FIGURE 5
Assessment approaches in relation to complexity and value of the fishery system

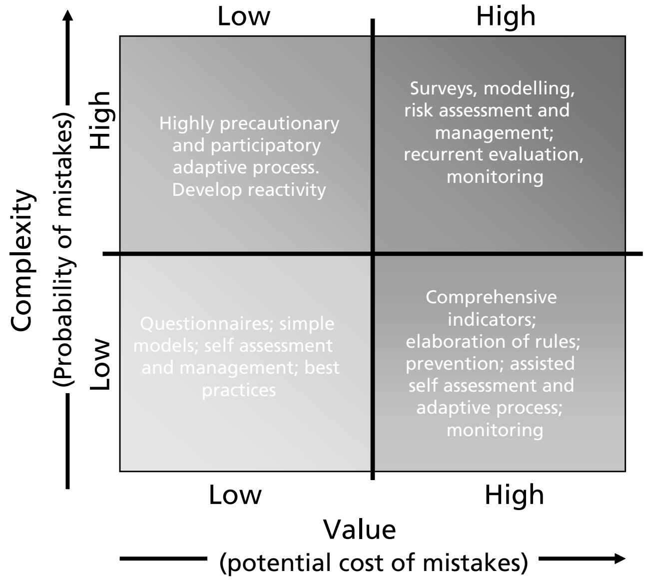
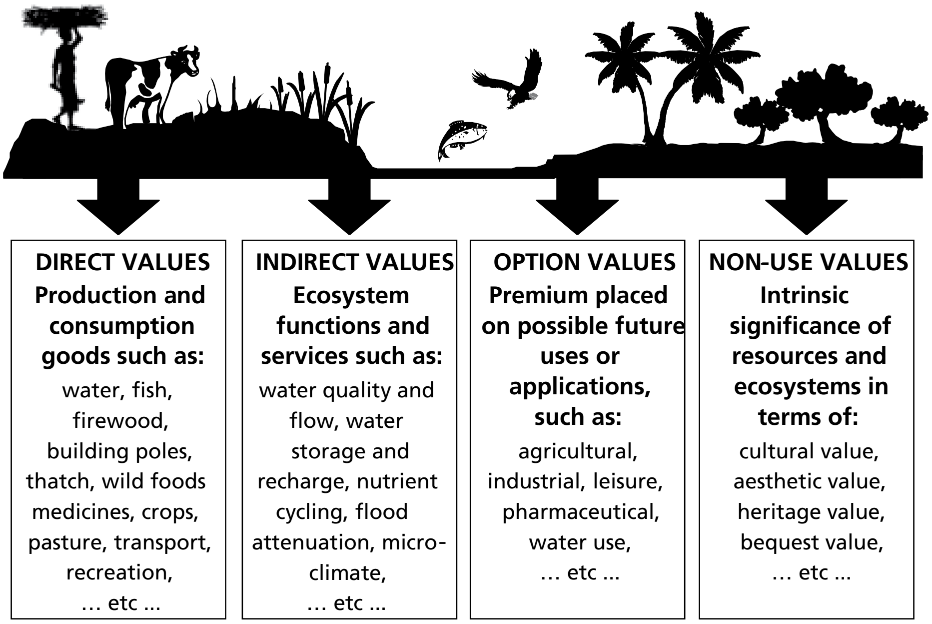


FIGURE 6
Total economic value of wetlands



Source: Emerton and Bos, 2004 after Barbier, 1997.

the market chain (FAO SFLP, 2006). It also includes the social value, as a safety net, or absorber of excess labour in times of employment shortage and its value in preventing food insecurity and the need for emergency aid assistance for at least some proportion of the landless poor. Fish and fisheries also have various cultural values: they contribute to our store of knowledge and understanding of ways of living and organizing ourselves; they play a prominent role in the visual culture of many countries; they are the source of symbols informing several major world religions; and, of course, they contribute to the culinary traditions and food cultures of many societies. These different categories of value (market, social, cultural, environmental) accrue to varying degrees to different stakeholders and at different scales in both time and space so they are difficult to identify. Further, once recognized, measuring them in a common currency is not easy, although various contingent valuation methods have been developed to do so and both environmental and social accounting are increasingly utilized to guide policy choices. In SSF, a simple proxy that captures some of these values is the number of households who depend directly and indirectly on the fishery for their livelihood.

The issue of value is further complicated by the fact that a fishery may have a low current value (e.g. as it is overfished) and a high potential value (e.g. if better managed). The potential value is probably a better indicator of what should be invested in managing the fishery in the long term, but current value may be the more realistic indicator of what could presently be spent. The value of a fishery might be high but the cost of the problem faced (and expected benefits of the intervention) might not justify the cost of the assessment and of the subsequent intervention (in cost/benefits terms). The economic value assigned to a particular fishery will depend on where the boundaries of analysis are drawn in each case. For example, a particular "fishery" (or "métier" in the sense of a boat/gear/species/season interaction) may have a limited economic value. However, the sum of the various "métiers" practised in a community is much higher. The value of the entire small-scale sector for an area would be even higher. The scale of valuation and assessment will be determined largely by the scale at which the dominant form of management is exercised, e.g. if most management decisions are taken at local community level, then that is the most appropriate scale for assessment. If management decisions are made on an ecosystem, coastal region or waterbody level, then that is the appropriate scale for assessment. In cases where there is little decentralization of management authority, larger, more aggregate scales of assessment may be used, as it is at that level that management actions will be implemented.

Complexity

Here, the term complexity relates both to the system to be studied and the assessment problem it raises. It includes aspects of both the system to be governed and the governing system which, in SSF, often overlap considerably (Bavinck *et al.*, 2005). The complexity of the system to be governed relates to the number of components, their interrelationships and their dynamics, such as: (i) the geographical spread; (ii) the number of species exploited and affected; (iii) the number of gear and boat types and hence of possible fishing strategies; (iv) the various types and combinations of livelihoods; (v) the variability (seasonal and interannual); (vi) the community heterogeneity; and (vii) the multiple-use coastal context. High complexity infers a wider information gap and higher levels of risk in making mistakes. Further, it is difficult to distinguish complexity and its effects from ambient noise or the effect of unaccounted factors. Holling (2000) proposes that "complexity may be in the eye of the beholder" and could relate more to our lack of understanding than to the number of components and relations identified. Nonetheless, in practice, the number of relevant components identified and their web of interactions will affect the choice of methods and the capacity to understand and produce a usable assessment. A key problem is balancing the level of complexity accounted for in order to achieve a realistic and accurate but still feasible assessment.

At the pre-assessment stage, complexity can be assessed against a simple checklist, for example:

1. Resources: does the fishery involve one or many species?

2. Ecosystem: is it pelagic or demersal? Simple or complex? Local or regional?
3. Stakeholders: Is there evidence of conflict and/or disagreement over management objectives and resource use? Is the fishery of significant value to groups beyond the fishers themselves (e.g. significant contributor to the economy, to nutritional security, cultural identity, etc.)?
4. Authority: Is the fishery under the jurisdiction of a sole formal or informal authority, or is responsibility shared among many (e.g. communities, private rights-holders, the State) such as common resources of transboundary stocks?
5. Technology: Does the fishery use multiple-gear types, or a single type? Does it involve one or multiple fleets?
6. Revenue streams: Do fishers or fishing households engage in other non-fishery related income-generating activities?

The responses will indicate how complex the fishery system is and, as a consequence, how "controllable" it might be. Some kind of complexity score can be set up and matched against the low/high scales in Figure 5.

Capacity

Operational capacity (e.g. financial, human and institutional) is another important criterion with obvious implications for the assessment strategy and process. Though not included explicitly in Figure 4, this criterion will, to some extent, be inversely related to complexity as the more complex the system, the less capable we will be to deal with it, under given conditions. Capacity is considered here in relative terms. Both capacity available and capacity deployment are important. It is important to know what capacity is available – for the assessment and implementation of advice – relative to each other. The lower the relative capacity (or the wider the capacity gap), the higher the risk of being unable to adequately tackle emerging issues. Every question to be resolved by an IAA necessarily raises the problem of capacity with its different components: the technical skills of the local experts available; the capacity to facilitate the participative process; the institutional competence (clarity of mandates) of the agencies involved; the data and time available for the assessment; and so on.

It is important to get a feeling for the capacity available versus what is needed at the level where the problem arises, whether locally (among fishers in the concerned community), or at national or regional levels. Capacity gaps may vary among disciplines and partners and it might be necessary to consider drawing on complementary external expertise.omplementary external expertise.

In the long term, the best way of closing the capacity gap is certainly to develop the national and local capacity in the deficient areas to a level commensurate with the value of the fishery. In the short term, however, the capacity gap determines the comprehensiveness, detail and reliability of the assessment and the level of precaution one will need to build in the proposed options. When the capacity gap is large, the options are: (i) to account for it in precautionary assessment and advice; (ii) to reduce it immediately, by bringing in external expertise when available; and (iii) to reduce it in the longer term adopting a capacity-building strategy. The choice among the three options is guided by the value of the fishery. However, it is also important to query whether the costs of the IAA process relative to outcomes/benefits warrant the use of capacity even where it is adequate.

There are various tools available for capacity assessment. The most relevant to a pre-assessment phase is institutional assessment, as implemented by the International Development Research Center (IDRC) as part of a process to strengthen the organizational capacity of its research partners (e.g. Morgan and Taschereau, 1996).

The scoping phase may conclude that it is inappropriate to proceed further with the assessment, for example for lack of consensus, excessively high levels of uncertainty, or a low value of the fishery or the benefit expected. While this may be an unfortunate conclusion, it is preferable to reach early in the process, before wasting precious resources. This does not always mean that nothing can be done to improve the fishery. In some cases the scoping will be a sufficient assessment to guide the direction of precautionary approaches, or those that increase capacity of stakeholders to address sustainability issues for themselves at lower costs. In some cases, the scoping may conclude that an assessment is feasible but not necessary, for example when there is already sufficient agreement among actors and a best practice solution is readily available (based on experience). In that case, it may be appropriate to proceed directly to the decision and implementation, building in the monitoring process. If the assessment appears indispensable and feasible with the means available, then the assessment phase can proceed. In reality, the distinction between scoping and assessment may not be clearly marked. Depending on the data and capacity available, some elements of the assessment may already start developing during the scoping phase. In addition, during the assessment itself, elements may emerge that require scoping before being fully assessed. It is important, however, within the IAA process to maintain synergy between the scoping and assessment phases of multiple components in order to keep all partners informed and optimize the assessment, e.g. realizing economies of scale.

ASSESSMENT PHASE

The assessment proceeds through different approaches, methods and tools (used here loosely but also referring to methodological categories nested in that order). Having conducted the scoping process and established the need for an assessment and the capacity available, the next phase proceeds first through an organizational mode.

Preliminary organization

Convening the assessment team

The assessment phase starts by building up of the assessment team, calling for: (i) the partners required to fulfil disciplinary requirements; (ii) key informants among stakeholders (users, managers and influential people); and (iii) other people with relevant knowledge but no stake in the process. This process is conducted with reference to the threats and opportunities identified in the “issue radar”.

In putting together the assessment team, the following qualities are a consideration, in addition to the obvious and conventional disciplinary and technical skills:

- open-minded attitude and willingness to learn;
- gender balance;
- ethnic balance;
- local language skills; and
- organizational background.

There will also be a trade-off between establishing a small or large assessment team (assuming human resources are available) and between splitting, or not, the large group needed into smaller teams. The trade-off is between the ability to assess a large area faster or tackle a number of issues simultaneously and the inherent difficulties in managing a large composite team from different disciplines (Pomeroy and Rivera-Guieb, 2006).

Allocating roles and responsibility

Roles and responsibilities are jointly agreed based on the prioritization of different issues and the relative importance of different components within these issues. The leading role might be taken by the discipline most relevant to the issue at stake. It might also be taken (or supported) by a facilitator that will give the highest priority to the completion of an integrated assessment, smoothing any “friction” between disciplines. The leader (or facilitator) identifies and proposes roles and responsibilities and obtains agreement on the allocation of tasks and expected contributions. Specific roles will be given to selected stakeholders, with the usual caveats about full and diverse representation.

Developing shared visions and strategies

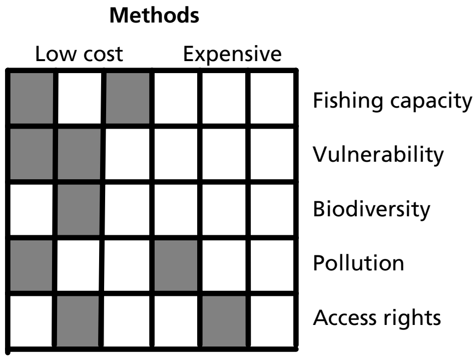
At this stage, the aim is to develop a shared vision and strategy for the assessment among those involved in the assessment process, building a common understanding on the nature of the problem and possible resolutions. This step should develop a common understanding of the relevant time and space frames to be used by the team (possibly allocating responsibilities and expectations across them) for a cross-scale assessment. This step involves also looking again, in more depth, at the "issue radar" given in Figure 4, confirming their relevance and relative priority. Efforts will be made to identify existing visions among stakeholders (including potential explanations), noting similarities and divergences. The common vision is, initially, the overlapping area between them. One key objective of the IAA will be to increase the overlap significantly as the various points of view converge. A variety of well-tested group process methodologies for developing a vision with a diverse group of stakeholders are available and the use of a facilitator[7] versed in these methods may produce a result that is consensual and that can be a strong foundation for moving forward.

Selecting approaches and methods

Once the team is established and responsibilities are allocated, the assessment work proceeds through a number of steps that are briefly described below. Based on the identification of key issues and the characterization of the assessment environment during the scoping phase, considerations for the disciplines, approaches and methods needed for the full assessment will start to emerge. Approaches are determined by the perceived complexity of the management issues, the resources and capacity available, the scale of application and the value of the fishery (see Figure 5). Depending on the degree of complexity and cost of the analyses to be conducted, directions might be different for the different areas of competence (e.g. resources, ecosystem, economics and institutions). Methodological specifications may be established first in broad terms, adding detail as the assessment progresses and the team is assembled.

At this point, experts from the various disciplines must identify the methods to be used, based on issues identified, data and competencies available, affordable costs, sophistication required, etc. (Figure 7). For low-value fisheries, for example, simple methods are required, using existing data, filling knowledge gaps from databases (e.g. Fishbase for biological parameters) and carefully selected case studies undertaken elsewhere on similar fisheries (with due caution – taking into account context effects). Learning will need to be low cost. Internet-based knowledge networks could be a good source of expertise.

FIGURE 7
Indicative matrix for identifying approaches and methods



Note: grey cells represent selected methods.

The diversity, severity and scale of issues will have implications for the selection of appropriate methodologies. Potentially useful methodologies, some of which are already used in fisheries, have been developed for other development sectors (e.g. agriculture, forestry, rural sector) or development frameworks (e.g. sustainable development, sustainable livelihoods) and their

[7] The facilitator's role is to assist in selecting the most appropriate methodology, planning the process and serving as a catalyst to help it along.

application to fisheries needs to be facilitated and promoted. For example, some participatory rural appraisal (PRA) tools used for the collection of social data and information have also begun to be used in the biological fields. Table 2 gives an indicative and limited selection of methods by domain of research, the intent of which is to show the range available compared to the very limited toolbox used in conventional assessment. As this framework matures through collaboration and testing, a more detailed catalogue will be developed indicating what these approaches and methods are and under which conditions they operate best and so on.

It would also be difficult to list all the tools that might be used in support of the various approaches listed above but, with the same intent, the following quantitative and qualitative tools can be mentioned: in-depth and informal, unstructured and semi-structured interview using open-ended questionnaires; participative mapping; transect walk; indicators; geographic information systems (GIS); desk research; stakeholders meetings; causal chain analysis (CCA); participant observation; group and focus group discussions; various ranking and scoring methods (pile sorts, Q-sorts)[8]; diagrams and other visual tools. More quantitative tools include: general and partial equilibrium models; multiagent models; and other models (macroeconomic, microeconomic, input–output, bio-economic). The use of qualitative methods may not be very typical in conventional stock assessment but their integration in multidimensional assessments becomes unavoidable.

While the process is made as transparent and objective as possible, the selection of the approach and the methods, in each assessment domain, implies reference to an explicit or implicit conceptual representation of the fishery (or conceptual framework) constructed from a body of theory (paradigm) and one's culture and experience. The conceptual (mental) models used by different knowledge holders (including stakeholders) are likely to be different. They will need to be clarified to and discussed by all team members, together with their basic assumptions. Clarification may concern:

- the criteria for selecting a particular method;
- the kind of information it uses, whether quantitative or qualitative;
- the kind of outputs it will bring (historical perspective, description of present state, trends and scenarios, alternative solutions) etc. and their relevance to the questions at stake; the robustness of these conclusions to uncertainty.

This process should clarify common understandings, or lack of, regarding the direction an IAA process is taking. Issues to consider in this part of the process could include an analysis of strengths and weaknesses of the given set-up, with its unavoidable shortages in data and resources. As a consequence, the expected synoptic output and single contributions to it could be outlined. Explicit judgement could be made about where to place emphasis in reducing uncertainty. The process of validating collective local knowledge should also be discussed as this is a sensitive and contested issue.

Conducting the assessment

Once the questions have been clarified, the team is in place (with external collaboration as required) and the methodological set-up has been determined, the assessment itself can take place. The expected outcomes of this phase include:

1. A definitive formulation of the question.
2. A clear statement of the objectives assigned to the assessment.
3. An updated report on status and trends in the area/sector/fishery, as appropriate.
4. A deeper understanding and clear expression of the issues at stake, e.g. the management problem, the conflicts, the policy formulation, the management plan.

[8] See Pomeroy and Rivera-Guieb (2006).

TABLE 2
Preliminary overview of methods used in the socio-economic and biological domain

	SOCIO-ECONOMIC DOMAIN		
	Fisheries only (incl. processing, etc.)	**Fisheries and related livelihood**	**Multisector**
Community	PRA (M) H/H survey (M) Stakeholder and gender analysis (M) Economic analysis (A) Socio-cultural analysis (A) Cost/Benefit Analysis (M)	SLA (A) PRA (M) Institutional Analysis and Development framework: IAD (A) H/H survey (M) Stakeholder and gender analysis (M) Economic analysis (A) Socio-cultural analysis (A) Cost/Benefit Analysis (M)	SLA (A) PRA (M) IAD (A) Stakeholder and gender analysis (M) Economic analysis (A) Cost/Benefit Analysis (M) Socio-cultural analysis (A)
Local admin unit	H/H survey (M) Stakeholder and gender analysis (M) Policy analysis (A) GIS (e.g. poverty map) (T) Economic analysis (A) Socio-cultural analysis (A)	H/H survey (M) Stakeholder and gender analysis (M) Policy analysis (A) GIS (e.g. poverty map) (T) Economic analysis (A) Socio-cultural analysis (A)	Stakeholder and gender analysis (M) Policy analysis (A) IAD (A) Economic analysis (A) Socio-cultural analysis (A)
Province/State	Economic analysis (A) H/H survey (M) Policy analysis (A) GIS (e.g. poverty map) (T)	Policy analysis (A) GIS (e.g. poverty map) (T) Economic analysis (A)	Policy analysis (A) IAD (A) Economic analysis (A)
Country	H/H survey (M) Policy analysis (A) GIS (e.g. poverty map) (T) Economic analysis (A)	Policy analysis (A) GIS (e.g. poverty map) (T) Economic analysis (A)	Policy analysis (A) IAD (A) Economic analysis (A)
Region	Policy analysis (A) GIS (e.g. poverty map) (T)	Policy analysis (A) GIS (e.g. poverty map) (T)	Policy analysis (A) IAD (A)
	BIOLOGICAL/ECOLOGICAL DOMAIN		
	Stock (single species)	**Multispecies**	**Ecosystem**
Community	Stock assessment (A) PRA (M)	PRA (M)	Ecosystem approach (A) PRA (M) Biodiversity assessment (M)
Local admin unit	Stock modelling (M) Stock assessment (A) PRA (M) GIS/RS (T)	Trophic analysis(A) Multispecies stock assessment (M) PRA (M) GIS/RS (T)	Ecosystem modelling (M) Ecosystem approach (A) PRA (M) GIS/RS (T) Environmental flow approach (A) Biodiversity assessment (M)
Province/State	Stock modelling (M) Stock assessment (A) GIS/RS (T)	Trophic analysis Multispecies stock assessment (M) GIS/RS (T)	Ecosystem modelling (M) Ecosystem approach (A) GIS/RS (T) Environmental flow approach (A) Climate/environment modelling (M) Biodiversity assessment (M)
Country	Stock modelling (M) Stock assessment (A) GIS/RS (T)	Trophic analysis Multispecies stock assessment (M) GIS/RS (T)	Ecosystem approach (A) GIS/RS (T) Environmental flow approach (A) Climate/environment modelling (M) Biodiversity assessment (M)
Region	Stock modelling (M) Stock assessment (A) GIS/RS (T)	Trophic analysis GIS/RS (T)	Ecosystem approach (A) GIS/RS (T) Environmental flow approach (A) Biodiversity assessment (M) Climate/environment modelling (M)

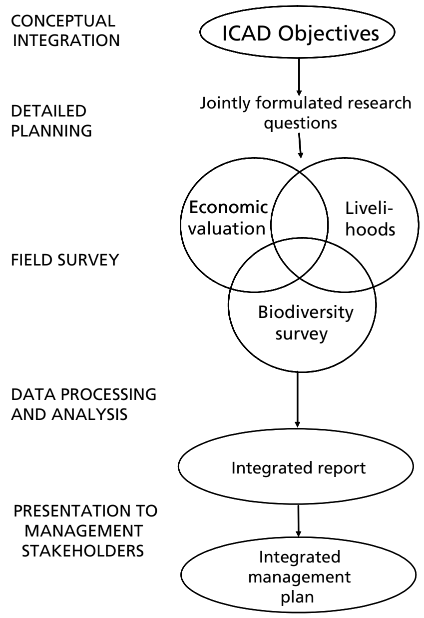
A: Approach
M: Method
T: Tool
Source: FAO, 2005a.

5. A series of options for action, evaluated in economic, social and bio-ecological terms, in the short and long run, including the transition phase.

A key element of the assessment is that it should be, as far as possible, carried out in an integrated manner throughout, from scoping through to discussion of assessment findings with management stakeholders. As discussed earlier, the delicate issue is to decide what part of the assessment is carried out separately by each discipline, what part must be undertaken jointly and what procedure will be used to blend the various findings into a single whole to be communicated to the demanding authority.

This integration has been achieved, for example, in a wetlands assessment project, where the challenges of integrating livelihoods, economic valuation and biodiversity analysis to provide information on integrated wetland conservation and development have been addressed (Figure 8).

FIGURE 8
Schema for integration of disciplines reporting on integrated conservation and development (ICAD) assessment and planning in wetland sites



Source: Darwall *et al.*, 2007.

Validating the assessment – peer review

The peer review of the ongoing science build-up, e.g. through the process of formal academic publication, is different from peer review of the expertise provided and the options developed in a decision-making process. A broader view of peer review is to be taken in this latter case. The peer review is "extended" in the sense that it involves not only the scientific discipline peers but also the end-users themselves. The peer review is extended also inasmuch as it is both a substantial evaluation (assessing the data, methods and conclusions) and a procedural evaluation (assessing the degree of participation, adhesion to conclusions, etc.). If such a service would exist, the assessment could be certified as procedurally correct and substantially sound. Certification could be obtained from a competent company or developed by consensus-building. The peer review may be undertaken immediately, at the end of the integrated assessment, advice and decision-making process, or it could also be delayed to later on as more data become available. If the participation was equitable and led successfully to an agreed set of ranked options, it could be concluded that the extended peer review has indeed been taking place, integrated in the IAA process. If the assessment process is institutionalized, it is advisable to plan an external review of the whole process every few years, to check its outcomes and objectivity.

ADVISING AND DECISION-MAKING

Contrary to previous approaches, in an IAA, all stakeholders are well informed of and contribute to the advisory process as well as the subsequent decision-making and negotiation processes. Interactions between these phases are complex with bifurcations and feedback loops.

Advising

The most recent analyses of science – decision-making relations in fisheries (e.g. in Wilson and Delaney, 2005) clearly indicate the need for:

1. A shift of the focus of management advice and subsequent action from the resource (stock) to the fishery, i.e. from a biological to a bio-socio-technological dimension. Under an ecosystem approach to fisheries, the advice is expected to account not only for interactions within and between fisheries but also interactions within the ecosystem *sensu lato,* including the role of external drivers.
2. Advice that is not open to interpretation, a requirement that is more difficult to fulfill in a complex coastal, multiple use context. As information on complex systems can always be interpreted differently by changing the angle or the basic assumptions, this requirement implies that the interpretation must be

legitimized by the actors concerned through participation that generates a consensus regarding the advice that is offered even when there is a wide variety of options.

3. An examination of the impact/performance of existing measures before advising new ones, avoiding the accumulation of norms and measures that overcomplicates the regulatory landscape within which the sector operates.

A particular complexity of interdisciplinary advice required for SSF is the need to blend together considerations related to the natural system (elaborated by "hard" natural sciences) with those related to the social subsystems (elaborated by "soft" social sciences). In theory, considerations about nature can be quantified and objectively verified. Considerations about the social world, on the contrary, rely on a communicative system of shared meanings that can only be interpreted and never directly verified (Wilson and Delaney, 2005). These distinctions have also been shown for fishery systems by Garcia and Charles (2007). The differences between the two types of science, as described above, are obviously simplified. On the one hand, the "truth" established by so-called hard sciences tends to appear, in the long term, as partial and often transitory explanations. The more complex the subject of the study, the more likely this is to happen. On the other hand, some of the key findings of the social sciences are experimental and quantitative. In addition, "socially constructed" local knowledge is elaborated through fairly robust adaptive learning systems (Wilson and Delaney, 2005). The blending of all these forms of knowledge is in any case advisable, requiring:

- establishment of a proper mechanism for such blending in a decision-making environment so as to produce usable advice in the required time frame;
- establishment of an adaptive learning process through which the conventionally agreed blended knowledge can be complemented, tested and improved, e.g. through monitoring and evaluation; and
- maintenance of the needed flexibility in the system of institutions, norms and regulations to allow for change as required.

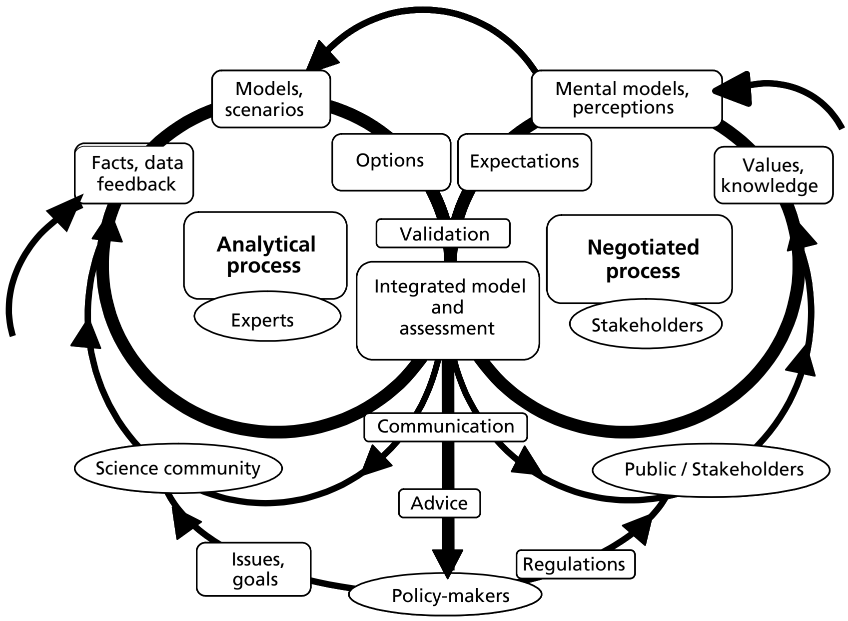
The assessment and its outcome must finally be evaluated – either by the authority that originally commissioned it or by an external entity called in for the purpose. This step involves both appraisal and decision. During the appraisal, the decision-maker develops insight about the various options available and the implications of each.

This last phase of the IAA process may take various forms, with different degrees of intervention of science and other stakeholders. It may involve the Minister alone (rarely), the minister and his/her advisers (often under lobbying pressure), or consensus-based decision-making through public for a (for example in the context of community-based management). For small-scale fisheries, the chances that decisions are successfully implemented will depend on the degree of transparency and stakeholder participation. The roles of stakeholders in this phase are different from the roles assumed during the course of the assessment. For example, stakeholders may play a role in positioning scientific information or other advice within a wider spectrum of other information, objectives and considerations (see Floistad, 1990).

The assessment must provide the distinct but connected advisory and decision phases (see Figure 9) with an understanding of the state of things and a set of possible options for action, with an analysis of their prospective implications in the short and longer terms. A scenario analysis would help in this respect. Comprehensible statements are essential. The assessment should also reflect the degree of gravity/urgency of the situation, e.g. being more directive in case of high risk. The options identified contain and identify explicitly the uncertainty in the assessment. The final outcome may or may not contain a recommendation as to the preferable option and the reasons for that.

Figure 9 provides a conceptual representation of the type of integrated assessment and decision-making process that could be used, in which careful knowledge

FIGURE 9
Integrated assessment and decision-making process



Sources: from Garcia and Charles, 2007. Adapted and redrawn from Pahl-Wostl, 2002.

integration, interdisciplinary alliance, active stakeholder participation and support for decision-making can take place in an integrated manner. It combines a rigorous scientific analytical subprocess and a participative negotiating subprocess. The participatory nature of the assessment legitimizes the options available and their evaluation, but attention must be paid to possible distortions owing to the proximity between the more objective and the more negotiated processes of advice and decision-making, respectively (see Floistad, 1990). The analytical subprocess uses facts, data and feedback information, within the current scientific paradigm, to generate a scientific understanding of the system. The negotiated subprocess, possibly facilitated by social scientists, provides inter alia an understanding of the functioning of institutions, values, perceptions, expectations, acceptable objectives and mental models to be considered in constructing the scientific model. It also mobilizes traditional knowledge to be integrated in the analytical process. Both processes contribute in an interactive mode to the elaboration and evaluation of the present situation, the identification, ex ante evaluation and ranking of implementation options and the elaboration of future scenarios. The same dual process monitors the evolution of the system during implementation and provides performance assessment as a basis for the adaptive management cycle.

The concept of a dual integrated process is not new to fisheries and may be prefigured by the processes used to elaborate operational management procedures (OMPs; Butterworth and Punt, 2003) and for management strategy evaluation (MSE; Fulton, Smith and Punt, 2005). It implies stronger levels of participation of stakeholders and social sciences in information-building, model conception and analysis of options. It implies a well-developed interface for integration of the respective assets of conventional fishery science, applied ecology and social sciences and provides a useful operational guideline for space-based integrated, cross-sectoral management. Its utility does, however, depend on whether the science-analysis is truly objective and free of the influence of informal mental models and perceptions and politicized viewpoints – for example between scientists who are also environmentalists and economists who are also advocates for social change. The policy-making process – including its advisory stages – can be highly politicized in complex systems (Sutton, 1999; Keeley and Scoones, 2000).

Decision-making

The IAA framework does not address the decision-making process *sensu stricto*. This process involves a specific set of actors, authorities, powers, constraints and objectives. Final decisions are made within policy frameworks that may extend well beyond the fishery sector and, *a fortiori*, the SSF sector.

The process is also different in different set-ups. In a top-down fishery management system, the minister may make the final decisions, while in a participatory set-up, that decision may be taken through an open and transparent system. It is obvious that the IAA framework makes a lot more sense if implemented in a participative, deliberative decision process and if it is embedded into a civic science approach (sensu O'Riordan and Stoll-Kleemann, 2002). Such an approach is a form of science that is deliberative, inclusive and participatory, and that recognizes the necessity of involving multi-stakeholder groups in society if fairer and more comprehensive decisions on natural resource management are to be made. For the fisheries sector, this would mean multistakeholder involvement in research and management. Participatory decision-making depends, however, on the existence of appropriate institutions that are based on a process of shared governance, where different groups in society are able to create their own pathways to the future (O'Riordan and Stoll-Kleemann, 2002).

Participation in the advisory process is extremely relevant as it creates outcomes that depend directly on the nature of the process. In this sense, the IAA recognizes the importance of institutions that aim to widen the process of decision-making by enabling participants to define problems from their perspectives and experiences and to seek solutions they regard as appropriate and suitable for their culture and aspirations. Outcomes so achieved, although perhaps not well liked, will tend to be accepted because the decision process was trusted and understood (O'Riordan and Stoll-Kleemann, 2002). In addition, while a consensual approach may sometimes lead to measures considered as clearly suboptimal from a strictly technical point of view, it has the potential to lead to better long-term performance (through the adaptive approach) because (or if) the steps on a difficult pathway are agreed by all the important stakeholders and implemented. On a similar note, in some cases high priority issues will be the ones for which data are not available and, therefore, negotiation will play a more important role than science. In such cases, precautionary principles will need to be employed while assessment and knowledge building can be done.

Information and communication

While communication and knowledge sharing has been a critical aspect throughout the assessment process, concentration here is on the communication of the assessment results and, leading into the next section, some implications for monitoring and evaluation. In the first place, it is important that in any communication of the results of the assessment there should be information about the uncertainties associated with it. Hoggarth *et al.* (2006) and Cochrane (2002) all provide useful advice relating to the presentation of information from stock assessments and Hoggarth *et al.*, (2006) also highlight some of the ways in which uncertainty can be communicated.

A key priority for communication activities is that information has to be generated and shared in an appropriate and timely fashion, allowing people to develop their own understanding and knowledge (Garaway and Arthur, 2004). In this respect, awareness of how information can best be shared, based on the knowledge, skills and experience of each target audience, is as important as the information itself. A useful principle therefore is to examine existing information flows – what methods different stakeholders already use – and start from there (Halls *et al,.* 2005). In achieving successful communication, developing trust and building mutual respect, the inclusion of different types of knowledge is challenging but essential. Where possible, the target audience should be engaged from the start and be involved throughout the assessment process. The barriers to communication, even within stakeholder groups, are many and go beyond issues of culture, translation, levels of education and terminology to include challenges posed by institutional and personal incentives and attitudes (e.g. Garaway *et al.,* 2006; Arthur and Garaway, 2006; Strigl, 2003).

In an adaptive learning process, the experience of Arthur and Garaway (2006) was that there is much to be gained if all stakeholders are involved in assessing or evaluating information or collaborate in generating it. They took an innovative "learning by doing" approach to information sharing in which, rather than being presented with the assessment results, the target audience was assisted to analyse some of the key data themselves and to discuss the implications of the findings (Arthur and Garaway, 2004). While time consuming, this approach often associated with "skills" training, ensured that those who needed to learn were doing so. This is important as it can be expected that when stakeholders understand the results, they can see their relevance and are more likely to be committed to the process. The results are then far more likely to be utilized than when decisions are imposed from the top (Bryan, 2004; Dalton, 2005; Faysse, 2006; Garaway and Esteban, 2003; Jentoft, 2000; Ribot, 2006; Rockloff and Lockie, 2006; Silva, 2006).

Greater participation and two-way communication by a range of stakeholder groups can greatly benefit the assessment process. While critical for accessing different knowledge types and for taking an interdisciplinary approach to fisheries systems, participation and communication can also help to improve the effectiveness and efficiency of data collection and the quality of the monitoring and evaluation systems (Arthur and Garaway, 2006; Halls *et al*., 2005). In developing countries, research and management take place in resource-poor and educationally-limited contexts. Without an emphasis on communication and participation, there is a very real risk that approaches will be unfamiliar to all the stakeholders and that key words, questions and concepts may become irrelevant or be misinterpreted. The likely result is poorly understood and executed designs that result in inaccurate or unreliable information (Arthur and Garaway, 2006). In addition, people are more likely to accept the results when they know where the information came from and had a hand in producing the answers.

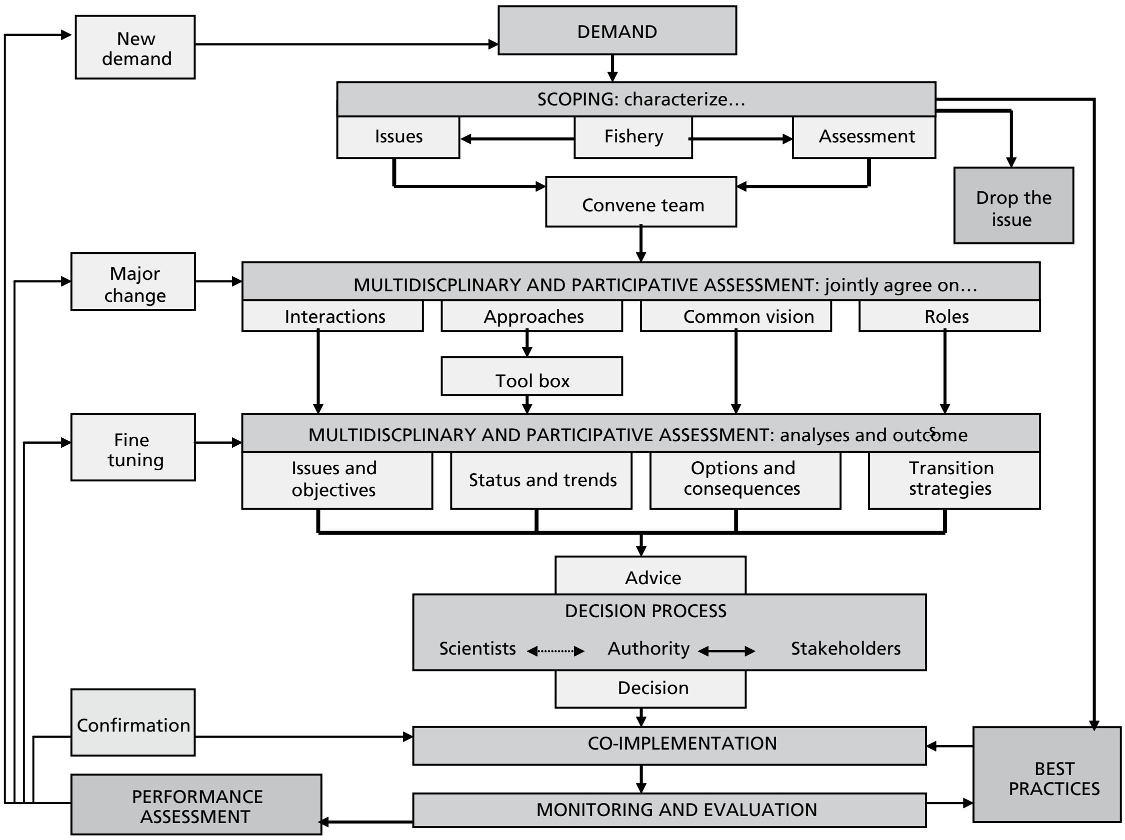
MONITORING AND EVALUATION

Monitoring and evaluation are critical components of adaptive learning and management performance assessment. They provide feedback information emerging from the application of available knowledge and the consequences of the new management actions. They are therefore critical to informing resilience-building adaptive management (Andrew *et al*., 2007). Thus, monitoring and evaluation should not be seen as a "before and after" process, but rather as a continuous, iterative and integral part of the IAA and adaptive management processes. Figure 10 pulls together in one single representation all the phases and steps provided for by the framework.

Purpose of monitoring and evaluation

In IAA, monitoring and evaluation (M&E) are integrated in the recurring assessment and decision-making process. They provide major feedback loops through which learning will increase and performance will improve. M&E are required to evaluate the IAA process in relation to its performance in the short term (operational, crisis solving) and in the long term (strategic, sustainable livelihoods). M&E are essential elements of the social learning process and the *sine qua non* condition of any effective adaptive

FIGURE 10
Complete integrated assessment and management process



approach. As for the assessment process itself, the M&E cost will have to be tailored to each situation and remain affordable (see next section).

- M&E in the short term: In this process, the assessment, advice and decision made to resolve a crisis, in terms of implementation and outcomes, are evaluated with the view to check their validity, to learn from experience and to improve the measures as required. The parameters for this evaluation are given by the initial objectives of the decision (e.g. translated into reference values) and the indicators regarding the resource and the fishery. This M&E process might be undertaken for a number of years depending on the resources concerned and the issue at stake. In practice, many decisions will need to be evaluated together. The cycle could go on indefinitely.
- M&E in the long term: In this process, undertaken every few years and ideally forever, the IAA process itself is evaluated in terms of its success rate, its efficiency, e.g. in achieving consensus, ability to find valid solutions and cost effectiveness, etc. This would include, from time to time, an evaluation of the M&E process itself and, in this case, will therefore need to involve external auditing. The parameters required imply that objectives are set for the IAA process (e.g. in terms of performance, cost, etc.) and that indicators are identified and collected.

The evaluation undertaken at this stage of the IAA cycle is undertaken *ex post* based on the data collected through monitoring. It follows and checks the validity of the *ex-ante* assessment undertaken during the initial phases of the IAA process or the preceding *ex-post* evaluation. In case of a recurring assessment, the *ex-post* evaluation of the past assessment phase and the *ex-ante* evaluation of the new assessment are confounded. Because of the cost involved in monitoring and evaluation, this part of the process can only be sustainable if there is a strong formal demand for performance-based governance.

Requirements for monitoring and evaluation

First of all, an M&E system requires a clear statement of objectives and expectations to be used as benchmarks. These objectives should be turned into indicators, and reference values for them identified where possible. These should cover both human and ecological well-being and could be quantitative or qualitative. The setting up (and institutionalization) of an ideal M&E system requires:

1. An agreed set of indicators determined for the purpose.
2. Enquirers, such as field enumerators or on-board observers for data collection and processing.
3. An integrated information system to store the data and make them available for analysis (e.g. databases connected to GIS).
4. Capacity to undertake recurrent analyses of such data to assess the stock and the sector.
5. Information support (e.g. through Internet) to feed the new information and knowledge back to the sector and the public, making the M&E process an instrument of transparency and oversight.
6. An authority specifically mandated for such oversight and auditing.

One of the key requirements for sustainable governance, however, is that it be affordable, e.g. viable at a cost commensurate to the revenues drawn from the fishery activities. As a consequence, the cost of the M&E process, as with the cost of the assessment itself, should be tailored to the value of the fishery. The costs of the above "ideal" system may scare off SSF managers from attempting any monitoring. This set of conditions can be short circuited. For example, if the "issue kites" from the scoping phase of the assessment are revisited with stakeholders periodically – in a group or individually – and their view of where thing are getting better or worse is recorded, that is a basic valid M&E process that does not require additional data collection.

While a thorough process would be advisable for an M&E of the SSF sector as a whole or in a large region, the ad hoc interventions undertaken in single fisheries or small communities will require simple procedures (that could be run by the community with minimal assistance) and simple data (that could be collected by the fishers themselves). In extreme cases, the M&E can be conceived as mainly or exclusively qualitative, e.g. largely based on questionnaires and discussions. An important point, however, is that without some reliable M&E process, the so-called adaptive approach is left entirely to informal processes, the capacity of which to face the rapidly changing context is more than dubious.

Indicators

The use of indicators as a means to monitor and assess progress in sustainable development was called for in 1992 UNCED Agenda 21, Chapter 40, as a basis for monitoring and decision-making at all levels and to contribute to self-regulating sustainability of integrated environment and development systems. Since then, indicators have become favourite instruments for monitoring, reporting and communicating progress in the process of implementation of the sustainable development framework (Bilharz and Moldan, 1995). Indicators and reference values have always been in use in fisheries management before their formal promotion in support of sustainable development and their formal use in management systems has been promoted by FAO (Garcia, 1997; FAO, 1999; Garcia and Staples, 2000). Indicators form an integral part of the implementation framework for the precautionary approach to fisheries (PAF) (Garcia, 1994; FAO, 1996; Garcia, 2000) and the ecosystem approach to fisheries (EAF) (Garcia *et al.*, 2003; FAO, 2003; Daan, Christensen and Cury, 2003; Garcia, 2008). The

BOX 5

Indicators, targets and reference points – definition and role

An indicator is *a variable, pointer, or index. Its fluctuation reveals the variations in key elements of a system. The position and trend of the indicator in relation to reference points or values indicate the present state and dynamics of the system. Indicators provide a bridge between objectives and action* (FAO, 1999). It is a *signal of processes, inputs, outputs, effects, results, outcomes, impacts, etc. that enable such phenomena to be judged or measured. Both qualitative and quantitative indicators are needed for management learning, policy review, monitoring and evaluation* (Choudhury and Jansen, 1999).

A reference point (or reference value) is a particular level of an indicator used as a benchmark for assessment and management performance. *It is an estimated value derived from an agreed scientific procedure and/or model, which corresponds to a specific state of the resource and of the fishery and that can be used as a guide for fisheries management. It indicates a particular state of a fishery indicator corresponding to a situation considered as desirable (target reference point, TRP) or undesirable and requiring immediate action (limit reference point, LRP and threshold reference point, ThRP)* (Garcia, 1997).

When reference values (and therefore objectives) cannot be expressed in quantitative terms, indicators could be interpreted in relation to reference directions (e.g. increased abundance; reduced discards; improved employment) as opposed to reference values. Indicators have a number of useful functions for small-scale fisheries assessment and management. As normative instruments (i.e. as standards), they can be used, for example, for attribution or not of a subsidy (when the latter is conditioned by, say, the level of revenue, or the overall value of the fishery) or to open or close a fishery (e.g. based on biomass levels). As instruments of quantification, they measure quantitatively (or qualitatively) the level of a criterion or of one of its components that can then be represented on a graph. As such they are considered important in monitoring and performance assessment. As instruments of communication, they intend to encapsulate the essence of a complex situation and convey a message (or performance, or risk) and can be used to inform the stakeholders as well as elements of mediation and dialogue, e.g. in a negotiation process. Finally, as a means of simplification, they aggregate the properties of complex components and systems into few aggregated or integrated variables. Simplification of complex systems and functions is a double-edged knife but it is central to communication. With all these functions, indicators can play a central role in evaluation and monitoring of SSF, provided they are affordable and agreed by stakeholders who understand their properties, the meaning of the changes, the factors behind such changes and the implications of these changes for action and are therefore willing to assist in their implementation.

development and maintenance of a system of indicators and reference values are central to the institutionalization of M&E as they formalize the demand and justification for collecting targeted information and providing a background scientific capacity for its routine analysis.

While the FAO Techical Guidelines on “Indicators for sustainable development of marine capture fisheries” (FAO, 1999) do refer to data-limited situations, integration of knowledge, use of rapid appraisal and capacity building (see the sections *Scoping phase* and *Advising and decision-making* of the Guidelines), their application, up to now, has focused on the development of quantitative indicators in both data-rich and high-capacity circumstances. It is recognized that designing a monitoring system for small-scale fisheries in resource-poor situations may require an approach, using qualitative indicators, that simply monitors a generalized system state and an indication of whether that state is moving in a societally-favoured or disfavoured direction.

Relevant indicators

The numerous indicators listed for use in fisheries (see FAO, 1999), whether referring to the resources, the sector or the governance system, are potentially relevant for SSF monitoring and assessment and the lists available are generally much too comprehensive for the means available to most SSF governance systems. The indicators of relevance for a particular evaluation programme obviously depend on the context, the nature of the fishery and, above all, on the question initially raised or problem to be solved, the solutions proposed and their expected outcome. However, the specific issues affecting SSF and the specific objectives retained for them imply giving particular attention to some of them relating for instance to sustainability, food security, poverty, empowerment, resilience, adaptability, vulnerability, livelihoods, etc. In addition to conventional fishery indicators, general indicators of human development will be particularly relevant for SSF, such as demography and level of education, nutrition and health. In small-scale fisheries, the main difficulty is likely to be in obtaining reliable indicators of the resources.

Issues with indicators

The experience accumulated during the last 15 years with the use of indicators in fisheries points to a number of difficulties that need to be foreseen and resolved, including, in a SSF context: (i) the selection of relevant and affordable indicators for population and ecosystem indicators; (ii) the process of obtaining the data and calculating and interpreting of indicators; (iii) the assessment of uncertainty (signal/noise ratio); (iv) the development of decision rules stemming from the observation of indicators; (v) the long-term cost of monitoring; (vi) the difficulty of separating the effects of climate, habitat degradation/pollution and fishing; (vii) the frustrating quest for relevant pre-exploitation baseline information; (viii) the agreeable formulation of value judgments attached to specific indicators levels (e.g. what is acceptable?); (ix) the ranking of objectives and risks among stakeholders with different expectations and perceptions; (x) allocation of the burden of proof in a precautionary approach; and (xi) development of a risk assessment and management culture; all of this in a context of chronic limitation of data and research capacity.

Indicators appear, therefore, as a source of hope in a data-limited context, but can lead to incorrect action if they are misunderstood.

Indicators are also seen as a useful means of communication, able to encapsulate summaries of complex information in a few graphs. For the same reason as above, these very concise summaries can be very difficult to decrypt by the constituency. Indeed, it is usually recommended to distribute indicator summaries with reading keys and scientific commentaries to assist readers in their interpretation.

Indicators and local knowledge in SSF

The development of indicators that are scientifically valid, less complex than conventional models and agreeable to stakeholders would be an important step in improving management frameworks, not only in the developing world. For indicators to be accepted in SSF management they need to address directly SSF communities' local agendas and concerns. However, these concerns might not match the general management/sustainability concern of more strategic importance but of little relevance perhaps to the poor communities. An example of this is the need for catch statistics at aggregate level for global monitoring of the sector by FAO, while locally developing a monitoring system to quantify total catch may not be a high priority and people may be more interested in tracking trends in catch rates, profitability or exploited species composition, all of which are too context-specific and influenced by different factors (technology, changing markets, etc.) to be useful for comparative purposes.

SYNTHESIS

This chapter has presented the integrated assessment and advice process, elaborating on the different phases. It should again be noted that while the presentation of the assessment process is linear, the framework is characterized by continuous feedback loops and founded on principles of adaptability and reflexivity. The integrated assessment and advice process (Figure 3) is coupled with the policy/management cycle described in the following chapter. Connections between the two – in the form of transfer of knowledge, power and legitimacy – are likely to work best if the wheels are turning in same direction.