Constructing a common representation of local institutions and land use systems through simulation-gaming and multiagent modeling in rural areas of Northern Vietnam: The SAMBA-Week methodology

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The authors propose to exploit the similitude and complementarity between simulation-gaming and multiagent modeling through the development of a new methodology called SAMBA-Week, which is used for agricultural research and development. The need for such a new methodology came from the context of mountainous areas of Northern Vietnam characterized by a high social and natural diversity. As actions of research and development typically involve multiple actors, a precondition for communication is a mutual understanding of each other's point of view. The authors thus used simulation-gaming, individual interviews, and multiagent modeling to enhance communication by constructing with the stakeholders a shared representation of their system as a basis for discussion.

KEYWORDS: *agricultural research; rural development; communication platform; computer simulation; interactive modeling; land use systems; multiagent modeling; participatory approaches; simulation-gaming; Vietnam*

Simulation-gaming and multiagent systems have both been used to model and simulate the evolution of complex systems over time. Even in their conception, they share common features. Ferber (1999) defines an agent as a physical or virtual entity that has objectives it tries to satisfy, is able to act in an environment it may only partially perceive, and may act on the environment and communicate with other agents. Such a definition could be applied to simulation-gaming as well as multiagent computer models, the main difference lying in the involvement of human players or virtual agents. As such, they may appear as complementary, human players presenting much richer behaviors than algorithm-based agents, but computer simulations have other advantages such as the reproducibility of simulations. Using this complementarity as a frame for our work, we decided to use simulation-gaming to feed multiagent models.

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Following previous experiences of linkage between these two tools (Barreteau, Bousquet, & Attonaty, 2001; Bousquet, F., Barreteau, O., d'Aquino, P., Etienne, M., Boissau, S., Aubert, S., et al., 2002; d'Aquino, Le Page, Bousquet, & Bah, 2002), we present a new methodology called SAMBA-Week combining simulation-gaming, individual interviews, and multiagent modeling.[1] It has been designed and used for land use systems analysis and local management of natural resources in Bac Kan province, Northern Vietnam.

In the first part, we will show how agricultural and institutional contexts challenge the research and development process in the mountainous areas of Northern Vietnam and lead us to the development of new tools. The second part will explain the three different but interrelated objectives that are pursued: data collection, theoretical research, and agricultural development. In the third part, the five steps comprising the SAMBA-Week methodology are exposed in detail, and the last part discusses some critical aspects of the methodology and its use in the particular context of Vietnamese agriculture.

A challenging natural and human environment

The development of a new methodology or a specific combination of tools is never innocent but rather comes from particular research issues and the context in which the research takes place. Existing methodologies may prove not to be completely satisfactory because they are not adapted to the research environment.

The need for rapid appraisals to understand land use changes from local to provincial levels

Bac Kan province is a mountainous province located 150 km north of Hanoi. The ethnic composition of its population is a majority of Tay (67%), followed by Kinh (20%), Dao (10%), and Hmong (3%). They mainly practice paddy rice cultivation in the valley bottoms and grow various crops (upland rice, maize, cassava, fruit trees, etc.) on the hillsides. After the collapse of the cooperative system and with the progressive privatization of production factors, agriculture in Bac Kan province has quickly evolved and is still in a process of rapid change (Castella, Husson, Le Quoc, & Ha Dinh, 1999). In this context, the regional component of the Mountain Agrarian Systems (SAM) project aims at understanding current agricultural dynamics to develop more sustainable production systems (Castella, Husson, et al., 1999). The challenge is to achieve this objective at the regional level in a province characterized by a high social (ethnic diversity, education, political integration), economic (from self-subsistence to market-oriented systems), and geographic (from lowlands to uplands) heterogeneity. In such a context, traditional research methods based on extensive field study and data analysis, which must concentrate at the village level to integrate the diversity, are not appropriate (time consumption, delay between research results and

effective action, etc.) or, more precisely, not sufficient (Castella, Boissau, Hoang, & Husson, 2001). On the other hand, conventional participatory methods have also shown limitations in providing access to the information on such brewing issues as land tenure, livestock management systems, and so forth.

Establishing communication with and among stakeholders

Traditional interviews using questionnaires (with open or closed questions) or open discussion are faced with the problem of a lack of trust between the interviewer and the interviewee who have only little or no contact before and between interview sessions. It often leads to partial or erroneous answers. This is particularly obvious when the interviewee and the interviewer come from different social environments and even more from different cultures.

Another obstacle to communication when working in Vietnam and especially northern mountainous regions is the confrontation between local practice and official discourse. Such a discourse repeats official views on the subject, regardless of personal opinions and passing over conflicts in silence. To understand particular situations, one has to go beyond this official discourse out of which no real discussion can be established. But this can only be done through nonconventional means of communication such as gaming.

Other methodologies such as participative observation and life histories, often used in social science, first try to establish a relationship based on trust between the researcher and the subject. But it generally implies a long investment in time, leading to very detailed monographic studies reconstituted from anecdotal fragments collected during the fieldwork. Because we needed to understand rapidly particular situations in several villages of the province in a short period of time, we could not afford such an investment, and we had to design other methodologies to collect only relevant but accurate information.

We consider the establishment of communication with and among stakeholders as an essential preliminary step for research and development objectives. We had to find a kind of balance, allowing us to collect precise and accurate information thanks to a good communication means without wasting time through extensive fieldwork.

SAMBA-Week: A new methodology serving interrelated objectives

In this context, we needed to develop a new methodology that could overcome the above constraints while providing precise insights on diverse local situations and enabling a real dialogue with local stakeholders. This has been achieved through a combination of simulation-gaming, individual interviews, and multiagent modeling, the whole comprising the SAMBA-Week methodology. Before presenting in a more

detailed way the different steps of the process, we propose to expose the concrete objectives addressed.

The SAMBA-Week methodology pursues three main objectives:

- collecting qualitative information and quantitative data as part of a participatory diagnostic process,
- studying the emergence of collective institutions out of individual actions, and
- improving sustainable agriculture through the development of a communication platform to make adoption of technical and organizational innovations easier.

Although these objectives refer to different epistemological contents, they are highly interrelated.

Collecting information to feed a diagnostic study

The first objective, which will be the basis for the two other ones, is collecting qualitative and quantitative information to have a better understanding of the system.

Information has to be collected at individual and system levels. At the individual level, we focused on management of production factors and decision-making processes. At the system level, we aimed at a global understanding of the agrarian system and local institutions regulating the access to production factors, particularly land.[2]

Studying the links between individual and collective

One can consider social organization as the emergent result of individual actions, but in turn, social organization constrains individual actions. This double-loop relationship has been called second-order emergence (Gilbert, 1995). In the context of Northern Vietnam agriculture, characterized by an increasing land scarcity, we studied how changing conditions lead to changes in individual behaviors and local institutions. For example, individual actions may slowly deviate from the collective norm and lead to the transformation of the collective rules. Through a methodology encompassing individual and collective levels of analysis, we studied this very process of emergence and change.

A communication platform to facilitate sustainable agricultural development

In a complex world characterized by uncertainty, purely technical solutions ignoring social factors cannot count as a solution. Sustainability should rather be seen as the emergent property of soft systems (Checkland, 1981; Röling & Jiggins, 1998), and the path to sustainability goes through negotiation with stakeholders. For this social

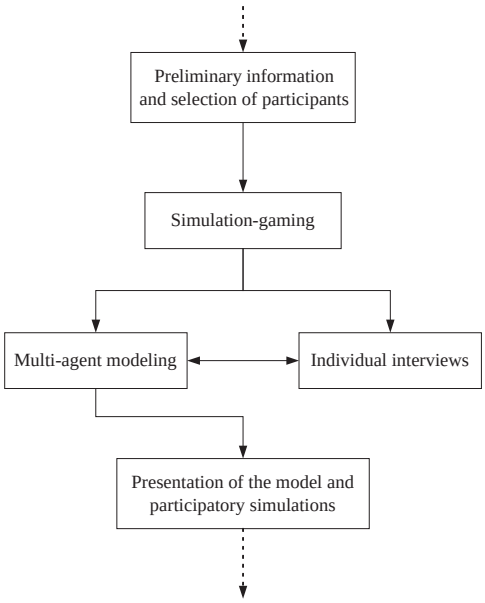

FIGURE 1: Steps of the SAMBA-Week Methodology

learning to be effective, a first requirement is a mutual understanding between stakeholders and researchers. We think this can be achieved through the construction of a common (shared) representation of the reality. Such a model can then be used for the introduction of technical and/or organizational innovations and, most of all, discussion on social factors that may facilitate the adoption of these innovations to develop a more sustainable use of natural resources.

In the next section, we describe the different steps of the SAMBA-Week methodology, elaborated to make a dynamic diagnosis of the institutional and agrarian situation of a selected site (typically one or two villages). This diagnosis will then be the starting point for, on one hand, the study of the interactions between individual actions and collective institutions and, on the other hand, the facilitation of technical and organizational innovations adoption.

Description of the different steps of the SAMBA-Week methodology

The SAMBA-Week methodology is composed of five steps, as represented in Figure 1. The whole process is organized in one commune at a time and lasts 1 week. Dotted lines displayed in Figure 1 at the beginning and the end indicate that the process is not closed on itself but is imbedded in broader approaches depending on the pursued objectives and not detailed in this article.[3]

Selection of participants and collection of preliminary information

The first step of the process consists in selecting the participants for the SAMBA-Week. This is usually done in a single day through meetings with commune authorities and with the headman of one or two selected village(s) in the commune. These villages and communes have previously been selected for their representativeness of particular agro-ecosystems in Bac Kan province (Castella, Gayte, & Do Minh, 1999). During these meetings, basic information is collected about the history, demography, ethnic composition, economic, and agricultural situation of the village. This information is intended to give a broad picture of local characteristics and is used to select about 10 participants representing as far as possible the household diversity of the villages.

Some other factors related to the Vietnamese context have to be taken into account for the selection of participants. Vietnam's population is composed of 54 ethnic groups with their specific languages. The official Vietnamese language is the one of the Kinh ethnic group that originally populated the deltas and the coastal area. The population of Bac Kan being composed of different ethnic groups, observation of processes, and communication with participants by researchers who do not understand local languages may be a problem. The selection of participants has thus to address language matters, and participants must be able to speak (even if not fluently) the Kinh language.

This may be seen as a serious constraint to the process. For example, it often compromises the participation of women, as they usually have a lower education level and fewer contacts with administration, which is the main place where the Kinh language is spoken in the province.

This language problem somehow challenges the representativeness of the participants. Regardless, the selection of participants does not aim at fulfilling the utopian objective of exactly representing a whole village through participation of 10 households. The emphasis is more on capturing broadly the diversity of individual situations regarding agricultural practices encountered in the village and enhancing communication and exchange between local stakeholders and researchers.

In addition to selected participants, representatives of local associations and authorities at the village and communal levels are invited as observers.

Simulation-gaming

The simulation-gaming step of the process takes place on a whole single day. Participants and observers are invited to come to the place chosen to conduct the game, generally the meeting room of the commune people's committee.[4]

The meeting starts with a broad presentation of SAM project activities and objectives. Participants are then asked to introduce themselves. The game board is presented: It consists in a square board composed of 625 wooden cubes (25×25). The

TABLE 1: Correspondence Between Cube Colors and Land Use/Cover

Color	*Land Use/Cover*
Black	House, residential areas
Red	Paddy field
Yellow	Upland crops
Blue	Shrub (fallow)
Light green	Young forest
Dark green	Old forest

cubes are painted with six different colors, one on each side. These colors represent six different land uses or land covers, as illustrated in Table 1.

One cube represents an area of 1,000 square meters, or one *bung*, which is the area unit commonly used by farmers in the region.

At the beginning, the artificial landscape created through the game board represents a mix of the different types of vegetation (shrub, young and old forest) in a proportion approximately similar to reality. This initial environment is validated with participants. Figure 2 presents a picture of the game board.

Players then have to draw a family card describing the members of their virtual household for the gaming-simulation in terms of kinship and age and defining their food requirements. Players also draw cards allocating buffaloes (between zero and three) and paddy fields (between one and three bungs or cubes). They have to choose a location on the game board for their house and also for their paddy fields. They are then asked to introduce their new family and situation to the other participants.

For the following stages, one simulation-gaming step represents 1 year. Hereafter, we describe what happens during each step.

Players are invited in turn to decide on their activities for the coming year. These activities typically encompass growing rice (one or two cycles) in paddy fields, clearing new plots, growing upland crops, managing buffaloes, and so forth. The only constraint on the activities of a household is the availability of labor force. Every time a new activity is proposed by a player, the typical reward and needed labor force for this activity is discussed among the participants until a consensus is reached. The result (i.e., crop yield, labor requirement for a particular activity) is then written on a board and becomes a local reference for all participants. At the end of the step, one of the participants draws a weather card (bad, average, or good), and the actual reward of each activity for the past year is decided. This random draw has been devised to introduce some uncertainty in the game as agricultural outputs are characterized by their variability from 1 year to another. Individual rewards in equivalent paddy unit are then distributed to the players at the end of each round. They have then to return to the game facilitators the amount of paddy rice corresponding to their family consumption (depending on the number of members in their virtual family). If they cannot satisfy their basic food needs, participants have to borrow from the bank or neighbors. They face a crisis situation that very often triggers changes in their decision-making process in the next rounds.

FIGURE 2: Simulation-Gaming Session: The Game Board and Players Evolving Around

Apart from the above constraint of food sufficiency, players are free to have personal initiatives. They can buy buffaloes from other players or from the game facilitator, sell buffaloes, borrow rice or any production factor, proceed to labor exchange, decide to conduct nonagricultural activities, elect a headman for their virtual village, and so forth.

In addition, the facilitator may introduce special events. They are intended to give more realism to the game and also to trigger particular situations. Such events need to be realistic to be accepted by the players. Examples include loss or death of buffaloes, crops damaged by buffaloes or climatic events, exceptional environmental conditions, and so forth.

Actions of the players, as well as all kinds of discussions (in Vietnamese and Tay languages) among them, often aside the game board, are recorded through written notes.[5]

In a session lasting 1 day about six rounds can be played, corresponding to the simulation of 6 consecutive years.

The meeting ends with a collective debriefing session during which players are asked to react to the gaming session. This first debriefing concentrates on the collective level.

The participants are first asked to make a general assessment of the game, giving their first impressions after the end of the game. They are then asked to comment on the correspondence between what they experienced during the gaming session and their

reality. The correspondence is generally considered very strong because during the gaming session, the players are relatively free of their actions and tend to reproduce the reality. If some elements of the game are considered unrealistic, the players are asked, for example, why things happened in a particular way during the game but happen differently in reality. Missing elements in the game can then be pointed out, as well as the consequences of the presence of such elements in reality. In the end, the discussion on the correspondence between the game and reality can be focused on elements of special interest for the researchers.

Individual interviews

The gaming-simulation session is followed by 3 days of individual interviews with the players and the observers (mainly authorities and associations representatives). These interviews are organized along the following lines.

The first part of the individual interview is an individual debriefing. It aims at understanding the rationale behind the actions of the player during the game session. Even a few days after the game, interviewees usually remember their actions step after step. If not, we remind them of their actions, using the notes taken during the game. Players are then asked to justify their actions, that is, why they undertook these particular actions at that particular moment in the game. Such questions are generally easy to answer for the players, as they directly refer to known situations in reality and their everyday life. If these actions are different from the situation of the player in reality, they may be similar to the ones of someone else in the village. Round after round (year after year), actions of the player in the game are recalled and the rationale underlying these actions is made clear. This process of reliving the actions of the players in the game is actually an individual debriefing. Players have to explain their perception of the situation in the game at every round, how it evolved, how they decided on their actions, and how the evolution of the environment (social and physical) made the players change their actions. At the same time, this process of reliving the game with the player provides much information on individual decision making that could not be collected during the game session or without considerably lengthening the game session and breaking the gaming dynamic because of interruptions in the process.

The second part of the interview consists of a comparison between the real situation of the players and their situation in the game. After evaluating the differences in terms of family structure, household members, and other production factors (mainly land endowment and animal husbandry), we try to understand how these variables are related to a behavior in reality that is different from the behavior in the game.

Finally, the interviewee is asked to assess the game in terms of similitude with reality. Differences are explored, as well as some important points arising from the game or the interview.

Multiagent modeling

In parallel with the individual interviews, a multiagent computer model is implemented using the Cormas platform (Bousquet, Bakam, Proton, & Le Page, 1998). The model aims at reproducing the gaming-simulation inside the computer. For this purpose, the virtual environment of the computer is very similar to the one of the game, including the chosen colors.

In multiagent modeling, only the agents' behaviors are specified, and dynamics at the global (macro) level are emerging from actions and interactions at the microlevel. In our SAMBA computer model, agents are households and buffaloes, and the behaviors of these agents are specified through an algorithm derived from observations of the gaming session and insights from individual interviews. Elaborating agents' behavioral rules out of the observation of the gaming session and individual interviews is also a way to debrief facilitators (Lederman & Kato, 1995). The information is being disseminated among facilitators and interviewers, and they have to bring together their information and experience to agree on proposed rules for the modeler to implement them in the computer model.

The objective of the computer model is thus to recreate outcomes of the game, especially concerning the evolution of the physical environment by specifying only individual behaviors of households and buffaloes.

A first computer model tries to reproduce as faithfully as possible the sequence of the events that occurred during the game. This can be considered as a kind of reference model. Derivations from this reference model are then modeled by correcting nonrealistic elements identified by the participants during the debriefings. New scenarios, also identified during the collective debriefing session or through individual interviews, are implemented by changing parameters of the computer model and/or agents' behaviors. Figure 3 presents the evolution of a landscape under a particular scenario.

Four days after the simulation-gaming session, participants are invited for a new half-day meeting. During this meeting, the computer model version of the game is presented to the participants (see Figure 4). Although the participants have generally never seen a computer, the similitude between the game board and the visual interface of the multiagent model (see Figures 2 and 3) helps them to understand the new visual environment. After explaining to them the meaning of the colors, participants are even able to comment on the running simulation, finding explanations in households' behaviors for the evolution of the virtual landscape. This reference scenario is typically run over six time steps, representing 6 years, to reproduce the game. In some cases, it is necessary to run this simulation a few times to make sure all participants become familiar with the model. After that, the model can be run for more time steps, typically 10 to 20, to explore the evolution of the environment beyond the end of the game. This simulation brings the question of how well the model represents the future and brings discussion among the participants. In particular, alternative scenarios may

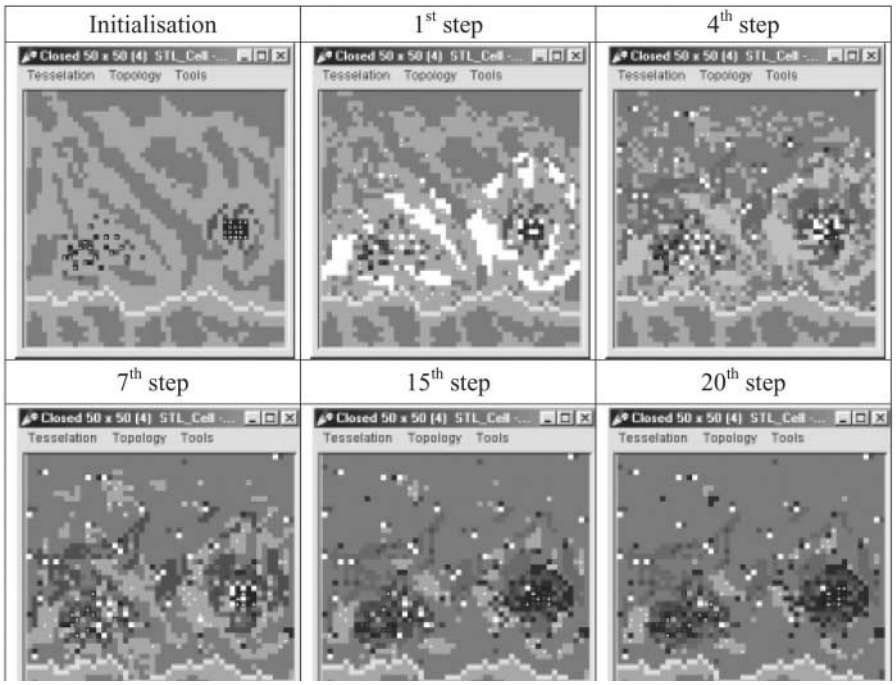

FIGURE 3: Screen Captures From a Computer Simulation

be proposed by the participants or by the facilitators and, if possible, simulated using the computer model.

Using this multiagent model, simulations can be run for more time steps but also in less time than the game, which requires a complete day for simulating about 6 years. The goal of the simulations is not to predict the future but rather to stimulate discussion on possible problems that farmers are facing in their activities or that could occur in the future. In this context, technical innovations can be proposed to the participants who can assess their need for it but also question social changes that would come together with the innovations (e.g., livestock management systems, cropping practices).

Discussion of some achievements

At this time (end of 2002), the sole gaming-simulation has been conducted twice and the whole SAMBA-Week methodology five times. Some lessons can already be drawn from these experiences.

FIGURE 4: Presentation of the Computer Model to the Participants

Collecting information and enhancing communication in a Vietnamese context

One of the main characteristics of the SAMBA simulation-gaming is that participants play a role very close to the role they have in the reality. A farmer always plays the role of a farmer even if his resource and production factors endowment is not the same as in reality. Another important feature is that the rules are voluntarily left very open, the only restriction being the availability of labor force. As a consequence, players set their own rules. During the game, the players may explicitly mention some of these rules, whereas others may not be expressed and stay in the mind of the players. One of the goals of the individual interviews following the gaming session is to identify these rules and compare them with rules people follow in reality. This comparison generally shows that participants reproduce rules from their reality in the game. As a consequence, the game can be considered to some extent as a model of the reality constructed by the players themselves. Such a game is in accordance with the use of simulation-gaming for social research as proposed by Greenblat (1981).

As a model of the reality, it simplifies reality by omitting elements that are not essential to the agricultural system functioning. It is also more easily understandable for someone outside the system, precisely the researcher who can grab information directly from the SAMBA gaming session. Such information only needs to be made

explicit if necessary and then confronted with reality through individual interviews. Also, consistency of the information is checked through the computer modeling process that should lead to the reproduction of the global outcomes of the game from the specification of individual (agent) behavior and landscape transformation rules.

Compared to other methods used for data collection, simulation-gaming thus appears to be very efficient in the Vietnamese context. As mentioned before, the establishment of trust is critical to get quality information, but the process is especially long and difficult in an intercultural or interethnic context. Farmers, especially those from ethnic minorities, generally have a low academic education level. Authorities often consider them as backward, making an irrational use of resources. This misunderstanding between people having different visions may lead to farmers' wariness of strangers in the broad sense of the word.[6] Also, because Vietnamese society is highly hierarchical, decisions follow a top-down process in which farmers from ethnic minorities have little opportunity to express their views. Especially, all information collected by the authorities comes exclusively from village headmen or mass associations' representatives. As a consequence, collecting information, especially qualitative information, from farmers reveals to be even more difficult if trust is not present. The SAMBA-Week methodology proved to be very useful to overcome these problems. Through the gaming session, participants give information they would not have been able to provide if asked in a more formal way. One of them once told us, "If you really want to understand me, you'd better see what I do than what I say about it." Using simulation-gaming, we could directly observe actions of the players but also how they evolved over time, especially to overcome periods of crisis. The gaming session simulates a few years of the reality and thus incorporates dynamic and temporal aspects that cannot be observed in reality or at the price of long-term field studies. Last but not least, the game also serves as an ice-breaking tool. During the role-play session, players, observers, and researchers share a common activity that establishes links among themselves. This considerably facilitates future interactions, starting with individual interviews in which a real enhancement of communication can be observed.

To build a common representation of the reality

Information gathered through simulation-gaming and individual interviews is implemented in a multiagent model. In the very process of modeling, consistency of information can be checked: Outcomes of agents' behavior must lead to a global environment close to the one observed in the gaming session. If it is not the case, individual behaviors must be further investigated. When the model is presented to the participants, they are asked to validate the model, that is, accept computer simulation as a good representation of their reality. They may also ask refinements on aspects that in their sense do not match the reality. Once a consensus has been found on the model, one may say that it is a common representation of the reality shared by the stakeholders (participants) and the researchers. Thanks to the process as it has been presented, participants easily understand the model. At several occasions, they related events on the computer screen to events that happened in their villages (e.g., buffaloes damaging

crops, the disappearance of primary forest). Such reactions from the participants proved that people without previous experience of computers or high education could easily understand the computer simulation and engage in discussion from it. Also, they did not confuse the model with reality. The model is not a predictive tool, and simulations are merely used to explore different futures, question their desirability, and discuss ways to achieve them.

Conclusion

Through the combined use of simulation-gaming, individual interviews, and computer modeling, we could build a shared representation of a system encompassing the point of view of the actor and the one of the scientist. Such an outcome is only a first step but in our view a necessary one in a broader process of research and/or development. Some conclusions can be drawn from this first step.

The methodology proved to be efficient in several ways. It has been developed, applied, and well accepted in an intercultural context where communication and trust are difficult to establish. Through gaming, a relationship could easily be established between the stakeholders and the researchers/facilitators.

Simulation-gaming was used in an interactive modeling process. By jointly modeling the system, the stakeholders and the researchers learned more about it. Stakeholders got a holistic view of the system of which they are part and better understood how individual actions may influence the system as a whole. Researchers got a synthetic view of the local agrarian system through the model that was constructed by the stakeholders during the gaming session. The subsequent interviews are conducted to validate the big picture drawn from the gaming session and explore individual decision making. Finally, the computer session aims at validating the understanding of the system by the researchers before engaging further discussions and/or interventions on the basis of this shared representation.

Notes

1. The name *SAMBA* is formed from SAM (French acronym for Mountain Agrarian Systems), the name of the project in which the methodology has been developed, and *ba*, meaning three in Vietnamese. The SAMBA-Week methodology is considered as a link between two components of the project: (a) one about diagnosis on land use changes and problem prioritization with local stakeholders and (b) the other about intervention through design and testing with farmers of technical and organizational innovations. The whole method is applied at a given location over a 1-week period.

2. A historically constituted and lasting mode of exploitation of the environment, a technical system adapted to the bioclimatic conditions of a given area and which complies with its social conditions and needs at that moment (Mazoyer & Roudart, 1997).

3. To see how the SAMBA-Week methodology is embedded in a broader multiscale approach, one may refer to Castella, Gayte, and Do Minh (1999).

4. The commune people's committee is the representation of authorities at the local level.

5. Video recording revealed to be difficult to use because conversations are not easily audible, and attitudes of the players are also difficult to observe as the action area is quite large. It thus appeared that written notes were much more efficient to capture actions and conversations.

6. We do not go into details, but other historical and political reasons also account for this wariness.

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