FOREST RESTORATION IN VIETNAM - LESSONS FROM APFNET PROJECT AND NEW APPROACHES

Asia-Pacific Network for Sustainable Forest Management and Rehabilitation (APFNet)

Silviculture Research Institute, Vietnam

Tran Duc Manh, Phan Minh Sang,
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This publication is an output of a project implemented with the financial and technical assistance of the Asia-Pacific Network for Sustainable Forest Management and Rehabilitation (APFNet). The views expressed in this publication do not necessarily reflect the official opinion of APFNet

Contents

List of tables

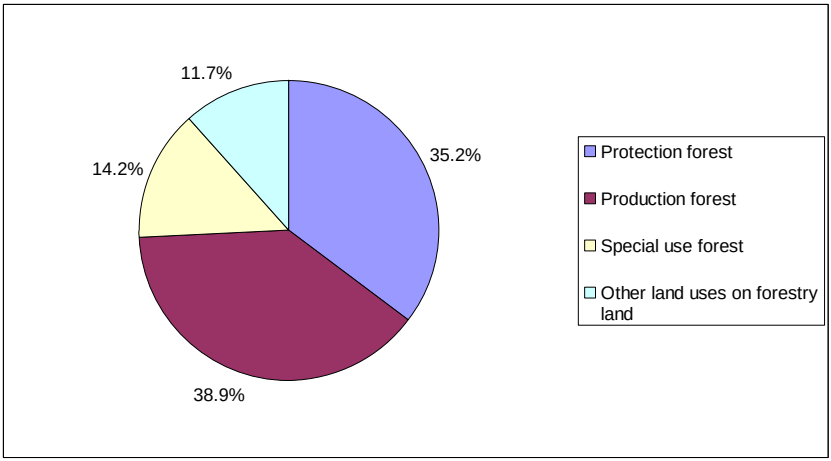
List of figures

Chapter 1. *Forest degradation* in Vietnam

1. 1. Forest status, history of deforestation and forest degradation

Vietnam has a high proportion of mountainous areas. Most of the territory is covered by forest. Vietnam has high diverse terrain, more than two thirds of its territory is mountainous, and the climate varies from tropical humid in the South to the subtropical in high mountainous areas in the North. This variation in climatic and geographical conditions have resulted in a variety of tropical and subtropical forest types. The forest types include evergreen broadleaf forest, semi-deciduous, deciduous, limestone forests, mixed forest of coniferous and broadleaf, coniferous forest, bamboo, mangroves, swamp forest, and freshwater wetlands forest. However, for a number of reasons, Vietnam's natural forests have been severely reduced or degraded over the last century.

According to Vietnamese Forestry Strategy 2006 – 2020, 16.2 million hectares of Vietnam's land has been classified for forestry purpose. Vietnam targets to have a stable level of forest area with 14.3 million ha of forests in addition to 1.9 million ha of forest land for other uses such as agroforestry systems (MARD 2006).

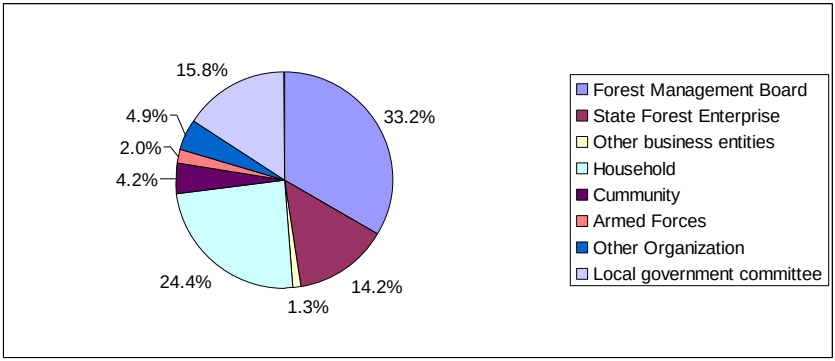


(Source: MARD, 2006)

Figure 1 Forest types planning by 2020 (total forestry land: 16. 2 million ha)

According to statistics of the Vietnam Administration of Forestry, in 2012 the total forest area was 13.86 million hectares (accounted for 41.9% of natural area total) divided into 10.423 million ha of natural forest and 3.428 million ha of plantations. Three types of forests reported in 2012 forest status data included: special use forest – 2,02 million hectares (equivalent to 15.7% of total forest area), protection forests – 4.7 million ha (36.1% of total forest area), production forests – 7 million ha (47.3% of total forest area), and other forests – 200.23 thousand ha (0.9% of total forest area) (VNFOREST 2013)

Classification of forest management by managers in 2013 reveals that forest management boards are the biggest managers responsible for managing 33.2% of total forest areas, mainly for special use and protection forests (Figure 2) (VNFOREST 2013).



(Source: Vietnam Administration of Forestry, 2013)

Figure 2 Forest classification by management entity

Farmers are managing the second largest part of forest area in Vietnam with 24.4 %. Smallholder forests are mainly commercial plantations.

Table 1 Status of forest and forest classification by management in 2012

unit: ha

	Total forest area	**Forest Manage-ment Board**	**State Forest Enterp-rise**	**Other business entities**	**Household**	**Comm-unity**	**Armed Forces**	**Other Organi-zation**	**Local govern-ment**
Total forest areas	13,862,043	4,606,365	1,965,471	177,573	3,388,948	588,253	271,599	672,446	2,191,388
Natural Forests	10,423,844	4,028,354	1,429,400	49,625	1,809,976	553,797	207,831	554,505	1,790,356
Plantation	3,438,200	578,010	536,071	127,948	1,578,972	34,456	63,769	117,941	401,033

(Source: Vietnam Administration of Forestry, 2013)

Forest cover has increased in recent years. However, it is unevenly distributed among the regions. The regions which have relatively high forest cover include North West, North East, North Central, Central-Coast and the Central Highlands, accounting for 40-50% . Some provinces like Bac Kan and Kon Tum, have very high forest cover level, 69. 5 and 64. 7%, respectively (VNFOREST 2013). The rest of the regions reported relatively low forest cover.

Although forest areas increased from 9.2 million ha in 1990 to 13.86 million ha in 2012, deforestation and forest degradation have been continuously observed in all regions in the country, from the Central Highlands to Central Coast and Southeast areas. Additionally, natural forests have become highly fragmented due to deforestation and forest degradation.

Forest area decline:

The degradation of forest resources can be seen clearly through a decline in forest areas. Originally, most of Vietnam was forested. The forests were severely degraded over the last century, and by 1943, forest cover was estimated to be about 43% of the national territory. The forests declined further by some 2 million ha during the war of almost 30 years. (Phung and Le 1994).

The main causes for degradation forest in the post war period from 1975 to early 1990s included: forest converted

to farm land for agriculture and cash crops such as coffee, tea, rubber and ineffective and unsustainable harvesting to meet timber demand for domestic market and export.

Table 2 Changes in Vietnam's forest area during 1943 – 2012

Unit: million ha

Year **Forest type**	**1943**	**1976**	**1985**	**1990**	**1995**	**2005**	**2012**
Total area	14. 3	11. 2	9. 9	9. 2	9. 3	12. 7	13. 5
Natural forest	14. 3	11. 1	9. 3	8. 4	8. 3	10. 2	10. 3
Plantation		0. 1	0. 6	0. 8	1. 0	2. 5	3. 2
Forest cover (%)	43. 0	33. 8	30. 0	27. 8	28. 2	38. 0	41. 9

(Source: Vietnam Administration of Forestry, 2013)

Table 2 indicates the trend in forest cover from 1943 to 2012. It was a continuous decline up to the early 1990s (loss of 5 million ha in 45 years; annual reduction of 0. 11 million ha) and and this was followed by an increase thereafter (Tran, Nguyen et al. 2006, VNFOREST 2013). From 1990s

to 2000 the forest area increased at over 1.6% annually (Pham, Moeliono et al. 2012, Phan 2014).

Plantation areas have rapidly increased since 1990, from about 1 million ha in early 1990s to 3. 428 million ha in 2012 (VNFOREST 2013). This substantial increase is as a result of better forest land allocation policy, market timber demand, improvement in plantation tree genetics, and intensive sivilcultural practices. This was further strengthened with international donors finance and improved afforestation programs.

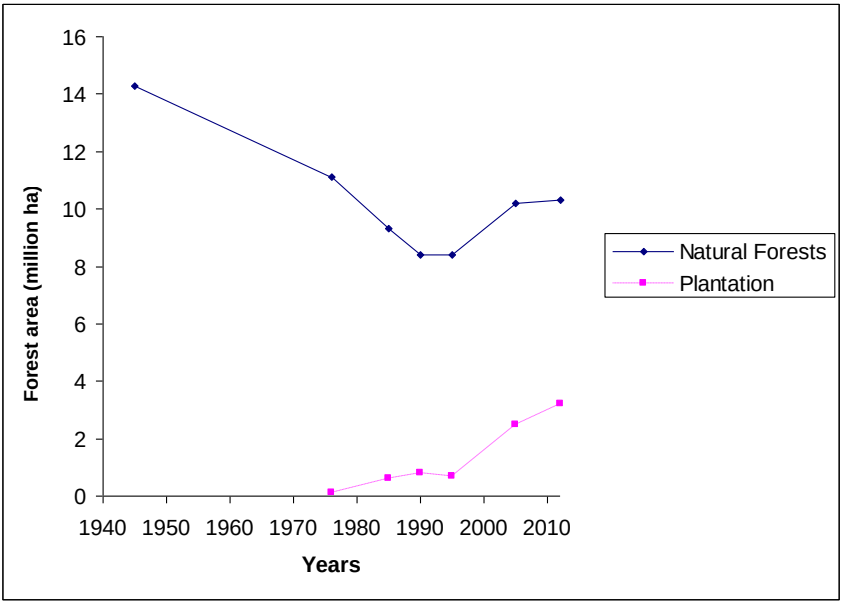


Figure 3 Changes in natural forests and plantations of Vietnam between 1943 and 2012

The forest area per capita of Vietnam is one of the lowest in the world. It has decreased dramatically from 0.63 ha/person in 1943 to 0.13 ha per person in 1995. In 2012, it increased 0.15 ha per person, which is far lower than world's average of 0.93 ha per person.

Table 3 Average forest area per capita of Vietnam in the period 1943 – 2012

Unit: ha/person

Year	1945	1976	1985	1995	1999	2005	2012
ha/person	0. 63	0. 23	0. 17	0. 13	0. 14	0. 15	0. 15

Source: VNFOREST, 2013; Phan 2014

Decline in forest quality

Natural forests which have the highest ecological and environmental values have declined considerably, and have been replaced with monoculture exotic timber plantations and industrial cash crops such as rubber and coffee.

According to the National Forest Inventory and Monitoring Assessment Program report, phase III, two thirds of the natural forests in Vietnam are considered poor (with volumes below 100 m3/ha); rich and medium forests only account for about 4. 6% of the total forest area and are found mainly in the high mountains and remote areas. Natural mangrove and *Melaleuca* forests in the coastal delta, which

have an important role in maintaining biodiversity and environment protection, have almost disappeared. Rehabilitated natural forests with high timber volume can only be found in small and fragmented patches. Forest quality and biodiversity are continuously in decline. In the period from 1999 to 2005, primary forest and secondary logged forest decreased by about 10. 2% and 13. 4%, respectively (FIPI 2005). The large number of natural forest areas in Central Highlands, South East and North West were destroyed during the period of 1991-2001 (FIPI 2005, Tran, Nguyen et al. 2006).

Natural forests have been reduced in quality, and are mainly for left as forests that are of special use and protection forests in the high mountains and remote areas. Primary forests declined from 384, 000 ha in 1990 to 187, 00 ha in 2000 and to 80, 000 ha in 2010 (FAO 2006, FAO 2010), which is about 0. 25 % of total land area (RECOFTC 2014). Total area of natural production forests is 3. 145 million hectares in 2006, of which 79-80 % is poor degraded forests and young regeneration with low volume (de Jong, Do et al. 2006, Tran, Nguyen et al. 2006). Watershed natural forests and mangrove forests are severely degraded too.

Plantations have increased rapidly recently both in area and volume. This has significantly contributed to the nation's forest cover and timber for domestic consumption and export. However, major areas of commercial plantations

are exotic monocultures of *Acacia* and *Eucalyptus* with possible ecological problems (Phan, Lamb et al. 2013).

1. 2. Causes of forest degradation

1. 2. 1. Direct causes

According to Vietnam State Environment Report 1998 on Deforestation and Forest Degradation, major causes of deforestation in Vietnam include over logging, shifting cultivation, conversion to agriculture, spontaneous migration, war and conversion to other land uses (Ministry of Science Technology and Environment 1998). The contribution of these causes to deforestation in each ecological region are shown in table 4.

Table 4 Causes of forest loss by economic-ecological region (%)

	Over logging	**Shifting cultivation**	**Conversion to agricultural land**	**Free migration**	**War**	**Conversion to other land uses**	**Total (100 %)**
Northern Basin	12		17	41	9	21	100
North East	27	29	11	7	8	18	100
Central North	29	27	16	9	5	23	100

North West	11	36	12	11	3	27	100
North Central	34	21	14	6	14	11	100
South Central Coast	28	17	11	9	29	6	100
Central Highlands	31	24	21	5	17	2	100
South Eastern	29	15	13	9	24	10	100
Mekong Delta	19	4	19	21	31	6	100

Source: Vietnam State Environment Report 1998 – Deforestation and Forest Degradation

In general, over-logging and forest clearing for growing crops are the biggest causes of deforestation in Vietnam. It is especially true in North Central, South Central Coast, Central Highlands and South Eastern, Meanwhile, land conversion and shifting cultivation are the main drivers of deforestation in the North West (Ministry of Science Technology and Environment 1998).

In their survey on the causes of forest degradation of 42 forest rehabilitation projects in 2006, de Jong et al. have

defined the most frequent causes are logging, grazing and fire (Table 5) (de Jong, Do et al. 2006). This is in line with reporting of Ministry of Science, Technology and Environment mentioned above.

Table 5 Causes of degradation leading to forest rehabilitation projects

Cause of degradation	Prod	Prot	SpU	Total
Agricultural production	5	7	1	13
Fire	1	17	3	21
Forest exploitation	4	5	1	10
Grazing	3	15	3	21
Flood	2	14	3	19
Logging	5	20	5	30
Other	3	6	3	12
Total	23	84	19	126*

* Totals exceed 42 sampled projects because single projects list different causes of degradation

Source: (de Jong, Do et al. 2006)

A further analysis of the major causes of deforestation and forest degradation in Vietnam is given below (de Jong, Do et al. 2006, Tran, Nguyen et al. 2006, MARD 2007, Meyfroidt and Lambin 2008).

** Shifting cultivation and conversion of forests to agricultural crops and industrial trees:*

After the wars and before economic renovation (late 1980s), shifting cultivation was considered as a major cause to deforestation in Vietnam. It is estimated that shifting cultivation and conversion to crops and industrial trees accounted for 50 % of deforestation in Vietnam during this

period (Phan 2014). Summary of total forest areas and reasons of changes for period 2004 - 2008 (Table 6) also reveals that, land use conversion is the biggest major cause of deforestation in Vietnam (Hoang, Do et al. 2010).

Table 6 Change in forest area in Vietnam, 2004 - 2008

(unit ha)

Forest category	2004	2005	2006	2007	2008	Total
Forest land with forest	**12 306 859**	**12 616 699**	**12 873 850**	**12 903 423**	**13 118 773**	–
1. Natural forest	**10 088 288**	**10 283 173**	**10 410 141**	**10 348 914**	**10 348 591**	–
a) Reasons for increase	**161 912**	**215 118**	**112 331**	**59 204**	**32 974**	**581 539**
Natural forest increase	161 912	178 596	74 328	59 204	32 974	507 014
Other forest	–	36 522	38 003	–	–	74 525
b) Reasons for decrease	**53 523**	**35 311**	**35 588**	**85 126**	**63 278**	**272 826**
Legal logging	238	530	120	376	355	1 619
Forest fire	2 141	446	259	697	109	3 652
Insects and disease	–	197	68	58	–	323
Illegal logging	3 061	7 989	6 199	1 694	3 395	22 338
Land use conversion	24 916	15 260	18 449	11 808	23 508	93 941
Other reasons	23 167	10 889	10 493	70 493	35 911	150 953
2. Planted forest	**2 218 571**	**2 333 526**	**2 463 709**	**2 554 509**	**2 770 182**	–
a) Reasons for increase	**205 257**	**158 624**	**195 601**	**178 779**	**203 601**	**941 862**
Newly planted	182 699	154 787	171 444	178 779	174 918	862 627
Others	22 558	3 837	24 157	–	28 683	79 235
b) Reasons for decrease	**43 566**	**35 120**	**39 231**	**45 153**	**45 334**	**208 404**
Legal logging	16 362	19 046	23 194	26 855	35 147	120 604
Fire	3 422	4 818	1 276	1 631	679	11 826
Insects and disease	–	153	71	279	18	521
Illegal logging	600	1 159	2 249	136	502	4 646
Land conversion	10 026	8 237	12 441	4 802	8 988	44 494
Others	13 156	1 707	–	11 450	–	26 313

Source: Hoang et al. 2010

Market economic boom in the 1990s and 2000s including agricultural production dramatically increased the demand for lands for industrial crops such as coffee and rubber with higher incomes . This has caused enormous pressure to convert forestry land and forests to industrial

crops. Coffee area increased from 120, 000 ha in 1990 to nearly 620, 000 ha in 2012 while rubber plantations increased from 250, 000 ha in 1990 to 910, 000 ha in 2012 (GSO 2011 - 2013, Phan 2014). Thus, more than one million hectares of hilly forest land were covered with coffee and rubber trees during this period.

In the coastal areas, conversion of mangroves to aquaculture farming systems was the main driver of deforestation over a large area. Approximately 5% of the total area of mangrove forest was lost each year to other land uses (GSO 2011 - 2013, Pham, Moeliono et al. 2012). In addition, mangrove forest was converted into paddy area with development of irrigation systems the Mekong Delta (Pham, Moeliono et al. 2012).

* *Overharvesting of forests:* After the war, for economic recovery and development, Vietnam conducted massive forest harvest for domestic consumption and export. Harvesting without consideration of forest ecological characteristics contributed to rapid decline in the quality of natural forests. Unsustainable selective logging of natural forest is one of the major reasons for severe decline in forest quality, which resulted in many rich natural forests to become poor secondary forests with few target trees. Weak governance in State Forestry Enterprises which held 4.9 million ha of forests and forestry land (which included the largest area of good natural forests), unsustainable forest

management, and top-down approach from Central Government, were the major causes of forest degradation (de Jong, Do et al. 2006, Tran 2006, Phan 2014).

In addition, illegal logging and collection of firewood also had strong influence on forest resources. According to Castrén (1999), firewood consumed in Vietnam was around 36 million cubic meters in 1992; a large proportion of this firewood was taken from forests. Compared with timber removal, firewood takes a much larger amount of biomass from forest ecosystems. Forest logging is the cause for the loss of about one third of the forest area in forest-rich regions in Vietnam including North Central, South Central Coast, Central Highlands and South Eastern regions (Ministry of Science Technology and Environment 1998).

* *Infrastructure development:* With rapid economic development, huge amount of forest land and forest resources were lost. Irrigation and hydropower projects across the country resulted in the conversion of extensive areas of forests. According to Ministry of Industry and Trade, 50, 000 ha of forest area was lost for hydroelectric dams (Vietnam News 2013). For the use of other infrastructure works such as road systems and electric power transmission poles, thousands of hectares of forest were cut down (Pham, Moeliono et al. 2012).

Wars: War is not only the direct cause but also the underlying cause of biodiversity decline in Vietnam. From

1961 to 1975, 13 million tons of bombs and 72 million litres of toxic chemicals were sprayed mainly in the south of Vietnam, which destroyed about 2.2 million hectares of forest (Phung and Le 1994). This resulted in the e national forest area to decline to about 9.5 million hectares, of which 10% was primary forest. The consequences of toxic chemicals sprayed by the U.S. army severely affected biodiversity as well as other ecosystem services of forests (Phung and Le 1994).

Forest fires: Forest fire is a significant cause of forest loss and degradation of forest resources. Forest fire negatively affected wildlife on a large area and also resulted in erosion and floods. According to the Department of Forest Protection, 7, 380 forest fire cases occurred with 48, 837 ha of forest destroyed during the ten year period (2002 - 2011) (VNFOREST 2014).

Figure below shows the area of forests destroyed annually from 1995 to 2010 (GSO 2014).

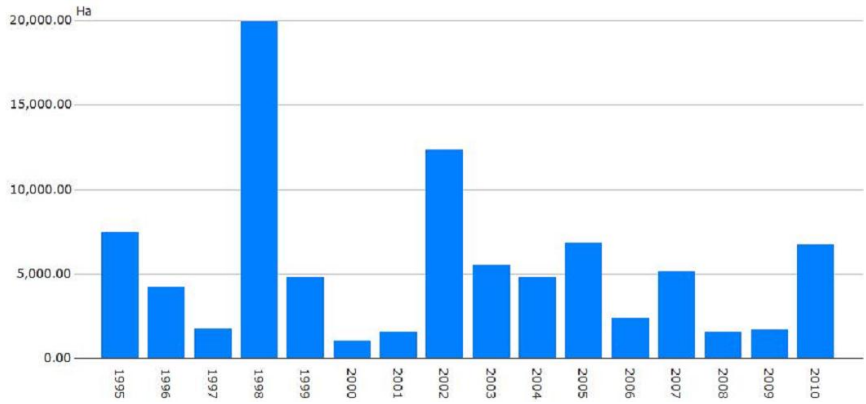


Figure 4 Forest area destroyed by fires in the period of 1995 - 2010

(Source: GSO, 2014)

1. 2. 2. Underlying causes

Pressure of poverty and high population: Vietnam's population is estimated to reach 100 million by the year 2020. This is an increase of four times from 20. 9 million in 1941. Rapid population growth and the limited farming land placed extremely high pressure to open up more forest land to meet the increasing demand for food and shelter. Mountainous areas in the North with natural forests were deforested. After the war, Vietnamese Government issued immigration policies to encourage people to migrate to the regions with lower density of population, rich natural resources and fertile soil in the South. Since early 1980s, the Government issued Decision 95 - CP (Goverment

Committee 1980) to encourage migration and establish new economic zones in remote areas where forest resources were, especially the Central Highlands (Phan 2014). These immigrants cleared forests for farming land (Dinh 2005, FAO 2010). In addition, a large number of free immigrants also caused deforestation in the mountainous regions (Tran 2006, Phan 2014).

Economic development policies: Economic growth based on exports of cash crops of coffee, rubber, cashew, pepper, and increasing demand for wood and timber from the wood resulted in conversion of the natural forests. For example, the Ministry of Agriculture and Rural Development issued circular 127/2008/TT-BNN for planting rubber on forest land (MARD 2008). This policy resulted in the conversion regenerating natural forests into rubber plantations in the Central Highlands and other provinces (Phan 2014). Policies to promote development of timber plantations for building the export-oriented wood industry also had negative impacts on natural forests . For achieving the economic growth targets, local governments of several provinces allowed conversion of natural forests into industrial plantations. Natural forest area shrank, and is continuing to do so with recent conversions to other land uses. It is the same with the policies which drove economic growth to from harvest of natural resources in an unsustainable manner, as was the case with the construction of infrastructures for economic development including

hydropower, mining and transportation also reduced forest area in Vietnam (Pham, Moeliono et al. 2012).

* *Institutional weakness, low law enforcement and financial shortage*: Forestry management system is well structured and built from grass roots level to central Government (de Jong, Do et al. 2006, Tran, Nguyen et al. 2006, Pham, Moeliono et al. 2012). However, the quality forest management system in localities is not good, especially at the commune level, where direct land management and forestry production activities are implemented (Pham, Moeliono et al. 2012). Due to many reasons, including low capacity and lack of economic incentives the commune-level agricultural-forestry staff often find it difficult to meet the requirements of forest management in their commune. At the same time, the local forest rangers who play essential roles in forest protection and management in the field do not fulfil their duties , and have been found to be corrupt as well (Sikor and To 2011).

Failure to follow the legal instructions on forest protection and management is one of the serious problems leading to forest degradation in Vietnam. Deforestation, shifting cultivation, and conversion of forest land into other agricultural crops and industrial trees have been occurring in manyplocalities. This has been amplified as a result of poor enforcement of the law and lack of awareness, corruption,

overlapping regulations, and low penalties (Sikor and To 2011, Phan 2014).

On the other hand, database systems for forest management including GIS data are not accurate, with overlaps in entities (e. g. different mapping systems for natural resources and environment sector and forestry sector). Moreover, the complicated history of land use including encroachment of state enterprise land , hand written land trading contracts, and inherited land make it difficult for the forest management and forest land management to achieve good results (de Jong, Do et al. 2006, Pham, Moeliono et al. 2012).

Finance: Under Decision 02 - CP of the Prime Minister, millions of hectares of forest land of state forestry enterprises and forest management boards were patrolled by local farmers under contracts with these entities. Initially, farmers received only 50,000 VND per hectare per year for forest management and protection, but it has recently been increased to 200,000 VND. This is too small to be an incentive for effective forest protection and management compared to the much higher economic values for growing monoculture industrial plantations and other crops (de Jong, Do et al. 2006, Pham, Bennett et al. 2013, Phan 2014) . The lack of resources for forest management and protection is also a major issue of the forest management boards, national parks and conservation zones. The number of personnel and

the budget allocated to the forest management boards are often lower than needed, making them ineffective in protecting and managing the forests (de Jong, Do et al. 2006, Phan 2014).

1. 2. 3. Impacts of deforestation and forest degradation

It is challenging to estimate the economic effects of deforestation and forest degradation. The available data in Vietnam currently can hardly give reliable estimation of the direct impacts on forest timber production and other non timber forest products, the negative effects on forest resilience against natural disasters (floods, droughts, storms, pests and diseases), and the reduced values of forests on protection of water catchment, hydropower, and irrigation dams etc. Since 1980, Vietnam has suffered a series of major disasters among which floods and droughts have severely affected human lives and property. Statistical data showed that on average, natural disasters killed 519 people per year and caused losses of about USD 256 million per year during the period 1980 – 2010 (PreventionWeb 2014). Soil erosion has reduced the life time, and increased the maintenance expenditure of the irrigation systems and hydropower, and decreased the stable power supplying capacity due to the irregular water supply to reservoirs. Forest resources play an important role in regulating the water supplies throughout the year, maintaining water levels at reservoirs during the dry season for irrigation and

minimizing floods during rainy seasons (de Jong, Do et al. 2006, Phan 2014).

Deforestation increased the impacts of the severe droughts in the Central Highlands in 1995 and throughout the country in 1997. Those droughts had serious impacts on agricultural crops and industrial tree plantations. Thousands of hectares of coffee plantations in the Central Highlands were destroyed due to irrigation water shortage, a direct consequence of deforestation and forest degradation (de Jong, Do et al. 2006, PreventionWeb 2014).

Deforestation and degradation have destroyed wildlife habitats. This is one of the main reasons of population reduction and possible extinction of many wild species. The endangered species in the Vietnam Red Book increased to 167 species in 2007 compared to the number of listed 1992. Vietnam witnessed a rapid reduction in populations of many rare and endangered species, and even possible extinctions of some. Unsustainable or illegal forest logging has led to overharvest of many high value timber species and NTFP, and some driven to the point of extinction (Ministry of Science & Technology 2007, Phan 2014).

Chapter 2. Policy and Techniques for Natural Forests Rehabilitation in Vietnam

2. 1. Forest rehabilitation policy in Vietnam

Initial efforts of forest rehabilitation and planting of scattered trees in Vietnam started in the late 1950s. The General Department of Forestry (later Ministry of Forestry and now Ministry of Agriculture and Rural Development) implemented five major programs, two of which were national programs of afforestation and national program of forest protection (Sikor 1998, Nguyen 2005).

Policies and forest rehabilitation activities should be understood in the context of the role of forestry and agriculture sector in socio-economic development of the country.

The Vietnamese Government prioritized forest rehabilitation and institutionalized in many types of legal documents listed in Table 3. 1 These documents related to policy, regulations, guidelines, rules, technical procedures about forest management and rehabilitation. This section discusses about some important issues related to rehabilitation policy in Vietnam.

Natural Conservation National Strategy 1984 is a significant proof for Vietnam's commitment to forest restoration, increase of forest cover to improve and protect soil, water resource conservation and flood controlling. This

is the result of high awareness of how the upstream forest loss threats to the economic development in the lowland delta and coastal plain.

Forest protection and development law was first promulgated in 1991. This law presented key objectives of forest rehabilitation and biodiversity conservation in Vietnam as below:

- Increase of national forest coverage to 40%

- Forest rehabilitation for 6 million hectares

- Establishment of 2 million ha of special use forests

This law was amended in 2004. The most significant change is area of forestry land. Under this law, the total planning area of forest land was more than 16 million hectares instead of 19 million hectares in the planning in the past. Land Law at 1992 was also amended in 2003. In which community (village) is recognized as a legal entity and can be allocated forests, forestry land for utilization, management and protection. Decree 02/CP of Vietnamese Government created opportunities for people to have more rights about forest land, including harvesting and utilization of most forest products. These rights also consist of exchange, transfer, lease, mortgage and inheritance of allocated forests and forestry land. Forestry land is allocated with a period of 50 years. The purposes of the allocation of forests and forestry land were protection and restoration of

forest cover in the mountainous areas and forest contribution to improve livelihoods and environment. Therefore, forestry land which was allocated to different entities must be used for forestry purposes. It means that after harvesting land has to be reforested. Other important legal documents related to assigning forestry land under the form of allocation was Decree 01/CP. According to this decree, state enterprises are encouraged to have forests and forestry land management contract with families and individuals. Most of the natural forests are managed by state forestry enterprises and state forest management boards. Under this decision these forests are contracted with local households and individuals for protection. Farmers are get paid VND 50,000 per ha per year for protecting forests and allowed to harvest non-timber forest products and fire wood. Timber logging and forest conversion to agriculture land are prohibited.

Decree 163 was issued in 1999 to replace decree 02 stipulates more details on allocation and leasing forestry land. This is the first time that forests and forestry land lease is indicated. This brings income opportunities for organizations, families and individuals who have demand and ability to use forestry land. It was also defined the rights and obligations of the parties more clearly in forest management, utilization and protection. Legal documents which are for guiding the implementation of the land law in 2003 as decree 181, decree 197, decree 182 and decree 198

stipulates related issues to the rights and obligations in different land uses including forestry land and forests.

Prime minister's decision 245 stipulates the responsibilities of the authorities in the forests management. It then amended by the decision 186/2006 of the Government on forest management policy and regulations. Decision 178 of the Prime Minister in 2001 is considered as a breakthrough in forestry policy in Vietnam. This is the first time benefit of households and individuals in forest product utilization are defined particularly and in detail. This decision created incentives for entities allocated forests and forestry land to manage and develop it more effectively. However, the regulations defined in decision 178 is very general and difficult to implement. Ministry of Finance and the Ministry of Agriculture and Rural Development issued the joint Circular No. 80/2003/TTLT/BNN - BTC dated 03/9/2003 guiding the implementation of Decision 178. In which it define forest beneficiaries, benefit sharing mechanism for allocated and leased forests and forestry land.

In general, legal systems and policies for forest rehabilitation in Vietnam is relatively comprehensive and complete. These policies relate to all aspects of land use rights, benefit sharing, supporting techniques and finance incentives to forest owners and has significant impacts on forest rehabilitation in Vietnam. However, a number of

policies are overlapped in the legislation system, sometimes conflict with each other. It limits of forest restoration effectiveness in the country. It is necessary to re-evaluate and amend policies to improve this situation.

a. Policies relating to rehabilitation

According to Nguyen Ngoc Lung (1998), forest management policy in Vietnam until the late 1990s could summarized in the following:

From 1945 to 1995

Along with the establishment of agricultural cooperatives, the majority of forests were nationalized and were under the management of cooperatives and state bodies. The forest management of the cooperative focus mainly on logging of forests for timber and land for growing food crops. In 1961, Government's Directorate of Forestry was established. Improvement of forestry production, including strengthening of forestry production entities, their management, as well as the increase number and area of forests and forestry enterprises managed by the state (later called the state forestry enterprise). Then, state forestry enterprises were established in many districts. Although it was a business entity, forestry enterprises acted as both a comprehensive enterprise and a state management agency on behalf of the Forestry County (MoF 1991 Nguyen Ngoc Lung 1998).

Forest policy was "the foundation for the development of agriculture" and to harmonize agriculture and forestry productions. Beside other forestry activities, it was necessary to monitor properly reforestation on bared land which was cleared by slash and burn (shifting cultivation). The shifting cultivation could be replaced by other methods of production, especially in the form of state-owned forestry production or cooperatives. Governmental body which was responsible to these goals is Directorate of Forestry under the direction of the Council of Ministers (MoF 1991).

From 1965 to 1975

Administrative framework of Vietnam during the period 1965 to 1976 was characterized by central planning and attempt to support country's liberation in the South. Agricultural policy emphasized cooperation and production of the mountains. Agricultural production must be intensive. Cereal production and industrial crops was increased due to the high investment in paddy rice production.

As in the previous period, forest policy focused on increasing productivity output, supporting agriculture and industrial productions (protection upstream forests) and also increasing production of timber and non-timber forest products.

Logging was limited. However, due to lack of infrastructure and labor, the storage conditions were not

good for harvested timber. It resulted to high damage of timber by fungi and insects. In 1968, local authorities had assigned more roles in the forests management. Directorate of Forestry became more consultative. Most industrial timber facilities were transferred to Directorate of Forestry during that time. A parallel organization, "the People's Ranger units", was established at the provincial and district level (MoF 1991).

Forestry activities were conducted in the state sector under the leadership of the local authorities. The national supervision of forestry production was strengthened by the establishment of forestry agencies as well as the promulgation of the first forestry law in 1975 (Forest Protection Ordinance 1975). This Ordinance consisted of regulations on forest management, reforestation and pests and forest fires control. Strengthening forest management aimed to enhance important role of upland development. Directorate of Forestry was upgraded to Ministry of Forestry in 1976 (MoF 1991).

From 1976 to 1986

After the Vietnam War ended in 1975, policy and administration systems were built on the basis of "collective ownership". Autonomy administration was abolished. Agricultural policy focused on increase crops with market values. Attempts were made to encourage the output both cooperative and state sectors. New approaches were piloted

such as allocation of agricultural and forestry land for "stable" production and agroforestry production.

In 1976, the Ministry of Forestry was established and lead forestry sector. The aims of forestry policy is to increase production and serve national defense. The majority of forestry production activities were managed by the state. This caused over-logging of forests because annual logging quota was based on the need of the state, not based on the forest production capacity (MOF, 1991). Increasing income by cash is the decisive ideology of all economic sectors as well as forestry in late 1970s and early 1980s. However, until the mid-1980s, that view for forestry sector was changed. The natural environment had been destroyed to the level that it was easy to see that "monoculture planting with industrial crops and intensive and intercropping system can not protect forests" (Ministry of Forestry 1985). In the management, protection activities were then emphasized. Since majority of forest land located in the mountainous areas where most ethnic minorities settled. Policy makers began to pay attention to policies relating to ethnic minorities. Especially unity among ethnic groups was put in the policy of the ethnic guidelines, No 29-CT/TU/1984 about strengthening forest land allocation and construction and agroforestry organizations (Ministry of Forestry 1984).

From 1986 to 1990

Since 1990, Vietnamese government began renovation economy policy which transfer central planning into market economy. Decentralization, especially in production and trade sectors, increases the role of local governments, provinces and districts, in planning and decision making.

Structural transformation process also extended to the agricultural sector. The government decentralized agricultural cooperatives and allocated most cropping land to farmers to use within 25 - 50 years. Cooperatives were reformed to carry out service functions mainly. At the same time, the market consumption were expanding. These lead rapid growth of agriculture sector. In particular, rice production increased rapidly and Vietnam has become one of the major rice exporting countries.

In this period, the goal of forest policy was not only expansion of plantation areas by state forestry enterprises, organizations and households (SPC / UNDP, 1990) but also sustainable use of forest resources. Developing timber processing industry linked closely to facilitation program of forestry product exports. Forest protection program is mainly conducted in mountainous highlands for upstream forest protection (MOF, 1991). The program was a continuous step of Forestry Ordinance 1975 and then was detailed in the regulations in 1987 related to the protection

of forests (Circular No. 1171/QD 1987). Other major forest programs were training and education was associated with national forest research and forestry extension (MOF, 1991).

Major changes were in management of state forestry enterprises. The state businesses had more financial autonomy than before. Government's subsidies to the enterprises was gradually cut. In general, forestry production was transferred from enterprises and cooperatives to contracted households and individuals.

In 1991, forestry sector proposed a new approach "social forestry". Social forestry development in the administration framework at that time is to allocate forestry land allocation to other sectors (from 1983) and to cooperatives, schools, military units and households (from 1986). The implementation of forestry land allocation also encountered many difficulties due to "technical limitations" (To Dinh Mai, 1987).

Agroforestry was one of most encouraged model (Nguyen Ngoc Binh, 1985; Ministry of forestry, 1987; Fingleton, 1990). Forests were officially recognized as resources for indispensable products for local people, and also an important resource for "socialism development" and the country's economy (Le Hong Tam and Nguyen Quoc Hung, 1991; Dinh Mai, 1991).

Table 7 Forest rehabilitation policies

Number	Date	Title	Promulgation body
Decision 179/CP	12/11/1968	Policies for forestry cooperative	Minister Council
Decision 129/CP	25/5/1974	Policy for cooperatives expanding areas for developing agriculture and forestry in midland and mountainous areas	Government Committee
Directive 257/TTg	16/7/1975	Promoting reforestation and forestry land allocation for cooperatives	Prime Minister
Decision 272/CP	3/10/1977	Policy for cooperative expanding areas for developing of agriculture, forestry and new economical zones and implementation of permanent farming and permanent settlement	Government Committee

Number	Date	Title	Promulgation body
Decision 682B/QĐKT	01/8/1984	Norm for designing forest management (QPN6-84)	Ministry of Forestry
	1995	Biodiversity Action plan	
Circular 01-TT/LB	06/02/1991	Instructions on forest allocation and forest land for plantation for organizations and individuals for forestry purpose	Inter-ministerial circular
Law	1991	Forest Protection and Development law	National Assembly
Law	1993	Land Law	National Assembly
Decision 200/QD/KT	31/3/1993	Norms for technical procedures applying for production timber and bamboo forests (QPN 14-92)	Ministry of Forestry
Decree 22-CP	09/3/1995	Regulations on forest fire prevention and control	Government

Number	Date	Title	Promulgation body
Directive 286/TTg	02/5/1997	Enhancing critical approaches for forest protection and development	Prime Minister
Decision 661/QD-TTg	29/7/1998	Objectives, missions, policies and arrangement for implementation of five million hectare afforestation project	Prime Minister
Decision 175/QD-BNN-KHCN	04/11/1998	Norms for forest restoration by zoning and promoting natural regeneration combining with enrichment planting	Ministry of Agriculture and Rural Development
Decision 245/QD/TTg	21/12/1998	State management of forest of governmental levels	Prime Minister
Decision 02/1999/QD-BNN-PTLN	05/01/1999	Regulations on timber and forest product harvesting	Ministry of Agriculture and Rural Development
Decision	12/3/1999	Regulations on	Ministry of

Number	Date	Title	Promulgation body
47/QD/BNN-KL		inspection of transportation, production and trade of timber and forest products	Agriculture and Rural Development
Circular 56/TT/BNN-KL	12/3/1999	Instructions of development of village regulation on forest protection and development	Ministry of Agriculture and Rural Development
Directive 24/CT-TTg	18/8/1999	National land and land use inventory in 2000	Prime Minister
Decree 163/ND-CP	04/11/1999	Temporary regulations on approval of forest protection, zoning and promoting natural regeneration combining with enrichment planting, planting and tending of plantation	Ministry of Agriculture and Rural Development

From 1991 to now

Along with the overall reform program, the Vietnamese Government also carried out restructure steps

with close collaboration with international donor community. The process began in 1989, when Vietnam joined Action Plan for Rainforest funded by Food and Agriculture Organization of the United Nations (FAO). The first step of this process is the overall assessment of the forestry sector. This work "National Forest Action Plan (NFAP)" was completed in 1991. The evaluation process was important because it is an opportunity for international and Vietnam experts work together to review entire status of Vietnam's forests and the guiding principles for forestry development. The principles were management decentralization, people participation, rearrangement of forestry agencies to support local activities, environment protection and increase of production and income of people living in forest areas.

Action Plan also presented a list of projects and necessary expenditures. NFAP had been supported by a series of legal documents, laws which approved by Congress, decrees and directives issued by the Prime Minister, regulations, guidelines or circulars issued by the related ministries. Provinces also issue specific guidelines to implement directives, regulations and circulars for development program of the forestry sector.

1990s were milestone for the recognition of the natural forests degradation, policy and practice efforts in order to solve this problem. Government's investment

enlarging created an important change in the management structure.

General assessment of the institutional framework and policy on forestry restoration

The difficulties and challenges (Nguyen Ngoc Lung 1998).

+ Policies on forest rehabilitation are not synchronized

The law enforcement and legal practice were not good

- There are much bureaucracy and cost for land allocation paperwork

- Financial policy: limited state budget is not adequate with the objectives and tasks; loans are less attractive because of high interest rates, short repayment period while the forestry business rotation is long time. Forestry production faces many risks, difficult economy – social conditions in mountainous areas and infrastructure limitation.

- Science and technology policy, especially forest tree breeding. Forestry extension is not good.

- Lack of policies to attract labor and facilitate forestry training. Income in rural mountainous areas is low while many other living conditions are difficult.

Mountainous rural people mainly work for their daily needs and less concerned about forests and forestry production.

- The benefit sharing policies are inadequate, insufficient motivation for local people

- A number of unnecessary transactions across multiple levels

+ National forest rehabilitation program is large but institutional framework for conducting it is weak such as land demarcation and allocation, planting species composition, capital etc., while the program carries out in disadvantaged areas, low education, and slow economic growth.

+ Forestry sector goals comply with real and emerging demanding of the country but implementation is inadequate.

c. Recommendation

- Defined goals of sustainable forest development program need to be stable in a certain long period about at least 15 - 20 years

- Land use planning and demarcation project should be transparent, sufficient legal basis and comprehensive participation of the parties, especially people directly received forestry land.

- Forestry planning, especially forest owners, need market research with reliable and update information.

- Project development must have feasible goals and reality

- Capital assist needs to be adequate with long term forestry production

- Tree breeding improvement and seeds are need to be qualified for growers

- Appropriate control of pests and disease and forest fire prevention.

- Forestry system organizations from the central to local levels must be strengthen to meet management requirements.

In general, policies and other socio-economic solutions had significant impacts on restoration of natural forests in Vietnam. Achievements of forest rehabilitation before 1990 are not documented well. From 1993 to 2011, 02 national - large programs on forest rehabilitation and sustainable forest management, 327 and 661, were conducted. More than 1 million hectares of natural forest were restored and regenerated under Program 327 (Tran Van Con, Nguyen Xuan Quat et al. 2006). 803,000 hectares of protection and special use forests were established in the 5 million hectares reforestation program (Ministry of Agriculture and Rural Development, 2011).

2. 2. Forest restoration techniques

While some degraded ecosystems capable to recover naturally, some others are not able to recover, due to limitations. Even in areas where natural recovery occurred, the recovery was slow. That thing caused increase of recurrence degeneration or degeneration once again. Human intervention may be necessary for the recovery process to begin or boost the speed of recovery occurs more quickly (Lamb, 2011).

A variety of different approaches that can be used including ways for the purpose of restoring the original ecosystem and restoring biodiversity and the simple purposes which used the land for agriculture or forestry (Lamb, 2011). Different approaches have increased the confusion of terms. The difference between the two terms is especially term restoration (Restoration) and rehabilitation (Rehabilitation) which is given in this report are quoted in Lamb (1999).

Restoration is used only in the case which intents to recreate ecosystems which have nearly similar characteristics to the original ecosystem once existed in that place.

On the other hand, recovery is used in place with ecological or commerce reasons, more introduced species need added into the next generation. That thing may be because only introduced species such as acacia (Acacia) can

withstand in current soil at the degraded site. They are necessary role as the plants produce nutrients in order to facilitate more, for the introduction and development of the primitive native species. Or may be an immediate economic request which demands some timber species, agricultural crops. They are included to demonstrate the restoration effort (Lamb, 2011).

The term rehabilitation is used in cases without using any native species. In such case there will be no direct benefit about the biodiversity of the area but there may be significant social advantages or other benefits such as watershed protection. The differences of approaches is that they can allow the original biodiversity to recover. Generally, these approaches aimed to establish and strengthen sustainable land use (Lamb, 1999).

It is possible to divide forest rehabilitation solutions in Vietnam into two groups: (i) Reclamation[1] and Reforestation/Afforestation; and (ii) Restoration of natural forests.

For forest restoration, the expression "forest zoning and maintenance" which is similar to “passive reforestation” (Lamb and Gilmour 2003, Lamb 2011) was introduced into government policies since late 1950s until 1980s. By the late 1980s, this expression was replaced by the term “forest

[1] *Reclamation: Clear high degraded natural vegetation and replant by forest trees*

zoning, maintenance and promoting regeneration" (shortened as forest zoning and promoting regeneration) which has been considered a change in scientific understanding of forestry sector for forest restoration, focusing on regenerating biological resources by promoting natural succession (Tran, Nguyen et al. 2006). Achievements from the study of forest restoration during this period were regulated in technical rules including "Norm of silvicultural techniques for timber forests and bamboos" (QPN 14-92), and "Norm of forest restoration by forest zoning, promoting regeneration and enrichment planting" (QPN 21-98) (Ministry of Forestry 1993, MARD 1998). These legal documents were breakthroughs in technical instruction and standardization for forest restoration and regeneration. However, they contained inadequacies in application with regards to the socio-economic circumstances in different regions (Tran, Nguyen et al. 2006, Phan 2014).

Based on these two regulations, techniques concerning reforestation and restoration of natural forests have been clearly specified for: (i) logging and regeneration; (ii) forest maintenance; (iii) forest enrichment; (iv) promoting natural regeneration; (v) forest zoning for passive restoration, and (vi) reforestation/afforestation and reclamation. Among the technical solutions for natural restoration and reforestation according to regulations QPN

14-92 and QPN 21-98, there are three restoration approaches as following:

i) Forest maintenance is defined as sivilcutural techniques for reasonably adjusting the density and forest structure at each succession stage. The importance of this technical solution is to fell diseased trees, poor-quality trees, or trees (liberation fellings) that block commercial tree growth in order to increase the forest's productivity, quality and shorten the harvesting rotation. Those sivilcutural practices have been regulated in QPN 14-92 (Ministry of Forestry 1993). However, natural forest managers often did not strictly follow introduced technical regulations. This was due to the lack of implementation funds or unavailability of enforcement on forest managers (Tran, Nguyen et al. 2006).

ii) Forest enrichment: This technical solution is to plant native tree species in severely degraded natural forests. This approach has two important technical matters: (i) species selection, and (ii) silvicultural techniques for planting, tending and protecting. In practice large scale forest enrichment did not often succeed. The major causes were reviewed such as unsuitable species selected, short tending time, only 2-3 years after enrichment planting was conducted. The enrichment species were mostly native timber trees with slow growth rates at initial stage, they could not compete with the competing regeneration in situ. Pilot forest enrichment models or research plots are often

successful owing to the thorough tending (Tran, Nguyen et al. 2006, Phan 2014).

iii) Promoting natural regeneration

Promoting natural regeneration in Vietnam can be considered as a derived solution of passive restoration (Lamb and Gilmour 2003, Lamb 2011), of which the major technique is to protect the forests from human interventions and natural incidents such as logging, firewood collection, grazing, and forest fires. In some cases, particularly for natural production forests, it is also combined with additional silvicultural practices such as removing creepers, undesired trees, growing regenerating targeted trees evenly distributed in the stand, direct seeding etc. However, the application of these techniques resemble enrichment planting. Below are some technical criteria to define natural forests applicable to restoration by promoting natural regeneration under Vietnam's technical guidelines.

Table 8 Subjects of forest restoration by of natural assisted regeneration

A. Timber forests 1. Degraded forest due to over harvested 2. Abandon forestry land after crop cultivation 3. Grasslands with timber trees, soil depth more than	Degraded forests should have at least one out of three following criteria: - Regenerating targeted saplings with height over 50cm > 300 saplings per hectare

30cm	- Base stump for regenerating shoots with even distribution in the stand and quantity > 150 stumps per hectare - Seed trees at the stand and even distribution with quantity of > 25 trees per hectare or available neighbour seed trees.
B. Bamboo 4. Restoration after logging or crop cultivation	Bamboo cover > 20% of the area with even distribution in the stand.
C. Critical and highly critical protection forest 5. Remote area without afforestation and enabling conditions in next 10 years.	Vegetation cover and shrub and grasses > 40%, height is more than 1 m.

Source: (Ministry of Forestry 1993, Tran, Nguyen et al. 2006)

Despite the highly detailed regulations, some technical norms of these legal documents still lack scientific basis, are conservative and/or do not take into account well known best practices that have emerged from research worldwide, including Vietnam. Therefore, a number of technical norms

do not fit with ecological and productive characteristics of natural forests and local socio-economic conditions. A typical example of this technical regulation is that logging intensity of conventional selective logging allows for up to 45% of forest volume, canopy cover after logging can be reduced to at least 0.4; and gap area below 1,500 m^2. These norms are far more adverse of the ecological thresholds which can allow natural forests after logging to recover to their original status (Phan 2014). Logging norms have to be adjusted according to forest structure and density of the stand (Sist, Fimbel et al. 2003).

Additionally, there are dozens of ODA international projects being piloted in large areas of forest restoration based on experience from other countries. However, extension of successful models have not been achieved yet, and so their positive impacts on forestry planning or forestry extension are limited (Phan 2014).

Reforestation/afforestation and reclamation is one of the greatest successes of Vietnam forestry sector in recent years. Before 2000, afforestation and reforestation were given first priority by the Government but the success rate was low for many reasons. The causes include low investment, poor quality of seeds and seedlings, unfamiliar silvicultural techniques, low incentives for farmers for growing trees, abundant timber resources from natural forests, and especially undeveloped timber market (de Jong, Do et al. 2006, Phan 2014). Since early 2000, plantation area

has been rapidly increased in Vietnam, with the small-holders contributing substantially in their establishment. Short rotation plantations of *Acacia* and *Eucalyptus* are the main source for chip-wood exports, in which Vietnam ranked as the biggest country over the last two years (Phan 2014).

Policies, techniques and socio-economic solutions have had decisive effects on natural forest restoration in Vietnam. The results from forest zoning and maintenance before 1990 had not been well documented. Since 1993, two major programs, 327 and 661 have been carried out. Over 1 million hectares of natural forest have been restored under 327 program (Tran, Nguyen et al. 2006). Meanwhile, the 5-million hectare project (program No. 661) has completed restoration of 803,000 hectares of protective and special use forests (MARD 2011).

2. 3. Effectiveness of rehabilitation measures

There has not been any comparative study on economic effectiveness of different forest restoration strategies. Some studies assessing economic values of forest types only focused on traditional forestry values (timber and NTFP). Estimations of forest growth, especially of natural forests, from the studies were not reliable, and thus the results have limited applicability (Phan 2014). Forest ecosystem services have been given additional attention in Vietnam recently (Hawkins, To et al. 2010, Pham, Moeliono et al. 2012,

Pham, Bennett et al. 2013) . Forest environment service fees were calculated and many hydropower stations, irrigation companies, clean water suppliers and ecological tourism services have been charged. Total revenue from forest ecosystem service fees during 2009 – 2013 was ≈ VND2850 billion (≈ USD135 million) (mainly from hydropower). The fees obtained for 2012 and 2013 were over VND 1,000 billion annually (VNFOREST 2014). Thus, in addition to traditional forest product values, it is financially valuable to invest in forest restoration, development, management and protection (VNFOREST 2014).

However, the time gap between payments for forest ecosystem services and restoration efforts are exist, which does not encourage forest managers and owners to restore natural forests with much higher ecological values other than afforestation with monocultures of exotic species. Unless, fees for other ecosystem services such as carbon sequestration, biodiversity, genetic conservation are available, natural regeneration forests and restoration approaches would not able to compete with afforestation and commercial plantations in Vietnam. The low forest ecosystem service fee paid for farmers in some localities in Vietnam (i.e., Son La province) makes it much less attractive for natural forest maintenance and protection over conversion into other land uses such as agricultural crops and industrial tree plantations (Pham, Moeliono et al. 2012).

In conclusion, it is important to find out a compromise point to achieve best possible values among forest restoration strategies. If ecological and environmental values of forests are completely quantified and highly recognized in the climate change context, there may be more chances for natural forest and landscape restoration due to their advantages of ecological values compared with the monoculture plantation

Chapter 3. APFNet project

3. 1. Introduction

The project of "Demonstration of Capacity Building of Forest Restoration and Sustainable Forest Management in Vietnam" sponsored by Asia-Pacific Network for Forest Rehabilitation and Sustainable Forest Management (APFNet) was implemented from September 2010 to December 2012 in Phu Tho province, Vietnam. The general objective of the project is to maximize contribution to livelihood improvement for local communities by enhancing economic and ecological values of degraded secondary forests in Phu Tho province, Vietnam (Forestry Department of Phu Tho, 2010).

The approach of this project is applying the best practices of natural forest restoration of Vietnam including silvicultural techniques and forestry community development. The best techniques consist of species selection, planting and tending. Project's participatory communities are the poorest ethnic minority communities in Phu Tho province with poor farming practices, therefore, forest restoration have been designed in the simplest and easiest way. These straightforward approaches are potential for expanding to other localities after project ending.

The biggest pressure on natural forest resources in project communities is shortage of land for cropping, while degraded natural forest is mainly protection forest which

people are not allowed to convert into production forest. Hence, the model of forest restoration should also ensure to provide direct income sources for the local people in both short term and long term. Indigenous and high value timbers which are suitable for forest enrichment in the areas and non-timber forest products species which are able to plant under the forest canopy are selected got model establishment (Forestry Department of Phu Tho, 2010,).

3.2. Forest status and natural, socio-economic conditions of APFNet's project areas

APFNet's project carried out in Thu Cuc commune, Tan Son district, and Thuong Cuu commune, Thanh Son district, Phu Tho province. The natural and socio-economic conditions of these communes have a number of key features as follows:

** Geographical location*

Two project's communes are mountainous regions with socio-economic conditions are difficult in Phu Tho province. The communes border with other districts and provinces. In addition, they are primarily inhabited of ethnic minorities such as Muong, Dao and Ray with poor economic and infrastructure conditions and low intellectual level.

** Terrain features*

The terrain has relatively high slope (the average slope between 10 - 20^0C). Area for pilot model in Thu Cuc is high

sloping from middle to the top of mountain. It is difficult for people in establishment of the model and field study at the model in the future.

** Climate and hydrology*

The annual average temperature ranges from 22^0C - 23^0C and the total heat ranges 8,300^{0}C- 8,500^{0}C year. The cold season has Northeast monsoon from November to next March, the average temperature of below 20^0C, and the lowest temperature is in January. The hot season is influenced of Southeast wind, the average temperature of over 25^0C. The hottest seasons are June and July with the hot, dry west wind on April, May and June, the temperature of up to 39 - 40^0C on some days with high evaporation of above 70-80 mm and low humidity.

The average rainfall is 1,826 mm annually. Most rainfall is in the rainy season (in April -October) accounts for 90 %. The highest rainfall ratios is on August and September and often with storm, causing flooding and even flash flooding. The dry season is from November to next March. The average air humidity is 86 %. Annual evaporation is 653 mm per year. Hoarfrost usually occurs in winter during days with temperature below 5°C. Hoarfrost possibly lasts for several days and causes negative impacts on the growth and health of plants and animals.

** Soil*

Soil is formed on complex geological background. Many types of terrains and parent rocks form variety of soil types, including: humus ferralsols on mountains, red - yellow ferralsols soil on low hills, limestone soil, alluvium along rivers in the basins and valleys. Soil is fertile and favorable for forestry farming including timber and non-timber product species.

Forestry land comprises majority, 73 – 85 %, of natural area in project's communities, of the total natural land area. At Thuong Cuu commune, protection forest is four times larger than production forest while people mainly get income from productive forest. The Protection forest is strictly limited in forest utilization. Additionally, cropping land accounts for only 6 % of natural area of Thu Cuc commune and only 1.5% at Thuong Cuu commune. Food security and agricultural production development for local ethnic minority people are challenging.

** Population, ethnic people and labors*

The project areas are mountainous communes and comprise Muong, Dao and Ray people. Muong people account for the majority (82 % of the population of Thu Cuc, 85 % of the population of Thuong Cuu commune).

Total labour force at Thu Cuc is 3,886 people, including 3,585 agricultural workman, accounting for 92.25%. Only 7.75 % people are working in industry and services.

+ Education: All communes have secondary schools. Primary schools and kinder gardens are available in every village. This bring chance for education needs of local children.

+ According to the survey project's communes, the number of households used the national electronic system reaches 70 – 80 % of total households. However, national electric is not avalaible in Sinh Tan village of Thuong Cuu commune, Thanh Son district. Additionally infrastructure is also very limited at this community. Bad road system does not allow access to the village on rainy days.

** Forest status*

The results of system inventory on the forest resources of two project communes, as well as detail survey on project model areas revealed that forests on the project area is severely degraded. Forests have simple species composition and layer structure with the dominance of light-demanding and fast-growing pioneer species. The pioneer species are occupying regenerating tree canopy after shifting cultivation. Large regenerating forests are mixed between timber species, bamboos, scrub, lianas and creepers.

Figure 5 A secondary forest in Thu Cuc commune, Tan Son district

Figure 6 A secondary forest in Thuong Cuu commune, Thanh Son district

Characteristics of canopy layer

The basic forest structure of inventory plots are summarized in table 9 and table 10

Symbols and abbreviations in table 9 and table 10:

Ni: The number of regenerating tree per ha

DBH: The average diameter at breast height

H: The average of tree height

Sd: Standard error of DBH

Sh: Standard error of H

G: Total basal area of tree per ha (m^2/ha)

Table 9 General forest status in Thu Cuc commune

SP	Forest State	Capony cover	Ni (trees/ ha)	DBH (cm)	H (m)	Sd (cm)	Sh (m)	G (m^2/ ha)	Species composition formula
1	Ic	0. 4	230	7. 08	8. 50	2. 12	2. 65	0. 98	44.5 Bumb+25. 74 Bob+21. 94 Bas+7. 82 Lk (2)
2	IIa	0. 5	250	11. 80	12. 74	4. 63	2. 85	3. 14	25. 33Lom+18. 91Bưa+9. 55Bac+Mat+7. 6Dung+5. 63Tram+5. 56Bumb+21. 42Lk(6)
3	IIa	0. 6	200	16. 34	11. 92	3. 82	3. 28	4. 41	18. 92Thb+13. 13Vaa+11. 72Mtr+10. 09Đb+8. 68Bab+7. 99Sog+7. 18Sang+5. 75Trâ+16. 54(4)
4	IIa	0. 6	120	10. 32	9. 75	2. 82	2. 02	1. 07	17. 69Ngat+12. 72Lom+10. 71Deâ+10. 41Khao+8. 71Mo+7. 97Bab+7. 08Va+6. 87Đatr+6. 68Dex+5. 8Bas+5. 37Huđ

5	IIa	0. 5	370	14. 47	12. 09	5. 84	3. 17	7. 04	16. 02Vaa+11. 09Sâ+8. 88Bas+8. 81Dea+8. 61Teon+6. 27Lom+5. 98Bua+5. 94Tramtr+28. 4Lk(9)
7	Ib	0. 3	120	8. 74	8. 25	3. 03	1. 63	0. 80	17. 33Bas+14. 73Mat+14. 7Bob+12. 54Va+11. 52Bab+7. 8Sâ+7. 53Chc+7. 28Thb+6. 58Lom
8	IIa	0. 3	340	9. 51	9. 71	3. 34	3. 13	2. 702	80. 69Bas+6. 67Mat+6. 38Tramtr+6. 25Lk(2)
9	IIa	0. 4	230	6. 94	8. 05	1. 40	2. 47	0. 90	29. 41Bac+12. 69Bab+8. 6Bas+6. 75Bua+6. 69Mutr+6. 14Ngat+5. 39Ngl+24. 33Lk(6)
10	Ic	0. 3	80	8. 72	8. 06	1. 74	2. 06	0. 49	35. 17Bas+16. 69Ngai+13. 03Deâ+11. 7Bac+11. 29Bob
Average			216	10. 83	10. 14	4. 92	3. 22	2. 1	

Table 10 General forest status in ThuongCuu Commune

SP	Forest State	Capony cover	Ni (trees/ha)	DBH (cm)	H (m)	Sd (cm)	Sh (m)	G/ha (m^2)	Species composition formula
1	IIa	0. 5	370	13. 47	9. 24	3. 27	6. 94	6. 629	45. 1Đb+13. 6Bas+9. 1Ngl+ 5. 3Dex+19. 7Lk(9)
2	Mỡ	0. 2	10	-	-	-	-	0. 054	-
3	IIIa1	0. 6	280	21. 66	13. 81	6. 06	30. 48	29. 984	41. 6Chox+13. 4Cal+12. 3Quch+ 6. 3Bab+26. 3Lk(8)
4	IIa	0. 3	120	19. 02	11. 73	8. 31	22. 07	7. 609	32. 7Sâ+26. 1Got+8. 8Cal+8. 7Sug+5. 4Mtr+5. 1Cot+13. 2Lk(3)
5	IIb	0. 3	220	16. 02	13. 91	5. 54	11. 90	6. 764	32. 2Rr+24. 9Bal+8. 9Bab+7.

SP	Forest State	Capony cover	Ni (trees/ha)	DBH (cm)	H (m)	Sd (cm)	Sh (m)	G/ha (m^2)	Species composition formula
									4Mtr+7. 4Ngat+6. 8Sot+6. 5Chc+ 5. 9Lk(2)
6	IIa	0. 3	240	16. 85	14. 13	5. 48	8. 27	6. 583	15. 7Chn+13. 0Khao+10. 4Sop+ 8. 4Bađ+8. 3Mađ+6. 6Cal+6. 0Bas+6. 0Gan+25. 7Lk(8)
7	Ib	0. 2	90	8. 85	10. 11	3. 82	3. 49	0. 629	31. 5Trau+25. 4Quy+19. 5Sug+14. 7Thb+8. 9Bas
8	IIIa1	0. 4	330	17. 23	15. 24	2. 98	6. 08	8. 613	17. 5Vaa+16. 0Đb+13. 9Cal+12. 5Bas+7. 7Ngl+7. 6Sot+7. 1Quy+ 6. 7Bab+28. 5Lk(3)
9	IIb	0. 5	330	19. 60	14. 85	3. 23	10. 20	12. 561	18. 6Sâ+13. 2Vaa+9. 5Cal+ 8.

SP	Forest State	Capony cover	Ni (trees/ha)	DBH (cm)	H (m)	Sd (cm)	Sh (m)	G/ha (m^2)	Species composition formula
									8Bab+6. 3Đb+5. 9Bas+5. 5Dư +32. 2Lk (12)
10	IIa	0. 4	250	9. 29	10. 54	2. 97	3. 18	1. 882	23. 2Bab+10. 2Khao+8. 5Bas+8. 2Vatr+5. 9Sâ+5. 2Thm+38. 8Lk (11)
Average			224	16. 18	13. 12	5. 02	14. 20		

Abbreviations in the tree species composition formula

Bab: *Mallotus floribundus*

Bas: *Macaranga denticulata* Muell

Bđ: *Hura crepitans*

Bumb: *Mallotus barbatus* Muell et Arg

Bưa: *Garcinia oblongifolia* Champ. ex Benth

Cal: *Caryodaphnopsis tonkinensis*

Choc: *Parashorea chinensis* Wang Hsie

Chox: *Terminalia myriocarpa* Huerch et M.A

Chc: *Schefflera arboricola*

Đb: *Achidendron robinsonii*

Deâ: *Castanopsis indica* a.d.c

Dex: *Lithocarpus pseudosundaicus*

Lom: *Pterospermum heterophyllum* Hance

Hđ: *Trema orientalis* (L.) Blume

Vaa: *Saraca dives*

Sâ: *Pometiapinana prost*

Khao: *Cinnadenia paniculata*

Thm: *Holarrhena antidysenterica* Wall

Sung: *Ficus racemosa* L.

Mađ: *Archidendron clypearia*

Sop: *Lithocarpus fissus* Champ ex Benth

Chn: *Platanus kerrii* Gagnep.

Sot: *Sapium discolor* (Champ.) Muell - Arg.

Got: *Aphanamixis grandiflora* Blume

Ngat: *Gironniera subaequalis* Planch

Rr: *Ormosia pinnata*

Bal: *Lagerstroemia speciose*

Bob: *Orthosiphon spiralis* (Lour.) Merr

Mtr: *Zenia insignis* Chun

Tramtr: *Canarium album*

Tram: *Syzygium cumini*

Mo: *Alchornea rugose* (Lour.) Muell.-Arg.

Trau: V*ernicia montana*

Quch: *Chisocheton paniculatus* Hiern

Ngl: *Ficus fulva* Reinw. ex Blume

Ngai: *Ficus hispida* L. f

Sog: *Dillenia* indica Linn

Thb: *Alangium chinense* (Lour.)

Teon: *Streblus* tonkinensis

Du: *Broussonetia papyrifera*

Dung: *Symplocos laurina* (Retz). Wall. exG. Don

The results in the tables reveal that the characteristics of forest status, forest structure, species composition, tree height and average diameter of secondary forest in Thuong Cuu commune are better than that in Thu Cuc. However, diameter and height variations in Thuong Cuu commune are also higher than that in Thu Cuc.

Summary of survey result, the proportion of preferred – desired timber species (purpose) and non-target trees (non-purpose) are described in the following chart:

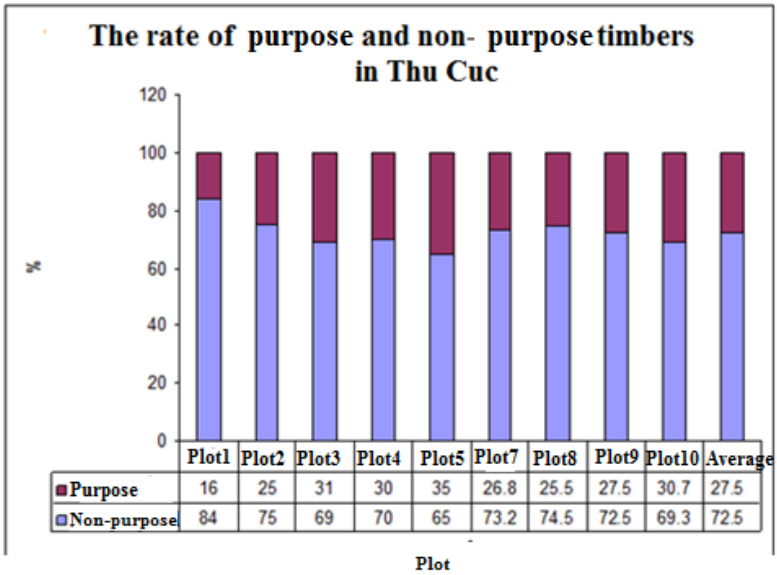


Figure 7 Commercial and uncommercial timber species rate in Thu Cuc commune

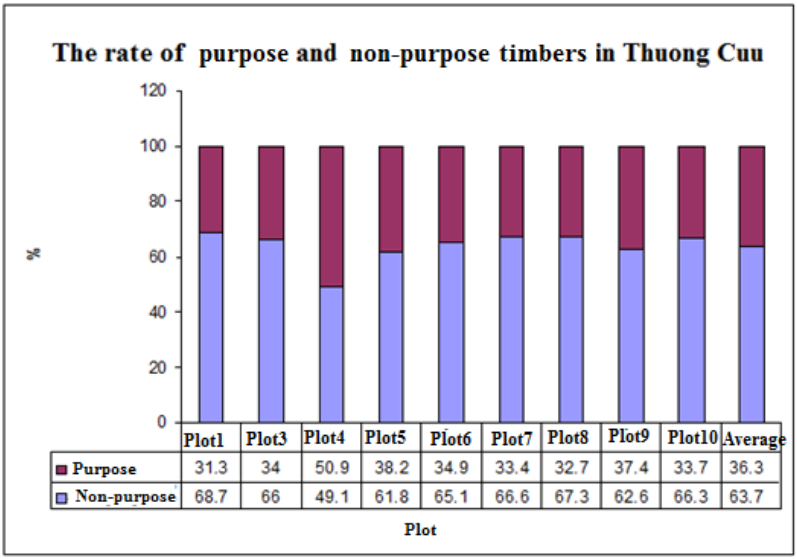


Figure 8 Commercial and uncommercial timber species rate in Thuong Cuu commune

Results in the figures above show that proportion of desired species is only 20 % on average in Thu Cuc and 30 % on average in Thuong Cuu commune.

Regenerating tree species

According to the survey results in Table 2. 3, the density of regenerating seedlings and saplings is between 8,000 -10,000 trees per ha. Most of regenerating trees have height less than 1 m. Desired regenerating trees are accounting for only 8 - 15 % of regeneration seedlings and saplings. Additionally, there is no regenerating species are of high value timber species. Most of them are in timber groups V – VIII (the lowest commercial value timber in

Vietnam's classification) such as *Ficus racemosa* L. , *Fagus sylvatica*, *Achidendron robinsonii*, etc. or non-timber forest products such as *Wrightia annamensis* Eberh et Dub, *Sterculia lanceolata*, *Claoxylon indicum* (Reinw. ex Blume), *Saraca dives*.

Table 11 Characteristics of regenerating tree species in two project communes

SP	The number of regenerating trees by height					N/ha	Desired regeneration trees (%)
	<0, 5m	0, 5-1m	1-3m	3-5m	>5m		
Thu Cuc commune							
1	2, 000	1, 500	1, 500	1, 000	-	6, 000	8. 3
2	3, 000	500	1, 500	500	1, 500	7, 000	14. 3
3	1, 000	3, 000	2, 000	-	-	6, 000	8. 3
4	3, 000	3, 500	2, 500	1, 000	500	10, 500	-
5	2, 000	4, 500	4, 000	500	-	11, 000	18. 2
7	500	1, 500	500	-	-	2, 500	20

SP	The number of regenerating trees by height					N/ha	Desired regeneration trees (%)
	<0, 5m	0, 5-1m	1-3m	3-5m	>5m		
8	0	3, 500	1, 500	500	-	5, 500	18. 2
9	3, 000	3, 500	1, 500	1, 500	-	9, 500	-
10	500	2, 000	1, 000	1, 000	-	4, 500	11. 1
Thuong Cuu commune							
1	500	6, 500	1, 000	-	-	8, 000	-
2	-	1, 000	1, 500	-	-	2, 500	-
3	3, 500	2, 500	2, 500	-	4, 000	12, 500	24
4	7, 500	500	-	-	1, 500	9, 500	5. 3

SP	The number of regenerating trees by height					N/ha	Desired regeneration trees (%)
	<0, 5m	0, 5-1m	1-3m	3-5m	>5m		
5	3, 000	-	-	-	500	3, 500	14. 3
6	1, 500	8, 500	2, 000	3, 000	500	15, 500	3. 2
7	-	500	5, 000	1, 500	2, 500	9, 500	31. 6
8	2, 000	4, 500	2, 000	1, 000	-	9, 500	-
9	4, 000	4, 000	1, 500	1, 000	1, 500	12, 000	4. 2
10	3, 000	1, 000	1, 500	500	1, 000	7, 000	14.3

Characteristics of under canopy vegetation

On the degraded natural forests of two communes, because lack of canopy cover of tree layer and uneven distribution of existing trees, scrub, lianas and creepers are occupying large area and compete with regeneration trees. In general, vegetation is mainly classified into three types:

- In bared hills wild bananas mixed with imperata grass, and occupying of 80 - 90 % of land area, scattering with *Chromolaena odorata, Maesaperlarius (Lour) Merr,* etc.
- In secondary forests along streams, there are *Cyclosorus parasiticus, Chromolaena odorata* (L.), accounting for 60 - 80% of land cover with height about 50 – 80 cm, scattering with *Languas officinarump, Psychotria rubra* (Lour.), *Alocasia odora* K. Koch, vines of Fabaceae family and *Ficus sumatrana*.
- Secondary forests on the hills comprises various types of vegetations such as *Chromolaena odorata, Axonopus compressus, Languas officinarump, Caryota mitis, Selaginella tamariscina, Rhodomyrtus tomentosa, Melastoma dodecandrum Lour, Boehmeria nivea* L. Gaud, etc. , growing with vines of Fabaceae family and Ficus .

In general most of the production forests of two communes growing some popular tree species like *Styrax tonkinensis*, *Acacia mangium*, and *Manglietia conifer* Dandy with relatively good quality. Whereas, natural forests are degraded with low economic, social and environmental values. On highly fragmented terrains, it is difficult to carry out improvement clearing and enrichment planting on degraded forests with high ratio of vines, creepers and shrubs.

Figure 9 Shrub vegetation in degraded secondary forest Thu Cuc

**Species diversity in natural forests in project areas*

Though these communes have large forest area, distribution on variety of terrain types and different habitats plant diversity is low.

Figure 10 Secondary forest in Thuong Cuu commune, Thanh Son district, Phu Tho province

Diversity on forest status:

+ Status IIb – natural regenerating forests: This type has dominance of light demanding pioneer species of Euphobiaceae family, including:

Mallotus apelta, Macaranga denticulatus, Mallotus barbatusand and *Vernonia arborea*. Other species can be find such as *Rhus chinensis, Litsea cubeba* and *Evodia lepta*. *Sacharum spontaneum* grass commonly seen with above timber species in project's communes. This forest state is regenerating forests after long term fallow.

+ In poor degraded forest, there is mainly *Musa acuminata* growing with pioneer plants.

This is common forest types found in steep hills. Wild bananas grows in monoculture or mixed with species like *Schizostachyum funghomii, Mallotus apelta* and *Macaranga denticulatus*.

+ Natural bamboo forest

Figure 11 Bamboo after inital cutting in secondary forest in SinhTan village

Bamboo tends to grow in big clumps, on average of 30-50 trees per clump, or mixed with native timber species such as *Mallotus apelta, Macaranga denticulata, Litsea cubeba, Evodia lepta, Knema globularia, Alangium kurzii, Ficus fulta* and *Ficus variegata* Bl.

Beside above three forest types, degraded forest after over-logging (IIIa1 status) comprise large trees but low commercial values like *Saraca dives, Albizia lucidior, Caryodaphnopsis tonkinensis*, and some other less common tree species such as *Alniphyllum eberhardtii, Callicarpa arborea, Castanopsis indica, Evodia meliaefolia, Pterospermum heterophyllum* and *Alangium kurzii*.

Timber species diversity: There are 76 natural timber species belong to 31 families and 54 genus. The most popular plantation species are *Eucalyptus camaldulensis, Styrax tonkinensis, Acacia mangium, Manglietia conifera, Vernicia montana, Dalbergia odorifera* and *Melia azedarach*.

Diversity of non-timber forest product (NTFP) species: There are 37 NTFP species, species for foods occuping the largest number of 15. Medicinal herds are 14 species, species for handicraft is 7, species for livestock feed is 5.

Project forest restoration approaches

Forest survey at commune level and detailed inventory at model sites is understand existing forest status. The results of

the inventories are one of the key bases for the selection of technical interventions of the project including model areas, species selection, silvicultural practices etc.

Participatory approach are used for species selection and model design. Based on best practices in natural forest restoration in Vietnam and expectation of local communities on restoration models, leading forest restoration experts worked together with local communities and the project management board to find out;

(i) the best suitable and high valuable native species for timber and NTFP enrichment pilot models;

(ii) silvicultural techniques for growing the selected species;

(iii) model design to meet ecological characteristics of species and forests, as well as local needs and awareness on growing trees and NTFP.

Local institutional framework is built through community forestry management activities. Community's regulations on forest development and management and village's forest development and protection board, protection team are set up. This is to ensure success of the project both in short and long term.

3.3. Forest after project intervention

Forest restoration by enrichment planting was designed for APFNet's project areas. 05 native timber species

and 05 non-timber forest product species are used in pilot model establishment. Figures below show model design in map.

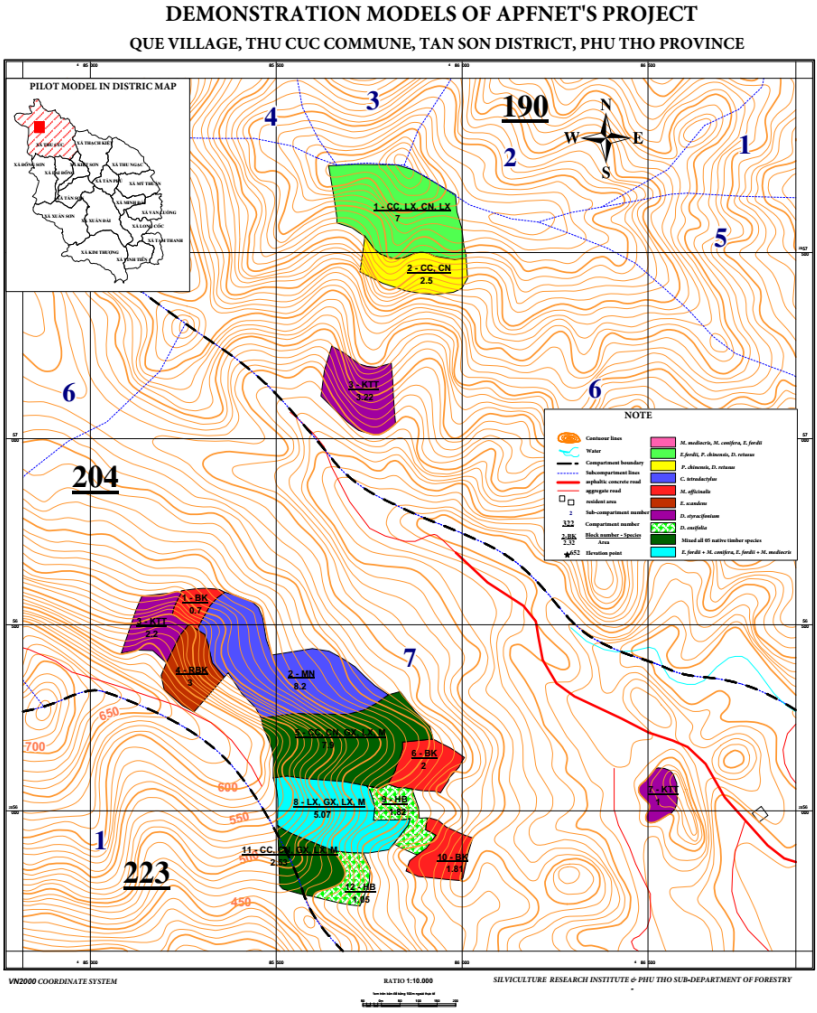


Figure 12 Pilot model map in Tan Son district, Phu Tho province, Vietnam

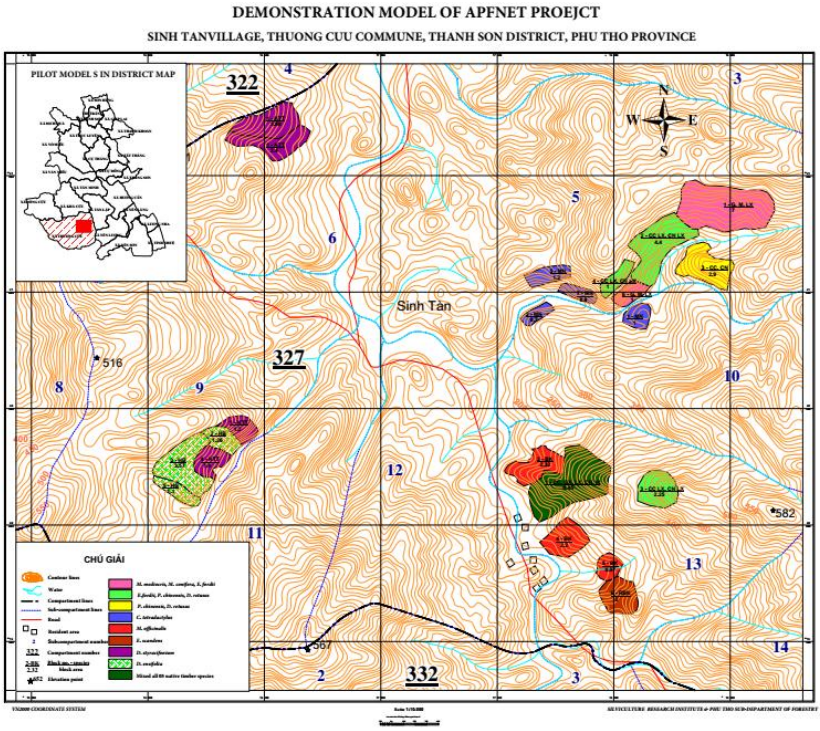


Figure 13 Pilot model map in Thanh Son district, Phu Tho province, Vietnam

Forest inventory at both commune and model levels at final stage of the project was conducted by late 2012. The high valued timber and NTFP native species that were introduced in piloting areas, contributed to an increase in the commercial value and biodiversity of tree compositions by up to 150 %. If the models are well managed it is believed that long term forest biodiversity as well as commercial value of forest in project's areas will be significant increased.

The involvement of local communities is a precondition for the success of the project. By applying the method of community forest management which has been successfully piloted in many projects of ODA and the government, the project has built micro institutional framework for the protection and development of forests in these communities. One of the most important is the development of village regulations on forest protection and management, benefit sharing from forest harvesting, establishment of village forest management board. The project had significant achievements, including:

In technical aspect: Project selected feasible and simple technical approach for forest restoration. However, this approach proved its highly effectiveness in the field. The survival and growing rate of planted species in the first few years proved that achievement. The simple method is easy to extending to other households and communities which still have limitations in capital and technical capabilities. Planting indigenous species by clear strips following contour lines is simple to conduct and high valuable in soil erosion protection.

Species selection: The objective of the project is to plant indigenous species for forest restoration, especially non-timber forest products with high economic value. Species selection was based on local communities' desire in forest farm and ecological & silvicultural characteristics.

The cultivation and forest enrichment techniques of their plants are available for applying.

The involvement of the community and local people significantly contribute to the success of the project. Because local people have participated and supported enthusiastically, thus the pilot models have been carried out and maintained successfully.

The project has applied effective methods with the participation of local people in all steps such as technical training, species selection, planting, tending, regulation development, harvest NTFP.

T*he establishment local institutional framework* is a vital factor to maintain long term forest development and sustainable forest management, particularly for natural forests. Micro institutional development based on legal framework of the Government is the basis for effective forest management (Forestry Department of Phu Tho in 2013, by Phan Minh Sang in 2014).

Figure 14 *Erythrophleum fordii* in enrichment model

Figure 15 *Calamus tetradactylus* planted in NTFP pilot model

Figure 16 *Parashorea chinensis* planted in enrichment pilot model

Figure 17 Community meeting for establishment of Sinh Tan Village Forest Protection Regulations (1)

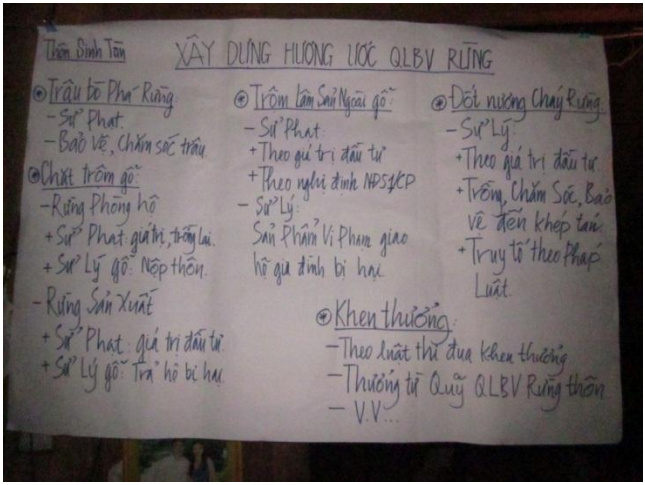


Figure 18 Community meeting for establishment of Sinh Tan Village Forest Protection Regulations (2)

The local communities have been aware of their roles in the forest management, rights and restrictions under by the Government's policy. Local farmers are keen on to improve degraded secondary forest through boosting the composition of high economic value timbers and non-timber forest products species. This has contributed to the restoration of natural forests and sustainable forest management of communities in the project. People got paid from participating in field activities of the project as well as initial income from NTFP pilot models. The income has helped to increase livelihood and reduce poverty in the project area.

Moreover, local people, partners and the authorities of Phu Tho province and Vietnam's forestry sector has learned about APFNet project and recognized its contribution to the development of forestry and sustainable forest management in Vietnam.

Chapter 4: Experience in natural tropical forest restoration in the world

4.1. Major approaches on natural forest restoration in the tropics

In general natural forest restoration approaches can be group into two pools. The first group is minimal intervention approaches which apply for natural forests with light disturbance or degraded forests having recovery timber species. Second group is to restore natural vegetation through extensive establishment in existing heavily degraded ecosystem.

4.1.1 "Passive" approach

Passive restoration

Passive restoration should be similar to forest maintenance approach in Vietnam. In which secondary forests are protected from further disturbances to allow natural regeneration to restore forest biodiversity and composition.

This method is best suited for sites which are not degraded extensively or regenerating tree species is already available. Sites are considered to be suitable for this method is recent slight disturbance forests, degraded forests with available recovery, sites close to intact forests or patches and sites with scattered mother trees.

Passive restoration is one the most economic method and applicable to large scale forest restoration. However, fire

and pest prevention and weed control are sometimes very expensive.

Table 12 Pre-conditions necessary if natural regeneration is develop at degraded sites

Pre-condition	Reason	Consequences of not achieving pre-condition
Further disturbances can be prevented	No sucessional development unless disturbances are excluded	Reforestation likely to fail
Weeds can be eradicated	Weed competition limits regeneration of native species	Weeds prevent regeneration or limit growth
Animal pests can be controlled	Act as seed predators or herbivores	Regeneration limited
Soils not degraded (or adverse conditions can be ameliorated)	Changes in fertility or physical properties may limit ability of original species to recolonize	Only tolerant (exotic?) species can establish at site

Pre-condition	Reason	Consequences of not achieving pre-condition
Representatives of plant and wildlife remain on site	Residual trees, seedlings or coppice allow rapid regeneration	All species will have to be re-introduced to site
Natural forest nearby; a range of seed-dispersers able to move across intervening landscapes	Allows new species to recolonize degraded site populations of existing species to be supplemented	Limits opportunity for species enrichment or population enhancement

Source: Lamb, 2011

Accelerating successional development

A similar term "assisted natural regeneration" is used for this approach like in Vietnam. Although colonized species usually have strong regeneration capability many constraints can hinder positive secondary succession. These include low number of woody plant seedlings, weed, and occupant of pioneer timber species. Accelerating successional development is to assist natural regeneration of target trees by clearing forest patches, weed control and thinning pioneer trees which are occupying main canopy of forests and slow down regeneration of primary species. The

table below suggest time for interventions to encourage recovery in secondary forests.

Table 13 Timing of interventions needed to encourage recovery

Action	In younger regrowth forest?	In older regrowth forest?
Protect from further disturbances	Protection essential	Protection less necessary
Thin to encourage growth of target trees	Less appropriate since the identity of target trees may not be clear	Preferable since identity of target trees more obvious
Create canopy gaps to 'unblock' successional development	Should not be done because it can encourage competitive pioneers	May be necessary to prevent truncation of successions
Enrich with key species	Preferable since canopy gaps more	Less optimal; only possible if

	frequent	naturally occurring gaps (e.g. old logging tracks) are still present

Source: Lamb, 2011

4.1.2. Active interventions

Enrichment planting

Enrichment planting is reintroducing tree species for accelerate recovery of natural forests. Selected species are normally native species and have high adaptability to existing secondary forests. Thus if light and other resources competition with existing vegetation is under control enrichment planting tend to be successful.

Enrichment planting is also use to transfer monoculture timber plantations to more diverse mixed forests. Gaps and/or strips are open up in the canopy of monoculture plantations to plant targeted species. Monoculture plantation trees are gradually harvested and replaced by new tree species. It bring income for forest owners while still keeping forest canopy for weed control and protection services (Lamb and Gilmour 2003).

Species for forest enrichment should be high valuable timber species and fast growing to overcome high competition from existing vegetation. Although most forest

enrichment planting timber trees were economically valuable it is suggested to enrich a secondary forest with wild animals food.

According Lamb, 2011, trials testing methods of enriching logged over production forests with timber trees have been carried out over many years in a number of silvicultural circumstances (Appanah and Weinland 1993, Dawkins and Philip 1998). Requirements for enrichment planting in timber production forests are that (Lamb 2011):

- There must be rules in place that regulate access to the site and guarantee harvesting rights.
- The species to be planted must be commercially (or ecologically) valuable.
- The species used must be capable of fast growth (meaning that most will be light-demanding).
- Seedlings should have well-established roots meaning that container- grown seedlings are preferable to bare rooted seedlings or wildlings.
- Species should have a low crown ratio (ratio of crown diameter to stem diameter).
- These species should be self-pruning and have good form.
- Planting lines should be oriented in an east-west direction and be sepa- rated at a distance about the

same as the crown diameter of the species when mature (e.g. around 10–15 m).

- Seedlings should be planted more closely along these lines (i.e. <10 m) to allow for deaths and perhaps thinning.
- All overstorey competition should be removed before planting (to avoid damaging young seedlings).
- Weeds along the planting line should be removed at least three times in the first year in a strip about 2 m wide.
- The technique will fail if seedlings are susceptible to grazing by wildlife.
- The regrowth between the planting lines should not be flammable

Source: Lamb, 2011

Advantages: This is a simple approach to improve species composition, particularly for timber target. It is a relatively inexpensive forest improvement method. It takes advantage of the existing seedling, sap- lings and residual trees of economically preferred species. It is much better than clearing remnant for planting in term of biodiversity and soils protection. It is most likely to be successful if implemented immediately after logging when canopy gaps are most extensive or in short secondary regrowth where it is possible to improve the light environment for newly planted

seedlings. It is likely to be less successful in tall secondary forests especially those growing at higher latitudes (Lamb 2011).

Disadvantages: The main disadvantage is that it still can be a high risk operation to apply enrichment planting on a large scale, unless the silvicultural requirements of the species used are known and cost of overstorey control is sufficient.

Direct seeding

This method is direct sowing seed by hand or by aircraft into degraded forest landscape which natural succession is limited by slow dispersal of seed. Seed are usually sown in bare soil so that it can establish quickly in weed-free conditions. Direct seeding can be done after the site was burned, or after site treatment like applying herbicide to kill grasses and scrubs. This approach has been developed for use in commercial forestry by burning sites after logging. It has also been widely used in mine reclamation projects immediately after mining before the weeds become established (Lamb and Gilmour 2003).

The success of each different species depend on site characteristics. Species with larger seeds have more chance to survive and grow. However, in general, most of the species can be established by seed at the abandoned land where no predation or herbivory. The establishment rates in

grassland sites and in secondary forests or primary are much lower than on bared land.

Advantages: Direct seeding is a low cost method and can be spread across large landscape easily.

Disadvantages: The field germination rate of direct seeding is generally less than 5% and low reliable (Lamb 2011). Seed germination might not evenly distributed in the stand results to patchy distribution of trees. This method requires large amount of seed per restoration area and is only applicable to certain species. Many native timber species were currently not widely domesticated for commercial timber land and seed orchards are limited. Additionally seed of some native species are not viable for germinating by direct sowing (Parrotta and Knowles 1999, Lamb and Gilmour 2003, Lamb 2011).

In general direct seeding depend on a number of conditions such as seed predation availability, seed viability, microsite suitability and seed size. Desirable characteristics of seeds which can be used for direct seeding method are described in table below:

Table 14 Desirable seed attributes for species being used in direct seeding

Attribute	Reason
Seed readily available	Large amounts of seed are needed because establishment rates are sometimes low
High viability	High viability reduces the amount of seed needed
Rapid germination	Allows seedlings to take advantage of short-lived favourable conditions
Large seed size	Large seed often have higher rates of establishment and survival
Rapid seedling growth	Rapid seedling growth allows seedlings to escape competition
Tolerance of some shade and competition	Some tolerance enables seedlings to persist

Source: Lamb, 2011

Nurse tree method

One method involves the cultivation of a small number of scattered, single trees or clusters or rows of trees, forming perches for birds. Seedlings produced from seeds under the pole shed. Finally the seedlings sprout clusters to form and become trees birds sitting around. The volume of trees enlarge and the process continues. The original plant can be one or more species for seed dispersal by animals.

Planting densities should be 1,100 seedlings per hectare. It can create enough dense canopy to limit weed development but allow native regenerating trees colonize the under-storey (Otsamo 2000, Lamb 2011)

Another nurse tree method in a situation where most of the plants was spread by wind rather than wildlife. In that case the wind dispersed species are planted in the landscape in rows perpendicular to the prevailing wind and the rows are spaced a distance equal to the average dispersal distance of seed (Janzen 1988).

Advantages: This approach is relatively simple and low cost and can be applied in large area without requirement of large number of seedlings. This approach may be useful in abandoned farmland to grassland and bush and on the site without a lot of greenery.

Disadvantage: The method depends on the majority of plant species dispersed by wildlife. Therefore, the only

suitable areas which have enough wildlife can pass or degraded lands where few species are wind dispersed. Another disadvantage is the rate of revegetation under scattered trees can be slow because many new seedlings sprout to compete with grasses and weeds

Framework species method

The framework species is similar approach to nurse trees but use a large number of species. 20 - 30 timber species are used to initiate the succession and provide a framework for future development successional (Elliott, Blakesley et al. 2006, Lamb 2011).

Selected tree species for planting should contain a number of species which can have fruits to attract seed-dispersers as well as species with a branching architecture which encourages the dispersers to stay and deposit seed on the site. All selected tree species must be able to tolerate the site conditions and able to grow quickly and close canopy within a few years thus weeds are cleared. It is equally important that some of the fast-growing species (up to 30%) should also be short-lived for canopy gaps creation to allow colonists continued to grow into the canopy.

A mixture made up entirely of the pioneers in the short term may be less successful because they will die before the preferred species have become established and if too many plants die too fast site can be invaded by grasses.

Generally 2,500 - 3,000 seedlings are planted per hectare but no instructions relating to the proportion of each species in this total. Because of the large number of seedlings is needed most popular species are likely to be the species which seeds available and it's easy to grow in a nursery. The species should be included in the mix are is poorly dispersed, preferred food plants for wild animals and nitrogen fixing species which is able to improve site conditions. In seasonal arid tropics it would also be advantageous to include fire-resistant species (Lamb 2011).

This method is suitable for sites near the ruins of an existing natural forests where seed dispersal is possible. The method is best suited for sites near existing natural forests thus it has plants and wildlife colonists. It is not appropriate for degraded sites which far from intact forest because the seed dispersal can be slow.

Advantages: Forest restored by this method can start succession development and recover biodiversity and other ecological services quickly. Additionally, the important species could be targeted for planting to accelerate succession development.

Disadvantages: this method requires large number of species for planting while seeds or seedlings of many native tree species, especially ones have not been domesticated, are limited or impossible to get. The necessary number of tree

species and seedlings is large result to complicated and costly silvicultural operations.

Maximum diversity method

This method uses a large number of species, all of which are planted at the same time, to quickly start succession. The number of species actually used depends on seed availability, the capacity of local nurseries, and the need to establish rapid biodiversity but can reach 80-100 species (Lamb 2011). This allows for the failure of some species can not tolerate the conditions of the site. Although a pioneer species that can be included to ensure a canopy gaps are created periodically most (90%) of the species should be from later successional stages. Special highlights can be given to species with large seeds that are often poorly distributed. Planting combination can also include endangered, vulnerable or rare species. It can also include other life forms than the trees. Rodrigues et al. (2009) reported that the use of> 50 species often provide better results in the restoration project in Brazil, although the reason for this is unclear.

Most of the species should be made at least 20-30 individuals per hectare to ensure enough of each species exist, but without guidance con- cerning the relative weight of each species; those known to be an important function or slow to reproduce may deserve to be planted with a larger number. Site preparation, planting methods and early weed

control is the same as used in the framework species method and should aim to achieve canopy closure in 12-18 months. The advantage of this method is that it ensures high species diversity from an early stage. It also ensures specific species is part of a plan to avoid the risks so that they can not be brought to the site by sowing seeds.

Advantages: This is high intensive method which can rapidly accelerate succession development and significantly increase success of restoration forests. This method can be used on severely degraded forest landscapes or bared land which other restoration methods might not work. It is also useful in locations distant from the natural forests and speed where colonialism brought in by sowing the seed is slow.

Disadvantages: It even more difficult to get enough qualify seeds and seedlings from numerous native timber species in natural forests than seed needed for nurse tree and framework species methods. How to mix species and arrange them to build complimentary structure in restoration stand is a challenging ecological and silvicultural work.

4. 2. Livelihood consideration

One of the most concern in forest restoration in the tropics is livelihood for local communities living in forest areas.

The role of forests in improving the livelihood or in reducing poverty and livelihood improvement is complex.

Natural forests often contain valuable commercial resources. However, the local communities have rarely benefited from more valuable resources (Sunderlin, Angelsen et al. 2005).

There are four ways in which natural forest resources might contribute to improve livelihoods improvement can be summarized in table below (Lamb 2011).

Table 15 Ways by which natural forests might be used to help alleviate rural poverty (Sunderlin, Angelsen et al. 2005, Lamb 2011)

Action	Mechanism or policy
Provide legal and fair access to the forest and its resources	Protect the forest (from illegal loggers and squatters) and allow people to make use of and benefit from its resources. Provide assistance in developing appropriate forms of silviculture and management that ensure production is sustainable and that benefits are equitably shared
Increase the value of forest products (timber and NTFPs)	Use technology to increase productivity (machinery rather than hand tools), enhance prices (via improved market access and marketing arrangements) and

Action	Mechanism or policy
	increase local value-adding activities (e.g. small rural sawmills and furniture factories. This may require access to new sources of financialassistance
Pay for the ecosystem services provided by forests	Develop mechanism for transfer payments to people for services such as watershed protection and clean water, carbon sequestration, recreational opportunities orthe biodiversity provided by their forests
Clear forest and develop alternative land uses	Use land for more profitable uses such as agriculture

However, ecological restoration does not normally provide an immediate economic return for landowner (Lamb 2011). Timber species in enrichment forest need several dozen of years to reach commercial log scale while poor local communities need income for their livelihood. This bring essential need to develop effective restoration method combining species which have different commercial products and different time length for financial return. High

value timber species of late succession stage, fast growing - small timber pioneer trees and non-timber forest product species should combine together to provide complementary ecological structure and economic return.

Chapter 5. The way forward

5. 1. Factors affecting to forest rehabilitation and forest development policies in Viet Nam

With political commitment, and supporting policies, Vietnam has achieved significantly in forest restoration, increasing forests' contribution to livelihood improvement, rehabilitating and protecting the environment, and creating rural employment. While forests are important ecosystems for environmental protection in Vietnam, most of thehave become highly degraded in terms of productivity and quality. In order to ensure the sustainable development and increase ecosystem-environment values of the forest ecosystems, the following measures would be additionally needed:

* Policy harmonization with international commitment

Firstly, it is necessary to state precisely the how management of forests will be undertaken, which in the case of Vietnam, it would be conservation and utilization, one which brings benefits to all related parties, particularly to the communities living in and near the forest (Tran, Nguyen et al. 2006).

- Accomplishment of the legal policies concerning forests, mountainous areas and mountain communities, by meeting the objective through reliable assessment of all values of forests on forestry products and environment

services in order to give solutions to promote the restoration of high valued forest ecosystems.

- Forestry and rural development policies need to pay deep attention to the rights and the participation of indigenous communities living near and in the forests. Absence of this participation brings potential risks to any forest restoration plan. Forest restoration, management and protection must bring worthy income to the people in order to prevent them from encroaching on the forests or supporting illegal logging (Tran, Nguyen et al. 2006). In any case, it is necessary to set up benefit sharing policies from the forest among the stakeholders, especially communities living in and near the forest. This is to guarantee equity and to attract them to be involved in forest restoration and management activities (Tran, Nguyen et al. 2006, Nguyen 2007).

- Vietnam has participated in a number of international conventions dealing in environment protection and environmental conservation, and is a signatory in nearly 20 environment and related conventions (table 19 below), and has proceeded to convert the agreement into laws and regulations concerning forestry sector including Law on forest protection and development, Law on biodiversity, Ordinance on Mineral resources, Ordinance on Phytosanitation, Law on Natural Resource Tax etc. Vietnam now needs to make its policies regarding forest management and other natural resources to be in line with the

international conventions so as to get benefits from forest plantation and restoration activities such as CDM, REDD/REDD+, all of which are linked to climate change mitigation processes. (Phan 2014).

Table 16 The list of international conventions related to management and protection of forest resources signed by Vietnam

Convention names	Signing date
Convention concerning on the protection of world cultural and natural heritage, 1972	19/10/1987
Convention on early notification of a nuclear accident (IAEA), 1985	30/10/1987
Convention on wetlands of international importance, especially as waterfowl habitat (RAMSAR), 1971	20/9/1989
Convention on assistance in the case of a nuclear accident or radiological emergency (IAEA), 1986	29/9/1989
Convention on international trade in endangered species of wild fauna and flora (CITES), 1973	20/1/1994

Convention names	Signing date
Convention for the protection of the ozone layer, 1985	
Montreal Protocol on substances that deplete the ozone layer, 1987	26/4/1994
The United Nations Declaration on environment and development, 1992	
The United Nations *Convention to Combat Desertification* (UNCCD), 1992	25/8/1998
The United Nations Framework Convention on climate change (UNFCCC), 1992	16/11/1994
Convention on biological diversity (CBD), 1992	16/11/1994
Cartagena Protocol on biosafety	21/01/2004
Convention on the control of transboundary movement of hazardous wastes and their disposal (BASEL), 1989	13/3/1995
Kyoto protocol	3/12/1998
International declaration on cleaner production	22/9/1999

Convention names	Signing date
Stockholm Convention on persistent organic pollutants (POP), 2001	10/8/2006

* Strengthening governance capacity

Vietnam forestry governance system is completely structured from the centre to the locality. However, there remains much overalp in the management of forests, forestry land and biodiveristy among the sectors. This overlap leads to conflict of interest among related government bodies (for example: The task of managing biodiversity has been assigned to both Ministry of Agriculture and Rural Development and Ministry of Resources and Environment), and this decreased the governance effectiveness. The Government needs to re-assess and clearly define these sectors and sub-sector roles and functions, and align the laws and regulations appropriately (Phan 2014).

In addition, the forestry staff at commune level and field forestry rangers' capacities need strengthening so they can perform their duties.

Much concern has been expressed about corruption in forest management force, including the forest management and protection bodies. Considering the low the salaries and allowances of the public administration in Vietnam, it is difficult to encourage them do their jobs seriously and

enthusiastically. Vietnam needs to solve this so as to enforce the sanction to fight against corruption in the forestry sector (de Jong, Do et al. 2006, Sikor and To 2011).

* Market

The demand for timber, especially for woodchips from China, South Korea and Japan is increasing and is an important factor in the push for forest plantations in Vietnam. In addition, the booming furniture industry is consuming a large amount of timber, some of which is currently imported from overseas. This would remain as an market for timber growers in Vietnam for a long time.

However, the plantation development is in contradiction with the major objective of forest restoration, which is directed at ecosystems with high environmental service values. Meanwhile, natural forests in Vietnam are mostly poor forests with low forestry product supplying capacity. Under the circumstances, it is very important to create a developed and equitable market for forest ecosystem services to compensate for the restoration and maintenance of tropical rainforests. The domestic market promoting factors include the Government's plan of ecosystem service fees to be paid by the customers such as the hydropower plants, irrigation stations, clean water suppliers and ecotourism. Vietnam can also tap into the international market of carbon sequestration under CDM and REDD/REDD+ schemes in order to get financial resources for the sustainable forest restoration and management.

However, in order to join this market, it is necessary to have an open policy and qualified executive teams in both state management and business sectors (Pham, Moeliono et al. 2012, Pham, Bennett et al. 2013, Phan 2014).

Besides, other marketing factors would influence significantly the natural forest restoration and sustainable management in the near future. They include:

- The forest ecosystem service prices are acceptable in the market (by buyers and sellers) and they are reasonably attractive to maintain and develop natural forests;
- The demand on Vietnam's furniture exporting markets and Vietnam's competitive capacity compared to other countries: If Vietnam's wood processing industry keeps gaining strength, it would be reliant on imported wood which will increase in cost and fail to bring about added value domestically. This will add pressure on the development of the natural forests in the country.
- Demands and prices of products from cash crops (rubber, coffee bean etc.): A few years ago, the demand for rubber and coffee increased and the prices exploded, which in opening more forest land for for their cultivation, with a tacit acceptance of some local government agencies;

* Formulating approaches for equitable societal benefits:

At present, most of the big forest owners in Vietnam are state owned bodies, including State forestry companies and Forest Management Boards of protection and conservation forests. These entities are holding the largest areas of natural forests with the high standing volume, lands that are good for production plantation, with accessible infrastructure and ease to approach capital sources including preferential capital source. But the State owned forestry companies are loss making agencies, while the natural resources managed by them are still degraded (de Jong, Do et al. 2006, Sikor and To 2011). Poor governance and restrictions by forestry management policies and forestry enterprises (for example: no permission to make company's own forest harvesting plans, or issuance of logging quotas for companies even with approved forest management plans[1]) prevent those companies from growing and contributing to forestry sector.

Despite the community being recognised as a forest manager and allocated forests and forestry land for management, local communities have not been given full legal rights of forest manager for effective management. Moreover, the allocated forests of communities are mostly poor and severely degraded and need a long time to recover before harvesting, making it difficult to persuade them

positively join in forest restoration and management activities.

Households are often given small forestry land pieces, mainly for production plantation. With income from payments for natural forest ecosystem services remaining unattractive, commercial forest plantation offer the best financial options. Moreover, it is often difficult for small households to approach preferential capital sources for forest plantation.

Furthermore, it is popular for most private forestry businesses to operate on a small scale (typically from 30 – 500 hectares of land bought from other individual households whose land was assigned or leased by the state), which force them to do business with short term forest plantations with rapid cash flow and profit.

Therefore, development of policies to guarantee equality among forestry managers in order to ensure fair competition and rights to access available resources would contribute to sustainable development of forestry sector and forest restoration. State forestry companies are managing large areas of land - a precious resource in Vietnam and the Government is cautious in privatization of these businesses. To increase effectiveness of state owned business governance and thus increase sustainable forest management, equitization of forestry enterprises is needed.

In addition, large areas of natural protection forests are managed by households' under contracts with state

companies and forest protection management board. The appropriate payment policy would contribute to improvement of the forest quality, reduce illegal logging and forest degradation (de Jong, Do et al. 2006, Tran, Nguyen et al. 2006).

5. 2. National policies on forest rehabilitation and development

After two national afforestation and forest restoration programs, the program 327 and five million hectare project 661, Vietnam continues to carry out the Forest Protection and Development Plan for the period 2011 – 2020. This plan focuses on increasing forest quality and value added to the forestry sector, and also continues efforts on restoration of degraded natural forests by promoting regeneration (VNFOREST 2011, GoV 2012). Major targets of this national plan are listed as below (GoV 2012):

Planning targets by the year 2020:

- Increasing the forest coverage up to 44 - 45 % of Vietnam's land cover,
- Restoration of 750,000 hectares of forest (mainly protection and conservation natural forests),
- Afforestation and reforestation of 2,600,000 hectares, of which protection and conservation forests account for 250,000 hectares, production and afforestation areas accounting for 1,000,000 hectares, and

reforestation after harvesting at about 1,350,000 hectares,

- Reclamation of 350,000 hectares of degraded natural forest,
- Forest cover increase to 15,100,000 hectares,
- Planting 500 million scattered trees,
- Improving the quality of natural forests, with increase of 25 % in productivity of production plantation by 2020 from that of 2011.

Plan from 2011 to 2015 as below:

+ Afforestation and reforestation of 1,250,000 hectares, of which 150,000 hectares of protection and conservation forests (30,000 hectares per year on average); 500,000 hectares of afforestation of production forest (100,000 hectares per year on average) and reforestation after harvesting of 600,000 hectares (120,000 hectares per year on average);

+ Restoration of 550,000 hectares;

+ Reclamation of degraded natural forests of 150,000 hectares (an average of 30,000 hectares per year);

+ Planting 250 million scattered trees (an average of 50 million trees per year);

+ Improve the quality of the natural forest, increasing 10 % in productivity of production plantation in 2015 compared to that in 2011.

Government proposed nine solutions for successful implementation of Forest Protection and Development Plan including: (i) Promotion and awareness raising; (ii) Management and planning of forestry land; (iii) Forest protection; (iv) Forestry land and forest allocation and leasing; (v) Science, technology and forestry extension; (vi) International cooperation; (vii) Markets; (viii) Development and implementation of sub-plan projects; and (ix) Capital demand and capital raising policy.

Policies

The Central Government has also decided to use existing good policies and propose new ones to designate legal framework for Forest Protection and Development Plan from 2011 to 2020. Under decision of the Prime Minister, with the promulgation of this program and other related policies, the Ministry of Agriculture and Rural Development approved the Plan for Restructuring of Vietnam's Forestry Sector in order to reach overall objectives of national Forest Protection and Development Plan (GoV 2012, MARD 2013).

Forestry sector also continues to apply effective policies for conserving and developing forest resources such as: (i) The policy for investing in forest development under

Project 661; (ii) Policy to provide food subsidy for mountain-residing people in order to reduce and avoid shifting cultivation and deforestation; and (iii) Policy for encouraging businesses investing in agriculture and rural areas.

Further to the above, the Government plans to amend and develop policies on: (i) Forest protection; (ii) Forest management; (iii) Forest land allocation and leasing; and (iv) Credit policy.

Proposing new policies: The Forest Protection and Development Plan has also set objectives for new policy development. These are new points for more open views of the government on the protection and management of forest resources. This plan emphasizes some possible renovation in the forestry sector management in the near future, including: (i) To allow all economic sectors to protect, develop and use protection forests properly; (ii) To eliminate quotas of timber logging and manage forest owners by their approved forest management plans; (iii) To implement mechanism of forest co-management to share responsibilities and benefits of forest management with local communities; and (iv) Equitization of State Forest Company to increase governance and business effectiveness (GoV 2012, MARD 2013).

Finance for Forest Protection and Development Plan: The Government's planned total capital needed for

implementation of FPDP is about 49,000 billion VND (≈ 2.4 billion USD), in which state budget is about 14,000 billion VND (≈ 700 million USD), which is about 29 % of the total fund. State budget is mainly for restoration and management of protection and special use forests.

Some comments on Forest Protection and Development Plan:

In general, targets set in the Forest Protection and Development Plan are not ambitious, thus Vietnam's forestry sector can easily fulfil the Plan. If Vietnam continues to maintain economic growth and market demand of chipwood and furniture does not decline, afforestation and reforestation are feasible targets. Forest restoration objective is feasible considering it is cheap and an easy technical solution. Improving plantation productivity by 10 % in 2020 compared with that in 2011 can be achieved by improved genetic seed sources, better silvicultural practices, and increasing investment capacity of forest owners including small-scale holders. However the target for improving the natural production forest productivity and quality seems difficult to achieve, for instance target to increase commercial timber volume accounts for 75% of standing volume of the natural forest is questionable.

Monitoring and evaluation: Monitoring and evaluating the implementation of forest protection and development Plan are not detailed in Decision No. 57/QD-

TTg dated in January, 2012 by the Prime Minister and Decision No. 1565/QD-BNN-TCLN by Ministry of Agriculture and Rural Development. However, it is recognized that reporting, monitoring and evaluation of activities and projects under Plan of Protection and Development Forests period 2011 - 2020 will be similar to those of other forestry programs and projects of the government, i.e. Project 661 - Five million hectare afforestation. Regulations on reporting, monitoring and evaluating government programs are often very strict. However, the execution effectiveness of these regulations is still an open question.

Public Awareness: The public media recently made a positive impact in improving people's awareness about the values of forests and the roles of good forest management and protection. Public media have kept people well informed of the consequence of upstream deforestation which has resulted in severe floods downstream. Thus, people are familiar with the negative impacts of deforestation. However, it is recognized that deforestation, slash and burn agriculture andr conversion to short term industrial species are a major cause, with high impact on people's livelihoods.

In general, following the previous successes in forest rehabilitation, Vietnam Government continues to pay high attention to restore and enhance the value of forest ecosystems by Forest Protection and Development Plan for

the time being. However, natural forest restoration and maintenance have not been given appropriate attention to bring benefits to all stakeholders. Moreover, forest landscape restoration has not been mentioned in legal documents relating to forestry and forest ecology and rarely introduced in scientific and technical documents so far. In the context of global forest values, particularly tropical rainforests, with increasing focused on ecological and environmental aspects, forest and landscape restoration and sustainable management are more important than ever. Forest and landscape restoration would create livelihoods and sustainable development for people through ecosystem services and conventional forestry prod

5. 3. The way forward

Like many other developing countries, Vietnam is under high pressure on economic development, livelihood improvement for mountainous farmers. For these reasons, policymakers tend to give great priority to the need of rapid economic development instead of paying more attention on slow economic development combining with social – environmental balance. According to restructuring plan for the forestry sector from 2013, enhancing the added values for forests through its forest products is strongly focused on. Particularly, natural production forests with the function of providing forest products are of major priority. Though Vietnam is one of the leading countries in development and

implementation of payment for forest environmental services, the plan of restructuring the forestry sector has yet to have a strong and clear orientation for recovery of rainforest ecosystems with relatively high ecological – environmental values (Phan Minh Sang 2014). In the short term, because of the attraction of industrial trees with the high and rapid economic return from monoculture exotic forest plantation, restoration forest is not comparable competitive in forestry land. Most of natural forests in Vietnam have been severely degraded in both timber production and ecological diversity and forest landscapes are fragmented, causing the damage of the habitat for wildlife. Therefore, maintaining and managing existing natural forest with species composition improvement is a suggested solution for biodiversity, water catchment and soil protection and carbon sequestration.

- Developing strong institutional framework and policy for better benefit sharing mechanism between local communities, government and other entities in natural forest protection and restoration and enhance the access ability to international market for carbon credits from reforestation and reduce emission from forest degradation and deforestation projects.
- Making payment for environmental services of the natural forest is attractive to reduce it’s conversion into monoculture plantations or cropping land.

- Introducing new restoration approaches into degraded forest landscape in Vietnam, particularly where critical needs to recover forest biodiversity and ecological services like watershed protection. Successful methods like nurse tree, framework species and maximum density should be introduced to find appropriate technical solutions for restoration of natural forests.
- Research and extension of low cost silvicultural techniques to improve forest composition and increase the quantity of reproductive species for degraded natural forests.

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ANNEX

Annex 1. List of native timber and non-timber forest product species in forest in project communes

No	Botanical name	Local name	Utilization
	THU CUC COMMUNE		
1	*Mallotus paniculatus*	Ba bét	G,
2	*Evodia lepta*	Ba chạc	G,TH
3	*Croton tiglium*	Bã đậu	G,TH
4	*Macaranga denticulata*	Ba soi	G,
5	*Styrax tonkinensis*	Bồ đề	G,DN
6	*Vernonia arborea*	Bông bạc	G,
7	*Mallotus barbatus*	Bùm bụp	G,
8	*Garcinia oblongifolia*	Bứa	G,TA
9	*Crewia hirsuta*	Cò ke	G,
10	*Castanopsis indica*	Dẻ ấn	G,
11	*Symplocos cochinchinensis*	Dung	G,
12	*Broussonetia papyrifera*	Dướng	G,

No	Botanical name	Local name	Utilization
13	*Alniphyllum eberhardtii*	Dương lá đỏ	G,
14	*Aizia lucidior*	Đái bò	G,
15	*Machinus bonii*	Kháo	G,
16	*Amorphophalus paeoniifolius*	Khoai nưa	TA
17	*Pterospermum heterophyllum*	Lòng mang	G,
18	*Claoxylon indicum*	Lộc mại	G,
19	*Litsea cubeba*	Màng tang	DN
20	*Knema globularia*	Máu chó	G,TH
21	*Manglietia glauca*	Mỡ	G,
22	*Zenia insignis*	Muồng trắng	G,
23	*Schizostachyum funghomii*	Nứa	TDK
24	*Gironniera subaequalis*	Ngát	G,

No	Botanical name	Local name	Utilization
25	*Solanum erianthum*	Ngoi	TH
26	*Duabanga grandiflora*	Phay	G,
27	*Sterculia nobilis*	Sảng	G,CC
28	*Pometia pinnata*	Sâng	G,
29	*Saurauia nepaulansis*	Sổ giả	G,
30	*Streblus tonkinensis*	Tèo nồng	G,
31	*Callicarpa arborea*	Tu hú gỗ	G,
32	*Smilaca glabra*	Thổ phục linh	TH
33	*Alangium kurzii*	Thôi ba	G,
34	*Evodia meliaefolia*	Thôi chanh	G,
35	*Canarium bengalensis*	Trám cạnh	G,TA
36	*Canarium alba*	Trám trắng	DN, LT
37	*Syzygium hancei*	Trâm	G,
38	*Ficus variegata*	Vả	G,
39	*Eurya laotica*	Linh lào	
40	*Saraca dives*	Vàng anh	G,C

No	Botanical name	Local name	Utilization
41	*Melia azedarach*	Xoan	G,
42		Sâm đất	TH
43	*Calamus tetradactylus*	Mây nếp	TDK
44	*Breynia fruticosa*	Bồ cu vẽ	TH
45	*Trevesia palmata*	Đu đủ rừng	
46	*Phrynium despermum*	Lá dong	
47	*Maesa perlarius*	Đơn nem	
48	*Clerodendrum cyrtophyllum*	Đẳng cảy	

TT	*Tên khoa học*	Tên Việt Nam	GTSD
1	*Mallotus paniculatus*	Ba bét	G
2	*Croton tiglium*	Bã đậu	G,DN
3	*Macaranga denticulata*	Ba soi	G
4	*Entada phascoloides*	Bàm bàm	TH
5	*Lagerstroemia tomentosa*	Bằng lăng trắng	G
6	*Stephania rutunda*	Bình vôi	TH
7	*Styrax tonkinensis*	Bồ đề	G,DN
8	*Litsea monopelata*	Bời lời lá tròn	G
9	*Garcinia oblongifolia*	Bứa	G
10	*Caryodaphnopsis tonkinensis*	Cà lồ	
11	*Meigyne hainanensis*	Cách thư	G
12		Cọ	TDK
13	*Imperata cylindrica*	Cỏ tranh	LT
14	*Elaeocarpus sylvestric*	Côm rừng	G

15		Củ ráy	DN
16	*Schefflera heptaphylla*	Chân chim	TH
17	*Dipterocapus tonkinensis*	Chò nâu	G
18	*Terminalia myriocarpa*	Chò xanh	G,
19	*Hydnocarpus anthelminthica*	Chùm bao	G
20	*Baccaurea ramiflora*	Dâu da đất	TA
21	*Lithocarpus pseudosundaicus*	Dẻ xanh	G
22	*Broussonettia papyrifera*	Dướng	G,
23	*Albizia lucidior*	Đái bò	
24	*Sp*	Đùng đình	C
25	*Wendlandia paniculata*	Gạc nai	
26	*Aphanamixis grandifolia*	Gội nước	G
27	*Aglaia dasyclada*	Gội tía	G
28		Hu đay	G,TA
29	*Sida rhombifolia*	Ké hoa vàng	TH
30	*Machinus bonii*	Kháo	G

31	*Aleurites moluccana*	Lai	G,DN
32	*Archidendron clypearia*	Mán đỉa	
33	*Litsea cubeba*	Màng tang	DN
34	*Streblus macrophyllus*	Mạy tèo	G
35	*Cryptocarya hainanensis*	Mò	G
36	*Deutzianthus tonkinensis*	Mọ	G
37	*Calocasia esculenta*	Môn nước	LT
38	*Zenia insignis*	Muồng trắng	G,C
39		Nấm,,,	TA
40	*Amorphophalus paeoniifolius*	Khoai nưa	LT
41	*Schizostachyum funghomii*	Nứa	TDK
42	*Gironniera subaequalis*	Ngát	G
43	*Ficus fulva*	Ngõa lông	G
44	*Solanum erianthum*	Ngoi	TH
45	*Chisocheton paniculatus*	Quếch	G,
46	*Ormosia balansae*	Ràng ràng	G

47	*Pometia pinnata*	Sâng	G,
48	*Sapium discolor*	Sòi tía	G,TH
49	*Sapium sebiferum*	Sòi trắng	G,TH
50	*Saurauia nepaulansis*	Sổ giả	G,
51	*Dillenia scabrella*	Sổ nước	TA
52	*Lithocarpus fissus*	Sồi phảng	G
53	*Ficus vasculosa*	Sung	G,LT
54	*Toona sinensis*	Tông dù	TH
55	*Aprosa tetrapleura*	Thẩu tấu	
56	*Acer oblongum*	Thích lá quế	
57	*Homalomena occulta*	Thiên niên kiện	TH
58	*Smilaca glabra*	Thổ phục linh	TH
59	*Alangium chinense*	Thôi ba	G
60	*Wrightia laevis*	Thừng mực	C
61	*Syzygium hancei*	Trâm	
62	*Syzygium formosum*	Trâm tướng	

		quân	
63	*Vernicia montana*	Trẩu	G,DN
64	*Amesiodeuchon chinense*	Trường	G
65	*Saraca dives*	Vàng anh	C
66	*Mytilaria laosensis*	Sau sau lào	
67	*Cinnamomum bejolghota*	Re bầu	
68	*Cinamomum cassia*	Quế	DN
69	*Cinnamomum parthenoxylum*	Re hương	
70	*Bischofia javanica*	Nhội	
71	*Sp*	Đùi gà	
72	*Toxicodendron succedanea*	Sơn	
73	*Allospondias lakonensis*	Xoan nhừ	LT
74	*Calamus poilanei*	Song bột	TDK
75	*Begonia tonkinensis*	Thu hải đường	CA
76	*Costus speciosus*	Mía giò	CA
77		Dương xỉ	

78	*Ampelocalamus patellaris*	Giang	
79	*Bambusa nutans*	Vầu	
80	*Trevesia palmata*	Đu đủ rừng	
81	*Phrynium despermum*	Lá dong	
82	*Selaginella argentea*	Quyển bá	
83	*Rhodomyrtus tomentosa*	Sim	
84	*Sonerila rivularis*	Mua	
85	*Thysanolaena maxima*	Chít	
86	*Sacchanrum odoratum*	Lau	
87	*Phragmites maximus*	Sậy	

G: Timber species

LT: Food species

TA: Animal foods

TH: Medicinal herbs

C: Bonsai plants

TDK: Other usable values

DN: Resin

CĐ: Firewood