

8. COMPANION MODELLING FOR EXPLORING NATURAL RESOURCES MANAGEMENT STRATEGIES IN PALAWAN, THE PHILIPPINES

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This paper reports experiences and lessons of a continuing study on the use of a contemporary analytical tool, Multi-agent Systems (MAS), to study the dynamics and complex interactions among stakeholders in the management of common renewable resources. In the MAS model, a renewable resource management system is represented with different autonomous entities, called agents, that are able to act, interact with other agents, and be affected by objects in the environment. In this study, the MAS model is developed using the Companion Modelling (ComMod) approach, a collaborative development of a MAS model between the stakeholders and researchers which places primary importance on the quality of process to ensure that the tools developed are acceptable and used with confidence. This approach involves the development and application of computer simulations and role-playing games (RPGs) to validate the MAS model as well as learn from it. Inferences are drawn from the learning and negotiation processes that the stakeholders and researchers undergo in the collaborative development of the MAS model and the techniques used to realize this model, i.e. computer simulation and RPG, as well as the development of a unified resource management plan for three villages. For the community, having acknowledged the RPG as a reliable representation of their reality, they see these tools as vehicles to reach the appropriate stakeholders and communicate their concerns about their livelihoods and resources. For local government agencies and non-government organizations, these tools serve as eye-openers about the dire livelihood conditions of the community. Furthermore, local governments see the RPG and computer simulation as effective techniques to inform and educate people about their plans or programs for the management of resources and livelihood for the community. The stakeholders also agree that these tools are useful in coming together and discussing issues pertaining to the management of their natural resources and livelihood activities. Given the benefits that could be derived from ComMod and MAS modelling in NRM, these techniques display a great potential in plantation management for increasing the financial returns.

INTRODUCTION

This paper reports the experiences and inferences of a continuing study on the use of A contemporary analytical tool, Multi-agent system (MAS) to study the dynamics and complex interactions among stakeholders in the management of common renewable resources. The study is being undertaken as one of the components of the *Levelling the Playing Field Project* in Palawan, the Philippines and is being implemented in the villages of San Rafael, Tanabag and Concepcion, in Puerto Princesa City in Palawan, the Philippines. In these villages, there are multiple stakeholders participating in the management of resources. These stakeholders have different and competing interests, objectives and motives, as well as different positions of power that make collaborative management difficult. Moreover, conflicting laws and environmental policies often lead to confusion and conflicts among the stakeholders. New management policies imposing new access rule to resources also threaten the livelihood of the community.

This research aims to support the various stakeholders in communicating and negotiating their different interests, in learning about the consequences of their strategies, and in coming up with an agreed common vision and management plan for their resources. This is being done through the development of a Multi-Agent Systems (MAS) model using the Companion Modelling (ComMod) approach (details are found in the succeeding sections). More specifically, this research aims to:

- 1) Characterize the existing Natural Resources Management (NRM) system and represent it with a MAS model.
- 2) Use existing tools or develop new tools for learning and for facilitating negotiations using the ComMod approach based on the developed MAS model. The tools, methods and

artefacts that would be developed and used include, but are not limited to a Multi-Agent System (MAS) simulation platform or platforms, and role-playing games (RPG);

- 3) Identify areas of intervention where these learning and negotiation tools can be used to initiate change and to use them in NRM learning and negotiation processes.

It is hypothesized that, through the process of ComMod, an environment would be created that is conducive to learning, as well as provide a venue for the different stakeholders to begin negotiating and collaborating on resource management issues on level grounds.

The succeeding sections of this paper present the conceptual foundation and the methods used in the development and use of the MAS model for three villages in Palawan, the Philippines. This is followed by a description of the study described within the context of the Levelling the Playing Field (LPF) Project for Palawan, the Philippines. The results and lessons gained from the research are then presented. The last section of this paper discusses how the methods and lessons derived from this research can be relevant and beneficial to plantation management.

RESEARCH METHODS

Multi-Agent Systems

A multi-agent system model is a system model style that represents a complex system using the following components: (1) a space, called the environment, (2) objects that are situated in the environment, (3) a special type of object, called agents that would represent the active entities in the system, (4) relations that link these objects, and consequently the agents, with their common environment, (5) a set of operations that could be performed by the agents to interact, transform or manipulate other objects in the environment, and (6) operators that represent the results when these operations are performed (Ferber 1999, as cited by Bousquet and Le Page 2004). Each agent has its own characteristics, goals, knowledge and specific but limited perception of the system, and is also able to communicate with other agents. Figure 1 is a visual representation of these components of a MAS model.

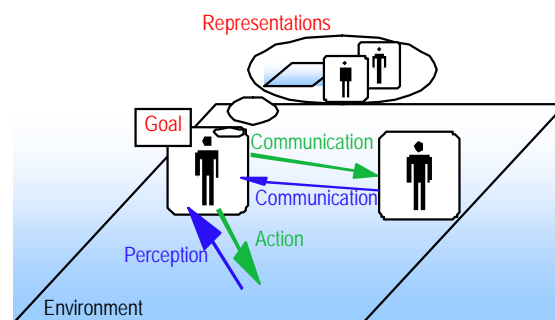


Figure 1. Multi-agent system

Ferber 1999 as cited by Bousquet and Le Page 2004

In the context of natural resource management (NRM), these agents may be the stakeholders of the NRM system, such as humans, animals, and government agencies having their own limited perceptions and goals about the environment in which they operate. Given this limitation in knowledge and perception, as well as the differences in goals and perception, there may arise miscommunication, lack of coordination and even conflict, which is often found in many NRM situations. A cellular automaton could also be used to represent biophysical processes present in the environment.

The Companion Modelling Approach

Companion modelling or ComMod (Barreteau *et al.* 2003) is an iterative approach in developing system models, in this case a MAS model, and simulation tools when dealing with complex systems, wherein fieldwork and system modelling are closely related and complementary activities. In this approach there is constant interaction between the researchers and stakeholders in the iterative process (Figure 2), such that the model will undergo modifications resulting from these interactions, or even produce a totally different model altogether. In ComMod, the quality of process of building the MAS model is paramount such that the stakeholders should be able to accept

the results of the modelling process. Ultimately, the goal of the ComMod approach is to achieve a collective understanding of the complex system with the stakeholders, and to be able to use the newly acquired knowledge in the process of negotiation.

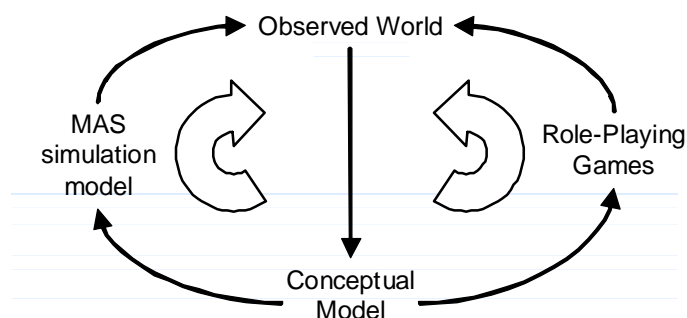


Figure 2. The companion modelling approach

Barreteau *et al.* 2001

The process of validating the MAS model is a series of back-and-forth steps from the field (reality) to the model to be able to take into account the different perceptions of the stakeholders and properly represent them in the model using tools such as simulation model and an RPG as platforms for discussion. A MAS simulation model is a computer implementation of the model with its components being represented as computer entities or objects. It simulates a complex system through the passage of time, usually for a period that is impossible or costly to observe in reality. On the other hand, a role-playing game is an implementation of a MAS model using a game, with the players (stakeholders) being the agents of the MAS model and having actions and interactions similar to that of reality. Although these two tools (simulation model and RPG) could be used individually in the development of the MAS model, together they complement each other depending on the purpose of the MAS modelling exercise. An example of this complementary relationship of RPG and simulation model is the case wherein the RPG is used as a facilitation tool to explain the MAS model. However, an RPG played with the stakeholders is limited in the number of steps or iterations that can be played and in the number of interactions that can be represented; the simulation model could be used to predict the outcomes of the RPG should the game be continued for a longer period or include more features and complex interactions that were not represented in the RPG. Other tools could also be used to support the modelling process such as tools and artefacts developed using PGIS and participatory land-use planning tools.

In order to represent properly the various perceptions of the stakeholders and build scenarios that would reflect their interests and goals, the step-by-step approach of Etienne *et al.* (2003) is proposed to be used as a guide to ensure that all stakeholders' perceptions are included in the model. Through this method, a stakeholder would be the one to define the system according to their perception, define how to view this perception by means of a spatial representation or viewpoint, define the indicators by which the model would be assessed and analyzed and define the scenarios or management strategies the stakeholder would like to pursue or explore.

RESEARCH SITE

The Levelling the Playing Field Project

This study is being carried out as a component of the Levelling Playing Field (Levelling the Playing Field: fair partnership for local development to improve the forest sustainability in Southeast Asia) project or LPF. Three countries are involved in this project, namely Indonesia, Malaysia and the Philippines. This research project is being managed by the Centre for International Forestry Research (CIFOR) and Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD), in partnership with local universities. In the Philippines, the University of the Philippines Los Baños has been tapped as its partner in the implementation of the research in the Philippine site.

The LPF Project aims to improve forest management in the region by improving the efficiency of the coordination of the various stakeholders through capacity building, while taking into consideration that different stakeholders have different perceptions of their resources and have varying powers to act on forest management issues. To achieve this goal, the LPF project is

focusing on the development of tools for the stakeholders that would improve communication and coordination of actions and also the development of an environment wherein the various stakeholders would be able to tackle forest management issues together with balanced power and responsibility.

Geophysical Attributes of the LPF project

The LPF study site in the Philippines is located in Puerto Princesa, Palawan (Figure 3). It is composed of three villages, namely San Rafael, Tanabag and Concepcion. In general, the topography is similar within the three villages such that it can be characterized as having three types of landscapes, namely a coastal area facing Honda Bay, a lowland area normally used for farming and coconut plantations, and an upland area covered by forests.

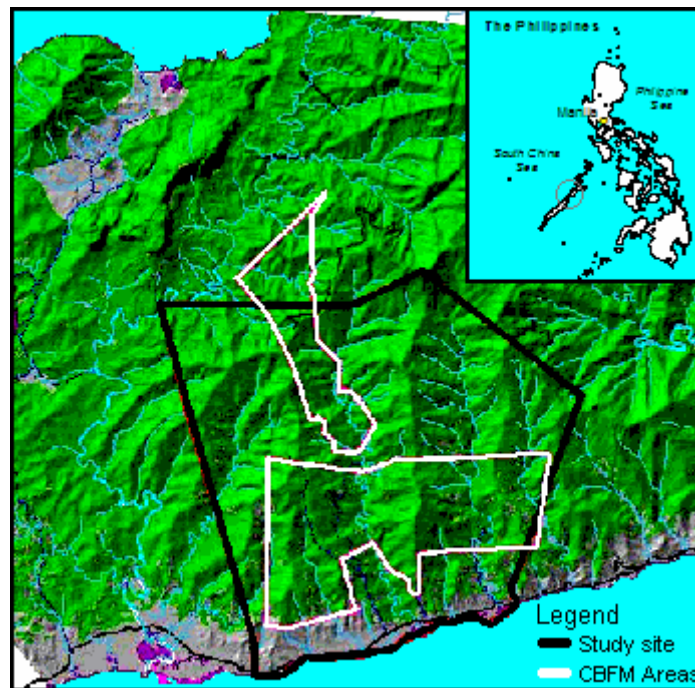


Figure 3. Location of study site

Social context of the LPF project

The people in these barangays, numbering around 3600, are composed of two types of communities, namely, the migrants and the indigenous people, called Bataks. Each of the three barangays has its own local leader and council members. The Bataks have their own chieftain as well. The livelihood activities of the migrants are fishing, farming (vegetable, corn and rice), copra production, charcoal-making, roof shingles-making, collection of non-timber forest products (NTFPs) including honey, rattan and almaciga resin, catching milkfish fries, livestock-raising, ornamental and flower plants gardening and trade (buy-and-sell). Some of the people are also involved with swidden farming for food security. The Bataks are limited to the collection of NTFPs, swidden farming, hunting and livestock-raising. For the case of the migrants, some of them are involved in more than one livelihood activity at any one time.

Aside from the communities in these barangays, there are other stakeholders that have influence in the exploitation of resources found within the boundaries of the three barangays, such as government organizations (GOs) from the local level (local government unit or LGU) up to the national level (Department of Environment and Natural Resources), as well as non-government organizations (NGOs).

Portions of the two Community-Based Forestry Management Agreements (CBFMAs) (Figure 3) fall within the boundaries of the three villages, with one of the CBFMAs for the migrants, and one is for the Bataks. A cooperative for the three barangays has been established to manage the CBFMA for the migrants and is called the San Rafael, Tanabag, Concepcion Multi-purpose Cooperative (STCMP). However, the cooperative itself is relatively inactive at present.

DATA AND RESULTS

LPF Palawan MAS conceptual model

Although Unified Modelling Language (UML) diagrams are more commonly used to describe object-oriented programs and models, they can also be used to visualize MAS models and describe the static and dynamic characteristics of a complex system. For this study, as seen in Figure 4, a simplified UML Class diagram is used to illustrate the various entities of the NRM system, the interrelationships of these entities and the operations an entity undertakes or experiences. The type of agents identified in the study are the *Villager*, which is further classified into two types, *Migrant* and *IP* (indigenous person), the organizations or groups the villagers form (i.e. *People's Organizations (PO)*, *Village Council*, *Household*, and *Village*) and *Mediating Institutions* (i.e. government organizations and non-government organizations). The environment, which is composed of cells or units of land, has components both on land and in the sea. A cell contains different types of resources depending on its cover. Other entities of the model are the *Management Unit*, which is composed of cells, and *Weather*, a global entity to represent weather that affects all the other entities of the model.

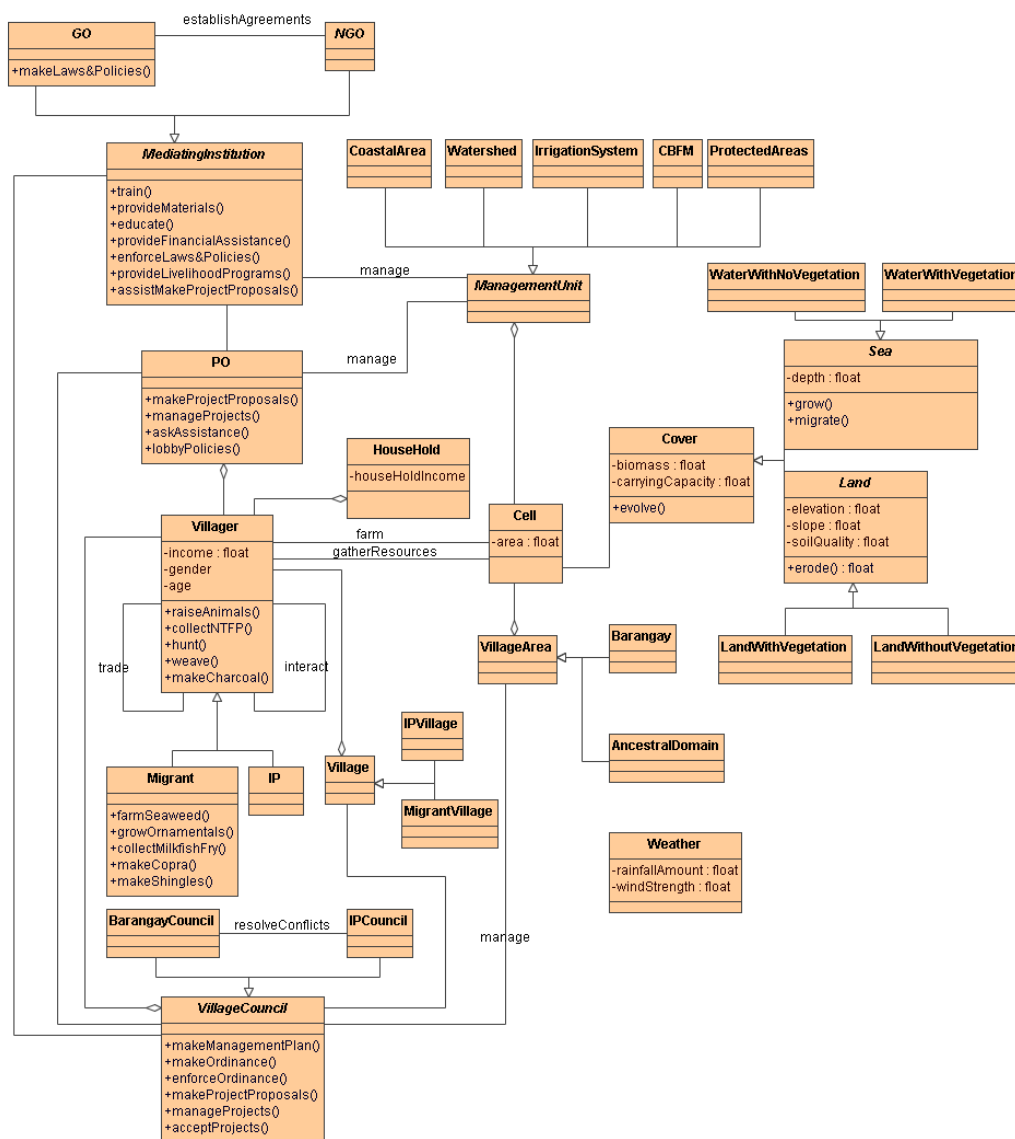


Figure 4. Entities of the MAS model and their interrelationships

Each entity may have different attributes or characteristics as well as operations or actions. For example, a *Villager* has attributes of income, age and gender and it can *raise animals*, *collect*

NTFP, hunt, and carry out other livelihood activities. A *Mediating Institution* may be able to conduct training, and provide livelihood materials and education for the PO. The lines connecting the entities represent the relationship between these entities. For example, both the *PO* and *Mediating Institution* are managing the *Management Units*. The operations or actions of an agent depend on its goals. For example, a *Villager* would have a goal of generating income, thus most of its actions are related to livelihood activities. On the other hand, a *Mediating Institution* would be interested in protecting the environment, thus it has actions that are meant for this purpose such as enforcing environmental laws and policies and educating the PO. Arrowheads are used to describe subclasses of an entity, e.g. *GO* and *NGO* are subclasses of *Mediating Institution*. Lines with diamond ends are used to describe membership of groups, e.g. a *PO* is composed of *Villagers* and a *Management Unit* is composed of *Cells*.

The ComMod Process in Palawan, the Philippines

The first ComMod cycle focuses on the management of natural resources within the three barangays (Figure 5). More specifically, it looks into the dynamics of the natural resources and the effects brought about by the various livelihood activities, and the rules of resource access and exploitation. These aspects of the NRM system would produce feedback affecting each other as one changes and this is investigated through the use of the MAS simulation models and RPGs.

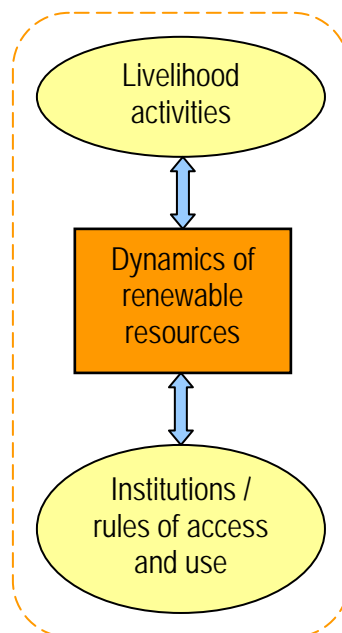


Figure 5. Theme of the first ComMod Cycle

Adapted from the Ecole ComMod Project Website: www.ecole-commod.sc.chula.ac.th

The ComMod process in the study site, as shown in Figure 6, began with a collective learning experience for the stakeholders, i.e. a workshop to introduce MAS. The objectives of this activity were to introduce to them the concept of MAS, present to them the aspects of the study and involvement of the stakeholders including the scientists, as well as to obtain their approval to continue with the process, which they subsequently gave. After gaining their approval, the survey of the problem followed. This involved baseline studies and gathering data to describe the NRM situation of the site. From these data, a conceptual model was developed, having a MAS framework as described in Figure 1. Participatory simulations involved the development of MAS computer simulations as well as RPGs to validate the conceptual model and at the same time immerse the stakeholders into a collective learning process. The double-headed arrow between participatory simulation and conception of model expresses the back-and-forth nature of the process in refining the model. In this study, several workshops were conducted wherein RPGs were used to validate and refine the MAS model. Scenarios or ‘what if’ situations about the NRM system were developed together with all the stakeholders to draw out their concerns about their resources. These scenarios and the results will be presented and used in the negotiation process, should the

stakeholders wish to do so. Because the stakeholders have different perceptions and interest, these perceptions will be represented using indicators they themselves have identified during the scenario-building process. Different points-of-views or graphical representations such as maps or charts will be used to examine these differences in perceptions. Future steps of the ComMod process will involve the development of management strategies using the results of the scenarios identified earlier as the starting point for discussions. These strategies could be plugged into the computer simulation or RPGs for testing. In the end, it is expected that the scenarios and strategies would be institutionalized in the management plan of the three communities.

Should the stakeholders feel that the model does not address their concerns and is not in line with their goals, they want to address a more specific concern, or they have new questions about their NRM system stemming from the learning and negotiation processes, then there would be a need to develop a new conceptual model; thus a new ComMod cycle would begin.

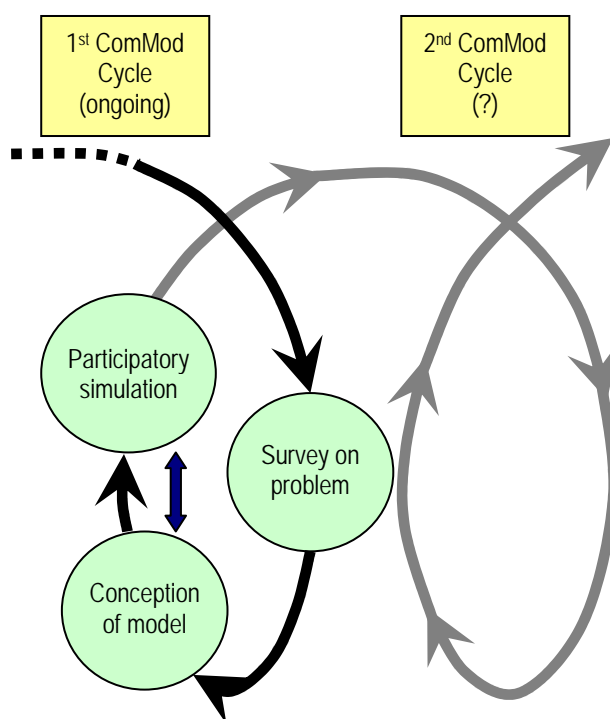


Figure 6. Implementation of the ComMod approach in Palawan, Philippines

Adapted from the Ecole ComMod Project Website: www.ecole-commod.sc.chula.ac.th

KEY RESULTS AND LESSONS LEARNED

At the beginning of the modelling process, the stakeholders were introduced to the concept of MAS modelling through a series of one-day workshops, conducted four times with different types of stakeholders. Aside from a brief presentation of what MAS is all about, for them to have a better idea of MAS modelling, they were shown an example of a computer simulation of an NRM case and they also played a RPG about resource use called Chering that was developed by French scientists from CIRAD. The participants of the workshop welcomed the idea of building a MAS model to represent their NRM system. They were interested in the computer simulation because they had several concerns which they thought could be addressed by the simulation model, such as effects of livelihood activities vis-à-vis resource availability. The RPG was seen as an effective tool in communicating information regarding natural resource management (NRM), because it was easier to explain or demonstrate ideas using games rather than oral presentations. The Chering game consists of several scenarios, in which the participants are given a chance to interact with each other in various conditions. This allowed a simulation of negotiation processes that might actually happen in real situations as well as development of strategies. There was excitement among the participants as they were learning and discussing resource management issues while having fun! Some GOs and NGOs requested that they be taught how to conduct similar activities because they

would like to apply it in other areas. Also, through the Chering game, played at different times with different participants, differing perceptions and priorities of the stakeholders were revealed.

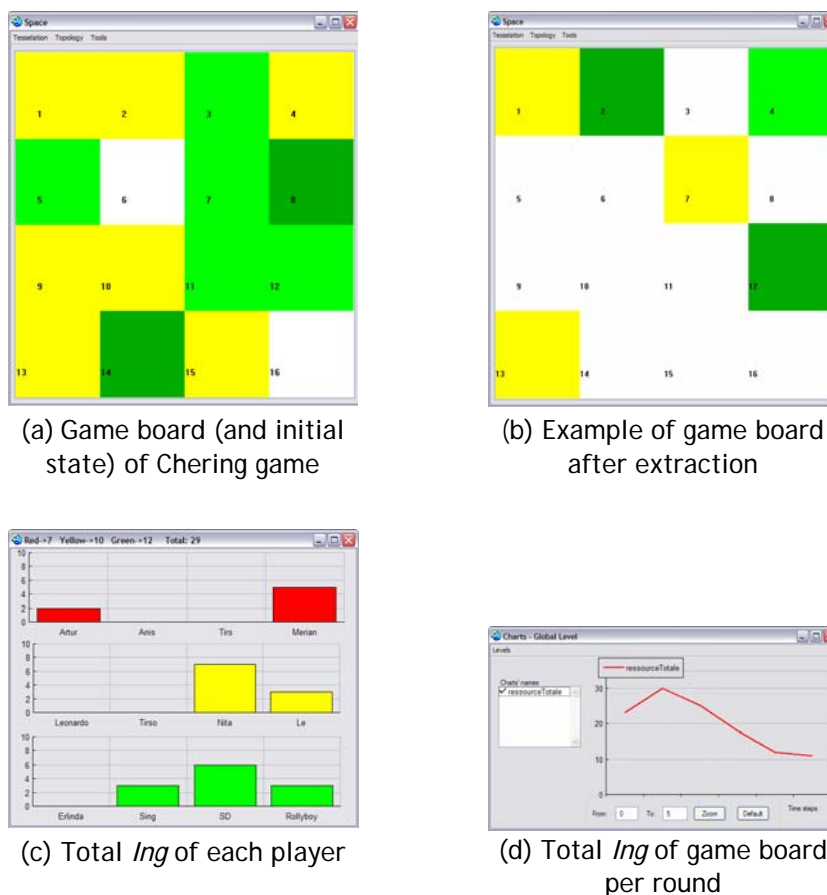


Figure 7. Chering game visualization tools

The data-gathering activities for the MAS modelling process, on the other hand, gave more insights into how the stakeholders interact within their group and with the other stakeholders. This also revealed that many of the migrants from the community perceive themselves as resource users rather than having a specific occupation or livelihood. Some of the other insights gained from the interviews and FGDs are as follows:

- 1) Most activities, programs or projects funded by government and non-government agencies sprang from ideas and proposals submitted by community members themselves, most of which, however, ended up in failure due to poor management by the communities. This indicates the need to strengthen the capability of community members in managing projects, as well as producing more sound proposals.
- 2) Farming and fishing activities were mostly undertaken for subsistence. However, for those engaged in fishing, they were more likely to sell their catch if given an opportunity. For those engaged in farming, they would sell some of their harvest if there was an immediate need for money. Livelihood activities including copra production, roof shingles-making, ornamental and flower plants gardening, charcoal-making, catching milkfish fry and livestock-raising were usually undertaken for commercial purposes. Most of these activities were conducted with other members of the household.
- 3) The forest is still viewed by community members as a reliable source of income. NTFPs are viewed to be always available and there is an available market for these products within and outside the community. However, due to difficulties associated with NTFP gathering, only able-bodied community members, usually men, are able to perform such activity. Furthermore, current restrictions in gathering NTFP have made this activity more difficult, especially for the Bataks who rely mostly on forest resources for survival.

- 4) A livelihood activity is prioritized according to (a) the needed investments or capital, (b) how quick one could earn money, and (c) the amount of money that could be earned.
- 5) Goods were sold through middlemen or traders who were also members of the same community. Those engaged in growing ornamental plants had regular clients in the city but they also sold them at the local markets or to buyers that passed by their gardens (which were normally located at the roadside).

RPG workshops were conducted with the stakeholders to validate the MAS conceptual model. An RPG was developed based on the MAS model and was simplified to focus on the livelihood activities. The new RPG, or RPG1, was patterned after the Chering game used in earlier workshops, which helped some of the participants learn the new RPG more easily since some of them had played the Chering game. The participants of the first RPG workshop were limited to the migrants and to the Bataks. They played RPG1 as they would do in real life; this already is a form of validation of the RPG and the conceptual model. As with any other model that is being validated, some of the aspects of the game have to be changed based on the feedback from the participants. These aspects are mostly on the monetary payoffs of livelihood activities. The RPG and the discussion afterwards was an eye-opener because it allowed a comparison between the three barangays, as well as between migrants and the Bataks about their livelihood activities and attitudes. Some of these elements were not revealed through the interviews and FGDs, probably because they could not be revealed by simply asking questions. The following insights were deduced from the observations during the game as well as the discussion about the game and its results with the participants:

- 1) At the beginning of this research, it was assumed that the three barangays would be sharing the same space for resource use. It was expected that there would be similarities as well as differences in their livelihood activities. Although this would be obvious for the case of the Bataks because they are limited to the forest area, it was much more difficult to identify the similarities and differences in the choice of livelihood activities of the migrants. It was during the RPG that a clearer picture was obtained of which of the barangays are more involved in a particular activity, based on the choices they made during the game as well as from the discussions that followed.
- 2) The income from just one livelihood activity is not enough to sustain the everyday cost of living in the community. Given such a situation, the migrants are often engaged in more than one livelihood activity. However, some of the livelihood activities they are doing now, such as fishing and vegetable gardening, given the right capital, training, and equipment, would actually be profitable based on the experiences of some of the participants. For example, in the RPGs played with the participants in the three barangays, most of those who engaged in fishing lost money. When asked if this result is realistic, they replied affirmatively. However, some players, who are experienced fishermen in real life and have invested money in their equipment, especially on their boats, were profiting from fishing during the game. They were asked if indeed such profits were attainable in real life, and they replied that it is indeed possible and they have experienced it as well in real life.
- 3) During the RPG, it was observed that most of the participants would be doing the same livelihood activity at one time. In the discussion it was explained to the researchers that all the Bataks will do one kind of activity at one time depending on the season or demand. For example, if it is the season for honey, all those who are physically able will gather honey. If there is demand for rattan, all of them will gather rattan.
- 4) During the discussion about the RPG, the Bataks were asked about their strategies during the game, such as when the community would be engaged in a particular activity, as well as if the payoffs they were getting in the game were correct. They explained that, for some of their commodities, these are gathered only if there is demand from the traders (migrants). When it comes to pricing, it is the traders who would dictate the price. Therefore, the Bataks rely on the trading activity of the migrants for their livelihood. Most, if not all, of their commodities are sold to the migrants from within the three barangays and are seldom sold in the main city due to high transportation costs.
- 5) At first glance, buy-and-sell activities would not be seen as directly connected with resource exploitation; thus they were not identified in the FGDs and were not included in the RPG. During the discussion of the RPG, however, the participants pointed out that these activities should be included in the game because there are considerable numbers of people in each of the three barangays engaged in this type of activity. At closer analysis, due to the number of

people involved in this kind of activity, plus the fact that the livelihood activities of the Bataks are demand-driven, this might dictate the speed and intensity at which resources would be gathered within and outside the boundaries of the barangays.

A revised form of RPG1, now called RPG2, was introduced in another series of RPG workshops. Again, this was done to validate the MAS model and its revisions, but this time other stakeholders from government institutions and NGOs were included as participants. Also, in this particular workshop, a scenario-building exercise was conducted with the stakeholders to reveal their concerns in terms of their natural resources. The results of the scenarios identified will be presented in the next MAS workshop involving all the types of stakeholders.



Figure 8. RPG conducted with representatives from the Bataks, migrants, government offices and NGOs (clockwise from top left)

From all these exercises in the MAS modelling process, a number of key results are obtained. The data gathered from the FGD exercise, in which the various aspects of the livelihood activities in the villages, including costs and income generated from performing a livelihood activity, were being used by the TWG to help them plan for their future livelihood activities. Discussions between the LPF staff, some government offices and NGOs are under way with regards to how to translate the RPG into a tool that would have minimal use of electricity and equipment, such that this tool could be used in remote areas where there is no electricity. The stakeholders appreciate the lessons they have learned from the MAS model and the processes used in making it such that they have endorsed it and its associated artefacts (i.e. the computer model and the RPG), to be used as tools to help the Barangay Development Council (BDC) – the decision-making body of a community composed of community leaders and representatives – in its resource management planning exercise. This endorsement comes in the form of an endorsement letter signed by the participants of the RPG workshops.

CONCLUSIONS: MAS MODELLING AND COMMOD FOR PLANTATION MANAGEMENT

Having presented the results of the implementation of ComMod and MAS modelling, how would these methods be applicable and advantageous in the management of plantations?

Understanding resource management systems and revealing hidden information

ComMod exposes the stakeholders to learning experiences that are not found in other methods such as surveys involving interviews. Although traditional methods are important in characterizing complex systems, there is specific information that is not readily seen as what was experienced in this study. The artefacts used in the process allow scientists to present the model in a more agreeable manner, even entertaining to a certain extent, which is useful in maintaining the

interests of the stakeholders in the process. The use of RPG would also allow scientists to observe stakeholders and reveal underlying principles, motives and attitudes towards decision-making in a controlled environment for a shorter period of time.

Platforms or tools for discussions and negotiation

Having the stakeholders have direct participation in the modelling process gives more credibility to the model and its artefacts; thus they have more confidence in using the results of the process in their planning. The knowledge and information come from the stakeholders, and these are shared with the other stakeholders as the tools are used. The results generated by the use of these tools can be used to support their negotiating positions and strategies, with outcomes from negotiations having a greater chance of acceptance. Being in collective learning situations also builds and strengthens the relationships between stakeholders as they now have shared knowledge and experiences. Thus this tool may be used effectively to discuss policies that are perceived by plantation developers to be disincentives to plantation development and management.

Development and testing of management strategies

Simulations allow planners and scientists to develop and test management strategies for a shorter period of time, and quite possibly, at even much lower costs. However, using MAS to model reality takes into consideration the unpredictable aspects of management, thus reducing false expectations among stakeholders. RPGs allow stakeholders to have a more direct experience in testing strategies because they are immersed in a 'realistic' situation giving them a more pragmatic approach in making plans and decisions.

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