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Setting Up Locally Appropriate Ecological Criteria and Indicators to Evaluate Sustainable Forest Management in Dinh Hoa District (Northern Vietnam)

Anna Stier, Jutta Lax and Joachim Krug
Johann Heinrich von Thünen-Institute (vTI), Federal Research Institute for Rural Areas Forestry and Fisheries, Institute for World Forestry
Germany

1. Introduction

The forests of Vietnam provide a high conservation value considering habitat diversity despite massive forest destruction within the last decades (World Bank, 2010). Following recent studies Vietnam is one of the 34 biodiversity hotspots in the world (Indo-Burma hotspot) (Myers et al., 2000; Brooks et al., 2002; World Bank, 2010; Werger and Nghia, 2006), but at the same time one out of eight tropical forest hotspots which will lose the largest number of species by cause of deforestation (Brooks et al., 2002). The impacts of the forest environment – and its ongoing degradation – on local socio-economic factors cannot be neglected. Actually, Vietnam has been defined as an archetypal case for a positive correlation between a high forest cover and a high poverty rate combined with a low poverty density (Sunderlin et al., 2007). In other words, regions with high forest cover are often sparsely populated but after all are among the poorest of the country. Forests are populated by the poor, but it is nowadays also an evidence that it is the poorest households which generally depend more on forests (Cavendish, 2003; Wunder, 2001), deriving several goods, income and services from them (Arnold, 2001; Dubois, 2002).

Human and ecological factors in Vietnam make it a candidate for the implementation of sustainable forest management (SFM) with the objective of win / win solutions for both human well-being as well as forest ecosystems (Sunderlin and Ba, 2005). The recently implemented forest management types defined by the government had to face wide criticism concerning their success in reaching such win / win objectives, such as the existing gap between state intentions and local applications of policies, the poor involvement of households in the forestry sector and their insufficient payment for protection activities, or the disturbance of traditional land-use systems (Clement and Amezaga, 2008; Boissière et al., 2009; Sunderlin and Ba, 2005; Wunder et al. 2005). In the course of national decentralisation processes the former state organised forest enterprises were fragmented and land / forest was reallocated to communities and private stakeholders. It is essential to record and compare the different stakeholder perceptions concerning SFM to elaborate adequate criteria and indicator (C&I) sets to be able to measure the sustainability of current forest management regimes (Karjala et al., 2004; Sherry et al., 2005; Ritchie et al., 2000).

The national Vietnamese set, based on Forest Stewardship Council standards, has not been finalized and accepted yet because of the lack of local consultation (anonymous personal communication). The mostly used sets, based on expert consultations, give results which often differ from local needs (Pokharel and Larsen, 2007; Purnomo et al., 2005; Adam and Kneeshaw, 2008; Sherry et al., 2005). By experience the ecological elements demonstrated the highest similarity among C&I frameworks (Purnomo et al., 2005; Sherry et al., 2005; Adam and Kneeshaw, 2008). It has still to be tested how far local perceptions differ from institutional ecological C&I sets in the case of Dinh Hoa, and how far they differ among different local communities depending on different forest management types. Accordingly an ecological C&I template that is appropriate to Dinh Hoa District for SFM assessment was set up, by:

1. Comparing local perceptions of SFM with those from institutional top-down approaches (comparing the sets from local communities with the sets resulting from national, province and district level workshops); and
2. comparing local perceptions between forest use type categories (comparing the sets from communities which hold high proportions of special use, protection and production forests).

2. Material and methods

2.1 Study site

Dinh Hoa is a district of the Thai Nguyen province in Northern Vietnam where forest land represents 68,7 % of the total area in 2005, with 33,0 % of it being classified as planted forest (Data provided by the Agriculture and Rural Development Department of Dinh Hoa). The high forest cover, combined with a high population density (189 habitants / km^2) results in high pressure on the forest resources.

All Vietnamese forest use types are represented in the district: special use forest (8 728 ha, 24 % of the forest area), protection forest (7050 ha, 20 % of the forest area) and production forest (20 009 ha, 56 % of the forest area) (The Prime Minister, 2008).

Following the law on forest protection and development of December 3rd 2004 (The President of the Socialist Republic of Vietnam, Tran Duc Luong, 2004) and by declaration of the department of policy and rural development (FAO and RECOFTC, 2000), the objectives of the forest use types / categories are defined as followed:

Special-use forest is predominantly related to the conservation of nature, scientific research and protection of landscapes and historical / cultural relics. Management boards directly manage these forests. Contracts are made on long-term basis with households for ecological restoration, afforestation and protection. Households are entitled to collect dead wood for self consumption.

Protection forest mainly fulfils protection purposes as to protect water sources and land, to prevent erosion and desertification, restrict natural calamities and regulate the local climate. Management boards make contracts with households, communities, individuals or organizations to protect and regenerate forestland. Contracted stakeholders possess some restricted utilization rights.

Production forest is managed mainly for the production and trading of timber and non-timber forest products. It includes natural and planted production forests.

2.2 Set development

Criteria and Indicator sets were built up through three workshops with forest management experts (top-down method where a generic set was modified using multi-criteria decision making) and group discussions with 12 local villages (bottom-up method where sets were elaborated from local visions) (Fig. 1), resulting in 6 criteria and 27 indicator (see Tab. 3a and 3b). These sets were then compared and compiled to a final set for all forest use types of the Dinh Hoa District, and the differences between the sets were analyzed.

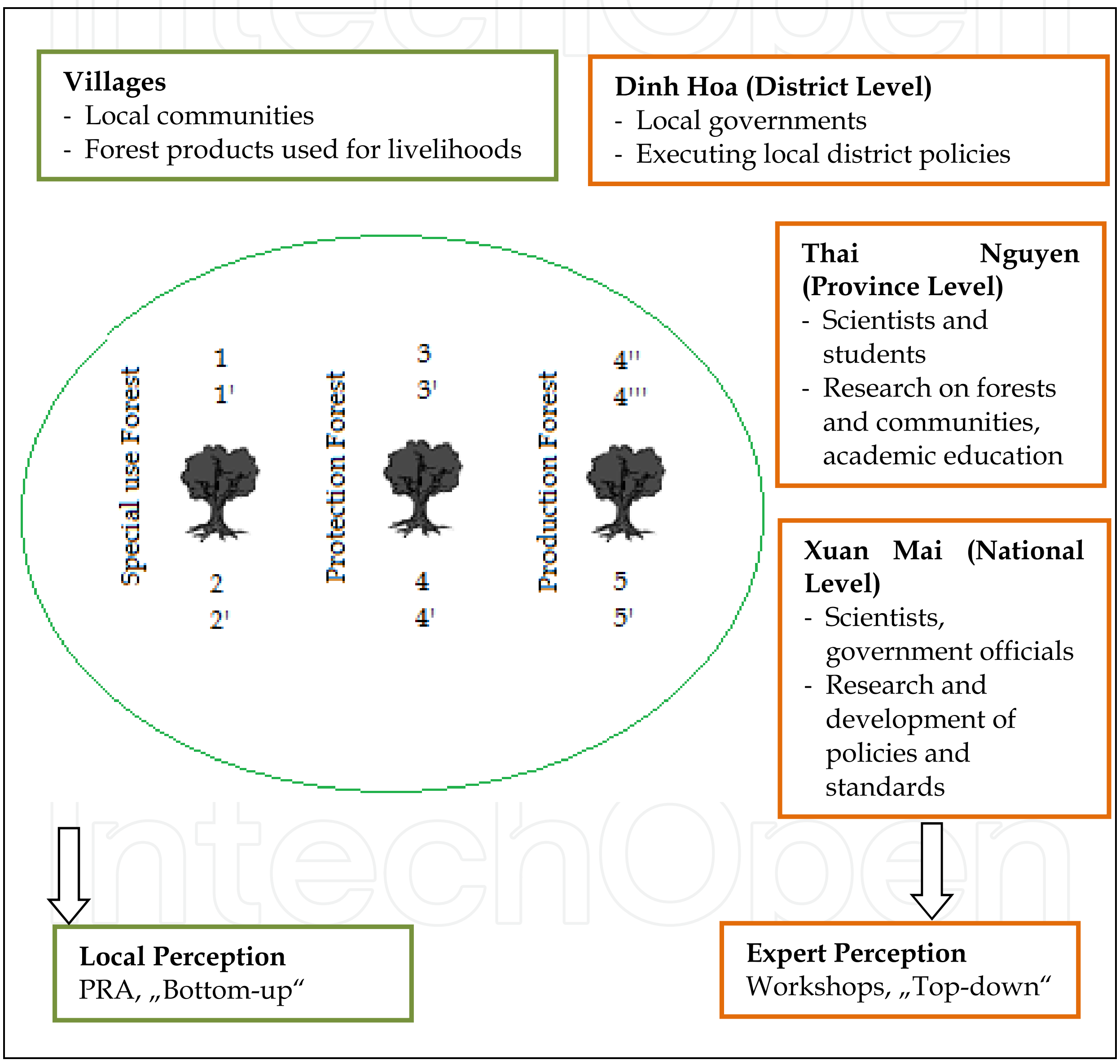


Fig. 1. Conceptual Framework of Dinh Hoa forests. The figure displays the connections of the forest concerned stakeholders to each other and towards the forest. The Bottom-up approach was implemented in twelve villages from five communes, meaning four villages from two different communes per forest use type. The Top-down approach was implemented through three workshops at national, provincial and district level. 1 and 1′, 2 and 2′, etc.: two villages belonging to the same commune.

2.2.1 Top-down approach

A generic set was built up through the combination of already existing templates:

- The **CIFOR** (Centre for International Forestry Research) generic template (CIFOR, 1999b);
- the **ITTO** set (ITTO, 2005); as the set was designed for tropical forests and focus on South-East Asia;
- **Lepaterique** (Anon., 1997) and **Tarapoto** (ACT, 1995) ; for further inputs concerning tropical forests;
- **Regional Initiative dry Forests Asia** (Anon., 1999) ; for further directions concerning Asia in general, inter alia because it is applied in countries close to Vietnam like Thailand;
- **MCPFE** proposal (MCPFE, 2003) ; an external example showing efficient methods to work towards a relevant C&I set; and
- **a local set of C&I** elaborated in Dinh Hoa in 2009 for elements and formulations that had already demonstrated their effectiveness for the region.

This generic set was modified during three workshops from May to June 2010, at national (Xuan Mai University of Hanoi), province (Thai Nguyen University of Agriculture and Forestry) and district level (Cho Chu, the Dinh Hoa District centre). The participants could eliminate, modify and add elements to the set.

Three tools were used during these workshops: rankings, ratings and pairwise comparisons, following the Multi-Criteria Decision Making (MCDM) application guidelines from CIFOR (CIFOR, 1999a), and its applications (Mendoza and Prabhu, 2000a; Mendoza and Prabhu, 2000b; Andrada II and Calderon, 2008; Gomontean et al., 2008; Ritchie et al., 2000). The proceeding lead to one final C&I set per workshop.

2.2.2 Bottom up approach

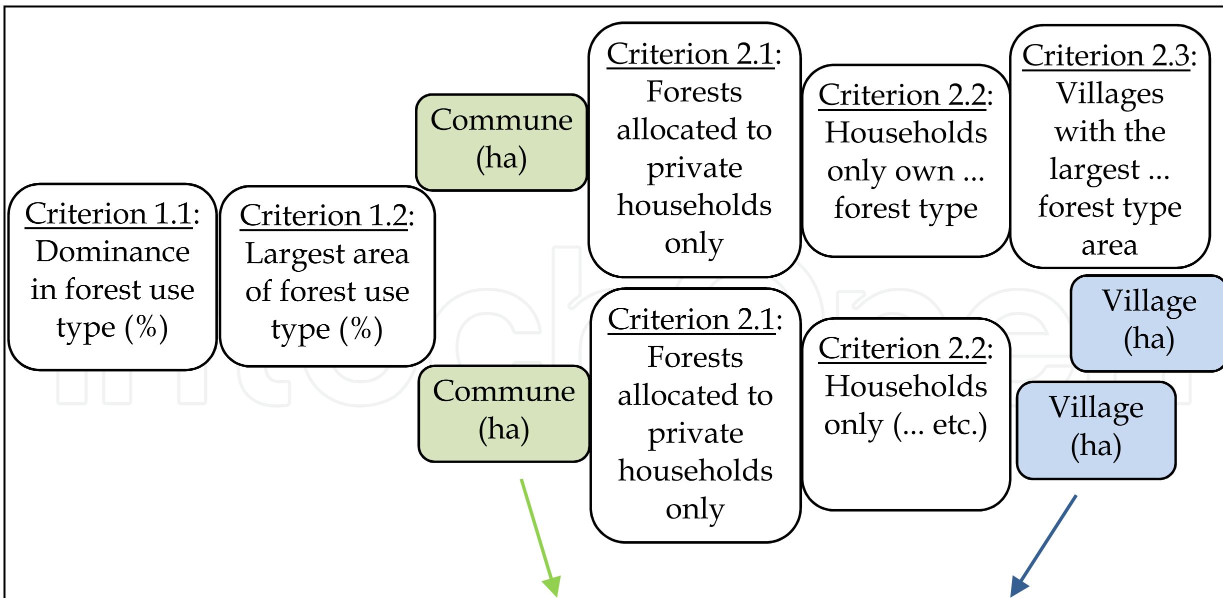
Sampling design:

The communes and the villages for the Participatory Rural Appraisal (PRA) were chosen following the decisional framework presented in Fig. 2: For each forest use type, two communes with territorial dominance of the concerned were chosen. Only those villages were chosen where the forest area is managed solely by households (Criterion 2.1) and belong exclusively to the forest function of interest (Criterion 2.2). Then, the two villages with the largest forest area were chosen for the Participatory Rural Appraisal (PRA) (Criterion 2.3).

In each village, 15 participants were chosen for the PRA method, including five people representing the village organizations and 10 households owning forest. The five representative villagers included the head of the village as well as representatives of the old soldier union, the farmer association, the women association and the youth union. The 10 households per village were chosen by respecting equity in gender, age, well-being and educational level.

Participatory methods and tools:

PRA tools were used at village level during half day group discussions. These discussions took place in the Fig. 2 mentioned villages, during July 2010. The tools included participatory mapping, open ended questions, semi-structured questionnaires and brain storming sessions, leading to one set of ecological C&I per village.



Criterion 1.1	Commune	Village
Special use forest	Phu Dinh (88 %), 1 755,8 ha	Dong Keu (100 ha)
		Dong Giang (44 ha)
	Diem Mac (76 %), 7 61 ha	Binh Nguyen 2 (57 ha)
		Ban Bac 4 (10 ha)
Protection forest	Quy Ky (80 %), 4 173,5 ha	Dong Hau (590 ha)
		Khuoi Tat (502 ha)
	Lam Vi (34 %), 1 052,4 ha	Na Tat (269,9 ha)
		Ca Do (51,4 ha)
Production forest	Lam Vi (53 %), 1 620,5 ha	Lang Co (106,6 ha)
		Ban Cau (102,5 ha)
	Phu Tien (99 %), 910,2 ha	Xom 2 (95 ha)
		Xom 5 (95 ha)

Fig. 2. Decisional framework for village selection. For each forest use type, two communes with territorial dominance of the concerned type (in % of the commune's forest area and ha) were chosen.

2.3 Analyzing methods

2.3.1 Final set elaboration

A consolidated list of indicators was generated with all proposed elements from all the workshops and PRA sessions. This list was used as a basis for comparison, so that the presence of an element in both consolidated and stakeholder list was coded as "1" whereas the absence of element analogy was coded as "0" (Tab. 1).
The final C&I set should have both expert and local population acceptance, and be applicable to all forest use types. Regarding the single forest use type, only elements accepted by more than 50 % of the workshops and villages were accepted. The same

counted for new elements proposed by villages which got incorporated if they were proposed by more than 50 % of villages under each forest use type (Fig. 3a and 3b).

Stakeholder	Indicator 1	2	3	...	27
Workshop 1	1	1	1	…	0
Workshop 2	1	0	0	…	0
Workshop 3	0	1	0	…	1
Village 1	1	1	0	…	1
Village 2	0	0	1	…	1
...	…	…	…	…	…
Village 12	1	0	0	…	1

Table 1. Binary representation of the stakeholders' perceptions (note: This table is made up and does not contain data of the study).

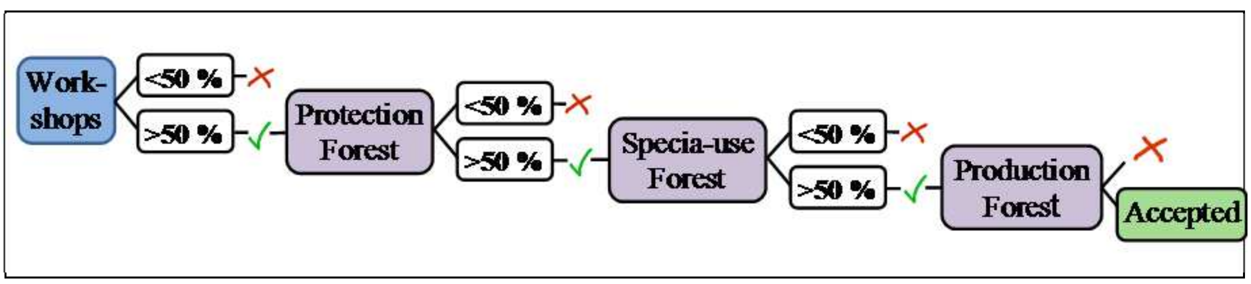


Fig. 3. Decisional Framework for the final set elaboration of indicators. To be accepted in the final list, an indicator had to be accepted by minimum 50 % of the expert workshops and 50 % of the villages for each forest use type.

2.3.2 Cluster analysis

One key objective was the identification of commonalities or differences within the participants' perceptions concerning the local value of ecological indicators suitable for the assessment of sustainability of forest management. Cluster analysis allows the identification of uniform groups of data within a data set (called clusters), meaning groups of data that have sufficient similarities. Cluster analysis has already been applied to analyze perceptions of different stakeholders concerning C&I (Purnomo et al., 2005). Following Gower and Legendre (1986), the simple matching coefficient is used as similarity coefficient. This coefficient is calculated as follows (Gower and Legendre, 1986):

$$S = (a+d)/(a+b+c+d)$$

with S the similarity coefficient and the standard notation a for the number of (+, +) matches, b for (+, -), c for (-, +) and d for (-, -).
Considering the made up data for workshop 1 and 2 and the example indicators 1, 2, 3 and 27 in Tab. 4, the similarity coefficient would be $S = (1+1) / (1+2+0+1) = 2 / 4 = 0,5$.

Given these similarity measures for all possible pairs of stakeholders, the data was organized into useful / meaningful groups, so that those within each group (cluster) were more closely related to one another than subjects in different clusters. Hierarchical clustering can either follow *agglomerative* or *divisive* methods (Janssen and Laatz, 2010; Manning et al., 2008). The output can be illustrated by a so called dendrogram (Fig. 4).

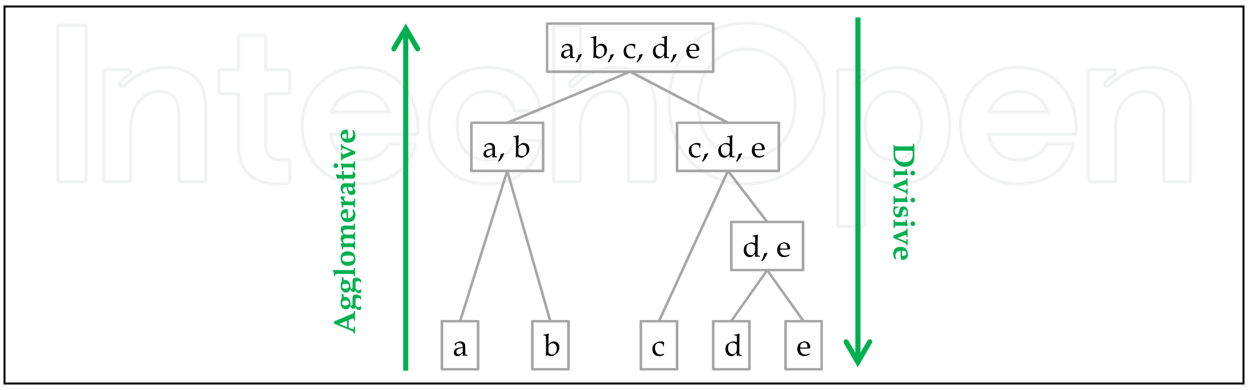


Fig. 4. Example of a dendrogram with fictive data. The agglomerative method makes series of fusions of the n objects into groups whereas the divisive method separates n objects into finer groupings.

As a result of various ways of calculating the distance between the clusters (Janssen and Laatz, 2010; Manning et al., 2008), different fusion procedures exist for the agglomerative method. In *single linkage*, the distance between two clusters is given by the value of the shortest link between two objects of the two clusters. In *complete linkage*, the distance between two clusters is given by the value of the longest link between two objects of the two clusters. In *group average linkage,* the distance between two clusters is defined as the average of distances between all pairs of objects, where each pair is made up of one object from each cluster (Fig. 5). This type of linkage appears to be the most useful for this study, because it takes into account all the possible pairs of distances between the C&I sets.

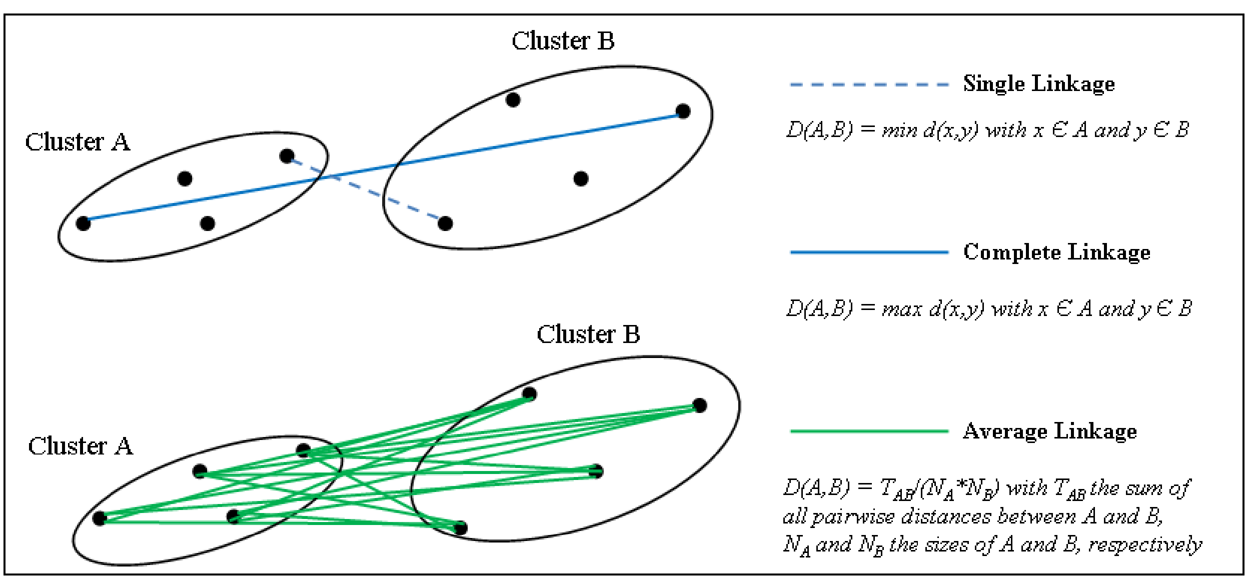


Fig. 5. Examples of three linkage calculation methods (adapted from Manning et al., 2008). The average linkage method is used in this study for its use of all possible pairs of elements.

2.3.3 Hypotheses testing

The cluster analysis evaluates the similarities of perceptions among the stakeholders based on all pairs at once, but it does not allow drawing conclusions about the analogy of the perceptions between stakeholders. In fact, a cluster can indicate a high similarity within its subjects, and still display significant differences among them when tested pair wise. Finally two hypotheses were tested. The first hypothesis was the similarity of perceptions between the villages and the experts. This test is relevant because experts play a decisional role in law and policy making although the results are implemented at local level. The second test concerned the similarity of perceptions between villages managing different forest use types. The data indicating the absence or presence of an indicator against a consolidated reference list of indicators is of binary character. Thus, the Phi coefficient [mean square contingency coefficient] was calculated (Janssen and Laatz, 2010). To test the significance of this Phi coefficient, the Pearson Chi-square was applied if the expected cell frequencies were all ≥ 5, otherwise the Fisher exact probability test was used (Janssen and Laatz, 2010; Sachs, 2002), both with a significance level of α = 0,05. The hypotheses were:

H0: Perceptions of X and Y are not associated   *H1: Perceptions of X and Y are associated*

If there is no association between variables, the answers of stakeholders are independent, meaning that the C&I sets are NOT similar: Perceptions of X ≠ Perceptions of Y.
Accordingly, if there is an association between variables, the answers are dependent, meaning that the C&I sets ARE similar: Perceptions of X = Perceptions of Y.

3. Results

3.1 Final set of C&I

During the workshops, the generic set was left almost unmodified. Strictly speaking no elements were added and two indicators were eliminated at the provincial level workshop. In all group discussions the villagers eliminated the same 12 indicators, including the 5 genetic indicators (compare Tab. 3a and 3b). The group discussions led to the addition of 2 new indicators. Generally the villagers had the same perceptions for eliminating and keeping indicators: 86 % of the indicators had over 80 % of similar answers (either 0 or 1) in the villages (Tab. 2).

Part of indicators (%)	Number of different perceptions	Similarity (%)
67	0	100
15	1	92
4	2	83
11	3	75
4	5	58
Total = 100		

Table 2. Similarity in perceptions between villages.

The final set was composed out of 15 indicators under 6 criteria and 2 principles (Tab. 3a and 3b).

One special case was decided to remain included in the final version of the C&I set, Indicator *"1.3.4 Minimization of soil degradation":* This indicator was accepted by 100 % of experts, special use and production forest villages, and rejected by three out of four protection forest villages. Dinh Hoa District is part of the mountainous regions of Vietnam which cover 3/4th of the country, having a complex topography and steep slopes (Werger and Nghia, 2006). Soil degradation and erosion is generally a great risk in the northern mountainous regions of Vietnam (Pomel et al., 2007; Thao, 2001). Land erosion has been identified to be a key point impacting many elements which influence farming systems (like water quality / quantity and soil fertility) thus causing crop yield reduction leading to a general income loss (Thao, 2001; Pomel et al., 2007). Though forests are the main subject of this study plus forests represent the land use option with the smallest erosion rate in Northern Vietnam (Pomel et al., 2007) the indicator was kept.

Principle 1 : Ecosystem integrity is maintained

Criterion		Indicator	Work-shops	Protection Forest	Special use Forest	Production Forest	Indicator Acceptance (Yes/No)
			% of agreement on the acceptance of concerned indicators				
1.1 Extent of forests	1.1.1	Maintain/Improve the forest area	100	100	100	100	Y
	1.1.2	Control of forest area loss	100	0	0	0	N
1.2 Forest ecosystem health	1.2.1	No chemical contamination	67	50	50	75	N
	1.2.2	No natural degradation	100	100	100	100	Y
	1.2.3	No human degradation	100	100	100	100	Y
	1.2.4	Regeneration and forest structure	100	100	100	100	Y
	1.2.5	Soil/Decomposition	100	100	75	100	Y
1.3 Forest ecosystem services	1.3.1	Product provision for local people	100	100	100	100	Y
	1.3.2	Protection of riparian forests	100	0	0	25	N
	1.3.3	Maintain the water quality/quantity	100	100	100	100	Y
	1.3.4	Minimize soil degradation	100	25	100	100	Y
	1.3.5	Valuation of Carbon sequestration	100	0	0	0	N
	1.3.6	Forest protection/valorisation for tourism	100	75	50	100	Y
	1.3.7	Minimize floods	0 (new)	75	100	100	Y
	1.3.8	Pleasantness of environment	0 (new)	100	100	100	Y

Table 3. a. Final Indicator selection. Principle 1: Ecosystem integrity is maintained.

3.2 Cluster analysis

As described in section 2.3.2, cluster analysis operates in successive stages of fusions, based on the calculation of similarity coefficients. The final structure of the grouping is determined by the desired number of clusters, or by a previously fixed level of similarity that is considered as "acceptable". There is no general rule for the minimal similarity level. In order to make the results comparable with a previous similar study implemented in Indonesia (Purnomo et al., 2005), 80 % of similarity are specified here as acceptable. For instance, the pairs of clusters (12, 13), (7, 12), (10, 11), (7, 10) and (1, 3) show 100 % similarity (Tab. 4),

Principle 2 : Socio-economic & cultural benefits are linked to ecosystem integrity or are of prime importance							
Criterion		Indicator	Work-shops	Protection Forest	Special use Forest	Production Forest	Indicator Acceptance (Yes/No)
			% of agreement on the acceptance of concerned indicators				
2.1 Forest ecosystem diversity	2.1.1	Maintain the forest landscape	100	100	75	75	Y
	2.1.2	No human habitat diversity destruction	100	0	0	0	N
	2.1.3	Presence of corridors	100	75	50	100	Y
2.2 Forest species diversity	2.2.1	Preserve species with key functions	67	0	0	0	N
	2.2.2	Preserve species diversity of animals/plants	100	100	100	100	Y
	2.2.3	Population sizes and demographic structures	100	0	0	0	N
	2.2.4	Protection of rare/endangered species	100	100	75	100	Y
2.3 Forest genetic diversity	2.3.1	Genetic diversity is preserved in rare/commercial species	100	0	0	0	N
	2.3.2	Implementation of measures for genetic diversity conservation	100	0	0	0	N
	2.3.3	All phenotypes are preserved	100	0	0	0	N
	2.3.4	Gene flow is maintained	100	0	0	0	N
	2.3.5	Mating system doesn't change	100	0	0	0	N

Table 3. b. Final Indicator selection. Principle 2: Socio-economic & cultural benefits are linked to ecosystem integrity or are of prime importance.

meaning the valuation of the indicators were similar for these groups of stakeholders. Moreover, about 93 % of the stakeholders (14 out of 15) display at least 80 % similarity (i.e. all stakeholders excepted number 8).

The 80 % threshold can be used to calculate the final number of clusters from the Agglomeration Schedule Table (Tab. 4) (Janssen and Laatz, 2010; Manning et al., 2008):

Number of clusters = Number of subjects – Value of the last stage over 80% similarity
=> 15-12 = 3 clusters

This makes it possible to draw a line across the dendrogram to specify the final grouping which is considered as meaningful with a fixed minimum level of 80 % similarity (Fig. 6). According to this final partitioning, 3 clusters were considered as reasonable:

1. The cluster (1, 2, 3) containing the three expert workshops;
2. the cluster containing all villages except village number 8; and
3. village number 8 alone, corresponding to the special use forest village Ban Bac 4.

The subgroups in cluster 1 and 2 are based on minimal differences (similarity between 87 and 100 %), showing a strong homogeneity in the stakeholder's perceptions. Noteworthy, the cluster formation is detached of the forest use types, all forest types appear in all sub-clusters (Fig. 6).

Agglomeration Schedule

Stage	Cluster Combined		Coefficients	Stage Cluster First Appears		Next Stage
	Cluster 1	Cluster 2		Cluster 1	Cluster 2	
1	12	13	1,000	0	0	2
2	7	12	1,000	0	1	4
3	10	11	1,000	0	0	4
4	7	10	1,000	2	3	6
5	1	3	1,000	0	0	9
6	7	14	0,963	4	0	7
7	6	7	0,957	0	6	10
8	4	9	0,926	0	0	11
9	1	2	0,926	5	0	14
10	6	15	0,915	7	0	12
11	4	5	0,889	8	0	12
12	4	6	0,873	11	10	13
13	4	8	0,791	12	0	14
14	1	4	0,479	9	13	0

Table 4. Cluster analysis using group average linkage. Cluster 1 and Cluster 2 (under cluster combined) display the membership of the stakeholders (3 workshops and 12 villages) towards the cluster. The bold line represents the 80% similarity threshold.

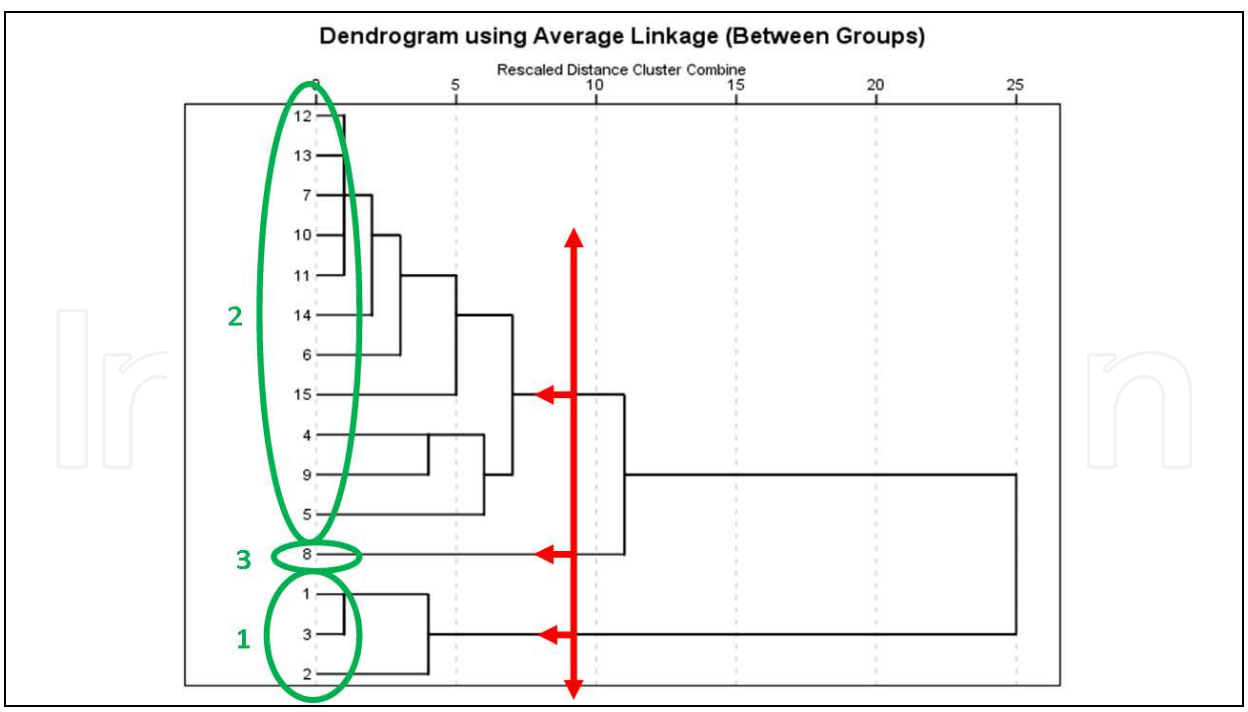


Fig. 6. Cluster Dendrogram of stakeholder perceptions. The red line represents the 80 % similarity threshold, delimitating three meaningful clusters in green. The numbers at the end of each cluster arm represent the concerning stakeholder: 1, 2, 3 = expert workshops; 4, 5, 6, 7 = protection forest, 8, 9, 10, 11 = special use forest and 12, 13, 14, 15 = production forest.

3.3 Hypotheses testing

As described in section 2.3.3, the null and alternative hypotheses are associated to similar or different perceptions between stakeholders. The results show that the null hypothesis cannot be rejected for any of the pairs of experts and local populations (all p-values > 0, 05). Thus, the local populations have different perceptions of what they consider to be important ecological elements for a SFM compared to national and province experts, as well as local authorities represented by the district workshop. The *p*-value is at the limit of significance (0, 055) for the national and district workshops compared to the village Ban Bac 4. This is in accordance with the cluster dendrogram results (Fig. 6).
There are similar perceptions about SFM among villages, irrespective of the forest use type they manage (all p-values are < 0, 006) (Fig. 6).

4. Discussion

4.1 Local and expert perceptions of sustainable forest management

Alike this study indicates, previous studies equally show that local and expert perceptions of indicators for sustainable forest management often differ, but that these differences decrease while concerning ecological indicators (Karjala et al., 2004; Purnomo et al., 2005; Pokharel and Larsen, 2007; Sherry et al., 2005; Adam and Kneeshaw, 2008). This has been explained by the fact that C&I processes always largely focus on environmental (not socio-economic) issues, so that there is less disagreement in what should be included in a meaningful set of indicators for ecological sustainability: ecosystem condition, biodiversity and ecosystem services are nearly always included (Adam and Kneeshaw, 2008). Rural populations often not only depend on natural resources, they also inherit a thorough traditional environmental knowledge (TEK) (Karjala et al., 2004) about their surrounding environment which is often in accordance with expert formulations, even if the vocabulary is different. Requirements like water and soil protection, critical habitat preservation or productive functions of forests are the concerns of both local people and experts.
In fact, the differences in perception between experts and villages in this study are based for a non-negligible part on the genetic diversity concept. About 42 % of eliminated indicators (5 out of 12) concern the criterion of genetic diversity. The neglect of genetic issues by local populations can be attributed to a lack of knowledge and difficulties to understand the concept.
On the other hand, villagers added some elements which were considered as relevant, independently from their scientific importance. For instance, the elements leading to the addition of *"1.3.8 Pleasantness of environment"* as an indicator included the beauty of the landscape, air quality, temperature and provision of shade. Aesthetic issues have been identified in previous studies to be typical local requirements which are not integrated at the expert levels (Adam and Kneeshaw, 2008). Bottom-up approaches and TEK can thus be seen as a way to integrate and connect ecological issues with cultural and communal aspects. This integration of connections / interlinkages in some indicators could be an answer to recent critics about the strict structure and isolation of elements into ecological, social and economic issues (Adam and Kneeshaw, 2008; Mendoza and Prabhu, 2003; Requardt 2007). Further this result also confirms that expert sets fail to address particular values and needs of local populations. Elements generated by local communities can complement expert sets by adding valuable knowledge. Moreover, they can increase the legitimacy of those sets,

facilitate their implementation and the acceptance of the results, they can contribute to the conservation and recognition of TEK and reduce hierarchical conflicts.

4.2 Perceptions among local communities

Local populations of the villages where PRA was implemented had almost the same perceptions of ecological sustainability of forest management as shown in section 4.0 and there were no measurable differences resulting from the forest use type the villagers were managing. The existing discrepancy of one indicator (Tab. 3a and 3b) dealt with the significance of forests for protecting or mitigating soil degradation. Villages surrounded by protection forests never experienced landslides or soil degradation, ergo could not make the link between the presence of forests and the absence of soil degradation. This does not mean that the indicator is not applicable; it even makes it a suitable element, showing that protection forests actually really protect the soil. It can thus be discussed if future research has to consider forest use types as a meaningful subdivision in the sampling design or not.
The village Ban Bac 4, representing the outlier in all data analyses, was the village with the smallest forested area (10 ha), entirely young *Acacia spp.* plantations planted in 2006 and decimated by a disease in 2008. The government did not support new plantations since then, resulting in a general disinterest in forests. Therefore, forest area could be a key element influencing the correct implementation of PRA and the resulting lists.

4.3 Pertinence of Multi-Criteria Decision Making (MCDM) for top-down approaches

MCDM has been identified in previous studies to be a pertinent method to use with experts (Mendoza and Prabhu, 2000b; Mendoza and Prabhu, 2000a; Andrada II and Calderon, 2008; Gomontean et al., 2008). It can save time to begin from a generic set and to modify it afterwards with local experts instead of generating new lists of indicators from scratch. MCDM is a method which easily helps to reach an agreement among all participants. The fact that in this study nearly no indicators were modified from the existent generic set could be explained in two ways. The first could be that the generic template, already resulting from several international processes and expert consultations, covered all requirements of the workshop members. Anyway, ecological elements have often been those where the most agreement appeared among stakeholders worldwide (Purnomo et al., 2005; Sherry et al., 2005). The second explanation could be that the method does not allow easy modifications of the generic template, for the following reasons. Providing a generic set resulting from several international consultations may make local experts hesitant to freely reject / modify elements. Moreover, even if MCDM allows the elimination of elements, the method is hardly adaptable to the addition of new topics.

5. Conclusion

This study reveals that local and expert perceptions differ in their perceptions of ecological sustainability of forest management. However, among experts and among local communities the perceptions were relatively uniform.
It can thus be recommended to combine expert consultations to ensure the scientific validity with local perceptions to ensure the recognition of local values and perceptions. To use only one of the two approaches may reduce the acceptance of the representativeness of the resulting set, leading to conflicts causing difficulties of implementation, and finally to change forest management practices if necessary.

6. Acknowledgements

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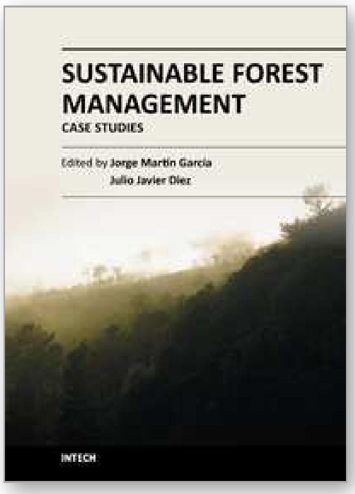

Sustainable Forest Management - Case Studies

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The concept of forest sustainability dates from centuries ago, although the understanding of sustainable forest management (SFM) as an instrument that harmonizes ecological and socio-economic concerns is relatively new. The change in perspective occurred at the beginning of the 1990s in response to an increased awareness of the deterioration of the environment, in particular of the alarming loss of forest resources. The book collects original case studies from 12 different countries in four continents (Africa, America, Asia and Europe). These studies represent a wide variation of experiences from developing and developed countries, and should clarify the current status of SFM worldwide and the problems associated with its implementation.