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Lessons learned from an in-depth review of social components within the SPICOSA SAF process

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1. Introduction

Managing the coast involves the inclusion of varied and often complex processes. The aim of this paper is to illustrate the necessity and value that can be gained by the inclusion and full integration of social sciences within a comprehensive systems approach to investigating the coastal environment. Social sciences approaches are uniquely situated to examine and explain a variety of processes occurring within coastal management from the behaviour, decision-making process and actions of individuals to the wider dynamics of coastal governance. Arguably, without combining social science understanding with other approaches understanding of the coastal system and its processes will be incomplete.

This research draws on experiences and perspectives from the EU-funded SPICOSA Project (Science and Policy Integration for Coastal System Assessment) which aimed to develop and test a 'self-evolving' operational research framework for the assessment of policy options for promoting the sustainable management of coastal systems. The project has developed a System Approach Framework (SAF) which advocates an inclusive systems-based approach to coastal management and aims to lead to more effective science and policy integration via the common deliberation of coastal issues. Through this deliberative approach, the aim of the SAF was to draw together of knowledge and experiences of different types of coastal scientists, coastal managers and other stakeholders, integrating social, economic and ecological system elements within the one analytical framework. The approach was implemented, tested and refined through the adoption of the SAF within 18 study sites in XX European countries with a varied mix of coastal environments and contexts. Initially, a key policy issue, focussing on an ecosystem dysfunction, was identified within each of the study sites and formed the basis for the SAF implementation. Users were then required to follow a series of steps in order to implement the approach, including the design of the system, the formulation of the modelling approach, an appraisal of this approach and finally presenting and deliberating the results – and their implications - with stakeholders (see Tett – for more detailed info on the SAF). Scientists implementing the SAF were required to engage stakeholders at all stages of the process and the framework has been designed to be iterative so that users might make changes to the overall approach or the simulation model being generated based on feedback from stakeholders. This paper explores how successfully the social elements of the system have been included within the application of a SAF. This might include how social data and approaches have been incorporated into a modelling approach and an evaluation how the social processes of stakeholder engagement and deliberation have been undertaken.

The inherent complexity of the coastal system, both in terms of ecology and society, requires a diversity of approaches to systems thinking. For ICZM to be effective decisions cannot be based solely on a hard-systems focussed perspective which ignores, or at best marginalises differing viewpoints of the system. From the outset the systems approach advocated by the SAF was designed to include approaches from both *General Systems Theory* (von Bertalanffy, 1968) as well as *Soft Systems Methodologies* (Checkland, 1999). This inclusive methodology recognises the inherent complexity of the coastal system and the recognition that social processes are as important in describing and making management decision within the coastal environment, as the more tangible and measurable elements of the system represented within 'hard' systems thinking. It also recognises the value of SSM, not only for the inclusion of social processes but also in hypothesis-building about the natural system (Tett – from book). For a systems approach to coastal management to be effective, implementing a dual approach linking GST with SSM is fundamental.

Much of the learning revealed in this review of social sciences inclusion within the SPICOSA project resonates with key concepts of the Knowledge-Based Society (KBS) and so we find that these ideas provide a broad framework for this analysis. Coastal management, like the management of many environmental issues, is a clear example of the diversification of knowledge and knowledge production: both in terms of both in terms of moving in the direction of trans-disciplinary science as well as the diversity in the model of knowledge with coastal managers and other coastal users acting as important knowledge carriers. Mobilising and organising this knowledge in order to facilitate the process of collective decision making is one of the fundamental goals of SPICOSA and the System Approach Framework. Acknowledging the role of social processes for the organisation of learning, the co-production and maintenance of knowledge and in facilitating the deliberation, dissemination and legitimisation of ideas within the context of a decision-making process made up of multiple viewpoints and experiences, are critical factors to the success of science and policy integration. Exploring results within the framework of the KBS allows critical reflection of the success of SAF users in representing social science and situates the research within wider debates of knowledge mobilisation.

2. Theoretical framework

Integrated Coastal Zone Management (ICZM) is primarily a social process during which stakeholders debate and negotiate values, purpose and approach. Human activities are always social and anthropogenic pressures have undoubtedly been socially conditioned. Hence coastal management is in first principles about human beings managing and steering each other and not steering algae or other elements of the biological or ecological world. This means that the social sciences have a strong contribution to coastal management through facilitating our understanding of a range of important social processes which define, for example, conflicts of interests and deadlocks. However, this social process is part of a broader socio-political process whereby science is integrated into policy and the resulting policy is enacted. This places the quest for improving ICZM strongly within the framework of increasing our understanding to do better in terms of science-policy integration and this is a key focus of this paper. Through examining lessons learned within the SPICOSA project, we seek to identify opportunities and constraints for better mobilisation of knowledge in the process of science and policy integration.

In first principles, science and policy integration is about learning or changing our worldviews about social and physical systems and their interactions. It is about exploring and deliberating the meaning of success and social goals, about spontaneous innovations that leads to improvements that are not foreseen - and exploring and understanding the small variations in human activities that make a difference to the ecological, economic and social sustainability of decision-making. Science and policy integration is underpinned by a model of learning for science-policy integration has in itself changed as ideas concerning the nature and production of knowledge have in themselves been transformed. Often the science-policy relationship is imagined to be a linear process in which scientists deliver their findings to policy-makers at the end of their research, and these findings then influence policy. Such a linear process carries with it, what is increasingly seen as, an unrealistic model of the character of knowledge as it as it implies that scientists have special access to 'complete' knowledge by reason of being a scientist, which they can simply package for policy-makers. By contrast, knowledge is viewed as 'incomplete' requiring mobilising from a range of theoretical perspectives, as the disciplines necessarily fragment knowledge into manageable areas, as well as from informal knowledge and innovation within local communities. In this view, knowledge production is not limited to a laboratory or ivory tower of a university, but has become polycentric. This means that the boundaries between knowledge, society and policy are blurred and knowledge networks are required to connect respective knowledge carriers (Evers, 2000). It also means that more and more knowledge will not by virtue produce a more and more perfect society (the linear infatuation) but that all policy is experimental in character and that knowledge-based means a society that is always open to learn from its failed policy experiments (Ostrom 2005).

This idea of the need for mobilisation of a range of sources of knowledge carriers has been one of the founding principles of the SPICOSA project. In the face of the complexity of coastal systems, coastal problems are cross-over problems, that is they can over many interests, multiple individuations and political constituencies as well as, for example, different knowledge sources for understanding and creating solutions to these problems. To make collective choices about objectives and means to solve coastal problems and organize human occupancy of land or sea coastal space calls for high levels of information flows both in terms of the quantity and quality of these flows. However, the type of knowledge and networks required for sharing information in an effective way still need to be developed or re-invented when they have been destroyed in rapidly changing coastal contexts (e.g. indifferently driven by wealth creation or poverty generation). SPICOSA has sought to explore this challenge and build lessons on how knowledge can be better mobilised fro improve policy alternatives in ICZM.

The value of mobilising diverse knowledge to produce economic benefits (knowledge-based economy) and to achieve more comprehensive sustainability goals (sustainable knowledge-based society) has been given particular prominence by the Lisbon Agenda. The scientific literature on the knowledge-based society (KBS) is diverse with different and sometimes conflicting ideas emerging from different scientific quarters. In addition, ideas regarding the importance of KBS society are also being eclipsed by the innovation society e.g. The European Innovation Plan (2010). There are a number of themes within the broad area of KBS which are clearly relevant to decision-making for ICZM. One primary idea is the role and power of information technology, as is the re-organisation of labour towards product-orientated services: on the coast it is also reorganisation due to new forms of transformations. Another characteristic is the global nature of the KBS, reflecting the intensification of trade partners, but also of particular relevant to the theme of this paper, the difficult but interesting link between the TEK (traditional Ecological Knowledge) and the global societies. This is often where the policy surprises originate. Discussions on KBS have also included the idea of redefining the concept of the common good by harnessing the individualisation process (e.g. privatization and competition) for the good of (traditional and new) collective activities into account e.g. the rise of 'new commons' like healthy coastal ecosystems needed for the aquaculture and tourism. The empowerment of the individual action within the confines of institutions worked out as collective choice arrangements is also a highly relevance them for the continued adaptation of coastal systems and communities.

However, there are three threads of discourse emerging from the debate on the knowledge-based society which we have particularly found to resonate with the experiences and lessons emerging from our experiences within the SPICOSA project. These threads set a broad context in which we can develop a series of specific lessons, particularly on the scientific process and on a legacy of improving how we as scientists think and conduct our research to equip ourselves to 'do better' engaging in research on integrating science and policy and better to integrate science (all science) in the policy making and governance of coastal systems.

The first of these broad themes emerging in KBS discourse relates to the mode of production of scientific knowledge. In 1966, the term "knowledge society" was used for the first time by the North-American political scientist Robert E. Lane (according to the etymological reconstruction of Stehr 1994, 14 p, 26 p) (Krings, 2006). In an article he argued against irrational politics and asked for more rational knowledge. He demanded rational knowledge as scientific expertise in order to improve societal decision making processes. On the basis of the technocratic optimism of the 1960s Lane demanded the strong co-operation between scientific (for him: objective) knowledge and the active creation of the societal development (Krings, 2006). The theory of knowledge society was used as a promise of a growing relevance of scientific, objective knowledge. Science possesses the primary growth potential and its use has an impact on the 'end of ideology', on the 'scientification' of manufacturing and services and on the raise of the quality of life. Even the properties of scientific norms are transferable to social practice, as knowledge is a public good having no limits to its growth. In its current political use the concept of knowledge is still in principle science dependent (Hayrinen-Alestalo (2001p 207). The increasing importance of experts within modern societies has created a specific scientific debate. The assumption is that modern societies create a new mode of production of knowledge, which implies trans-disciplinary as well as interdisciplinary methods and is based on project oriented organisation of work (Gibbons et al. 1994). But the central idea is that the role of (scientific) experts becomes more and more important in all societal fields. The ideas of transdisciplinary and the potential for maximising integration in the process of engaging science in policy-making are central emerging tenets from the analysis of the experiences of scientists within the SPICOSA research project.

However as previously referenced the OECD, the EU and the member states have increasingly replaced the concept of knowledge with the concept of innovation. This idea of innovation in terms of the model of knowledge which underpins sustainable modern societies is a second theme with which we see strong reflections from within our learning from the SPICOSA project. According to the EC 'innovation concerns the search for, and the discovery, experimentation, development, imitation, and adaptation of new products, new production processes and new organisational 'set-ups'. So the traditional scientific orientation, where the search for new knowledge and a free problem setting are the primary goals, has come to comprise all the steps that are needed to produce and market new products and information. In this sense academic knowledge has lost its monopoly status as the model of knowledge (Hayrinen-Alestalo, 2001). Experience has increasingly shown that social actors are not so predictable, they have a highly developed capacity to surprise and to innovate – both individually and collectively. Our innovative capacity has formed the basis for new approaches in social science which seeks micro-interactional explanations for most social changes that takes place, also in relation to the human use of crucial ecosystem services. The accumulated knowledge of such innovations is extensive on a case basis (Poteete & al 2010), but the scope for generalising this into directly executable policies is limited. To a large extent human agents as innovators can be seen a learners that make mistakes – and to some extent learn from these mistakes – at least within one and he same generation. When such "fallible learners" come together in collectives to make policies, these policies will appear as experimental mixes of various measures, the interactions of which are hard to predict beforehand (Ostrom 2005). A key point in this model of learning is the diversity of knowledge sources and knowledge carries and the necessity for innovation to integrate across polycentric knowledge production.

A final strongly emerging theme within KBS discourse is the importance of developing learning organisations and the roles that these organisations play in transforming implicit to explicit knowledge. Many approaches and frameworks for knowledge creation and conversion have been presented and inform how learning both within and between organisations occurs and might be organised. One important theme relates to ideas of transforming implicit to explicit knowledge and centrality for knowledge-based organisations to facilitate the process of converting implicit to explicit knowledge through meaningful dialogue. Polanyi (1958) presented the initial differentiation between explicit and implicit knowledge and according to Polanyi implicit knowledge refers to that knowledge of a person, which has to do with his or her personal experiences, his or her biography and other learning processes in the meaning of an individual "know-how". On the contrary explicit knowledge is a formal and documented knowledge, an individual knowledge, which is markedly conscious and functional. A post-normal perspective argues that a substantive portion of knowledge comes from this latter source; the very experiences and understanding gained from working and managing the environment itself.

Using the three themes outlined above as general indicators of good practice for knowledge mobilization, and having the broad challenges of science-policy integration in view, the following section highlights a series of lessons from our specific experiences in SPICOSA. Why is better knowledge mobilisation so important for improved ICZM? We have highlighted that in coastal systems there are plenty of cross-over problems: there are many inherent problems in solving such cross-over problems. Decision makers and scientists tend to approach such cross-over problems from different sides. The decision makers always have to decide what to do, and whether, given other priorities, to do anything at all now. Scientists, faced with an issue, do not necessarily want to make any proposals for action until they have studied the issue in more detail. Once they have studied the issue, it can become their sole priority. Scientists often complain that the decisions of others are made for ‘political reasons’. Yet, the balancing of priorities, values and vested interests through a political process is precisely what a democracy is about. But a particular political process, a particular power play, a particular coalition of parties and a particular set of politicians may be unsatisfactory from the view of science, but still decisions ought to be made through a political process. The implied alternative is a meritocracy or some form of scientific dictatorship. And the simple fact is that not all scientific research is driven by a devotion to the welfare of others or to the environment: scientists can (and do) have their own agendas and science can be interest of both the “good” and the “evil”. From the policy perspective there are also difficulties in integrating research with existing and emerging legislation (Quevauviller *et al.,* 2005). Laws, rules and norms are in many ways the “hardware” of past policies and “frozen social structures and power relations”. New scientific knowledge does not automatically lead to a change in such institutional structures, often a “brittle” governance system has to experience a “political crisis” before a “creative destruction” and a reorganisation of institutional resources can create a policy environment more receptive to such knowledge. Science-policy integration is both an experimental and a social learning exercise: understanding the differences in the roles and values underpinning the perspectives of the range of experts and non-experts, evaluating the effects of current policy measures as experiments, learning from erroneous policies, and moving towards figuring out more effective means of working together to identify more ecologically, economically and socially desirable options and actions for environmental management. Success in this learning exercise depends on continuous innovation in enabling learning and on exploring the working limits of new visions of knowledge and knowledge networks. The discussion looks in-depth at the broader theme highlighted above and suggests a series of signposts for exploring the opportunities and constraints in providing newer, more innovative visions of knowledge and knowledge flows for ICZM.

3. Methods

Assessing the production and organisation of knowledge within the SAF approach requires a detailed assessment of the procedures for including social processes within the implementation of the SAF (such as stakeholder engagement as well as the scientific interactions) and how social data and knowledge have been incorporated into the whole approach. An in-depth semi-structured interviewing approach was selected in order to be able to identify and capture the often complex decision-making, interaction and integration processes that scientists undertook in order to try to successfully integrate social aspects within the SAF. In-depth interviewing clearly presented a vehicle for exploring the in-depth responses of the individuals involved as this was particularly important to the research. It also facilitated greater attention on continuity and connections between the topic areas. This was useful from the perspective of gaining insight into the attitudes and behaviour of the respondents and understanding the possible range of experiences and perceptions across the interview group.

In was infeasible to undertake such a detailed analysis of all eighteen of the study sites implementing the SAF within the SPICOSA project and therefore it was necessary to select a subset of five case study sites. Basic information about each case study site was initially captured and this information was used to try to select case studies which provided a range of different experiences and approaches to incorporating social science. A series of representativeness characteristics were identified as outlined in Table 1. A geographical criterion was chosen which provided a broad cultural proxy. The studied policy issue, the range of social components, as well as their level of integration in the numerical simulation model were also considered. The state of progress of the teams in the SAF process at the time of the selection and the presence of a social scientist in the study site team were also important criteria for the choice of case studies. Five sites were selected, in order to give an interesting and useful representation of the social dimensions of the 18 study sites part of the SPICOSA project; whilst still permitting a detailed and comprehensive review to be undertaken.

Table 1 Characteristics of the five case study sites

Study Site	**Himmerfjärden**	**Søndeledfjorden**	**Pertuis Charentais**	**Taranto Mare Piccolo**	**Guadiana Estuary**
Country	Sweden	Norway	France	Italy	Portugal
Policy issue	Eutrophication	Increasing local benefits from tourism whilst minimising impacts on cod stock	Water quantity in the Charente River	Mussel aquaculture: reduction of productivity and mussel quality	Water and sediment quality
Range of social components (including deliberation)	Surveys, issue of willingness to participate in environmental measures	Issue of conflict, many indicators; governance issues included	Issue of conflict and answers to water shortage crises, test of deliberation methods	Surveys, issue of legal and illegal activities	Transboundary and international issue, public perception examined
Level of integration of social component in simulation model	Social elements fully integrated	Social elements fully integrated	Social elements partly integrated	Social elements partly integrated	Social elements partly integrated
Social scientist on the team	Yes	Yes	Yes	Yes	No

In-depth interviews were conducted with a number of different scientists within each case study site in order to obtain as much detailed information about the integration of social sciences as possible. All interviewing was conducted face-to-face and in some case studies the interviewer met with individual scientists and in others, interviews were undertaken with a group of scientists. The time spent interviewing different between case studies, but the total length of interviews in each case study ranged from XX to XX, with case study investigations being conducted over a number of days. A detailed interview schedule was used to provide some structure to the interviewing process however the approach allowed sufficient flexibility to explore other areas relevant to the inclusion of social scientists. A copy of the interview questions is provided in Appendix A, however the broad themes that were explored in the process are provided in Table 2.

Table 2: Broad analytical themes from the interview schedule.

- How do the stakeholders within the case study view the social components?
- To what extent does the specific issue selected have an impact upon the process – for instance are some of the required SCs more difficult to tackle than others? Why?
- Are SSAs incorporating social elements in different ways in the SAF model e.g. social facts as inputs into the model or as intermediate or final outputs, or in understanding the social relevance of model outputs?
- How important have data availability issues been when including the social components in the SAF so far? Is this a critical issue to SSAs and does it relate to the need to provide numerical components for most things? Did this impact the selection of the Policy Issue?

- To what extent are social elements being excluded from the SAF model? Why? E.g. as a result of the focus on putting social components in the Extend simulation model and/or the way the policy issue was framed?

- How do the SSA scientists view the social components and in the SSAs scientists' opinions? What importance has been placed on them? Why? For example, is the balance of social components simply related to the available expertise within the SSAs?

- What in the opinion of the SSA scientists are the shortcomings of the SAF model? It is possible to identify which arise from not having sufficient social components incorporated? Are there any chunks of knowledge that stakeholders have which could have provided information to address any of these shortcomings?

4. Emerging lessons from the case-studies

Analysis of the empirical evidence has provided twelve key findings emerging from varied aspects of the SAF process: from more practical concerns about modelling and handling of social data and the way in which the social process of engagement were conducted to broader concerns about integration between disciplines and the level of complexity required to represent the system. Table 3 highlights these key findings and presents them grouped into five overarching emerging lessons. These lessons provide clear advice to future implementers of the SAF as well as other scientists undertaking activities likely to lead to science and policy integration. These lessons are:

- The effort given to defining the problem to be explored by the team is absolutely critical for the development of social component.
- There are both real and imagined constraints with regard to integrating social components in SAF-type models: time and effort is required (early in the process) to reduce the impacts of these on integration.
- A narrative of the process is nearly as important as the results of the process itself.
- The supreme importance of transparency and trustworthy process
- Developing effective relationships with key stakeholders brings significant rewards.

As well as providing some key lessons for the SAF gained from the SPICOSA project, the empirical evidence also resonates with some of the ideas and characteristics of the KBS. Three key ideas are also provided in Table 3 and provide a structure and context for further analysis and discussion of the results.

Table 3: Relationship between the empirical findings from the in-depth review of social components within SPICOSA and emerging categories of lessons from the Knowledge-Based Society.

<table>
<tr><th>Provisional findings from the in-depth review</th><th>Emerging lessons</th><th>Framework of Knowledge-base society: Emerging characteristics of KBS</th></tr>
<tr><td>The importance of a truly interdisciplinary CORE team</td><td rowspan="3">The effort given to defining the problem to be explored by the team is absolutely critical for the development of social component.</td><td rowspan="3">A new mode of production of scientific knowledge: transdiscplinary methods</td></tr>
<tr><td>The selection of the Policy Issue is a major defining force on the ability to integrate across components</td></tr>
<tr><td>To maximise the potential for achieving integration, there needs to be a strong focus on achieving integration outcomes early in the process</td></tr>
<tr><td>Data isn’t as constraining a problem as we may think it is</td><td rowspan="3">There are both real and imagined constraints with regard to integrating social components in SAF-type models: time and effort is required (early in the process) to reduce the impacts of these on integration.</td><td rowspan="7">Development of learning organisations: transforming implicit to explicit knowledge</td></tr>
<tr><td>There was a widespread lack of understanding of the extend model</td></tr>
<tr><td>There remain real challenges to the process of integration between the sciences: however, these don’t seem to be insurmountable (but have not yet been overcome).</td></tr>
<tr><td>Political processes are important social components both inside and outside of the model.</td><td rowspan="2">A narrative of the process is nearly as important as the results of the process itself.</td></tr>
<tr><td>Degree (or lack) of social science ambition – small steps for the inclusion of social science or giant leaps?</td></tr>
<tr><td>The challenge of obtaining a balance between providing simplicity in process but promoting complexity in understanding</td><td rowspan="2">The importance of transparency and the role of notions of credibility</td></tr>
<tr><td>The central role played by perceptions (misconceptions?) of legitimacy in defining the approach to, and use of, social components</td></tr>
<tr><td>There are significant added benefits of having a core group of stakeholders who maintain a regular relationship with the research world.</td><td rowspan="2">Developing effective relationships with key stakeholders brings significant rewards.</td><td rowspan="2">Academic knowledge has lost its monopoly status as the model of knowledge: the diversity of knowledge</td></tr>
<tr><td>Scientists engaging with stakeholder reference groups should conduct this on the basis of expert to expert conversations. Engagement shouldn’t be viewed as always communicating with ‘laymen’.</td></tr>
</table>

4.1 A new mode of production of scientific knowledge: transdiscplinary methods

Social learning often has this character of “learning together” from failures of collective attempt to solve collective dilemmas in complex situations. The knowledge available in the social science that can aid such social learning is available in a host of empirical studies and thus tied to specific ecological and social settings. To some extent, certain crude principles of design of workable institutional arrangements can be distilled from all these the studies, these heuristics include the need for boundaries, for credible commitments, for efficient monitoring and sanctioning and the provision for nesting local systems into larger regional and national systems (Ostrom 2005). Social learning thus tend to become the “property” of the collective involved in the policy experiment – or the deliberation exercise, and does not contribute directly to the current store of social science knowledge. In the interaction with other disciplines, modern micro-interactional social science has no panacea to offer as a cure-for-all medicine for the challenges of governing common pool resources in a sustainable way.

But compared to the more fundamentalist belief in certain preset ways to organise economic incentives, e.g. in a transferable quota system for harvesting of marine organisms, this more deliberative approach has a number of clear advantages. In the Pertuis-Charentais area in France the rival use and the overexploitation of fresh water as a common pool resource was a major problem. To frame the problem in a solvable way the SPICOSA project here chose to use a focus group to undertake a participatory investigation towards the best achievable cognitive representation of the system – sorting out which aspects of the problem belonged to a “constitutional level”, a “collective choice level” and an “operational level” of analysis. The combination of a truly interdisciplinary CORE research team and a many-facetted focus group here enhanced the potential for Social- Ecological modelling for the exploration of socially acceptable new institutional arrangements, mainly by ensuring that all formal representations were kept as close to “real life” as possible. The effect was that when each participant felt confident that the model would integrate her concerns, she became more interested in facilitating changes in other parts of the system. Thus the “soft institutional changes” based on enhanced participation proved to be more enforceable than radical institutional changes based on some abstract knowledge-based blueprint external to the social-ecological system.

Even if the idea of a “store of academic knowledge” has lost some of its traditional clout, there are still important insights to be gathered from the array of analytical tools in social sciences. One is that the choice of research question - or the choice of variables - are crucial to an entire research process. In the world of science –policy integration therefore, the choice of a particular policy question as the defining issue can decide the whole fate of a policymaking process. In the case of the Himmelfjärden shallow fjord/sewage recipient near Stockholm, Sweden, the choice of nitrogen load as the defining policy issue might seem trivial indeed. But because the causal linkages in the conceptual model underlying this choice were multiple – and increasing as the project developed, this proved to be a fortunate pivotal choice. The multiple causal linkages into both the sewage producing/treatment social system and the receiving ecosystem made nitrogen a very “pregnant” choice that led to many offspring policy questions that could be addressed both by the scenario modelling and through various deliberation forums.

If a heavy emphasis on integrating scenario outcomes is not present early in the process of engaging science in policy-making, such integration is difficult to achieve at a later stage. In the case of Soenderled Fjord in southern Norway, the policy issue was the “tourist fishing of cod” as a typical conflict issue in the coastal community. However, this fishing activity was not linked to very many other ongoing social and ecological processes in the total coastal system, thus the integration of outcomes towards the final stages of the SAF process was limited, and the public interest in modelled scenarios was modest. This is maybe the hardest lesson from the various SPICOSA case studies and the one where the cross cutting lessons are most difficult to synthesize. In deciding exactly which policy issue gives the “richest” potential for modelling various scenarios. This is where social science knowledge of related empirical cases around the world can be of the greatest value if engaged at an early stage in the exercise. But as shown in the case of the Pertuis-Charentais, a participatory and collaborative approach to the issue identification, utilizing all the social-ecological insights present in a particular coastal system in a micro-interactional process, can also contribute to a successful science-policy integration.

4.2 Academic knowledge has lost its monopoly status as the model of knowledge: the important of the diversity of knowledge

This is in many ways the *raison de étre* behind the role of social science in the SPICOSA integrated project: the body of social science knowledge should be generated from micro-interactional processes in actual coastal settings where the stakeholders and the emerging policy issues should be identified. Based on this, the modelled scenarios should be worked out and presented to a new social arena for micro-interactional knowledge production: the deliberation forum with the aid of a deliberation support tool (DST). Based on "methodological situationalism" the "communicative rationality" in such forums should produce good collective decisions where the innovative capacity of human actors could find good solutions together with other concerned coastal citizens.

Denis to add some text in draft form for the deliverable

Developing effective relationships with key stakeholders brings significant rewards

1) There are significant benefits of having a core group of stakeholders who maintain regular relationship within the research world
2) Scientists engaging with stakeholder reference groups should be conducted on the basis of expert to expert conversations. Engagement shouldn't be viewed as only communicating with 'laymen'

4.3 The development of learning organisations: transforming implicit to explicit knowledge

Fazey et al. (2006) argue that expert, and especially experiential knowledge, can be divided into three types of knowledge: "explicit knowledge that has been articulated, implicit knowledge that can be articulated but has not, and tacit knowledge that cannot be articulated." They suggest that that although experimental knowledge can lead to quantitative data and the integration with other forms of knowledge, in many instances the translation of implicit to explicit knowledge needs to be undertaken qualitatively. This is required to reflect the type of information and in particular the context in which it is situated and subsequently understood (Wyssuesk and Totzke, 2004). This challenge of the modelling space in which integration is facilitated, the nature of data and information and the integration of various forms of knowledge are key emerging themes from the SPICOSA scientific experiences. Within the social sciences, and particularly within sociology and between sociology and anthropology versus psychology there is also an argument as to the superiority of quantitative versus qualitative measurement methods. To oversimplify drastically, the argument of the qualitative school is that if people have to construct a response to a question rather than answer it from memory, and if in constructing a response they would normally discuss it with others in their family, friends and so on, the only way both to get a considered answer and to understand how they construct a response is to observe the process through which they construct a response. A quantitative approach would then produce only a trite answer of little meaning or use (Green, pers comm.). Although different viewpoints emerge from within this debate on the nature of social information and data, perspectives from the social sciences bring useful insights into organising learning and integration allowing flexibility necessary for transforming knowledge in useful ways for ICZM. These insights are useful to promoting the development of effective learning organisations whether they are informal or formal in nature e.g. groups of scientists, networks scientists and policy-makers.

The lessons emerging from this review builds particularly on facilitating the integration of implicit knowledge, that is knowledge derived from personal experiences and other learning processes, within a systems approach to coastal management; but extends these to consider the broader theme of integrating different sources of knowledge in an effective learning process. Three main messages highlighted through the SPICOSA experience are identified as important learning points for improving the mobilisation of knowledge within science-policy engagement processes.

The first of these messages is that there are both real and imagined constraints with regards to integrating social components within systems-based coastal assessments. Time and effort are required early in a science-policy integration process to reduce the impacts of these constraints on the potential for integration. A numerical modelling approach was used within the SAF to organise the incorporation of ecological, economic and social elements of the system and for many study sites provided the major framework for integration. However, organising learning and integration in this way, meant that the opportunities presented by: the flexibility inherent in the SAF approach, in social data itself and in how this data might be handled, had not be effectively utilised. This limited the integration of social sciences from an early stage in the scientific process. It was also possible to identify a lack of understanding about the potential offered by the chosen modelling software (ExtendSim™). As largely unfamiliar software package, a majority of scientists needed to devote to significant efforts to learning the ExtendSim™ software and this distracted many away from concentrating on identifying social relationships which would turn into achievable and interesting components of the SAF model. Another fact is that the social scientists were not trained to think in the form required by the SAF modelling process e.g. threshold values and critical points and this was a challenge to developing ESE relationships within the SAF models. In this case, social science was a 'supply discipline' which was forced to confirm with the 'lead disciplines' (marine biology, ecological) model of science.

However, there were clear imaginary constraints; for example, many impressions of ExtendSim™ held by social scientists meant they imagined a weaker bargaining position than they in reality had. There was a significant lag time before the uptake of Extend commenced to any degree within the small group of social scientists, primarily with the recognition that whilst ambitious, some elements – particularly institutional/regulations – may be manipulated in the simulation model. However, this raises an interesting question. If a similar analysis was conducted on the physical scientists' uptake of social concepts and tools, the lag time would also be identified as an important constraining factor. Is this lag time a common problem to trans-disciplinary work? This leads us to ask how we can better structure knowledge exchange in a project to reduce this lag time and its impact on integration. The issues emerging on the availability of data also fitted to a significant degree within this category, and the fact emerged that data wasn't as constraining a problem that many of the project scientists, particularly physical science colleagues, imagined it to be. The concept of data as 'known facts or things used as the basis for interference or reckoning' is broad and a wide range of potential data sources can be utilised in seeking to understand social processes. In reality, the lack of appropriate social data was not seen by social scientists within the SPICOSA community (or no more seen) as a major drawback because adopting a flexible view about how it is organised provides room for innovation to acquire it e.g. with the help of surveys or other vehicles like using ongoing PhDs or Masters Projects. Broader notions of data need to be fully considered at the beginning of a science-policy integration process; including such guidance within the SAF of the modelling exercise would have provided results which drew on a wider breadth of knowledge and which more effectively captured the complexity of coastal problems.

Being able to simultaneously model and integrate both numerical and qualitative models is the real challenge to the SAF and of course more widely in the integration of the sciences. An important essence of this problem is making sure systems-based models, such as the SAF, adequately reflect the complexity of coastal systems. We know the differences between simplification and model refinement. Simplification is reducing complexity and loosing something along the way: refining is keeping most of the essential crucial information but reducing the number of variables. However, there might be a thin line between these two concepts. An interesting finding was that the source of innovation itself (i.e. the integration) became a strong barrier for new and interesting trans-disciplinary work. The example was that the integration of biosciences, economics and social science did in some respects act as a hindrance to social scientists for developing interesting social science research questions. There was real conflict between the 'keep it simple' message which was the key driving force behind the integration philosophy, and the social processes which necessitated incorporating more complexity than was facilitated by the 'simple as possible' ethos. Hence, a real constraint to modelling social science dynamics was the simplification needed to make these fit within a simulation model. Social processes are perceived as too complex to fit in a simulation model: for the social scientists, the SAF process simplified system functionality at the cost of the essential complexity and this led to over simplification or omission of important social dynamics. There is no doubt that as a result of our disciplinary perspective, we have different requirements and visions of how complex a complex system model needs to be. This issue is challenging. At the very least it is critical that scientists become more reflective when it comes to navigating the challenges of modelling.

This discussion leads to the second message on mobilising knowledge through the development of effective learning organisations and this is the importance of transparency and the role of creditability within a learning process. There is an interesting bridge between the constraints discussed above and issues of trust, creditability and transparency. The dichotomy between social scientists striving for complexity within the representation of social elements and the elegance in approach to which modellers are striving to achieve leads to the challenges of creating a balance between providing simplicity and transparency within the process (i.e. through the utilisation of simulation models to represent the system and focus on the key cross-system linkages) and representing the true complexity present in the social system and an understanding of this complexity. This issue is of course representative of many scientific processes, however in the SAF experience it was compounded through a lack of social science expertise and experience of integrating concepts such as multiple viewpoints and power relationships.

Guadiana scientists, for example, argued that as they did not have a social science background and experience they did not feel credible and lacked confidence, to introduce and utilise social science tools; not having a social science background. This stemmed from the skill set and experiences of the scientists and their own confidence and experiences. These are potentially easy issues to solve (for instance through training or the inclusion of additional team members), but may have had a profound impact on both how the SAF was implemented and ultimately the outcomes. However as the course of the SAF process evolved, natural scientists in this study site showed a growing interest in participative methodologies and worked hard to improve their stakeholder engagement. There has been a clear learning effect within this case study and as there were no social scientists within the team, a clear benefit of engagement and the additional knowledge generated would not have occurred without a scientist 'stepping up' and taking responsibility. These natural scientists approached the social science methods in a cautious way, recognised their own lack of knowledge and limitations. They have educated themselves (through reading the materials in the SAF manual and where necessary sought additional advice) in order to try to learn how to best undertake engagement, adopt a deliberative process and where possible incorporate other social elements into their modelling approach. There are many positive facets about this study site experience. However, the fact remains that as the SPICOSA scientific community was predominately physical science in make-up and when tasked with considering and implementing social science tools, a lack of experience and knowledge means that some errors in judgement are made. This raises challenging questions regarding the credibility of the social contributions to the SAF models: do the benefits of 'stepping up' within integrated projects, outweigh the costs associated to not having utilised the skills, knowledge and experiences of social scientist in undertaking these activities. One clear message is that significant improvements in systems-based approaches to coastal management could be achieved if more social scientists became actively engaged in the challenges of applied, transdisciplinary research.

A second case has led to more ethical questions and issues related to the transparency of the process and the roles and responsibilities of scientists. Within the Taranto study site the engaged representatives of the mussel farmer community believed that scientists were better placed to act as their voice, raising ideas with public officials. The farmers did not feel that they would have the same impact as given they were not as cultured, important or as articulate as the scientists. Again the Taranto scientific team is highly dominated by marine and fish scientists and the decision was taken by the group to adopt the role of speaking on behalf of the farmers. Although this position may have been adopted for practical reason, it raises many challenges, particularly in terms of creating effective dialogue and an open and transparent process. Engaging social scientists to at least give expert advice about whether the representative voice of the stakeholder group was a credible reflection of interests and knowledge would have strengthened the learning processes within this study site.

Another theme relates to notions of credibility within a science and stakeholder engagement process and the significant influence which these exert on learning potentials (McFadden and Priest, 2010). One issue raised by a number of study sites was the difficulty of developing and sustaining stakeholder interest and participation through the SAF process. This was particularly related to the strong methodological focus of the project, which was perceived as acting as a barrier to engaging stakeholders. In particular, the lack of practical outcomes for stakeholders meant that the project was not perceived to provide a credible vehicle for solving management problems. However, there was also evidence of a clear 'saving face' dynamic on behalf of scientists, who were reluctant to engage with an open learning process when they either did not understand elements of the project or were having 'difficulties' with the project themselves. Pressures from both groups led on some occasions to scientific teams engaging with stakeholders on the basis of 'SPICOSA by stealth', that is filtering the project strongly so as not to refer explicit to concepts or theoretical ideas related to the project. The importance of a '*reality check*' within science-driven projects was raised frequently; however a 'SPICOSA by stealth' approach which was adopted by some of the study sites significant limits the potential for this to occur. Barriers to effective learning are created by perceptions of credibility, perhaps even more so in integrated project which engage both scientists and policy-makers. Could the better design of projects enable scientists to be facilitators of learning rather than filters of expert knowledge and the learning process?

The third message on mobilising knowledge through the development of effective learning organisations is the fact that a narrative of the process of learning within and between scientists and policy-makers is nearly as important as the results of the process itself. Narratives and the study of narratology, have of course been an area of interest to the social sciences for a long time. In specific relation to the concepts of learning organisations, Wyssuesk and Totzke (2004) highlight that "narrative forms of knowledge presentation are capable of triggering communicative processes of learning", illustrating the need to use methods of discourse to develop learning situations. From the SPICOSA experience, reflections on the role and inclusion of political processes within the SAF particularly highlight the importance of narrative as a form of knowledge transfer.

There were clear examples of political processes impacting the learning potentials and outcomes within the SAF process. From the perspective of the Habermasian concept of communicative rationality, there were clear instances of using the power of arguments in deliberations to reach "good coastal policies" e.g. debates between different decision-makers within a reference group reflecting on the political risks of different management measures. Alternatively there was evidence of power play based on interests and control (Weberian methodology), the result of which can lead to "bad coastal policies". There were numerous examples of scientists selecting only to meet with those stakeholders who they perceive to be most relevant and key to the process. In some instances however these have tended to be those with political influence and in some cases all other stakeholders have been sidelined as irrelevant. Although the approach advocated by the SAF might not be able to formulate or address many of the problematic issues arising from the role and influence of power within a systems –based approach to ICZM, the debates that might be generated will certainly contribute to a collective reflection about the approach adopted. There may also be the potential to eliminate some management options early in the process, through discussion and recognition of the political risks of their implementation and subsequently avoid wasting time in developing scenarios and options that will not be agreeable to the decision-makers and therefore not adopted. Capturing a narrative of the process, reflecting on the politics, power plays and the different viewpoints of the organisations and individuals during the process of a SAF implementation might lead to substantially greater and more effective sense-making of the process of decision-making.

From a modelling perspective, political processes proved to be very difficult to incorporate into the simulations and SAF models generated in each of the study sites. This may have been due to the difficulty of transposing scientists' observations about the politics within the study site into a simulation model, particularly given the prevalent ideas that all information needs to be quantified. However, from an overall project perspective the formalisation of political processes was also not sufficiently formalised within the SAF manual with a lack of political scientists within the SPICOSA scientific community. In addition to the failing of social scientists to explicitly work with modellers to explore and develop ways in which to reflect political processes into the simulation modelling, some study sites wanted to maintain 'on good terms' with their stakeholders and were concerned about trying to incorporate potentially contentious political processes in any explicit form. Another constraint was the perception that the SAF simulation models could be considered 'wertfreiheit"; that the model-generated scenarios were truly neutral and should be left "unpolluted" by constructivist social sciences and the professional policy makers.

The use of narrative to reflect on and document political processes, could provide a clearer framework for evaluating those aspects which are successful (or not) in the learning processes, providing insights from which to alter and improve the organisation and facilitation of knowledge mobilisation. However, narrative must be constructed with care e.g. some voices however are loud, articulate and powerful, while others are silent or unheard, and the social sciences have an important role to help facilitate the progress of narrative building. The SPICOSA experience also suggests that in developing guidelines for system-based approaches to ICZM more targeted effort should be defined towards exploring the use of narrative and its integration with other forms of knowledge transfer. Important issues within the social sciences such as the legitimisation of particular narratives and issues of representativeness need to be harnessed and these ideas interfaced with progress on multi-disciplinary and transdisciplinay models of knowledge transfer for more innovative and hopefully more effective learning potentials in ICZM .

5. Conclusion

Science and policy integration has been, and remains a challenge, underpinned by a spectrum of complex ideas and facets. This short deliverable has aimed to identify some prominent discussion points and lessons in this arena, particularly about how to better mobilise knowledge in a systems-based approach to strengthen science-policy integration for ICZM. It is a social science analysis, identifying processes and attributes of the SPICOSA research experience, which if conducted differently, could have made significant impacts on both the process and outputs from the SAF.

We have argued that science-policy integration is both an experimental and a social learning exercise: understanding the differences in the roles and values underpinning the perspectives of the range of experts and non-experts, evaluating the effects of current policy measures as experiments, learning from erroneous policies, and moving towards figuring out more effective means of working together to identify more ecologically, economically and socially desirable options and actions for environmental management. Success in this learning exercise depends on continuous innovation in enabling learning and on exploring the working limits of new visions of knowledge and knowledge networks. The discussion in this deliverable has been based on empirical findings from an in-depth review within the SPICOSA project of procedures for including social processes within the implementation of the SAF (such as stakeholder engagement as well as the scientific interactions) and how social data and knowledge have been incorporated into the whole approach. It suggests a series of signposts for exploring the opportunities and constraints in providing newer, more innovative visions of knowledge and knowledge flows for ICZM. The strongest recommendation from this deliverable is that significant improvements in systems-based approaches to coastal management could be achieved if more social scientists became actively engaged in the challenges of applied, transdisciplinary research. This requires efforts on behalf of the social scientists engaged in environmental research, but also better facilitation, organisation and funding of research to allow better engagement with the social science community.

APPENDIX A: IN-DEPTH INTERVIEW SCHEDULE

Broad analytical themes on the SAF model:

How do the stakeholders view the social components?

To what extent does the specific Policy Issue selected have an impact upon the process – for instance are some of the required SCs more difficult to tackle than others? Why?

Are SSAs incorporating social elements in different ways in the SAF model e.g. social facts as inputs into the model or as intermediate or final outputs, or in understanding the social relevance of model outputs?

How important have data availability issues been when including the social components in the SAF so far? Is this a critical issue to SSAs and does it relate to the need to provide numerical components for most things? Did this impact the selection of the Policy Issue?

To what extent are social elements being excluded from the SAF model? Why? E.g. as a result of the focus on putting social components in the Extend simulation model and/or the way the policy issue was framed?

How do the SSA scientists view the social components and in the SSAs scientists' opinions? What importance has been placed on them? Why? For example, is the balance of social components simply related to the available expertise within the SSAs?

What in the opinion of the SSA scientists are the shortcomings of the SAF model? It is possible to identify which arise from not having sufficient social components incorporated? Are there any chunks of knowledge that stakeholders have which could have provided information to address any of these shortcomings?

An overview on the process of multi-stakeholder dialogue

1. In what ways have stakeholders been engaged across the various steps of the Spicosa SAF process?

    a. Which stakeholders provided knowledge to inform the process of designing the SAF model? To what degree?
    b. Has knowledge collection evolved over time in terms of which stakeholders provided what knowledge and when?
    c. Have multiple points of views of stakeholders been addressed in the design of the SAF model?
    d. Have different sources of knowledge at times been contradictory to each other? How have these contradictions been addressed? In your opinion have some contradictions been hidden as a result of the stakeholders representing collectives e.g. municipalities?
    e. If contradictions between stakeholders have not been resolved, have the discussions clarified the tensions and contradictions?
    f. Has the knowledge been mainly quantitative or qualitative or both?

2. Please think about discussions with stakeholders throughout the whole of the SAF process - have informal discussion been held with stakeholders about the model/components/scenarios that have not been documented? What was discussed? Did this lead to any changes?

3. Have you implemented a specific methodology to run stakeholders meetings (*or has it been generally organised as a brain-storming format*)? If yes, what tool did you use?

4. Have you used the KerCoast DST within your stakeholder dialogue process? If not used? Why not?

    a. If yes: at what stages of the SAF process was it employed? In your opinion, how effective was it in assisting the process of deliberation? E.g. More focussed discussions by the stakeholders? More interactions between different stakeholders and between scientists and stakeholders?

b. **If there is a social scientist associated to the SSA:** Though your use of the DST, do you feel that it contributed to capturing a critical level of complexity in social interactions or has the tool too narrowly focussed the scope. Has the starting-point of stakeholders (or their prior relationships) made any difference to the success of the DST in the SAF?

5. **If there is a social scientist associated to the SSA:** are there any informal grass-roots community networks in the coastal community which have not been able to be included in the SPICOSA SAF process? Are you aware of innovative or creative ideas emerging from any of these groups which would add insight to the SAF process?

6. **If there is a social scientist associated to the SSA:** are there existing cultural ideas and structures that would condition the nature of multi-stakeholder dialogue in the SSA?

CATWOE

The CATWOE model can be used to think about the variation in systems scales in which different human activities are primarily embedded. E.g. the 'system' is the level of the process [what]; activities contributing to doing this are then the sub-systems [how]. The wider system level is that of Ownership – who could stop (T) [why].

1. Have you used the CATWOE model in your SSA? If yes, did you find it useful?
2. Have you used any other conceptual models as a base for mapping stakeholders and their interactions and human activities?

3. Have you mapped stakeholders in your SSA on the basis of different scales of the system? Have you engaged with stakeholders across this range of scales? If not, why not? (*This might already be addressed in your discussion of the previous section on multi-stakeholder dialogue*)
4. **If there is a social scientist associated to the SSA**: CATWOE seeks to help identify sub-systems within the main social system in terms of linkages and dependencies across human activities, flows of power and the context for such flows. What are the key flows, linkages and dependencies within the social system in your SSA and what are the implications for the SAF model?

Institutional Mapping

Institution: a governance structure defined by the existence of a set of formal or informal rules. All organisations are institutions as they are characterised by internal and external rules which govern its behaviour, but not all institutions are expressed by organisations e.g. systems of property rights.

1. Were any institutional maps developed in addition to those presented in the Design step report from this SSA?
2. How was this undertaken within the design step and did it (and how) evolve throughout the subsequent SAF process?
3. At what stages of the SAF process has the Institutional mapping been used (e.g. conceptual model to Extend model)? Have there been barriers in the SAF modelling process to its use and - on the other hand – did particular elements of the SAF approach made it 'easier' to incorporate this information?
4. How useful was institutional mapping in helping understand governance processes?
5. Did you produce an institutional map for each of the key human activities which link to the policy issue? These identify different 'action spaces' for management options.
6. If yes, have you also identified how these different action spaces currently interact?
7. **In addition, if there is a social scientist associated to the SSA**: could you provide some text on the institutional context of the SSA and its implications for the SAF model?
8. **In addition, if there is a social scientist associated to the SSA:** are there any organisational incentives for improving the policy issue in the study area? Are there different coastal management policy-issues for which there may have been greater organisational incentives?

Conceptual mapping

1. Were there any conceptual maps developed in addition to those presented in the Design step report from this SSA?
2. In practice, how were the conceptual maps produced (including those within the Design step) e.g. was Cmap used?
3. How much stakeholder engagement was undertaken in producing the conceptual maps?
4. At what stages of the SAF process has the conceptual mapping been useful? How useful was it?
5. What social components of the model have been identified within the conceptual model as being important to the policy issue?
6. **In addition, if there is a social scientist associated to the SSA:** did the stakeholder engagement process allow differing interpretations of the relevant activities ('boxes' and 'links' in the map) related to the policy issue to emerge? Was there any discussion on which interpretation was most useful to the solving the policy issue, or was there an assumption that the 'right' interpretation could be found? Could you summarise the differences in interpretations of various stakeholders to the policy-issue?

Indicators and other quantitative sources of social data

1. What type of quantitative social data been used?
2. What was the assessment rationale behind the data i.e. why was it important to measure this variable?
3. Was it an existing database or is this new data collected by the SSA team?
4. If it is new data, how was it collected e.g. interviews, focus groups, questionnaires?
5. How has this social data been included? e.g. directly as an equation, as a proxy through an equation, as a switch in EXTEND
6. **In addition, if there is a social scientist associated to the SSA:** Knowledge is mediated, situated and contested. Was there a joint fact-finding process which facilitated a consensual understanding of the issues and facts impacting them?
7. **In addition, if there is a social scientist associated to the SSA:** Did any evaluative criteria for social and institutional systems underpin the selection of social variables, indicators and other sources of data e.g. social justice, redistributional equity, accountability, adaptability?

Formulating and appraising the SAF model – building the SAF model

1. Which of the social components identified within the conceptual model been incorporated within the formulation of the SAF model – either within the simulation model or outside of the simulation model?
2. Are the social components linked, partially linked or not linked at all to the behaviour of both economic components and natural components? Can we identify where in the SAF process the social components lost ground?
3. What has not been included and why? Are they any social components that you tried to incorporate and then abandoned?
4. What aspects of SPICOSA have constrained the social components that have been included or those that have not been included? We realise that it may unlikely that one-to-one relations which cause constraints, but they result from more complex interactions.
5. How might the incorporation of social components be improved in the formulation and appraisal step? What would be necessary to achieve this improvement?
6. **In addition, if there is a social scientist associated to the SSA:** Time delays are frequently important in models. There is often a delay between changing conditions and a response occurring. Responses may not be to the current conditions but to anticipated or predicted conditions. Therefore they may only occur when a change in current conditions has lasted long enough for predictions to also have changed. Can you consider likely time delays in societal, community and individual responses to changes in the physical system and in implementation of potential management options? Have these time delays be considered in the SAF model? If not, is this related to the drive for simplicity in the modelling exercise (tendency to view social science as a factor that adds complexity)?
7. **In addition, if there is a social scientist associated to the SSA:** can you reflect on the assumptions regarding individual and community behaviour that have been incorporated in the SAF model?
8. **In addition, if there is a social scientist associated to the SSA:** Are useful parts of the social process not being emphasised sufficiently because they are not simulated within the model – could the SSA make

more of these elements and 'sell' them better? Are there different ways of presenting information that may make the use of a social process more overt?

9. **In addition, if there is a social scientist associated to the SSA:** Can you provide some comment on how communities affected by the Policy Issue (including decision-makers and the public) might value social components?
10. **In addition, if there is a social scientist associated to the SSA:** Have you been able to make historical legacies visible in the SAF process? The idea of memory in the system is an important as social systems might have a long memory e.g. culture, social norms. Historical legacy can present inertia to change, producing a reinforcing feedback loop. Is there any evidence of this in your SSA?

Scenarios

1. How were the scenarios selected? Who selected them? Why were those individuals nominated?
2. Was the selection/development of management options part of the dialogue process? How acceptable to stakeholders are the management solutions?
3. What are the scales of the scenarios? Local, regional, national?
4. Have socio-economic-environmental futures been used within the scenario selection?
5. Have the scenarios been adjusted to different governance constraints – such as current legislation?
6. How have the results of the modelling and scenarios been visualised? How has the visualisation been incorporated into the deliberation and decision-making procedure?

Other social tools

1. Are there other social tools or methodologies that have been used by your SSA in SPICOSA which have not been mentioned in the SAF handbooks?
2. If yes, what were these tools? Why were they chosen? How were they used? Did they complement tools recommended in the handbooks?
3. Are there other project from which you are gaining information? What are the constraints and opportunities which this joint-project process may have had on the SAF approach?

Systems interactions

1. Do the different components (social/economical/ecological) need to be examined over different spatial/temporal scales? Is this a problem that is hampering the incorporation of the social elements into the modelling process?
2. Have trade-offs been made between the different social, ecological and economic components? Why has this been necessary? What impact has this had upon the modelling and the results presented?
3. **In addition, if there is a social scientist associated to the SSA:** In what ways has the regulatory framework (e.g. the degree of centralisation or decentralisation of decision-making; informal or formal regulation) affected the social dimensions of your SAF model (i.e. affecting the participation process, the selection of management options) and linkages between ESE components?
4. **If there is a social scientist associated to the SSA:** modelling by definition simplifies the representation of social components, resulting in a loss of meaning in terms of the complexity of the social system. How can SAF models be supported to illuminate patterns of interactions which define social behaviour relevant to the policy issue? Are there functional linkages between social components and physical and economic components which could be improved?