A stance justified by the needs of sustainable development

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Chapter 8

ComMod: engaged research's contribution to sustainable development

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The emergence of the sustainable development concept

The question of how to conciliate ecology, economy and society was first raised in the 1970s with UNESCO's Man and the Biosphere (MAB) programme. The term, 'sustainable development', a product of the growing awareness that ensued, was defined in 1987 as: 'development that responds to the needs of the present without compromising the ability of future generations to meet their own needs' (Brundtland, 1988).

Sustainable development asserted itself as a response to a preoccupying global situation, notably the fragility of ecosystems and natural resources and the imbalance between extreme poverty and wealth. The search for solutions to these problems was part of a perspective allying 'sustainable resource management', 'social cohesion' and 'economic rebalancing'.

At the 1992 Earth Summit, Agenda 21, a set of action goals[1] and principles[2], was established[3] to give form to sustainable development. Agenda 21 proposed an overall action plan to governments, development institutions, United Nations bodies, and independent groups active in all of the fields in which human activity influences the environment. Since then, the programme has been continuously discussed and refined within the framework of various international, national, regional and local agreements.

Consequently, the goals of sustainable development are relatively explicit and there is a consensus within the development and scientific community of United Nations member countries[4].

– Social, economic, and environmental policies must be addressed in a spirit of synergy and with a long-term perspective. 'If threats to future quality of life are not anticipated, they will have irreversible consequences and will lead to a sharp increase in costs for society.' A message was thus sent to public policy-makers to assume responsibility for choices facing society here and now and for their future consequences.

– Environmental concerns must be taken into account in daily life as in public policy.

– Better sharing of material and immaterial resources must be foreseen. This concerns both natural resources as well as access to goods and services, the reduction of inequalities, and the development of individual and collective 'to do and to be' (Sen, 1982) capacities. This assumes a patrimonial development approach[5].

– Tensions produced by unbalanced development must be reduced: sustainable development concerns social equity between generations and within the same generation, the fight against social vulnerability, and an improvement in access to goods and services.

– Sustainable development thus generally is considered as an 'operating concept that should enable the evaluation of risks, inform opinions and guide public action' (Aubertin and Vivien, 2006). However, as long as sustainability remains difficult to define and

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[1] Return human beings to the centre of sustainable development concerns because people have the right to a healthy and productive life in harmony with nature, notably through a fight against poverty respectful of present and future generations.Preserve global balances and environmental resources for long-term development by altering development modes and eliminating unsustainable production and consumption modes in favour of sustainable ones.

[2] The principle of precaution, the principle of integrating the environment into the development process, the principles of responsibility and international solidarity, the principle of paying for pollution and the principle of participation for a new governance.

[3] Declaration of principles concerning forests and the Rio Declaration on the environment and development.

[4] At the 1992 Rio Summit, 150 countries committed themselves to linking the challenges of economic and social development with those of the environment to create a more unified world preserving resources and natural environments. This commitment was reconfirmed at the sustainable development summit in Johannesburg held 26 August to 4 September 2002.

[5] According to de Bradt and Gadret (1998) a communal heritage is constituted by: 'the ensemble of objects and products (including the natural environments that were or were not exploited by man and therefore a kind of "product" for him) to which this collective group or a sufficient portion of its members attach a value because what is involved are realities that testify to the identity of this collective group by establishing a temporal link between its past and present (witness to the past), and/or between its present and what it imagines for its future (witness to plans)'. Torrès (2002), specifies: 'the expression "ensemble of objects and products" is very broad: it encompasses objects and natural environments but also architectural monuments, works of art, sites and landscapes, as well as information that can exist in different forms. Local social networks, customs, oral traditions, significant collective memories… can furthermore be considered as non-material components of heritage. The patrimonial goods require an economic treatment that is different (existence value, analysis in terms of "support and services") than that applied to standard goods'.

imagine from an ecological, social or economic perspective, the means to achieve sustainability will be controversial and uncertain. In principle, the use of the concept assumes the existence of norms enabling the evaluation of sustainability or managing contradictions between the three pillars of sustainable development (ecological, social and economic): 'Yet these norms, particularly in the field of territorial development, cannot be defined scientifically or abstractly: while one may know approximately what the sustainable management of resources might be, one is incapable, for example, of defining an appropriate threshold in terms of an environment's "carrying capacity"' (Theys, 2002).

The definition of sustainable development requires the examination of 'the effects of economic and ecological decisions on the social dimension, but also the effects of decisions taken within the social sphere' (Dubois and Mathieu, 2002). This returns to the notion that the three pillars of sustainable development rest on an ethical (fairness) and political (geopolitical stability) foundation, which presumes individuals' access to the ensemble of goods and services, the reinforcement of people's personal and collective capacities, and fairness given available and transferable resources. The social sustainability of development, approached either from the angle of risk of social dysfunctions[6] within any society or from that of preventive solutions developed by social stakeholders to address such risks, is determined by the elaboration of 'principles of social precaution enabling the anticipation of risks and guiding social stakeholders in their undertakings' (Dubois and Mathieu, 2002). These principles of precaution or social prudence are understood within an ethic of 'responsibility' in relation to others whose goal is to guide and evaluate public policy decisions implemented within the framework of development strategies, and which aims to reduce inequalities in access to goods and services through redistribution policies.

The social legitimacy of research decisions

The emergence of the concept of sustainable development not only brought 'development' under debate but also generated new societal expectations from science. Science has been at once called into question and strongly solicited, notably in order to provide a rational foundation for this new vision of development.

In this context, the social legitimacy of research choices must be reinforced. 'Research efforts must take stakeholders' expectations into better account, develop surveillance methods and link these with procedures to define priorities and, above all, be more transparent.' It is necessary to 'move beyond the decision model or the alliance of enlightened technocrats with competent scientists imposing choices on the rest of society'. What is needed is not more science but a science anchored in democracy (Guesnerie, 2003).

In response to this injunction, the ComMod approach places particular emphasis on taking into account stakeholders' expectations at various points in its application. The demand for companion modelling may or may not be explicit (Chapter 4). In either case, it is up to the research scientist to formalize the demand and facilitate its evolution so

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[6] 'Biodiversity conservation favours a collective good, in principle open to all humanity, but the social cost and restrictions associated with it are not borne equally. A way of softening this negative effect consists of seriously considering instituting social compensation mechanisms that will compensate the regional society for the advantages conceded to the collective. The definition of the compensation for the losses borne shall be the focus of extensive negotiation between public bodies and the affected population' (Lima, 2002).

that it can both be understood through theoretical and methodological mechanisms and enable the involvement of the ensemble of stakeholders concerned by the social change.

As the demand generally emanates from particular operators, the formalization of the initial social demand is not always sufficient to take into account the expectations of everyone who may potentially be interested in participating in the ComMod approach, or of those who may question the work undertaken by others actively involved. It is necessary, therefore, to identify and appeal to stakeholders directly or indirectly involved in the management of the ecological or social system targeted and in the associated decision-making processes. This collective exercise is assisted by the commodian filling the role of facilitator. Given the importance of this stage, and of its determining impact on the rest of the process, the commodian should fully appreciate the opportunities and risks of the application of the ComMod approach and discuss them with participating stakeholders.

Once this stage is completed, the expectations of different stakeholders will be clarified and debated through the expression of their respective points of view. These points of view, rooted in different personal paths through life, express different value systems that sometimes may be incompatible with each other, yet all are considered to be legitimate. Companion modelling must organize these convergences, contradictions and incompatibilities to feed the dialogue between stakeholders and define future courses of action.

Companion modelling is not used to constitute *ex nihilo* a monitoring-evaluation system, although this may be one of the elements of a joint construction effort to be undertaken with participants in the approach. The approach is put at the service of sustainable development to further, within a given context, the emergence of values and priority actions expressed by social actors. These actions must enable the organization of the ecological and social system to evolve towards a configuration collectively defined as desirable, most often at the scale of a territory.

Transcending traditional divisions within the organization of science

To achieve the objectives described above, the ComMod approach tries to go beyond the divisions and hierarchy induced by traditional scientific classification between cognitive (fundamental) and applied research. Each case study provides an opportunity both to increase knowledge and respond to a social demand. The ComMod group mobilizes an international community of research scientists from diverse disciplines who share the precepts stated in the ComMod Charter and who work in specific fields in which they are expected to seek recognition from their peers. In addition, the application of the process aims to obtain practical results which, in the context of the problems as they are understood, is rather ambitious.

The ComMod approach meets the requirements of sustainable development research: positioned at the intersection between research and action, it encourages the development of a systemic dimension, mobilizes and crosses competencies from natural and social sciences and introduces the notion of risk and uncertainty. The approach aims to increase the individual and collective capacities of the stakeholders participating in the process while promoting the participation of citizens in public policy decision-making.

The approach proposes one method to discuss how the modalities by which societies make collective choices and are governed highlight the challenges of sustainable development, and a second method to facilitate reflection and transversal action across academic disciplines as well as across envisaged social and environmental issues. The

approach is open to improvement, and its application remains heavily dependent on the involvement of the stakeholders who mobilize it, their access to cooperation arenas and their capacity to position themselves within such arenas.

A way to apply the principle of participation

The ComMod group is dedicated to proposing to stakeholders of localized ecological and social systems a process that permits the principle of participation to be applied. To do so, it institutes a mediation process to help stakeholders handle uncertainty in decision-making processes. It also facilitates the stakeholders' understanding of the targeted ecological and social system by applying the principle of participation in different ways.

Different modalities for applying the principle of participation

The principle of participation is one of the fundamental principles of sustainable development. The first definition was provided in the Rio Declaration (Principle 10[7]) and was later elaborated by international law, notably in the framework of the Aarhus Convention that was signed in Denmark on 25 June 1998 by 39 countries[8].

The principles of public information and participation in terms of the environment involve transparency in policy development (in terms of the direction as well as the consequences of choices made) and the empowerment of stakeholders. The information principle aims to provide stakeholders with data on their objectives and the measures and expected impacts of public intervention. Technically, the application of the principle of participation involves consultation, which seeks to collect the opinions or data needed to evaluate public intervention and participation, which should identify alternative or compensatory measures proposed and jointly studied by stakeholders.

The implementation of the principles of information and participation attempts to make economic agents and citizens assume responsibility for the impact of their actions, and to inform them of the risks or hazards to which they may be exposed. The principles underlie the transparency of policy development and the reduction of risks linked to the application of policies to better meet sustainable development goals. They also allow discussion on the social consensus needed to achieve these goals by ensuring that no stakeholder is omitted from the consultation and that everyone's interests are considered.

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[7] 'Environmental issues are best handled with the participation of all concerned citizens, at the relevant level. At the national level, each individual shall have appropriate access to information concerning the environment that is held by public authorities, including information on hazardous materials and activities in their communities, and the opportunity to participate in decision-making processes. States shall facilitate and encourage public awareness and participation by making information widely available. Effective access to judicial and administrative proceedings, including redress and remedy, shall be provided.'

[8] 'The Aahrus Convention concerns access to information, public participation in decision-making processes, and access to justice concerning the environment. It focuses on the following three themes: developing citizens' access to information held by public authorities, notably by ensuring the transparent and accessible diffusion of essential information; encouraging public participation in decision-making with environmental ramifications notably, encouraging public participation from the start of a development process "in other words, when all of the options and solutions remain possible and the public can have a real influence" the outcome of an individual's participation must be taken into account in the final decision, which must also be openly communicated; broaden access to justice concerning environmental laws and access to information.' URL: http://www.ecologie.gouv.fr/Communication-la-convention-d.html

While these principles are constantly reaffirmed in political discourse, their mode of implementation mostly remains vague. In practice, the supply of information (the communication of meaningful data), and the effective participation of populations in public decisions, and therefore the empowerment of stakeholders, are far from systematic.

The ComMod process presents itself as a means of applying the principle of participation by being an explicit approach enabling, within a given context, stakeholders to reflect on their respective roles in terms of information and participation, and on the consequences of their investment (or lack of investment) in consultations.

The ComMod approach may contribute to discussions in existing consultation arenas, generally within a functional framework defined by the law or the prescriptions accompanying land planning and management. It may also involve the creation of new discussion arenas. In the first case, the discussion arena's pre-existing functional role will facilitate the insertion of companion modelling into the decision-making process. In the second case, this arena will need to be co-constructed through discussions taking into account how it will be integrated into the existing decision-making process and collective action. Procedures must be developed to determine the conditions under which other institutions will recognize the legitimacy of this new group to involve itself in the decision-making process.

In most cases, commodians wish to pursue all three application modes of the principle of participation (i.e. information, consultation and participation). However, given that it is heavily dependent on the intervention context, the ComMod approach might be limited to information, consultation or participation of a panel of selected stakeholders. This prior choice reflects a conscious decision taken by the ensemble of participating parties in a context marked by uncertainty.

Instituting a mediation process for stakeholders to assume responsibility for uncertainty in decision situations

Commodians understand the decision-making process as being 'the result of a process of interaction between individual stakeholders and/or groups holding different representations and weights in the negotiation' (Weber, 1995a). In adherence to the provisions of the charter, they focus on a mediation process. 'As an alternative form of regulating conflicts, inserted to a greater or lesser degree into the judicial framework, mediation has become a fundamental concept (in fact a notion) to ensuring good governance at the national and international scale, thus contributing to globalization with greater facility as the English notion of mediation has experienced analogous changes' (Marshall, 1984).

Various authors who have studied the concept in depth consider mediation to be a learning process that restores to 'mediation participants' responsibility for their actions (Guillaume-Hoffnung, 2005), or a 'personal and social creative space, citizenship at work' (Six, 1998). All agree on three essential points:
– mediation is an optional procedure that requires the free and conscious agreement of the people involved to engage in an action (the 'mediation') with the help of an independent third party (the 'mediator')
– mediation cannot be imposed; it is accepted, defined and carried out by an ensemble of actors
– for each party, the acceptance of mediation means committing oneself in good faith to seeking, with the assistance of the mediator, whatever is needed to establish a new balance in their relationship.

The 'third party' question has been, however, the subject of heated debate due to the stakes at play in the 'mediator' function. Commodians, who are intensely conscious of their own influence during the implementation of a ComMod process, do not accord themselves the role of 'mediator'. They believe the model fills this role. While this position distances them from the set of considerations related to the training and activity of mediators, issues related to the conduct of mediation feed into discussions on how to implement a ComMod approach.

The model becomes a 'mediator' to assist stakeholders in their search for viable and acceptable solutions concerning the management of the targeted ecological and social system. As is true in any mediation process, the implementation of the ComMod approach involves several stages: the presentation of facts, or '*theoria*', the confrontation of points of view, '*crisis*', and the development of a consensus, '*catharcis*' (Morineau, 1998). The process also involves participants projecting themselves into the future. In a given conflict situation, effectively it is easier to find a compromise on a vision of future social, economic and ecological arrangements (generally on the scale of the next generation) than on current uses where conflicts of interest are often violent. Once the convergence of points of view is formalized, the way is open to reconsider the elements of the present that will enable participating parties to continue towards the envisaged future(s).

Nevertheless, no theoretical element can ensure that a mediation process will result in consensus. This will depend on the engagement and will of the stakeholders to invest themselves in the search for, and implementation of, a compromise. It will also depend on socio-political interactions existing prior to the process, and the possible rearrangements that the process might provoke (Lesage, 2007). Such uncertainty often does not meet political timeframes or satisfy demands for rapid results.

Public decision-making processes consequently have a long way to go before they are based systematically on mediation. Autocratic, oligarchic, rational or irrational decisions may be involved, which may occur before, during or after a certain number of stakeholders have invested in a participatory process. The ComMod approach is subject to this state of affairs.

Although a number of research scientists in the ComMod group would like to accompany the decision process up to the effective implementation of the solutions devised by stakeholders, this in fact is not always possible because 'the accompaniment is situated upstream of technical decisions'. In reality 'the ComMod group lays claim to a modelling process enshrined in the decision process that is not the consultation process in and of itself' (Chapter 1). Companion modelling also emphasizes the importance of recognizing 'the uncertainty of decision situations in renewable resource and environmental management' (Chapter 2), and aims to help stakeholders handle this uncertainty while proposing a negotiated framework for social action.

Facilitating the understanding of ecological and social system operations

For individuals to be informed, express an opinion or participate in a mediation process in a complex situation, they must be able to understand and make themselves understood. To do so, we believe they must be placed first in a learning situation, be provided with information and organize this information into a meaningful whole.

By adhering to the charter, and by accepting the refutation of explicit hypotheses as an essential means of increasing knowledge, commodians place themselves in a learning situation. Furthermore, as is true for all mediation processes, the ensemble of participating parties, not only the research scientists, should place themselves in a learning situation in relation to other people's points of view during the ComMod process.

The information allowing understanding of interactions between ecological and social systems is often disperse, incompatible, incomplete, redundant, unreliable or contradictory. Commodians try to get around this situation by soliciting not only the knowledge of the research scientist but also the layperson, the technician, the institution and the student (Chapter 2). Irrespective of how these different forms of knowledge are made explicit, their consideration is conditioned by their integration, at the source, in a co-constructed, conceptual model. What is important is to understand and make understood the organization of the ecological and social systems of the intervention through the expression of different points of view.

The modelling process, applied to transformations in ecological and social systems, their resilience and the search for the conditions of their viability, helps to overcome data inadequacies and barriers to experimentation through simulations. Modelling neither aims for nor is based on an exhaustive dataset; rather, its objective is to render data coherent through a simplification that makes sense to the stakeholders consulted and involved.

This is the basis that makes interactive forecasting possible, not to 'foresee the future' but to discuss 'envisaged futures'. The expression of different viewpoints allows the organization of the targeted ecological and social system to be envisaged. The commodian's role is then to 'to encourage the system of interactions presiding over change, to continuously monitor and make explicit changes in the system in order to be able to propose adaptations and to continually learn by observing the effects of these adaptations' (see Introduction).

This role involves making choices that are not neutral (Daré *et al.*, 2007), because the mere presence of scientific observers shapes the representations that each person makes of the system. However, neutrality is not the objective of the ComMod research scientist as he is a stakeholder among other stakeholders. He is committed to ensuring the transparency of hypotheses and procedures and to maintaining the possibility of refuting them.

The impact of the implementation of the principle of participation

It is difficult to evaluate the impact of the implementation of the ComMod approach (Chapter 7). However, in terms of promoting sustainable development, we can affirm that the group's research scientists contribute to the clarification of dynamics regulating ecological and social systems, the development of tools and methods promoting stakeholder involvement for sustainable development, and the precision and operational potential of the concept.

Clarification of the dynamics regulating ecological and social systems

'The application of the approach allows an increase in knowledge about the targeted ecological and social system through learning about the existence of different viewpoints and the consequences of their diversity on the way the system functions' (Introduction).

This knowledge, related essentially to the management context, highlights and clarifies interactions between stakeholders and the consequences of these interactions on the dynamic of the targeted ecological and social system. Exchanges orchestrated through companion modelling around a contextualized set of problems allows participants to ask themselves questions regarding the resilience of ecological and social systems and, continuing in this direction, on the living conditions of present and future generations. This questioning enables individual and collective learning adapted to the promotion of sustainable development.

The confrontation of scientific and social viewpoints around and about the sustainability of a socio-ecological structure, and ensuing systematic discussions, contribute to the emergence of shared knowledge produced by the group and reintroduced to be validated and evaluated by each of the disciplinary fields mobilized. Beyond case studies and monographs, the implementation of the ComMod process authorizes the development of a constructivist approach concerning the operations of ecological and social systems. The relevance of the theoretical models developed by the 'thematic specialists' is often discussed during the co-construction of multi-actor conceptual models and is questioned in interactive simulations. Whatever the school of thought or discipline of the research scientist[9] involved in the ComMod process, these doubts and implications for the evolution of knowledge in their field often leads to the publication of scientific articles.

The scientific knowledge produced, whether contextualized or theoretical, enriches the concept of sustainable development and increases its operational potential in so far as the management of renewable natural resources (a favourite commodian domain) is a field where interactions taking place between stakeholders at different territorial organizational levels strongly influence the well-being of future generations.

The development of tools and methods promoting stakeholder involvement

Along with other actors, commodians also generate knowledge about companion processes. Methods and tools are developed, adapted and improved during a dynamic research process aiming for ever greater efficiency and effectiveness. The value of these methods and tools appreciates, among other elements, proportionally to the involvement of stakeholders in favour of sustainable development.

In the fields of cognitive and computer science, commodians help to develop methods allowing the formalization of complex systems (e.g. the ARDI method, UML diagrams, ontologies, etc.), the placement of stakeholders in contextual situations (e.g. role-playing games, participatory mapping, focus groups, etc.), and the simulation of the co-evolution of ecological and social systems' (e.g. the development of simulation platforms such as Cormas and Mimosa, enriching knowledge about multi-agent systems, etc.).

The participation of stakeholders, envisaged through the formalization of complex systems, practical case studies and/or interactive forecasting[10] helps them to refine their

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[9] In terms of economics, Kat Aware relates to an attempt to internalize externalities, Tarawa to economic ecology, Domino Réunion may be associated with questioning initiated by de-growth theories given the issues linked to maintaining agriculture in La Réunion in a context of strong population growth.

[10] These different forms of participation may be considered separately or simultaneously depending on the objective pursued and the resources available.

knowledge of interactions between society and the environment, the impact of changes in systems influenced by humans and their possible evolution over time.

Furthermore, the development of a shared vision of a complex system enables participating parties to understand better the issues confronting the socio-economic structure in which they will insert themselves and the role they will play there. Companion modelling facilitates the expression of different viewpoints about a targeted ecological and social system, and the confrontation of these different viewpoints enables stakeholders to develop arguments that enrich democratic debate. Once thus articulated, the different viewpoints can be presented to territorial managers and decision-makers. In this way, the participating parties influence public decision-making while taking into account the necessary collaboration between institutional stakeholders. What is involved here is a contribution to governance because it helps to 'clarify the links that sustainable development institutes between stakeholders and land by proposing a decision-making rationale better adapted to assuming responsibility for the environment' (Laganier *et al.*, 2002).

Interactions developed within the framework of the ComMod process thus *a priori* induce within participants 'a modification of knowledge concerning their interactions with the dynamic of renewable natural resources, a modification of power relations, a modification of their capacity to plan the collective use of resources, a possibility of transferring new knowledge to actors who have participated in only one of these processes' (Chapter 1). Potentially, these interactions reinforce the stakeholders' capacity to control the social changes induced by projects trying to stabilize social, economic and ecological organization, and reduce the vulnerability of some of them in the face of these changes.

The contribution of research to the precision of the concept and the operational potential of sustainable development

The implementation of the ComMod approach in several case studies stimulated numerous exchanges between research and development, particularly regarding how to reformulate the stakes of sustainable development and how to assess the risks and opportunities related to the management of renewable natural resources that present themselves to citizens, managers and decision-makers.

Given the extent of the hazards threatening the ecological systems on which people depend for their survival, the international community is imposing models aiming for sustainable development. The ComMod approach contributes to this effort by applying a model on a territorial scale. This is the scale best suited to development projects (Torres, 2002)[11] We work to increase the resilience of societies or, in other words, their capacity to adapt to change within an emerging socio-ecological system.

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[11] 'Local stakeholders need to produce norms concerning their territory. The correct mechanism thus is the following: within a procedural, overall framework, one sets the overarching agenda (descending logic of the production of norms) and the local stakeholders produce norms to apply this agenda with their own perceptions and arbitrage (ascending logic). Local stakeholders cannot imagine a precise objective of optimal sustainability, which is necessarily a complex concept, but they can act on the basis of the overall agenda for which there are strong reasons to believe they will converge on the set of objectives considered as simply appropriate. The production of local norms will therefore take place through empirical trial and error, step by step, in a context of daily grappling with the area's environmental problems and in relation to the overarching agenda articulated at a global level' (Torres, 2002).

Sustainable development effectively involves a radical change in the structural organization of society. It means moving from a 'modern' social system focused on increasing productivity to exploit natural elements to satisfy human needs to another, post-modern system based on the sustainability of ecosystem management and the exploitation of renewable natural resources to satisfy the needs of both present and future generations. This change involves a significant capacity to adapt, which we propose to accompany. In this context, social resilience (USAID, 2006) is understood by commodians to be the society's capacity to absorb the full amplitude of the perturbations revealed by this new vision of development, that is sustainable development.

We take a territorial-based ecological and social system, we construct a representation with stakeholders and, through the learning enabled by interactive role-play, and we reinforce the social resilience of the group of participants. Their capacity to adapt to change (e.g. in practices, representations, discourses, etc.) increases thanks to the appropriation of the concept and stakes of sustainable development and to the interactions that develop within the project group. The process improves the capacity of the group to identify and address perturbations (e.g. predator behaviour, inertia of unsustainable exploitation systems, etc.) that might destabilize the structure and organization of the socio-ecological system revealed by the co-construction. This has, furthermore, consequences for reducing the vulnerability of the most fragile stakeholders.

We thus adhere to the view of the Resilience Alliance (www.resalliance.org) that a social system's resilience aims to increase the capacity of stakeholders to anticipate and plan their future. Applied to socio-ecological systems, resilience is characterized by the amount of change a system can integrate while remaining functional and conserving control over its structure, the system's capacity to reorganize, and the degree to which it is involved in building and increasing its capacity to learn and adapt.

This being the case, companion modelling also reveals the importance of taking into consideration different organizational levels in the development of a decision process concerning an ecological and social system (Chapter 10). Up until now, our case studies generally focused on the local level, even if this level was linked to other organizational levels. At this scale, the analysis of social relations and the context of collective action enabled public decisions to be sensitized to social equity requirements that are integral to sustainable development.

Changing scales, however, is now one of our research priorities, first to expand the reach of the outcomes obtained at a local scale, but also because we know that all change at the territorial scale can induce damaging effects of inequity, inequality or social exclusion on neighbouring territories. The model of the socio-ecological system that is co-constructed in the ComMod process is in reality subject to numerous other perturbations than those imagined in the model. These perturbations come notably from the reintegration of the socio-ecological system in dimensions involving multiple spatial and temporal scales. Beyond mobilizing the ComMod process to research management options for renewable natural resources at the local scale, it is appropriate to ask whether these options may be acceptable to, and accepted by, other organizational levels in the territory.

This leads us to take an introspective look at the nature of engaged research's contribution to sustainable development. The question is whether the ComMod approach should contribute to the development of participative democracy by seeking the involvement

of other organizational levels from the start of the process, or should it limit its role to uniformly reinforcing the capacities of all stakeholders in order to give them the argumentative tools for negotiations that they must undertake on their own (Chapter 5)?

Transparency on the empowerment of stakeholders

The application of the ComMod process comes up against a number of difficulties that are shared by all participatory approaches. The number of individuals willing to participate is necessarily limited as it is impossible to involve the entire population potentially concerned by the problem raised in the participatory process. In numerous cases, the legitimacy of participants is debated and their representative capacity questioned. Some therefore abandon the process in midstream just as others are joining. Thus there is a turnover, the importance of which is generally correlated to how long the participatory process lasts. Participants rarely are autonomous at the end of the implementation of a participatory process, one that remains long and expensive and which generally does not lend itself to the rapid implementation of concrete action. Finally, the involvement and sensitization of concerned managerial decision-makers in a territory is indispensable because they will be the supervisors of the concrete actions decided by the collective formed during the process. However, a hegemonic vision of political and institutional rationality is sometimes difficult to surmount.

According to some authors, these difficulties tend to weaken the relevance of participatory democracy as an engine of sustainable development. In our view, the main goal of sustainable development is to promote the involvement of all the stakeholders concerned by a renewable natural resource management issue through a process of information, decision and collective action. Ideally what we need to envisage, through the establishment of consultation arenas, are social relations fostering sustainable development.

While sustainable development is a process of change that concerns everyone, it is not possible to place *de facto* the entire population into a dynamic of thinking and acting differently and adopting another way of understanding development. The population cannot uniformly and instantly divest itself of the positivist, universal and linear vision of mankind's future that was developed over time to justify 'modernity'.

By considering sustainable development as a process induced by a complex and dynamic socio-ecological system that generates strong uncertainties, commodians assume the position of companions to change. They recognize that the impact of the ComMod approach is necessarily contingent and that they do not have at their disposal the means to guarantee perfect control over a sustainable development process whose implementation relies on considerations outside the scientific domain. In other words, ComMod research scientists place themselves in a post-normal framework. According to Funtowicz and Ravetz (1994), when dealing with decision processes in the highly uncertain situations lying at the heart of important social challenges, it is not the quality of the decision that needs to be improved, but the quality of the process that leads to making the decision. While the quality of the decision-making process may not necessarily guarantee the quality of the decision, the post-normal stance is based on the hypothesis that the former greatly influences the latter. It consequently is important to associate within decision-making processes diverse stakeholders holding divergent values and interests in relation to the stated problem.

Under these conditions, the objective is to mobilize oneself, according to the progressive articulation of stakeholder demands, to improve the quality of decision-making processes related to the conception, elaboration, implementation and evaluation of public decisions. To do so, one of the fundamental elements in the application of the ComMod process is seeking the maximum transparency possible to empower stakeholders.

The concern for transparency is founded on a culture of evaluation. In our view, this is part of a 'quality approach' in which the contractual terms established with partner stakeholders may be constantly redefined. Furthermore, by relying significantly on peer review, such evaluation aims for recognition from the scientific community regarding its approach and originality, and thus enabling its evolution and diffusion.

The accompaniment of socio-ecological organizational change applied to renewable natural resource management commits research scientists to constructing possible 'solutions' and their modes of implementation. While a research scientist normally is much less subject to socio-affective manifestations related to the identification and sense of belonging to a territory than members of civil society, he nevertheless holds, consciously or not, values that he draws on in such a social project (if only in referring to the framework of discussion and action of sustainable development). The research scientist must take care that his scientific status, which naturally gives him the legitimacy to set an agenda, is not experienced or seen as a problematic imposition laid down with a symbolic violence to which one agrees without actually believing. However, this must not lead him to remain removed from the practical solutions that the participants develop rather, the research scientist should continue to analyse them critically and transparently so that governance rules may come to light.

More transparent research for the increased empowerment of stakeholders may be included in a quality approach framework applied to the formalization of objectives and to the conduct and consequences of implementing a ComMod process.

Regarding objectives

Before initiating a ComMod process, it is important to define clearly the objectives of the research with all of the participating parties. This process must be transparent in so far as it is the foundation for the legitimacy of the research activity. The Association française de normalisation (AFNOR) proposes three basic criteria to construct the quality process during this first stage: (i) relevance, or novelty and originality; (ii) opportunity; (iii) feasibility.

(i) The question of the relevance, or novelty and originality, of a new application of the ComMod process can be assessed by looking at the work already carried out by the group. This analysis is facilitated by systematizing the way different case studies are presented through the frameworks and various typologies proposed in this book. These also make it possible to assess whether the field of application, problem set, implementation and final goal of the planned project correspond to, and/or are likely to enrich, the group's practices. Furthermore, when the approach involves several commodians, or when the case studies are debated during annual meetings, discussions between members of the network help refine the evaluation of the project's objectives in regards to the state of the art.

(ii) Given its nature, the potential of a ComMod approach must be assessed on a case by case basis with the ensemble of stakeholders. The evaluation of objectives, therefore,

will be undertaken in relation to the strategic directions and needs identified by each as a function of the situation. In this context, it is appropriate to assess the modalities and end goals of the application of the principle of participation as envisaged by each stakeholder. Is the question one of informing or training, evaluating, having pre-constructed decisions accepted or applied, or helping co-constructed decisions emerge and be formalized? The definition of companion modelling objectives, determined within each project by sustainable development stakeholders, inherits the conceptual uncertainty linked to the application of the principle of participation. Yet the effects of companion modelling are heavily dependent on the strategies employed by the concerned stakeholders with a view to the application of the principle of participation, and the approach relies on the active investment of these stakeholders. This investment is motivated and limited by the end goal they initially attribute to the principle of participation. The risk of manipulation exists. The commodian, who is aware of this situation, must make his position to pre-existing power relations explicit while helping everyone else involved do the same (Chapter 5).

(iii) The feasibility of the research consequently is heavily dependent on the context of intervention. In fact, the ComMod approach is not a theoretical, experimental tool seeking to find an optimal organizational solution for a given ecological and social system. It aims to accompany a political process anchored in the social, economic and ecological systems of a territory. It is, therefore the responsibility of the commodian to understand this context. In which political processes are potential ComMod participants involved or wish to be involved? How is this process integrated into the socio-political environment (e.g. organizational level of public decision-making, NGO intervention, etc.)? Is the commodian able to facilitate the emergence of shared knowledge, promote collective action, call into question prefabricated solutions (including his own) for the problem raised and work over the long term to reinforce stakeholders' capacities and defend their interests? These questions may be addressed through preliminary studies and surveys. However, the interactive understanding of the context also constitutes an opportunity for the commodian to clarify his own position and the nature of the ComMod approach, and to ensure that his point of view is understood and accepted by various partners. It is important to make explicit and to specify the objectives each stakeholder assigns to a ComMod approach as far up the organizational hierarchy as possible. Each stakeholder will formulate specific expectations, ones based on his own status, history and responsibilities, and in defence of his own interests, that deserve to be made explicit to all participating parties (Chapter 4).

The research scientist, who is evaluated by his publications, will use the information produced by the application of the ComMod approach to enrich scientific knowledge in his field of expertise. This objective must be explicit because it might conflict with the ethics of a mediation procedure, if this was what motivated the appeal to the ComMod approach, or with a desire for confidentiality on the part of those involved. Politicians, while they are often subject to an ethical and even legal obligation to communicate openly to the public the objectives and modalities of their intervention, may be led to invoke the need for secrecy, or to abuse their power when confronted with a sensitive, controversial or conflictual issue. For their part, participating citizens must establish their legitimacy, both in the eyes of the group they are supposed to represent and in those of their counterparts. In such a context, they must manage multiple contradictions while defending their personal and community interests.

The identification and formalization of political stakes and power relationships by the commodian in each case study and preliminary discussions with stakeholders concerning these issues are difficult, but contribute to the assessment and sharing of risks linked to the implementation of the process. On this basis, and as far as possible, the attempt to be transparent and formalize relations between stakeholders will improve the social utility and overall quality of the research work by anticipating the difficulties linked to possible manipulation, concealment of information or refusal to participate. Lastly, the planning of the implementation of the process assumes that there will be a match between available resources (e.g. technical and financial) and expected results. The formalization of this match, even if it is repeatedly modified afterwards, is a means of soliciting the involvement of the stakeholders approached. The precision and shared formalization of objectives incontestably guarantee a better appropriation of the context by all stakeholders, greater legitimacy for the implementation of the approach, and a better assessment of the promise of the solutions that may be developed. If the initial idea of turning to modelling is maintained, this exercise will help to verify whether the process meets the expectations of the research and the society, and if such is not the case facilitate stakeholder ability to reorientate the project.

Regarding the conduct of the ComMod approach

The implementation of the ComMod approach is subject to numerous uncertainties that are further amplified by its iterative character. Despite efforts undertaken during the collaborative definition of objectives, it may be difficult to envisage *a priori* a rigorous description of the research process. 'On the other hand, it is always possible, realistic and often useful to specify *a posteriori* the intellectual, technical and scientific path followed by the research team once they achieve their goal or when they choose to take a break in order to discuss their work. In this case, the quality approach favours knowledge and skill-learning mechanisms and a return to experience and making the most of knowledge' (AFNOR, 2001).

AFNOR proposes four basic criteria for the construction of a quality approach in this second stage: transparency regarding the realization of objectives; respect for the time allocated to research; control of resources mobilized and used; seeking alternatives when initial avenues reach an impasse.

The logbook was developed to meet the objective of transparency (Chapter 1). It is kept by the promoters of the approach as work is underway to increase the transparency of the process and ensure the traceability of activities and results. This tool makes it possible to inventory intermediate results and place them in their production context, which allows, when need be, debate over whether the objectives or resources initially allocated should be revised. Respecting the time allocated for the implementation of the approach depends greatly on the availability and involvement of partners. It is here that animators play a fundamental role. They are responsible for organizing and circulating among the diverse partners the information exchanged or developed during collective key moments and to note actions undertaken between these periods. When required an animator must also, in association with the promoters of the approach, ensure that 'the necessary transparency and foreseeable nature of the process does not result in a blockage of initiatives and projects, notably due to the time and resources required for consultations'.

In companion modelling, the most important technical and methodological points to master are – beyond a required command of social science data collection tools (e.g. interviews and participatory observation) – collective key moments and, when the need arises, the development of models. Concerning the first point, transparency and formalization falls once again to the animator who must be sufficiently experienced to be able to play the role of facilitator, mediator or guarantor of group unity depending on the situation. Throughout the process, these roles, made explicit by the work of the ComMod group, are updated and recognized by the different stakeholders involved in the process. Concerning the second point, it has been noted that participants do not always feel capable of contesting a model (notably when it has not been accompanied by role-play facilitating discussion and its appropriation by stakeholders). Their ability to refute a model depends on their capacity to grasp the level of complexity that the modeller chooses to represent, and on their will to invest themselves in a co-construction effort that would enable the more or less precise decoding of the model's black box. It is up to the modeller to minimize the difficulties that stakeholders encounter in questioning the model. The modeller must seek to differentiate between commonly accepted ideas about 'experts' models' (from which companion models strongly differ) and to diminish the risk of continuing confusion. 'The commodian, therefore, will consecrate part of his energy to clearly framing the quantitative or spatial validity of data produced, or to impeding the aesthetical or visual aspects of proposed model outputs from obscuring the relevance of discussions.'

The control of material and financial resources generally is imposed on ComMod research scientists by their parent institutions responsible for the administrative manage-ment and financial accounting of projects. These institutions, subject to budget controls, are developing tools that are increasingly powerful (and time consuming) within the framework of their own quality processes. Lastly, the search for possible alternatives to problems arising from the realization of the objectives that were set initially lies in the iterative character of the process. Companion modelling can lead to unexpected but interesting results, and orientate itself towards undertaking a 'new loop'. If, on the other hand, the problem is caused by certain partners' attempts to manipulate, conceal infor-mation or refuse participation, alternative solutions must be developed, as upstream as possible, with the remaining partners with the intention of continuing the research effort if it is still deemed relevant.

Regarding the valorization of results

'Research produces a set of often complex elements that cannot always be precisely defined and specified in advance. This set is notably made up of new information and knowledge, arguments regarding the limits and field of validity of this knowledge in addition to new, clearly expressed questions. Outcomes that do not correspond to the initial objective, as well as research avenues that have been dropped, can be of great value' (AFNOR, 2001).

AFNOR proposes two basic criteria for the construction of a quality approach during this third stage, which consists of the validation of outcomes and their transfer. This must be carried out first with the partners of the research, in other words, the stakeholders involved in the ComMod approach. They are the first to validate the significance of outcomes and the envisaged use of knowledge and uncertainties attached to them. During

each collective key moment, debriefing stages play this role. This validation is documented by the writing and validation of reports on the proceedings. It is, however, more difficult to validate results linked to participant learning, unless specific questionnaires are distributed, ideally given to participants not only during collective key moments, but also on a regular basis.

The transfer to the scientific community of the outcomes of a ComMod process can be envisaged, within the limits of possible confidentiality clauses, in various forms (e.g. articles in scientific journals, congresses, colloquia, expertise, patents, etc.). However, this transfer must also involve managers, decision-makers and citizens. The ComMod approach presents itself as a means to promote sustainable development in so far as it allows stakeholders who so wish (and who have a stake in so doing) to be involved in the design, development and evaluation of public decisions. These stakeholders' expectations consequently often go beyond having the outcomes simply validated by the people directly involved in the ComMod process. This is the context that the scope – and thus the modalities of transmission – of outcomes produced through the application of a ComMod process is placed.

Commodians, however, cannot assume that the consultations initiated will necessarily result in the taking or implementation of a public decision. These dimensions are the responsibility of stakeholders who are directly and indirectly concerned for two essential reasons. Beyond the identification of norms likely to establish an environmental policy, their formalization is an autonomous process (writing, legislation); once the environmental policies are formulated, their implementation concerns another type of dynamic (i.e. the effectiveness and efficiency of environmental policies given the continuously evolving social and environmental context).

By eliciting the participation of stakeholders in the analysis of socio-ecological dynamics and the potential impact of their actions on the systems studied, the ComMod approach creates a sense of responsibility among stakeholders directly involved in the application of the process. However, the transfer of outcomes is not always enough to elicit the same sense in stakeholders who remain outside the process yet who nevertheless play a crucial role in making and/or implementing public decisions.

The ComMod research scientist, who is aware of this situation, helps to reinforce the conditions that allow participants to influence public decisions and their implementation as far as his resources permit. This contribution can take the form of an adapted and detailed formalization of the outcomes obtained, or even the development of recommendations relative to the appropriation and communication of the outcomes of the process in order to fuel the decision process to come. In terms of sustainable development, it appears important to transfer the outcomes of engaged research to citizens, notably through training. The case studies may thus enrich the examples of training given by members of the group (Chapter 11).

The work undertaken under the ADD-ComMod project undeniably has helped to clarify a formal framework for the quality approach. This approach is considered as a tool to be used and adapted on a case by case basis with project sponsors (e.g. identification of criteria and indicators, definition of resource obligations, specification of expected products, means of communication outcomes, etc.). It ideally is complemented by a peer evaluation using a grid proposed by the ComMod group (Chapter 6), which enables the different points addressed above to be finely formalized through the aid of

an external perspective. The quality approach and evaluation methods are now systematically planned by commodians, who are convinced that these contribute to the increased satisfaction of partners, enriching the knowledge produced by companion modelling, and the recognition and development of the group.

Conclusion

The ComMod approach is firmly part of the sustainable development process. It contributes to promoting engaged research aimed at the empowerment of people in the management of renewable natural resources and the fight against inequality and social vulnerability. The network of experts mobilized use improvable tools and methods to further scientific knowledge about understanding and managing the complexity of socio-ecological systems and contribute to a more masterful application of the principle of participation. In a context in which the end goals of the application of this principle are uncertain, supporters of the approach wish to give themselves the means to be transparent, as much regarding the objectives and conduct of the approach as the scope, through the control of risks and opportunities induced by the methods mobilized. The quality approach is one means to achieve this objective of transparency.

The ComMod approach hopes to contribute, through interactive research on modes of governance adapted to concrete situations, to the empowerment of a growing number of stakeholders faced with the challenges and means of sustainable development. Nonetheless, the ideas put forth within the framework of a ComMod approach do not lead systematically to collective action, which involves other considerations that cannot be controlled with certainty.

This does not mean that commodians disengage themselves from the use made of the process once their involvement is over. It is clearly up to them to help define the modalities by which participants may critically appropriate the solutions and actions defined during the process. This means that they are not in a position to decide public action, but they can think about and perhaps orientate it.