Multi-Agent Systems (MAS) Modelling to Improve the Management of Common Renewable Resources in Palawan, Philippines

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1 Introduction

1.1 Research context

This paper reports experiences and inferences of an on-going study on the use of 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 conducted as one of the components of the Levelling the Playing Field Project in Palawan, Philippines and is being implemented in the villages of San Rafael, Tanabag, and Concepcion, Puerto Princesa City in Palawan, Philippines. Here, the management of renewable resources is characterized by participation of many stakeholders who have different and competing interests, objectives and motives. The community groups and government and non-government organizations also have different positions of power that makes collaborative management difficult. Conflicting laws and environmental policies often lead to confusion and conflicts among the stakeholders. New management policies imposing new access rule to resources also threatens the livelihood of the community.

1.2 Objectives

This research aims to facilitate different 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 would be done through the 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 artifacts that would be developed and/or used includes, 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 believed that thru learning and providing a conducive environment by means of a platform or a mechanism for negotiation that the stakeholders would be able to begin to talk to each other on level grounds with matters regarding the management of their resources.

1.3 Structure of this paper

The succeeding sections of this paper will present the conceptual foundation and the methods used in the development and use of the MAS model for the LPF Philippine site. This would be followed by a short presentation of the LPF Project and the study site in the Philippines. The next section would discuss the data, results and lessons that have been learned in the implementation of the modelling process. Finally, a synthesis of the accomplished work, as well as the future activities of the research, will be presented.

2 Conceptual framework

2.1 Multi-Agent Systems

In a multi-agent system or MAS, a complex system is represented thru the use of agents, objects in space, a space or environment for these agents to move about and as a place for objects to be located in and a set of relationships linking these entities together, as well as operations which allow these components interact, be transformed, moved or manipulated (Ferber 1999 as cited by Bousquet and Le Page 2004).
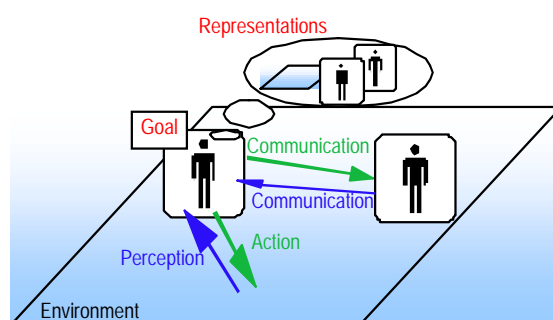

Figure 1. Multi-agent system (Ferber 1999 as cited by Bousquet and Le Page 2004)

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 perceptions and goals about the environment they are in. These agents are able to act on their environment, on objects and also to interact with other agents to achieve their goals. An important characteristic of an agent in a MAS is that it has a limited knowledge and perception of the environment. This limitation in knowledge and perception, as well as the differences in goals and perception may lead to miscommunication, lack of coordination and even conflict, which is often found in many NRM situations. The biophysical processes existing within an environment can also be represented by means of a cellular automata.

2.2 Companion Modelling Approach

In order to build the conceptual model representing the study site, the companion modelling (ComMod) approach would be used in order to ensure the active participation of the stakeholders in the development of the model. In ComMod (Barreteau et al. 2003) the development of a conceptual model and its associated tools, i.e. MAS simulation models and role-playing games (RPGs), is an iterative process wherein fieldwork and system modelling are closely related and complementary activities, as shown in Fig. 2. It is characterized by the constant interaction between the researchers and stakeholders such that the model may undergo several modifications or a totally new model may emerge from the process. In this approach the quality of process of building the MAS model is given emphasis such that the stakeholders would accept the outcomes. 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.

The process of validating the conceptual 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. To be able to visualize or experience the model, tools can be used, such as MAS simulation models and RPGs. 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 thru 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, such as stakeholders, being the agents of the MAS model and having actions and interactions similar to reality. Although these two tools (simulation model and RPG) could be used individually in the development of the conceptual model, together, they complement each other depending on the purpose of the MAS modeling exercise. Other tools could also be used to support the modelling process such as tools and artifacts developed using participatory GIS (PGIS) and participatory land-use planning tools, etc.
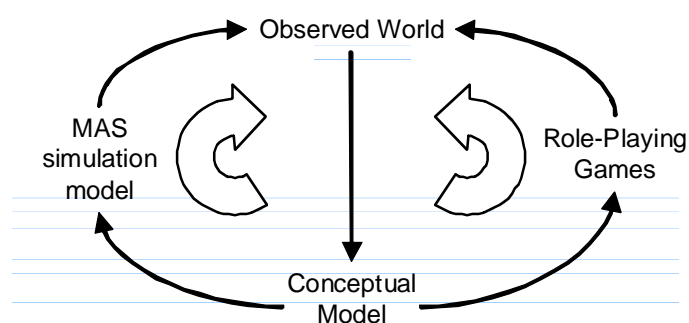

Figure 2. The companion modelling approach (Barreteau et al. 2001)

In order to properly represent the different 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 its 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.

3 Research site

3.1 The Levelling the Playing Field Project

This study is being conducted under the The Levelling the Playing Field (Levelling the Playing Field: fair partnership for local development to improve the forest sustainability in Southeast Asia) project or LPF, a research project involving six study sites spread across three countries, namely, Indonesia, Malaysia and the Philippines. This research project is being managed by the Center for International Forestry Research (CIFOR) and Centre 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 partners 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 different 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 on the development of an environment wherein the various stakeholders would be able to tackle forest management issues together.

3.2 LPF Project in the Philippines

Geophysical characteristics

The LPF study site in the Philippines is located in the city of Puerto Princesa, in the province of Palawan (Fig. 3). It is composed of three villages, namely San Rafael, Tanabag and Concepcion. The topography of the three villages are similar 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.
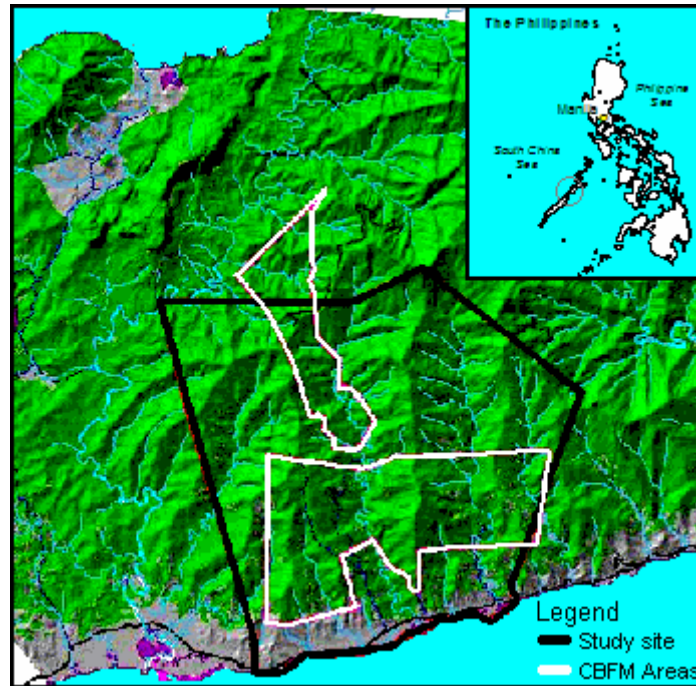
Figure 3. Location map of the study site

Social context

The people in these villages are composed of two types of communities, namely, the migrants and the indigenous people, called Bataks. The three villages, also known as *barangays*, being the smallest political unit in the Philippines, has it's 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) such as 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 Natural Resources), as well as non-government organizations (NGOs).

Within the boundaries of the three barangays are two Community-Based Forestry Management Agreements (CBFMAs) (see Fig.3), one for the migrants and one for the Bataks. From one of the CBFMAs, a cooperative for the three barangays has been established to manage the CBFMA called the San Rafael, Tanabag, Concepcion Multi-purpose Cooperative (STCMP). Although the CBFMA still exists, the cooperative itself is inactive.

The site was selected because the management of its renewable resources, as in many other places, is characterized by multiple stakeholders who have different and competing interests, objectives and motives. The community groups and government and non-government institutions also have different position of power that makes collaborative management difficult. Conflicting laws and environmental policies often lead to confusion and conflicts among the stakeholders. New management policies imposing new access rule to resources also threatens the livelihood of the community.

4 Data, results and lessons learned

4.1 LPF Palawan conceptual model

Figure 4. Entities of the MAS model and their interrelationships

To represent the NRM system of the study site, several representations could be made to visualize the static and dynamic characteristics of the system. In Figure 4, a simplified Unified Modelling Language (UML) Class diagram is used to show the different entities of the system, the interrelationships of these entities and the operations an enitity undertakes or experiences. Going back to the MAS model representation in fig. 1, the type of agents in the study site are the *Villager* which are subclassified into two types, *Migrant* and IP (indigenous person), the organizations or groups the villagers form, i.e. People's Organizations (*PO*), *VillageCouncil*, *HouseHold*, Village, and *MediatingInstitutions, i.e.* government organzation (*GO*) and non-government organization (*NGO*). The environment, which is composed of cells or units of land, has different types of cover subclassified as *Land* and *Sea*. It contains different types of resources depending on the cover. A ManagementUnit is composed of cells. A *Weathe*r is an entity that represents the weather, which is a global entity that affects all the other entities of the environment.

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 *raiseAnimals*, collectNTFP, *hunt*, and other llivelihood activities. A *MediatingInstition* may be able to conduct trainings, provide livelihood materials, educate, etc. for the PO. The straight lines connecting the entities would represent the relationship between these entities. For example, both the *PO* and *MediatingInstitution* are managing the *ManagementUnits*. The operations or actions of an agent would 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 *MediatingInstitution*, would be interested in protecting the environment; thus it has actions that are meant for this purpose such as enforcing environmental laws and policies, educating the PO, etc.

4.2 ComMod Process

In the first ComMod cyle (see Fig. 5), the focus is on the management of natural resources within the three barangays. More specifically, it will look into the dynamics of the natural resources and the effects brought about by the different livelihood activities, as well as the rules of access and use of these resources. These interacting aspects of NRM would produce feedbacks as an aspect changes and this would be investigated as well through the use of the MAS simulation models and RPGs.
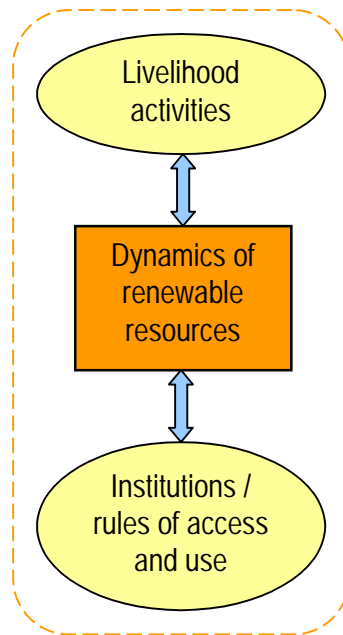
Figure 5. 1st ComMod Cycle (adapted from the Ecole ComMod Project Website: www.ecole-commod.sc.chula.ac.th)

The ComMod process in the study site, as shown in fig. 6, began with the survey of the problem. This involved baseline studies and gathering of data to describe the NRM situation of the site. From these data, a conceptual model was developed, having an MAS framework as described in Fig. 1. Participatory simulations involves the development of MAS computer simulations as well as RPGs to validate the conceptual model and at the same time immerse the stakeholders in a collective learning process. Scenarios about their NRM system would also be developed together with all the stakeholders and these scenarios would be presented and used in the negotiation process, should they wish to do so. As the stakeholders have different perceptions and interest, these perceptions would be represented using indicators they themselves would have identified during the scenario-building process, as well as different points-of-views or graphical representations such as maps or charts will be used to visualize these differences in perceptions. 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 are not in line with their goals, should they want another model to address their other concerns, or they have new questions about their NRM system after the learning and negotiation process, then there would be a need to develop a new conceptual model; thus a new ComMod cycle would begin.
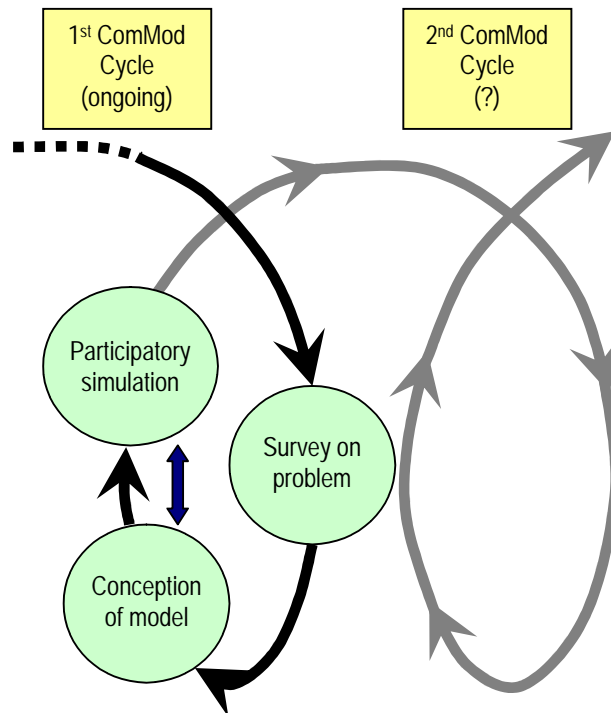
Figure 6. Implementation of the ComMod approach in Palawan, Philippines (adapted from the Ecole ComMod Project Website: www.ecole-commod.sc.chula.ac.th)

4.3 Accomplished activities

The activities that have been conducted so far for the MAS modelling component of the LPF project are related to the preparation of the stakeholders in the process, data-gathering for both bio-physical and social processes, and the initial validation of the MAS model thru the use of RPG. As much as possible, the same participants were invited to attend the different activities to assure the continuity of the learning process among the stakeholders and lessen the time in trying to familiarize the participants of the modelling process. It is also important to note that, aside from the regular team of the LPF project in the Philippines, the project has tapped the help of the government offices thru their representatives, such that there is 3 local government representatives helping the team conduct these activities. This also gives the government representatives a first-hand look as to how the process is being implemented.

Introduction to MAS modelling

For the stakeholders to be able to fully participate in the activities of the modelling process, they would need to know and understand the process that was going to be followed in building and using the model. To start in this process, they were introduced to the concept of MAS models and the implementation process that would be followed as shown in Fig. 6. This introduction was done in a one-day workshop, conducted four times, and consisted of a small presentation about MAS modelling. For them to have a better idea of what is MAS modeling, they were shown an example of a computer simulation of an NRM case. They were also invited to play a

generic role-playing about resource use game called Chering that was developed by French scientists from CIRAD.

In the Chering game, players are to gather a generic resource, called *Ing*, from a plot in the game board, as shown in fig. 7a. The colors in the game board represent the amount of resources present in a certain plot with white having no resource and dark green having the most *Ing.* They are to assume that *Ing* is essential to their lives. For each round of the game, a player is given a short time to choose a plot in the game board while taking into consideration that others are doing the same thing. Note that the players would be making their choices all at the same time; thus none of them know what the others have chosen. Their choices are then marked on the game board and shown briefly for everyone to see. After which, the pay-offs, or the amount of *Ing* they got in their plot of choice, are computed, as well as the effect of the extraction of *Ing* on the environment or the game board. An example of the result of extraction is shown in Fig. 7b. The resulting board is then shown to the players and will be used in the following round. One game is played with 5 rounds. After a game, the rules of the game are changed, more specifically, the rules of interaction between players. This change in rules represents a different scenario of the game. In total, there were four different scenarios played with the stakeholders, which are the following:
1) The players are not allowed to interact with the other players. Their choices would be theirs alone.
2) Before the start of the game, the players are grouped randomly and each group is given time to discuss within their respective groups. In each group, they may discuss a group strategy in terms of how or where they will extract the *Ing*, but they are not obligated or forced to do so. Also, a group is not allowed to discuss with other players outside their group. This is the only time, that they are allowed to discuss. During the game, no more interaction is allowed between any of the players within a group.
3) The same groups are retained as in the second scenario. Before the game, the groups are given some time to discuss. During this time, they may discuss a new group strategy. However, during this time period, the groups may also discuss with other groups about their strategy, if they have any, and they may establish agreements with other groups. Again, they are not forced to do it.
4) The fourth scenario has the same rules as the third scenario. However, a moratorium in the extraction of *Ing* would be imposed during the game. The groups are now made to discuss together how they would meet the requirements of the moratorium, as well as the punishment for violations.

(a) game board (and initial state) of Chering game

(b) example of game board after extraction

(c) total Ing of each player
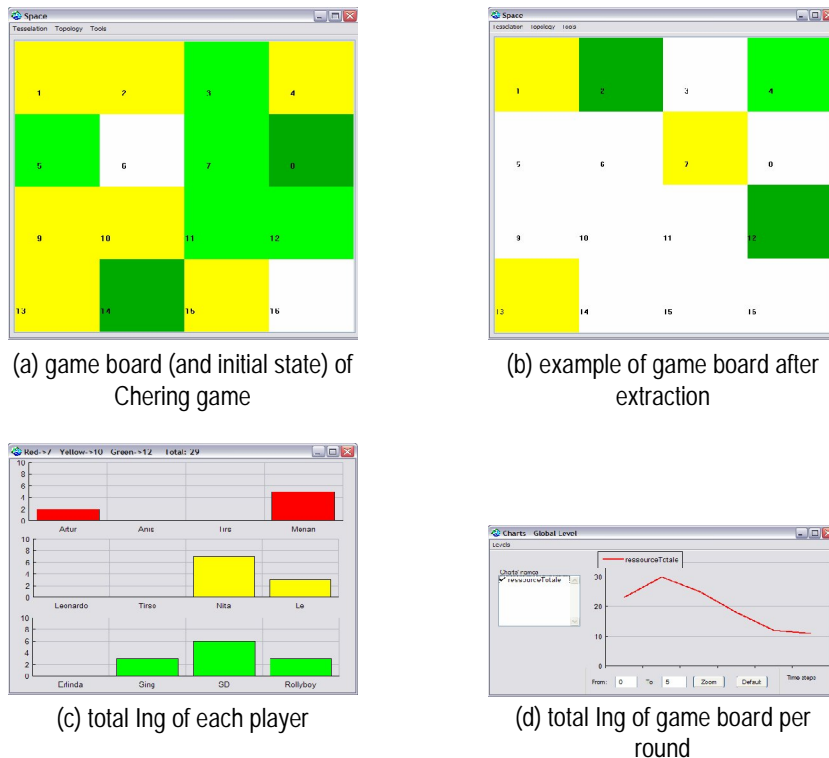
(d) total Ing of game board per round

Figure 7. Chering game visualization tools

After each game, the results of the game are shown to the players, i.e. the final state of the environment or the game board (fig. 7b), the total amount of *Ing* each player got after five rounds (fig. 7c), and total amount of *Ing* in the game board at every round (fig. 7d). After all the scenarios have been played, all the results from the different scenarios are gathered and discussed all together.

Data-gathering activities

Aside from the baseline studies that have been conducted for the LPF project and data from the different institutions, data pertaining to the perspectives, behaviors, activities and decision-making processes of the stakeholders were gathered using various methods such as focus group discussions (FGDs) and individual and group interviews. The people from the community were interviewed about their perspective about themselves in terms of using the available resources. Representatives of various government and non-government institutions were interviewed about their activities within the study site and how were these activities conducted. The FGDs focused on the livelihood activities of the community related to the use of natural resources, discussing the different kinds of livelihood activities they perform and how these activities are done. The discussions also elaborated on the kinds of decisions an individual makes before and while performing a certain activity. These were elucidated by asking the questions when, where, how, how often, how long and why, the costs related to the activities and the process of marketing or selling their products or commodities.

Role-playing game workshop

To validate the information that has been gathered, there was a need to present this information in a more agreeable way. This was done using an RPG. As it was difficult to validate every piece of information by just using one RPG, the RPG was simplified and was focused on the livelihood activities of the community. The new RPG was based on the Chering game but adapted for the situation in the site, i.e. having different resources, different activities, and different pay-offs or rewards in the game based on the information gathered from the field. After the discussion of the game and its results, the participants were asked to evaluate the activity in connection with the MAS modelling process and its relevance to their everyday lives using guide questions. This is not only to improve the succeeding activities, but more importantly, this would train them to be more critical of the information and the activities that they receive, either from within the community or from external sources such as the LPF project. This exercise of evaluation will be implemented in all the succeeding activities of the MAS modelling process. Also, some of the participants were requested to become observers to the activity as a way of being able to look at the activity from another perspective. This proved to be beneficial as they were also able to provide insights that the research team itself were not able to perceive.

4.4 Lessons learned

During the introduction of the MAS modelling process to the stakeholders, they welcomed the idea of building a MAS model to represent their community. They were interested with the computer simulation as they have several concerns in which they think could be addressed by the simulation model. The RPG itself is seen as a good tool in communicating various information regarding natural resource management (NRM) as it is easier to explain or demonstrate ideas using games rather than just have plain presentations. As 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. They were excited that they were learning and talking about matters regarding natural resource management and they were having fun! In fact, representatives of some GOs and NGOs were already requesting that they be taught how to conduct similar activities as they would like to apply it in other areas. The Chering game also revealed the difference in perceptions of the stakeholders. Since the game was played at different times with different participants, this revealed the different perceptions of the stakeholders. For example, when people from GOs and NGOs played the game, they would play how they think the community members would gather resources and that is continuous exploitation. However, when the Chering game was played with the community, they would actually consider the regeneration of the resources. This is most especially true for the Bataks as it is part of their cultural practices in utilizing forest resources.

The data-gathering activities for the MAS modelling process, on the other hand, gave more insights on 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 certain occupation or livelihood. Since most of them are engaged in small livelihood

activities, also known as sidelines, at any given time, they even say that their main livelihood is the combination of sidelines. The livelihood activities they go into depend on the season, their social and physical capacity and the available capital. Some of the other insights gained from the interviews and FGD's 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.. 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 done mostly for subsistence or food security. However, for those engaged in fishing, they were more likely to sell their catch given the opportunity. For those engaged in farming, they would sell some of their harvest if there was an immediate need for money. Livelihood activities such as copra production, roof shingles-making, ornamental and flower plants gardening, charcoal-making, catching milkfish fry and livestock-raising were usually done for commercial purposes. Most of these activities were done 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 such products within and outside the community. However, due to difficulties in carrying out such a task, only able-bodied community members, usually men, are able to perform such an activity. Furthermore, current restrictions in gathering NTFP have made this activity more difficult to do, 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 thru middle-men or traders who were also members of the same community. Those engaged in 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 road side).

The RPG workshops conducted with the migrants and the Bataks was to validate the conceptual model. The participants were playing the RPG 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 pay-offs of livelihood activities. Overall, the activity was successful following the response of the participants as well as the new insights gathered from the said activity. The RPG and the discussion afterwards was an eye-opener as it revealed certain information about the two different communities about their livelihood activities and how they actually interact with each other. Some of these elements were not revealed through the interviews and FGDs; probably because they cannot be revealed by just 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 as 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 wherein it was made clearer which of the barangays are more involved in a certain activity based on the choices they have 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, there are 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 certain activity, as well as if the pay-offs 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 very 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 it was not identified in the FGDs and was not included in the RPG. During the discussion of the RPG, however, the participants pointed out that it should be included in the game as there is a considerable amount of people in all 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 as to which resources would be gathered within and outside the boundaries of the barangays.

5 Conclusions and future tasks

The activities conducted for the MAS modelling process has so far been a very good learning experience for both the stakeholders and researchers. For the community, they are learning about the different strategies of their neighbors in terms of generating income as well as learning the effects of their livelihood activities on their

natural resources. Also, they are able to appreciate the possibility of being able to negotiate matters on NRM on level grounds through the use of tools such as simulation models and RPG. The GOs and NGOs are learning about the tools as well and already they are thinking of using these tools in other sites. They plan to use the RPG and simulation model for information dissemination. Aside from the request of teaching them how to use the simulation model, which they also intend to use for planning, another request has been made to transform the RPGs into something that no longer requires the use of electricity, computer or laptop for places wherein there are no sources of power as well as lack of equipment. In fact this process of transformation has already been started. Since the small village of the Batak has no electricity, the RPGs had to be prepared such that a laptop will only be used for computations and presentation of the results.

Although the long term effects of the activities have yet to be monitored, there are some signs of its effects. Recently, the technical working group (TWG), a group composed of community members and was created under the initiative of the LPF project, requested the data gathered from FGDs pertaining to the livelihood activities. They intend to use them for the planning of their next livelihood project. Also, during workshops, the participants are becoming more open to speak and express their feelings, whether its satisfaction or disappointment.

The next steps of the MAS modelling process would involve individual scenario-building, wherein each group of stakeholders would be asked about the possible futures of the community should certain conditions exist or persist. As each type of stakeholder has different perceptions of the resources and its management, each would also be asked define what kind of information that would suit its interest and how would these information be presented. These scenarios would then be showed to all stakeholders at the same time, and hopefully, a harmonization of perceptions and goals based on the mission-vision statement they have created for the community at the onset of the project would be achieved through negotiation and strategy-building using these tools, i.e. RPG and MAS simulation model. From there, the researchers hope that the tools that have been developed would be used for further planning and negotiations.

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