Scientists dealing with stakeholders’ demand for coral reef management indicators: methodological approach and issues

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Abstract: The purpose of this paper is to analyse how to relate scientific supply to demand regarding sustainable management indicators. This discussion is based on coastal zone management in Réunion Island, for which socioeconomic indicators have been developed. This research allows us to establish conditions to connect social demand with the scientific supply of indicators:
• to develop an iterative process, which associates stakeholders, for identifying and selecting indicators
• to strengthen the coherence between demand and supply of indicators: this should be achieved through better connections between the representations developed by stakeholders and scientists of the system to be managed
• to consider the issue of environmental decision making and responsibility.
Environmental research must focus on the design of the process of selection of relevant indicators. This research must also assess and monitor the use of indicators for the decision-making process. This involves the development of methodologies enabling this co-elaboration between users and scientists, while considering areas of public policy action and assessment.

Keywords: coastal zone management; coral reef; environmental crisis; sustainability indicators; participatory research; sustainable development.


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1 Introduction

The need to reconcile environmental protection and socio-economic development is a main issue as regards coral reef coastal zone management. This paper is based on a single study case, which enables the scientific point of view to be related to the social demand concerning sustainable development indicators. In Réunion Island, a national marine protected area (MPA) including most coral reef formations of the island is currently being created. For its promoters, implementing sanctuary zones and areas where uses are subject to regulations should be a sufficient measure for ensuring efficient coral reef protection. The vulnerability of the coral reef environment is increased as it covers a limited area (12 km²) and is greatly attractive for small-scale fishing and seaside tourism. Very small coastal plain and steep catchment areas in which urbanisation is developing rapidly make it necessary for the MPA to be reinforced by an integrated coastal zone/catchment area management. To do so, integrated management is to be considered as a necessity by public authorities and in particular by local elected bodies, and to be backed up by appropriate indicators.

MPAs represent a typical defensive solution for dealing with deterioration threats affecting coral reefs (Salm and Clark, 1984; Wilkinson, 1998). MPA-related impact indicators are based, on the one hand, on MPA biological economic and social ‘zero state’ assessment procedures, and on the other hand, on ‘reserve effect’ monitoring procedures, which have been implemented progressively (Gell and Roberts, 2003; Sales et al., 2005; Schmidt and Osenberg, 1996).

As shown by a recent summary based on the review of international academic literature, although many indicators have been proposed as studies have progressed, no standardised indicator dashboard has been prepared so far (Pelletier et al., 2004). These studies generally refer to ‘on-site observations’, which cover in-situ collection of data and their processing. They represent the most common research regarding coral reef environments and their management. They are generally carried out according to a disciplinary approach which excludes attempts to make biological-, economic- and social-type indicators coherent for the management of a given site (Clua et al., 2005). In the case of the reserve effect, even if such an initiative was proposed, it would be hindered by the lack of indicators characterising social systems.
and their dynamics. Most works are related to ecology and a small number to economics; other social sciences have shown no significant involvement in this area of study (Pelletier et al., 2004).

This paper emphasises the elaboration of socio-economic-type indicators supporting integrated coastal zone and coral reef management. Such indicators have been ignored so far, as opposed to ecological-type indicators, which were studied in detail in 1997 and 1998 in relation to the Environment Regional Programme of the Indian Ocean Commission (Commission de l’Océan Indien) (Conand et al., 1998). Moreover, the only demand issued by actors upon scientists is mainly related to environmental crisis management indicators. The notion of social demand for sustainability indicators is then to be challenged.

The major trends in environmental indicator development are briefly presented. The methodological approach we developed and its three main steps, are the core subject of this paper. This presentation will be followed by a discussion on the social demand related to sustainability and management indicators. How is its absence to be interpreted? Does it depend on the nature of the scientific supply? Why should crisis indicators be favoured rather than operating indicators? The conclusion draws the conditions to connect social demand with the scientific supply of indicators and highlights the need for environmental research to develop methodologies enabling this co-elaboration between stakeholders and scientists.

2 Two major trends in environmental indicator development

The review of international literature on coral reef monitoring indicators underlines the existence of two major trends: assembling literature-based indicators to produce synthetic, predominantly ecological indicators; and building field-based indicators on a pluridisciplinary basis.

In the first case, collecting a set of relevant indicators involves assembling literature-based indicators which are considered as robust, as they have been validated by the assessment system of the international scientific journals in which they have been published. The final objective is to produce synthetic indicators through models using these indicators as inputs. Although the results of these studies seem to be interesting, we may however question the efficiency of the method employed for collecting relevant indicators. How would those indicators be coherent with one another? How would they enable an indicator dashboard to be built? On the one hand, a potential source of indicators, which have been published in reports, guides and manuals, are not accounted for (Salm and Clark, 1984). For example, literature concerning ‘reserve effect’ indicators does not describe MPA management plans, or their day-to-day organisation. On the other hand, as these disciplinary-type indicators are not sufficiently generic, their relevance does not project beyond the context of the study having enabled their elaboration.

The sets of indicators elaborated according to this method do not seem to be related to a demand expressed by MPA managers or stakeholders. Their use by these actors is not tested nor considered as an explicit issue. As these research results are published in international papers, it is doubtful that these indicators will be used by coral reef environment managers if scientists do not actively diffuse their results for
the benefit of relevant actors. The diffusion issue is all the more sensitive when indicators are generated by modelling.

In the second case, field-based indicators should be elaborated on a local multidisciplinary basis in answer to a specific demand expressed by stakeholders who will sometimes participate in this elaboration. The objective is then to measure what is locally important and to reinforce the stakeholders’ capacity to address management problems (Fraser et al., 2006). This approach, sometimes qualified as ‘bottom-up’, has been promoted for coastal zone management (CEL, 2002; Denis and Hénocque, 2001). It has been applied for freshwater lenses management in coral reef islands (Dray et al., 2006; Lille, 2004). While developing these field-based indicators, the main questions raised are the spatial and temporal scales for which they are relevant, and thus the genericity of the proposed indicators. This underlines the need for adapting the proposed indicators, and for organising the interactions between scientists and actors.

These two trends of methods for building environmental indicators illustrate the disconnection between a scientific supply-driven elaboration and a user demand-driven elaboration. Between these two extremes, there is a variety of situations in which indicators are to be elaborated. Five different procedures may be listed: bibliographical compilation of indicators and standard ecological modelling; on-site disciplinary observation; scientific expertise in answer to potential needs or an expressed social demand; and co-elaboration of field based indicators with actors having initiated a social demand (Table 1).

<table>
<thead>
<tr>
<th>Non-existent</th>
<th>Non-existent/partial</th>
<th>Moderate</th>
<th>Strong</th>
<th>Very strong</th>
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<tbody>
<tr>
<td>Bibliographical compilation standard ecological modelling.</td>
<td>On-site disciplinary observation.</td>
<td>Scientific expertise and observation in answer to potential needs.</td>
<td>(Multidisciplinary) scientific expertise in answer to an expressed demand.</td>
<td>Co-elaboration of field based indicators with social demand actors.</td>
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The structuring variable for building management indicators is then the relationship with a social demand. When this relationship is non-existent or partial, scientists in charge of building indicators define indicator needs at the upstream level (i.e. the demand) and simultaneously choose the relevant indicators to comply with this demand. When it is moderate to strong, the initial phases are to identify the need for indicators and to model the user demand. These phases are as essential as the development of the actual indicators. The last situation, with a very strong demand, raises the issue of understanding how actors, managers and environment users use and appropriate the management indicators, then the decision-making process.
3 A methodological approach

The methodological approach developed in the Réunion Island corresponds to an intermediate situation. It involves scientific expertise developed in answer to a potential demand and is based on issues related to a ‘reasoned’ management of coral reefs (Mirault, 2007). This research aimed to assess socio-economic indicators supporting integrated coastal zone management. Beyond ecological functions, the coral reef ecosystem also ensures social and economic functions whose issues may be significant as regards socio-economic consequences induced by coral reef ecosystem damage.

The three main steps are:

* analysis of the coral reef geo-eco-socio-system, including the coral reef environment and all its users
* identification of the social and economic functions ensured by the coral reef ecosystem, i.e. the services performed by coral reefs for man via direct or indirect uses, and their related values
* development of indicators and their combination as a synthetic coral reef area management dashboard.

Emphasis will be put on the last step of the method.

3.1 Four categories of proposed indicators

We have studied the direct and indirect uses of coral reef, and analysed the users’ behaviour and motivations. This analysis has enabled us to identify and define the functions performed by the coral reef ecosystem in Réunion Island, including its main socio-economic functions.

Each of the values, which are related to these functions, i.e. touristic, recreational, livelihood-based and aesthetic, cultural, scientific, food, and legacy values, displays an economic and social dimension. In this regard, assessing these values on the basis of use values seemed appropriate, even if this approach remains insufficient. Related indicators have been chosen according to their potential for defining a baseline situation, and for preparing future assessments. Overall, around 40 indicators have been constructed and can be divided into four main categories: attractiveness indicators, user behaviour indicators, social indicators and economic indicators (Figure 1).

* Despite its complexity, attractiveness allows an unbiased and quantified approach. Attractiveness refers to the ability to attract towards a location or area. Attendance, motivation, attraction area, and equipment and facility supply are all indicators which represent the recreational, touristic and livelihood-based values of sites via their attractiveness for users.

* In addition to attractiveness indicators, the use behaviour category includes indicators that give a valuation by the users: loyalty to the sites, frequency of the visits, and satisfaction expressed by the users are indicators of the values attributed to the coastal reef sites and their associated services.
- **Social** indicators are used for estimating the impact on the Réunion island population of all coral reef uses and associated activities. Three social indicators have been selected: employment, social relationships linked to the uses and salience for the community, i.e. the percentage of the Réunion Island population that benefit from the presence of coral reefs.

- **Economic** indicators refer to different final purposes. Incomes indicators are based on the profits generated by the activities using the coastal resources. They are used for valuing the economic spillover effects, which are related to the various uses and activities depending on the presence of coral reefs. Market indicators, combines the prices of the services or goods of the coastal reef environment (for example coastal land price) and their trends. These indicators express the use value of the coral reef services, Willingness to pay indicators, although expressed as a monetary value, reveal other value systems than the use values i.e. non use or existence (legacy) values.

**Figure 1** Categories of indicators, and their relationships

Elaborating synthetic indicators on the basis of descriptive indicators requires summarising data contained in each criterion as a single piece of information. Two major difficulties are encountered. Firstly, the diversity of measurement units greatly complicates, or even prevents, the process of data aggregation as a synthetic index. Secondly, weightings between indicators to be aggregated are difficult to work out (Boulanger, 2005). We shall study this question using two examples.
Combining indicators in an synthetic management indicator dashboard

According to the degradation to which the coral reef ecosystem is exposed, the affected uses, the spatial and temporal scales of the impacts and the socio-economic consequences may vary. Implementing a single indicator dashboard, which can be applied to all types of degradation, seems therefore illusory. It will be illustrated with the two examples of coral reef bleaching and lagoon water pollution, which are the main non-mechanical degradation affecting coral reefs in Réunion Island. The four categories of proposed indicators were appropriate to assess their impacts at various time and spatial scales.

Coral reef bleaching is interesting as this significant degradation is often unobserved by most of the population and users. It occurs each year in Réunion Island around February/March, when lagoon water reaches a high temperature or when significant turbidity occurs after heavy rainfall. Impacts vary according to the geographical area, frequency, duration, seriousness of the episodes and the resilience degree of the ecosystem, i.e. the capacity of a coral reef system to retain its potential, regenerate and continue to develop (Bellwood et al., 2004). Estimating the socio-economic impacts related to such an event is a sensitive issue. Immediate evaluation after the first coral bleaching signs could lead to an inaccurate estimation of its true effects. On the other hand, a too belated assessment may involve distortions inasmuch as other factors, which are not related to coral bleaching, may appear over time and affect the evaluation. Therefore, monitoring must be carried out over several months, and therefore proves costly.

In the short-term, uses which are the most sensitive to coral bleaching are, a priori, those which depend directly upon coral reef resource abundance and biodiversity. This can be captured by attractiveness indicators. However, when bleaching occurred in 1998, diving club managers confirmed that divers continued to appreciate coral reefs even when the bleaching was most significant (due to the fluorescence of corals prior to whitening). This showed the difference between scientists and users in relation to the representation of the coral reef state.

In the mid-term, other activities such as coral reef fishing are affected later when coral bleaching has extended and spread, which results in a high mortality rate, thus modifying habitat complexity and diversity. These effects can be captured through the economic indicators. In the mid- and long-term, tourism and related activities, and recreational uses may also be affected. It depends on the changes in users’ behaviour (captured by the use behaviour indicators) following the announcement of coral bleaching. However, the real impact that bleaching has on these sectors will probably not be observed before several years and will probably only occur once the coral reefs have undergone considerable damage.

Lagoon water pollution is a phenomenon which may be spectacular and apparent more rapidly in terms of social-economic impact. Occurrence of lagoon water pollution in Réunion Island involves the links between catchment area development and the coral reef state, but also the role of natural events (cyclones, streams, seasonal rains). Spatial repercussions of such events will increase with pollution duration.

To assess the social and economic impacts of the analysed phenomena, we proposed an indicator dashboard per type of degradation which provides:
The measurement of the selected indicators in the four categories: attractiveness, users’ behaviour, social, economic.

The assessment of the relevance of each indicator: relevance is estimated according to the nature of uses and their degree of dependence on coral reef ecosystems. The more uses are narrowly and directly linked with damaged resources, the more it is necessary to consider them in the assessment.

A reference to the ‘zero state’, prior to degradation.

The assessment scales: relative to time (short-, mid- or long-term) and area (site, coral reef coastline, entire Réunion Island).

In both cases, our observations showed that the same indicators could not be applied to the same spatial and temporal scales and moreover, the lack of significance of a single synthetic indicator.

4 Discussion: social demand in relation to management indicators

4.1 Does the indicator demand expressed by coastal zone stakeholders depend on the supply?

The indicators described have been elaborated based on ‘scientific expertise’. No social demand has been formulated by the local elected officials nor economic decision-makers of the coastal zone, but by public bodies. This demand was expressed as a ‘willingness to pay’ (Valsecor research programme funding from Europe – FEDER and from the Réunion Environment Public Body – DIREN), and then as discussions at mid-assessment of this programme (Miraault and David, 2002).

Does the absence of any spontaneous social demand represent the lack of interest of local managers and elected officials for the coral reef management indicators, or more simply, a misunderstanding of indicator supply? If so, the expression of a demand related to environmental management would largely depend on the existence of an indicator supply.

The Réunion Island pilot action of the AGIL research programme has been enable to test this thesis (David et al., 2005b). Firstly, we compared the indicators which have been elaborated by the AGIL scientific teams to the day-to-day management indicators employed by catchment area and coastal zone decision-makers or managers (David et al., 2005a). Forty-six people from 22 various institutions (nine administrations, five professional organisations, four local governments, four NGOs) have answered a survey. Twenty-two of them occupied management and decision-making positions, while the remaining 24 occupied study management and effective management positions. The results of the survey showed that no organisation used environmental or sustainability indicators on a regular basis for managing the economic activity, the coastal resource or area for which it was responsible, apart for one exception. The ‘Western County Territory’ (EPCI) is the only institution which intended to do so. This institution groups several councils located on the catchment area close to the coral reef environment and the planned MPA. The EPCI selected 50 indicators, in relation to the elaboration of the
Territorial Coherence Scheme (Schéma de Cohérence Territoriale or SCOT), which is a land use and urban planning scheme requested by a law issued in 2000. These indicators covered a large range of subjects and were mostly represented as maps to satisfy SCOT thematic and technical annual monitoring requirements.

Secondly, we assessed the stakeholders’ potential demand related to the satellite imagery products elaborated in relation to AGIL. Three types of demand have been revealed:

- indicators for monitoring the land use changes, and particularly, urbanisation and facilities, at the territorial management unit scale (town council or urban community); the indicators elaborated for the SCOT illustrated this demand
- indicators – related to industry, agriculture, transport, biodiversity conservation or water – for advisory purposes at the geographical zone scale (coastal zone, catchment’s area, mid-slope, high points)
- indicators employed for controlling compliance with regulations and linked to specific economic activities.

Therefore, understanding the supply has enabled us to identify the nature of demand for sustainability indicators.

4.2 How is the lack of social demand expression to be interpreted?

The Valsecor and Agil research programmes are at a very preliminary stage concerning relationships between science and social demand. We are far removed from the ideal-type pattern where actors, on-site users, or managers, express a ‘social’ type demand upon scientists, who then conduct an ‘application-oriented’ research in order to provide answers and raise new issues. If no social demand has been expressed upon scientists, this may be for two reasons:

- Either decision-makers or managers are not willing to express a demand for which the scientific outcome is expected to be inappropriate. This applies to time scale issues – research time scales being longer than decision-making time scales for decision-makers and managers – as much as to the form in which scientific works are diffused. Thus, managers prefer to hire practitioner teams which they consider to be more attentive to their demand. These practitioners sometimes act as mediators between scientists and managers. When research results are provided by scientists in the form of indicators, appropriation problems of the research results by the actors are partly solved, but practices and doubts remain.

- Scientists and managers do not have the same representation of the system to be managed. But indicators answer to issues whose interpretation calls for a consensus (Boulanger, 2005). When scientists’ and managers’ representations are highly divergent, managers have no demand regarding environmental management indicators. The state, regional or local managers should not consider the scientific interpretation of the system, then the produced indicators, as useful for the environmental management decision-making process.
In both cases, scientists produce and offer knowledge to support coastal management. However, several scenarios can be considered for supplying indicators according to the confidence or connivance existing between scientists and decision-makers, and to the level of integration of the demand in the indicators elaboration process (Table 2).

**Table 2** Possible scenarios for elaborating an indicator supply

<table>
<thead>
<tr>
<th>Scenario 1</th>
<th>Step 1</th>
<th>Step 2</th>
<th>Prerequisites</th>
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<tbody>
<tr>
<td></td>
<td>Elaboration of a potential demand based on scientific expertise</td>
<td>Elaboration of a supply based on scientific expertise</td>
<td>‘Expert’ scientists possess good field knowledge. Institutional forums are to be specified in order to present and discuss and validate the produced indicators.</td>
</tr>
<tr>
<td>Scenario 2</td>
<td>Co-elaboration of a demand</td>
<td>Elaboration of a supply based on scientific expertise</td>
<td>‘Expert’ scientists are acknowledged by coastal management actors to possess good field knowledge. The uses of those indicators is to be analysed by the scientists.</td>
</tr>
<tr>
<td>Scenario 3</td>
<td>Co-elaboration of a demand</td>
<td>Co-elaboration of an indicator supply</td>
<td>Confidence relationship between on-site actors and scientists. Need for participative methods enabling this co-elaboration within reasonable deadlines.</td>
</tr>
</tbody>
</table>

The first two scenarios describe situations where researchers aim, in a first step, to either construct this potential demand based on scientific expertise, or to co-elaborate, in association with the stakeholders themselves, a demand which is more relevant for their preoccupations. Then in step 2, researchers construct a supply liable to satisfy this demand. Institutional forums where these indicators are socialised and the use of the produced indicators should be accounted for.

The third scenario involves co-elaborating the indicator supply with the stakeholders. This co-elaboration requires a common effort for working together, which generally results from a confidence relationship, or even from a connivance relationship, which has been established beforehand. It should be noted that this confidence may be developed during the co-elaboration of the demand. The issue is a shared representation of the system, i.e. a conceptual model of the coastal zone management and dynamics. This construction will then enable the co-elaboration, in association with actors, of management indicators which will have been initiated by understanding the conceptual model. In this case, a methodological field is to be developed in terms of participative research with the management stakeholders (decision-makers, managers, coastal users).
4.3 A well identified social demand: crisis management

When considering decision-maker/scientist relationships in Réunion Island, is the demand regarding management indicators still so under-developed that indicator demand should be determined by the offer?

The answer is no. If there is a field where indicator demand exists, it is that of crisis management. Preparatory meetings for the implementation of the future European Framework Water Directive (DCEE), held by the DIREN, were particularly informative in this field. The main objective was the environmental information system, which is to monitor and assess the progress made by Réunion Island to comply with this directive in 2015. But most actors underlined the risk related to water quality, to extreme climatic events, such as droughts and floods, and the need for indicators enabling to manage such crises when they occur.

For the local managers and stakeholders, the main expected advantage provided by risk indicators would be to facilitate decision-making when it is saturated with a lot of useless information and when it requires less but more relevant reference data, to ensure that the prevention or the remediation actions are successful. Such a demand is practically recurring regarding yearly coral reef bleaching in Réunion Island. An emergency committee is then set up by the DIREN for assessing the geographical distribution of coral bleaching and evaluating the damage to which the coral reef ecosystem has been exposed. A need is expressed for indicators to provide accurate information and to manage the crisis situation. It seems that this need is not specific to seawater and freshwater management. This need could be generalised to all national and local government services which are in charge of areas or resources exposed to any natural or anthropogenic hazards liable to generate an ecological, economic or social crisis.

4.4 How should the demand for crisis management indicators be processed?

Demands for crisis management indicators involve two obvious questions for scientists:

- can we simply elaborate indicators only for managing crises without worrying about routine indicators enabling the management of the whole system?
- or, should we focus on routine indicators while expecting that an accurate understanding of the system dynamics will allow current management failures and expected risks to be identified?

Answering yes to the first question favours the hypothesis in which hazards outside the ecological and social system are crisis triggering factors. This hypothesis also disconnects the analysis of the system dynamics from the analysis of the crises which may affect this system. This point of view is obviously shared by most actors structuring or liable to elaborate a social demand in relation to coastal zone and catchment area management indicators.

Three reasons may be put forward:
the visibility of the required expert appraisal is increased, when this appraisal is obviously linked to crisis situations (Foray, 2002)

- crisis situations outline the population concerned by the decisions to be made
- it is probably easier to consider, from an intellectual point of view, that the origin of a crisis is merely external to the managed system.

Answering positively to the second question means that coastal system crisis analysis should not be considered separately from the analysis of system dynamics. Our main hypothesis is that, when external hazards occurs, the coastal system internal dysfunctions should trigger or increase the crisis. Then routine indicators constructed for monitoring these dynamics are linked to the relevant crisis management indicators.

Few studies are carried out in the Indian Ocean area concerning the socio-economic impact of coral reef bleaching. These studies show the extreme complexity of characterising this impact, with no previous understanding and no indicators of the ‘normal’ situation having preceded the bleaching events. The methodological approach that has been developed is based on understanding the dynamics of the coral reef geo-eco-socio-system to produce routine indicators, and therefore, relies on this second point of view. Indicators elaborated for this study are not crisis management indicators but will be indispensable for monitoring any future crisis or for investigating vulnerability in the coral reef and coastal system.

Therefore, there is a need to reduce this discrepancy between the representations of local elected officials and coastal area managers – which should motivate their demand for coastal area management indicators – and the point of view of scientists which ground their empirical and conceptual procedures.

5 Conclusion

In order to connect social demand and scientific inputs in relation to sustainability environmental management indicators, three stakes, stating scientific and policy-making issues, may be identified, detailed below.

5.1 Associating decision makers, managers and stakeholders to the identification and the production of environmental management indicators

We have already noted that the social demand for sustainable coastal management indicators is not always expressed by policy makers, coastal managers and stakeholders. In order to make up for the gap existing between scientist supply and ‘social’ demand, there is a challenge to jointly elaborate or reveal this demand, and even, to co-elaborate an indicator supply. This involves developing methodologies enabling this co-construction between potential users of the indicators and scientist knowledge. A researchers’ network has developed a co-construction approach, called Companion Modelling (ComMod), so that it can be tested in relation to natural area or resource management (d’Aquino et al., 2003; Etienne and collectif ComMod, 2005). This approach employs simulation models and role-playing games as mediation tools for stimulating stakeholders’ participation in the elaboration of
land or resource management scenarios (Bousquet and Le Page, 2004). It is focused on the design of an iterative process between stakeholders and scientists to foster collective learning.

The companion modelling approach acknowledges the diversity of the representations held by the various stakeholders – including scientists – and the uncertainty of the decision-making context, when dealing with environmental management. It is used according to three directions:

- providing a shared representation of the interactions between stakeholders and resources
- assisting mediations between the various actors involved – managers, users, policy makers but also scientists – and enabling the exchange of representations and point of views about the situation to be managed
- facilitating the elaboration by the stakeholders of scenarios dealing with management issues and then, incorporating the stakeholders in the selection process of relevant indicators to monitor changes.

5.2 Providing a coherence objective between social demand and the answer provided by scientists

In this paper, we have attempted to illustrate two cases where this coherence is to be reinforced. This lack of coherence is linked to scale issues in relation to the system to be managed. The example of coral reef bleaching underlines the need for coordinating analysis time scales. A long monitoring period is required for understanding the bleaching event and assessing its impacts. However, this long analysis duration does not comply with the public decision-making time: the impact of indicators on management choices is thus reduced.

The AGIL example shows how the same natural or social phenomena call for divergent spatial scales of analysis, according to the various decision-makers and to their objectives for environmental or sustainability indicator use: ex-post monitoring, ex-ante advising or regulation control. It is therefore difficult to obtain a set of relevant indicators for all actors.

A better coherence should be achieved through better connections between the representations developed by stakeholders and scientists of the system to be managed. Research projects must emphasise how to design the relevant indicator selection process (see above), but also how the elaborated indicators are to be used for the decision-making process, and how to monitor this use.

5.3 Considering the issue of public decision and responsibility

Indicator demand expressed by stakeholders and decision makers depends on how collective action arenas are set up and how public action is to be assessed. Indicator supply (whether based on a co-constructed appraisal or not) cannot ignore management power relationships and the issues of public responsibility and accountability. This is shown by the upward example of crisis management and the demand for alarm indicators dashboard.

As stated by Fraser (2006), to be considered as relevant by their potential
users, indicators should be elaborated through forums that formally feed in environmental decision-making processes. Then, the link between demand for environmental management indicators, scientific expertise and public decision making is correctly constructed via public responsibility. Discussion areas and mechanisms are necessary for defining this link. However, past experiences of platforms employed for sustainable management indicator elaboration show that the existence of such mechanisms does not ensure a change in environmental decision-making. Such change is more likely to occur when these platforms account for power relationships and for the economic and political constraints of the actors involved.

References


Notes

1 The Indian Ocean Commission comprises five members: the Comoros Islands, Madagascar, Mauritius, the Seychelles, and France-Reunion Island.

2 The AGIL research project (Aide à la Gestion Intégrée des Littoraux ou Integrated Coastal Zone Management Support Program) was carried out over 2 years, from mid-2003 to mid-2005. This project has drawn up a ‘state-of-the-art’ in relation to ICZM, and to the use of earth observation in ICZM, in order to develop management indicators. The second year was dedicated to implement two pilot actions: one concerning French Mediterranean coastal lagoons, the other concerning the coral reef coastal zone of the Reunion Island (David et al., 2005b). Research for the Reunion Island was funded by the Earth-Space network, French Ministry of Research, French Ministry of Industry (AGIL project) and UE-FEDER and DIREN-Ministry of environment (Valsecor Program).