Chapter 12

An Approach for Assessing Changes of Forest Land Use, Their Drivers, and Their Impact to Society and Environment

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Additional information is available at the end of the chapter

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Abstract

Globalization, urbanization, and new policies are changing land use, environment, and rural life. Policy makers need means to understand changes and their impacts for making wise decisions. This paper explores a methodological landscape-level approach for assessment and monitoring of changes in land use, forest cover and society, its drivers and impacts. It is based upon experience from case studies in Asia and Africa. The paper suggests that such approaches should address major issues of land use change including its drivers and impacts, generate policy relevant and accurate information, be cost-efficient and practical to implement, make appropriate use of modern knowledge, and engage stakeholders and decision makers. Technically, the approaches should cover all land types, objectively describe current land use and trends, enable verification, and be robust and flexible to address upcoming needs.

The approach combines participatory field point sampling for estimating land use trends with remote sensing and GIS, household and key informant interviews for obtaining socio-economic and other information, and meetings with farmers and decision makers for feed-back and discussing policy issues. It illustrates that land use assessments for policy purposes can be developed to meet proposed requirements by combining different techniques and involving local stakeholders in inventory processes.

Keywords: Landscape level, Participatory point sampling, Combining methods, Policy relevant, Asia, Africa

1. Introduction

1.1. A changing society and environment

Globalization, urbanization, and economic developments are changing land use, environment, climate, and rural life. Existing policies and strategies combined with demographic, economic, market, institutional, and technological issues are often identified as dominant underlying causes of tropical deforestation and land use change [1, 2]. Policy makers need means to understand changes and their impacts for making wise decisions.

Forest land use in tropical regions is mostly not about managing permanent forest estates for increased and sustained timber production, but multi-purpose, multi-stakeholder oriented and related to land management. Governments and rural stakeholders continuously try to adapt and understand changes but the consensus on driving forces, impacts, and how to address them is often missing [3]. While rural households do their best to manage land and other resources within given frames and to develop livelihood strategies that consider risks and opportunities, governments attempt to manage resources and promote a sustainable development through policies, legislation, and implementation of appropriate strategies. The role of the international community is to influence development and address the multi-functionality of the forests through multilaterally agreed principles and programs [4,5].

The development of sustainable policies and management strategies on forest and land use requires data and information that accurately describe the current situation and on-going changes. It requires systems for assessment and monitoring of changes. It also includes the impact of previous strategies that may need to be improved. Data is sometimes used in combination with modelling and scenario building for evaluating land use options [6,7]. The research area land change science includes the dynamics of human and biophysical land systems, its drivers and impacts, and how to address it through observation, monitoring, modelling, and evaluation [8, 9].

1.2. Acquiring data needed to understand and address land use and land cover change in forest policy

There is an increasing number of methods and approaches to assess, understand, and predict land use change with various degrees of sophistication [10,11]. Modern technology, such as remote sensing, Geographic Information Systems, and various forms of regression modelling enables the analysis of significant amounts of data and information. This situation provides new opportunities (e.g., in the context of monitoring climate change and in analyzing large-scale trends in forest cover). Various information including spatial land use data and socio-economic data are also being integrated in GIS systems.

However, dynamics that is not reflected in land cover change, but having socio-economic and environmental impacts, such as the intensification of agriculture, is still not very well captured by new technology [9]. Besides, in order to predict and meet future changes and policy it is critical to understand the driving forces of the changes [11, 12]. Those drivers are mostly related to the needs and expectations of the local stakeholders.

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Policies and strategies regarding land use and deforestation require data and information from different sectors and sources. Examples are population censuses, official agriculture and socio-economic statistics, macro-economic data, production and consumption statistics, maps, forest inventories, agricultural surveys, and research data. However, combining data from different sources and analyzing it for a policy-specific purpose is difficult, when data are not accurate enough, not aggregated in the same way, or not intended to be used for the purpose [13].

Involving stakeholders at local level in data collection and analysis can help establishing the broad policy base needed for a more sustainable use of natural resources than today. When the data providers are outsiders without a local perspective on the land use there is a risk that derived strategies fail to target important issues. Concepts such as "Integrated Natural Resource Management" call for active stakeholder involvement in problem formulation, data collection, and resource use planning and decision making [14].

In many western countries, development of policies and strategies in the forestry sector is supported by National Forest Inventories (NFIs) [15]. Those are often combining field sampling and remote sensing and producing objective, unbiased, and statistically precise data on timber volumes and forest cover changes. Being designed to produce data covering the entire land area on a regional, national, or sub-national scale, their purpose is to facilitate forest policy decisions based on evidence or factual knowledge [16]. They are increasingly evolving as continuous assessments enabling monitoring of changes. Their objectives are expressed by policy processes which assume that systematic and quality controlled information is required [17]. Acknowledging that forest sector data produced without consideration of local livelihoods have a narrow use, consultative and integrated methods including agriculture and institutional aspects are increasingly being introduced in the NFIs [3, 18].

The links between data capture and policy processes are still vague and ambiguous in many countries [19]. One reason is that inventory results are often politically sensitive and that governments could be more interested in forwarding a certain message than presenting a correct analysis [13]. Another is compartmentalization and lack of policy integration [20, 21]. Forest inventory data are usually handled by forestry or other technical departments with limited attention or capacity on socio-economic policy issues. Therefore they rarely provide answers to questions such as "why do local people do what they do?" and "what is the livelihoods impact of a particular policy?" There are also administrative and technical reasons. At broad (e.g. national) scales "the level of aggregation of data tends to obscure the variability of situations and relationships" [6]. The inventory design makes capture of, for example, timber data efficient but often makes it difficult to combine results with agriculture or socio-economic data in the analysis. The increased use of remote sensing and GIS have changed the conditions and time required but these technologies only address some of the information needs in resource management, and field inventories are still important [22].

When local management is in tune with and supported by national policies and strategies, it improves the potential for problem solving and development [23]. That perspective is also well reflected in the three pillars and six principles of "good forest governance" [24]. The degree of decentralization in decision making on resource management differs among countries and over time. Local level management based on bio-physical, cultural, and socio-economic and institutional considerations (e.g. [25]) is an equally important base for local development as national policies. The case of Tanzania where government policies back up community-based decision making in forestry is one positive example [26]. The Participatory Forest Management that was initiated in a number of projects by the Ethiopian government in the 1990s is another positive example that involved the local stakeholders in planning and decision making [27]. Other examples show that poorly harmonized policies and programs in agriculture and forest protection can have negative effects on local communities' life and environment [28].

One case illustrates the importance of combining resource assessment with social surveys and participation of stakeholders when developing land use policies and programs. In the 1980s the government of Ethiopia launched an ambitious program of community tree planting. It was known as "community forestry" and supported by donors and non-governmental organizations. The program never met its intended development goals and much of its efforts were wasted, largely because of its failure in assessing and estimating the resource and socio-economic needs of the rural households and communities, and other associated benefits [29, 30].

The described governance situation, whereby the role of the state in forestry is focused on policy issues and providing an enabling environment for local actors and stakeholders through various steering instruments, requires adequately supportive methods for assessment, monitoring, and interaction with local stakeholders. The situation to be considered (as described in this introduction) and the requirements to address those are summarized in Table 1.

Situation and aspects to be considered	Requirements on assessment approach
Land use forestand society are changing rapidly	Reflect current situation and trends
Land use isdynamic (e.g., decreased forest area means expansion of another land use)	Cover the entire landscape
Land use is multifunctional and involving multiple stakeholders	Reflect how stakeholders perceive changes
Policy makersneed to understand drivers and impacts of change to address it	Enable inclusion of different data sources.
Policy makers need adequate tools to obtain information for responding to upcoming needs	Generate information within reasonable time and cost. Be robust and flexible.
Stakeholders and policymakers need consensus on change for policy implementation	Involve actors and stakeholders

Source: original

Table 1. Situation to be considered and corresponding requirements on approach that could assess land use change for the purpose of policy development.

2. The methodological approach

2.1. Background and purpose

This paper discusses the applicability of a participatory landscape-based sampling approach applying the requirements mentioned in the previous section. It was developed and tested for the purpose of assessing forest landscape changes, their drivers and their impacts to local societies and environments, and has been tested and applied in various countries and contexts in Asia and Africa. The term "approach" is defined herewith as set of methods combined for the purpose of addressing a specific issue.

The developed approach includes a core component for primarily quantitative assessment of land use and its trends named participatory field point sampling (pfps). It also contains various supportive components aimed to generate information that verifies the sampling data and further explains the trends, why and how land use has changed, for example, information on socio-economics, market conditions, policy, and farmer's perspectives on the impact of the changes (Figure 1). The idea is to improve our understanding of drivers and impacts of change by combining various sources of information [31].

To facilitate any response to results and findings, the approach also aimed to promote a policy dialogue among local actors (farmers), local government representatives, and decision makers. Therefore, the presentation and discussion with stakeholders of work plans and preliminary results, and discussion with decision makers on the final outcome, are important steps of the approach.

2.2. A landscape-based point sampling approach, design, and implementation

The general approach is to combine quantitative data and information of actual land use based on objective field observations and measurements with qualitative information on the land use and its changes, which is obtained from local actors and knowledgeable local informants.

The inventory design is based upon a systematic grid of sample points covering the area of study (Figures 2 and 3). The area would be a landscape, normally with administrative boundaries. It could be small (for example, a village) or bigger (such as a district) depending on situation and needs. In some cases, as illustrated in Figure 2, a two-step approach could be applied, whereby plots are initially allocated on commune level, and later on village level for detailed follow-up of specific issues. In the Ethiopian case, Figure 3, an initial assessment on a satellite image showed that most wood lots were situated nearby roads. Therefore separate strata, one for field sampling and one for image interpretation only, were defined.

Generally, the distance between the sample points is set to achieve a certain precision. In systematic sampling, the standard error cannot be correctly estimated [3]. Equations for simple random sampling may however be used for the purpose of defining how many points are needed to ensure that a certain required precision is achieved. In this case we adopt a conservative estimate of the variance by assuming that the true error may well be smaller than the error at simple random sampling, but will not exceed it [32]. In the various case studies we

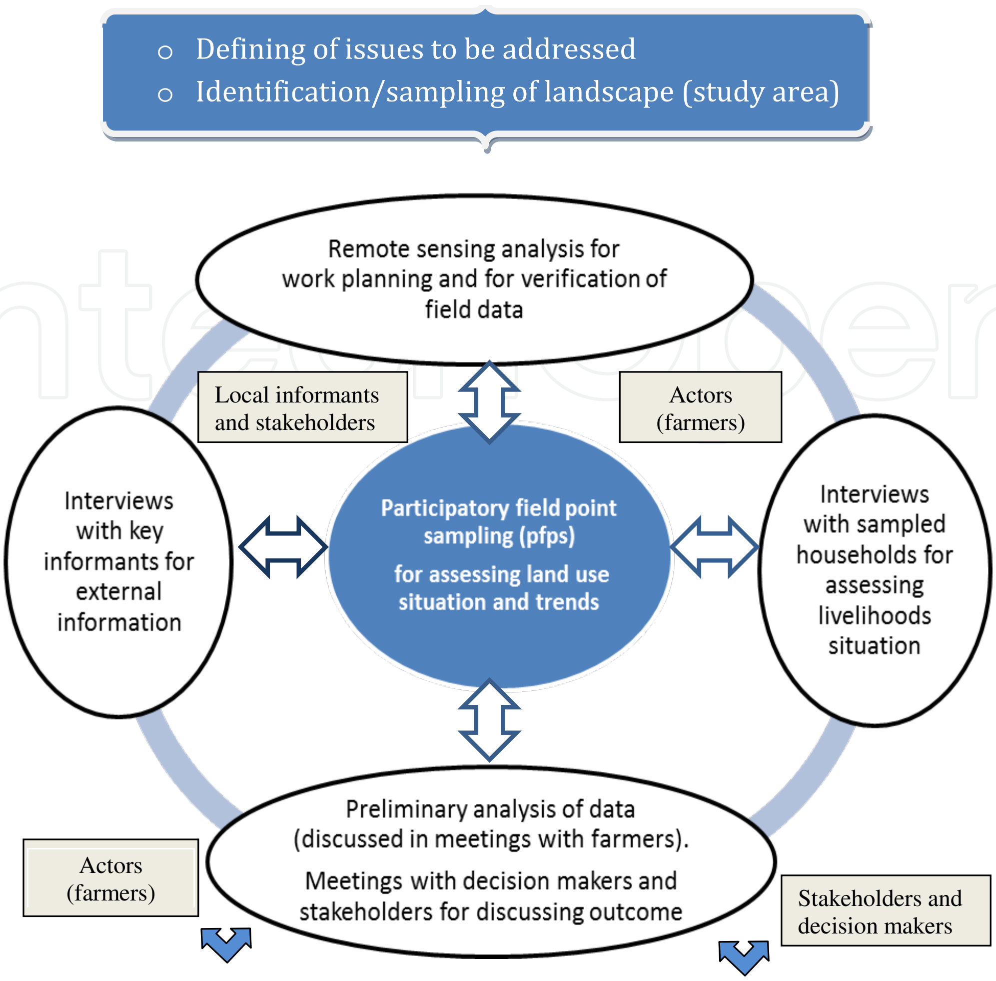

Figure 1. Main components of the approach (Source: original).

have used sample sizes between 50 and 75 sampling points, which have generated standard errors less than 10% for any class representing more than 25% of the total area.

Sampling points are defined and located on the ground using alternative techniques depending on local situation and available materials such as satellite images, aerial photos, topographic or other maps, compass, and GPS. Approaches similar to the one used in the Ethiopian study (Figure 3) have become more feasible lately as a result of improved access to satellite imagery and GPS. The advantage of using a GPS is that it reduces subjectivity and bias in the location of the sampling points in the field. It also provides the opportunity to identify the same point on images originating from different years.

Data collection: The recording is made when the surveyor and the key-informant, for example, an experienced and knowledgeable farmer or an extension worker, jointly visit the sampling point. While observing and recording the current land use the key informant provides further data on the present, past, and intended future land use (Figure 2). Data related with land use change, drivers of changes, and potential consequences are recorded on each point. Historical data are collected for certain years (e.g., every fifth year) including those years when remote

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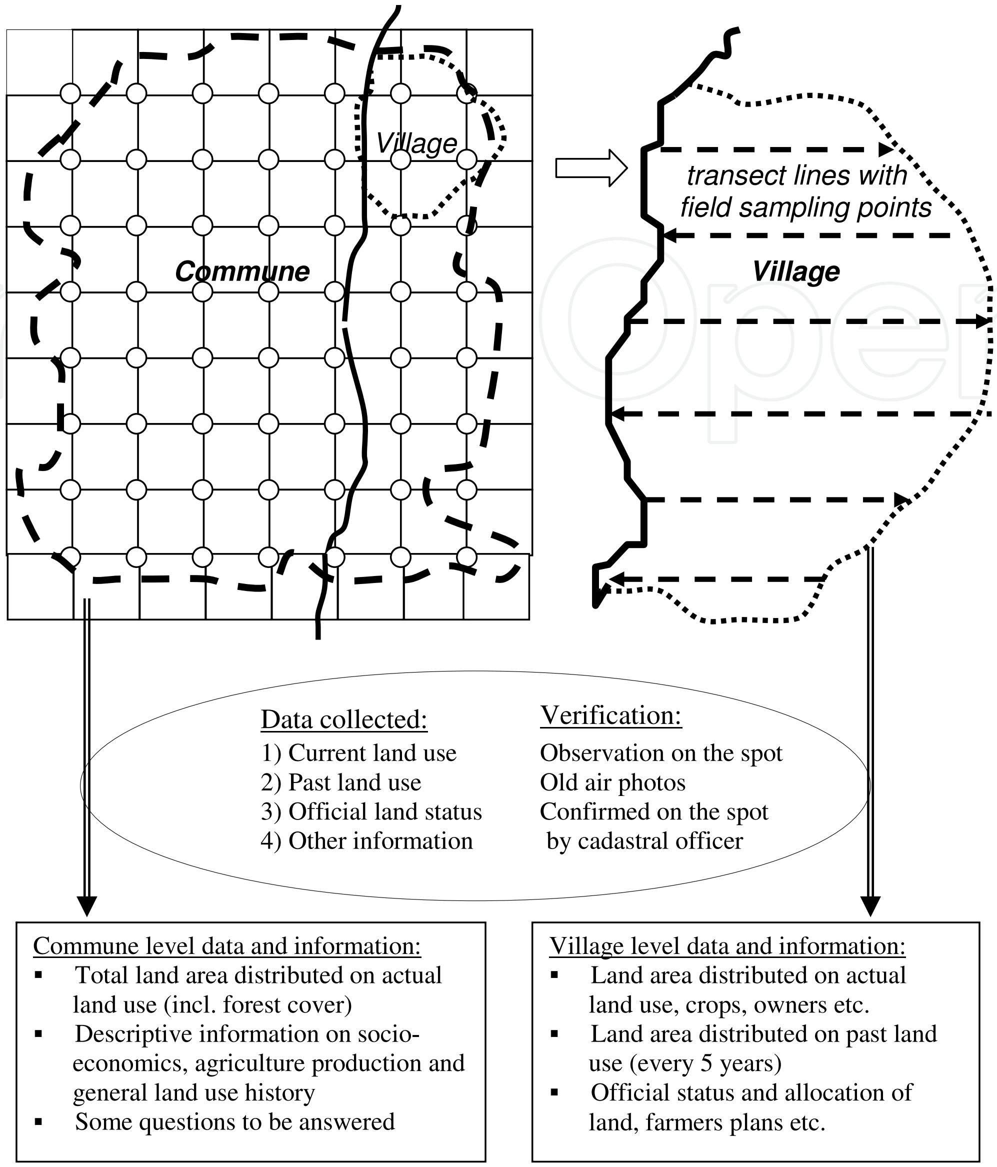

Figure 2. Participatory field point sampling in a Vietnamese commune (Ohlsson *et al.,* 2005).

sensing data sources are available. When the key informant does not know the details, local farmers are contacted (during the field visit or afterwards). Notes are taken on issues to be followed up during subsequent meetings with households and other stakeholders.

Output: The first output is a table or diagram based on data from all sampling points, which illustrates the changes in land use and forest cover over time (Figure 4). A map that shows the spatial and temporal land use change may also be produced later. The first output is prepared in connection with the field work and used in participatory meetings on the causes and implications of the trends. The outcome of discussions and meetings are recorded and used in the further analyses of trends and their drivers and impacts, during which also the information form interviews and other sources are included. When documented, the analyses are presented and discussed with centrally placed decision makers in a way that it reaches the policy level.

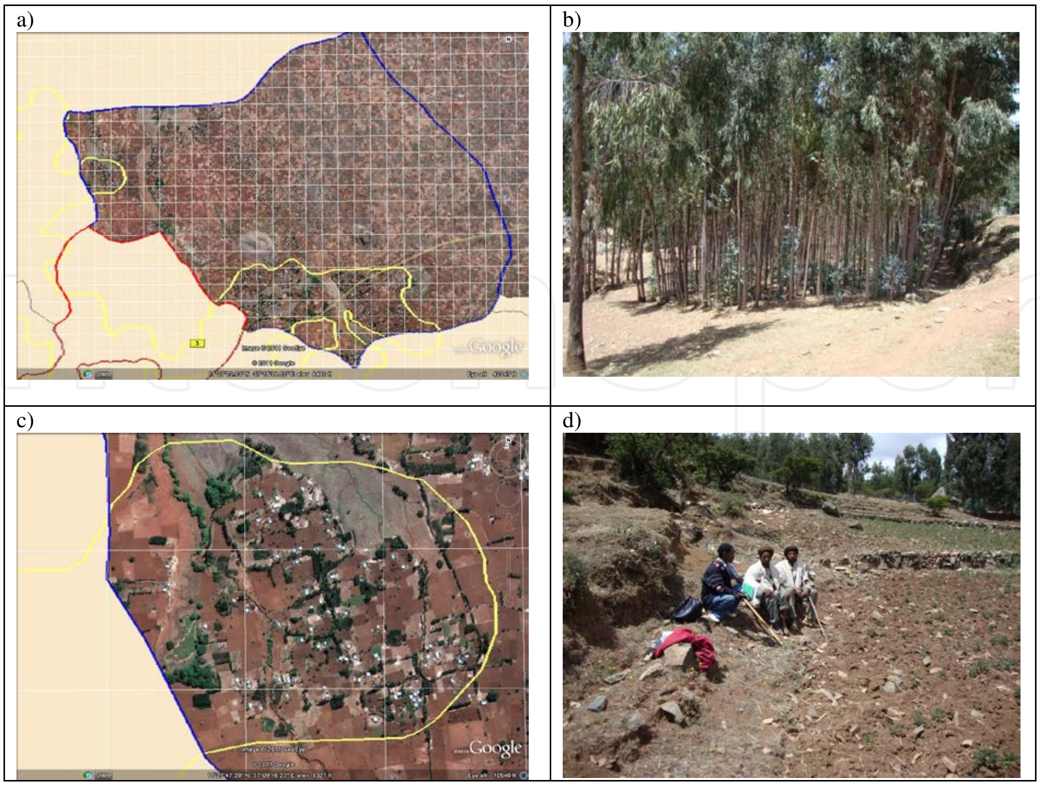

Figure 3. Pfps approach applied in Ethiopian study on household based plantation forestry a) Layout of strata and sampling grid on satellite image b) Wood lot plantation c) Stratum for field sampling d) Discussion of land use history with local key informants at a field sampling point (Source: original).

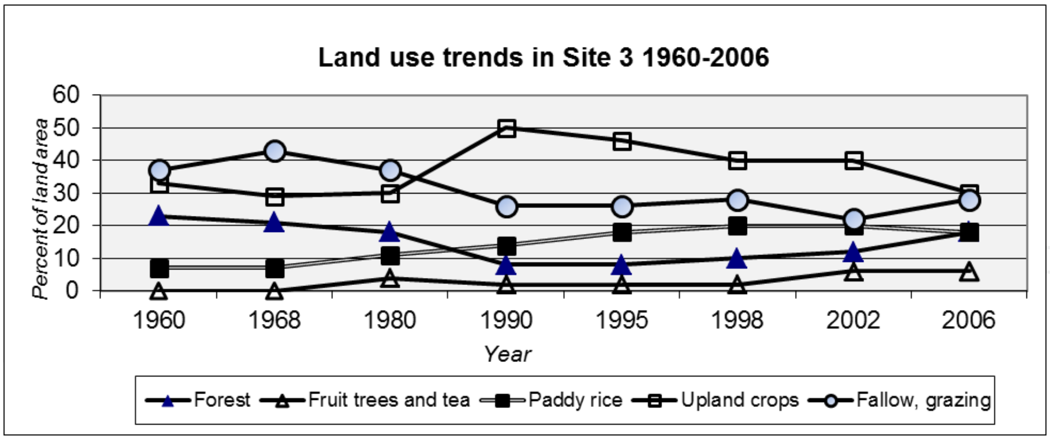

Figure 4. Output diagram based upon land use data from pfps points in Vietnamese study (Source: original).

2.2.1. Other system components

Verification of accuracy: Some data are verified by observations in the field. Other data, which cannot be verified during fieldwork (e.g., historical data) are verified by use of remote sensing data (when available) and secondary sources including triangulation of interview data. The pfps output may be supplemented by land use land cover classification using remote sensing data sources [33].

Analysis of data: An immediate analysis of land use data is made at the time of the survey, when the team is still in the area. Preliminary findings and trends are presented to villagers in stakeholder meetings for obtaining comments and feedback on possible causes of trends of change. Use of maps and remote sensing data often facilitate the communication in those meetings.

Complementary information: In order to obtain additional information about an area, for example, demographic and socio-economic issues and livelihoods situation of households, pfps is combined with other forms of data capture, such as image classification, structured interviews with households and key informants, formal and informal focus group discussions, or other forms of Participatory Rural Appraisal [34].

Participatory process for information and experience sharing: Stakeholders include farmers, experts, policy-makers, researchers and other individuals, groups and organizations that are directly affected by decisions and actions or have the power to influence the outcomes of these decisions [35]. The pfps as well as all other components of the approach (e.g., planning, household interviews, key informants interviews, meetings with stakeholders and decision makers) therefore include participatory elements (Figure 1).

3. Experience of case studies

3.1. Studies undertaken

The approach has been applied within the frames of various research studies in Laos, Vietnam, China, and Ethiopia during 1997–2012 [7, 12, 33, 36, 37]. The objective of the first two studies (1997–99) was to identify and develop a feasible method for estimating the actual land use and its changes as a base for various types of strategic land use planning including scenario modelling. The methodological requirements of the approach (Table 2) were defined based on needs referred in literature and/or experienced by the research team. More recently the applicability of the approach has been tested under other conditions in another region (Ethiopia). The review of the various studies in the following text serves to illustrate the range of various applications.

Laos (1997-99): The objective was to understand how land use changes had been affected by various events in shifting cultivation landscapes in Northern Laos. Data were also to be used for testing a land use scenario model. In a watershed with seven villages (10000 ha) some 75 sampling points were laid out on topographic maps and visited in the field with an extension officer. Five sets of aerial photos and satellite images 1953–1996 were used for verification of land use data and historical events. Interviews with sampled households and meetings involving farmers and decision makers were held at various stages of the process.

Consideration	Requirements
1. Area coverage and details	a) Cover the whole landscape and not only, e.g., forest land. b) Provide data with sufficient geographic resolution.
2. Accuracy and precision	a) Provide unbiased data with known precision. b) Enable cross checking of data to improve accuracy.
3. Time perspective	a) Reflect current land use (the actual use of the land at the time of the inventory). b) Describe historical trends and on-going and expected future changes. c) Enable continuous monitoring of changes in relation to current policies and strategies if desired.
4. Cost and robustness	a) Be based on adequate technology as regards cost and human resource. b) Be robust and simple to plan, undertake, process, and analyze and thereby provide data timely. c) Be acceptably independent of local security and terrain difficulty.
5. Flexibility	a) Make use of local knowledge and enable incorporation of additional spontaneous information from field observations. b) Be applicable in different situations (with respect to budget, available tools, physical conditions, and so on).
6. Data and information	Provide cross-sector data such as a) forest cover, b) stocking, c) current agriculture crops and production level, d) over-lapping land use, e) land suitability for agriculture, f) income-consumption-market, g) historical trends, h) people's perceptions and plans, i) land tenure, j) official land status, and k) demography.
7. Inventory output	Data and information should provide an understanding of current situation and trends, which is needed in strategic planning. It should also enable analysis of optional strategies, e.g., through modelling of scenarios on future developments.

Source: original

Table 2. Considerations made while developing the approach in Laos and Vietnam 1997–99.

The original idea was actually to interpret air photos as a base and verify data through field samples but the sampling provided so much external information that the reverse approach was adopted [36].

Vietnam (1997-99): The aim was to understand the impact of state planning by comparing government reporting, farmers' information, and observed changes. A commune of 21 villages (5400 ha) was first surveyed, trends were determined, and issues raised. One village was then surveyed in detail for better understanding of discrepancies between government plans and observed trends. Pfps points were laid out along transects and visited by a survey team and a senior villager (Figure 2). Interviews in sample households from three income strata were made. Key informants (market, government) were interviewed separately. Land use scenarios

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were elaborated based on survey data, and village meetings with local actors and decision makers were held for discussing outcomes in a land management context [7]. The study illustrated the difference between harmonized (agreed) official data prepared for management purposes and strategic data showing factual trends needed for strategic planning. Pfps turned out to be an appropriate method as farmer's awareness and memory of historical details was specific and mostly correct when verified by other sources.

Ethiopia (2005-2007): The issue was to understand drivers and impacts of land use and land cover changes in relation to political, demographic, and environmental trends in a semi-arid agriculture landscape and adapt previous research methodologies to an African context. Two adjacent villages were studied [33] and scenarios elaborated. Socio-economic studies for determining issues of food security were included. The study identified a need for remote sensing data to verify trends, as farmers' memory of historical details was linked to events, but not to years in the same way as in the Asian studies. An application involving GPS and satellite imagery was elaborated.

Vietnam (2006-2007): The issue was to analyze trends in farm households' tree plantation, its drivers and livelihoods impacts. The study took place in an area with increasing wood demand from new industries. Three villages at various distances from a pulp industry were studied through point sampling, interviews with households and key informants (business, science, and political representatives), and stakeholder meetings [12].

China and Ethiopia (2011-2012): This study analyzed trends in plantation forestry, its driving forces and impacts to environment, climate, economic growth, and livelihoods in China, Ethiopia, and Vietnam by combining regional, national, and local scale analyses (of which the pfps approach was applied in the local scale analyses). The purpose was linking the internationally and nationally reported trends with observed situations on the ground for identifying features, trends, and aspects that were not reflected by national data and/or required an integrated societal context [37].

3.2. Applicability of the approach in a new context

The approach was initially developed in Southeast Asia. When applied under other conditions in a new country and context, the flexibility of the approach is challenged. This section reviews experiences from application of the approach in Ethiopia.

The issue was trends of wood lot plantation in agriculture landscapes. The choice of study areas was based on an initial assessment using Google Earth satellite imagery in the Asian studies conducted 10 years earlier we had not had that opportunity). It revealed that wood lots were clustered nearby roads while the ambition was to select administrative villages for the purpose of connecting data from various sources. A major share of those villages had little forestry or other cultivation. To make work efficient, pfps points were laid out on satellite images in pre-defined strata, of which strata with many wood lots were subject to field work, while other strata were interpreted on image only (Figure 3). As a result, the degree of details and the historical trends were best described for the woodlot strata but this was also the purpose.

Pfps was combined with household and key informant interviews, focus group meetings, and discussions with concerned stake holders and decision makers at sub-national level. Official documents related with land use and related policies were compiled as a complement. The time for planning, arrangements of maps, and pfps field observations was about one week for a team to cover about 60 field plots. Household interviews and village meeting required additionally one week. All data collection, except the complementary interpretation of image plots, was undertaken in a sequence. The time required corresponds well to experiences from the Asian studies

The possibility to verify historical data given by the key informants depends on their age and experience, type of information and access to remote sensing data. In the studies in Laos and Vietnam people were often used to memorize their history connected to certain years, and many senior village representatives had a good memory of the land use history of each village member. In the Ethiopian study, it was necessary to systematically locate and consult the concerned farmer to obtain similar information and farmers' memory of land use was primarily linked to critical events (e.g., under what regime did it happen). Similar observations were made in another study [33]. The preparedness of farmers to forward information varied but did not provide any major difficulty when sufficient time had been given to introduce the purpose and when farmers were not too busy doing other work. Access to old air photos often vitalized people's memory. Concerning drivers and impacts, the initial pfps provided ideas, but structured interviews and other means were needed to provide a representative picture of, for example, livelihood issues.

4. Discussion

This paper highlights criteria and questions to be considered in the context of assessing and monitoring forest and land use change for the purpose of addressing forest policy issues. It suggests that the multi-functional type of forestry and land management present in many parts of Asia and Africa and the rapid changes of land use, society, and environment requires approaches for assessment and monitoring, which are supportive to policy and strategy development.

The presented cases were pilot studies by external research teams for studying policy-related issues. The authors do not have access to the policy level but may need to "speculate" on its potential appropriateness as policy tools. The approach scrutinized in this paper satisfied the requirements set-up in Asia also when it was used in an African context. The questions formulated and addressed in the following text serve to illustrate some crucial aspects of the approach.

What major issues in relation to forest and land use change could be addressed?

The approach is rather flexible and can basically address a broad number of issues related to land use and its change such as deforestation, afforestation, and change of forest cover over time including drivers and impacts of changes, ambitions, and expectation for the future (Table

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3). The approach does not generate detailed information on changes in the structure and composition of the forest, soil conditions, or other strictly bio-physical aspects for which purpose controlled measurements are required.

Context and Questions	Information source[1]					
	1	2	3	4	5	6
Deforestation, reforestation: What are the land use and land cover fluctuations over a given period of time, e.g., the latest 30 years?	x	x	x			
Deforestation, reforestation: What type of land/forest management systems have been applied	x	x		x	x	x
Deforestation, reforestation, land use: What kind of change is it, e.g., what type of land has changed to what?		x	x			
Driving forces: What is the use or market of the products from a specific land use?		x		x	x	x
Driving forces: When farmers changed land use, what was their reason for doing so?		x		x		x
Driving forces: How do farmers perceive the change, its causes, and environmental impacts?				x		x
Impacts: Does the change refer to a certain category of farmers (e.g., wealth, gender)?				x	x	x
Impacts: How has the change influenced the poverty and livelihoods situation?				x		x
Policy: What can the government do to support farmers toward a more sustainable land use and livelihood?				x	x	x
Driving forces: How has the observed land use change been influenced by external and internal factors during the period?						x

Source: original

[1]Information sources: 1) pfps observation, 2) pfps informant, 3) remote sensing/GIS, 4) household interviews, 5) key informants, and 6) meetings with local farmers and decision makers

Table 3. Some questions that can be addressed through the approach, and the main corresponding method or source supplying the information.

Does the approach generate policy relevant information?

In the case studies the approach has covered small pilot areas, which have been chosen with the aim to address a certain issue. It cannot simply be extrapolated to represent, for example, provinces or the nation, for which purposive inventories, censuses, and other data sources are needed [37]. However, it enables study of the relation between various types of conditions and changes over time and it could be designed to address rather specific policy issues. In that context it should be seen as a tool that supports a process of generating policy input which may be combined with other methods and data for verification and up-scaling.

Does the approach provide accurate information?

It builds on information that can be verified to a certain extent but not entirely. Through the sampling approach the quantitative land use information of the pfps is basically unbiased and it is possible to (conservatively) estimate its precision. The qualitative information relies on the proper use of social science methods and requires persons trained with that background [34, 38]. One of its advantages is that it captures both quantitative and qualitative changes and assesses how those changes are perceived by the local actors and stakeholders.

Is the approach cost-efficient and practical?

It involves human expertise in the fieldwork, which may be considered expensive. On the other hand it is based on relatively small landscape samples and generates data and certain results almost instantly, which is an advantage for interaction among those performing the study and the local actors. It also provides opportunities to assemble decision makers from different sectors discussing cross-sector issues.

Does the approach make proper use of modern knowledge?

The approach builds on analysis of systematic observations in combination with local knowledge and experience. It is seen as a package of various techniques and methods that can be flexibly exchanged and integrate new components and knowledge. Remote sensing and aerial photos are used for planning, discussion with actors and stakeholders, and for verification while advanced applications in data base management, remote sensing analysis, and GIS will primarily be needed for up-scaling purposes and broader analyses. One aspect is that technological methods sometimes alienate scientists and decision makers from local level perspectives and driving forces, whereby emerging trends could easily be missed out.

Does the approach engage actors and stakeholders?

Most of the data collection activities including pfps, household interviews, and stakeholder meetings are participatory and integrate local knowledge and perspectives with collection of data and information. Meetings with decision makers for discussing findings and related policy issues, sometimes also including scenario modelling [7], aim to ensure that those findings and issues are disseminated and reach the intended target groups. A basic principle is to make use of existing knowledge and perspectives of local actors, in order to improve the information, broaden the understanding of the situation at hand among all actors and stakeholders, and to facilitate their ability to address findings and results in the future. By involving stakeholders, results will be potentially available as decision support in resource management [39].

What are the potential applications?

Previous case studies have shown that it can provide an effective tool for initial pilot and baseline studies in research studies, rural development projects, and various situations where the land use conditions at a proposed site are not sufficiently well known. The compact setting enables completion of studies in a relatively short time and makes it appropriate for pilot project purposes. With some modification it may also provide an option as a component in national monitoring and assessment of forest and land use. In some tropical countries, inventory systems have integrated participatory approaches in order to improve data quality and broaden knowledge of the systems [18].

5. Conclusions

This paper explores a methodological landscape-level approach for assessment and analysis of changes in land use, forest cover and society, its drivers and impacts. It is based upon experience from a number of case studies in Asia and Africa. It suggests that such approaches should a) address major issues regarding land use change including its drivers and impacts, b) generate policy relevant and accurate information, c) be cost-efficient and practical to implement, d) make appropriate use of modern knowledge, and e) engage actors, stakeholders, and decision makers. From a technical aspect, the methods of the approach should preferably cover all land (not only forest land), objectively describe current land use and trends, enable verification, and be robust although flexible enough to address upcoming needs.

The presented approach was flexible and feasible for addressing a range of policy issues related to forestry and land use change in tropical countries. It illustrates that by combining different techniques and involving local stakeholders in inventory processes, it is possible to meet a number of requirements on tropical land use and forest change assessment for purposes of policy and strategic planning. It could possibly be useful as a tool supportive in generating input to strategic planning for addressing forest policy issues. In what way this would be organized and how attractive it could be in a national context would ultimately depend on the governance situation and other conditions.

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References

[1] Contreras-Hermosilla, A. 2000. The Underlying Causes of Forest Decline. Center of International Forestry Research. Occasional Paper No. 30, 1-23.

[2] Geist, H.J. and Lambin, E.F. 2002. Proximate causes and underlying driving forces of tropical deforestation. *Bioscience; ProQuest Biology Journals* 52, 143-150.

[3] FAO, 2012. National Forest Assessments. FAO-IUFRO Knowledge Reference. Chapter Rationale - Policy Influence.

[4] UN, 1993. Statement of forest principles. In: Earth Summit Agenda 21. The United Nations Programme from Rio. The final text of agreements negotiated by Governments at the United Nations Conference on Environment and Development (UNCED), 3-14 June 1992, Rio de Janeiro, Brasil.

[5] UN-REDD, 2012. UN-REDD programme social and environmental principles and criteria. Eighth Policy Board Meeting, 25-26 March 2012. UNREDD/PBB/2012/V/1.

[6] Lambin, E.F. 1994. Modelling deforestation processes, a review. Trees, tropical ecosystem environment observation by satellites. Research Report No. 1, European Commission Joint Research Center and European Space Agency, Brussels.

[7] Ohlsson, B., Sandewall, M., Sandewall, R.K. and Phon, N.H. 2005. Government plans and farmers intentions - a study on forest land use planning in Vietnam. *Ambio,* 34, 248-255.

[8] Turner B.L., Lambin, E.F. and Reenberg, A. 2007. The emergence of land change science for global environmental change and sustainability. *PNAS* 104(52), 20666-20671.

[9] Rounsevell, M., Pedroli, B., Erb, K-H., Gramberger, M., Gravsholt Busck, A., Haberi, H., Kristensen, S., Kuemmerle, T., Lavorel, S., Lindner, M., Lotze-Campen, H, Metzger, M.J., Murray-Rust, D., Popp, A., Perez-Zoba, M., Reenberg, A., Vadineanu, A.,

Verburg, P.H. and Wolfslehner, B. 2012. Challenges for land- system science. *Land-Use Policy* 29, 899-910.

[10] Bahadur, K. 2011. Assessing rural resources and livelihood development strategies combining socioeconomic and spatial methodologies. *International Research Journal of Agricultural Science and Soil Science* 1(2), 40-52, April 2011.

[11] Wang, J., Chen, Y., Shao, X., Zhang, Y. and Cao, Y. 2012. Land-use changes and policy dimension driving forces in China: present, trend and future. *Land Use Policy* 29, 737-749.

[12] Sandewall, M., Ohlsson, B., Sandewall R.K. and Viet, L.S. 2010. The expansion of farm based plantation forestry in Vietnam. *Ambio* 39, 567-579.

[13] Janz, K. and Persson, R. 2002. How to Know More about Forests? Supply and Use of Information for Forest Policy. CIFOR Occasional Paper, No. 36, 1-23. Bogor, Indonesia.

[14] Lovell, C., Mandondo, A. and Moriarty, P. 2002. The question of scale in integrated natural resource management. *Conservation Ecology* 5(2), 25. [online] URL: http://www.consecol.org/vol5/iss2/art25/

[15] Tomppo, E., Gschwantner, Th., Lawrence, M. and McRoberts, R.E. (eds.), 2010. *National Forest Inventories - Pathways for Common Reporting*. Springer, 612 p. ISBN 978-90-481-3232-4.

[16] Head, B.W. 2010. Evidence-based policy: principles and requirements. In: Strengthening Evidence- based Policy in the Australian Federation, Roundtable Proceedings, Canberra: Productivity Commission, 13-26.

[17] Holmgren, P. and Marklund, L-G. 2007. National Forest Monitoring Systems - purposes, options and status. In: *Forestry & Climate Change* edited by P.H. Freer-Smith, M.S.J. Broadmeadow & J.M. Lynch, pp. 163-173. CAB International. ISBN 139781845932947.

[18] FAO, 2006. Support to National Forest Inventories. Pilot Assessments. http://www.fao.org/forestry/foris/webview/forestry2/.

[19] Forbes, A. and Russo, L. 2011. Impact evaluation of the FAO National Forest Monitoring and Assessment Programme. FAO. Final Report, June 2011.

[20] WCED, 1987. *Our Common Future*. Oxford: Oxford University Press.

[21] European Environment Agency, 2005. Environmental policy integration in Europe. Administrative culture and practices EEA. Technical Report No 5/2005. EEA, Copenhagen.

[22] Holmgren, P. and Persson, R. 2002. Evolution and prospects of global forest assessments. *Unasylva* 53(210), 3-9. Rome: FAO.

[23] Nilsson-Axberg, G. 1993. Forestry sector and forest plantations sub-sector planning in South and Southeast Asia. Swedish University of Agricultural Sciences. Department of Forest-Industry-Market Studies. Report No 34.

[24] Kishor, N. and Rosenbaum, K. 2012. *Assessing and Monitoring Forest Governance: A User's Guide to a Diagnostic Tool.* Washington, DC: Program on Forests (PROFOR).

[25] Reenberg, A. 2001. Agricultural land use pattern dynamics in the Sudan-Sahel – towards an event-driven framework. *Land Use Policy* 18, 309-319.

[26] Wily, L.A. 2000. Forest law in eastern and southern Africa. Moving towards a community based forest future? *Unasylva* 51(203), 19-26. FAO, Rome.

[27] Tesfaye, Y., Roos, A., Campbell, B.M. and Bohlin, F. 2010. Forest incomes and poverty alleviation under participatory forest management in the Bale Highlands, Southern Ethiopia. *International Forestry Review* 12(1), 66-77.

[28] Mertz, O., Wadley, R.L. and Christiansen, A.E. 2005. Local land use strategies in a globalising world: subsistence farming, cash crops and income diversification. *Agriculture Systems* 85, 209-215.

[29] Mekonnen, A. 2000. Valuation of community forestry in Ethiopia: a contingent valuation study of rural households. *Environment and Development Economics* 5, 289-308.

[30] Bekele, M. 2003. Forest property rights, the role of the state, the institutional exigency: The Ethiopian Experience. PhD dissertation. Swedish University of Agriculture, Uppsala.

[31] Benoit, M., Williamd, S., Ousseynou, N. and Eric, F.L. 2000. Impact of macroeconomic change on deforestation in South Cameroon: integration of household survey and remotely-sensed data. *World Development* 28 (6), 983-999, Elsevier Science Ltd.

[32] Gregoire T.G. and Valentine H.T. 2008. Sampling strategies for natural resources and the environment. *Biometrics* 64(2), 652-653.

[33] Garedew, E., Sandewall, M., Söderberg, U. and Campbell, B.M. 2009. Land-use and land-cover dynamics in the Central Rift Valley of Ethiopia. *Environmental Management* 44, 683-694.

[34] Rocheleau, D.E. 1994. Participatory research and the race to save the planet: questions, critique and lessons from the field. *Agriculture and Human Values* 11(2-3), Spring-Summer, 4-25.

[35] Reidsma, P., König, H., Feng, S., Bezlepkina, I., Nesheim, I., Bonin, M., Sghaier, M., Purushothaman, S., Sieber, S., van Ittersum, M.K. and Brouwer, F. 2011. Methods and tools for integrated assessment of land use policies on sustainable development in developing countries. *Land Use Policy* 28, 604-617.

[36] Sandewall, M., Ohlsson, B. and Sawathvong, S. 2001. Assessment of historical land use changes for purposes of strategic planning – a case study in Laos. *Ambio* 30, 55-61.

[37] Sandewall, M., Kassa, H., Wu, S., Khoa, P.V., He, Y. and Ohlsson, B. 2015. Policies to promote household based plantation forestry and their impacts on livelihoods and the environment: cases of Ethiopia, China, Vietnam and Sweden. *International Forestry Review* 17(1), 98-111.

[38] Kvale, S. and Brinkman, S. 2008. *InterViews*, 2nd Edition. Thousand Oaks: SAGE.

[39] Walker, D.H. 2002. Decision support, learning and rural resource management. Agricultural Systems 73, 113-127.