Interactive models to catalyze collective water management: a companion modeling approach in northern Thailand

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Abstract

How can simple interactive models catalyze collective learning and action about local water management? This paper aims at providing an answer to this question by drawing on a Companion Modeling (ComMod) experiment on irrigation water sharing in a highland community of Northern Thailand. In a ComMod process, simulation models integrating different stakeholders' points of view on the problem at stake are developed and used as communication platforms to facilitate the collective exploration and assessment of various possible future scenarios. In this case study, the ComMod process combined a preliminary diagnostic-analysis of the heterogeneous socio-political context, a Role-Playing Game (RPG) and an associated simple Agent-Based Model (ABM). An ABM was used to run simulations to stimulate a plenary debate and, later on, to facilitate discussions within small homogeneous groups of farmers. The various effects of the process on the participants in term of learning, communication, behavior change, and new practices were evaluated through series of individual interviews. This ComMod process stimulated individual and collective learning and coordination among multiple stakeholders exploring pathways to solve their common irrigation water use problem. We show that in participatory modeling, simple models can be useful to mediate water use conflicts and accommodate multiple interests among stakeholders. To do so the participatory aspects of the modeling and simulation process must be carefully managed. In particular, much attention needs to be paid to the initial socio-political context and its power inequities to ensure the genuine involvement of all concerned stakeholders, including the usually voiceless and resource-poor ones.

Introduction

In the highlands of Northern Thailand as in several upper watersheds around the world, water management issues are more and more complex and uncertain, involving an increasing number of stakeholders and combining more and more interacting agro-ecological and socio-economic dynamics (Johnson et al., 2001). To tackle such a complexity, researchers have built a wide range of models aimed at better understanding these issues and/or facilitating decision making processes in these complex systems (Costanza and Ruth, 1998). Box and Draper (1987) wrote that "all models are wrong, but some are useful". Building up on this idea, we wonder how to produce useful models. More precisely, we wonder how simple models can catalyze collective learning and action about local water management.
This paper aims at providing an answer to this question by drawing on a Companion Modeling (ComMod) experiment on irrigation water sharing in a highland community of Northern Thailand. In a ComMod process (which is participatory by its very nature), simulation models integrating different stakeholders' points of view on the problem at stake are developed and used as communication platforms to facilitate the collective exploration and assessment of various possible future scenarios (Bousquet et al., 1999). In the ComMod process presented in this paper, we adopted a critical perspective, i.e. much attention was paid to the initial socio-political context and its power inequities to ensure the genuine involvement of all concerned stakeholders, including the usually voiceless and resource-poor ones.
After a presentation of the context, methods and tools of the ComMod process conducted in the Akha community of Mae Salaep, this paper analyses the main effects of this process in terms of collective learning and action about local water management. To conclude with, we present the main lessons drawn from this experiment.

The Companion Modeling Process conducted in Mae Salaep, Northern Thailand

A ComMod approach
ComMod is a continuous and iterative modeling process alternating field and laboratory activities in a cyclical way, its main successive phases being as follows: (i) Characterization of the problem, (ii) Modeling, i.e converting knowledge into a formal tool to be used as a simulator; and (iii) Simulations to explore various scenarios (Bousquet et al., 2005). Two kinds of simulation tools were used: Agent-Based Models (ABM) and Role Playing 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 and the number of participants remains limited. To alleviate these constraints, it is possible to build a simple computerized ABM, very similar to the RPG in its features and rules, but far more time-efficient to simulate scenarios and allowing a higher number of participants. Moreover, the RPG allows the players to understand the ABM model, to validate and criticize it, and later on to easily follow ABM simulations.
Discussions about a specific problem in a ComMod cycle might raise new questions, which can then be examined in a following one. This is what happened in the ComMod process conducted in the village of Mae Salaep (Figure 1).

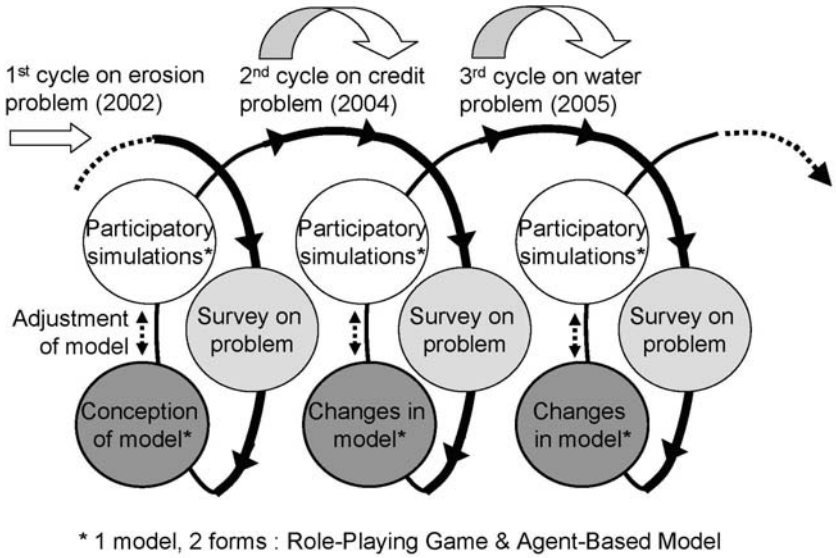

Figure 1. Successive ComMod cycles conducted in Mae Salaep, Chiang Rai Province, 2002-2007.

Context of Mae Salaep catchment

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. In the meanwhile, these changes led to an extensive socio-economic differentiation among farming households, characterized by different availability of productive resources, and different socio-economic and land-use strategies. Type A farmers are smallholders growing mainly maize for cash, while type B farmers hold self sufficient medium-sized farms and grow upland rice for self consumption in addition to maize. Some of these type A and B farmers have small non irrigated plantations of lychee or Assam tea. Type C farmers have relatively large and diversified farms, grow paddy rice and maize, and have extensive irrigated plantations of lychee or Oolong tea. In this context, after an initial ComMod cycle focusing on the interactions between soil erosion and crop diversification (Trébuil et al. 2002), the participants requested to focus the second cycle on the credit constraints to the adoption of non-erosive perennial crops such as tea and lychee (Barnaud et al. 2007, 2008). In a subsequent third cycle, which is presented in this article, the villagers requested to focus on water management at the catchment scale because these perennial crops 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-come-first-served rule stipulating that once a farmer has set up irrigation pipes to draw water from a creek, other villagers cannot get water from its upstream section. Villagers also requested the participation to this ComMod cycle of the *Tambon* (sub-district) Administrative Organization (TAO) which is funding local projects such as the construction of small-scale water infrastructures.

The initial socio-political context related to this water management problem involved several types of stakeholders with their own interests and perceptions of the issue at stake. Figure 2 is a matrix illustrating the relative influence and importance of these stakeholders.

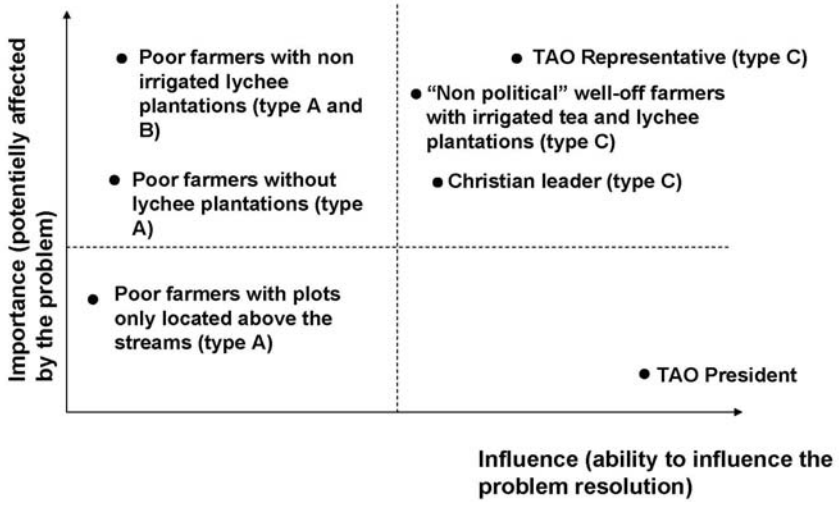

Figure 2. Matrix showing the relative influence and importance of the main stakeholders regarding the water management issue in Mae Salaep, northern Thailand.

Type C farmers are well-off farmers belonging to influential clans of first settlers. Fifteen years ago, they started to irrigate their orchards and claimed that the first-come-first-served rule was an ancestral custom to regulate access to water. Using their high economic status and their traditional authority to exert power, they reinforced this rule when more villagers sought access to water. As a result, most of type A and B farmers do not have access to irrigation water. Some of them do not feel concerned by this issue since their plots are located above the streams and could not benefit from gravity irrigation anyway. But some others start to complain about the "lack of water" in the catchment, especially the farmers with small lychee plantations who could increase their production if they had access to irrigation water during dry season. However, most of them do not question the first-come-first-served rule, since they are usually in a relation of dependence (or patronage) with the powerful type C clans from whom they borrow money when needed or work as daily hired labourers on their farms. Two opposing leaders played a key role in this ComMod cycle about water. The first one is one of the two elected villagers sitting on the TAO council. He recently concluded a deal with an external investor who bought a very large piece of land in the village catchment to plant Oolong tea in the future. As such a plantation would require a lot of irrigation water, he had a strong personal interest in participating to this ComMod process. Another key stakeholder of the process is the religious leader of the village Christian community (60% of the village population). He is a respected person in the village, not only as a religious leader but also as a leading innovator and a knowledgeable person for agricultural matters, actively supporting poor households facing difficulties (by providing technical advice, through free distribution of tea seedlings, etc.). He was the first one who suggested to the research team to use the ComMod tools to discuss about water management issues in the community.

Methodology & tools

This ComMod cycle started with field interviews about the water problem in the community and its related socio-political context. The RPG and the associated ABM used in the previous cycle were modified to address the irrigation water sharing issue and used in a three-day participatory workshop. On the first day, gaming sessions were organized with 12 villagers-players (box 1 and figure 3.b). After a first session played with rules corresponding to the current water use situation, a collective debriefing was organized for the participants to discuss the problems encountered in this gaming session and their possible solutions. A second gaming session allowed them to test these potential solutions by modifying the initial rules of the game. On the second day, individual interviews were conducted to better understand the players' behaviors during the game and the plenary discussions, to validate the model of the game, and to assess its learning effects. On the third day, participatory ABM simulations were conducted to support plenary discussions about possible future scenarios (figure 3.a). An original feature of this semi-autonomous or hybrid ABM lied in the possibility to run very interactive simulations in which some of the decisions were taken by the villagers, while others were taken by artificial agents. At each time step, the simulation stopped when it was time to allocate water among the farmers, and the 12 participants in the game (corresponding to 12 "Farmer" agents in the model) had to decide together how they would allocate the water among them. Three weeks later, new simulations were conducted within smaller and more homogenous groups of farmers to accompany the evolution of discussions about water allocation in the village. To assess the short-term and mid-term effects of the ComMod process, individual interviews were conducted 3 weeks, 3 months and 10 months after the workshop.

The 12 participating villagers play the role of farming households managing their farm. They are given various amounts of land resources, family labor 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 irrigating them yet.
The representation of the water system is highly simplified. Farmers can set up pipes in creeks for gravity irrigation. Depending on rainfall, that varies randomly each year, one creek can provide enough water for 1, 2, or 3 farms only. Players decide what rules for access to water are used. If there is not enough water for all the farms and if no agreement has been reached, priority is given to farms having pipes set up in the upstream section.

Box 1. Main principles of the Role-Playing Game focusing on water management in Mae Salaep.

3.a. Model's spatial interface 3.b. Gaming board

Figure 3. Similarities between the gaming board and the spatial interface of the agent-based model used in the ComMod cycle focusing on water management at Mae Salaep, northern Thailand.

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 did not allow others to get water from the upstream sections later on. This highlighted the current conflict due to the first-come-first-served rule and increased the participants' awareness of the problem, its urgency and the need to solve it collectively. As a village leader said during an interview: "no need to say anything, the game showed to everyone that we need to change the water allocation rules".

During interviews before the gaming sessions, well-off farmers who had access to water always said: 'there is no water problem in the village, no conflict, everything is all right.' They had obviously a good BATNA (Best Alternative To Non Agreement) and more interest in maintaining the *statu quo* than being part of a process raising the water problem. If the ComMod process had started with a more classical meeting in which communication skills prevail, the water sharing problem might not have been put on the agenda of the discussions. The game facilitated a different form of communication which allowed the less powerful villagers to raise this problem and to create a collective awareness of its existence.

Exchanges of perceptions among stakeholders about the problem

The ComMod process also stimulated exchanges of perceptions among the participants about their common water problem. 10 out of the 11 participants interviewed after the gaming sessions said that the game allowed them to better understand the other villagers' situations, problems and/or perceptions. Players without access to water could see that "many villagers faced the same problem", while well-off farmers with water access realized that the first-come-first-served rule would create more and more social tensions under the current expansion of irrigated plantations. Such a result might be surprising at first sight since these villagers belong to a small community in which they all know each other, but as a participant said: "in every day life, every one goes to his fields; we do not have such opportunities to discuss together."

Problem reframing and integrative negotiation of possible solutions

Once the problem was identified, the ComMod activities facilitated a collective process of problem reframing and integrative (or win-win) negotiation. First, the TAO representative suggested to build a single reservoir for the village. This idea was rejected by the other players who feared that this would benefit only a minority of households. Later on the religious leader suggested to build small weirs on each creek and to share water among small groups of households. This idea was accepted by the majority by vote. It is interesting to notice that this leader did not openly put into question the first-come-first-served rule because he knew that the well-off clans would not accept it. He suggested instead a more integrative solution which was acceptable to them: he said the problem was the lack of water, therefore new water storage infrastructure was needed to increase the volume of water available at the village level. Then, when such infrastructures would be built, farmers would have to discuss again about the water allocation rules. As several players stated, "new infrastructures are the only way to change the rules". This was a typical integrative negotiation process in which stakeholders looked for solutions to "increase the size of the cake" instead of fighting about the way to "divide the cake".

Collective evaluation of solutions through interactive simulations

The small weirs solution was collectively tested in the second gaming session. It stimulated discussions among players regarding the way to share water among beneficiaries of the weirs facilitated by the hybrid ABM. During the first set of participatory simulations in plenary session, the member of the sub-district administration (a well-off farmer) imposed to share water proportionally to the farmers' plantation size. But three weeks later, the participants had continued to discuss this point, and during the simulations, within each small group, they collectively decided to simulate the sharing of equal volumes of water among them, adding that there should be a possibility to lend temporarily water rights to other farmers in case the volume of water available exceeded ones needs. This illustrates the importance of discussions occurring between field workshops and the necessity to monitor them and take them into account.

Discussion

Empowerment of the resource-poor stakeholders: a levelled playing field

Aware of the fact that power inequities express themselves in a participatory process and of the subsequent risk of increasing social inequities, much attention was paid to the initial socio-political context to ensure the genuine involvement of all concerned stakeholders, including the usually voiceless ones. This ComMod process successfully empowered them in the negociation arena and allowed them to voice and assert their interests. This was achieved through a process of both personal and collective empowerment. The ComMod activities improved the participants' self-confidence and supported the development of their capacity to understand the situation and imagine new solutions: 'I am so proud. I did not know that I would be able to play the game, to think by myself about solutions,' said a female participant. As for collective empowerment, 7 out of the 11 interviewed participants claimed that the game made them realize that they were collectively 'stronger' or 'more intelligent' (in their own words) than individually. This ComMod process also triggered a process of collective empowerment through the creation of alliances allowing the reinforcement of a counter power as the less powerful stakeholders realized that they could join a charismatic leader (the Christian leader) to make their voice louder. 'If I think alone, I do not have good ideas. But if we think all together, we can all benefit from the good ideas of people like the Christian leader,' said a woman.

Negotiation with higher level institutions: the main limit of the process

Ten months after the last workshop, the villagers had prepared a document to request funding from their TAO to build such new water infrastructure. Unfortunately, the president of this administration rejected their proposition, in spite of her previous discourses about the importance of villager's participation in local politics and management of renewable resources. This was the main limit faced by this ComMod process and one of the key future challenges.

Conclusion

How can simple models catalyze collective learning and action about local water management? This paper demonstrates that a model's usefulness relies much more on the modeling process than on the model itself. Moreover, although water management issues are complex, when the model aims at facilitating collective learning and communication, there is no need for exhaustive models computing a large amount of data, very simple models can be very useful. Their simplicity is even an advantage 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 accompany evolving local stakeholders' representations and preoccupations. However, the modeling process itself should not be "quick and simple", but carefully participatory to ensure the genuine involvement of the concerned stakeholders.

To sum up, what we call a carefully participatory process or a critical companion modelling process includes: (i) an initial analysis of the socio-political context to identify constraints to an equitable outcome of the process and to mitigate them by adapting the tools and methods used, (ii) the careful selection of participants to ensure that all participants are able to defend their interests and, eventually, to empower some of them through increased self-confidence and creation of alliances, (iii) the use of tools which are accessible to all kinds of stakeholders, whatever their level of formal education, (iv) the use of tools and methods highlighting the diversity of interests so that all interests are taken into account during the debates, even the usually voiceless' ones, (v) the use of tools and methods favouring integrative or win-win negotiation processes which are acceptable to both influent and more marginal stakeholders, (vi) alternating plenary discussions, small group debates and individual interviews, to ensure that all stakeholders feel free to express themselves (sometimes not in the presence of the most powerful stakeholders), (vii) not to stop at the first apparent consensus as it often reflects the most powerful stakeholders' opinion, (viii) a continuous and iterative process to favour and accompany discussions behind the scenes, where most of negotiation processes finally take place, and therefore (ix) the need for a specific monitoring and evaluation system to know what happens between two gaming and simulation field workshops.

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