Scenarios in the System Design

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INTRODUCTION

Scenarios represent above all some projection of the future. Projections or visions of the future have always inspired the thinking of possibilities and provided incentives for creativity. Be it a warning, a visionary desire - projections of the future can give orientation for actions.

Scenario planning is a method allowing to develop flexible long-plan strategies regarding specific issues. Basically, a group of stakeholders build together some models allowing to launch simulations games in a policy perspective. These models are based on observed facts for the but also on plausible trends regarding different driving forces which influence the dynamics described. These driving forces can be demographic, economic, political or environmental ones.

Robert Costanza and Matthias Ruth (1998), among others, have highlighted the importance of developing some user-friendly models that would permit to build consensus across not only within each field, but also between scientists and local stakeholders, in order to develop legitimate scenario for all stakeholders.

System dynamics models are particularly adapted to adopt both a systemic and reference scenario approach to launch simulations in which interaction indicators are connected by non-linear relations (Couvet et al., 2008; Levrel et al., 2009a; Vennix 1996; van Eeten M. and Roe 2002; Janssen 2003; Gurung et al. 2006). Scenario planning involve aspects of system dynamics, especially the fact that social-ecological parameters are interlinked through non-linear relationship. It is a source of complexity, of surprises and of unpredictable feed-back loops.

It is why it has been suggested to use simultaneously scenarios planning and system models to improve information and governance regarding social-ecological interaction .

With such models one may develop artificial social ecological systems where human and ecological entities evolve together. One could test alternative "what if" scenarios in order to project what scenarios are to come and to facilitate negotiations among local stakeholders. They have been used successfully in many contexts to get a better understanding of how social and ecological interactions work and to facilitate collective discussion regarding natural resource management (Costanza and Ruth 1998; Rouwette et al. 2002; Etienne et al. 2003; Bousquet and Le Page 2004; Gurung et al. 2006).

This scenario approach would highlight interactions between economic dimensions, social questions, ecological dynamics and individual representations. This leads to a better understanding of current social-ecological dynamics at different scales and to clarify the main stakes linked with specific issues.

BACKGROUND

Scenarios are pluralistic, future-oriented models of the state of systems such as social-ecological ones in the coastal zones.

Many modeling paradigms are built on the basis of "equilibrium" and "optimum" concepts. These model categories are not suitable in the context where uncertainty is high (Boulanger et Bréchet, 2005). By exploring different "what if" scenarios, system modeling helps in articulating long term dynamics and short term preferences. Simulations enable users to take into account uncertainty because it is possible to compare, for example, the best and the worst scenarios, and all the scenarios which correspond to potential concrete future situations or to potential policy decisions.

The idea is not to find an optimum but, at contrary, to test several assumptions, to explore potentiality and to raise discussions about the results obtained.

Such scenarios, comparing the effects of different policies, bringing information to stakeholders, supposedly to contribute to decision-making, might be advantageous for several reasons: the capacity to transport people to the future and to connect the future events they observe with current choices; the capacity to connect together some ecological trends, some economics goals and some political decisions; the capacity to develop "what if" scenarios proposed by the participants in order to make the indicators more dynamic, or, shall we say, more 'lively' ; to make explicit heterogeneities in the relationships between stakeholders ; to analyse the outcome of the manifold interactions between stakeholders. In addition, using scenarios from an artificial worlds is a source of savings. Saving of money because you don't need to launch a huge experimentation in the real world to test some assumptions. Saving of natural resources because you don't need to destroy an ecosystem to assess the potential impact of a natural damage. Saving of time, human resources, monitoring system, etc.

To be short and clear, "the chief value of scenario planning is that it allows policymakers to make and learn from mistakes without risking career-limiting failures in real life. Further, policymakers can make these mistakes in a safe, unthreatening, game-like environement, while responding to a wide variety of concretely-presented situations based on facts. This is an opportunity to 'rehearse the future', an opportunity that does not present itself in day-to-day operations where ervery action and decision couts" (Wikipedia, entry "scenario planning").

It is possible to uses scenarios in two ways:

1) As explorative scenarios which are used for strategic decision making. These scenarios are characterized by „investigating" the future. They need to open up the scope of the

relevant future possibilities and they are usually constructed based on key factors and their possible future developments (supported by combinatory methods).

2)As normative scenarios which are most used in innovation processes in order to reach an objective and as creativity pool. They have a normative and explicitly assessment-oriented character and need to present attractive, sufficiently positive and preferably precise images/illustrations of the future. They also combine possibilities that can become reality and which are based on reality. However, they select them with regard to the desired developments.

Table XX : Different types of scenarios

Different types of scenarios	Trend scenario	Framing scenario	Normative scenario	Contrasted scenario
Main goal	What are the potential futures	Ranging future options	Desirable futures Path to get this	Trade-off regarding future desirable goals
Background	Main assumption : Business-as-	Main assumption : Business-as-	Main assumption : desirable goals	Main assumption : desirable goals
Process	Maintain the current trends and the main	Test different options regarding the	Links between the future goals and the current	Links between the future goals and the current

Source : ???

PARTICIPATORY SCENARIO BUILDING

With the help of scenarios, stakeholders can learn the process of “decision-making“. Scenarios give them projections of different and consistent ways of development and they reflect possible consequences and options for action.

The aim of communicating and presenting the scenarios is that stakeholders become aware of the different alternatives for the future and training possibilities (on a scientific basis).

It has to be made clear to the audience that scenarios are by no means a certain prediction of the future. Their objective is in fact to present possible future conditions in such a way that this same audience is able to imagine these conditions, to find subjective interrelations/connotations and to thus creating a basis for discussion and deliberation. They are about gaining own imaginations and desires with regard to the described futures – depending on whether the presented scenarios and their details seem desirable, ambivalent or even frightening.

Also, it has to be made clear that none of the scenarios will need to be accepted entirely. Some people of the audience can favour it or not and identify themselves with a certain person or attitude – or not. Scenario modelling is a tool for empowerment towards a proactive and framing perception of the future and the transition to the deliberation process.

A significant characteristic of scenarios is that they allow a positive look into the future. The desirable chances and benefits can be put in front without letting the scenarios become an utopia and without fading out disadvantages, risks or problems – they are faced, not removed. Not an "utopia" shall mean that scenarios are linked to social contexts, to trends and to developments of the region or community. They can as well be hooked to technology and are dealing with innovations which are considered as possible/feasible for the expert group.

Speaking about trends implies that the logical time scale for the presented scenario is a medium time horizon: ten up to a very maximum of twenty years.

When constructively and critically dealing with the scenarios, the stakeholders could ask the following questions during the presentation of the scenarios:

- How desirable do the presented developments and conditions seem?

- Which aspects should be different and which ones need to be added in order to make the overall results more coherent?
- Would it be possible to promote those scenario elements which seem desirable to "me" and to avoid those that don't seem desirable?

Public audience

Owing to their larger public audience, participatory scenarios should contribute significantly to a choice between policies (Couvet et al., 2008). Participatory scenarios bring larger public audiences because a larger number of individuals are involved and are willing to broadcast the results. The greater the public awareness of scenarios, the more likely these scenarios will influence policies, for three sets of reasons: first, individuals will be more likely to alter their behaviour when environmental consequences are scientifically demonstrated (Milinski et al., 2006); second, new policies involving intricate socio-economic consequences should be easier to enforce when their consequences are clearly explained (such policies concern for example economic incentives and disincentives to avoid the 'tragedy of the commons', specifically over-exploitation and under-delivery of common resources) (Rosales, 2006); third, 'what if' scenarios are strongly connected with alternative perceptions of a common problem and allow clarification of the main sources of divergence (e.g. amongst the four MEA scenarios, 2005).

Identification of significant heterogeneities

Participatory scenarios could be an important tool for identifying the range of human responses to the diversity of environmental and socio-economic conditions occurring. Both indicators and scenarios ought to characterise the relationships between the environment and the different stakeholders, through productive, consumptive and recreational activities, in order to proceed to a relevant analysis of such socio-ecosystems. Relevant analysis of socio-ecosystems requires the significant sources of heterogeneity in these relationships to be taken

into account, as well as adequate representation of the diversity of motivations and responses among human actors (Pretty, 2003).

Professional scientists might overlook the diversity in the relations between humans and the rest of nature, as some social groups are poorly represented in ecological research (Starzomski et al., 2004). Participatory scenarios might facilitate identification of these heterogeneities since the diversity of citizen viewpoints will add to the diversity of viewpoints already considered by professional scientists.

Analysing the effects of interactions between stakeholders

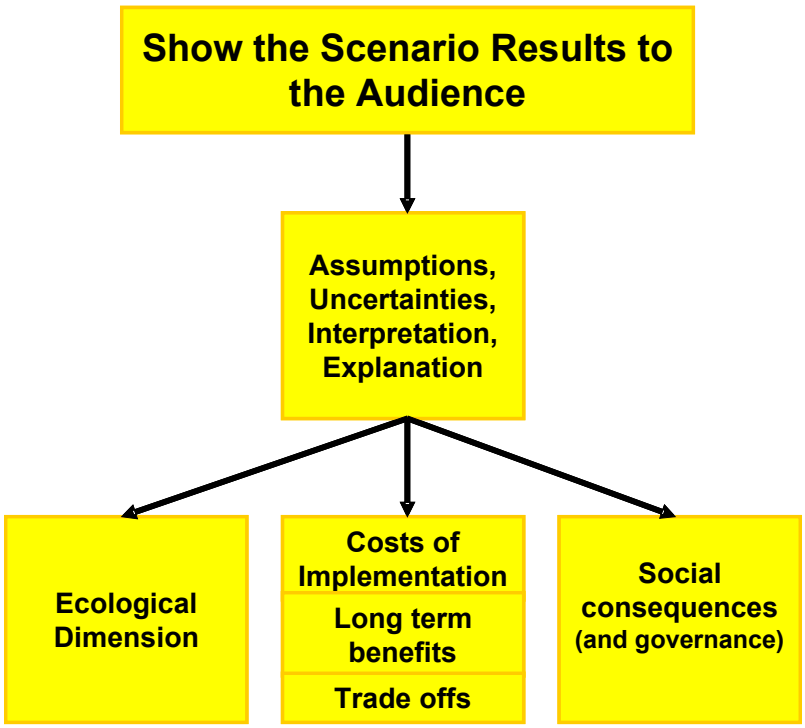
Participatory scenarios contribute to exploration of the complexity of interactions between stakeholders. Given the large number of interactions to consider, a large number of experimenters might decisively contribute to the analysis of these interactions. A related example illustrating such advantage is the large-scale participation of citizens in modelling exercises, as with the large-scale computer model of the climate change project (Lundmark, 2006).

To analyse interactions between stakeholders, participatory scenarios can rely on interactive and experimental in order to examining stakeholder reactions to different situations, and more importantly to responses of interacting stakeholders, the effects of each (simulated) participant's action(s) depending on the others' (Bousquet and LePage, 2004). This can be more generally formalised as adaptive learning, where new institutions and new models are regularly tested by stakeholders to decide on their relevance (Wilson et al., 2007).

It contributes to an understanding of which conditions led to the benefits of cooperative relationships being reaped (Galasz, 2005). Stakeholder participation in scenarios might contribute to mutual understanding of different motives, the outcome of (non)-cooperative interactions, and most generally how the overall functioning of the ecosystem depends on the different actions, and hence to defining ecosystem resilience. Resilience depends on the set of

stakeholders present and on their reactions and interactions. As such, resilience cannot be a scientific construction independent of any interaction with citizens, and indeed citizen participation is expected.

Figure XX: Running the scenarios for audience



USER-FRIENDLY SUPPORTS TO MANAGE SCENARIOS

In the system modelling, simulations are based on “what if” scenarios which are proposed by participants. It is why it is necessary that the supports used to develop these scenarios and to present the results coming from them must be user-friendly.

Several types of tools can be used for this purpose: interaction matrices, indicators, diagrams composed of icons and arrows, geographic maps, role-playing game, pictures or movies (Levrel et Bouamrane, 2008).

Scenario modelling use in particular indicators in many ways:

- as some reference indicators to compare different scenarios at different moments and on various scales;
- as alternative sense-making indicators corresponding to alternative points of view on the same phenomenon;
- key interaction indicators, identified through sensitiveness analysis, which determine the main outcomes;
- as micro-indicators based on individual behaviours, connected with macro-monitoring indicators.

With such an approach, crossing scenarios and indicators, it is easier to improve discussions and collective learning process, balance arguments and provide information to carry out trade-off analysis for social, ecological and economical purposes (Reed et al. 2006).

Actually, the success of deliberation support tools is directly linked with his capacity to provide a mediation tools. A recent study compared different deliberative support tools regarding interactions between economic and conservation issues in West African Biosphere Reserve in order to identify the more sense-making ones (Levrel and Bouamrane, 2008 table XX). The tools tested were interactions matrices, diagram of interactions composed of icons and arrows, geographic information systems, and role-playing game (table XX).

Table: Example of mediation tools used to facilitate deliberation regarding social-ecological dynamics

	Matrices of interaction	**Diagrams with icons and arrows**	**Geographic maps**	**Role-Playing-Game**
Reserve where tool has been tested	W	Boucle du Baoulé and du Niokolo Koba	Boucle du Baoulé and Niokolo Koba	Niokolo Koba
Pro	Allow to support complex information concerning interactions	Allow to communicate vis-à-vis interactions	Allow to support spatial representations (area of the reserves…)	Allow to launch interactive and collective learning processes

Cons	Lack of relevance for local stakeholders	Lack of information	Lack of interactions	Lack of scientific status
Efficiency to launch discussions about interactions	Weak	Medium	Medium	Strong

Source: Levrel et Bouamrane, 2008

The utilization of interaction matrices did not yield useful results due to the complexity created by the large number of parameters, retroactive effects that were difficult to grasp, and the use of nouns and verbs that were often hard to express in a non-written way (most of participants were analphabet). The diagrams based on icons and arrow provided a way to communicate more easily, but did not make it possible to convey much information. It is the same for GIS: the spatial information is really sense-making but is limited to share information regarding the dynamics coming from social-ecological interactions. Role-playing turned out to be the most effective means to carry out simulations (Bousquet et al., 2002; Gurung et al., 2006). It stimulated a great deal of interest among the participants, with very strong participation and long impassioned discussions.

When simulations were based on matrices or graphics, these representations were produced by the mediator. When simulations were based on role-playing, the mediator simply organized them. In the first case, participants take a ‘command and control’ approach to system, making it possible to describe or ‘pilot’ it. In the second case, they are in a system and interact with it through the utilization of indicators (Levrel et Bouamrane, 2008). The scenarios are themselves the result of choices made by the players during the game. These choices have an impact on individual indicators – income, time available, investment, etc. – but also on the collective indicators that each player uses – availability of common natural resources. This type of simulation is useful because participants become individual users of the system they previously participated to create, which offers them a unique opportunity to appropriate this

model. In such a way, the players enjoy the direct observation of the impact of their uses, social interactions, certain rules of biodiversity dynamics, or of the retroactive effects that occur. In this context, scenarios are not really normative but more a kind of “emergent effect” based on the choices made by stakeholders during the game, and especially on their adaptive behaviour during it.

By taking system-based decisions, stakeholders capture it and realize they need new information to carry out their game plan. The connection between the system refinement and decision-making enables players to become aware of the direct and indirect interactions – social and ecological – on which they and the surrounding resources depend, but also to adapt their behaviour (individually or collectively) in order to deal with these changes. They provide the opportunity to begin repeated processes of individual and collective learning through different emergent scenarios about society-nature interactions. Role-playing in fact makes it possible to link ecological, social, and economic dynamics to individual decisions that have an impact on parameters concerning various players, which sooner or later prompt the participants to begin collective discussions with the goal of proposing and negotiating solutions to deal with these collective problems. These negotiation processes imply comparing the arguments of the various parties who use the co-constructed social-ecological system to justify this or that viewpoint. The process makes it possible to gradually identify the key or structural indicators that determine, to a large extent, the dynamics of the society-nature system tested through the scenarios. Lastly, role-playing gives managers and scientists an experimental tool to work on the system, since it enables the observation of how the information modelled are used as a tool for communication and decision making: those that make the most ‘sense’ for the players when they make choices concerning their activities or when they adapt their practices; those that will be mobilized during collective debates to justify a viewpoint or an action; and, lastly, those that seem to be the most legitimate for all

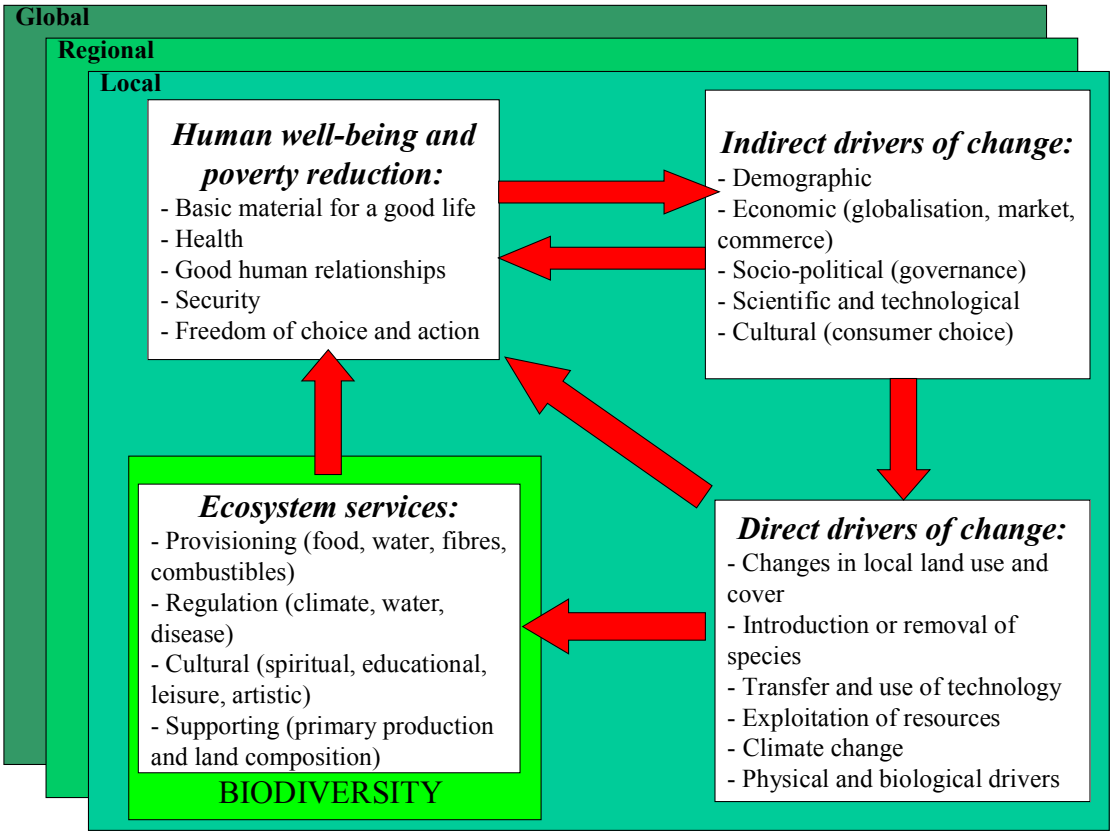
parties: all of this being necessary information to ensure better communication among stakeholders within coastal social-ecological systems.

Therefore, while models often represent a traditional tool for centralized planning and expertise, related most of the time to an approach in terms of 'command and control', role-playing offers the opportunity to use the model in an interactive, decentralized way at a local scale.

A GLOBAL SCALE EXAMPLE : THE MILLENIUM ECOSYSTEM ASSESSMENT

It was to improve the understanding of these interdependencies that the Millennium Ecosystem Assessment was launched by Kofi Annan in June 2001. Lasting for a period of four years, with 1360 scientists from 95 countries and an independent board of 80 people responsible for verifying the results of the research programme, its goal was to inform governments, NGOs, scientists and the general public about ecosystem changes and their effect on human well-being (MEA, 2005; Figure XX). This makes it the first large-scale program whose goal is the integration of the economic, ecological and societal issues involved in the conservation of biodiversity.

Figure XX: Relations between biodiversity, ecological services, change factors and well-being



Source: MEA, 2005, pp. 13-14

To perform this integrated assessment, the MEA analysed developments in ecological services over the last fifty years. The only services which increased were the provisioning services.

Between 1960 and 2000, world population doubled, going from three to six billion people. To cope with this explosion in human needs, major artificial components were introduced into ecosystems in order to adapt them to intensive extraction of food, fresh water, energy, wood, fibres, and other needs. These efforts were crowned with success: during the period 1960-2000, food production for the planet as a whole doubled; wood logged for the production of pulp and paper tripled; hydro-electric capacity doubled; the production of construction timber increased by more than 50%; the use of water doubled (MEA, 2005).

As a result, the average number of calories consumed per person per day for the world as a whole went from 2290 in 1962 to 2805 in 2002 (http://faostat.fao.org/faostat/); life

expectancy went from 46 in 1955 to 65 in 2005; the infant mortality rate went from 157 children per thousand to 57 per thousand (http://esa.un.org/unpp/index.asp).

However, the benefits of this intensified use of resources were distributed very unevenly[1] and were accompanied by major depletion of 15 out of the 24 services inventoried by the MEA (Table XX).

Table XX: Change in ecosystem services

Type of service	**Services**	**Direction of change**
Provisioning services	Agriculture	+
	Livestock	+
	Fishing	-
	Aquaculture	+
	Food gathered in the wild	-
	Construction timber	+/-
	Cotton, jute, silk	+/-
	Firewood	-
	Genetic resources	-
	Biochemical products, natural medicines, pharmaceutical products	-
	Fresh water	-
Regulatory services	Regulation of water quality	-
	Regulation of world climate	+
	Regulation of regional and local climate	-
	Regulation of the water cycle	+/-
	Regulation of erosion	-
	Water purification and waste treatment	-
	Regulation of disease	+/-
	Regulation of parasites	-
	Pollination	-
	Regulation of natural dangers	-
Cultural services	Spiritual and religious values	-
	Cultural values	-
	Recreation and eco-tourism	+/-

Source: MEA, 2005, p. 46

[1] The number of calories consumed per day in Africa is 2100 compared to 3400 in Europe (FAO); 800 million of the world's people still suffer from hunger (MEA); life expectation in Africa has gone from 51.5 years in 1985 to 49 years today (WPP); a child born in sub-Saharan Africa is 20 times more likely to die before the age of five than a child born in an industrialised country (MEA).

The 2005 report emphasises that 60% of ecosystem services are deteriorating. Among these, the renewal of fishery stocks and the production of fresh water seem to be the most threatened. This erosion has been more substantial during the last fifty years than in all of human history, and it will be even more substantial in the next fifty years. The inhabitants of the developing countries are directly affected by the threats resulting from the erosion of ecosystem services, and they bear most of the burden[2].

Based on its assessment, the MEA has developed a table showing the dangers expected over the next hundred years in the form of four scenarios. These scenarios were constructed using both the pooled opinions of experts on the "possible futures" of ecosystems, ecological services and human well-being, and global models which include the principal forces for change that impact ecosystem services[3]. The four types of scenario are as follows:

- "Order from Strength", which assumes that in a world of increasing risk, the solution will focus on security and protectionism. On this assumption, a fragmented world is organised into large regions split by conflicts of many kinds. Environmental problems are addressed reactively, in response to crises. Human and ecological risks increase globally. Economic growth is the weakest of all four scenarios, while population growth is the greatest.
- "Global Orchestration", which envisages an increase in the liberalisation of trade, as well as stronger global interconnections and the emergence of a world governance which will pursue a more effective war on poverty. The approach to the management of environmental crises is still a reactive one, resulting in serious risk from natural disasters for a large proportion of the population. This scenario leads to the strongest economic

[2] As Carl Folke observes (2003, p.233), "In rich regions the resulting crises have led to spasmodic lurches of learning with expensive actions directed to reverse the worst consequences of past mistakes. In poor regions the result has been dislocation of people, increasing uncertainty, impoverishment and a poverty trap".

[3] These scenarios were constructed in relation to the topics of globalisation and ecosystem management. Two different assumptions were used for each topic. With respect to globalisation, dynamics would be either regional or global. With respect to management, management would be either proactive or reactive. In all the scenarios, human pressure on ecosystems will increase for at least the first fifty years. The forces of change taken into account are: habitat change (changes in land use, physical alteration of rivers or extraction of water from rivers); over-exploitation; invasive species; pollution; climate change.

growth and the weakest population growth, with an increase in environmental risks to human populations.

- "Adapting Mosaic", which refers to a vision of the world in which governance moves not towards the global but towards the local level. A great diversity of local styles of ecosystem management will co-exist. Extremely strong emphasis is put on education and health. These dynamics correlate with local and diversified processes of "learning by doing", with varying degrees of success. The preferred political and economic decision level is the ecosystem and the large watershed. Out of these local experiences networks are formed to improve overall ecosystem management. However, there is no global-level governance. Economic growth is relatively weak at the beginning but increases after some time. Population growth is substantial.
- "TechnoGarden", which gives pride of place to ecological engineering and the integration of ecosystem services into the commercial sphere, in an approach that uses revolutionary technological change to reduce the use of physical resources and reach optimal management of ecological functions. Agriculture becomes multifunctional. Massive reliance on new technologies is instituted. Economic growth is considerable and population growth is average.

It should be noted that none of the scenarios results in economic decline or even in stasis. In contrast, all the MEA's scenarios, even the Adapting Mosaic, which envisages an increase in all the ecosystem services, predict the erosion of species diversity. There is thus no direct connection between change in ecological functioning and change in biodiversity as traditionally understood.

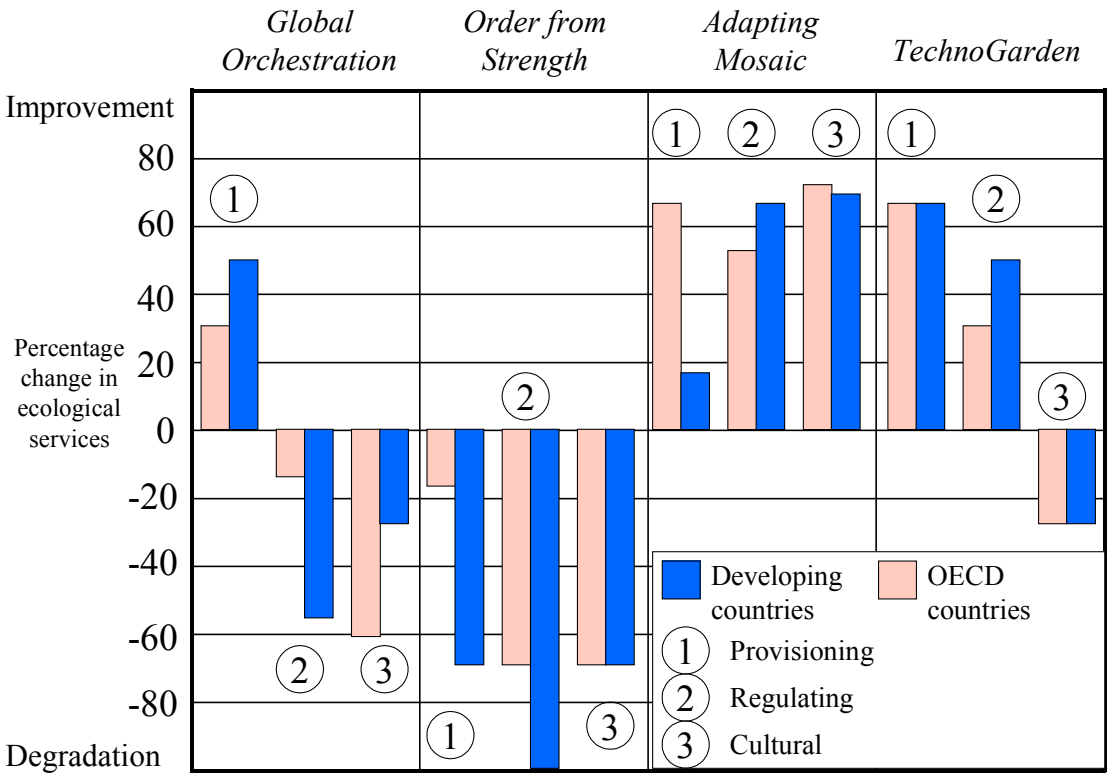
Three of the scenarios - Global Orchestration, Adapting Mosaic and TechnoGarden - conclude that at least one of the four types of ecosystem services will increase between 2000 and 2050.

These three scenarios involve societal responses which require major innovations for the institution of sustainable development policies.

Global Orchestration envisages a “liberal” revolution in which agricultural subsidies are abolished. It incorporates an active commitment to the war on poverty. This leads to sustainable development from the societal point of view, but not necessarily from the ecological one. In Adapting Mosaic, the majority of countries substantially increase the share of their gross national product (GNP) devoted to education (from 3.5% of GDP in 2000 to 13% in 2050). In addition, there is a proliferation of institutions designed to support exchanges of knowledge and information about ecosystem management. In the TechnoGarden, technological and economic measures give rise to improvements in ecological engineering and the remuneration of individuals and companies who provide and maintain ecological services.

Thus, in MEA’s view there are not one but three models of sustainable development (Table 7) and one truly non-sustainable model (“Order from Strength”).

Figure XX: Change in ecological services according to the four scenarios



Source: MEA, 2005, p. 139

A LOCAL SCALE EXAMPLE: THE SPICOSA PROGRAMME

SPICOSA understands scenarios as a dialogue in process. Modelled situations are the starting point of the dialog in the *Output Step*. In doing so, the dialogue is characterized by the following:

a) „normative“ means that the scenarios are based on an explicit value orientation. They pick up desires/visions and describe them in detail. However, they never leave the scope of what is (in principle) feasible.

b) As opposed to the explorative scenarios, which extend today’s trends into the future or which explore impacts of dysfunctions, normative scenarios are constructed based on precise desires or objectives of a group of people (which often represents society).

c) For the stakeholders, the normative orientation of scenario is central because they shall pretend and simulate orientation for decision making. They therefore achieve the role of a *model*.

d) "Narrative" means that the scenarios are presented quasi-literary in the stakeholder forum, in its preparation and wrap-up. They are presented as "stories" about notional persons or institutions of the real world. This way of presentation does not only force the facilitator and speakers to a high level of preciseness, details and realism. When preparing and thinking about the narrative presentation and contextualization, the underlying social, economic and cultural visions of the scenario are classified, integrated and analysed with regard to interconnections and possible (unexpected) consequences and impacts.

e) "Collaborative process" means that in the scenarios the perspectives and visions, as well as the ideas of the stakeholders are integrated. In terms of legitimization and implementation, it is crucial that the scenarios are accepted by all stakeholders as "their own". By promoting the participatory process when implementing the Design, Formulation and Appraisal step in a participatory process, we are assuring this.

f) The scenarios shall show possible implementations of future innovations in the feasibility context of the real world. They shall give incentives for reflection and debate about scopes and frames of formation and implementation, in particular about desirable futures and risks. With this they can support the development of precise implementation and where necessary prevention measures. In the broader sense, those scenarios shall show that the future is not totally predictable but that it can be shaped significantly.

g) Scenarios try to demonstrate the visionary content of transitions or technological or social innovations in a (to the best possible degree) coherent and (to the best possible

degree) desirable overall "picture". They do so by using what-if illustrations and as close to the real world as possible:

- How do challenges in society, economy and the environment look like? Which are the challenges?
- How can those challenges be tackled?

Scenarios are therefore by no means a certain prediction of the future. Their objective is in fact to present possible future conditions in such a way that one is able to imagine these conditions, to find subjective interrelations/connotations and to thus creating a basis for discussion and deliberation. They are about gaining own imaginations and desires with regard to the described futures – depending on if the presented scenarios and their details seem desirable, ambivalent or even frightening.

Also, none of the scenarios will need to be accepted entirely. Stakeholders can favour it or not and identify themselves with a certain person or attitude – or not. Keep in mind that those possible constraints or hidden pitfalls support the scenarios and the reflection, as well as the discussion about them and about action options and possibilities for implementation and formation. They are a tool for empowerment towards a proactive and framing perception of the future.

For constructively and critically dealing with the scenarios, the stakeholders could ask the following questions during the presentation of the scenarios:

- How desirable do the presented developments and conditions seem?
- Which aspects should be different and which ones need to be added in order to make the overall results more coherent?
- Would it be possible to promote those scenario elements which seem desirable to "me" and to avoid those that don't seem desirable?

LIMITATION OF THE SCENARIO APPROACH

Even if scenarios tools are well-recognized as some very useful interactive and user-friendly instruments, it is important to highlight some of their limitations. First, scenario are most of the time not supported by experiments. It can be considered as a good things because it enables to save time, money and resources as well as to learn without really testing the thing from which you learn about. But, at the same time, it is a source of great uncertainty for several parameters.

It is crucial to keep in mind that your model is not necessarily representative of the real world because it is based on partial information on interactions between users and resources, users and users, resources and resources. More the number of interaction taken into account in the model is high, more the risk of developing a biased model and to test false scenario is higher.

Another problem is that it is often difficult to interpret some results. Indeed, they come from complex interactions and interconnected dynamics which are very difficult to disentangle.

We can suppose that it is sometimes more useful to test simple linear scenarios based on two or three simple political options.

One option to improve the quality of the interpretation is to use some sensitiveness analysis. This statistical analysis enable to identify through hundreds simulation of scenarios what are the parameters which structure the dynamics. Higher is the number of simulation, higher is the quality of information and lower is the confidence interval.

Another way to improve the scenario methodology is to use in parallel a multi-criteria analysis which allows making explicit stakeholder preferences, to classify them and to identify sense-making indicators for the different categories of community of practices. Indeed, scenarios represent above all a selection of driving forces (in qualitative and

quantitative terms) which impact the social-ecological system. This selection is made by "non-objective" stakeholders who have their own preferences, beliefs and goals. It is therefore interesting to have information about why they have chosen these scenario among other, what kind of conflicts these choices reveal. The multi-criteria analysis could help to do that but it is not enough.

In any case, the scenario building must be organized by a mediator (Levrel et al., 2009b). Indeed, the mediator has the crucial role to facilitate and govern negotiation processes in order to select scenarios. To achieve this task, mediator constantly redirected the discussions towards the initial issue and the interaction which are connected with it, especially the social-ecological ones. Moreover, he can provide technical, disciplinary and epistemological supports when it is necessary to make some trades-offs between divergent points of view. The mediator was at the very heart of all the discussions and continuously translated collective agreements into a user-friendly modelling language in order to embody the diversity of knowledge in the model. By enforcing the rules of the game, he also helped enforce the principles of justice and managed the co-construction process. Had it not been for the mediator, the majority of participants would not have agreed to take into account all the social parameters. The mediator represented the judiciary order of the technical democracy system, guaranteeing that the separation of powers was respected. In this situation, the mediator must be legitimate for all participants.

CONCLUSION

Perform simulations based on "what-if" scenarios of interest to all disciplines and to all stakeholders is a huge challenge to build capacities of adaptive management of costal areas.

The scenario building and running enable to create some emergent effects during collective decision-making processes. First, the core issues are gradually and collectively explored.

Secondly, the problems of uncertainties are clearly formulated and enable participants to define a set of complementary research programs. Thirdly, agreements, which are accepted by all the participants, gradually turn into conventions, paving the way for the building of a common language. These emergent processes may be defined as a meaning convergence process helping to create a community of interest around specific issue collectively discussed.

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