Chapter 2
Companion Modelling: A Method of Adaptive and Participatory Research

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The principles laid down in the ComMod Charter and presented in the general introduction relate to a stance or attitude towards how a specific issue and specific field are addressed by taking into account the various types of knowledge and perceptions already present and the use of certain tools. These principles suggest a framing for the teams committed to them, but the adaptation capacity in organizing the implementation of companion modelling in a given case study is in practice left to the commodian. This chapter aims to detail the diversity involved in implementing a ComMod process and the common points that emerge from it. The objective is to describe in order to understand better, with no normative intention.

We relied essentially on *ex post* analysis of case studies and documents listed in the introduction. Our analysis compiled real-life cases and practices that claim to be companion modelling[1] and which will, therefore, be considered as such in our

[1] The ComMod Charter as it exists at the time of this work authorizes any person who has joined the group, and been accepted into it, to consider if his research work follows, or not, a companion modelling approach.

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M. Étienne (ed.), *Companion Modelling*, DOI: 10.1007/978-94-017-8557-0_2,

analysis. We shall then discuss in the overall conclusion to the work whether the nature of diversity observed remains within the framework of adherence to the initial principles of the charter, or dilutes them.

For this analysis we used the documents compiled in the project presented in the introduction to this work. Despite the care taken in the collective writing of frameworks for these documents, a certain amount of subjectivity in completing them must be considered in the analysis. Heterogeneity is added to this subjectivity, as every Montfavet canvas, Canberra Protocol and logbook is completed by one (or more) different authors. To reduce this methodological risk, all interpretations and comparative analyses have been discussed with the contributors to the original documents.

Based on this comparative analysis, we can suggest, therefore, a few key points describing companion modelling. The section ‘Organising a companion modelling approach’ below thus describes the components of companion modelling. These components unite individuals with specific roles for which we suggest a typology that is used in the remainder of the work. Alongside the individuals is a description of the tools, especially the models mobilized in all these approaches. We then address the sequences used to describe the stages of a ComMod process before comparing the dynamics as they are generated. We emphasize in particular the existence of collective ‘high points’, that is, key moments used to understand the dynamics at work. Finally, this section concludes by presenting a conceptual model of the approach summarizing all its constituent components. The next section ‘An iterative approach’ compares the different possible iterative faces of the approach, as this iterative organization is featured in its presentation—right up to the logo of the ComMod group. This comparison specifies the various types of loop or iteration encountered and discusses the central role of the iterative nature in any ComMod process. The following section ‘Invariants noted during implementation’ addresses a few invariants observed, that is, importance of local anchoring to ensure legitimacy and trust, stakeholder involvement in the entire process, use of models and organization of debriefings. Lastly, the ‘Discussion’ opens up a debate on this approach, its originality, effectiveness, partners’ perceptions and its potential for adaptation in the face of a diversity of situations and stakeholders.

Organizing a Companion Modelling Approach

Given its challenge of intervening in real life (i.e. a diversity of protagonists, with assumed or even expected heterogeneity of viewpoints and objectives), companion modelling finds itself faced with a complex ‘stakeholder-orientated’ problem that induces reflexivity. Those responsible for a case study consider, in particular, their own intervention objectives as a challenge that is not necessarily shared and must be capable of validation or amendment. These objectives must, therefore, be explained or debated. We present in this section the main components of a

ComMod process, its human and non-human protagonists[2] (Callon 1986; Latour 1999), its temporal organization and especially, the time set aside for exchanges. These are the elements used to narrate a ComMod process on a specific case study, to confront the principles of the charter and its actual implementation. They especially allow the understanding and possibility of (in)validation by the associated stakeholders of mobilized representations to be addressed at every stage of the initiative.

The Main Protagonists

Any companion modelling involves creating interrelationships between a certain number of individuals in managing one or more natural resources. They have the ability to advise or regulate the relationship between other individuals or with the resource, or to use the resource. Companion modelling aims to generate collective reflection: it introduces into the system new individuals specialized in the companion modelling process, who we call commodians, and gives certain individuals already mentioned a new role within the system—the bearer of the approach. Companion modelling also relies on sharing knowledge as a favoured method of advancing relationships between individuals and between individuals and the resource. We have, therefore, classified the protagonists in our case studies into six categories, distinguished fundamentally by the forms of knowledge mobilized during a ComMod process.

Four categories are internal to the system. The ‘lay’ category relates to people whose knowledge of the system comes from their empirical experience of the world, which is not necessarily formalized or explained. It is borrowed from the world of hybrid forums (Callon 1986), which aims to provide equal consideration to the various types of knowledge. The ‘researcher’ category relates to academic knowledge, organized and validated under encoded formats, frequently based on experimentation, constructed in an external and formalized analysis and intended to be tested in the case study. The ‘technician’ category relates to formalized knowledge, but based fundamentally on the knowledge and typology of a large number of situations and on specialist technical data. These stakeholders are generally not directly concerned with the question being considered, but can at any time contribute their knowledge and expertise to the operating part of the system. The ‘institutional’ category covers more political or economic knowledge of the system. It groups individuals with a specific knowledge of development issues and activities of local stakeholders, who also have system steering objectives. By extension, we shall designate later the knowledge attached to each category.

[2] Considering ‘non-humans’ as protagonists can be surprising. We are following here the sociology of translation that considers world objects as stakeholders in social and political networks used to understand social dynamics.

Two other categories lie outside the system and are linked directly to the implementation of a companion modelling approach. The ‘commodian’ category includes researchers who are familiar with the approach, have committed to respecting its ethics by signing the ComMod Charter and who are basically going to use methodological and organizational knowledge. The ‘student’ category corresponds to commodian apprentices who are going to test their scientific knowledge and construct a representation of the approach by participating in one or more of its stages. When they remain part of the entire process, such as thesis writers, this apprenticeship gives them a chance to acquire a certain familiarity with the approach and to open up a still uncertain aspect of its implementation.

Associating a Virtual World

In addition to these human stakeholder categories, companion modelling approaches also mobilize a whole network of non-human agents. These are artefacts, with the majority intended to represent or evoke issues of renewable natural resource management shared by at least one portion of the protagonists mentioned above. By artefact we mean any (temporarily or permanently) stabilized component that can be used as a reference by a group of stakeholders or otherwise support their interactions. More often than not these are actual objects, such as a map, a mock-up, a document, etc. Some ethnomethod-ological research has shown that these objects, like the prototypes in a design office, play a major role in an interaction network (Conein and Jacopin 1994; Suchman et al. 2002). We shall extend this notion to intangible objects in the remainder of the collaborative work (Bossen 2002). It can act, for example, as a reference in oral yet duly ratified agreements, such as after a ritualization stage in an assets’ initiative (Ollagnon 1989; Weber 1998), to which reference can be made in an interaction. This can be the case especially in oral cultures.

Among these artefacts, models in the widest sense play a special role in a ComMod process, by offering a virtual world in support of reflection. The term ‘companion modelling’ originates with them. Almost all case studies, therefore, use at least one explicit model. Chapter 4 describes these models, the types and their construction in more details. However, because models are at the heart of the approach, ever present in the network of interactions between the various types of stakeholder described above, their initial presentation can prove useful.

These are virtual models designed to represent an issue of renewable natural resources management from the world of the stakeholders, that is, irrigated system model, wetland model, shrub progression dynamics model, etc. These models are in all cases based on the viewpoint of renewable resources management, focused on the interface between the resource dynamics and the use dynamics of these resources. The introduction presented this viewpoint in greater detail. They include, therefore, at least a representation of individual and/or collective interactions of stakeholders with the resource, such as samples, maintenance activities and checks on its dynamics.

As a virtual world they simulate the processes assumed to be representative of the dynamics of the real world. They result from hypotheses chosen by the modeller(s) on the dominant dynamics in the actual system. This is thus a first level of intervention of the model in the ComMod process: the model authors the discussion of the principal dynamics of a system. For complex systems like those involved in renewable natural resource management, models offer an extension to experimental approaches (Legay 1997): they test through simulation combinations of hypotheses for the system, without being subject to ethical or logistical constraints inherent in performing experiments in actual systems.

The dynamics of a ComMod process are, therefore, entirely a matter of moving from exploring these virtual worlds towards questioning the implementation of what they can bring to the real world. We have a dual translation/interpretation process: translating the real world to the virtual world to ensure a minimum degree of representativeness; interpreting what is going on in the virtual world for the real world and to interpret the results of simulations in action modalities in the real world.

This dual translation/interpretation process is an essential driving force in companion modelling dynamics: the evolution of the virtual world produces new simulations and a chance to discuss their significance for the real world; the changes induced in the real world, or at least in the viewpoints stakeholders have of it, revise its representation in the virtual world. The involvement of participants in this translation and interpretation process makes the insertion of models in the network of stakeholders taking part in the approach, a fundamental issue in the success of its implementation.

Key Sequences

The canvas painted at the beginning of the project, as presented in the introduction, suggested a seven-stage description framework for a companion modelling approach.

- Raising the awareness of the main stakeholders to the ComMod approach and its options for application to the local problem.
- Inventory of scientific, expert and lay knowledge available through surveys, diagnostics and analyses of published works as well as knowledge elicitation for the model.
- Design of the model.
- Choice of tool (computer or otherwise) and implementation of the model.
- Checking, validating and calibrating the model with local stakeholders.
- Exploratory simulations with local stakeholders.
- Diffusion to stakeholders not taking part in the approach.

Following several training sessions (Chap. 12), an 'education' stage has quickly been added to these seven stages. Analysing canvases has also been conducted to further precisely the unfolding of a ComMod process and to suggest a 12-stage format, described in the final chapter of this book. Although these stages are not systematically mobilized or progress in a different order, they form a typical sequence, a sort of full model for implementing a companion modelling approach. These phases are more or less interwoven over time and frequently have to be repeated, either to deal with certain uncertainties or to incorporate new knowledge produced during the process, or due to down times linked to social (e.g. the non-availability of partners or researchers at a given moment) or economic (seeking financial support) constraints. Figure 2.3 below presents the time charts, illustrating the linking of these stages in all the case studies analysed in this book.

Collective Key Moments

The sequences described above relate to the process conducted by the commodians of the companion modelling process in its strictest sense. This interacts with a dynamic of collective action specific to the system within which the intervention on a question of natural resource management takes place. This dynamic of collective action exists regardless of the companion modelling process implemented. Its centre of gravity is in the lay world, extending possibly to institutional stakeholders and experts/technicians. The ComMod process is punctuated by collective key moments. The key moments are where these two dynamics meet. They are the structuring components of a ComMod approach. They are where the principle of confrontation of viewpoints and exchange of representations is explicitly implemented. They also potentially allow a shared evolution of objectives.

In practice, these key moments are organized as a workshop or working meeting, uniting stakeholders from at least two different categories, with the facilitation of a commodian. Although theoretically no one category of stakeholders is essential to these key moments, effectively all key moments mentioned in the collected information indicate the presence of at least one commodian. Key moments are where scientific, technical and lay knowledge confront each other.

These key moments have their place in the dynamic of the dual translation process described above. Table 2.1 below summarizes the types of key moment as identified. Note that they can be included in all stages of this dual translation/interpretation process: from analysing the actual system up to defining an action plan for this real world, via collective exploration of the virtual world (i.e. role-playing game session or interactive simulation session), which remains the most frequent case. Lastly, the objectives specific to commod-ians and academics, such as model comparison, also gave rise to a key moment, which shows the interpenetration of interests of the various stakeholders.

Table 2.1 Types of key moment and case studies with examples

Type of key moment	Case studies
Training	Radi
Collective surveys	Tarawa
Presentation of the virtual world	SAGE Drôme
Co-construction virtual world	Nîmes-Métropole, Ouessant, Pays de Caux, Larzac, Vosges du Nord
Collective exploration of the virtual world	Mae Salaep, Méjan, Nan, Nîmes-Métropole, Njoobaari, Ouessant, Pays de Caux, Radi, SugarRice, Tarawa, Ubon Rice Seeds
Scriptlets and scenario building	Kat Aware, Méjan, Nan, Larzac
Model validation	Kat Aware, Méjan, Nîmes-Métropole, Pays de Caux, Larzac, Vosges du Nord
Collective action plan discussion	Méjan
Presentation/discussion of results of the virtual world exploration	Nan, Ouessant, Larzac
Presentation/discussion of formalizing hypotheses on the real world	Njoobaari, Sage Drôme
Comparison of virtual worlds	Ouessant

Collective exploration of the virtual world is the most frequent type of key moment. These are most often role-playing games, but there are also some cases of interactive computer simulation sessions. This type of key moment is described in Chap. 4 with the associated artefacts. The case study with irrigated systems in Senegal (Njoobaari) has, for example, featured role-playing game sessions to lead Senegalese farmers to criticize the model representing them as well as to elaborate consequences for themselves. In this case, the commodian in charge of the case study called upon the farmers to take part in a game session and then to discuss this session in relation to their activities in the real world. The organization of a key moment starts with the identification of the targeted population. It continues with the selection of a suitable place to gather all the participants. It goes further with the facilitation of interactions among participants. It ends up with the facilitation of interpretation in the light of daily life. Pre-tests of the setting for the key moment are crucial. In the case in Senegal, the commodian had a little control over the choice of participants: the local partner, a leading farmer, was in charge of finding 10 volunteers to participate. It was first a test of the setting and its ability to generate discussion on the real irrigated systems. The place was chosen in order to make the implementation of the key moment easier: proximity but also some neutrality have led to the selection of schools in many sessions. Facilitation of interpretation in light of daily life took place as an open non-structured discussion. This discussion in the Senegalese case was rich and continued beyond the key moment. This caused the commodians to think about a more structured organization of this stage: the debriefing is presented below.

Initial Conceptual Model of Companion Modelling

All these items make up a companion modelling model that we have been able to clarify by implementing the project. It is a representation of the project's common culture at start-up. The follow up to this book shows how the reflexivity involved in this comparative research generated changes in the representation of this common cultural background. This conceptual model, which required clarification at the beginning of the project, is the framework for the design of documents used in completing the case studies. Figure 2.1 below summarizes the presentation of components detailed in this section and includes the relationships between these components.

The companion modelling approach inserts itself into this fairly traditional collective action dynamic, and brings in status and additional types of interaction, related to knowledge of the resource. The two approaches exist side by side and meet during key moments, which rely on mobilizing tools and implementing virtual worlds available to the commodian who provides the approach dynamic. Agents who endorse other statuses contribute to the elaboration of these tools and/ or in their exploration. The typology of tools is not developed in Chap. 4. With this point of view, the companion modelling approach is clearly thought of as having to take charge of the interaction between the two dynamics, as the collective action approach that existed before it has, in most cases, its own dynamic. These interactions also theoretically cause the participants in the two dynamics to modify knowledge of their interactions with the dynamic of renewable natural resources, to modify the power relationships, to modify their ability to schedule the collective use of resources and potentially, to transfer new knowledge to stake-holders only involved in one of these approaches. These types of modification theoretically induced by the crossing, or even a temporary merger, of two approaches form the basis for Chaps. 5–12 of this book.

An Iterative Approach

One of three principles underlying the definition of companion modelling is the principle of commitment over time and adaptability. The commodian commits to following the decision-making process in the ways he changes the object, objective or participants. He upgrades his tools and interventions based on changes in the decision-making process during his support time. When we talk about loops and iterations we are not referring to learning theory loops as postulated by Argyris and Schon (1996). They describe several loops that differ according to the learning register (about the object itself, the values, the learning itself).

The principle of committing to the process over time is a pioneering concept for researchers in modelling. The model is most frequently considered as an object of

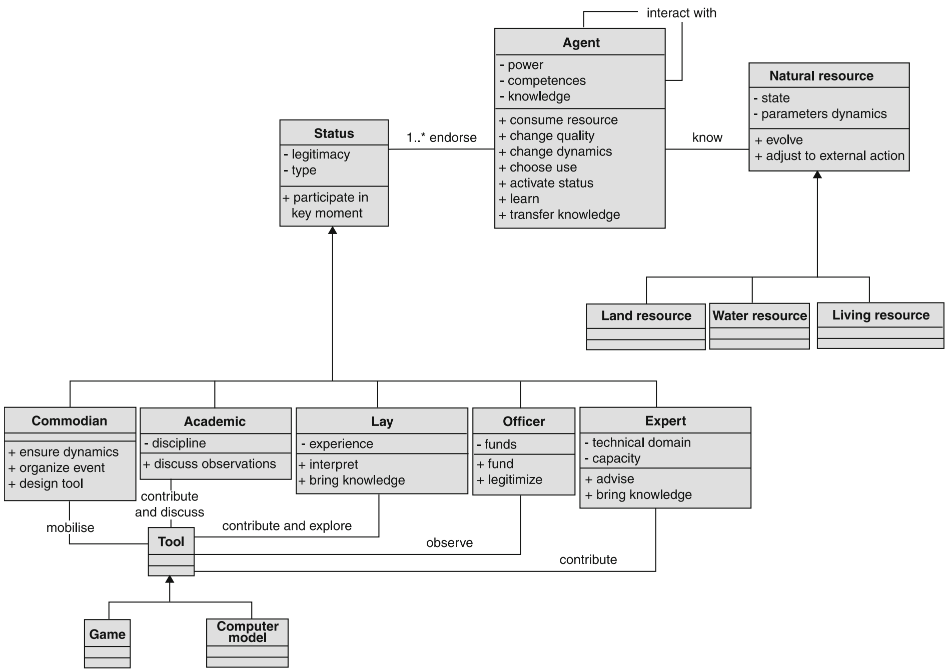


Fig. 2.1 Classes in a generic model of companion modelling

A case study is considered to be a set of agents in relation to each other and with one or more resources. The existence of these relationships structures the whole. The agents are described at least by: status based on their type of knowledge of the system; powers corresponding particularly to the chances they have of controlling or regulating the relationship of other agents with each other or with the resource (or in helping to control the regulations). Every agent uses the resource (i.e. consumption, modifying quality, intervening in the attributes of the dynamic) and has some knowledge of it. Every agent has their own methods of choosing how to interact with the resource and is capable of taking into account their relationships with other agents and reasoning on the system's dynamic. The resource units are described by their state, location and the parameters specifying their dynamic. They change over time based on the usage of agents in relation to them and parameters for their dynamic.

synthesis, of integrating acquired knowledge, regardless of the time the process takes. The few researchers who have committed to the participatory modelling processes (Costanza and Ruth 1998; Gonzalez 2000) have frequently underlined that the modelling time should be the decision-making process time. Thus the modelling by Costanza and Ruth lasted seven years. Although ComMod does not stand out for its intervention time, one of the features of the approach is the potential development of a series of models, more or less interlinked. The social dynamic encompassing companion modelling could prompt all participants to develop their questions and thus construct new models to support -consultation and even negotiations.

Thus the ComMod group claims a modelling process set into the decision-making process, which is not the consultation process in itself, meaning that: (i) it is not considered as the social consultation process itself but a 'snippet' based on the modelling within a social process that may have started before the collective modelling experiment and which will continue afterwards; (ii) it is susceptible to changes or ruptures based on the social process encompassing it; these cannot be scheduled; it can also be mobilized at various points in the social consultation process (e.g. issue diversity recognition phase, dispute solving phase, common issue co-construction phase, phase identifying collective actions to be undertaken, etc.), depending on a variety of devices including mobilizing miscellaneous tools.

Although modellers find this principle innovative, it is well known and a constituent of research intervention approaches towards a social group, such as action research. Lewin, the founder of action research thought that it should spiral through stages, with each loop in the spiral made up of steps for planning, action and assessing the results of the action (Lewin 1946). List (2006) in a review of the theme, noted that the iterative cycle, the basis of the approach, had not been much developed methodologically. We do not have here the elements for detailing how the iterative process we are attempting to characterize differs from the action research spiral. In the methodology advanced here, we work on a gradual refining of one of possible action research 'stances', especially in how to design and implement a 'spiral of steps' to consider the diversity of viewpoints in the world in the best way possible. Note in passing that one of the reasons for the emergence of the ComMod group was the possibility of using models to allow stakeholders to plan collectively, experiment and assess their actions in virtual mode before considering performing these actions in real life. In a way 'action research' means that the research action is shared with the stakeholders. Companion modelling was thus involved in the emergence of participatory research processes starting during the 1990s, more in the medical field (Cornwall and Jewkes 1995) or with the development of action research in agronomy.

In the next section, we define loops, before going on to test this definition through various case study analysis methods. We lastly choose a few cases that we feel reflect the diversity of sequences within a ComMod process.

Notions of Loops and Cycles

The first stage in this work on the iterative nature of the approach was to organize a series of collective discussions on the notion of loops and cycles. We relate here briefly a pictorial story, with each graphic innovation reflecting a new vision of the iterative process (see Fig. 2.2). The first proposal came from Barreteau in 1998. It establishes the relationship between the model and the field and introduces the idea that the process can be repeated (Barreteau 1998). A few years later, d'Aquino and colleagues suggested a synthesis in the form of a new figure, featuring the integration of lay knowledge using models that can be either computer simulations or role-playing games (d'Aquino 2002). Barnaud and colleagues then suggested a representation in the form of spirals that were sequences of loops (Barnaud et al. 2006a). This pictorial evolution underlines the discontinuity that exists when moving from one loop to the next: loops are changed when the problem changes or when the stakeholders change. This proposal was adopted by the collective.

D'Aquino and Étienne (unpublished) then went further to consider the breaking down of a loop as presented by Barnaud et al. (2006a) into subloops. These subloops are phases used to deal with the same question, phases which run in-field operations and modelling operations alternately.

Finally, two types of loops were considered and defined:

- 'macro-loops': the macro-loop changes when at least one design phase and one collective visioning phase (scriptlet) have taken place in succession and further investigation is necessary
- 'micro-loops': the micro-loop changes when moving from one phase in the approach to the next, that is, an iteration similar to that of the real world and the model. The possible phases are as presented above.

We decided to test this conceptual model by confronting it with data acquired during the description of case studies.

Diversity of Implementations

The aim here was to consult the empirical data compiled to see whether the macro-loops can be defined unambiguously. Three methods were used for this purpose. The first uses an algorithm for automatic detection based on different phases. This method assumes that moving from one macro-loop to another takes place after a validation phase, a scriptlet phase or a reproduction phase. Figure 2.3 illustrates the result of this investigation. Each vertical bar marks the end of a macro-loop.

The second method involves cross reading the descriptive canvases of the case studies. Apart from the time chart used to produce the previous figure, these canvases contain a literary description of the operation. Two independent readers indicated the number of macro-loops they recognized in a sample of 12 case

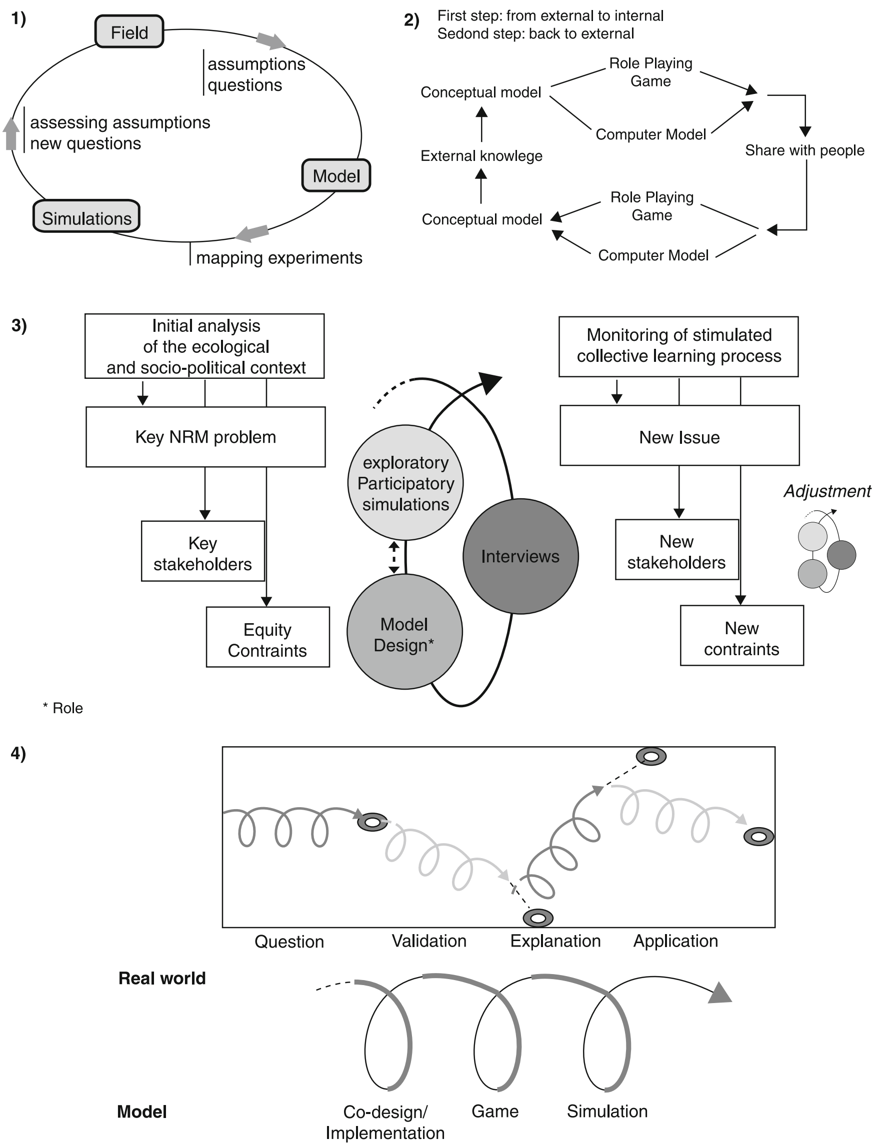
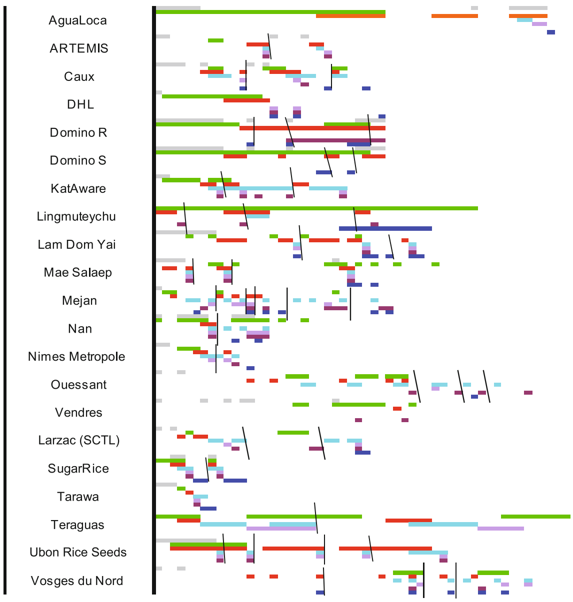


Fig. 2.2 Evolution of figures showing a companion modelling process.From left to right and top to bottom: (1) Barreteau (1998), (2) d'Aquino et al. (2002), (3) Barnaud et al. (2006a), (4) d'Aquino and Étienne (unpublished)

studies. This assessment was compared with the perception of each designer of a ComMod process. Among the 12 case studies, only three show total consistency. These differences were due generally to a different appraisal of the cause for changing a macro-loop: one reader considered that moving from one macro-loop

Fig. 2.3 Description of the ordering of various phases for several case studies, with indication of macro-loop ends according to the automatic detection algorithm



to another took place if the perception of the system changed (mirrored in a modification to the model), whereas the other reader considered that the move occurred if the question changed explicitly (e.g. changed objective, change in question dealt with). However, the evaluation makes a clear point that change in issue is barely explicit as it is never mentioned during interviews with participants.

The concept of cycle and loop can be used to construct a model of a ComMod process; this serves as a tool in organizing its presentation by synchronizing the various field phases with the inflections of the decision-making process. This organization of a ComMod process postulates that the loop changes when there is an explicit change in the question dealt with in the opinion of the process designer. This construction is very subjective and cannot, therefore, be presented as the viewpoint of its author(s). The advantage of this framework and rules we have thus established is that the author must be in a position to clarify their model. We shall describe below a case study that is used to appreciate the heuristic range of the model in a companion modelling process.

Evolution of Questions During a Companion Modelling Process

The case we present here covers work in a catchment area in the north of Thailand, the Mae Salaep basin. Figure 2.4 shows the whole sequence for this case study. There are three distinct loops.

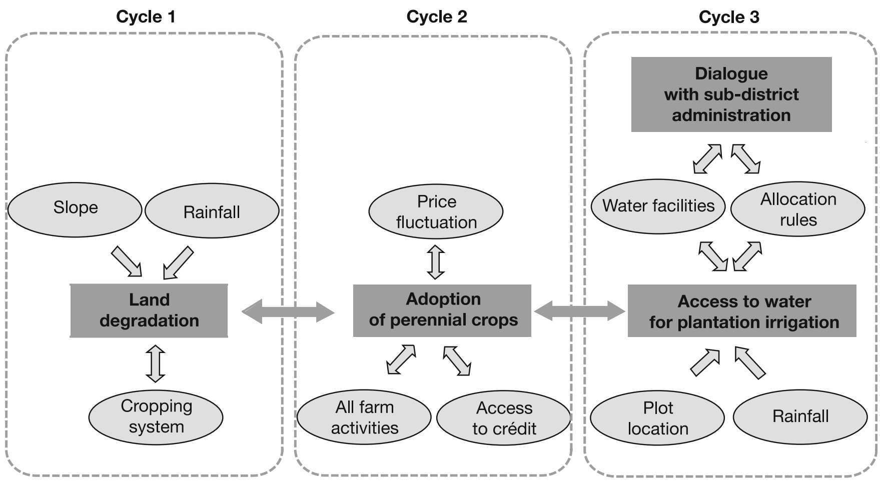


Fig. 2.4 Cycles implemented in the Mae Salaep case study (from Barnaud et al. 2008a)

During the first cycle, the focal point of discussions changed agro-ecological topics concerning soil erosion towards the envisaged solution, that is, the adoption of perennial crops (Trébuil et al. 2002a). The participants then asked for the model to be modified to address the social and economic conditions for this adoption.

This was the purpose of a second cycle covering the interactions between formal and informal credit, off-farm work and investment in plantations (Barnaud et al. 2006a). The participants formulated scenarios for changing the credit rules to offset the problem of unequal access to perennial crops. One proposal was to increase the duration of loans allocated by the government under a decentralized rural credit policy. However, such decisions are taken at government level. The villagers then explained that several villages had already alerted the government to this proposal (independently of the ComMod process) and, if the government agreed to it, new role-playing game sessions would be useful so that they could adapt collectively to these changes. The government was overturned in the meantime and so this proposal could not be pursued.

The villagers expressed two hopes for the future during assessment surveys in this second cycle: bringing the question of irrigation water into play and involving the representatives of the Tambon Administrative Organization (TAO)[3] ‘so that they knew what was happening in the village’. The third cycle, therefore, addressed the interinstitution consultation between village and subdistrict. The villagers linked the water question to TAO participation in the ComMod process, as the TAO could finance hydro-agricultural development projects. The third ComMod cycle thus aimed to stimulate a collective learning process on water management in the under-catchment area between villagers and the TAO.

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3 Administration at the subdistrict level, which most often includes 10–12 villages.

Invariants Noted During Implementation

Apart from the overall organization and the use of the concept of cycle (inherent in the approach even though quite heterogeneous across case studies), other invariants testify to a common ComMod culture. An invariant is an element found frequently in documents describing case studies. We discuss these invariants successively in the remainder of this section: sources of legitimacy for the approach; stakeholder involvement; regular recourse to a complex system model combined with simulations or long-term exercises; amount of time allocated to debriefing, especially during role-playing games.

Local Anchoring of the Commodian as a Source of Legitimacy

Analysis of canvases has shown that over 60 % of the case studies investigated were initiated and carried by commodians. The question arises in these situations as to the legitimacy of implementing a ComMod process: what makes participants in collective action dynamics accept companion modelling dynamics, which comes in interaction, up to taking part in them? The collective key moments, such as interpreting observations from the virtual world to the real system, are times when stakeholders could refuse the interaction between the two dynamics. For that, we have noted the importance of local anchoring of the commodian, especially in case studies that have worked well.

Local anchoring often seemed afterwards as one condition for the trust placed by the local stakeholders in the implementation of the approach. This local anchoring either comes from the social capital of the commodian due to extended work experience shared with some of the participants in the accompanied collective action process, or from recourse to an intermediary with this social capital and ready to mobilize it to set up the ComMod process, or from indirect social capital. This local anchoring installs a relation of trust in principle. This is particularly useful when implementing the companion modelling approach after an experience of failure by participants in traditional consultation methods that also had a collective decision-making basis. These consultation failures can nevertheless prompt the stakeholders involved to find new ways of doing things and, therefore, to be curious about the method proposed by a known researcher recognized for his skills, all the more so when he has been seen at work locally. Companion modelling, therefore, more easily becomes a participatory approach, perceived as a new method that can be tried out by the stakeholders when the legitimacy of the researcher has already been established. This trust also theoretically endangers any exploratory situation or role-playing game (Caillois 1967): this endangerment is acceptable when associated with trust, like a safety-net for a tight-rope walker. The acquisition of this trust, which is essential, incites individuals to reveal their viewpoints and questions on the system under the cover of simulation.

In many situations, the ComMod approaches have been implemented successfully by researchers during their stay in a country as a foreign national. The personal insertion of the researcher into local academic or professional networks ensures this local anchoring by relying on the social capital of members of this network. Some even organize and formalize a specific strategy to mobilize this local social capital successfully: identifying stakeholders with the power to block, persuading them to accept the opening induced by the approach, and helping existing institutions to maintain legitimacy over and beyond any changes that may be concluded (d'Aquino 2009). In several cases, as in Thailand or Bhutan, the commodians were local and had acquired this strong local anchoring through past experience. The experienced commodians taking part in the project supported them methodologically. Training researchers within academic networks of international commodians has produced new commodians who have adapted the implementation of the approach in contexts familiar to them. This is illustrated by two experiments in Bhutan. In 2002, a first contact at the request of a hydrologist responsible for solving irrigation problems in the Lingmuteychu catchment area, especially when replanting the rice, prompted the interest of the CIRAD in this question. However, it was the involvement of a senior researcher from the Renewable Natural Resources Research Centre (RNR-RC) in Bajo, who attended a ComMod course when studying for his Master's degree in Thailand, which actually launched the first study in Bhutan. Having identified ComMod as a promising approach, he decided to devote his Master's placement to developing role-playing games covering the sharing of water between two villages in this catchment area. The success of this first role-playing game led to other sessions being organized, which a few years later would culminate in the creation of a management committee for the catchment area. Armed with this first ComMod experience, this researcher, as requested by the Ministry of Agriculture, then decided to apply the same approach in another sector, Radi, which he knew well, having worked in the region in the late 1990s. This Radi site was an area of conflict between two communities of herdsmen belonging to different ethnic groups who had been disputing access to high-altitude grazing areas for more than 30 years. The previous experience at Lingmuteychu, considered to have been successful, made a major contribution to legitimizing the use of the ComMod approach in the eyes of the Ministry of Agriculture.

Involvement of Stakeholders

As described at the beginning of this chapter, companion modelling is based on a dynamic of exchange between various categories of stakeholders. It is regularly going to associate or confront 'lay' knowledge (of local stakeholders), 'technical' knowledge (of the development engineers) and academic knowledge (of researchers). This is active involvement, providing the stakeholders involved with a real chance to intervene either by explaining their vision of the world or by constructing intermediate objectives or formulating projects for the future. These exchanges or confrontations of knowledge are especially intense during the key moments that regulate the progress of the approach.

Numerous criteria can be brought into play in the choice of stakeholders associated with these key moments. Based on the situations and sponsor preferences, three types of situation are currently encountered.

A global vision of the system is preferred: the participants will then be 'connoisseurs' of the region where the local experience legitimizes their invitation to speak on behalf of stakeholders with whom they meet every day (technicians) or who they have studied in depth (scientists). Attention must be paid to not forgeting a theoretically decisive activity for the question raised and overrepresenting one activity versus another.

Priority is given to the involvement of local stakeholders, while maintaining a global vision of the system: the participants will then be representatives of local stakeholders chosen for their legitimacy (e.g. presidents of unions or producer groups, association directors, elected representatives) and for the relevance of their activity in terms of the question raised.

The involvement of local stakeholders is always preferred while seeking to appreciate the diversity of the system: the participants will thus be local stakeholders chosen for the diversity of their practices, according to the question raised.

These three ways of forming the involved collective can alternate during the various phases in the process of a single companion approach. For example, priority is given initially to the involvement of local stakeholders to cover the diversity of practice and social status. On the other hand, the collective will subsequently be expanded to include researchers and people in charge of the various administrative levels. Or in the case of fisheries management in Thailand (Don Hoi Lord), all the agents of the industry were interviewed at the beginning of the process. First game sessions gathered fishermen of one village, who requested that the following sessions be opened up to fishermen from other villages, other stakeholders in the industry, local authorities and finally, to policy-makers. It should be stressed that this evolution was controlled by the participants themselves. Similarly, according to the translation/interpretation stage, which includes the key moment, certain stakeholder categories will be preferred as they are found to be more relevant than others. Thus, when analysing the actual system, local stakeholders and researchers will be the dominant elements in the group, whereas priority will be given to local stakeholder involvement during the collective exploration of the virtual world.

The place of researchers, and thus of scientific knowledge, in the process remains variable and is still subject to discussion. Normally, scientists are selected who possess knowledge on the main processes in play. Some will be present, therefore, as soon as the approach is initiated as the question raised is linked to one or more clearly identified processes of which they are well aware. Others will be included during the work on dynamics or interactions, if the participants feel a need for expertise on a particularly important theme to gain a better understanding of how the system functions.

Lastly, the involvement of institutional stakeholders (e.g. elected representatives, administrations), frequently sought when defining an action plan for the real world, in most cases is inadequate. This is either because they have not been involved in the first phases of the approach or because their time schedules and acceptability of the approach require adapting the group to these constraints. Chapter 11 returns to this involvement of people whose decisions concern various levels of organization.

Systematic Mobilization of a Complex System Model and Dynamic or Long-Term Simulations

Another strong common point to ComMod processes is the use of complex system models for simulation purposes. Whether constructed along the approach, as is frequently the case, or imported, they take their place in the social and technical network mobilized by any commodian. They can be intermediate objects (Vinck 1999) or boundary objects (Star and Griesemer 1989). As intermediate objects they convey the viewpoints of a group or stakeholder at a given moment in the shared system. Presented or used by others (even by the same people later on), the model communicates these viewpoints. Although this model language occasionally looks esoteric, Chap. 4 will show that it explains the dynamics clearly and assembles heterogeneous knowledge. We will also show that implementation techniques exist to adapt the communication modalities and that the model construction process can limit the implicit assumptions in the collective decision process. As boundary objects, models support interactions. They concentrate the viewpoints of a group of stakeholders (be they lay, expert, commodian, etc.) on the same object and focus the interactions on a restricted number of domains. In the daily relationships of these stakeholders when they exist, the complexity and size of the system that this object is assumed to represent, as well as the time constraints, often make it difficult to confront viewpoints.

Recourse to these intermediate objects can also go beyond the constraints of field interventions with practical (need for simulation over long periods) or ethical (problems in taking charge of the consequences of a full-scale experiment) difficulties. Simulation can thus complete the arsenal of experimental approaches (Bousquet et al. 1999). On this point, companion modelling thus revives a long tradition of using models as an advisory tool for the state (Saunders-Newton and Scott 2001), by reinstating it in the perspective of a distributed decision-making process collecting together all the stake-holders involved. The second objective explained in the charter is a form of decision-making support. However, it is modified from classical decision-support approaches, because it embodies a collective decision-making process considered as a flow of interactions between individual and/or collective, heterogeneous stakeholders in terms of their political weight and representations of the world (Weber 1995b).

The models used in the case studies bolstering this work are found in three types of usage, which are not mutually exclusive.

- First, sharing viewpoints in the same medium: in SelfCormas, the medium, initially basic, forces each individual to state his representations and to complete his statement with what seems essential to him to characterize the issues at stake (d'Aquino et al. 2003).
- Second, social mirror: in SHADOC/Njoobaari Ilnoowo, the model sends back to the peasants of the Senegal valley an image of the collective they are forming by interacting within an irrigated system (Daré 2005). The role of this social mirror forces the stakeholders into an awareness of their interactions. The social mirror is, therefore, a catalyst for collective learning (Hatchuel 2000; Pahl-Wostl and Hare 2004).
- Lastly, the model encourages an exploratory stance towards understanding the world (Auray 2006; Richard-Ferroudji 2008): the SylvoPast model is restricted to a cohabitation of forest officers, cattle farmers and hunters, and reacts to a catastrophic event threatening their activities (Étienne 2003). Experimentation in a virtual world allows the testing of possible modifications with a controlled endangerment due to the distancing it introduces. Taboo issues can thus be explored, and the consequences of the experiment can always be discredited later on because of the virtual nature of the support. One example is the introduction of water stealing in Njoobaari Ilnoowo (Daré and Barreteau 2003).

Chapter 4 will discuss these key components in companion modelling at more length, by specifying the stages and the diversity of implementation and the technical modalities for their use.

Importance of a Debriefing Time

When acting out role-playing games, that is, interactive simulation, the debriefing is an integral part of a key moment. Debriefing provides the way back from the virtual world to the real world: it supports the interpretation of the virtual to the real, and must be structured as such. These essential stages allow us to understand the link between behaviours noted in the game and the specific situation of participants when it takes place.

In all the case studies featuring a role-playing game, an immediate collective debriefing was arranged on site, at the end of the game session. Later individual, or more rarely collective, debriefings took place to complete these. These later debriefings occurred days or weeks following the original session and were based, in the vast majority of case studies, exclusively on the game sessions. In a few cases, the analysis also took into account results from surveys before or after the game and/or results of other role-playing game sessions (see Fig. 2.5).

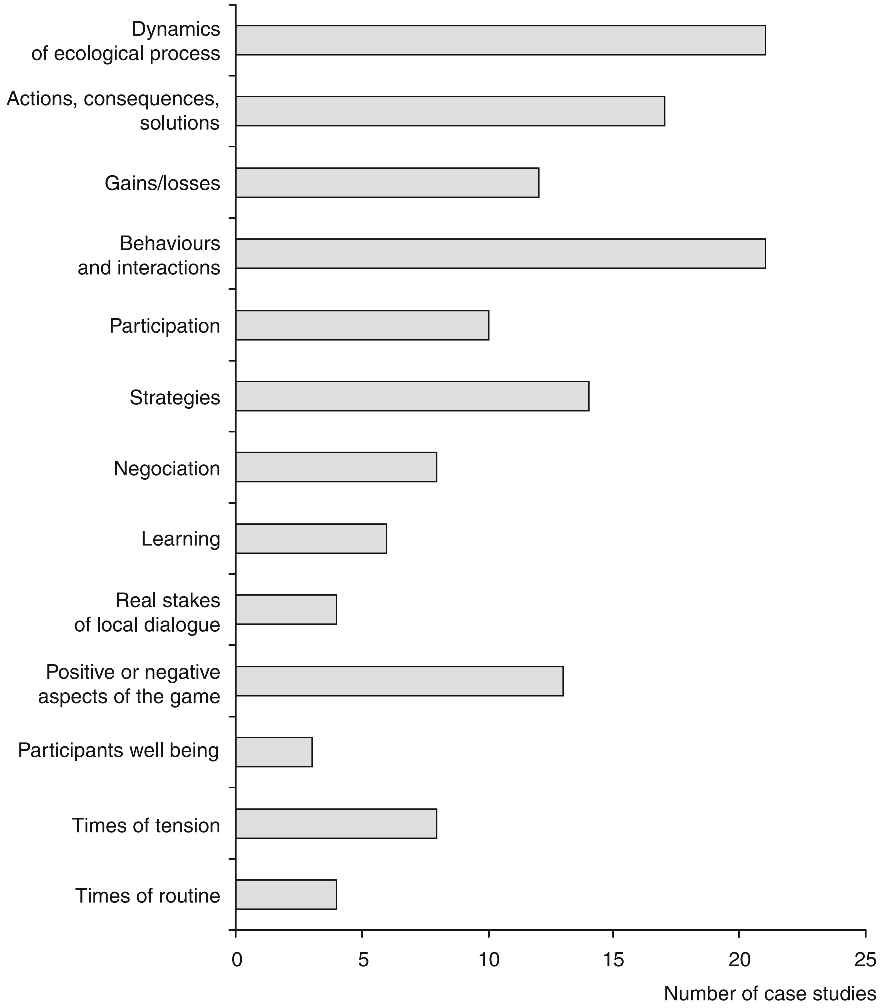

Fig. 2.5 Elements analysed during debriefings

This analysis relies mainly on the participation of players and coordinators. However, any observers present also systematically take part in the analysis of the role-playing game. In very rare cases, the players are not required to contribute and the analysis is provided by the coordinators or observers only. Lastly, also very rarely, non-players are invited to put forward an opinion.

Figure 2.5 features the diversity of items that could be included in debriefing sessions to generate discussion between participants in order to return them to their daily life and facilitate the emergence of a sound interpretation.

Discussions most often concerned items relating to the dynamics of the ecological processes represented and linked most often to changes in land use. The ecological processes analysed varied considerably between case studies: resinous tree planting of the environment or regrowth on fallowland, access to water or forest resources, degradation of grazing land, risk of runoff and erosion, etc. Given that this evolution results from participant decisions during key moments, a major part of the debriefing period is also given over to analysing the decisions made by stakeholders during the simulation, and the consequences in terms of managing the natural resources in question and the solutions provided individually or collectively to offset any harmful effects. Computerization can provide in most cases a quantitative analysis of elements described previously by dynamic monitoring of indicators.

Mathevet and colleagues carefully worked out the organization and setting of the debriefing in the Camargue case study (Mathevet et al. 2007). Working on the decline of reedbeds, they designed the role-playing game ButorStar, with a special focus on social learning and understanding of socio-ecological processes. In game sessions with stakeholders of the Vendres lakes (Hérault county, France) and Scamandre (Gard county, France), they organized a debriefing to discuss and collectively analyse the outcomes of the game, in order to explain the reasons for specific collective or individual decisions during the game session, and to understand what occurred during the game session. Mathevet and colleagues facilitated the debriefing in three stages: (i) individual identification by each player of the rationale, values and behavioural patterns of other players; (ii) collective assessment of results, emotions and understanding of the processes at stake (i.e. perceptions of the social behaviour of various players, suitability and coherence of decisions, group behaviour and dynamics); (iii) discussion of any misunderstanding of the social, economic and ecological processes; assessment of the negotiation of the agreed process and its evolution.

In this case study, the debriefing also included a comparison of the results of the game (e.g. indicators, charts and maps) with those of previous game sessions. This provided an interpretation of the outcomes of another group of players, less directly concerned but with the experience of one session. This comparison pushed participants to discuss the outcomes according to various fields such as integrated management, environmental problem solving, communication, information sharing, ecological processes, group dynamics, public policies and their implementation or negotiation. Finally the debriefing provided the commodian with a basis on which to assess the results from the collective exploration of the role-playing game (Mathevet et al. 2008).

Discussions during debriefings also cover the behaviour between players, how they interact together and changes in their relationships during the process, to understand better the mechanisms of individual or collective decision-making processes. This rather more qualitative analysis relies most frequently on observations during the role-playing game by observers and coordinators. It can be supplemented later by studying video and audio media when *ad hoc* recording devices have been used (e.g. camera, recorder or camcorder). Depending on the case study, the analysis pays particular attention to stakeholder participation levels and clarification of the individual or collective strategies followed. The coordinators and observers also spend time identifying and -understanding the various negotiation phases observed. With whom and why do the stakeholders -negotiate? How do any existing power relationships and the presence of formal and informal leaders guide the negotiations? Does any particular subgroup emerge, for example, conveying the involvement of certain stakeholders in debates, or indeed their exclusion from them? In some cases, the coordinators and observers also try and decide whether learning took place during role-playing game sessions in particular. They rely most frequently on questionnaires that measure this learning, as the same questions are asked just before and just after the role-playing game session.

Debriefing discussions finally consider the feelings of participants as the game session unfolds. The coordinators are keen to know whether the players felt at ease, or if there were moments of boredom or tension. Many questions are raised over identifying positive or negative points of the game, with the specific goal of improving the game and the representation of ecological processes if necessary. The debriefing can then become a way of evaluating the companion modelling approach implemented.

Discussion

Companion modelling case studies feature widely varying implementations, up to particularly identifying components, such as the iterative nature. However, a number of elements are seen as strong components of the case studies assessed in this project, that is, the use of virtual worlds in the models of complex systems, the legitimacy of the approach and its participants, anchoring to local settings and a high level of interaction between researchers and stakeholders.

Although discussing the approach is one objective of this book, at the end of this chapter we return to these key points in companion modelling. We discussed initially the originality in the huge number of participatory research approaches, restricting our investigation to the field of renewable natural resource management and more specifically, those projects undertaking computer modelling. Here we discuss originality in terms of method, not of stance, which will be addressed in the next chapter. We shall then take advantage of surveys carried out afterwards with stakeholders to see the perception held by stakeholders of these key points and what are the consequences in terms of a framework for the approach and sustainability of the dynamic introduced. Another point noted in numerous assessment reports that should be addressed before promoting this type of approach is the cost/effectiveness ratio. Lastly, we end by discussing the possibility of adapting the implementation of companion modelling.

What are the Original Features of the Method?

Companion modelling is a constructivist approach, in that it suggests devices and settings for its implementation. In terms of use of models, these approaches aim for a consensus in constructing representation tools. This provides a means of assisting participants to build up a representation for themselves (Dias and Tsoukias 2003; Tsoukias 2007), which serves to confront and sometimes structure the various viewpoints. The choice of constructivism, however, is based far more on a choice of stance than of method: some methods fall more in line with a constructivist stance than others, but even interactive methods are not necessarily constructivist (Dias and Tsoukias 2003; Tsoukias 2007). This justifies the distinction we make in the book between this discussion on originality in implementing the approach (this chapter) and the discussion on the originality of stance (Chap. 3). It also makes this comparative exercise difficult, as companion modelling is first and foremost defined by a stance and resorting to all the elements described above is not enough to qualify a companion modelling project.

The wide diversity in experiences of ComMod processes relies thus on a set of invariants. These include: the origin of the legitimacy of the approach via the involvement of stakeholders; the use of artefacts serving to represent issues under discussion; the system-atic use of debriefing periods for the collective interpretation of what is happening in the virtual world formed by the artefact.

The first invariant deals with instilling an initial trust between the participants and at least one of the commodians. Although trust is an issue normally considered to be a product of a participatory approach, few other comparable approaches pay much attention to initial trust. Thus a comparison of four participatory modelling experiments only highlighted the question of trust in the results of these approaches by the participants (Hare et al. 2003). The rare works devoted to initial trust within participatory approaches in general conclude that there is a need for participation over time (Höppner et al. 2007), towards merging the decision-making support processes (in the widest sense) with the actual collective decision-making processes. Companion modelling considers that the modelling process interacts strongly with the decision-making process it is supporting: this powerful interaction implies that both processes share timeframes, but that it is always possible to identify within the decision-making process one time ‘before’, one time ‘after’ and one time ‘beside’ the modelling process. The good level of trust installed at the start means that the companion modelling approach can lead participants in the decision-making process towards an exploratory approach (Auray 2006).

The second invariant is stakeholder involvement. This is not original in itself. This view of the approach makes it one method of participatory modelling among several others. In fact we have frequently borrowed the techniques used (e.g. workshop, role-playing game, etc.) from classical participatory methods. Organizing this involvement around collective key moments is also a feature of many collaborative decision-making support experiments, such as the group model building exercises (Vennix 1996; Rouwette et al. 2002). However, they focus basically on business issues where it is easy to identify the population concerned: there is a customer, a company or an organization within an easily identified network of formal relationships. Moving to issues of natural resource management raises problems of fluctuating population or changing natural dynamics, and prompts us to revise the question of participating populations (Barreteau 2007): customers are 'affected people' or stakeholders (Landry et al. 1983). The term 'stakeholder' itself is poorly defined (Claeys-Mekdade 2001). In addition, being affected does not produce customers in the same way: when there is a transaction it is frequently only moral, and the heterogeneity of this whole, combined with its lack of representative organization, does not produce a representative, legitimate spokesperson. Companion modelling take this situation in charge with an adaptive approach used to enable the evolution of this participating population and how it is involved, based on joint evolutions in the supporting and supported processes.

The mobilization of intermediate objects, especially models, is not original. Nor does it particularly relate to the involvement of stakeholders. Decision-making support approaches produce, sometimes co-produce, a number of such artefacts, despite still being fairly poorly perceived in the corresponding scientific community (Kikker et al. 2005). Multi-criteria approaches can, however, be found in the literature, which consider that the result of aggregating preferences aims to provide a starting point for the debate (Hämäläinen et al. 2001). These artefacts often form representations of issues under discussion. The translation process introduced into companion modelling from the world of stakeholder issues to a virtual world supporting reflection is thus encountered in many other methodological approaches. Most of these tools are used to take charge of heterogeneous knowledge. More significantly original in companion modelling is the use of non-computer tools, such as simulation models (this term will be explained in Chap. 4). Companion modelling is even more original, however, in not targeting the convergence of the modelling process. It thus differentiates from approaches, such as the evolutionary system design (Shakun 1996), which aim for 'the' suitable representation.

Lastly, the debriefing period (we have been greatly inspired by work in communities exploring the use of simulation games: Lederman 1992; Ryan 2000; Peters and Vissers 2004) provides interpretative feedback on the collective action process. Although this specific time period is well documented in the use of role-playing games, specifically for questioning the possibilities of exporting what happened in the simulation to the real world, few experiments outside the companion modelling examples implement this interpretation period simultaneously with the translation period specific to the design of the virtual world. This is the heart of the iterative nature of the companion modelling approach: alternating translation/interpretation is specifically included in the implementation.

Stakeholder Perceptions of the Approach

The iterative nature of the approach, substantial to the group is effectively barely perceived by the stakeholders in the field and partners in research or involved in the collective action processes in which the commodians intervene. Thus the words 'loops' or 'iteration' never appeared in the responses of participants to our questionnaires. The word 'cycle' appeared in a few questionnaires but never when referring to the implemented approach. It covered cycles in the world of collective action, that is, political, economic or cultural cycles. Cycle was also used when referring to the tools used: role-playing games where 'rounds' are sometimes called cycles, in a similar fashion to computer simulation time steps. Confusion can also reign between the notions of cycle and workshop in a case study.

The external assessments themselves rarely used these key words. They occurred when it was a question of a quality approach to monitoring and complying with the companion modelling process, therefore, for issues only found within the commodian world.

The notion of cycle/loop/iteration does not relate, therefore, to a perception framework for stakeholders taking part in *ex post* interviews. These interviews lead more to an integrating viewpoint on the effects of the approach rather than on its implementation. More than anything, the stakeholders questioned kept returning to changes in their viewpoint resulting from the entire process, regardless of the number of cycles taking place. They found it difficult to remember cycles clearly, even in case studies like Mae Salaep, which had clearly identified cycles. Traditionally the last cycle wins in the analysis made by the stakeholders questioned.

The stakeholders thus maintain their analysis categories and do not take on the commodians' categories for implementing the approach. Their perception comes across as being more from the collective action process in which they are involved, where interactions become grafted on to the companion modelling process, and its effects on their own positions. This does not involve two sealed dynamics side by side, which are involved independently. Instead, it involves for a limited period a single dynamic created from their interaction, where researchers and stakeholders have two different viewpoints.

Any framework for the approach created implicitly by the methodological choices is scarcely felt by the participants, at least in terms of its iterative nature. Note that this framework, however lightweight, is totally exogenous to the field. The methodological choices, like the iterations between the real world and the virtual world, are not defined jointly with the participants. In current practice, there is normally no prior discussion to initiating the debate on creating companion modelling and deciding how it will be run. This framework is tempered by increasing the interaction formats and adapting them to the local context, thereby limiting the exclusion phenomena due to the formats not matching the way some stakeholders grasp the world, with the methodological choices remaining in the remit of the commodians.

This framework can, however, be counterbalanced in certain cases by key moments combining lay contributors and commodians, the co-construction of intermediate objects and learning phases on the use of these intermediate objects. This is the second key methodological point: the strong interactive nature of the companion modelling between researchers and stakeholders. Participant questionnaires and assessment reports show good perception of this feature of the approach by qualifying it more precisely. A secondary effect of the iterative nature on legitimacy is thus revealed, as the strength of inter-action between researchers and stakeholders is in part attributed by the participants and assessors to the regular appearances by researchers in the local arena. These appearances give the stakeholders the chance to monitor the research process.

As addressed in the participant questionnaires, the interactive nature firstly gives more weight to this relationship, by taking into account the diversity of researcher and commodian numbers on one side and lay, expert and institutional contributors on the other. A few researchers have preferential links with a few stakeholders in several case studies. In their responses, the stakeholders recognize network heads, some even identify themselves as such—'the researchers are always directed to me'. The social network analysis of logbooks confirms these favoured go-betweens, both researchers/commodians and lay/expert/institutional contributors.

These privileged relationships raise questions over the influence of companion modelling on power relationships (see Chap. 5). They also raise the question of case studies where the commodian is only present for a limited period. This is because of the necessary sustainability of the relationship, which is essential in consolidating the legitimization of intermediary stakeholders in their 'risk taking' in relation to the local context, due to their central role in changes induced by the approach, as shown in the external assessment of the Nan case study.

Lastly, the interactive nature of the approach is also recognized for its effects induced in terms of learning, that is, transfer of knowledge on the use of resources or to develop political arguments, mediation and contribution of know-how in the collective decision-making process.

The perception of the interactive nature of the approach is therefore shared: the specific role of the researcher in the network of interactions even manages to be erased in certain case studies, whereas this relationship is institutionalized in others. Nevertheless, most frequently the perception of the relationship gives researchers a supervisory role, confirming the residual asymmetry of the approach in practice.

The Costs of Implementation with Regard to Profits

A great deal of work in assessing participatory approaches highlights the importance of fostering participant development, maintaining a certain equity, trusting that knowledge will be shared and ensuring transparency in the learning method

(Reed 2008). The participatory nature of the companion modelling approach is coupled with a process of co-construction and shared use of a model based on an intense and complex social process. Based on the principle of technical democracy, the co-construction method channels the various types of knowledge involved towards shared interests: solving a problem jointly or thinking about a common future (Levrel et al. 2009). This process can generate problems of organization (when participant availability is limited), fatigue (when the approach does not produce concrete elements quickly) or integration of the process (when new participants join in during the ongoing process).

As the participants must gradually share partial qualitative knowledge on the workings of a socio-ecological system with precise quantitative knowledge on a specific domain of the same system, the process can be heavy and costly in time and information. It generates high transaction costs that only can be compensated by the pleasure of the collective construction and the widening of knowledge of relationships with others and the processes that drive the system dynamics. This constraint forces participants to volunteer immediately for an exercise of variable length, but which always requires intense cognitive investment and an acceptance that doubts potentially will be cast on their knowledge by other bodies of knowledge or that it will not be considered sufficiently precise. It is partially raised by the variety of tools used (e.g. conceptual model, role-playing game, computer simulation) and by the partial effect of surprise they generate when involving local stakeholders more accustomed to traditional meetings for exchanging or reproducing views.

The design, implementation and use of a model are central to the approach but require a mediator, a crosser of boundaries who will gradually lead the stakeholders from a personal expression of their knowledge and practices towards a logical and structured explanation that can easily be converted into computer-speak. Where the transparency of the conversion process is respected, and the levels of uncertainty and lack of knowledge are clearly identified and accepted, the model is validated socially. This process poses the problem of the non-generic nature of the models produced or at least a validity linked to a particular context.

Lastly, many participants underline the difficulty in coordinating this type of approach, as the way in which debates are led and familiarity with tools used are critical to the degree of success of the exercise (Chess and Purcell 1999). Companion modelling requires the facilitator to have coordination abilities, a minimum knowledge of the socio-ecological processes in play, a certain ease with computer tools and an undoubted ability for dialogue and exchanging information. This makes the standardization of the approach and its broader diffusion even longer and more difficult.

A Flexible Approach, A Heterogeneous Implementation

Choosing companion modelling does not, therefore, appear to restrict too much the ways of getting involved in a decision process. The assessment reports show tremendous dependence on the coordinator of the approach. Just like every participatory approach, the diversity specific to companion modelling experiences demonstrates the need to characterize and explain the process: the label 'ComMod' is not enough to let the participants in the approach know what they are in for. Without this explanation, the participants may expect something different from what will actually happen; thwarting this expectation risks discrediting all future implementations of the approach. This does not involve characterizing explicitly the forthcoming process, including the possibilities for adaptation. It can relate more simply to specifying the role taken by surveys in the process, the nature of the interaction devices between participants that may be introduced, and the place given to the model in the process.

Indeed, this flexibility is also a constituent of the companion modelling stance. It offers a contingency in the conditions of each case study, which is not restricted to taking into account the know-how and favourite subjects of each bearer of a case study. Companion modelling is subject therefore to the condition of triple contingencies in order to understand changes proposed by Miettinen and Virkkunen (2005): contingencies in time, stakeholders present and available artefacts (Miettinen and Virkkunen 2005). By adapting to the questions that evolve at each iteration, by involving the available stakeholders and by mobilizing the existing artefacts or those co-constructed during the process, the commodian takes on the role of a DIY enthusiast or craftsman, fashioning the dynamic of collective decision-making by relying on his context and the stakeholders setting it up (Innes and Booher 1999). This is the basis for the entire companion modelling issue: remaining flexible and iterative whilst maintaining specific principles and a common stance. This is the direction taken by the collective work and reflections in the ComMod group, which is reported in the following chapters.

http://www.springer.com/978-94-017-8556-3

Companion Modelling
A Participatory Approach to Support Sustainable Development
Etienne, M. (Ed.)
2014, XII, 403 p. 72 illus., 35 illus. in color., Hardcover
ISBN: 978-94-017-8556-3