Chapter 11

Transferring the ComMod approach

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As the ComMod group is composed exclusively of research scientists, the facilitation of a ComMod process is for them an ongoing experiment that has lead to a diversity of practices. This penchant for experimentation has enabled them to define more precisely the stance and functions of facilitation during various stages in the implementation of the process (Chapter 2), and to identify and test methods and 'ways of doing'. These are meant to guarantee that stakeholders are able to share knowledge about the management of renewable natural resources in a given area, stimulate the co-design of a development project in this area, and/or facilitate communication between parties often in conflict. In numerous cases, project holders or certain participants expressed the desire to apply a similar approach to another issue or field, or to generalize the use of a tool on a population that was broader than initially covered by the process in which they had participated. In other cases, a project with expatriate research scientists came to an end; to guarantee the continuation of the process, a local corps of young teacher-researchers needed to be prepared to take over. Lastly, there were times when a development project's principal objective was to train such a corps of teacher-researchers, with the possibility of doctoral research over several years.

Most often, people interested in knowing more about companion modelling discovered it through an example of its application. Although they were not part of the application, they nevertheless could find elements that were sufficiently interesting to provoke a desire to discover, or better understand, the main principles of the approach. In the case of the pedagogical heads of teaching modules, there was a wish to adopt an innovative approach to open new perspectives for their students. Beyond this first, conventional stage of transmitting knowledge on a new approach, we also rapidly were confronted with requests to appropriate the approach. These requests generally came from people who had participated in its application, either closely or at a distance, and wished to apply a similar approach to other questions or field but who felt insufficiently autonomous and wished to acquire the necessary 'know-how'.

This type of wish raises the issue of transferring the approach to some of the stakeholders with whom we habitually work. The concerns often expressed by participants in ComMod processes relate to the difficulty of facilitating the collective moments that punctuate the approach and of mastering the design, implementation and use of models that serve to support the process (i.e. conceptual model, computer model, role-playing games). The first concern relates principally to social dialogue, the second is more involved with the technical mastery of the tools. These two stumbling blocks are joined by the main difficulty of making a radically new scientific stance known and appreciated. The basic principles instilled before the start of a companion modelling process are difficult to practise in the field by those raised on conventional scientific ways of thinking and immersed in a cultural context that takes these principles into an unfamiliar framework. This chapter examines three paths that were recently explored to familiarize some of our partners with the application of a ComMod approach: using face-to-face or distance learning teaching modules, organizing professional development training programmes, and accompanying some individuals in the application of a ComMod process.

Teaching the approach

Teaching modules were developed for degree programmes, the professional training of research scientists or technicians, and on-the-job training for young research scientists and doctoral students. The first set of modules enabled potential practitioners to become aware of the approach and its possible applications in their field. The second allowed our approach and the use of models in mediation contexts to be debated and compared with other ways of viewing and practising participatory research. The last made it possible to render students progressively more autonomous and critical of stances and tools used in the framework of what was often a long operation (up to five years in certain cases), in which they were the main designers and facilitators.

There is no consensus within the ComMod group on whether it is necessary to differentiate the types of audience during professional training. Some consider that the principle of companion modelling is itself to promote the sharing of heterogeneous skills, and it thus is anachronistic to tailor professional training for particular audiences. Others consider that research scientists and development professionals do not refer to the same worlds or share the same expectations and, consequently, they cannot be trained in the same way. Research scientists plan to reinforce references to theoretical aspects, and also seek clarification of the scientific approach, information acquisition and validation issues, discussions of the implementation, verification, adjustment and validation of models, in addition to reflections on the research scientist's stance. On the other hand, development professionals prefer to emphasize technical aspects, the way of implementing and facilitating a process, the choice of partners, cost and length issues, or adjusting to regulatory procedures. Finally, in projects involving teachers, they focus on the pedagogical advantages presented by the originality of the ComMod approach and tools used, discussion on the acceptability of levels of simplification imposed by the chosen teaching curriculum, or adjustments to specific learning questions.

The issue remains open to debate and there has not yet been a sufficient opportunity to gain a perspective on mixed training to reach a decision on this point of divergence. Nevertheless, numerous experiments show that the training dynamic with a mixed

audience can be rich when the schedule allows significant amounts of time for research scientists and development professionals to work together to apply new knowledge acquired on a topic to a situation they have chosen together and in which everyone is interested.

Degree programmes

The degree programmes in which we are involved essentially are for students in higher degree programmes (i.e. final year of engineering school, second year of a research or professional Master's programmes). The principal objective of the training is to help students understand that it is possible to model complex systems with local stakeholders by helping them collectively to represent interactions between ecological and socio-economic dynamics. We also aim to make them aware of the ComMod stance and help them discover the principal tools used in the approach. This last task is difficult to achieve but it is important for students to understand that this original approach corresponds to a particular mode of co-construction and use of models rather than their simple production. When time allows, activities take place in the form of interactive workshops. In two to four course hours, activities generally consist of an introduction to the approach followed by a detailed presentation of one or two examples of its application. Interactive workshops are based on the presentation of actual experiences (to explain how a given complex system was modelled), coupled with the manipulation of a model that is easy to grasp (e.g. forest/fire/fireman type) or a rapid role-playing game (harvesting a resource by an actor). The teaching exercise then consists of gradually making the situation more complex, either by rendering the representation of stakeholders or resources increasingly sophisticated, or by introducing new stakeholders or resources.

In longer training, two formats were tested based on a common structure of four modules that are linked together differently, and which are more or less developed depending on the type of training and its length (from several days up to two weeks):

– illustrated introductory course on the characteristics of the approach and its application
– description of a conceptual model or the co-construction of this conceptual model
– context immersion through a role-playing game corresponding to this model
– visualization of dynamics on computer simulations.

In the first format, after a brief introduction to the process, the pedagogical approach is focused on a detailed analysis of an actual, completed case study. Students first try to understand the complex system by representing it in the form of a conceptual model that dynamically describes interactions between actors and resources in a given territory. They then visualize these simulated dynamics by means of a multi-agent model and propose management alternatives (e.g. exercise on development scenarios), or play the role of the stakeholders represented in the model and experience interactions with other stakeholders or with the environment (role-playing sessions). In the second format, after the core introductory course, the pedagogical approach chosen for one- to two-week training favours the progressive construction of applications, individually or in small groups during the afternoons, inspired by morning presentations of case studies.

ComMod teaching games were specifically developed with this aim (see the Appendix for a description) and were adapted to the main themes addressed in the courses of study taught by ComMod group members. A tutorial programme was developed for those whom a teacher thought could be more independent (see references at the bottom of the

corresponding case studies). These ComMod games can be divided into three categories according to what guides the designers in their development: a game designed specifically to teach, a game designed specifically to organize workshops with stakeholders of a particular system but later used in training sessions (Njoobaari, Don Hoi Lord), or games that from conception claim the right to ambivalence (SylvoPast, ButorStar). The first category groups together games that are either generic or abstract but can be contextualized easily (CherIng), games adapted to students' specializations that either are completely made up (YeunEllez), inspired by a game designed by stakeholders of a system studied (MéjanJeuBiodiv), or contextualized based on a more abstract game (PâtureLesCommuns or ReHab inspired by CherIng).

Within the companion modelling community, there is a synergy to develop both games to teach students and games to facilitate consultation and dialogue between stakeholders in a system studied. At times a game designed to teach the approach (CherIng or RuisselPois) is the foundation for a more sophisticated game destined for stakeholders in the system represented (Radi or Pays de Caux). From a pedagogical point of view, having students play a game that was played by stakeholders of a reference system opens particularly interesting perspectives on the link with reality that can be addressed during the debriefing. Thus in a game like SylvoPast, which is based on a relatively abstract representation of a Mediterranean forest area, students assuming the roles of woodman, shepherd and hunter implemented strategies in the game that were similar to those used by stakeholders in reality (Étienne, 2003).

The one-day module includes an introduction to companion modelling, a short example of its application adapted to the central theme of the course of study, an exercise in the co-construction of a conceptual model (i.e. ARDI method to determine the stakeholders and resources available, their respective dynamics and interactions) representing an issue with a strong tie to the curriculum, and a pedagogical game illustrating the conceptual model. The game may be chosen from the following themes: runoff, fire, biodiversity and agroforestry.

In the two-day module, it is possible to add a clarification exercise of stakeholders' decision-making rules, the selection of relevant viewpoints to understand the dynamics of a modelled system, the construction and simulation of a scenario, and a search for abnormal behaviour in the model and the causes. Exercises alternate with the use of a model and role-play. The territory and application example chosen may be adapted to a particular theme or environment (e.g. coastal zone, steppe zone, Mediterranean forest or humid zone).

Over one week, it is possible to integrate learning on a UML diagrammatic formalism and, while retaining the preceding format, favour group work on development issues (e.g. biodiversity management, risk prevention or multi-functional development). In certain cases, the questions will be identified and chosen according to the issues on which the students are working elsewhere. In other cases, priority will be given to the application of the process at three different levels of resolution (i.e. landscape, watershed and farm) on a question that is presented and which the students must appropriate.

In two-week modules, the second week is spent on students learning to construct a computer model able to serve as an intermediate object in a companion process. The training covers the construction of a spatial environment based on GIS data, the modelling of a process spatialized by a cellular automaton, modes of formalization, modelling

Box 11.1 – MéjanJeuBiodiv sequence.

2.5-day workshop on biodiversity and companion modelling

The first half-day is dedicated to an introduction to companion modelling and an example of its application. The second half-day is dedicated to an exercise of co-construction of a multi-agent model representing the biodiversity of Causse Méjan. The third evaluates the co-constructed model and the selection of viewpoints and indicators. The fourth presents the structure of the model implemented and simulation of the actual situation according to different points of view. The fifth half-day associates a role-playing game and computer simulations with test scenarios meant to improve biodiversity management.

(i) Modelling interactions between ecological and social dynamics

Alternating lectures on companion modelling with demonstrations of a simple model of fire and firemen. The application example is chosen according to the students' course of study (e.g. fallow land process on Hussant island, harvesting razor clams in Thailand, hunting, grazing and harvesting reeds in the Camargue).

- Principles and contribution of multi-agent modelling (1 hour)
- Companion modelling and biodiversity management (1 hour)
- Application to a concrete case (1 hour)

(ii) Co-construction of a model of biodiversity management on a steppe

Co-construction work in groups of six to eight students on a conceptual model of a MAS describing a steppe area based on a set of photographs in the framework of implementing the ARDI method.

- Identification of stakeholders and resources (1 hour)
- Identification and description of natural dynamics (1 hour)
- Interactions between ecological and social dynamics (1.5 hour)

(iii) Evaluation of modelling

Critique of interaction diagrams between groups, development of a joint conceptual model, followed by group discussion of the most relevant indicators in visualizing model outputs.

- Comparison of conceptual models (1 hour)
- Development of a joint conceptual model (1 hour)
- Selection of indicators and viewpoints (1 hour)

(iv) Use of modelling

Learning how the conceptual model is translated into computer language in the Cormas platform. Then the use of MAS to simulate an actual situation and evaluate its impact according to different viewpoints.

- Model presentation (1 hour)
- Simulation of model (1 hour)
- Identification of each stakeholder's problems (1 hour)

(v) Development and simulation of scenarios

Simulation exercise for participants to identify and discuss what does not work, and to propose a solution for these dysfunctions. Use of a MAS collectively to simulate solutions proposed.

- Role-playing game (1.5 hour)
- Simulation of proposed scenario (1 hour)
- Analysis of effects of these scenarios (30 minutes)

a negotiation, the development of logical stages clarifying the decision process, the identification of indicators and the coding of spatialized points of view, the validation of models and tests of sensitivity. Each topic lasts for half a day during which theoretical examples alternate with concrete examples and practical exercises. The entire week is structured around a project to manage the grazing of several herds, a scenario that is made more precise and complex as the learning continues (see PâtureLesCommuns in the Appendix).

Many of these training courses are evaluated both on the pedagogical aspects of the companion modelling tools used and the learning fields observed (Étienne *et al.*, 2008d). The enjoyment found in learning by doing, learning by playing, and learning while simulating is cited repeatedly by students. Becoming aware of the complexity of interactions between human activities and ecological dynamics is often identified as a strong point of the pedagogical approach. Lastly, numerous students announced that they recognized the need for consultations in this type of problem, and the capacity of a computer model to support consultations between different stakeholders.

Professional training for research and graduate teaching

The involvement of ComMod group members in training sessions for researchers and other research seminars aims both to train research scientists and university staff in the approach and to confront the approach with those of other groups working on participatory methods of research or the use of models in consultation processes. We will address these two components in order.

Training

To make the approach known, the first companion modelling training developed out of a two-week training session entitled 'Simulation of complex systems: multi-agent systems (MAS) and renewable resources management', implemented by the Renewable Resources and Environment Management (Gestion des ressources renouvelables et environnement – GREEN) team at CIRAD beginning in October 1997. Between that date and March 2006, 12 sessions were organized in Montpellier and nine sessions (in English) abroad. The format of the session evolved over the decade, notably in the way the role-playing games were integrated. Initially presented as tools allowing interaction between stakeholders in order to co-construct and validate computer simulation models, they gradually were introduced as one of the principal tools structuring the companion modelling approach by drawing on the diversity of their use modes within actual projects. Today, it is clear that specific training in companion modelling must be offered independently of training focused on teaching the basics of simulation tools.

A demand for specific training in companion modelling rapidly emerged. A first attempt was made between 2001 and 2004 with scientists from various disciplines in south Asia through an interuniversity project financed by the Asia IT&C programme of the European Union. Ten one-week sessions were organized with the premise that the mastery of companion modelling requires multiple skills and in order to reflect the principle of expressing multiple viewpoints in the teaching method. In each, a professor gave a course on a given field (e.g. multi-agents, simulations in social sciences, watershed management, communication sociology in agriculture, etc.). Approximately 100 people participated in these courses. Some of the most industrious began to develop applications

to test whether the approach was suited to an actual system that they needed to manage. About 12 case studies in Asia thus are linked to this cycle of brief training. Following this series, six students undertook doctoral studies on the subject. The lessons learned from the project were described by Bousquet and Trébuil (2005).

In parallel, sessions focused on understanding and mastering the Cormas multi-agent simulation platform developed by CIRAD were organized beginning in April 2002. In the same spirit, a collective training effort focused on the 'role-playing game' tool because it constitutes an original element in our approach and is enthusiastically received in the field but involves some very special skills. Having also been the subject of complaints and criticism, we rapidly undertook rigorous formalization and theoretical referencing work. Relying on the works of numerous scientific groups (particularly those connected with the international journals, *Artificial Societies and Social Simulations* and *Simulation and Gaming*) and the opinions of those who have read numerous scientific articles on the use of our role-playing games (Barreteau *et al.*, 2001; d'Aquino *et al.*, 2003; Étienne, 2003; Mathevet *et al.*, 2007), we set up, with the assistance of FormaScience, INRA's training department, a training session for researchers on 'The use of role-playing games in companion modelling. Simulation exercises for stakeholders to share representations and simulate dynamics'. This training has been organized four times in France and twice overseas (Bolivia and Bhutan). Participants were research scientists from CIRAD, INRA, l'institut de recherche pour l'ingénierie de l'agriculture et de l'environnement (CEMAGREF), CNRS and numerous universities (e.g. Paris and Brest), who are working on natural resource management, territorial development and sustainable development issues. The selection of candidates has always favoured a cross selection of disciplines to improve the quality of exchanges during the training and to make the most of exercises planned for days of practical work. The training takes place over four days, during which lectures on theoretical aspects alternate with practical workshops and role-playing. The training proposes to explain the stance, methodology and application conditions of role-playing games. This can be broken down into four objectives: sensitizing and initiating participants in the use of role-playing games in companion modelling; clarifying the operating conditions of role-playing games to support territorial and environmental decision-making processes; illustrating the use of the approach using concrete and diverse applications; providing the methodological basis for the design of this type of interactive tool that facilitates communication between stakeholders, the exchange of viewpoints and collective learning. In the case of the one-week training in Bhutan, young researchers and development officers worked every afternoon in small groups to construct different versions of possible role-playing games (Box 11.2). The theme of the games was conflict over the use of high altitude pasture lands in Radi, where the tool was to be implemented the week following the training with numerous trainees working in the region.

Confrontation

The confrontation component consisted of bringing our approach into debate in a series of training sessions for researchers and seminars organized by different institutions. The debate focused either on the tools, the approach or the stance of researchers. In this way, role-playing games were compared with other platforms of negotiation between stakeholders in the NSS Dialogue workshop on 'Contribution of modelling to the management of natural resources: dialogue between disciplines', or with other survey

Box 11.2 – Training course on role-playing games in companion modelling.

The training comprised four modules and three workshops.

Module 1: Methodological framework.
Lectures at the beginning and end of the training identify the stance and principles of companion modelling, present the theoretical framework used and its methodological implications, and recall the ethical rules developed by commodians in the ComMod Charter.

Module 2: Typology of role-playing games.
Briefings and examples of case studies to give a broader view of the various types of games and the particular features of companion modelling role-playing games.

Module 3: Association of role-playing games with models of resource dynamics.
Succinct lectures present models of resource dynamics, the way these are integrated into multi-agent simulation models applied to the management of renewable resources and the different modes of association between the multi-agent simulation models and role-playing games (see Chapter 3).

Module 4: Design of role-playing games.
Briefings and simple exercises run through the stages of game design, present the most commonly used formalization tools and, since 2006, several monitoring and evaluation methods.

Workshop 1: The CherIng game.
This pedagogical game was designed as a simple role-playing game allowing the rapid understanding of the tool's principle characteristics and its gradual adaptation to questions that are increasingly complex. It is based on the simulation of a harvest of a virtual resource (the Ing) in a territory where the resource is present at different levels of availability. There is a double objective: (i) to 'break the ice' and allow participants to get to know one another in a relaxed manner; (ii) to discover in a short amount of time (one hour) the principles and essential stages of a role-playing game used in companion modelling: briefing, alternating between individual and collective decision stages following collective discussions, and debriefings on the results obtained from both ecological and social perspectives.

Workshop 2: Game practice.
Participants simulate a situation by practising one of the role-playing games developed by the ComMod group. The game session is then the subject of a debriefing during which the observation methods and analytical tools are discussed. The choice of game is a function of participants' expectations, its effectiveness in conveying the design and animation difficulties of a ComMod game, and the presence of a teacher with good experience (i.e. command of debriefing and feedback on actual experiences).

Workshop 3: Game design.
The workshop either takes place in one day or is divided over several days in afternoon sessions putting into practice the lectures and examples provided in the morning. It takes place in four stages, in three separate groups, and on an imposed question and territory. Participants first analyse diverse documents (e.g. maps, statistics, stakeholder files, atlas, photographs, etc.) to understand the context and the problem set. They then select which information is relevant to the question raised and may ask for complementary information from the animator of the training. Lastly, they put into use the tools and methods proposed during the preceding days to freely design their game. The workshop ends with a presentation of the games developed by each group, followed by a general discussion. The question addressed is usually a question that has already been addressed by the ComMod group and has been the topic of a role-playing game (e.g. grazing, tourism and conservation on Ouessant island, farming, hunting and the protection of the great bittern in the Camargue).

methods during a CNRS session on 'Survey techniques: scientific update on the method and tools'. It also was compared with conventional, multi-criteria analytical methods during an INRA session on 'Approaches and methods for multi-criteria evaluation of the sustainability of livestock and cropping systems'.

In parallel, we were invited to numerous training sessions for researchers and seminars as representatives of an original approach. The approach's capacity to promote dialogue between disciplines was discussed during the session 'Interdisciplinarity between biotechnical and social sciences: agriculture, environment, territories, public policies and sustainable development'. The originality of the approach in relation to other participatory modelling approaches was debated within the multi-agent modelling community during a CNRS session on 'Modelling and complex multi-agent system simulations for human and social sciences: principles and methods of design and use', within the research development community during an INRA session 'Which participatory research for which development dynamic?', and during a research seminar of the ADD-ComMod programme on 'Taking into account stakeholders and their representations in sustainable development'.

Lastly, the ComMod approach was compared with those for modelling dynamic systems, changing land use (the CLUE model by P. Verburg of the University of Wageningen), and the evaluation of vulnerability (school represented by C. Polski of Clark University in the USA) during a one-week summer school organized at the University of Sapporo by the coordinator of the Global Land Project.

Professional training for the development world

The objective of this training is to help development service technicians and local government agents understand the principles of companion modelling and learn how to animate one or several of the group exercises that punctuate the process. The training often is adjusted to a particular institutional framework, such as the review procedure of UNESCO's biosphere reserves network, or the development of charters in regional and national nature reserves. This type of training was developed with two different perspectives: one was to sensitize, while the second was to 'render autonomous'.

In the first case, activities were based on taking apart a case study in which the process was conducted up to its completion, and on the presentation and discussion of the actual experiences of numerous participants in the implementation of participatory or companion modelling approaches. In the second case, the emphasis was placed on the methods used, as much for the development of a joint representation of the question raised as for the animation of a collective session during which models accompanied the exchanges between participants.

In UNESCO's MAB programme biosphere reserves network, the second option was chosen. The approach first was adapted to the context of biosphere reserves (Étienne, 2006), and to procedures imposed during the creation or revision of these 'sustainable development models at the regional scale' (Étienne *et al.*, 2007). It then was transmitted through training modules presenting the overall logic of the approach and emphasizing a particular tool. With the Swedish MAB committee and animators of future Swedish biosphere reserves, the focus of the training was the ARDI method of co-constructing models representing the functioning of the biosphere reserve that was the focus of the training. With representatives of local stakeholders, conservationists and national MAB

committee heads of six francophone countries of West Africa, the training focused on role-playing games and the resolution of conflicts over use. With participants in the EuroMAB network, the guideline was the application of the approach to a concrete case of a biosphere reserve review. Lastly, training with French biosphere reserve agents emphasized the specific character of animation during highly collective periods by combining workshops on describing and mastering tools with simulation exercises allowing participants to animate sessions of tool design or use. Training always included a positioning of the approach in relation to other methods currently used by managers (e.g. Agenda 21, management assistance guides, development plans, landscape charters and forestry charters).

Accompanying its application

Another form of learning about companion modelling may take place during the application of a ComMod approach. This involves either professional or doctoral students who generally already have participated in one of the training sessions described in the preceding sections.

The first option was regularly applied in operations in southeast Asia. People who demonstrated an interest in starting a companion modelling operation were invited to observe various parts of a process already underway and participate in several stages of the approach. The objective was to render the process concrete and provide touch points for practical learning based on imitation, and to enable the candidate to acquire confidence, project themselves, and to construct their own application. Over the last five years, six French and Asian doctoral students have undertaken theses on subjects related to the conduct of a ComMod process in a given field.

Most of them decided to do so after having participated in a short training course for higher education teachers-researchers of the type described above. This proved to be, with a few rare exceptions, insufficient to enable the doctoral student immediately to adopt an adequate stance and construct a process based on a solid theoretical foundation and methodology. Thus there was a need to plan for close and intensive supervision of the student, particularly when they have followed an academic course of study and come from a culture very different from our own. In this case, the young researcher-in-training needed to learn multiple skills to become autonomous and this may be beyond the capacity of certain candidates: synthesize information, integrate different kinds of knowledge from different disciplines, different modelling techniques, mastery of multi-agent simulation platforms, gift for communication with different kinds of stakeholders (coming close to the art of diplomacy in conflict situations), animate groups of heterogeneous stakeholders over the long term, interest in the transdisciplinary practice of research, writing reports of varied nature, etc. The mastery of the ‘art of the ComMod practice’ thus is the result of long and demanding careers that can be very fulfilling when they meet with success, with the scientific publication of results relatively easy. However, this path is reserved only for candidates with advanced potential who are extremely well qualified academically. It is still too early to evaluate how well the young teachers-researchers who underwent training will transfer the approach to their students once they have returned to their respective faculties and universities, or once they have returned to professional life.

Disseminate the approach

Through the Internet

A website (www.commod.org) was set up to provide a range of information for those seeking to become more familiar with companion modelling. The text of the ComMod Charter is online, as are the case studies, which are presented in a standard format that provides a concise description of the application of the approach, specifies the question raised, the territory concerned, the sponsors (those behind the demand), the research scientists involved, and the bibliographical resources available for further information. Standardized descriptive forms provide specifications of the tools developed (i.e. role-playing games, simulation models).

In order to make it easier to consult all of the documented case studies (the site currently offers 34 listed in alphabetical order), three entry keys are proposed. The first is based on thematic cues (i.e. biodiversity, water, forest, agriculture, livestock, peri-urban, other themes). The second distinguishes cases according to the social dynamics addressed (i.e. markets, credit, migration, creating institutions, learning, cooperation, conflict). The third is geographic.

The website also provides lists of various types of publications referring directly to companion modelling, as well as lists of training modules in which companion modelling has been taught for the past five years. These pages distinguish between diploma programmes in France and overseas (targeted audience: students), non-diploma programmes (targeted audience: researchers, managers, decision-makers, etc.), periodic interventions that may or may not be specific to companion modelling, and presentations in research seminars.

The private section of the site, which is only accessible to signatories of the charter, constitutes a space for collaborative work and the sharing of information that effectively supports the animation of the network, notably with an archive of messages exchanged in the discussion forum and access to teaching aides produced by members of the network.

Distance learning

Between 2004 and 2008, following the training project in southeast Asia described earlier in this chapter, a website was developed (http://www.ecole-commod.sc.chula.ac.th) to respond to requests for training from numerous countries in the region and to develop tools for a network of researchers in training. This website is divided into three parts that we believe complement the teaching of companion modelling.

– A part divided into six modules: introduction, theoretical bases, method of UML graphic design, multi-agent simulations, role-playing games and the Cormas simulation platform); a second part groups together a set of applications undertaken in the region.
– A role-playing game inspired by the CherIng game that can be played over the Internet.
– A part known as e-governance based on the principle that stakeholders who have participated in a ComMod approach should express their views about the process so that potential users in other areas can profit from their impressions and experiences. This was the most ambitious component but we were unable to develop it to the desired level despite having opened an electronic forum to encourage discussion.

The site has only been online for a short time and we have not yet had sufficient time to gain the perspective needed to evaluate its use. The challenge will be to reconcile the use of this distance learning site with the supervision of those who desire to be trained more fully. The Internet tool may also serve to maintain exchanges within a network of people who have experienced a ComMod process. Through the use of the site, a newcomer might thus be integrated into a network and benefit from the experience of its members by following them on some of their field operations.

Through consulting firms

In the framework of sustainable development, authorities and technical departments in charge of managing environmental issues must implement participatory field research operations. They often call upon consulting firms for this activity, but such firms rarely are specialized in this type of work. Partners who have participated in a companion modelling process sometimes are also interested in generalizing the approach or applying it to a theme other than the one addressed with commodians. They seek consulting firms specialized in the design, implementation and evaluation of participatory processes.

Several scientists who participated in companion modelling operations through their university study programmes decided to set up a consulting firm known as Lisode, which offers services to public stakeholders that are specially designed to accompany cooperation components of area projects. They can intervene in the application and evaluation of participatory processes associated with the implementation of Schéma directeur d'aménagement et de gestion des eaux (SDAGE), Schéma d'Aménagement et de gestion des eaux (SAGE), Schémas de cohérence territoriale (SCOT), Plan local d'urbanisme (PLU), Plan de prévention des risques (PPR), Zones d'aménagement concerté (ZAC), Agenda 21, regional nature reserve park charters, etc. They regularly intervene in participatory democracy programmes of regional administrations, such as the organization of citizen conferences or public debates, and propose training modules on mediation and territorial cooperation.

Perspectives

We are working on three new ways of transferring companion modelling, that is, the preparation of a training programme covering the entire process, discussions with agriculture teaching experts on teacher training, and an attempt to develop a distance learning module.

Comprehensive companion modelling training

The need for training on a process that is not tied to mastering a tool led us to develop a new training project addressing the entire companion modelling process. This project aims to combine sessions explaining the principles of companion modelling with sessions on the difficulty of animating the collective exercises that mark the process. Two potential targets were selected: development partners who were likely to appropriate, and who were interested in implementing, the process; and research scientists intrigued by our approach and interested in understanding the entire process.

The FormaSciences team retained and developed the one-week training session for researchers. The idea was to teach the ComMod approach on the basis of a series of simulation exercises allowing the different stages of the process to be addressed successively. Each teaching module corresponds to a stage described in Chapter 1 and is constructed according to the same sequence:
– an initial simulation exercise
– a debriefing to understand the issues emerging from the simulation
– a formal lecture period (methodological and theoretical references) presenting a number of key points directly linked to the issues selected
– individual work periods in which participants are invited to look through the database of case studies and select documents produced by the ComMod group to research elements related to these key points
– a brief feedback period.

The approach then is applied to a case study chosen from the bibliography put together by the ComMod group according to the profile of participants or the expectations of the sponsor. The training thus includes six modules in which participants will try to put themselves in the position of a commodian (see Box 11.3).

Professional training for the teaching world

A special case concerns the experiments underway in French agricultural schools to adapt certain tools that were developed in ComMod processes for more generalized teaching. Three levels were targeted: the final two years of the agriculture lycée programme (premiere and terminale), advanced technical diplomas (BTS Management and Protection of Nature, Analysis and Management of Farming Systems, and Forestry Management), and engineering schools. The project is an initiative of SupAgro Florac and the Fondation pour la recherche sur la biodiversité (FRB). It operates from the hypotheses that the ComMod group's methods and aids may be used in different educational situations in agricultural schools to cover three topics:
– modelling: step by step formalization of a complex situation involving the management of a biodiversity issue
– analysing dynamics: observe ecological and socio-economic dynamics through spatialized and non-spatialized computer simulations and try to understand their interactions (i.e. search for information and indicators, interpretation of observations by formulating hypotheses and testing these hypotheses)
– simulating interactions between stakeholders on the same territory: play the role of stakeholder to grasp their means of action, understand their rationality, lead a negotiation, take decisions and measure the impact on biodiversity.

The experiment involved a pilot group of teachers from secondary agricultural schools willing to adopt the aids and methods produced by ComMod, test all or some with their students, and share their experiences. SupAgro Florac, FRB and the ComMod network volunteered to accompany this group by providing support, organizing the group and sharing experiences, monitoring and accompanying field applications, adapting the aids and eventually producing new ones, and promoting and diffusing relevant experiences and products. Education inspectors from the agricultural school system, the Direction generale de l'Enseignement et de la Recherche (DGER) offices and support services, and SupAgro Montpellier were also involved.

Box 11.3 – Training course on the ComMod approach.

Module 1: Organize the process.
The exercise involves formulating a question, defining the specific objectives of the accompaniment, identifying the contextual elements to be taken into account, specifying the source of the demand, organizing the process to be implemented, and selecting different types of participants (e.g. project holder, facilitator or stakeholders) by identifying their level of involvement and what makes them legitimate participants.

Module 2: co-construct a representation of the system.
The exercise consists of making explicit the various points of view on the question and considering the breadth of knowledge on the topic. This leads to choosing a methodological framework that will enable a structured set of terms and concepts about the stakeholders (decision-making rules, roles) and resources (processes, adjustment procedures) to be produced. It imposes the definition of a spatial-temporal framework (i.e. choice of spatial expanse and simulation timeline). Lastly, to remember the co-construction work, participants must imagine a method to clarify the hypotheses used in the different submodels (biophysical and social processes), keeping track of the choices made among the diverse solutions put forth and their justifications.

Module 3: implement the model.
The workshop makes it possible to acknowledge the variety of tools that can be used (e.g. computer simulator, role-playing games, hybrid models) and the platforms and languages most commonly used. It then provides an overview of the various kinds of data that could be integrated into these models: state variables describing the state of a system at a given moment, and parameters linked either to possible scenarios or to biophysical and social processes. It also encourages reflection on the relevant indicators for understanding the effects of decisions taken on the dynamics of a system according to different points of view. Lastly, it leads to discussion on validation problems of the mathematical, statistical and social processes represented.

Module 4: stage and simulate the situation.
Participants must organize a highly collective period in which the model serves as an intermediate object to facilitate cooperation. The workshop focuses on different aspects of animating these sessions by facilitating discussion on the preparation, animation itself (introduction, facilitation, immediate debriefing), co-construction of scenarios, observation (attitudes, lectures, aids used), and results analysis (consequences for the environment, management of resources or the social system; learning, decisions, and negotiations between participants).

Module 5: handing on the process.
The exercise focuses on both the identification of future bearers of the approach and on the training modes planned (teaching module, self-teaching, accompanying an actual case). It also addresses the advantages of being involved in a network to ensure methodological support (ComMod network, network of participatory approach practitioners) and guarantee the diffusion and appropriation of the approach (creation or activation of local networks). The issue of transferring and adapting tools is also raised.

Module 6: monitoring and evaluating.
Tools for monitoring and evaluating are proposed and tested on a selected case study.

Three pedagogical components were developed with teachers to evaluate their contribution to professional learning on area management in these study programmes, and to constitute the outline for a future collective sustainable development week that is in the process of being incorporated into teaching references:

– (i) formalize a joint representation of a complex system: group work on a diagram of social-environmental interactions according to the ARDI method

– (ii) place students in simulated situations so that they can experience this complexity: role-playing games around biodiversity management
– (iii) use the modelling of this complexity to imagine alternative management: development and computer simulation of scenarios providing insight into the dynamics of a system according to different management modes.

The obvious interest aroused by the proposed methods and process is due to the fact that they consistently rely on creative approaches and naturally induce active teaching positions. Although many teachers think of this as the pedagogy of their dreams, they generally do not find a way to integrate it into their usual routines, particularly when the subject involved demands strong technical and scientific skills. ComMod's accompaniment of this innovative teaching component should result in the institutionalization and spread of the approach in the entire agricultural profession.

Distance learning

The virtual University on Environment and Sustainable Development (l'Université virtuelle environnement et développement durable – www.uved.fr) is an association that aims to share the contents of training courses from more than 40 French-speaking partners. A web teaching course entitled 'New Participatory Approaches to the Management of Renewable Natural Resources' is in progress. It is formatted through a two-week Master's 1 course, providing methodological skills arranged in three blocks:

(i) participatory approaches
(ii) modelling complex systems
(iii) the ComMod approach.

These methods can then be applied to five issues related to natural resources management:

(i) integrated management
(ii) land tenure
(iii) land planning
(iv) water management
(v) agro-biodiversity management.

An exercise based on a role-playing game is also proposed. This training course can be used either as a self-training process monitored by a tutor or in a classroom.

Conclusion

The transfer of companion modelling is undertaken through very different frameworks and on extremely varied themes. It includes academic education, targeted training and broad mediums such as the Internet. Nevertheless, a certain number of principles and tools remain common to all of the activities undertaken.

The teaching of companion modelling prioritizes how to pose questions (Fleury and Fabre, 2005). It concentrates on seeking the significance of data that lead to debate and on an approach that must help to identify action choices. To do so, it relies on four operations linked to socio-scientific reasoning (Sadler *et al.*, 2004): recognize the complexity inherent in an issue; examine the issue from several angles; admit that the issue should be the focus of further enquiry; demonstrate scepticism of information presented. However,

it also adds two fundamental elements of reasoning: identify risks and uncertainties; take into account values and ethical principles in decision-making.

Learning through role-playing also is a constant feature of our pedagogical approach. Within a creative setting, it leads participants to understand ecological functions, complex interactions between nature and society, and the advantages of consultations – and indeed cooperation – between stakeholders involved in the game. Participants can be placed in an original context in which attitudes, behaviours and situation actions are revealed. However, learning only occurs when teaching methods allow learners to reflect and progressively conceptualize while keeping in mind each individual's capacity for abstraction.

Lastly, participatory modelling is at the heart of our pedagogical approach. We hypothesize that the co-conception of a model and the joint use of model simulations facilitate understanding of complex systems and encourage collective reflection on management alternatives (Hare *et al.*, 2003). Teaching through modelling stimulates both a learner's capacity for abstraction through formalization and their imaginative capacities via the possibility to project into the future (Lane, 1992).