừng phòng hộ"***	Decision No. 17/2015/QĐ-TTg on ***"Promulgating the regulation of protection forest management''*** issued by Vietnam Prime Minister on 9th June 2006	Prime Minister
13	Quyết định 178/2001/QĐ-TTg của Thủ tướng chính phủ ngày 12 tháng 11 năm 2001 về ***"Quyền hưởng lợi, nghĩa vụ của hộ gia đình, cá nhân được giao, được thuê, nhận khoán rừng và đất lâm nghiệp***"	Decision No. 178/2001/QĐ-TTg on "***Benefits and obligations of households and individuals allocated, leased or contracted forests and forestry land***", issued by Vietnam Prime Minister on 12th November 2001	Prime Minister

14	Quyết định số 83/2007/QĐ-BNN của Bộ trưởng Bộ NN&PTNT về "***Nhiệm vụ công chức Kiểm lâm địa bàn cấp xã***", ngày 4 tháng 10 năm 2007	Decision No. 83/2007/QĐ-BNN on "***Assignment of civil service of the ranger at communal level"*** by Minister of MARD on 4th Oct, 2007	MARD
15	Quyết định số 08/2001/QĐ-TTg của TTCP ngày 11 thán 1 năm2011, về việc "***Ban hành Quy chế quản lý rừng đặc dụng, rừng phòng hộ, rừng sản xuất là rừng tự nhiên"***	Decision No. 08/2001/ QĐ-TTg on "***Promulgating the management regulation of special-use forests, protection forests, and production forests being natural forests***" issued by Vietnam Prime Minister **on** January 11, 2006	Prime Minister
16	Quyết định số 661/QĐ-TTg của Thủ tướng Chính phủ ngày 29 tháng 7 năm 1998 về **"*Mục tiêu, nhiệm vụ, chính sách và tổ chức thực hiện dự án trồng mới 5 triệu hecta rừng*"**	Decision No. 661/QĐ-TTg on ***"Objective, target, policy and organization for implementing 5-million hectares forest plantation"***, issued by Vietnam Prime Minister on 29th Jul 1998	Prime Minister
17	***Quyết định 24/2012/QĐ-TTg của Thủ tướng chính phủ ngày 1 tháng 6 năm 2012 về "***Chính sách đầu tư phát triển rừng đặc dụng giai đoạn 2011-2020"	Decision No. 24/2012/QĐ-TTg on "***Development policy of Special-use forests in period 2011-2020"*** by Vietnam Prime Minister on 1st June 2012	Prime Minister
18	Quyết định 3570/QĐ-UBND của Ủy ban nhân dân huyện Võ Nhai ngày 24 tháng 4 năm 2015 về "***Phê duyệt kế hoạch khai thác rừng do dân tự trồng thuộc quy hoạch rừng phòng hộ và phương án trồng lại rừng sau khai thác rừng phòng hộ"***	Decision No. 3570/QĐ-UBND on ***"Approving extraction plan of local-people-planted forests in protection forest planning and reforestation project after protection forest extraction"***, issued by Vo Nhai DPC on 24th April 2015.	DPC
19	Quyết định số 1604/QĐ-UBND ngày 08/7/2009 của UBND tỉnh Thái Nguyên về việc Phê duyệt ***"Dự án xác lập khu bảo tồn thiên nhiên Thần Sa-Phượng Hoàng, huyện Võ Nhai, tỉnh Thái Nguyên"***	Decision No. 1604/QĐ-UBND on July 8th 2009 by Thai Nguyen PPC on ***"Approving project of establishment of the Than Sa-Phuong Hoang natural conservation area, Vo Nhai district, Thai Nguyen province"***	PPC

20	Nghị định 117/2010/QĐ-CP của Thủ tướng chính phủ ngày 24 tháng 12 năm 2010 về "***Việc tổ chức và quản lý hệ thống rừng đặc dụng"***	Decree No. 117/2010/QĐ-CP on ***"Organizing and managing system of special use forests in Vietnam***", issued by Vietnam Prime Minister on 24th December 201	Prime Minister
21	Thông tư liên tịch số 80/2003/TTLT/BNN-BTC của Bộ NN&PTNT và Bộ tài chính ngày 3 tháng 9 năm 2003 về ***"Hướng dẫn thực hiện quyết định số 178/2001/QĐ-TTg ngày 12 tháng 11 năm 2001 của Thủ tướng chính phủ về quyền hưởng lợi, nghĩa vụ của hộ gia đình, cá nhân được giao, được thuê, nhận khoán rừng và đất lâm nghiệp***"	Joint circular No. 80/2003/TTLT/BNN-BTC of MARD and MOF, issued on 3rd September 2003 on "***Guiding the implementation of Decision No. 178/2001/QĐ-TTg by Vietnam Prime Minister on 12th November 2001 about benefits and obligations of households and individuals allocated, leased or contracted forests and forestry land***"	MARD-MOF
22	***"Thông tư liên tịch"*** của Bộ NN&PTNT - Bộ Nội vụ số 61/2008/TTLT-BNN-BNV ngày 15 tháng 5 năm 2008	***"Joint circular"*** of MARD – Ministry of the Interior, No. 61/2008/TTLT-BNN-BNV, issued on 15th May 2008	MARD – MOHA
23	"***Thông tư liên tịch"***của Bộ TNMT và Bộ Nội vụ số 03/2008/TTLT-BTNMT-BNV ngày 15 tháng 7 năm 2008	***"Joint circular"*** of Ministry of Environment and Resource – Ministry of Interior, No. 03/2008/TTLT-BTNMT-BNV, issued on 15th Jul 2008	MONRE– MOHA
24	Thông tư 35 /2011/TT-BNNPTNT "**Hướng dẫn thực hiện khai thác, tận thu gỗ và lâm sản ngoài gỗ"** ngày 2 tháng 5 năm 2011 của Bộ NN&PTNT	Circular No. 35/2011/TT-BNNPTNT on "***Guiding implementation of extracting and salvaging timber and NTFPs***", issued on May 20th, 2011 by MARD	MARD
25	Thông tư số 38/2007/TT-BNN ngày 25 tháng 4 năm 2007 về "***hướng dẫn trình tự, thủ tục giao rừng, cho thuê rừng, thu hồi rừng ch tổ chức, cá nhân, hộ gia đình và cộng đồng dân cư thôn***" của Bộ Nông nghiệp và Phát triển nông thôn	Circular No. 38/2007/TT-BNN on ***"guiding procedures for allocation, lease, and withdrawal of forest to organizations, households, individuals and communities"***, issued on 25th Apr 2007 by Ministry of Agriculture and Rural Development	MARD

26	Công văn số 872/SNN-LN ngày 30 tháng 7 năm 2014 của Sở NN&PTNT tỉnh Thái Nguyên về việc "***Khai thác rừng trồng thuộc quy hoạch rừng đặc dụng"***	Official document No. 872/SNN-LN on 30th July 2014 on "***Extracting plantation forests in special-use forest planning***", issued by Thai Nguyen PDARD	PDARD
27	Công văn số 1112/SNN-LN ngày 14 tháng 08 năm 2012 của Sở NN&PTNT về việc ***"Hướng dẫn khai thác diện tích rừng trồng phòng hộ, đặc dụng sau quy hoạch chuyển thành rừng sản xuất"***	Official document No. 1112/SNN-LN on 14th August 2012 on "***Guiding to extract plantation special-use and protection forests becoming production forests after planning",*** issued by Thai Nguyen PDARD	Thai Nguyen PDARD
28	Công văn số 1541/HĐ-UBND của Ủy ban nhân dân huyện Võ Nhai ngày 28 tháng 8 năm 2012 về "***Hướng dẫn khai thác diện tích rừng phòng hồ, đặc dụng sau quy hoạch chuyển thành rừng sản xuất"***	Official document No. 1541/HĐ-UBND on 28th August 2012 on "***Guiding to extract special-use and protection forests becoming production forests after planning***", issued by Vo Nhai DPC	Vo Nhai DPC
29	Công văn số 48/SNN-LN ngày 14 tháng 01 năm 2014 của Sở NN&PTNT về việc ***"Trình tự lập hồ sơ thiết kế khai thác rừng trồng thuộc quy hoạch phòng hộ và sản xuất***"	Official document No. 48/SNN-LN on 14th January 2014 on ***"Procedures for extraction projects of plantation forests in protection and production forest planning",*** issued by Thai Nguyen PDARD	PDARD
30	Công văn số 3186/HD-SNN ngày 20 tháng 10 năm 2011 của Sở NN&PTNT về việc "***Hướng dẫn thực hiện khai thác, tận thu lâm sản ngoài gỗ trên địa bàn tỉnh Thái Nguyên***"	Official document No. 3186/HD-SNN on 20th October 2011 on "***Guiding to extract and gather all NTFPs in Thai Nguyen province***", issued by Thai Nguyen PDARD	PDARD
31	Công văn 147/HD-CCKL ngày 22 tháng 2 năm 2012 của Chi cục kiểm lâm Thái Nguyên về "***Hướng dẫn kiểm tra, giám sát khai thác, tận thu gỗ và lâm sản ngoài gỗ theo thông tư 35/TT-BNNPTNT của Bộ NN&PTNT***"	Official document No. 147/HD-CCKL on 22th February 2012 on "***Instruction for control and supervision of exploitation NTFPs following circular 35/TT-BNNPTNT issued by MARD***", issued by Thai Nguyen PFPU	PFPU

32	Công văn số 70/KH-NN&PTNT của Phòng NN&PTNT huyện Võ Nhai ngày 14 tháng 4 năm 2015 về ***"Kế hoạch khai thác rừng do dân trồng thuộc quy hoạch rừng phòng hộ"***	Official document No. 70/KH-NN&PTNT on 14th April 2015 on ***"Extraction plan of local people – planted forests in protection forest planning"***, issued by Vo Nhai DDARD	DDARD
33	Công văn số 71/PA-NN&PTNT của Phòng NN&PTNT huyện Võ Nhai ngày 14 tháng 4 năm 2015 về ***"Phương án trồng lại rừng sau khai thác rừng phòng hộ"***	Official document No. 71/PA-NN&PTNT on 14th April 2015 on "***Reforestation project after extraction of protection forests"***, issued by Vo Nhai DDARD	DDARD
34	Công văn số 1047/SNN-LN của Sở NN&PTNT ngày 11 tháng 9 năm 2014 về việc "***Khai thác rừng trồng thuộc quy hoạch rừng phòng hộ***".	Official document No. 1047/SNN-LN on "***Extrating plantation forests in protection forest planning***", issued by Thai Nguyen PDARD on 11th September 2014	PDARD
35	Thông báo số 416/TB-HU của Huyện ủy Võ Nhai ngày 12 tháng 8 năm 2013 ***"Thông báo kết luận của Ban thường vụ huyện ủy về việc bảo vệ, không được chặt hạ các cây cổ thụ trên địa bàn huyện"***	Confirmation No. 416/TB-HU on 12th August 2013 on ***"Announcing the District Communist Party Commission´s conclusion of protecting and not felling the old trees in the district"***	Vo Nhai Commission of Communist Party

Note:

MARD	Ministry of Agriculture and Rural Development
MONRE	Ministry of Natural Resource and Environment
MOHA	Ministry of Home Affair of the socialist republic of Vietnam
MOF	Ministry of Finance
PPC	Provincial People´s Committee
DPC	District People´s Committee
PFPU	Provincial Forest Protection Unit
PDARD	Provincial Department of Agriculture and Rural Development
DDARD	District Department of Agriculture and Rural Development
NN&PTNT	Nông nghiệp và phát triển nông thôn (Agriculture and Rural Development)
UBND	Ủy ban nhân dân (People´s Committee)

Appendix 6. Biodiversity in the research area

These lists in this Appendix are conducted from report of forest inventory of Than Sa - Phuong Hoang natural conservation area.

Some abbreviations:

Endangered level:

IUCN and Redbook of Vietnam 2007: EW- Extinct in the wild; CR - Critically Endangered; EN – Endangered; VU – Vulnerable; NT - Near threatened; LC - Least concern

Decree **32/2006/NĐ-CP**: IA: The flora species that was prohibited to extract and utilize for commercial purposes

IB: The fauna species that was prohibited to extract and utilize for commercial purposes

IIA: The flora species that was restricted to extract and utilize for commercial purposes

IIB: The fauna species that was restricted to extract and utilize for commercial purposes

Recorded Places: 1- Than Sa, 2 - Thuong Nung, 3 - Nghinh Tuong, 4 - Phu Thuong, 5 - Sang Moc, 6 - Vu Chan, 7 - Dinh Ca

Information sources:

QS: Recorded by observation in fieldwork

NG: Recorded by the voice

DV: Recorded by food prints

PV: Recorded by interview

MV: Recorded by specimens

Popular level: PB: Popular, H: Uncommon, RH: Scarce, NN: suspicious of existences

A - Specious and valuable timber species in research area (source: TSPHMB 2008)

No.	Scientific name	Vietnamese name	Endangered level		Recorded places
			Red book of Vietnam-2007	Decree 32/2006/NĐ-CP	
1	*Acanthopanax gracilistylis* w. w. Sm	Ngũ gia	EN		1, 4, 6
2	*Adinandra megaphylla* Hu	Dương đồng đại diệp	VU		2, 3, 4
3	*Aglaia spectabilis* (Miq.) Jain et Bennet	Gội nếp	VU		1, 2, 3, 4, 5, 6
4	*Balanophora laxiflora* Hemsl	Khoả dương hoa thưa	EN		1, 2, 4, 5, 6
5	*Canarium pimela Leenh*	Trám đen	VU		1, 2, 3, 4, 5, 6, 7
6	*Chukrasia tabularis* A. Juss.	Lát hoa	VU		1, 2, 3, 4, 5, 6, 7
7	*Cinnamomum balansae* Lecomte	Vù hương	VU	IIA	1, 2, 3, 4, 5, 6
8	*Cinnamomum parthenoxylon (Jack) Meisn.*	Re hương	CR	IIA	1, 2, 3, 4, 5, 6
9	*Codonopsis javania* (Blume) Hook.f.	Đảng sâm	VU	IIA	1, 2, 3, 4, 5, 6
10	*Dipterocarpus retusus* Blume	Chò nâu	VU		1, 2, 3, 4, 5, 6
11	*Excentrodendron tonkinense*(A.Chev)H.T.Chang et R.H.Miau	Nghiến gân ba	EN	IIA	1, 2, 4, 5, 6
12	*Ixodonerium annamense* Pit	Tử ngạc	VU		1, 2, 4, 5, 6
13	*Lithocarpus bacgiangensis (Hickel et A.camus) A.camus*	Sồi bắc giang	VU		1, 2, 3, 6
14	*Lithocarpus balansae (Drake) A.camus*	Sồi lá mác	VU		1, 2, 3, 4, 5
15	*Lithocarpus bbonnetii (Hickel et A.camus) A.camus*	Sồi chiêm hoá	VU		1, 2, 4, 5, 6

16	*Lithocarpus corneus var.zonatus C.C.Huang et Y.T.Chang*	Sồi bán cầu	VU		1, 2, 3, 4
17	*Madhuca pasquieri* (Dubard) H. J . Lam	Sến mật	EN		1, 2, 3, 4, 5, 6
18	*Mahonia nepalensis* (Thunb.) DC.	Mã hồ nê-pan	EN		1, 2, 4, 5, 6
19	*Markhamia stipulata (wall.)* Seem. Ex Schum.	Đinh mật	VU	IIA	1, 2, 4, 5, 6
20	*Melientha suavis* Pierre	Sắng	VU		1, 2, 3, 4, 5, 6
21	*Michelia balansae* (A.DC.) Dandy	Giổi lông	VU		1, 2, 3, 4, 5, 6, 7
22	*Quercus glauca Thunb.*	Dẻ lục phấn	VU		1, 2, 3, 4, 5, 6
23	*Quercus platycalyx* Hickel et A. Camus	Dẻ đài rộng	VU		1, 2, 3, 4, 5, 6
24	*Stephania dielsiana* C.Y.Wu	Dòm	VU	IIA	1, 2, 3, 4, 5, 6, 7
25	*Vatica subglabra* Merr.	Táu nước	EN		1, 2, 4, 5, 6
26	*Asarum glabrum* Merr.	Tế tân nhẵn		IIA	2, 4, 6
27	*Asarum petelotii* O.C. Schmidt	Tế tân pê-tơ-lô		IIA	2, 4, 6
28	*Cycas miquelii* Warb.	Tuế gai ít		IIA	1, 3
29	*Garcinia fagracoides* A.chev	Trai lý		IIA	1, 2, 3, 4, 5, 6
30	*Stephania hernandiifolia* (willd.) Spreng.	Tiền xuyến thằng		IIA	1, 2, 3, 4, 5, 6, 7
31	*Stephania japonica* (thunb.) Miers	Thiên kim đằng		IIA	1, 2, 3, 4, 5, 6, 7
32	*Stephania rotunda* Lour.	Bình vôi		IIA	1, 2, 3, 4, 5, 6, 7

Date of statistics: 15/11/ 2008

Statistician: Kiều Văn Quế

B - Mammalia species in the research area (Source: TSPHMB 2012a)

No	Scientific Name	Vietnamese Name	Recorded Places	Source	Endangered level				Popular level
					IUCN 2007	Red book of Vietnam-2007	Decree 32/2006/NĐ-CP	Annex of CITES	
	SCANDENTA	**BỘ NHIỀU RĂNG**							
	Tupaiidae	**Họ Đồi**							
1	*Tupaia belangeri*	Đồi	1,2,3	QS, MV	LC			II	PB
	CHIROPTERA	**BỘ DƠI**							
	Pteropodidae	**Họ Dơi quả**							
2	*Cynopterus sphinx*	Dơi chó ấn	1,2,3	DV					
	Rhinolophidae	**Họ Dơi lá mũi**							
3	*Rhinolophus paradoxolophus*	Dơi lá quạt	1,2,3,4	DV	VU				
	Hipposideridae	**Họ Dơi nếp mũi**							
4	*Hipposideros armiger*	Dơi nếp mũi quạ	1,2,3	DV					
	Vespertilionidae	**Họ Dơi muỗi**							
5	*Murina tubinaris*	Dơi mũi ống lông chân	3	MV					
6	*Murina cyclotis*	Dơi mũi ống tai tròn	3	MV					
	PRIMATES	**BỘ LINH TRƯỞNG**							
	Loridae	**Họ Cu li**							
7	*Nycticebus coucang*	Cu li nho	1,2,3,4	PV, QS,	VU	VU	IB	II	H
	Cercopithecidae	**Họ Khỉ**							
8	*Macaca assamensis*	Khỉ mốc	1,2,3	PV	VU	VU	IIB	II	RH
9	*Macaca arctoides*	Khỉ mặt đỏ	1,2,3,4	PV	VU	VU	IIB	II	RH
	CARNIVORA	**BỘ ĂN THỊT**							
	Mustelidae	**Họ Chồn (Ho Triet)**							
10	*Artonyx collaris*	Lửng lợn	3	PV					PB
11	*Melogale moschata*	Chồn bạc má bắc	1,2,3	PV,QS					PB
	Felidae	**Họ Mèo**							
12	*Prionailurus bengalensis*	Mèo rừng	1,2,3	PV,DV	LC		IB	II	H
13	*Catopuma temminckii*	Beo lửa	2.3	PV,DV, QS	NT	EN	IB	I	H

	ARTIODACTYLA	**BỘ GUỐC CHẴN**							
	Moschidae	**Họ Hươu xạ**							
14	*Moschus berezopskii*	Hươu xạ	1,2,3	PV, MV	NT	CR	IB	II	RH
	Cervidae	**Họ Hươu nai**							
15	*Cervus unicolor*	Nai	0.3						
16	*Muntiacus muntjak*	Hoẵng	1,2,3	PV,MV					H
	Bovidae	**Họ Trâu bò**							
17	*Naemohedus muntjak*	Sơn dương	1,2,3	PV MV		EN	IB		RH
	PHOLIDOTA	**BỘ TÊ TÊ**							
	Manidae	**Họ Tê tê**							
18	*Manis pentadactyla*	Tê tê	1.3						
	RODENTIA	**BỘ GẶM NHẤM**							
	Sciuridae	**Họ Sóc cây**							
19	*Callosciurus erythrraeus*	Sóc bụng đỏ	1,2,3	PV,QS					PB
20	*Ratufa bicolor*	Sóc đen	1,2,3	PV,QS	NT	VU		II	H
	Pteromyidae	**Họ Sóc bay**							
21	*Belomys pearsonii*	Sóc bay lông tai	1.3						
22	*Petaurista philippinensis*	Sóc bay lớn	1,2,3	QS					PB
	Muridae	**Họ Chuột**							
23	*Rattus flavipertus*	Chuột nhà	1,2,3	QS					PB
24	*Rattus losea*	Chuột đồng be	3	DV					
25	*Rattus norvegicus*	Chuột cống	3	DV					
26	*Rattus remotus*	Chuột rừng	1,2,3	QS					PB
27	*Rattus sabanus*	Chuột núi	1,2,3	QS					PB
	Rhizomyidae	**Họ Dúi**							
28	*Zhyzomys pruinosus*	Dúi mốc lơn	1,2,3	QS, MV					PB
	Hystricidae	**Họ Nhím**							
29	*Acanthion klossi*	Nhím klos	1,2,3	DV					

C - Eves species in Research areas (Source: TSPHMB 2012a)

No.	Scientific Name	Vietnamese Name	Recorded Places	Source	Endangered level			Popular level
					IUCN 2007	Decree 32/2006/NĐ-CP	Annex of CITES	
I	**CICONIIFORMES**	**BỘ HẠC**						
	Ardiedae	**Họ Diệc**						
1	*Ardeola bacchus*	Cò bợ	1,2,3	QS,MV				PB
2	*Butorides striatus*	Cò xanh	1,2,3	PV, QS				H
3	*Nyxticorax nyticorax*	Vạc	2.3	MV,QS, PV				H
II	**FALCONIFORMES**	**BỘ CẮT**						
	Accipitridae	**2.Họ Ưng**						
4	*Milvus migrans*	Diều hâu	1,2,3	QS	EN			H
5	*Spilornis cheela*	Diều hoa miến điện	1,2,3	QS	LC	IIB		H
III	**GRUIIFORMES**	**BỘ SẾU**						
	Rallidae	**3. Họ Gà nước**						
6	*Amaurornis phoenicurus*	Cuốc ngực trắng	2.3	QS				
IV	**COLUMBIFORMES**	**BỘ BỒ CÂU**						
	Columbidae	**4.Họ Bồ câu**						
7	*Streptopelia chinensis*	Cu gáy	1,2,3	QS, MV				PB
VI	**PSITTACIFORMES**	**BỘ VẸT**						
	Psittacidae	**5.Họ Vẹt**						
8	*Psittacula alexandri*	vẹt ngực đỏ	1.3	PV			IIB	PB
VII	**CUCULIFORMES**	**BỘ CU CU**						
	Cuculidae	**6.Họ Cu cu**						
9	*Eudynamys scolopacea*	Tu hú	1,2,3	QS				
10	*Centropus sinensis*	Bìm bịp lớn	1,2,3	QS				PB
11	*Centropus bengalensis*	Bìm bịp nhỏ	1,2,3	QS				PB

VIII	**CAPRIMULGIFORMES**	**BỘ CÚ MUỖI**						
	Caprimulgidae	**7.Họ Cú muỗi**						
12	*Caprimulgus macrurus*	Cú muỗi đuôi dai	1,2,3	PV, C				H
IX	**STRIGIFORMES**	**BỘ CÚ**						
	Strigidae	**9.Họ Cú mèo**						
13	*Otus spilocephalus*	Cú mèo latuso	3	QS				
X	**APODIFORMES**	**BỘ YẾN**						
	Apodidae	**10.Họ Yến**						
14	*Aerodramus brevirostris*	Yến núi	1,2,3	PV				
XI	**CORACIIFORMES**	**BỘ SẢ**						
	Alcedinidae	**11.Họ Bói cá**						
15	*Alcedo atthis*	Bồng chanh	1,2,3	QS				PB
16	*Halcyon smyrnensis*	Sả đầu nâu	1,2,3	QS				PB
	Meropidae	**12.Họ Trảu**						
17	*Merops viridus*	Trảu họng xanh	1,2,3	PV, QS				PB
18	*Nyctyornis athertoni*	Trảu lớn	1,2,3	PV, QS				PB
XII	**PASSERIFORMES**	**BỘ SẺ**						
	Alaudidae	**13.Họ Sơn ca**						
19	*Alauda gulgula*	Sơn ca	1.3	QS				PB
	Hirundinidae	**14.Họ Nhạn**						
20	*Hirundo rustica*	Nhạn bụng trắng	1,2,3	QS				PB
21	*Hirundo rustica*	Nhạn bụng xám	1,2,3	QS				PB
	Motacillidae	**15.Họ Chìa vôi**						
22	*Motacilla flava*	Chìa vôi vàng	1,2,3	PV, QS				PB
23	*Motacilla alba*	Chìa vôi trắng	1,2,3	PV, QS				PB
	Picnonotidae	**16.Họ Chào mào**						
24	*Picnonotus jocosus*	Chào mào đít đỏ	1,2,3	QS, MV				PB
25	*Hypsipetes proquiquus*	Cành cạch nhỏ	1,2,3	QS				PB

	Laniidae	**17.Họ Bách thanh**						
26	*Lanius collurioides*	Bách thanh nhỏ	2.3	PV				QS
27	*Lanius schach*	Bách thanh đầu đen	1,2,3	QS				QS
	Turnidae	**18.Họ Chích choè**						
28	*Copsychus saularis*	Chích choè	1,2,3	QS				PB
29	*Monticola solitarius*	Hoét đá	1,2,3					
	Timalidae	**19.Họ Khướu**						
30	*Garrulax chinensis*	Khướu bạc má	1,2,3	QS, PV				PB
31	*Alcipe rufogularis*	Lách tách họng hung	1,2,3					
32	*Stachyris nigriceps*	Khướu bụi đầu đen	2.3					
33	*Garrulax canorus*	Hoạ mi	1,2,3	QS, PV	LC		II	PB
	Sylviidae	**20.Họ Chim chích**						
34	*Orthotomus atrogularis*	Chích bông canh vàng	1,2,3	QS				PB
35	*Phylloscopus fuscatus*	chích nâu	1,2,3	QS				PB
	Monarchidae	**21.Họ Rẻ quạt**						
36	*Rhipidura albicollis*	Rẻ quạt họng trắng	1,2,3	QS				PB
37	**Paridae**	**22.Họ Bạc má**						
38	*Parus major*	Bạc má	1,2,3	QS				PB
	Dicaeidae	**23.Họ Chim sâu**						
39	*Dicaeum concolor*	Chim sâu vàng lục	1,2,3	QS				PB
	Nectariniidae	**24.Họ Hút mật**						
40	*Aethopiga saturata*	Hút mật ngực đỏ	1,2,3	QS				PB
41	*Nectarinia jugularis*	Hút mật họng tím	1,2,3					
42	*Arachnothera magna*	Bắp chuối đốm đen	1,2,3	QS				PB
	Estrildidae	**25.Họ Chim di**						
43	*Lonchura striata*	Di cam	1,2,3					
44	*Lonchura punctulata*	Di đá	1,2,3					

	Zosteropidae	**26.Họ Vành khuyên**						
45	*Zosterops japonica*	Vành khuyên nhật bản	1,2,3	QS, PV				PB
	Ploceidae	**27.Họ Sẻ**						
46	*Passer montanus*	Sẻ	1,2,3	MV				
	Sturnidae	**28.Họ sáo**						
47	*Acridotheres cristatellus*	Sáo mỏ ngà	1,2,3	MV				
48	*Sturnus sinensis*	Sáo đá trung quốc	1,2,3	QS				
49	*Sturnus nigricollis*	Sáo sậu	1,2,3	MV				
	Dicruridae	**29.Họ Chèo bẻo**						
50	*Dicrurusmacrocercus*	Chèo bẻo	1,2,3	NG				

D - Reptilian species in the research area (Source: TSPHMB 2012a)

No.	Scientific Name	Vietnamese Name	Recorded Places	Source	Endangered level			Popular level
					Red book of Vietnam-2007	Decree 32/2006/NĐ-CP	Annex of CITES	
	SQUAMATA	**BỘ CÓ VẢY**						
	SAURIA	**PHÂN BỘ THẰN LẰN**						
	Agamidae	**1.Họ Nhông**						
1	*Physignathus cocincinus*	Rồng đất	1,2,3	PV, MV	VU			H
	Scincidae	**2.Họ Thằn lằn bóng**						
2	*Mabuya longicaudata*	Thằn lằn bóng đuôi dài	1,2,3	QS				PB
3	*Mabuya multifasciata*	Thằn lằn bóng hoa	1,2,3	PV, QS				PB
	SERPENTES	**B.PHÂN BỘ RẮN**						
	Colubridae	**3.Họ Rắn nước**						
4	*Amphiesma stolata*	Rắn sãi thường	1,2,3	QS				
5	*Enhydris plumbea*	Rắn bồng chì	1,2,3	MV				
6	*Ptyas korros*	Rắn ráo thường	1,2,3,4,5	QS,PV, MV	EN			PB
	Elapidae	**4.Họ Rắn hổ**						
7	*Bungarus fasciatus*	Rắn cạp nong	1,2,3	QS,PV, MV	EN	IIB	II	H
8	*Bungarus multicinctus*	Rắn cạp nia	1,3,5	QS	EN	IIB		H
9	*Naja atra*	Hổ mang	1,2,3,5	QS, MV		IIB		H
	Viperridae	**5.Họ Rắn lục**						
10	*Trimeresurus albolabris*	Rắn lục mép trắng	2.3	QS				

E - Piset species in the research area (Source: TSPHMB 2012a)

No.	Scientific Name	Vietnamese Name
I	**CYPRINIFORMES**	**BỘ CÁ CHÉP**
A	**Cyprinidae**	**Họ Cá chép**
1	*Microphysogobio kachekensis*	Cá đục đanh chấm hải nam
2	*Mylopharyngodon piceus*	Cá trắm đen
3	*Onychostama fangi*	Cá sỉnh fang
4	*Onychostama gerlachi*	Cá sỉnh
5	*Onychostama lepturus*	Cá sỉnh gai
6	*Osariichthys bidens*	Cá cháo
7	*Platysmacheilus of exiguus*	Cá đục chấm mõm ngắn
8	*Pseudohemiculter hainanensis*	Cá đầu sông gai ngắn
9	*Puntius semifasciolatus*	Cá đòng đong cân cấn
10	*Sarcocheilichthys hainanensis*	Cá nhọ chảo
11	*Spinibarbus hollandi*	Cá chày đất
B	**Balitoridae**	**Họ Cá chạch suối**
12	*Balitora kwangsiensis*	Cá vây bằng vẩy
13	*Beaufortia leveretii*	Cá bám đá có khuyết
14	*Homalosoma crassicauda*	Cá vây bằng đuôi chẻ
15	*Micronemacheilus taeniatus*	Cá chạch suối
16	*Stristura cf. fasciolata*	Cá chạch đá
C	***Cobitidae***	**Họ Cá Trạch**
17	*Leptobitia cf. elongata*	Cá chạch cát dài
18	*Misgurnus anguillacaudatus*	Cá chạch bùn

No.	Scientific Name	Vietnamese Name
II	**SILURIFORMES**	**BỘ CÁ NHEO**
D	**Bagridae**	**Họ cá lăng**
19	*Pelteobagrus fulvidraco*	Cá bò
20	*Pelteobagrus pluriradiatus*	Cá quất tia
E	**Siluridae**	**Họ Cá nheo**
21	*Silurus asotus*	Cá nheo
F	**Clariidae**	**Họ Cá trê**
22	*Clarius fuscus*	Cá trê
III	**SYNBRACHIFORMES**	**BỘ LƯƠN**
G	**Synbranchidae**	**Họ Lươn**
23	*Monopterus albus*	Lươn
H	**Mastacembelidae**	**Họ Cá chạch sông**
24	*Mastacembelus armatus*	Cá chạch sông
IV	**PERCIFORMES**	**BỘ CÁ VƯỢC**
I	**Percichthyidae**	**Họ Cá rô mo**
25	*Coreoperca whiteheadi*	Cá rô mo thường
	Anabantidae	**10.Họ Cá rô**
26	*Anbas testudineus*	Cá rô
K	**Osphronemidae**	**Họ Cá tai tượng**
27	*Macropodus opercularis*	Cá đuôi cờ
L	**Channidae**	**Họ Cá chuối**
28	*Channa maculata*	Cá chuối
29	*Channa striata*	Cá xộp

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