

Companion modelling to support collective land management in the highlands of Northern Thailand¹

by
Cécile BARNAUD^{2,4}, Tanya PROMBUROM³, Guy TREBUIL⁴, François BOUSQUET⁴

Introduction

For the last two decades, the highlands of northern Thailand have been the theatre of numerous conflicts dealing with natural resource management (NRM) among an increasing number of stakeholders with different and sometimes contradictory perspectives. These conflicts mostly originate in an increasing scarcity of farmland and water resources, which is due to factors such as increasing population density, integration into the market economy, and environmental policies (Bruneau, 2002; Thomas *et al.*, 2002). Two main types of conflicts dominate in upper northern Thailand: water-related conflicts opposing highlanders and lowlanders, and conflicts regarding farmland and forest cover opposing local communities to the State (Rutherford, 2002). Highlanders did not have much say in the regulation of these conflicts so far. Their agricultural practices were considered harmful to the environment and the government highly restricted their access to land and its management. As a result of several decades of highly centralized NRM, not only did degradation of environment continue, but many communities dependent on natural resources were impoverished (McKinnon *et al.*, 1989; Suwannarat, 1995).

In Thailand, as in other countries of Southeast-Asia, the recent general policy-making framework regarding NRM is favouring decentralization and public participation. This is an important opportunity for local communities to regain control over NRM and to increase their say in public affairs (Neef *et al.*, 2000; Ganjanapan, 2002). During the last decade, participation became a key word in numerous projects, but most of them adopted participation as a mean, and not as a goal (Hirsh, 2002). Moreover, they were often based on a so-called "ethno-romantic" view of hill tribes communities and failed to take into account diversity and divergence of points of view among stakeholders within local communities (Hirsh, 2002; Neef *et al.*, 2003). Therefore much effort is still needed to really enable the various local stakeholders to participate genuinely in local NRM issues. But their eco-sociosystems are complex and uncertain, with numerous interacting ecological, social, and economic dynamics, as well as an increasing number of stakeholders with different socio-economic interests, land-use strategies, and points of view (Rerkasem *et al.*, 1994; Trébuil *et al.*, 1997).

The general objective of the research activities presented in this paper is to develop innovative and context-adapted methodologies and tools to enable local stakeholders to identify and rank their key problems, to exchange their points of view on these problems, and to reflect collectively on ecologically adapted and socially acceptable solutions in such agrarian situations. We assume that this can be achieved through the facilitation of a collective learning process. In our work, learning is broadly defined as a change in the way people perceive their social and ecological environment (and consequently the way they act on it), according to their experiences, beliefs, values, intentions, and interactions with other people (Röling *et al.*, 1998). Companion Modelling (ComMod) is an emerging approach designed to facilitate collective learning and action at the community level. In most cases, it is combining the use of Multi-Agent Systems (MAS) and Role-Playing Games (RPG) to facilitate dialogue between various stakeholders concerned by a given local NRM issue (Bousquet *et al.*, 1999).

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² PhD candidate, Department of Geography, Paris X-Nanterre University, France.

³ Multiple Cropping Center, Faculty of agriculture, Chiang Mai University

⁴ GREEN (Management of renewable resources and the environment) research unit, Cirad, France & Comnod Project, Faculty of Science, Chulalongkorn University, Bangkok, Thailand

Since late 2002, such a ComMod process is being tested in Mae Salaep, an Akha village of upper northern Thailand, to promote collective catchment management. This research takes place while highlanders are accused by lowlanders to continue deforestation and accelerate soil erosion in the head watersheds, and to disturb the functioning of whole watersheds through sedimentation in rivers and reservoirs, as well as flash floods in downstream areas. In the past, numerous development projects attempted to solve this problem by proposing technical erosion control measures to farmers. Most of these attempts failed because of a lack of compatibility with local farmers' practices and strategies. The initial objective of the ComMod process was to stimulate collective learning on the soil erosion problem at the community level in Mae Salaep village. In particular, it aimed at examining the interactions between soil and water conservation, agricultural diversification, and social equity with the local stakeholders.

Following a presentation of the local context, the problem, and the original characteristics of the ComMod approach, this article describes its concrete use with Akha villagers. The article explains how a shared representation of the watershed and its dynamics is achieved, and the way it supports collective learning on land management. The flexibility and adaptive characteristics of the gaming and simulation tools used with the people are highlighted as they fit with the evolving nature of coordination processes in adaptive NRM. How the focus of discussions evolved from agro-ecological to socio-economic dynamics related to soil erosion issue is also explained. Finally, preliminary lessons from this ComMod experiment are presented, as well as new perspectives for improving this approach.

The agrarian situation and the soil erosion problem in Mae Salaep

Located in the northwestern part of Chiang Rai Province, Mae Salaep is a settlement made of two hamlets inhabited by Akhas people. The border with Burma is just a one-day walk across the mountains and the village was established in 1907 by a first group of migrants who crossed the border. Along the last century, the village has been permanently occupied by several groups of migrants. Since the construction in 1979 of an all-weather road connecting the village to the cities in the lowlands, small-scale farmers are being integrated into the market economy. As in many other parts of mountainous northern Thailand, the former agrarian system based on swiddening is being replaced by a (semi-)permanent and cash crop-based agriculture (Trébuil *et al.*, 2000). This transition started more than 20 years ago and has reached an advanced stage in this area. Horticultural productions such as lychee or tea are now playing a key role. Fallow periods are already very short (generally 1 or 2 year long only), and every year more fields become permanently cultivated. As most of the farmers' fields are located on steep slopes with angles up to 60%, the perceived increase of the risk of land degradation through soil erosion by concentrated runoff is becoming a major issue. But whether this risk is increasing, as believed by most of the powerful lowlanders, or not, and how to prevent this to happen is a complex issue.

Land degradation is complex because it is not only related to agronomic and ecological factors, such as rainfall intensity, vegetative cover during critical climatic periods, or the angle and the length of the slopes (Turkelboom *et al.*, 1998). It is also interacting with economic, social, and political driving forces and dynamics (i.e. price fluctuations, land ownership, access to credit, off-farm employment, etc.) that determine the choice and extent of different cropping systems. Moreover, when dealing with such a problem, we need to take into account the diversity of the concerned stakeholders. The households' integration into the market economy led to an extensive socio-economic differentiation among farmers having different amounts of productive resources, socio-economic objectives, and related land use strategies (Trébuil *et al.*, 1997). Beyond the local farming community, other key stakeholders are the recently-established sub-district administration office (TAO), the Royal Forestry Department (RFD) and other government agencies promoting rural development in the highlands.

Companion Modelling based on Multi-Agent Systems and Role-Playing Games in Mae Salaep

According to Ostrom (2005), it is possible to avoid the tragedy of the commons (over-exploitation of common resources) described by Hardin (1968) if users coordinate to set up rules regulating their access to resource. As NRM situations are rapidly changing and highly uncertain, it would be vain to attempt to define what are the "best" rules (Funtowicz *et al.*, 1999). Therefore our objective is to reinforce people's adaptability by improving collective decision making-processes for elaborating these rules. Rölöng (1998) assumes that this can be achieved through a collective learning process.

ComMod is a participatory modelling approach aiming at facilitating such collective learning processes. Alternating field and laboratory activities in an iterative and continuous way, its objective is to facilitate the adaptive management capacity of local communities through the collective building of a shared representation of the problem at stake to identify acceptable solutions and related action plans (Barreteau *et al.*, 2003).

In ComMod, the following tools are closely associated:

- (i) Multi-agent systems (MAS). They belong to the emergent field of Distributed Artificial Intelligence (Ferber, 1999). They are particularly appropriate to represent and simulate complex agroecosystems to examine NRM problems because they focus on interactions among heterogeneous social agents and their common environment. The various users and resource managers can be represented with their own interests, strategies, and set of practices in, for example, a cultivated watershed having its own bio-physical dynamics (Bousquet *et al.*, 1993; Lansing *et al.*, 1994).
- (ii) Role-Playing Games (RPG). To involve local stakeholders in the modelling process, in this experiment, we choose to translate an initial MAS-GIS model built by researchers to integrate knowledge about the soil erosion problem into a Role-Playing Game (RPG). To play this RPG helps local stakeholders to understand the structure and operation of the computerized MAS model, and gives them a chance to validate, to criticize and to improve it. Such a transformation is possible because MAS have similar features to RPG: agents corresponding to roles, the spatial interface to the gaming board, the time step in a simulation to a round of the game, etc. (Barreteau *et al.*, 2001). Moreover, a RPG implicating several stakeholders involved in solving a common problem is expected to stimulate discussions among them that do not occur easily in reality because of potential conflicts, or of the lack of opportunity and suitable platform to interact in a non-threatening environment.

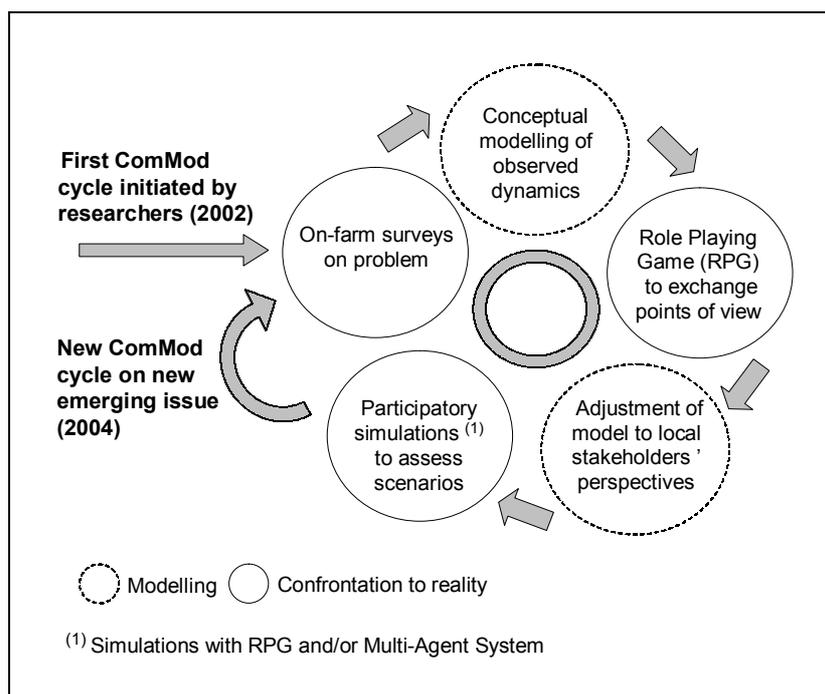


Figure 1. The iterative companion modelling process alternating field and laboratory activities carried out in Mae Salaep, Chiang Rai Province, upper northern Thailand.

Figure 1 displays the main methodological phases implemented in this case study. The first participatory modelling cycle carried out during 1999-2002 is described in details elsewhere (Trébuil *et al.*, 2002). At the end of this first cycle combining the design and use of two MAS models and a RPG, the local stakeholders requested to change several features and rules of the tools to update them and to better represent their new preoccupations. The second ComMod cycle was implemented accordingly with the following steps:

- (i) Field survey to collect information about the new problem to be examined,
- (ii) MAS modelling of the observed dynamics,
- (iii) Conception and implementation of a new RPG associated to this new MAS model. Two gaming sessions were implemented during the first day of a participatory workshop held in the village in May 2004. The first gaming session was played according to the organizers' representation of the system and was followed by a short collective debriefing. Players were asked to suggest changes to make the RPG more in touch with their representation of reality, or to test a given scenario to solve the problem at stake. The second gaming session was played according to the suggested new features and rules,
- (iv) Individual interviews of the players the following day to better understand their behaviour during the game, and to evaluate the short-term impact of the game,
- (v) Modification of the new MAS model to integrate the participants' suggestions for improvement and new knowledge acquired during the game,
- (vi) Plenary session of participatory simulations on the third day using this improved MAS model to support a negotiated agreement on a desired situation among stakeholders, and to explore several scenarios identified by them for reaching this objective,
- (vii) Back to the laboratory, more advanced simulations of scenarios were carried out (Barnaud *et al.*, forthcoming),
- (viii) More interviews with players were also carried out to assess the short and medium term effects of this ComMod cycle on their perceptions of the problem and their behaviour, their opinion about the usefulness of the process, and their wishes regarding a third ComMod cycle.

ComMod in action: co-learning among Akhas villagers and researchers

The first researchers' model and the villagers' requests for changes

The research team built a first MAS model to synthesize the existing knowledge about the interactions between crop diversification, soil erosion, and households' economic differentiation. This model was used to conceive a first RPG to confront this research team understanding of the situation with the local stakeholders' one (Trébuil *et al.*, 2002). The knowledge acquired during the game was used to build a second and much simpler MAS model, very similar to the RPG in its rules and features and therefore easier to understand for the participants. This simpler model was used to support discussions and exploration of scenarios with them.

The participants validated the researchers' representation of the agro-ecological aspects of soil erosion, but they requested changes in the model to focus on the expansion of perennial crops in the catchment, as this came out as their preferred way to alleviate the land degradation problem. They requested to integrate more perennial crops and to focus on socio-economic aspects closely related to the adoption of plantation crops, in particular access to credit, off-farm employment, and price fluctuations as shown in Figure 2.

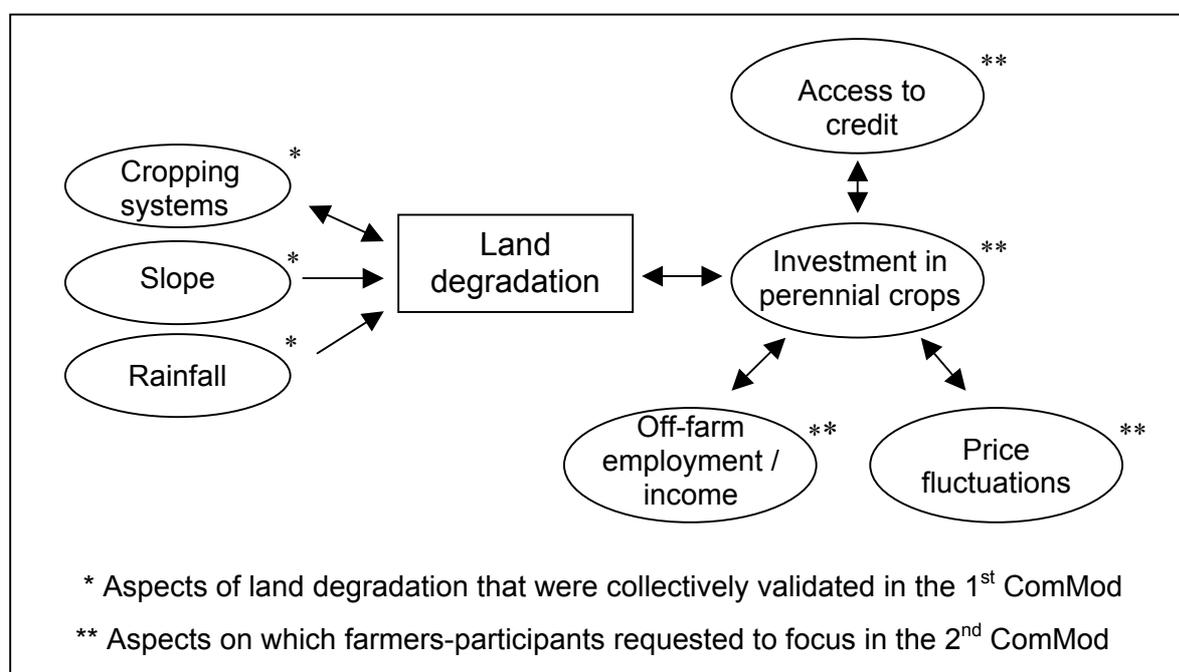


Figure 2. The shift of focus from agro-ecological to socio-economic aspects of land degradation along the successive ComMod cycles in Mae Salaep, Chiang Rai Province, upper northern Thailand.

Perennial crops are seen by the villagers as a way to alleviate land degradation while providing more stable farmers' incomes. Moreover, as they require less labour than annual crops, they provide more time for off-farm employment, a major source of income in this area. Two perennial crops dominate in the watershed. Lychee was introduced in the early eighties but could be adopted by the wealthiest farmers only. More recently, green tea has been expanding and is accessible to a broader range of farmers because it requires no input, reaches maturity faster, and has a more stable market price than lychee. Farmers call it "the plantation crop of the poor". However even green tea plantations are not adopted by all villagers because harvesting the first leaves occurs only several years after planting. In fact, the possibility to invest in perennial crops is closely related to access to credit.

Adaptation of the model and the role-playing game to stakeholders' preoccupations

As requested by local stakeholders, the objectives of this 2nd ComMod cycle were as follow:

- (i) To better understand the interactions between the adoption of perennial crops by the different types of farmers, access to credit, and off-farm employment.
- (ii) To stimulate exchanges about this question between researchers and local stakeholders, and among local stakeholders themselves.

Understanding the local system through an on-farm survey

Two credit systems, formal and informal, co-exist in the village. Informal credit corresponds to loans settled among villagers, either without interests within networks of acquaintances, or with high interest rates (more than 5% per month) when loan sharks are involved. Regarding formal credit, beside a traditional village fund created ten years ago, a new government fund was made available in 2002. The older village fund provides small amounts of cash to any household, with interest rates fluctuating between 2 and 5 % per month. The government fund provides larger sums, without interest, but is only accessible to well-off households because they are the only ones who can guarantee that they will reimburse the loan. This unequal distribution of the government fund is only partially compensated by its redistribution through informal loans within networks of acquaintances. As those networks are usually small and quite homogeneous, there is a number of small landholders, acquainted with households as poor as them, with no access to this source of credit.

A new model to represent the observed dynamics

The objective of this model was to represent the new complex problem under study according to the various stakeholders' perspectives, and to support the collective identification and assessment of possible future scenarios regarding access to credit.

Because the stakeholders were more comfortable with it, we chose to improve the simpler RPG-based MASalaep model to strengthen the appropriation of the modelling process by users. Changes made from this MASalaep model to produce the MASalaep 2 version were needed to fit the evolution of the agrarian situation. They concerned the introduction of green tea, the new access to government fund credit, further differentiation among households. Changes were also made to tailor the new model to the shift of focus from agro-ecological to socio-economic aspects, particularly modelling of decision-making processes regarding investment in perennial crops, formal/informal credit, and off-farm activities. Figure 3 displays the various attributes, and methods assigned to the MASalaep 2 model entities (in particular the "Farmer" entity), as well as the new social entities, such as "Credit Sources", added in this new version of the model.

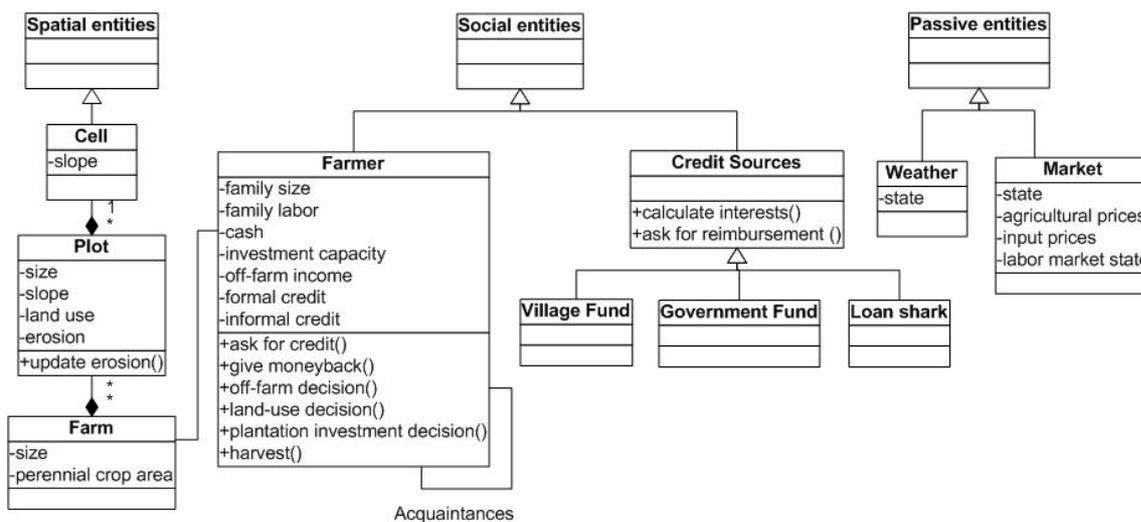


Figure 3. Class diagram of the MASalaep 2 model.

As in the game, there are twelve farmer-agents in the model. The time step is the cropping year. During each simulation, 15 time steps, i.e. 15 successive cropping years, are run. To represent

informal credit, each farmer-agent is assigned two acquaintances among the other agents. Each year, if credit is needed, a model agent will successively try to find the required loan with the government fund, his acquaintances, the village fund, and, in a very last resort, through loan sharks. When an agent is indebted with loan sharks, he sends all his family labour to work in off-farm activities. If this is not enough to raise enough money, this agent disappears as he is forced to sell his land and to leave the village. A labour constraint was also introduced into the model. Each year, the agents decide whether they assign family members to off-farm opportunities or not, knowing that off-farm employment may limit areas planted to annual crops.

A new role- playing game to share this model with stakeholders

The objectives of this new RPG were as follows:

- (i) To stimulate exchanges between researchers and stakeholders, i.e. to “open the black box” (Barreteau *et al.*, 2001) of the model and give them a chance to validate, criticize or improve it,
- (ii) To stimulate exchanges among the farmers-participants with various interests, land-use strategies, and perspectives on the problem.

To facilitate model sharing, its associated RPG displays very similar features and mode of operation. Consequently, changes made in Mae Salaep RPG 1 to conceive this second RPG were almost the same than the modifications made in the MASalaep model to build its second version. Because a gaming session should not be too long and must remain lively, we could not add more features and rules linked to socio-economic processes without simplifying some agro-ecological features related to soil erosion. The main principles and rules of this new game are presented in box 1.

Box 1. The main rules and features of the second Mae Salaep role-playing game.

Each participant plays the role of a farmer managing a set of fields located on different slopes of a 3D block model representing a catchment. The 12 players-farmers are given various amounts of land, labour, and capital according to the actual farming conditions of the three main types of farms present in the village (types A, B and C for small and cash crop-oriented, medium and conservative, and largest and diversified farming households respectively). There are 3, 6, and 3 players representing type A, B, and C respectively, played by farmers who actually belong to these categories. During each gaming round (corresponding to one crop year), the players successively assign a given crop to each of their fields (taking the labour constraint into account), harvest their products, observe cash crop prices conditions, go to the market to sell their products, pay for their annual expenses, draw an "exceptional expense card" which they have to pay for, draw an "off-farm opportunity card" which they can accept or refuse, and finally go to the credit desk to ask and/or reimburse credit if needed. At any time they can exchange money with other players. Each year, the general climatic and market price conditions are determined by drawing a card at random. The annual incomes obtained by players depend on their choice of crops, the level of prices for cash crops, and the two "chance cards". Six cropping years could be played within two half day gaming sessions.

Gaming sessions, discussions and collective exploration of possible future scenarios

What happened during the game?

Box 2 and the related photographs provide an example of the dynamics generated by the RPG.



Photo 1. Explanation of the features and rules of the game in Akha language.



Photo 2. Discussion about loans between two players in front of the "credit desk".

Box 2. Dynamics observed during two gaming sessions of the Mae Salaep second role-playing game on 26 May 2004 in Mae Salaep village of Chiang Rai Province.

During the first gaming session, medium-sized and large landholders (type B and C) invested massively in tea and lychee plantations by making extensive use of both formal and informal credit. The small landholders (type A) chose much less risky strategies by “growing” mainly low input annual crops. Because everybody needed cash, the players were eager to draw off-farm opportunity cards. Off-farm income was a main source of cash and this kind of revenue was extensively redistributed among players through numerous informal exchanges.

This first gaming session was followed by a short collective debriefing. The participants noticed that type A smallholders were the only ones who did not invest in plantation crops because they lacked access to credit. An old participant suggested to solve the problem with informal credit: "It is not possible to change the rules of formal credit. Informal credit is more efficient. They should ask me, I would agree to lend them money without interest." On the other hand, some younger participants suggested changes in the formal credit: they proposed to try a 3-year grace period for smallholders under the government fund. Type A farmers said that to be able to reimburse their loans, they should be allowed to send all their family workers to off-farm employers until the plantations reach maturity.

This new rule was tested in the second gaming session: all the smallholders invested in small tea and lychee plantations and succeeded in reimbursing their loans.

Exchanges stimulated by the game

The first gaming session revealed the social inequity regarding investments in plantation crops because of unequal access to credit. All the participants agreed on the fact that this situation represented the real circumstances and create a problem. This collective agreement stimulated discussions among them. Questions were raised such as: how could they change the rules of formal and informal credit so that smallholders (type A) would have a better access to credit? Is it possible to change those rules? Would smallholders benefit from such a change or would they face a higher risk of bankruptcy? What would be the consequence of such changes for the medium-sized and larger landholders (type B and C)? They exchanged their views on these topics and proposed two possible solutions (Box 2):

- 1) One regarding changes in informal credit: in the game, like in reality, small landholders that are not acquainted with wealthy farmers do not have access to informal credit; a player suggested that

there should be more solidarity for those small landholders and that wealthy villagers should lend them money without interests,

- 2) Another one dealing with new rules for formal credit: in the actual situation, the government fund provides annual credit but small landholders do not have access to it; two players suggested to establish a 3-year grace period for smallholders under this government fund.

This second scenario was tested in the afternoon gaming session (Box 2).

Scenarios identified, selected, and simulated

During the individual interviews following the game, the participants were asked to assess the model of the game, to assess whether some important dynamics related to the problem were missing or not well represented. The model of the game was validated by all the players. "It is exactly like reality!" was a frequently heard comment during these interviews. A few suggestions for improvements were made by some players, in particular regarding the calibration of off-farm incomes in the game (depending on the situation they faced in reality, some of them found these incomes to be too high, while others found them too low). This validated model integrating the suggestions made by the players was used as a support in participatory simulations. Indeed, if the game succeeded in stimulating discussions and suggestions of scenarios by stakeholders, only one new scenario could be played within the afternoon. To remove this time constraint and be able to test more scenarios, simulations could be run by using the MaeSalaep 2 model with the participants. They could easily follow the simulations and understand the functioning and the limits of the model, as they had played the game corresponding to this model.

Three tested scenarios are presented in figure 4:

(i) The first scenario corresponds to the current situation, i.e. the rules for the operation of formal and informal credit are similar to the actual ones: one-year long loans from the government fund distributing Baht⁵ 0, 10, and 20 thousands to type A, B, and C farms respectively.

(ii) The second scenario tests new rules for the operation of informal credit corresponding to the suggestion of an old player: the lack of access to credit of type A smallholders should be solved through informal credit. This is translated into a scenario with larger and more heterogeneous social networks allocating informal credit (Figure 5). This scenario is very efficient to reduce the number of bankrupt smallholders but does not allow them to increase their investments in plantation crops. This is because they borrow money from their acquaintances only for urgent family consumption needs, not for investment. Moreover, this scenario is very hypothetical because there is no explicit rule in the current functioning of informal credit

(iii) The third scenario is implemented with a new set of rules for formal credit⁶: three-year long loans of 12, 24, and 54 thousands baths for type A, B, and C farms respectively. This option enables the three types of farmers to invest significantly more in plantation crops. If the loan is rather small, smallholders manage to reimburse it. They face less risk of bankruptcy than in the current situation thanks to the incomes from their plantations. However, this solution is less efficient than the previous scenario (type A villagers acquainted with type B and C villagers) to reduce their risk of bankruptcy.

⁵ In April 2005, 1 Thai baht= 0,0193 euros.

⁶ The set of rules tested in the game which included a 3-year long grace period for smallholders was not thoroughly analyzed because the participants representing the medium-sized and larger farmers considered that they too should be awarded similar long-term credit and a longer period to reimburse loans.



Photo 3. Participatory simulation of a scenario with MASalaep 2 model.



Photo 4. Divergence of opinions and debate among players about rural credit.

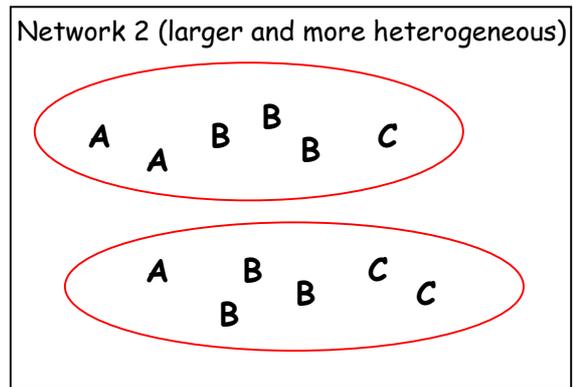
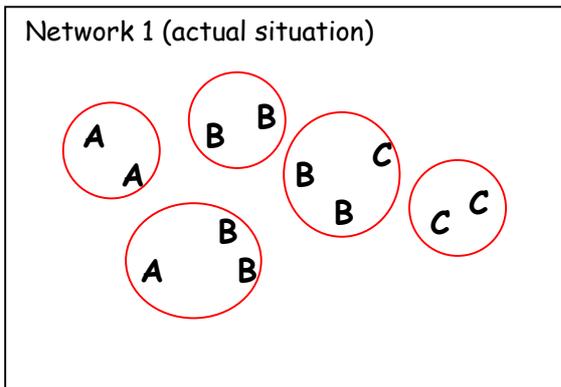


Figure 4. Different social networks among three (A, B, C) types of farms to regulate the distribution of informal credit in the simulations.

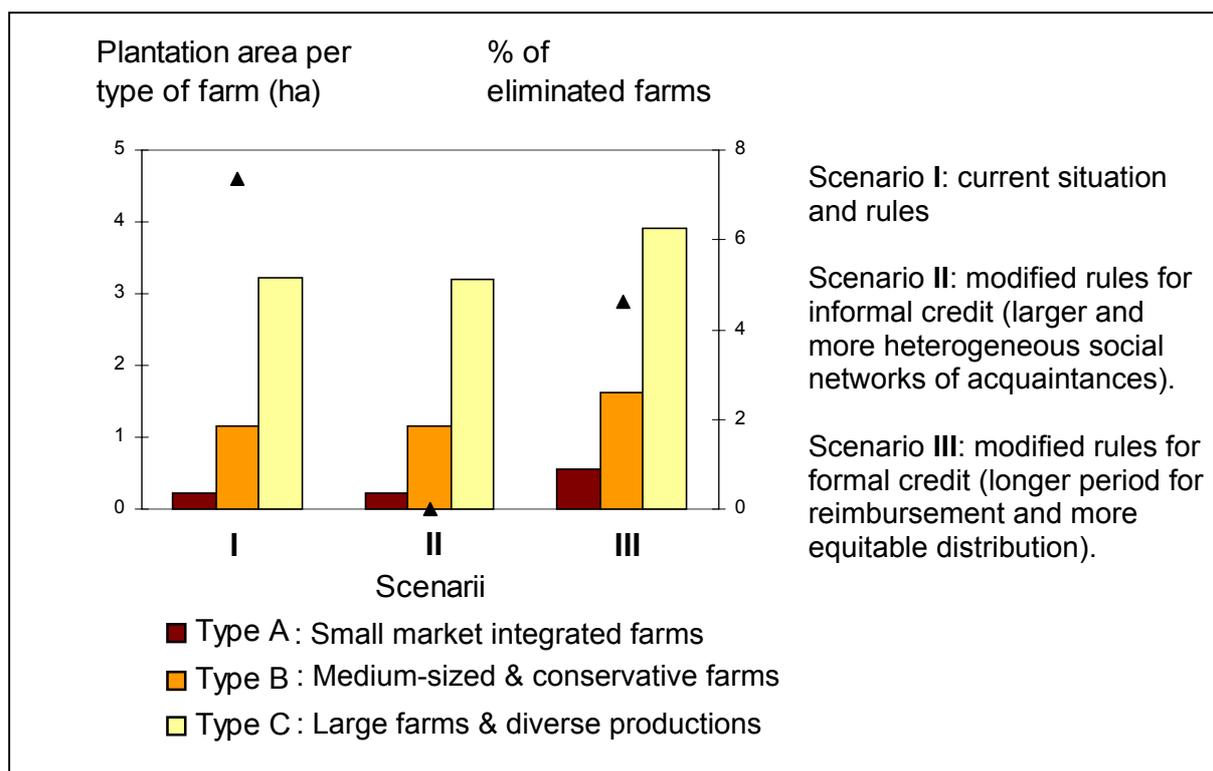


Figure 5. Results of simulations (after 15 years/time steps) exploring the effects of various rules for the allocation of formal and informal credit on the adoption of perennial crops and farmer's differentiation.

Preliminary lessons from a ComMod-facilitated collective learning process

In this section, we will evaluate the first phases of this ComMod experiment according to its objective, i.e. to stimulate a collective learning process for sustainable participatory land management at the community level. According to Leeuwis ((Leeuwis, 2004) and van Paassen (Van Paassen, 2004), the facilitation of a collective learning and negotiation process requires several tasks: a good understanding of the local context by the facilitators, the participants' awareness of the existence of a problem and of the necessity to solve it collectively, the exchanges of their different perspectives on this problem, the negotiation of a joint desired situation, and the exploration of possible scenarios of changes to achieve this desired situation. As discussed below, the ComMod experiment in Mae Salaep achieved to a certain extent to stimulate these different aspects of a collective learning process. But these authors also underline the importance of the communication with higher institutional levels to enhance the room for manoeuvre of local stakeholders and to support and strengthen their projects. This is the main limit of this experiment so far and we are now working to improve this weak linkage. As discussed at the end of this section, the collective learning and negotiation process that occurred in Mae Salaep did not yet turn into action partly because of the lack of an effective dialogue with local administrative institutions having the resources to support village projects.

Researchers' continuous understanding of the complex socio-ecological system under study

Lavigne-Delville (Lavigne-Delville *et al.*, 2000) underlines that an important limit of participatory approaches conducted in the past was the lack of understanding of the complexity of the local context in which the projects were embedded. The experiment in Mae Salaep started with an in-depth diagnostic analysis of the local socio-ecological context while investigations and every key agro-ecological processes took place before. But the ComMod process itself allows researchers to fine tune their understanding of the complex socio-ecological system under study through an interactive exchange of perspectives between researchers and local stakeholders. For example, in the game of the first ComMod cycle, local stakeholders were invited to react on the representation of the land

degradation process as seen by the research team. They could express their own perspectives on the problem and suggest their preferred way to alleviate it, i.e. the expansion of perennial crops in the catchment. The process enabled the research team to better understand local farmers' preoccupations and to adapt their tools accordingly. This underlines the relevance of alternating field and laboratory activities in an iterative way. Such a process allows researchers to adapt models and games to the evolutions of the learning and negotiation process and of the local socio-ecological context. This approach requires very flexible tools, and the availability of model developers who genuinely want to understand and represent the rationality of the local stakeholders.

The game and the discussions it stimulated also enabled the research team to better understand the social context in which the process is embedded. In particular, we could better elucidate tacit knowledge and distribution of power among villagers related to decision-making for credit allocation. Such tacit knowledge explains the difference between the way people say they behave (that corresponds to the limited knowledge acquired from previous interviews) and their actual behaviour. It is crucial for the researchers to understand the status, interests, and relationships of the various participants to be in a position to facilitate a genuine collective learning process.

Awareness of a problem and of the need to solve it collectively

According to Röling (1998), such awareness is a prerequisite to motivate the participants to join in a collective learning and negotiation process. In our experiment, the ComMod process seems to have contributed to a certain extent to a growing awareness about the soil erosion problem and the "need" to change current crop production practices towards the adoption of more perennial plantations. This is also because the Royal Forestry Department is still threatening to further restrict the villagers access to farm land if they do not adopt soil & water conservation practices. In fact, this awareness was already present in the minds of several innovating villagers, and the game served as a support for these villagers to communicate their ideas and knowledge about perennial crops. In the second ComMod cycle, the game also triggered awareness about the problem of unequal access to perennial crops and credit among the villagers.

The Role-Playing Game is a key tool to raise awareness. It triggers an experimental learning (Kolb, 1984, in Leeuwis, 2004) in which the participants can observe by themselves the feedback resulting from their actions. Leeuwis distinguishes between positive feedback, information that indicates that one is on the right track, and negative feedback indicating the existence of a problem. This author notes that negative feedbacks might have less impact than positive feedbacks because people tend to close their eyes on "bad news", but it can also stimulate willingness to solve the problem. In our experiment, both kinds of feedbacks occurred. While, on the one hand the players could see that perennial crops provided better incomes than annual crops, on the other hand they stated that a category of villagers were unable to move in that direction.

Exchanges of perspectives on the problem among stakeholders

In the second ComMod cycle, a key observation in the interviews with participants was the fact that the experiment allowed them to better understand each other's situations and points of views by providing a new platform for communication where none existed before. Some medium-sized and large farms owners said that they had the opportunity to better understand the kind of difficulties faced by smallholders. Moreover, they could exchange and express their different views regarding the credit issue. A community leader declared that "in every day life, everybody has his own problems, people do not have the opportunity to think about others' situations. There is no place where we can think all together".

Two local officers of Department of Public Welfare working in this village facilitated our research activities. Whereas at the beginning the one with a higher hierarchical level was quite suspicious about the efficiency of the experiment, he recently declared that the experiment allowed him to better understand the villagers' problems and even changed their relationship towards more frequent and friendly contacts. The ComMod experiment provided a missing place not only for dialogue among villagers but also between villagers and the local development agency.

Negotiation of a common goal and possible solutions

The increasing awareness and exchanges of perspectives about the problem of unequal access to perennial crops that were stimulated by the morning gaming session triggered discussions among players to define a joint desired situation and possible new rules to achieve it. In this game the desired situation was access to perennial crops for a wider range of farmers, and the discussed possible solutions regarded the rules of allocation of informal and formal credit. After negotiations, they decided that small landholders could benefit from a credit and would manage to reimburse it if they could change the duration of the grace period from one to three years, because this is the time needed for tea to provide a few harvest. When commenting on the negotiation process that occurred to identify this idea, a player said that he saw the game as a kind of democratic platform where all voices could be expressed. It would be ideal, but is it really the case? And if yes, could all the voices be really heard?

It is the role of the facilitation team to make sure that all stakeholders feel free to express themselves during the process. To achieve this, the first difficulty is that some players do not dare express themselves in the presence of Thai and western researchers, or government officers. This is especially true in the context of northern Thailand where ethnic minorities have been used to more top-down kinds of interventions. The second difficulty is that people of little influence do not express themselves in the group, in particular Akha women who are rarely able to speak Thai because they are less involved than men in off-farm activities. "In Akha communities, women work, men speak" said a female participant. Still, their voice is essential as they are the most active actual users of natural resources. The ice-breaking playful mood of the game was also a determining element to reduce these difficulties. Moreover, individual interviews were conducted besides collective discussions to ensure that all voices could be expressed. But whether they were all heard and taken into account in the formulation of possible solutions is another matter.

There are no open conflicts among villagers in Mae Salaep. Their cultural background is deeply oriented towards social cohesion and avoidance of such conflicts. In the case of a divergence of interests, an Akha person would rather accept any compromise than to face a confrontation (Goodman, 1996). Still, because all farmers do not have similar amounts of resources and interests, there can be divergence of interests among them. And these divergences can block the process of collective identification of solutions. Typically, in the village, some relatively wealthy villagers exert influence over small landholders through informal loans (with interests in the case of loan sharks, or even without interests in the case of more hidden relations of dependence). Those people might be afraid to lose some of their privilege by changing the rules of formal credit systems. And as those villagers are also the ones who decide the allocation of formal credit, even if they are not ill-intentioned, they could be tempted to maintain the status quo. In this respect, the Role-Playing Game plays a key role, as the playful mood and the fact that "it is a game" helps villagers to discuss potentially conflicting issues more freely than in a conventional and more threatening classic meeting.

According to van der Veen (2000), in a communicative learning process, the phase during which participants synthesize the diverse expressed facts and arguments to formulate a "collective" solution is determining. It is at this stage that the most influential or intelligent participants risk to impose (consciously or not) their point of view. Therefore there is a need to draw special attention to the composition of the group of participants. Researchers and participatory workshop organizers should be aware of the status and social role of the participants in the community to be able to interpret correctly the collective discussions and agreements stimulated by the ComMod process. In our case, the participant who formulated the suggestion for changes in the rules of formal credit allocation is the well-known community leader. He is an innovative and rather well-off farmer that other villagers observe and imitate "because he is clever and always make good choices" said one of them. He does not express himself very easily in groups, especially because he cannot speak Thai very well. But by leading the Christian community in the village, he benefits from the respect inspired by his status. Moreover, we should keep in mind that the ideas he is supporting are very much in line with Christian precepts, and that only one half of the villagers are Christians, the other one being animists.

Exploration of possible scenarios to achieve this goal

The participants could assess the solutions they suggested by simulating them in the role-playing game, and with the computerized MAS model. This exploration of scenarios corresponds to an experimental learning process in which the participants get a better insight in their complex socio-ecological system by observing the effects of their individual and collective decisions. Such an experimental learning had a strong impact on the participants. The Christian leader said that "in the game, the players can try by themselves. It is more efficient than speaking." According another wealthy farmer, the game "helps to think in advance" because during a gaming session, players could observe six cropping seasons and assess the effects of their choices regarding crop and credit. In every day life we do not have the opportunity to think in advance. We can only think to grow maize each year to buy and eat rice". A woman mentioned that the experiment provided her with the opportunity to plan a credit, because this was usually a matter managed by her husband. At the collective level, they could test the new rule for loan reimbursements they had suggested and observed the benefits of this solution. However, these discussions about changing the rules governing the management of credit did not translate into concrete action.

The lack of linkage with institutions at a higher level: the main limit of this experiment so far

The lack of concrete action so far is easy to understand. In the game, villagers suggested to change the rules for the allocation of the government fund, and more precisely a three-year long credit that would allow small landholders to invest in perennial crops and to reimburse their credit on time. However, if the allocation of this fund among villagers is managed by a committee of villagers, the grace period is decided by the government. Still, the discussions about credit stimulated by the ComMod process did not disappeared totally as they switched to exchanges about the rules governing the other formal source of credit available in the village, the village fund. Here, the villagers are fully responsible for the definition of the rules governing this fund. However, the idea of a three-year grace period was abandoned as the fund was considered insufficient, and they discussed its rates of interest. They decided to lower these rates to favour credit to smallholders. The real impact of the game in this decision is uncertain, as these kinds of discussions and decisions had already occurred in the past. This limited impact of the ComMod process in this experiment raises an important question. People, rules and practices are embodied in an institutional context. Very often, if a community wants to change things, the villagers need the support of institutions at a higher level. There is a need to facilitate dialogue between these two levels and to reinforce institutional linkages in a bottom-up way to increase the impact of this ComMod process. Except the local officers of the Department of Public Welfare that facilitated our research activities in the village, official representatives of administrations at a higher level were neither integrated into the model nor invited to the participatory workshops so far because we thought that their presence could have intimidated villagers and brought the collective discussions to a standstill. But, now that the participants feel confident enough and even willing to integrate them in the collective learning process, this new phase can occur. When asked what other stakeholders should be invited to take part in a future gaming session, the villagers mentioned the TAO (*Tambon* Administrative Organization at the sub-district level) officers who should be invited to play their own role in the game, "so that they know what is happening in the village". The impact and legitimacy of ComMod process could also be improved with a further implication of facilitators belonging to local institutions. In this experiment, the local officers of the Department of Public Welfare could have played this role, but until now they were reluctant to be genuine drivers of the process because of the difficulty to integrate it in their obligations towards their hierarchy. However, as their interest is growing, they might adopt the game as a tool in their development activities with villagers in the future. The transmission of the game to this local development agency and the evaluation of its use and effects will be implemented in a future step of this experiment.

Conclusions and perspectives

The association of simulation and gaming tools tested in this experiment displayed a great potential and flexibility to facilitate and accompany collective learning and negotiation processes on complex NRM issues with local communities. It was efficient to stimulate an interactive dialogue between researchers and stakeholders, and more importantly, among local stakeholders themselves. The

participants defined collectively what was the problem in their opinion, exchanged their perspectives on this problem, negotiated a joint desired situation, and explored possible scenarios of change to reach it. But what to do to ensure that this kind of experiment does not remain only a dialogue among a few villagers that is admittedly very interesting for the participants and for the researchers but has no concrete benefit for the community? How to strengthen the effects of ComMod experiments? Local institutions should be more implicated in such approaches. The effective adoption of genuine participation by administrative institutions is a challenge in Thailand where a highly centralized form of governance was the norm during the past decades. However the current process of decentralization, and in particular the adoption of the 1997 Constitution and the establishment of elected *tambon* councils at the sub-district level, constitute important opportunities to remodel the institutional framework in a way favoring dialogue between local communities and the once untouchable bureaucracy. Such a dialogue is particularly necessary in the context of mountainous northern Thailand because institutions have long been biased against ethnic minority groups, accused of damaging the environment. Our future challenge is to test and adapt ComMod approach to facilitate such a dialogue. To improve ComMod approach in this regard, we suggest that the research team should first conduct an institutional analysis of local organizations' strategies and interests, identify local institutions that could participate in the process, present to them the principles of ComMod approach, and establish with them in which way and with which objectives they would be interested to implicate themselves. Moreover, in the recent context of decentralization, this underlines the growing need to train local officers towards more bottom-up way of thinking.

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