Integrated local knowledge in implementing forest allocation policy in Central Vietnam: potential use of local indicators in forest monitoring.

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1. Introduction

In forest management, monitoring activity is always considered time- and resource-consuming. In order to design an appropriate monitoring system, most efforts are invested in staff training and techniques application (tools and practice). With an urgent need on information at acceptable accuracy, several scientists have proposed use of indicator to monitoring forest status. Several examples come from research by scientists such as ants as bioindicator to monitor biodiversity of Australia's rangelands (Andersen 2004), birds as ecological indicator of forest condition (Canterbury 2000), herbaceous plants as indicator for function of an area of wetland (Cole 2002), understory plant species as indicator for impacts of military activities on longleaf pine (Dale 2002), or understory herbs as indicator for deciduous forest restoration (McLachlan 2001). Most of these studies, however, employ academic research methods that require high qualification either to apply in reality or difficult to use by local people in developing countries. Moreover, there are no researches or applied work related to using local knowledge, especially indicator concept, for forest monitoring purpose. The main reason is that most of local knowledge is not integrated in development and conservation project work at from the beginning of these programs. Besides, there is a fact that difficulties in collecting and validating this source of knowledge is not focused appropriately. Several projects just take local knowledge as source of information for writing proposal to get project approved. Others conduct survey on local knowledge as 'description' report that is normally contracted by donor or following either too general (e.g. sustainable development) or too narrow (e.g. soil differentiation) topics. Finally, most of this survey often uses local knowledge in short time as stipulated in contract, research period, or amount of money invested.

In Vietnam, study on local knowledge of indicator is very limited. Normally, research on indicators is often integrated in traditional knowledge collection. Most of them are conducted by organizations or persons who are working with projects related to general development or conservation issues. Some examples are Research Center for Forest Ecology and Environment in Forestry Science Institute of Vietnam (FSIV) working mainly in Northern mountainous Vietnam; Center for Indigenous Knowledge Research and Development (CIRD) working in the North and Central north of Vietnam. These two centers are working mainly in conservation and rural development. There is another research by Dien (2002) in Tuyen Quang province in Vietnam-Netherlands Research Program about indigenous knowledge applied in natural management. Recently, a consultant report on indigenous knowledge, cultural characteristics, and livelihood strategy of local people in one central province of Vietnam (Quang Tri) was carried out as one section in Rural Development Project by Finland. Most of work in local knowledge mentioned above just focuses on description of knowledge system of local residents in general manners such as land use practices or product harvesting experiences.

This paper tries to explore how local people define their forest by using indicators species and potential use of these findings integrated in forest allocation process. At first, a list of all plant species that have potential use as indicators is recorded through individual interview and group discussion. This list is then re-arranged in general forest categories according to local definition. Following step is forest survey by plots which are selected randomly from allocated forest within two communes. At each plot, information about list of these aforementioned species is recorded in corresponding with local categories. Finally, comparison between forest categorization by local system and by government system is made to find out similarities and differences. Findings from this analysis are then used to propose more local-oriented participation in forest allocation policy.

2. Concepts and uses of indicators in local context

As general judgments, using indicators is normally occurred when there is an urgent need on information about specific interest meanwhile resource conditions (time, finance) are not sufficient enough. Indicators are, therefore, selected for meeting the demand on information with acceptable accuracy at reasonable cost (NAS 2000). In order to collect information quickly about the status of forest, conservation biologists have used concept of 'surrogate species'. These species are often represented for several characteristics of a habitat or status of specific group of species or particular status of environment which are difficult to measure or cannot measure directly. Therefore, they are named as 'surrogate' species which are normally under three major forms: umbrella species, flagship species, and indicator species. An umbrella species is defined as a species whose conservation is expected to confer protection to a large number of naturally co-occurring species (Roberge 2004). In fact, umbrella species is often used for setting minimum size of area or group of species for conservation purpose. Flagship species are used to raise awareness or attract funding to a conservation cause (Caro and O'Doherty 1999). Finally, indicator species is often understood as "an organism whose characteristics (presence of absence, population density, dispersion, reproductive success) are use as an index of attributes too difficult, inconvenient, or expensive to measure for other species or environmental conditions of interest" (Landres et al. 1988).

Conservation biologists have applied biodiversity indicators in different ways with various judgments. Some scientists use indicator species, others emphasized on using a group of species based on the critique that single species does not encapsulate all information of other taxa (Noss 1990). Consequently, critics of single-species studies are calling for approaches that consider higher levels of organization such as ecosystems and landscapes (Noss and Harris 1986; Noss 1990; Salwasser 1991; Hobbs 1994). Recently, Failing & Gregory (2003) have seriously identified 10 common mistakes in developing and using forest biodiversity indicators from the standpoint of making better forest management choices. The mistakes relate to a failure to clarify the values-basis for indicator selection and a failure to integrate science and values to design indicators that are concise, relevant, and meaningful to decision makers. They result in frustrated professionals, a confused public, an inability to assess performance with respect to key forest policy objectives and, almost certainly, types and amounts of biodiversity conservation that fail to achieve either scientifically or socially preferred levels.

The accuracy and relevance of indicator species with its indicating subjects are still remaining debated. In sense of application, however, none of scientific research have searched indicator from the knowledge base of local people who expressed themselves as good examples of close link with their living environment. If we can use local knowledge filtered and assembled in form of ‘local indicators’, we may find out potential uses for a particular purpose such as forest monitoring on specific forest type or a threatened wildlife species. By using this source of knowledge, we can save our time in finding relationship among living things or non-living things in local context for specific objectives such as conservation practices of local people with soil characteristics. Moreover, the word ‘local indicators’ here means that these indicators come from knowledge of local people who have been living in those areas for a long time. Thus, their knowledge was accumulated through their daily activities on forestry, farming, fishing, and other fields. Integrated this source of knowledge will help local people feel more self-confident in their ability to carry out conservation and development activities.

In Vietnam, the process of decentralization in forestry management started since 1986 associated with ‘Doi moi’ (Renovation period). However, clear evidence just began from year 2000 with series of policies stated about role of local people in forest and forest land management at household and community level. One of them is Decision 178 by Prime Minister on allocating forest (including natural forest, planted forest, forestry land without forest cover) to household and group of households for long-term management and gaining benefits from allocated forest areas. The process is various from district to district but generally including following steps. At first, a *participatory land use planning* is carried out to categorize different types of landuse in locality and total areas of land resource available for allocation. Follow-up is a meeting with local people to get comments on land use planning strategy and inform local people about their rights and duties when receiving forest areas as stipulated in Decision 178. In this step, group of households are voluntarily established by local people themselves depend on their kinship, their interest or their residential distance. Survey on forest is done to draw a map of allocation with relevant attributes such as type of forest, forest stock, and location of specific area for each group of households. Final step is allocating forest area to predetermined group of households in field. Number of groups in one village is different from the other. In average, this number is ranged from one to five groups per village.

This study was conducted in Nam Dong district, a mountainous area in Central Vietnam which carried out Decision 178 at earliest stage. Despite great improvement in forest management, the implementation of this Decision sill has some shortcomings. Forest survey was only done in large scale levels (compartment or block) with limited number of plots due to shortage in financial and staff resource. Meanwhile, forest area is allocated by small areas (coupes) for each group of households. This different approach has created a poor data for household record in management of allocated forest in future. In addition, concept of ‘participation’ from local people is only confined within several meeting regarded to introduce content of the Decision such as rights, duties, and required procedures to receive forest. In another way, local knowledge is not concerned during allocation process. As a result, local people do not know about their forest status before receiving in such a way of their understanding. If they do not know clearly about the actual status of their forest, they will not be able to manage the forest in an optimal way.

3. Materials and Method

1. Study sites:

Nam Dong district is located in southwest of Thua Thien Hue province in central Vietnam (Figure 1). With total area 650.5 km^2, average density is 33.5 people /km^2 calculated base on total population 21.800 people. Apart from Kinh ethnic as majority here (59.4%), rest of population are Katu ethnic minority (40.6%). There are 78.7% of labors are working on agriculture and forestry sectors due to large area of forest land (64.5%) and agriculture land (5.3%). Three communes of Nam Dong district are selected for this study. They include Thuong Quang, Thuong Long, and Huong Son. Majority of local people are Katu ethnic groups. They are highly dependant on forest resources for daily income and foodstuff. Forest areas account for 65%, 68%, and 51% in these communes, respectively. All three communes are allocated natural forest area for long-term management with land use certificate (LUC). This allocation was mainly based on Decision 178 as described above.

2. Methodology:

In order to collect information on local indicators applied in forest categorization, a questionnaire is designed in format of forest type by disturbance factors. At first, we hold meeting with groups of local people who are knowledgeable on forest resource and forest uses. In this meeting, concept on three forest categories was agreed based on types of disturbance. As local understanding of government system on forest categorized by disturbance types, there are three forest categories by disturbance factors namely forest after swidden (SWF), selected logging forest (SLF), and relatively intact forest (RIF) (Table 1). A tabular form of questionnaire was designed to collect information on potential indicator species from 118 interviewees in two communes namely Thuong Quang and Huong Son.

All of these interviewees are selected by purposive sampling techniques. At first, village heads and commune staff are consulted to help selecting list of interviewees who have such characteristics as long residence in village, having career related to forest uses or agroforestry practices (e.g. swidden agriculture), and experienced in uses of forest and forest land. In addition, some of them have received forest following allocation policy (i.e. Decision 178). The last criterion helps to select allocated forest to make survey for collecting information on indicator species which are recorded after interview step. A group meeting at every village is made after individual interview in order to get agreement or comments for list of potential indicator species. Those species with high level of recorded frequency are put at top of comparison with data from forest survey to test their level of indication. We combine this criterion with other three criteria suggested by scientists in selecting local indicators for forest disturbance level. Those criteria include (i) sufficiently sensitive to provide early warning (Noss 1990); (ii) Representative of critical components, functions, and processes (New 1995); and (iii) taxonomically well-known group, readily identified, taxonomic expertise readily available (Stork 1994).

In order to test level of indication of selected species from key informant interview, we set up 60 plots in two forest types (SLF and RIF as definition mentioned above) in two communes (Table 2). All plots are selected randomly from forest allocated to groups of household in both communes. Each plot has an area of 314 square meters in round shape as methods used in

International Forestry Resources and Institutions (IFRI) Research Program (Ostrom, 2004). Information about all plant species is recorded in every plot by Forest Plot Form (Form P) in IFRI and by field diary. Forest survey at each commune was done with at least two local people from the group who provide list of species in the interview. Scientific names of each plant species are identified at Faculty of Forestry, Hue University of Agriculture and Forestry.

Indicator value (IV) of each species was calculated using the method of Dufrêne and Legendre (1997). This IV was combined between relative abundance and relative frequency values. All data are run by PC-ORD software (McCune et al., 1999).

4. Results

1. *Potential indicator species from interview of local people*

Total 118 key informant people were interviewed on plant species that can be used as indicators for forest status. From preliminary survey, we screened 25 plant species from local knowledge on their relative abundance and relative frequency in different disturbed forest types. These species then were ranked based on highest number of respondent in Table 3.

When the same species appears in both forest types, higher respondent value is used to select forest type in which this species is occurred.

In selected logging forest (SLF), species that have highest relative abundance are recorded in families of Myristicaceae, Poaceae, Apocynaceae, Arecaceae, and Gnetaceae. Among these species, Horsfieldia amygdalina (Sang mau) get highest frequency of respondent. There are two species in Arecaceae family in this top group namely May (*Calamus spp.*) and La non (*Rhapis laosensis*). Majority of species in this list are either shrubs, bamboo, or palms.

In Relatively intact forest (RIF), most of respondents refer to woody tree as potential indicator. Most of species are appeared in families such as Dipterocarpaceae, Caesalpiniaceae, Sapotaceae, and Sapindaceae. Arecaceae family also provides two species as in SLF.

2. *Indicator species from IFRI forest database:*

Our second data source of potential indicator comes from IFRI forest survey plots. In each plot, we measure seedling, saplings, and trees separately. In order to yield potential indicator species, we test indicator value (IV) of saplings and trees since these two measurements are commonly used by local people in identifying indicators. Results are shown in Table 4.

There are 20 species which appear to be potential indicator for different disturbed forest types. They have high indicator values as well as statistical significance through Monte Carlo test (which included in PC-ORD software). Among these species, 6 species can be good indicators for relatively intact forest. They include *Schefflera octophylla* (Chan chim), *Gironniera subaequalis* (Ngat), *Nephelium cuspidatum* (Vai thieu rung), Alangium ridley (Nang), *Elaeocarpus griffithii* (Com la rong), and *Cratoxylon ligustrinum* (Thanh nganh). Five species are potential indicator for selected logging forest namely *Scaphium lychnophorum* (Uoi), *Croton cascarilloides (*Cu den la bac), *Knema pierrei* (Mau cho la lon), *Barringtonia macrostachya* (Tam lang), and *Nephelium sp.* (Truong vai). These species are selected based on high indicator value and statistical significance (P value is less than 0.005).

3. *Comparison between local interview data and forest survey data on list of potential indicator species*

In order to explore possibility of using local knowledge integrated in forest monitoring, we compare list of potential indicator species between data of local interview and that of forest survey (Table 5). We found that four species appeared to be good indicators resulted from both local interview and forest survey data. These species include *Schefflera octophylla* and *Gironniera subaequalis* (for relatively intact forest); *Gonocaryum maclurei* and *Horsfieldia amygdalina* (indicator for selected logging forest). One species (*Scaphium lychnophorum*) apprears to be different between local knowledge with forest survey data. From local people interview, *Scaphium lychnophorum* (Uoi) indicates for relatively intact forest meanwhile forest data testing shows that this species can be used as indicator for selected logging forest. This difference will be mentioned in discussion part.

5. Discussion

1. *Similarities and differences between results of local knowledge and forest survey data on selection of indicator species*

Among forty species in combination of both local knowledge and forest survey, four species are found to be potential indicator for two disturbed forest types. This result shows that local knowledge can be used in developing indicator species for different disturbed forests. However, there are several different details among these species even although results of identifying them are similar. Among two species that can be indicator for relatively intact forest, *Schefflera octophylla* (Chan chim) has higher indicator value (IV) compared with *Gironniera subaequalis* (Ngat) in forest survey data. Meanwhile, results from local interview show that *Gironniera subaequalis* yields higher respondent value over *Schefflera octophylla*. One possible reason for this difference in local knowledge is from local uses of these two species. In survey, local uses of *Ngat* are more intensive for house construction and handle of production tools. On the contrary, *Chan chim* seems not provide any use in local knowledge. Those species that provide more uses are often recorded by local people than those of less uses. Therefore, the relative abundance of Chan chim is higher in natural condition while higher respondent value is given to Ngat due to its frequent uses.

Similar results for two species indicating for selected logging forest. Local uses of trees affect results of interview respondent. Between *Horsfieldia amygdalina* (Sang mau) and *Gonocaryum maclurei* (Cuong vang), the former is small or medium size trees. The latter are in shrub form and less values for local uses. In natural conditions, both species have similar IV (42). In summary, local uses can influence abundance of one species and therefore indirectly make results of IV different from others.

An exceptional case of seeking indicator species is occurred with *Scaphium lychnophorum* (Uoi). This is a multi-purpose species. Its fruit can be used as natural ‘agar-agar’ for drinks with high market value (Ho Hy, 2005). Its timber is soft and light using for ply wood production. Due to special characteristics on morphology and phenology (height, long-life fruit time), it is difficult to harvest fruits of this tree during its fruiting season. The only way that local people can harvest fruits is to cut down the whole tree. Therefore, this tree is recorded in Red Book of Vietnam (Plant section) and was prohibited for harvesting due to its destructive harvest. In ecological theory, this species is light-demanding tree and appears in upper part of forest canopy. The regeneration, therefore, is always occurred in condition of light exposition. Consequently, result from forest survey shows that this species is occurred in selected logging areas at high relative abundance and relative frequency (i.e. occurrence in most of plots). Local people, however, responded to interview by their knowledge about mature trees and appearance. The outstanding height and recorded number of mature trees can influence local people when giving information on this species. The occurrence of Scaphium lychnophorum was also recorded at high frequency in poor forest (see Ho Hy, 2005).

2. *Issue on methodology*

Testing indicator species from local knowledge seems to be difficult because it related to questionnaire design and interview techniques. In details, a questionnaire requires fully understanding of concept on 'indicator species' and explained clearly to local people. Knowledge of local people on different species varies from person to person. Especially, respondent answer on a particular species is much dependant on their perception of uses and frequency of encountering that species in reality. Local preference on uses of specific plant is really important in identifying indicator species. If one species is very much abundant in natural condition, record on its occurrence may be very low if it has no value to local people.

Local responses on indicator species also depend on their knowledge of living forms, stage of growth, and special features of a particular species. For example, local people can easily identify a good timber tree species rather than a woody climber. Results of our study show that local people are more knowledgeable on trees and shrubs than seedlings.

3. *Potential uses of local indicator in forest allocation program*

Currently, forest allocation program is being carried out in Nam Dong district. This allocation, however, did not integrate local knowledge during its implementation. Therefore, some conflicts on forest boundary and forest types have occurred. Identifying correct disturbed forest types is really important of allocation program since it relates to future harvest scheme and future benefits. Using indicator species can be a tool to identifying forest types agreed by both government system and local knowledge. As a result, conflicts on uses and harvest mechanism can be achieved in allocation file of forest management.

One of most important value of local-based indicators is their use of monitoring forest disturbance by the time. By recording these indicator species, we can update more information on number of indicator species as well as their indicator value (relative abundance and relative frequency) by the time. Their indicator value can help to describe disturbed forest types and trend of disturbance level.

6. Conclusion

Local knowledge on indicator species shares similar results with scientific research. From list of plant species found in Nam Dong district, four of them can be used as indicator species: two species for relatively intact forest and two species for selected logging forest. Results also show that local uses and biological characteristics of plant species have much influence on research results. Therefore, questionnaire design are very much important in local interview to get information on indicator species. These results can be integrated in forest allocation program to help reduce conflict on identification of forest boundary and forest types.

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Table 1: Forest types by government system (followed QP 84/1984)

Forest types	Description	Local uses
Nuong ray cu (Swidden forest-SWF) Category: IIA	- Swidden was completely banned since 1990 - Dominant by pioneer species, bamboo, shrubs, and vines. - DBH are small (<20cm)	- Used to grow cassava, maize, and dry rice. - Recently clear for rubber plantation
Rung khai thac chon (Selected logging forest– SLF) Category: IIIA1	- Remaining logs - Forest gap with pioneer and shade-tolerant plant species - Relatively equal DBH size	- Fuel wood collection - Tools for home production - Some kinds of NTFPs
Rung gia (Relatively intact forest – RIF) Category: IIIA2	- Dominant by native species such as Cho, Kien, Sen, Lim xanh, Tram chua - Long distance from residential place - Signals of wildlife animals	- Wood for house construction - NTFPs in majority: rattan, fruits, honey, *la non*, mushroom - Wildlife hunting

Table 2: General information on surveyed forests

Characteristics	Forest sites		
	Thuong Quang	Huong Son	Total
Total natural forest area (ha)	10105.5	2167.5	12273
Total surveyed plots (10m radius), of which:	30	30	60
- Relatively intact forest (IIIA2)	21	0	21
- Selectively logging forest (IIIA1)	9	30	39
Number of families (in plots)	63	46	64
Number of species	135	106	151
Number of individuals	1087	1355	2442

Table 3: List of potential plant indicator species from local interview in two disturbed forest types

No	Species name		Family	Forest type	Respondent value
	Local name	Scientific name			
1	Kien	*Hopea pierrei*	Dipterocarpaceae	RIF	42
2	Lim xanh	*Erythrophloeum fordii*	Caesalpiniaceae	RIF	30
3	Cho	*Parashorea stellata*	Dipterocarpaceae	RIF	23
4	Gu	*Sindora tonkinensis*	Caesalpiniaceae	RIF	21
5	May	*Calamus spp.*	Arecaceae	RIF	20
6	La non	*Rhapis laosensis*	Arecaceae	RIF	19
7	Ngat	*Gironniera subaequalis*	Ulmaceae	RIF	14
8	Sang mau	*Horsfieldia amygdalina*	Myristicaceae	SLF	13
9	Uoi	*Scaphium lychnophorum*	Sterculiaceae	RIF	12
10	Dao	*Palaquium annamense*	Sapotaceae	RIF	10
11	Giang	*Ampelocalamus sp.*	Poaceae	SLF	10
12	Thung muc	*Wrightia annamensis*	Apocynaceae	SLF	10
13	Sen	*Madhuca pasquieri*	Sapotaceae	RIF	7
14	Chan chim	*Schefflera octophylla*	Araliaceae	RIF	6
15	Day gam	*Gnetum latifolium*	Gnetaceae	SLF	6
16	Bua	*Garcinia cochinchinensis*	Clusiaceae	SLF	5
17	Tram	*Syzygium spp.*	Myrtaceae	RIF	5
18	Bop bop	*Macaranga denticulata*	Euphorbiaceae	SLF	4
19	Danh rung	*Gardenia annamensis*	Rubiaceae	RIF	4
20	Hu day	*Trema orientalis*	Ulmaceae	SLF	4
21	Bai bai	*Mallotus barbatus*	Euphorbiaceae	SLF	3
22	Cuong vang	*Gonocaryum maclurei*	Icacinaceae	SLF	2
23	Huynh	*Tarrietia javanica*	Sterculiaceae	RIF	2
24	Bim bim	*Ipoemea sp.*	Colvolvulaceae	SLF	1
25	Mua	*Melastoma candidum*	Melastomataceae	SLF	1

Table 4: Result of finding indicator species from IFRI forest plots

No	Species		Family	Indicator value	Forest types	p *
	Local name	Scientific name				
1	Chan chim	*Schefflera octophylla*	Araliaceae	65	RIF	0.0010
2	Uoi	*Scaphium lychnophorum*	Sterculiaceae	56	SLF	0.0050
3	Cu den la bac	*Croton cascarilloides*	Euphorbiaceae	55	SLF	0.0010
4	Ngat	*Gironniera subaequalis*	Ulmaceae	51	RIF	0.0010
5	De gai	*Castanopsis sp.*	Fagaceae	51	SLF	0.0460
6	Mau cho la lon	*Knema pierrei*	Myristicaceae	50	SLF	0.0030
7	Tam lang	*Barringtonia macrostachya*	Lecythidaceae	44	SLF	0.0020
8	Sang mau	*Horsfieldia amygdalina*	Myristicaceae	42	SLF	0.0150
9	Cuong vang	*Gonocaryum maclurei*	Icacinaceae	42	SLF	0.0410
10	Truong vai	*Nephelium sp.*	Sapindaceae	41	SLF	0.0010
11	Vai thieu rung	*Nephelium cuspidatum*	Sapindaceae	39	RIF	0.0080
12	Truong sang	*Pometia pinnata*	Sapindaceae	38	SLF	0.0370
13	Nang	*Alangium ridley*	Alangiaceae	37	RIF	0.0040
14	Mit nai	*Artocarpus rigidus*	Moraceae	34	SLF	0.0370
15	Rang rang mit	*Ormosia balansae*	Fabaceae	31	SLF	0.0160
16	Com la rong	*Elaeocarpus griffithii*	Elaeocarpaceae	30	RIF	0.0040
17	Son lu	*Melanorrhoea laccifera*	Anacardiaceae	28	SLF	0.0110
18	Thanh nganh	*Cratoxylon ligustrinum*	Hypericaceae	24	RIF	0.0020
19	Dung san	*Symplocos cochinchinensis*	Symplocaceae	23	SLF	0.0260
20	Bach benh	*Eurycoma longifolia*	Simaroubaceae	23	SLF	0.0350

Table 5: Comparison between local knowledge and forest survey data on selecting indicator species for different forest types

No	Species		Family	Forest types in which species indicates for:		
	Local name	**Scientific name**		*Local knowledge*	*Forest survey*	*Similarity/ Diffrence*
1	Bach benh	*Eurycoma longifolia*	Simaroubaceae	-	SLF	
2	Bai bai	*Mallotus barbatus*	Euphorbiaceae	SLF	-	
3	Bim bim	*Ipoemea sp.*	Colvolvulaceae	SLF	-	
4	Bop bop	*Macaranga denticulata*	Euphorbiaceae	SLF	-	
5	Bua	*Garcinia cochinchinensis*	Clusiaceae	SLF	-	
6	Chan chim	*Schefflera octophylla*	Araliaceae	RIF	RIF	S
7	Cho	*Parashorea stellata*	Dipterocarpaceae	RIF	-	
8	Com la rong	*Elaeocarpus griffithii*	Elaeocarpaceae	-	RIF	
9	Cu den la bac	*Croton cascarilloides*	Euphorbiaceae	-	SLF	
10	Cuong vang	*Gonocaryum maclurei*	Icacinaceae	SLF	SLF	S
11	Danh rung	*Gardenia annamensis*	Rubiaceae	RIF	-	
12	Dao	*Palaquium annamense*	Sapotaceae	RIF	-	
13	Day gam	*Gnetum latifolium*	Gnetaceae	SLF	-	
14	De gai	*Castanopsis sp.*	Fagaceae	-	SLF	
15	Dung san	*Symplocos cochinchinensis*	Symplocaceae	-	SLF	
16	Giang	*Ampelocalamus sp.*	Poaceae	SLF	-	
17	Gu	*Sindora tonkinensis*	Caesalpiniaceae	RIF	-	
18	Hu day	*Trema orientalis*	Ulmaceae	SLF	-	
19	Huynh	*Tarrietia javanica*	Sterculiaceae	RIF	-	
20	Kien	*Hopea pierrei*	Dipterocarpaceae	RIF	-	
21	La non	*Rhapis laosensis*	Arecaceae	RIF	-	
22	Lim xanh	*Erythrophloeum fordii*	Caesalpiniaceae	RIF	-	
23	Mau cho la lon	*Knema pierrei*	Myristicaceae	-	SLF	
24	May	*Calamus spp.*	Arecaceae	RIF	-	
25	Mit nai	*Artocarpus rigidus*	Moraceae	-	SLF	
26	Mua	*Melastoma candidum*	Melastomataceae	SLF	-	
27	Nang	*Alangium ridley*	Alangiaceae	-	RIF	
28	Ngat	*Gironniera subaequalis*	Ulmaceae	RIF	RIF	S
29	Rang rang mit	*Ormosia balansae*	Fabaceae	-	SLF	
30	Sang mau	*Horsfieldia amygdalina*	Myristicaceae	SLF	SLF	S
31	Sen	*Madhuca pasquieri*	Sapotaceae	RIF	-	
32	Son lu	*Melanorrhoea laccifera*	Anacardiaceae	-	SLF	
33	Tam lang	*Barringtonia macrostachya*	Lecythidaceae	-	SLF	
34	Thanh nganh	*Cratoxylon ligustrinum*	Hypericaceae	-	RIF	
35	Thung muc	*Wrightia annamensis*	Apocynaceae	SLF	-	
36	Tram	*Syzygium spp.*	Myrtaceae	RIF	-	
37	Truong sang	*Pometia pinnata*	Sapindaceae	-	SLF	
38	Truong vai	*Nephelium sp.*	Sapindaceae	-	SLF	
39	Uoi	*Scaphium lychnophorum*	Sterculiaceae	RIF	SLF	D
40	Vai thieu rung	*Nephelium cuspidatum*	Sapindaceae	-	RIF	

Figure 1: Map of the study areas