Using simple models to accommodate multiple interest in water management: a companion modelling approach

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Abstract

Decentralization of renewable resource management provides an opportunity for local stakeholders to increase their participation in decisions affecting them. Research should propose adapted methodologies and tools enabling the numerous stakeholders of complex socio-ecosystems to identify and discuss about possible solutions to their common problems. We show that in participatory modelling processes, simple models can be as useful as comprehensive and sophisticated ones to accommodate multiple interests among stakeholders, on the condition that the modelling and simulating process itself is carefully participatory, i.e. pays much attention to the initial socio-political context in which this participatory modelling process takes place to ensure the genuine participation of all concerned stakeholders (including the usually voiceless and ressource-poor ones). This assumption is discussed by drawing on a Companion Modelling (ComMod) experiment on water management in a Northern Thailand highland community. The basic principle of the ComMod approach is to develop simple simulation models integrating different stakeholders' points of view on the problem at stake, and to use them in communication platforms to explore and discuss collectively various scenarios for the future. By combining a preliminary analysis of the heterogeneous socio-political context with a very simple Agent-Based Model, a Role-Playing Game, individual interviews, and group debates, this ComMod process was efficient at stimulating collective learning and coordination among multiple stakeholders exploring pathways to solve their common water use problem.

Introduction

In Northern Thailand, recent decentralization of natural resource management is an opportunity for local resource users to increase their participation in decision making processes, especially for minority highlanders. However, more and more conflicts occur in these socially heterogeneous contexts (Rutherford 2002). Local users are managers should progressively take more responsibilities in the resolution of these conflicts, but the eco-sociosystems that they have to manage are complex and rapidly changing, with not only numerous stakeholders but also numerous interacting agro-ecological and socio-economic dynamics. There is a need to develop innovative methodologies and tools to enable them to manage adaptively such complex systems.

Thanks to advances in the field of distributed artificial intelligence, agent-based models can now be used to run simulations of social phenomena (Axelrod 1997). They can be useful to analyse social heterogeneities as they focus on interactions among various agents and between these agents and their common environment. This is the reason why agent-based modelling is a central tool in the Companion Modelling (ComMod) approach which aims at stimulating collective learning and coordination among multiple stakeholders for renewable resource management (BousquetTrébuil et al. 2005). The basic principle of the ComMod approach is to develop simple simulation models integrating different stakeholders' points of view on the problem at stake, and to use them in communication platforms to explore and discuss collectively various scenarios for the future.

"All models are wrong, but some are useful" (Box and Draper 1987), and we argue that their usefulness relies much more on the modelling and simulating process than on the model itself. In the literature about participatory processes (including participatory modelling), proponents of a "critical" vision argue that, in socially heterogeneous contexts, a careful analysis of socio-political contexts needs to be conducted prior to the modelling exercice. Otherwise there is a high risk to see the participatory process being manipulated by powerful stakeholders and leading to increased social inequities.

The objective of this article is to demonstrate that in participatory modelling processes, simple models can be as, or even more, useful than comprehensive and sophisticated ones to accommodate multiple interests among stakeholders. But the modelling and simulating process itself should be carefully participatory. It should pay much attention to the initial socio-political context to ensure the genuine participation of all concerned stakeholders (including the usually voiceless and ressource-poor ones), their understanding of the model, and its matching with their own representations and preoccupations of the moment.

This article discusses the above-mentioned assumptions by drawing on a ComMod experiment on water management in an Akha community of Northern Thailand where an institutional analysis of the socio-political context was conducted prior to the modelling process.

Context, Method & Tools

The Companion Modeling Approach in Mae Salaep, Chiang Rai Province

ComMod is a continuous and iterative modelling process alternating field and laboratory activities in a cyclical way, its main successive phases being as follows: (i) Characterization of the problem, (ii) Modelling, i.e converting knowledge into a formal tool to be used as a simulator; and (iii) Simulations to explore various scenarios of solutions (Bousquet, Trébuil et al. 2005). Two kinds of simulation tools were used: Agent-Based Models (ABM) and RolePlaying Games (RPG). According to Duke (1974), RPG is an excellent mode of communication to convey complexity as it allows multiple stakeholders to interactively examine the complex systems they are part of. Players can test alternative scenarios, but quickly this becomes costly and very time consuming. To remove this constraint, it is possible to build a simple computerized ABM, very similar to the RPG in its features and rules, which is far more time-efficient to simulate scenarios. Moreover, the RPG allows the players to understand the ABM model, to validate and criticize it, and, later on to easily follow ABM simulations (Bousquet and Trébuil, 2005).

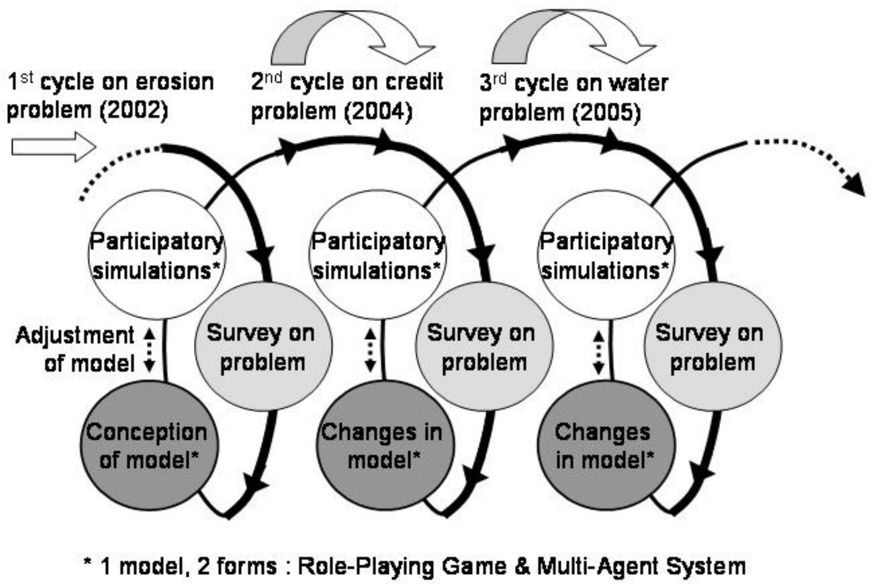


Figure 1. Successive ComMod cycles conducted in Mae Salaep, Chiang Rai Province, 2002-2005.

Discussions about a specific problem in a cycle might raise new questions, which can then be examined in a following cycle. This is what happen in the village of Mae Salaep in which a ComMod process has been conducted since 2002 (Figure 1). In this village located in a highland catchment of Chiang Rai Province, small-scale poor farmers are being rapidly integrated into the market economy. Over the last two decades, their former agrarian system based on swiddening was replaced by permanent cash-crop based agriculture. Because of the perceived increase in the risk of soil erosion on steep slopes, the initial ComMod cycle focused on the interactions between soil erosion and crop diversification (Trébuil, Bousquet et al. 2002). The participants identified the expansion of perennial crops (lychee and Assam or Oolong tea) as a promising solution and requested to focus the second cycle on the socio-economic constraints to their adoption, particularly the access to credit (Barnaud, Promburom et al. 2005). In a subsequent third cycle, which is presented in this article, the villagers requested to focus on water management at the catchment scale because lychee and Oolong tea require irrigation and their expansion in the catchment creates conflicts over water in the community. Presently, only a minority of relatively well-off farms have access to water to irrigate their plantations because of the "first arrived first served" rule that stipulates that once a farmer has set up irrigation pipes to draw water from a creek, other villagers cannot get water from the upstream section.

The main steps of the third ComMod cycle about water management are presented in box 1.

(1) Field interviews about water problem and related socio-political context
(2) Modification of the RPG and associate ABM used in the second ComMod cycle to focus on water management in the third ComMod cycle (ABM built using the Cormas platform http://cormas.cirad.fr)
(3) Gaming sessions with 12 villagers-players (Participatory workshop, day 1)
 Morning : 1st gaming session (scenario "current situation"),
 Collective debriefing : identification of problems & suggestion of solutions by participants,
 Afternoon : 2nd gaming session to test the suggested solutions.
(4) Individual interviews of players (Participatory workshop, day 2)
 To better understand players' behaviour during the game & discussions,
 To validate the model of the game,
 To assess the learning effects of the game.
(5) Participatory ABM simulations & collective discussion about scenarios (Participatory workshop, day 3)
 (i) Scenario corresponding to the actual situation,
 (ii) Scenarios testing the solutions suggested by the participants.
(6) 3 weeks later, participatory ABM simulations within smalll homogenous groups to accompany the evolution of discussions about water allocation.
(7) Monitoring-evaluation of the process: individual interviews to assess the effects of the ComMod process 3 weeks later, 3 months later, and ten months later.

Box 1. Main steps of the third ComMod cycle in Mae Salaep, April 2005-June 2006.

The Role-Playing Game (RPG)

The objectives of this RPG were to stimulate exchanges of perceptions between researchers and local stakeholders about the water problem, and to facilitate collective learning and negociation among farming households and with sub-district officials. The key question examined was: which collective agreements could reduce social tensions due to water shortage and unequal access to irrigation ? The main principles of this RPG are presented in box 2.

The 12 participating villagers play the role of farming households managing their farm. They are given various amounts of land ressources, family labours and financial means according to the actual farming conditions of the three main socio-economic types of farming households in the village (types A, B and C for poor, medium and well-off farms respectively). Their plots are located on a 3D gaming board representing a small catchment with two creeks running into a river. Each year, the players successively :

- Go to the "credit desk" to ask for credit if needed,
- Decide whether or not to send some family members to work off-farm in town,
- Assign a given crop to each of their fields (taking the labour and financial constraints into account),
- Decide whether or not to invest in water pipes for irrigation,
- Go to the "market desk" to sell their farm products and to pay for their expenses,
- Go to the credit desk to reimburse their credit if needed.

The situation at the beginning of the game is similar to the situation of the village 20 years ago: the players have neither perennial crops nor pipes for irrigation yet.

Box 2. Main principles of the game focusing on water management in Mae Salaep.

The representation of the water system is highly simplified. Farmers can set up pipes in creeks for gravity irrigation (figure 2.b and 2.c). Depending on rainfall which varies randomly each year, one creek can provide enough water for 1, 2, or 3 farms. The players decide themselves what rules for access to water are used. If there is not enough water for all the farms who have set up pipes in a creek, and if no arrangements have been decided, priority is given to farms having pipes in the uppermost .

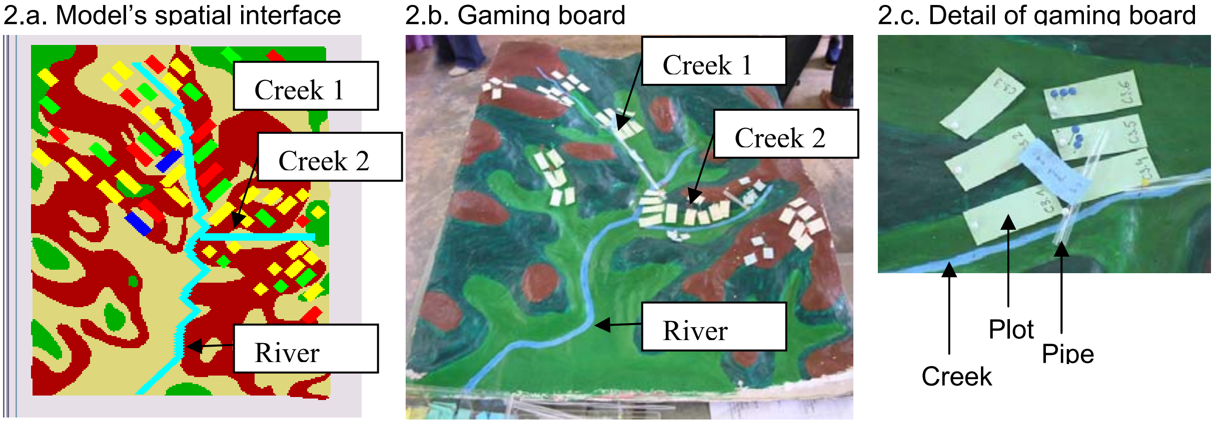


Figure 2. Similarities between the gaming board and the spatial interface of the agent-based model used in Mae Salaep Commod cycle on water management.

The Agent-Based model (ABM)

The ABM is similar to the RPG in its features and rules (figure 2.a and 2.b, figure 3). Basically, the ABM just "plays" the game (see Le Page et al.'s communication in this conference on this theme).

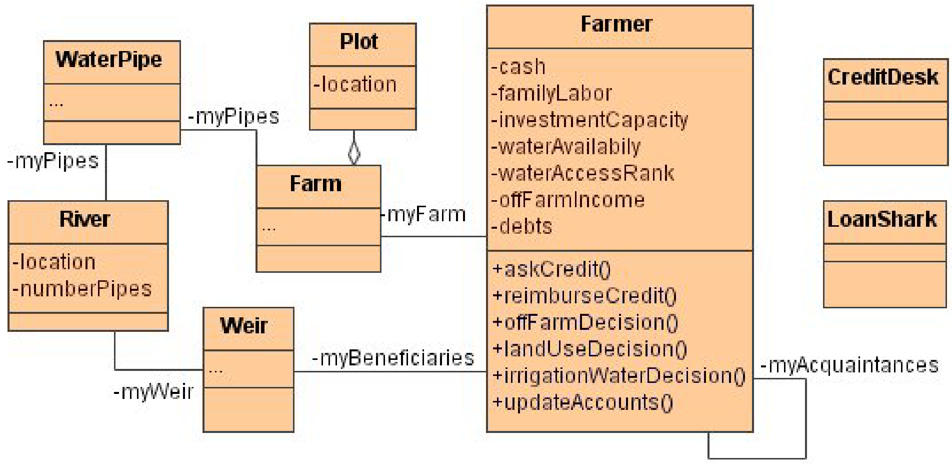
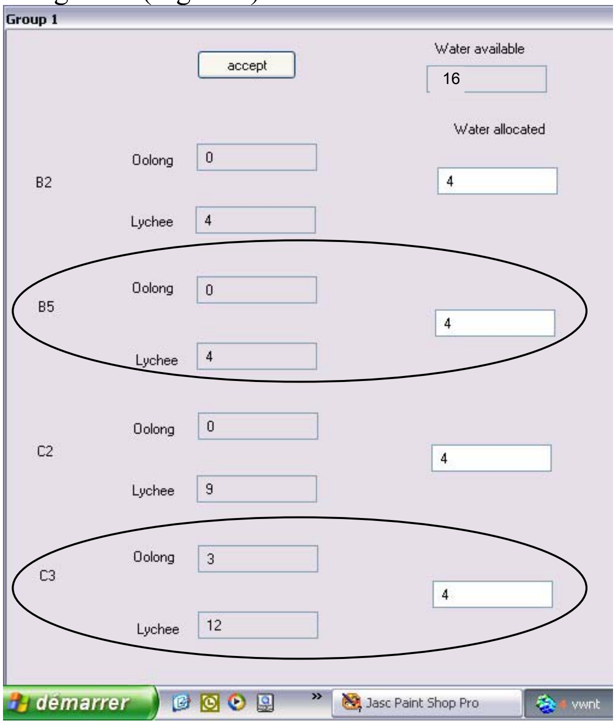


Figure 3. Class diagram of the agent-based model used in Mae Salaep Commod cycle on water management.

An original feature of this model lies in the possibility to run very interactive simulations in which some of the decisions are taken by real participants, while others are taken by artificial agents. This can be called a semi-autonomous or an hybrid ABM. As we will see in the result section, the participants proposed to "build" weirs to increase water availability. Then they had to discuss how they would share water among the beneficiaries. At each time step, the simulation stopped when it was time to allocate water from the weirs, and the 12 participants in the game (corresponding to the 12 "Farmer" agents in the model) had to decide together how they would allocate the water available among them (Figure 4).



B2, B5, C2 and C3 are four farms benefiting from a weir. This year, the amount of water available from this weir is 16 units. They have to decide how they allocate it, knowing that they have various water needs. For example, B2 has no Oolong tea and only needs 4 water units for his lychee plantation, while C3 has larger plantations and needs 3 units for his Oolong tea plantation, and 12 units for his lychee plantation.
In this case, they decided to share the water equally among them (4 units per farm).

Figure 4. The interface used to help participants decide about water allocation during simulations in Mae Salaep Commod cycle on water management.

Results

Increased awareness of the problem to be solved collectively

During the first gaming session, the players acted in the game as in reality. The well-off farmers urged to install their pipes first, and then they did not allow others to get water from the upstream sections. This highlighted the current conflict due to the "first arrived first served" rule. As a village leader said: "no need to say anything, the game showed to everyone that we need to change the water allocation rules".

Exchanges of perceptions among stakeholders about the problem

The players without access to water could see that many villagers had the same problem, while well-off farmers with water access realized that the "first arrived first served rule" would create more and more tensions with the expansion of irrigated plantations. However, this rule was not openly put into question as it is considered as an ancestral community rule. The participants said the problem was the lack of water and therefore new water storage infrastructure was needed. But this was an indirect way to change the rules: as several players said, "new infrastructures are the only way to change the rules".

Suggestions and discussion about possible solutions

Two suggestions were made. First a representative of the sub-district administration suggested to build a single reservoir for the village. This idea was rejected by the other players for fear that it would benefit only a minority. Then a religious leader suggested to build small weirs on each creek and to share the water among groups of households. This idea was accepted by the majority by vote.

Collective evaluation of solutions through interactive simulations

The solution of the small weirs was tested in a second gaming session. It stimulated discussions among players regarding the way to share water among beneficiaries. Participatory simulations using the hybrid model were very useful to stimulate further discussions on this issue (figure 5).

5.a. Water shared proportionnally to plantation size 5.b. Water shared equally among farmers

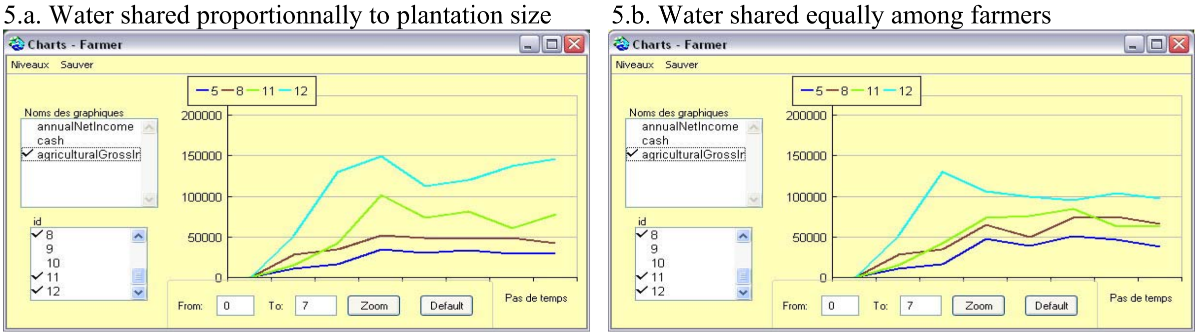


Figure 5. Changes in four farmers' agricultural gross income during the simulations of two water allocation rules in Mae Salaep catchment.

Two different simulation sessions were organized: in plenary just after the game with the 12 participants, and three weeks later within smaller and more socially homogeneous groups (3 groups of 4 farmers each: resource-poor women, resource-poor men, and well-off men). Figure 5 shows the evolution of four farmers' agricultural gross incomes benefiting from a weir in two simulations. In the first one (5.a), the participants decided to share water proportionally to their respective plantation size while in the second one (5.b) they shared water equally among them. During the first participatory simulations in plenary sessions, the member of the sub-district administration (a well-off farmer) imposed the first way to share water. But three weeks later, the participants had continued to discuss among themselves, and within each small group (even among the well-off farmers' one), the participants agreed on the second rule, adding that there should be a possibility to lend temporarily water rights to other farmers in case the amounts of water available exceeds ones needs . This illustrates (i) the importance of the group composition to ensure that all the participants are able to express themselves (sometimes not in the presence of the most powerful stakeholders), and (ii) the importance of discussions behind the scene.

Conclusion

This article demonstrates that simple and quickly built ABM can efficiently stimulate a process of collective learning and negociation among stakeholders involved in a common water problem. Their simplicity is even a favouring factor as it facilitates the understanding and appropriation of this model by local stakeholders. Such simple models also have the advantage to be highly adaptive, and can be easily modified to match with local stakeholders' representations and preoccupations. Moreover, because ABM are able to simulate the decisions of heterogeneous agents and their interactions, even simple models can highlight differences among stakeholders and help to answer the question "who is going to benefit?", which is a key question in a process of accommodation of multiple interests.

However, the modelling process itself should not be "quick and simple", but carefully participatory to ensure the genuine participation of all stakeholders. There is a debate among ComMod practicionners about the need for an initial analysis of the socio-political context. We argue that such an analysis is necessary to identify constraints to an equitable outcome of the process and to mitigate them by adapting the participatory modelling and simulating. To sum up, what we call a carefully participatory process includes: (i) an initial analysis of the socio-political context, (ii) the careful selection of participants (leaving space to empowerment through increased self confidence and creation of alliances), (iii) the alternance of plenary discussions, small group debates and individual interviews, to ensure that all stakeholders feel free to express themselves at some moment, (iv) not to stop at the first apparent consensus as it often reflects the most powerfull stakeholder's opinion, (v) a continuous and iterative process to favour and accompany discussions behind the scenes, where most of negociation processes finally take place, and therefore (vi) the need for a specific monitoring and evaluation system to know what happens between two simulation events.

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