Small-scale Forest Economics, Management and Policy, 2(2): 259-275, 2003

Collaborative Modelling to Support Forest Management: Qualitative Systems Analysis at Lumut Mountain, Indonesia

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Complex ecological and social processes in tropical forests imply that observations on any single element of the system do not provide an adequate basis for sound forest management. A collaborative modelling process engaging all relevant stakeholders led to a shared understanding of how to manage forests around Lumut Mountain, Pasir District, East Kalimantan. The model was developed by identifying forest management objectives, building a conceptual model using a causal loop diagram, and defining performance indicators. The model was then used to explore future scenarios to improve the well-being of local stakeholders while maintaining forest quality. Finally, roles needed to implement the chosen scenarios were defined and assigned to individual participants. This qualitative modelling process was found to be an effective way to assist the development of a collaborative action plan.

Keywords: qualitative modelling, causal loop diagram, collaborative action plan, Kalimantan, Indonesia

INTRODUCTION

Differences in stakeholder perspectives are a potential source of controversy in forest management. These differing views may lead to a wide range of concerns including issues relating to the focus, setting, and process of management (e.g. Kearney *et al*. 1999). Accommodating these concerns, involving stakeholder groups in decision-making is viewed as increasingly important in natural resource management, particularly where forests are managed for multiple values (Schmoldt

[1] The authors wish to acknowledge that this paper has been produced with financial support from Department for International Development of UK, the Asian Development Bank under RETA Grant 5812 and CIFOR. The views expressed contained herein are solely of the authors and do not necessarily reflect official views of the donors or of CIFOR. The authors would like to thank Richard Dudley and Bruce Campbell for their inputs to the paper.

and Peterson 2000). Appropriate approaches are needed to achieve consensus and sound decisions. Diverse alternatives have been offered towards this end (e.g. Vanclay 2003, Legg 2003, Purnomo *et al*. 2003) and may be loosely classified as hard and soft systems.

Clayton and Radcliffe (1996) defined a hard system approach as an approach that starts with a basic acceptance of the objective and problem specification. When this situation is not apparent then the soft system approach may be more appropriate, especially if it is regarded as a contribution toward solving a problem, rather than as a goal-directed method. Checkland (1989) defined soft systems methodology as a learning system about a complex problematical human situation leading to purposeful actions aimed at improvements, and where these actions seem sensible to those concerned.

The utility of any approach depends on the knowledge of and the ownership by the various stakeholders. Indigenous knowledge alone is not sufficient for rural development (Ostrom *et al*. 1993). Conversely, reliance solely on scientific knowledge is likely to produce 'engineering marvels that languish underutilized', consuming more resources than they produce. Consequently, both local knowledge and modern science are prerequisites for efficient and sustainable forest management. This requires a participatory approach that takes into account the views of all stakeholders.

Participatory research is a process through which members of a community identify a problem, collect and analyze information, and act upon the problem to find solutions and to promote social and political transformations (Selener 1997). A combination of both systems methodology and participatory research can theoretically facilitate the integration of various disciplines and different types of knowledge. Such a combination is consistent with the definition of soft systems methodology and is referred to in this paper as a collaborative model.

The research reported in this paper has aimed to develop a common understanding of forest management around the Lumut Mountain Reserve to develop more equitable sustainable forest management techniques. In this area villagers collect and plant rattan (*Calamus* spp.), collect non-timber forest products (NTFPs) and practice extensive shifting cultivation. Village livelihoods rely, in part, on NTFPs gathered from forest legally allocated by central government to a timber company, PT Telaga Mas. These activities can create conflict with the timber company and government, relating to resource access, logging benefits and costs, and ecological and social functions of the forest. The research was initiated to discover a way to resolve these common and potential conflict situations by sharing perceptions amongst stakeholders. These perceptions were structured and formulated into a model. The model was then used to understand ecological and social systems involved, and to produce possible scenarios that could improve outcomes. The questions addressed during the research included:

- Could this modelling process help to harmonize different stakeholder interests?
- Could the model contribute to collective learning?
- Could this modelling process contribute to collaborative action?

Many modelling options are available to address such questions, and include qualitative and quantitative; static and dynamic approaches. Participatory research should not use tools or media that create gaps between participants. Thus, the representation of a model should be decided by stakeholders and not be decided prior to the collaborative modelling process.

CONTEXT AND METHOD

The study area includes a nature reserve (Lumut Mountain Forest), two villages (Rantau Layung and Rantau Buta) and a forest concession located in District of Pasir, East Kalimantan (Figure 1). Lumut mountain was declared a protected area through Ministerial Decree No. 24/Kpts/Um/1993. It involves 35,350 ha of steep country, and was decreed to conserve soil and water resources. Timber cutting is prohibited. The main tree species found in the area are *Aglaia tomentosa, Artocarpus elasticus, Madhuca sericea* and *Shorea leprosula*. During 1970-93, the timber concession company PT Telaga Mas had harvested timber from the area. Telaga Mas retains rights to 130,000 ha outside the protected area. The central government had allocated the area to Telaga Mas in 1970 without considering the concerns of local communities, as was the practice in Indonesia in the past.

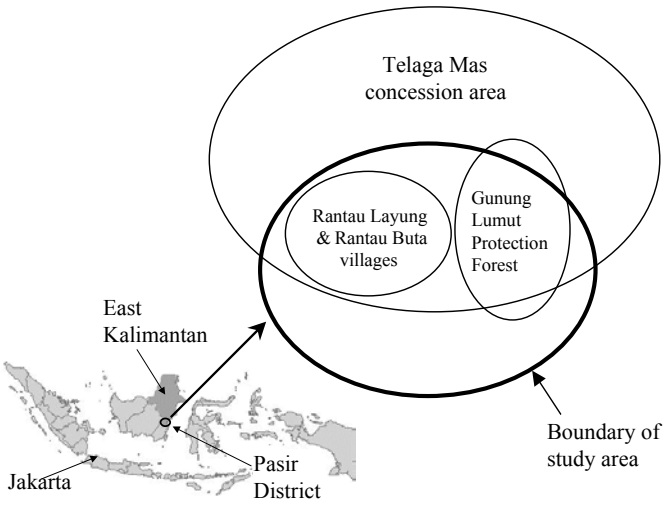

Figure 1. Location of the study area in East Kalimantan, Indonesia

In 1970, government was highly centralized, and Provincial and District governments were rarely consulted on land-use matters, despite policies and procedures intended to protect their interests. This situation lasted until 1998. However, over the last three years, the Indonesian government has issued several important pieces of legislation aimed at transferring authority to the Provincial and District governments, and at allowing resource-rich regions to retain a larger share of revenues generated within their jurisdictions. The most important of these has been Law 22 on Regional Governance and Law 25 on Fiscal Balancing, both of

which were enacted in May 1999. These laws have been supported by a variety of regulations and sector-specific laws, including Law 41 (1999), a revised version of Indonesia's Basic Forestry Law, outlining administrative authority in the forestry sector under regional autonomy (McCarthy 2001).

The collaborative modelling process combined simulation (Grant *et al*. 1997), soft systems methodology (Checkland 1989), participatory research (Selener 1997) and process agreements among the stakeholders. It commenced with a field visit, consultations and meetings with local communities in May 2001, and was followed by a stakeholders' workshop in August 2001 to develop the model. The visits aimed to observe biophysical conditions and to listen to problems and issues revealed by the *Rantau Layung* and *Rantau Buta* people, the formal heads of villages, and customary leaders. Existing data regarding the field site was also collected. The collaborative modelling workshop was held in Pasir District between 31 July – 2 August 2001 and was attended by 18 people from several relevant institutions (Table 1).

Participation in the workshop was based on several objective criteria: proximity to the area, expertise in legal rights, traditional rights, dependence on the forest, knowledge of forest management (both indigenous and scientific), and cultural links (Colfer *et al*. 1999). All participants met at least one of these criteria (Table 1). Participants were stakeholders in the forest, and represented local communities, district parliament members, district government officials, the Telaga Mas timber company, the NGO Yayasan Padi Indonesia (YPI), and the Center for International Forestry Research (CIFOR).

It was assumed that village and customary leaders would represent the interests of local communities in the area. Local communities elect their village leader through a direct democratic election, while customary leaders are based on their hereditary lines. It is evident that local communities generally trust their leaders, and their customary leaders in particular, to act on their behalf. Village visits and cross-checks with other stakeholders ensured that community leaders did articulate their own interests to the detriment of communal interests. Similarly, it was assumed that the parliament member represented the district of Pasir. The Telaga Mas representative had a formal mandate to articulate his company's interests. It was also assumed that NGO representatives could articulate the interests of local villages or organizations they represented. The Government and timber company could articulate their interests easily, but local communities were less able to do so without help of trusted local NGOs. Given the variety of the stakeholders involved, a model that could be easily understood, especially by local communities, was essential for a successful collaborative modelling activity.

A 3-day workshop was envisaged, with participants identifying prerequisites for sustainable management on the first day; designing a conceptual model and discussing performance indicators on the second; and on the final day, revising the indicators, devising and evaluating future scenarios, and establishing the individual reponsibilities needed to achieve the desired scenario. This timetable was amended as needed during the workshop to allow closure on each step in the process. CIFOR and YPI facilitated the workshop as YPI have worked in these villages since 1997 and have a good understanding of the local situation and communities. The national language, *Bahasa Indonesia*, was used in the modelling process and local languages were used for clarification as needed.

Table 1. Participants at the modelling workshop

Representative or capacity	Relevant institutional roles	Number of participants	Basis for inclusion
Customary leaders	Oversee traditional laws and rules	2	Proximity; dependency; traditional rights; knowledge of forest; Cultural links
Village leader	Effect formal laws and rules	1	Proximity; dependency; traditional rights; knowledge of forest; cultural links
District Parliament	Represent people in public policy making	1	Legal rights
Forestry District Unit	Execute forest policy	2	Legal rights; knowledge of forest
Development Planning Agency, Pasir	Policy and planning	1	Legal rights
Environmental Control Agency, Pair	Control impacts	1	Legal rights
Office of National Land Agency, Pasir	Administer land rights	1	Legal rights
Government Bureau of Economics, pasir	Economic plans and evaluation	1	Legal rights
Government Bureau of Laws, Pasir	Administer regulations	1	Legal rights
Telaga Mas	Harvest timber	1	Proximity; legal rights; knowledge of forest
Yayasan Padi Indonesia	Empower local communities	3	Proximity; cultural links; knowledge of forest
CIFOR	Forest research	3	Knowledge of forest
Total		18	

Observation and evaluation of the scenario-based actions took place in the field between August – December 2001. The observation sought to evaluate the actions taken by stakeholders as a result of commitments they made during the workshop. This evaluation aimed to reveal the extent to which the modelling process stimulated improvements in management practices and in the sustainability of resource use in the area. This impact assessment of modelling was targeted primarily at the stakeholders.

The ultimate goal of this collaborative modelling approach was not to produce a rigorous model, but to propose an approach to integrate different stakeholder perceptions for forest management. Modelling offers a useful framework to observe a particular problem systematically and rationally, but is too often perceived as a complicated tool with complex mathematics, inappropriate for use by local communities. This study explores the utility of a modelling approach selected by stakeholders for its accessibility. The quality of resulting findings depends on the ability of the approach to faithfully represent the views articulated by stakeholders.

THE MODELLING PROCESS

The description below portrays the results of the modelling process in four main phases. While these four phases are evident, they were not necessarily sequential, but represent the conclusion of an iterative process of development.

Phase I: Identifying Components of Forest Management

The workshop participants suggested dividing the components of forest management into three general categories: 1) social and economic, 2) forest utilization and environment, and 3) rules and laws. The participants then wrote down their ideas on these aspects. A synthesis of this process is presented in Annex 1.

Phase II: Inter-relationships Between Components

Participants divided into three groups representing the categories identified in Phase I. Each group discussed the interrelationships between relevant components of forest management. In subsequent plenary discussions, facilitators took a passive role, letting the stakeholders express their perceptions, and ensuring that the process reflected the perspective of participants, not of facilitators. Relationships were established by drawing causal loop diagrams (Sterman 2000). Such diagrams (e.g. Figure 2) assist participants to identify feedbacks explicitly.

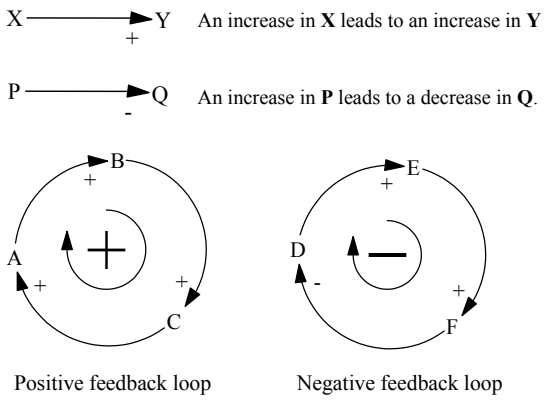

Figure 2. A causal loop diagram with positive (A-B-C) and negative feedback loops (D-E-F; note that more of F leads to less of D)

Participants perceived that 'Law certainty' was the key indicator in relationships involving forest laws and rules (Figure 3). 'Law certainty' is the level of transparency, persistence and enforcement of law perceived by stakeholders. 'Law certainty' influences quality of forest utilization rules, community income, and re-investment of forest taxes in other sectors. Quality of institutions and law-making processes need to be improved in order to improve 'Law certainty'. Participants also perceived that the improvements in 'Law certainty' would improve the 'Quality of institutions' (Figure 3). This leads to four feedback loops involving 'Quality of institutions', 'Strength of law enforcement' (in loop A; other nodes in loops B-D), and 'Law certainty'. Any improvement in the 'Quality of institutions' is thought to be a self-sustaining investment, as any improvement will, after some lag time, tend to lead to further strengthening of the same institutions.

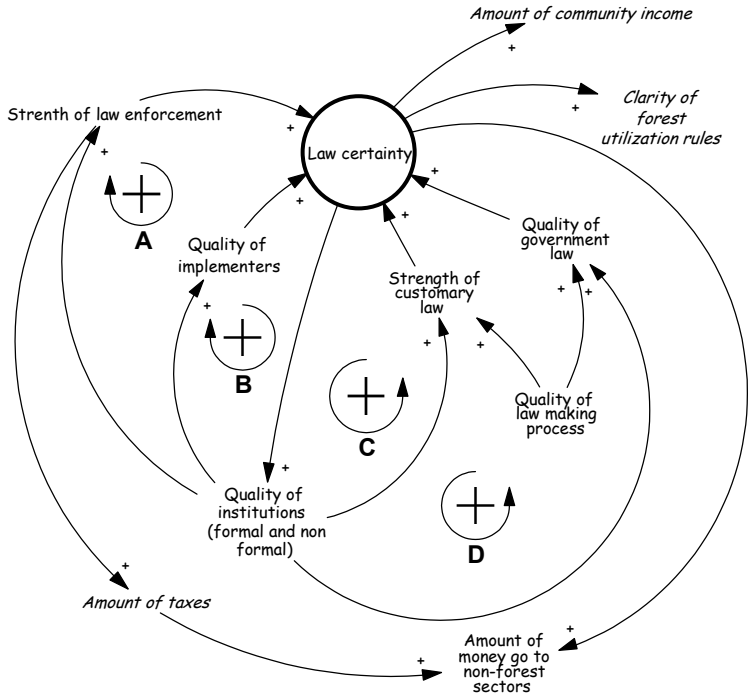

Figure 3. The inter-relationships between forest laws and rules as perceived by workshop participants

The 'Amount of forest standing stock and cover' and 'Amount of community income' (Figure 4) were also selected by the participants as key factors within feedback loops. They identified a negative loop (E) between 'Amount of timber and non-timber production' and 'Amount of forest standing stock and cover'. They saw scope for this production to be tempered by 'Clarity of utilization rules' (F) and 'Amount of communication' (G), both of which involve positive feedbacks. Participants also noted that 'community logging' influenced the 'amount of timber and non timber production' and increased the 'Amount of community income'.

'Amount of community income' and 'Amount of taxes' (Figure 4) were also identified as key indicators. The feedback loop (I) highlights the role of education in

increasing community income. Figure 4 also reveals the expectation that better education will foster small planned families rather than unplanned families, as a result of the government's family planning campaign in schools.

Phase III: Performance Indicators of the Model (1990-2010)

Key indicators in the model nominated by participants as performance indicators included 'Law certainty', 'Amount of forest standing stock and cover', 'Amount of community income' and 'Amount of taxes'. These indicators were used as the basis for discussions to establish past trends (1990-2000) and to try to predict future trends (2000-10). Time constraints during the workshop, precluded any quantitative values, but participants were able to indicate likely trends in the chosen indicators. After anticipating what might happen in the future if current practices were maintained, the workshop proceeded to define 'Desired outcomes'. Table 2 illustrates how the indicators were rated by participants, and how they were used in examining scenarios. Trends for selected indicators are shown in Figure 5. Similar patterns, but without the decline during 1990-2000, were presented for 'Amount of community income', 'Amount of taxes' and 'Amount of forest concession income'. These illustrations are not intended to be accurate projections, but are meant to highlight differences between the status quo and the desired future condition.

Table 2. Possible actions (in the order of preference expressed by participants)

Proposed action	Indicator [a]						Participant roles
	1	2	3	4	5	6	
A: Improve rule-making process through public consultation; Strengthen village and customary institutions; Oversee implementation of the law and rule by community, parliament and NGOs.	+	+	+	+	**?**	**?**	Send suggestions to district government and parliament; Request public consultation on relevant laws and rules; Seek NGO facilitation in key meetings; Ask District Land Agency to explain communal land rights; Lobby for socialization of laws and rules; Ask Parliament member to visit villages.
B: Demonstrate plantation trials in Ladang areas.	+	+	**?**	+	+	**?**	Concessionaire to establish demonstration plantation.
C: Increase timber and non-timber production.	+	–	–	–	+	+	All participants agreed not to support this action.
D: Recognized fully the rights of the concessionaire	–	–	+	–	+	+	All participants agreed not to support this action.
E: Recognize land claims of *Raden Panji Suryanata* and *Panembahan Sulaeman* (former Kings of Pasir).	–	–	–	–	–	**?**	All participants agreed not to support this action.

Note: [a] Indicators are 1 Community income; 2 Forest cover (including standing timber resources); 3 Law certainty; 4 Participation; 5 Taxes; and 6 Concessionaire's revenue. Note: '+' means enhances; '-' means diminishes; '?' means uncertain.

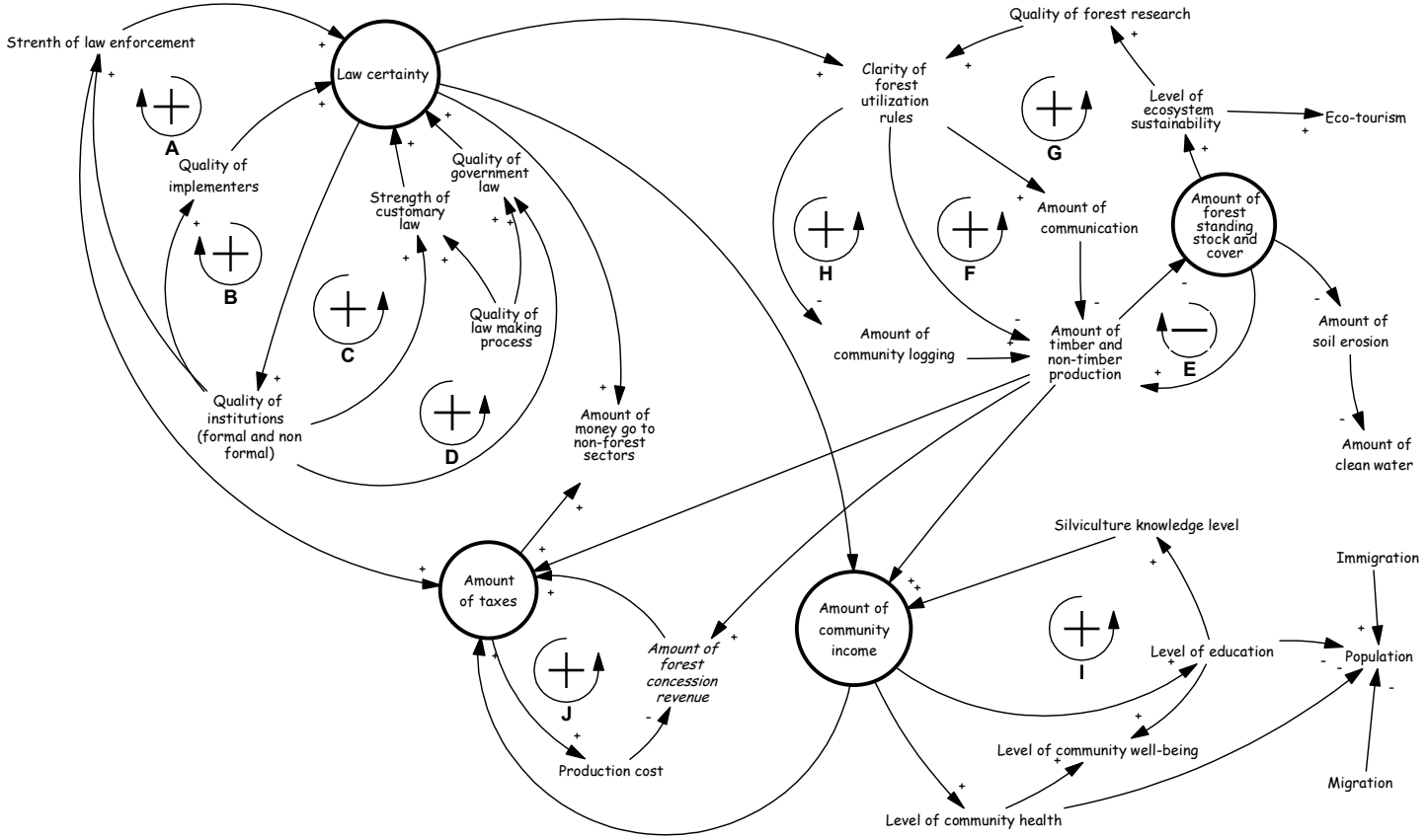

Figure 4. The complete causal loop diagram developed by workshop participants

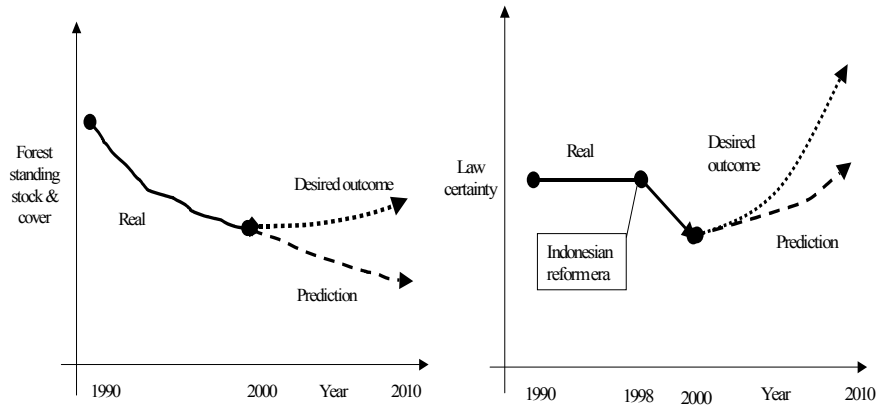

Figure 5. Forest standing stock and cover (left) history, prediction and desire, as perceived by the workshop participants

Phase IV: Finding Ways to Achieve Expectations and Establish Roles

Causal loop diagrams were summarized as 'causal trees' to illustrate key factors contributing to community income (Figure 6) and law certainty (Figure 7). Similar diagrams were also prepared for forest standing stock, taxes and concession revenue. These causal trees were used to focus discussion about selected concerns (Table 2) to establish what could be done to improve outcomes. The casual loop diagram and causal trees helped participants realize that the underlying problem that currently exists in forest management relates to uncertainty in law. Therefore, improving laws and rule-making processes is necessary to improve the whole system.

Participants searched for 'the best' action for Pasir by ranking the possible outcomes based on their preferences. Action A (Table 2) was the highest-ranked alternative. All participants expected that this would provide the greatest desired impact.

Outcomes of the Modelling Process

Observations on durable impacts of the participatory modelling process were made after the modelling workshop, and were concluded in January 2002 through a follow-up workshop. As a result of the participatory modelling exercise, the following outcomes were realized:

- *Public consultation*. The draft District Government Regulation on Utilization Permission of Timber Forest Products (*Ijin Usaha Pemanfaatan Hasil Hutan Kayu*, IUPHHK) was opened for public comment.
- *Collaborative forest management*. Part of the concession will be allocated to the communities under existing regulations such as Permission of Timber Collection and Utilization (*Ijin Pemungutan dan Pemanfaatan Kayu*, IPPK). The proposed scheme is shown in Figure 8. Community representatives are to be elected by and from community members. The representatives, acting through the Forest District Unit, negotiate a contract with the existing forest concessionaire, Telaga Mas, to provide mutual benefits. Telaga Mas is to provide capital items such as funding, heavy equipment and road

infrastructure for the community to access the forest. In time, the local communities will repay the forest concessionaire. Clear benefits for the community, for Telaga Mas and for the district government need to be identified to sustain the collaboration.

- *Public hearings*. District Parliament Members initiated a series of public hearings on the future of forest management in Pasir.

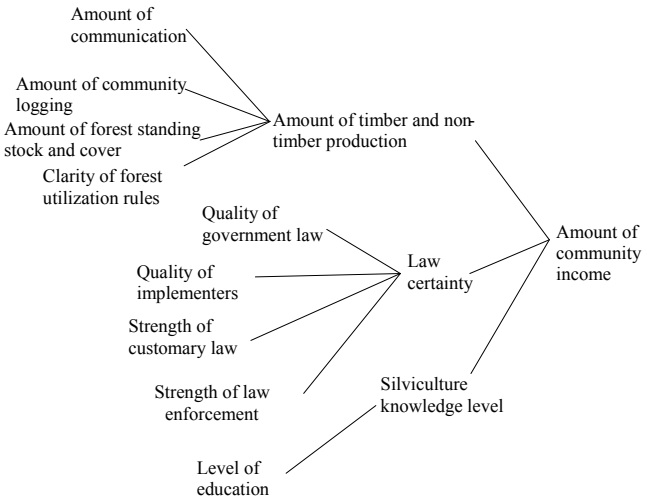

Figure 6. Factors contributing towards community income, as perceived by workshop participants

Figure 7. Factors contributing towards law certainty, as identified by workshop participants

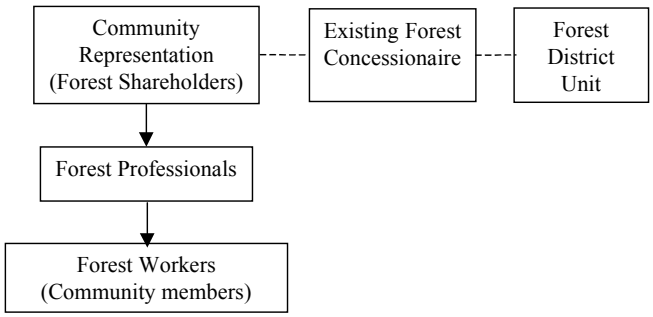

Figure 8. The proposed collaborative forest management scheme

Note: Vertical arrows indicate a command line structure, while horizontal dashed lines indicate written collaborative agreements.

DISCUSSION

A model is an abstraction based on a specific objective, so different perspectives and interests may yield different forest management models. Thus, the first phase of a collaborative modelling process is to understand stakeholder perspectives of forest management. The second phase is to establish the relationships between key components using a causal loop diagram. It offers a good way to integrate different stakeholder perspectives, and offers a basis to agree on performance indicators of forest management. Participants in the exercise reported in this paper developed a greater understanding of forest management issues and of the expectations of other stakeholders, but the long-term impact on forest management will not be easy to measure or assess. However, it is clear that the modelling process could encourage a more collaborative approach to forest management.

The collaborative modelling process is a positive way for stakeholders to express their views and interests in managing forest, and encourages collaborative learning through participation in defining the model. The process helped participants realize that achieving their respective goals required collaboration, including the sharing of costs and benefits of forest management. The participants identified problems associated with the modelling process. They established the objectives of the models, discussed the process, built, ran and interpreted the results. They preferred the qualitative approach over quantitative alternatives because of ease, data availability and many intangible system components that may be difficult to model in a quantitative way.

Facilitators played a critical role throughout the process, particularly in helping local community representatives to express their views despite their limited reading and written ability. Visiting the site and holding discussions with these stakeholders prior to the workshop helped to ensure a smooth modelling process.

This exercise also sought to address several research questions. The first such question was whether this modelling process could effectively contribute towards harmonizing the different interests of stakeholders. We conclude that the process is able, and is potentially a good way, to harmonize stakeholder interests. The

modelling process, as conducted in the Pasir District does appear to function as a learning process (Morecroft and Sterman 1994).

Experiences with this modelling process have been published in the Indonesian newsletter, '*Wisma Paser*', distributed to NGOs, local governments and researchers, who perceived the process as a new approach, complementary to the well-known approaches such as participatory rural appraisal, participatory mapping and action research. It appears that it can be a positive contribution in helping to forest management in Indonesia more democratic.

The scenarios and roles defined in the modelling workshops, as well as the development of a mutual understanding of stakeholder perceptions, influenced stakeholder plans for collaborative action. Such a shared perspective on forests management should precede any collaborative action planning. The modelling process can contribute to a collaborative action plan by helping to integrate stakeholder perspectives in a systematic way. Most NGOs and facilitators in Indonesia have used participatory mapping to solve conflict. This collaborative modelling approach could complement that method to systematically portray different perceptions of stakeholders, to emphasize causality, and to propose scenarios in managing forest.

CONCLUSION

Collaborative modelling involves identifying objectives, crystallizing concepts, defining performance indicators, exploring future scenarios and establishing roles of stakeholders. This process helps to harmonize stakeholder interests, to enhance collective learning, and to formulate collaborative action plans. However, there remains scope to improve the process and achieve tangible benefits.

Indonesia is currently in the process of making forest policy and management more democratic, and there is a clear role for collaborative modelling in this process. The novelty of this method, in the context of defining forest management scenarios, is attractive for some Indonesian institutions.

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APPENDIX 1: Forest Management Components Identified by Workshop Participants

Table A.1. Social and Economic components

Category	Component
Income and empowerment of local communities	Development of home based industry (*kerajinan rakyat*) Change paradigm of local community development. Prosperity Community revenue Telaga Mas revenue Taxes to government Income per capita Personal income Low personal income Forest products marketing Marketing Capital aid
Organization and institution	Security of area managed by communities Organization and institution Rights of customary organization to manage Communities participation for sustaining forest Empowerment of village customary institutions Customary law Collective action Communication Unity of communities Communities' access rights to forest
Education	Education The availability of general and religious education Building Teachers Religion and technology Home based industry
Health	Health Community health level and services Medical doctors and paramedics
Silviculture	Sustainability of the small plantation Rattan silviculture Biodiversity Livestock techniques
Accessibility and information	Transportation Information access Road transportation
Demography	Profession Population Household number

Table A.2. Forest utilization and environment components

Category	Component
Timber and non timber production	Timber flow monitoring (flow out from forests) Timber and other forest products clearly calculated Sub optimum of rattan utilization. Timber logging. Amount of rattan flowing out has to be cleared Rattan silviculture Trees produce timber and 'damar' Furniture industry Timber and non timber production Illegal logging Trees produce timber need to be sustained by the communities Bamboo based activities.
Clean water	To avoid flood, forests have to be sustained Clean water need to be improved mainly by non-villagers Clean water of rivers has to be maintained Water pollution Clean water 'bank' Social forestry for clean water purposes Clean water of rivers
Forest utilization rules	Rules for taking out timber have to be clear Rights and roles of communities in forest utilization Fair forest benefit distribution Forest product production techniques (exploitation and regrowth) Forest status according to laws Forest managed by communities and commercial companies Forest benefits sharing for communities, companies and governments.
Soil erosion	Maintaining soil quality Logging techniques /silviculture Soil erosion Soil contamination Preventing erosion Land rehabilitation
Forest cover and stock	Forest stand structure High forest cover High forest standing stock
Ecosystem sustain-ability	Balance of forest ecosystem Protection of endangered species Biodiversity Sustainability of fauna Forest products continuity Sustainability
Eco-tourism	Utilization of potential sites for eco-tourism and adventure Forest tourism 'empowerment' Establishment eco-tourism environment
Extension	Dissemination and socialization of protection forest
Research	Forest research area

Table A.3. Law and rule components

Category	Component
Customary law	Customary laws of resource access Improvement of customary laws by communities Customary laws are respected Customary laws are recognized Community inheritance rules Customary rights Recognition of customary rights to forests Clear forest access rights Community rights to forests
Law certainty	Rules for quantitative benefits sharing Forest utilization permission Redefining forest utilization rules
Rule making process	Community participation in rule making process Transparency of rule making process Process of rule creation
Rules of forest ownership	Rules of resource ownership (forest and land) Current law status of the forests Laws certainty Rules are not overlapping Clear rules Clear and non-confusing rules Rule enforcement
Land boundary	Boundary of communities' land in their village Forest land boundary needs to be solved Certainty of village and forest boundary
Village community institution	Village institution Community institution Establishment of conflict resolution mechanism
Clear forest utilization permission	Rules of land ownership Clear resource ownership (forest and land) Land ownership distribution Community land ownership