ANNEXE 3

Analysis of the standards and indicators for sustainable development of aquaculture

CENTRE D'ETUDES DE PROJETS

UICN
Unión Mundial para la Naturaleza

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1. BACKGROUND AND OBJECTIVES

1.1. The emergence of sustainable development as a frame of reference

In 1972, the Club of Rome published *The Limits to Growth* (Meadows et al., 1972). In view of the overexploitation of natural resources associated with economic and demographic growth, this private international association founded in 1968 advocated zero growth. Economic development was presented as incompatible with the long-term protection of the planet. It was in this climate of confrontation rather than conciliation between the environment and development that the United Nations Conference on the Human Environment was held in Stockholm in 1972. It was there that the concept of sustainable development was first put forth, termed *ecodevelopment* at the time. Figures such as Maurice Strong, the Conference organiser, as well as Professor René Dubos, Barbara Ward and Ignacy Sachs, insisted on the need to incorporate social equity and ecological prudence into the economic models of both the developed and the developing world. This conference gave rise to the creation of the United Nations Environment Programme (UNEP) and the United Nations Development Programme (UNDP).

In 1980, the IUCN coined the expression *Sustainable Development* (translated into French at the time as "développement soutenable"). Nonetheless, the term went virtually unnoticed until it was used in the report by Gro Harlem Brundtland, Our Common Future, published in 1987. Prime Minister of Norway and Chair of the World Commission on Environment and Development at the time, Gro Harlem Brundtland endeavoured to define the concept of *Sustainable Development* as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". This report gave a decisive impulse to disseminating the notion of "sustainable development" on a world-wide level. It was politically recognised and adopted at the Earth Summit in Rio de Janeiro (1992) through the Rio Declaration, which established 27 universally applicable principles of sustainable development, as well as through two legally binding international conventions – one on climate change (ratified by 154 countries) and the other on biological diversity (ratified by 168 countries) – and a set of non-binding yet internationally accepted principles for the protection and sustainable use of forests. A document advocating a programme of action, "Action 21" or "Agenda 21", was drawn up at this summit as well and has come to constitute the framework for applying the principles of sustainable development in the 21st Century (hence the term Agenda 21). At the Rio Summit, the majority of countries, including France, committed to take stock of their initiatives to implement measures in favour of sustainable development and to define their national strategy for sustainable development. In the case of France, this strategy was not really defined until the Johannesburg Summit held in September of 2002 (a preliminary strategy had been defined in 1997, but had not been implemented as it was deemed unfeasible). The Johannesburg Summit – following the World Summit for Social Development that advocated a global, integrated approach to social issues in 1995 – reinforced the legitimacy of sustainable development by insisting on the social aspect, the goals of equity and the struggle against poverty. A Political Declaration and an Action Plan were adopted, leading to a series of initiatives and measures to be undertaken in order to meet the standards of sustainable development. For developing countries, these objectives are part of the Millennium Development Goals defined by the UN in the year 2000.

Such initiatives were accompanied by studies attempting to define information systems suitable for the programming and monitoring policies promoting the principles and goals of sustainable development. Thus, a variety of initiatives to develop indicators were undertaken by the majority of international and national commissions or organisations specifically concerned with sustainable development. By way of example, consider the United Nations Commission on Sustainable Development (UNCSD) and the Mediterranean Commission on Sustainable Development (MCSD). Once completed, these often pioneer studies were followed by more operational ones carried out by more focussed institutions or by commissioned statistical organisations such as Eurostat at the European level or the French Institute for the Environment (IFEN) for France. These institutes produced long lists of indicators (over 50) for "measuring progress towards sustainable development goals". The majority of these initiatives follow an approach defined in 1993 by the OECD for measuring the pressures exerted on a system and the corresponding answers, as well as for monitoring progress with regard to the different domains or

pillars of sustainable development (framework known as PER or DPSIR). This framework, highly relevant for the environmental dimension of sustainable development, became and remained a standard, at least until the past few years, when the concern on social and territorial aspects increased. The most recent studies demonstrated a regression of the range of indicators proposed. The sets of indicators originally put forwards, which sought to be relatively exhaustive and precise, have been substituted by more limited sets. Not only are the latter more operational, but they also combine the functions of measurement and emblematic communication to the benefit of sustainable development. Hence, in France, the initial list of 45 national sustainable development indicators divided into 12 categories (Ayong, le Kama, 2005) was reduced to only 8, more focussed categories two years later (Ayong, le Kama, 2006).

1.2. Objectives and methodology

The objective of this study is to map and assess initiatives to develop indicators for sustainable aquaculture, in particular at the Mediterranean level. It necessitated inventorying and classifying initiatives based on the bibliography available and requires the creation of a tailored analysis grid. Applying this approach to the Mediterranean requires, moreover, an overview of the sector in the region and of the key factors of sustainability at the aquaculture company level.

In order to compile this inventory of initiatives, extremely hard work has gone into the drafting of a summary file describing the main characteristics of the initiatives recorded, the point being to establish a structured database facilitating the study of this experience. Note that this has involved analysing two major types of measures or initiatives: those seeking to define principles or strategies promoting the sustainable development of aquaculture (therefore called: Standards for Sustainable Aquaculture) and those primarily focussing on developing sustainability indicators and making them available (called: Initiatives to Develop Sustainability Indicators for Aquaculture). The latter can be an expression of the former, or a different measure altogether.

1.2.1. Standards for sustainable aquaculture

The analysis of these standards involves studying both the institutional origin of measures, their degree of implementation, the types of measures, their scope of application and the main results obtained. Above and beyond the traditional problems of access to information cropping up in any inventory attempt, the main difficulty encountered at this stage was the multiplicity of the types of measures undertaken. We have chosen to report these measures based on their institutional status, adopting the typology put forth by Clément (2001), which distinguishes between: codes of conduct, best practice guides, laws, programmes, action plans, charters and declarations (cf. Table 1).

Table 1. Means of fostering sustainability

Code of Conduct	A voluntary, often sectoral, non-legally binding document (also known as soft law) drawn up in response to the development of self-regulation in a sector to define the manner in which the actors should behave.
Best Practice Guide	Document defining best practice more in detail than a code of conduct and in a more interventionist way. Its aim is to stipulate what actors should do. It is based on the initiatives and active involvement of the actors. In this category, it is possible to integrate the guidelines (not in the sense of EU directives) and principles whose more or less operational content provide instructions on the behaviour and practices to follow.
Charter	Morally binding commitment that involves signature by the stakeholders and the publication of protocols. Endorsement is not legally binding.
Seal of Approval and Certification	Specifications providing instructions on the practices to adopt in production. Obligation is based on delivery and not on certification, but also on the company's rating insofar as its efforts towards attaining sustainable development goals. Assessment is often done by an external organisation.
Convention	Agreement that involves commitment by a number of States and that can be preliminary to the establishment of an action plan.
Action Plan	Programme of measures that can be launched by State institutions, professional groups or inter-professional groups.
Programme of Action & Territorial Strategy	Provisional timetable and co-ordinated action plan established on the State or Institutional scale.
Law	Rule issued by a State entailing the obligation of individuals to abide by it on pain of punishment.

These different forms of action can be classified according to two criteria: the degree of obligation they entail and the level of decentralisation of the decisions from which they derive. In sum, we thus obtain the following matrix:

Table 2. Typology of the means of fostering sustainability

	Decentralised Initiative	Centralised Initiative (launched by the State or a centralised institution)
low level of obligation	**Recommendations** **Declaration**	**Convention** **Action Plan**
high level of obligation	**Code of Conduct** **Best Practice Guide** **Charter** **Seal of Approval and Certification**	**Programme of Action** **Territorial Strategy** **Law**

The Charter and Seal of Approval procedures can be implemented on different scales: between producers and actors in the industry; or internally, within a company as part of measures for sustainable development and / or corporate social responsibility (CSR). This approach aiming at involving individuals in sustainable development can resort to different procedures that regulate their involvement: a succession of activities related to auditing (assessing the subject), certification (validating action), communication (informing all partners) and training (effecting in-house training and implementing a process of continuous improvement). This is an interpretation of sustainable development that is currently very common in enterprise (social responsibility) but which is neither widespread nor well-known among aquaculture companies. The corporate charter can be included in this approach. Along these lines, the voluntary steps towards certification and corporate environmental and / or social management (of the ISO 9001 or 9004 types, referring to quality; ISO 14001, regarding the environment; OHSAS 18001, on hygiene and safety; or SA 8000, on society) can also be considered as means for fostering sustainable development. Many experiences and examples exist in this domain, with different standards and codes according to the country (Brodhag et *al.* 2004), brought to the international level by the Global Reporting Initiative of 1997 and the World Compact initiative launched by the Secretary-General of the United Nations in Davos in 1999, aiming to encourage companies to commit to the 9 major international principles. With regard to aquaculture, in the USA, industry and the authorities have succeeded in conceiving global HACCP plans for certain cultures, namely turbot, crayfish and mollusc farming. Australia, Chile, Norway, New Zealand and Thailand have adopted a similar approach. In this regard, the Hazard Analysis and Critical Control Points (HACCP) system is about to become obligatory in several countries.

1.2.2. Initiatives to develop sustainability indicators for aquaculture

For these initiatives, we used the same approach based on file analysis (with certain changes in the categories,). In particular, the degree of success and maturity of the measure has been ascertained on the basis of the three major categories distinguished by Madec (2003):

- Reflection and conception stage
- Selection and informing of indicators stage
- Dissemination and routine use stage

2. EXTENT TO WHICH SUSTAINABLE DEVELOPMENT IS CONSIDERED IN AQUACULTURE

In aquaculture, sustainable development began to be considered in 1995, with the FAO's Code of Conduct for Responsible Fisheries, which contains a specific article on aquaculture development

(Article 9). Later, in 1998, a version of this code specifically applied to aquaculture gave rise to a set of technical guidelines for responsible aquaculture development (FAO, 1998). This inquiry into sustainability in aquaculture was motivated by a serious crisis experienced by the shrimp culture industry in 1993, after a period of exponential growth (Clément, 2005). The image of aquaculture was seriously damaged by this crisis: the activity came to be associated with the destruction of fragile ecosystems (in particular, mangrove), poorly stabilised zootechnical accomplishments and deplorable social consequences for the poverty levels of local populations (Clément, 2001). This crisis (*"the red blood of the blue revolution"*) led to condemnation of the shrimp aquaculture industry by international NGOs. Within the context of the Rio Summit, it has played a significant awareness-raising role fostering the inception of several international initiatives that were originally strongly polarised around the shrimp industry (Clément, 2001).

As with the general standards for sustainable development, initiatives relative to aquaculture have been divided into different levels going progressively from general international standards to industry-specific applications and finally, to the development of the decentralisation approach and the participation of actors at the local geographical level.

2.1. Industry-specific initiatives for sustainable aquaculture development

2.1.1. On a general level

At the global level, following the FAO Code, two "cornerstone" initiatives had a structuring effect. The first is the Responsible Aquaculture Programme, initiated in 1996 by the Global Aquaculture Alliance (GAA). Within the framework of this programme, the GAA established Codes of Practice to advance practices fostering responsible aquaculture, in particular with regard to shrimp farming. The establishment of general guidelines organised according to 9 topics (reduction of ecological impact, conservation of water quality, improvement of feed and medication, reduction of waste products, etc.) was designed to facilitate the subsequent establishment of regional and national codes. From the start, at the initiative of Norwegian research centres at the Holmenkollen Symposium in 1994, a document on the principles of sustainability in shrimp farming developed in 1994 and expanded in 1997 to all aquaculture species led to the adoption of the Holmenkollen Guidelines for Sustainable Aquaculture, consisting of 17 general recommendations for complying with the principles of sustainable development, precaution and ethical behaviour in aquaculture operations. These principles were addressed to all actors in the aquaculture business.

Various types of initiatives were implemented thereafter on different geographical scales and launched by a variety of institutions (syndicates, international organisations, NGOs and research institutions). Providing an exhaustive inventory, in particular with regard to local initiatives, would be beyond the scope of this document. A variety of experiences were recorded in different countries, particularly in Asia, in response to the questions posed by the crisis and criticism of the impacts of tropical shrimp farming. Figure 1 shows the main standards in chronological order while Table 3 presents them according to the above classification matrix (cf. Table 2). The presentation of these initiatives is limited to institutional programmes and plans in applied research. We have therefore not included, for instance, the case of Canada, where the Department of Fisheries and Oceans created the Office of Sustainable Aquaculture in August of 2000, in order to supervise the rapid development of coastal aquaculture (with a 15% annual growth rate) by launching a five-year research and development programme - biological and environmental sciences, human health, sanitation and quality of water, management and regulatory framework, safety and coherence of policies and programmes.

Fig. 1. Timeline of emergence of the principal standards for sustainable aquaculture

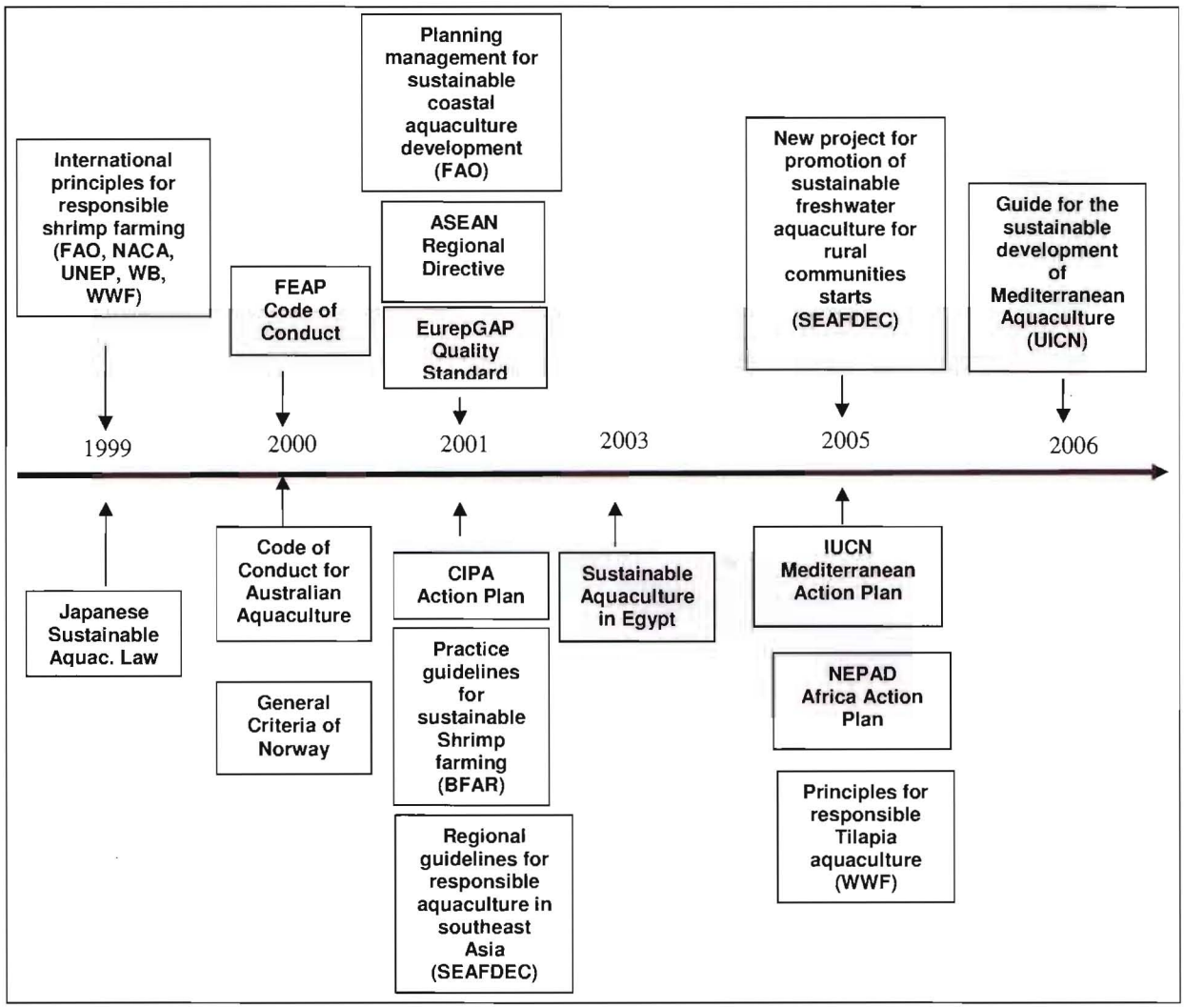


Table 3. The principal standards according to obligation and decentralisation levels

	Decentralised Initiative	Centralised Initiative (launched by the State or a centralised institution)
Low Level of Obligation	Sustainable Aquaculture in Egypt General Criteria of Norway Holmenkollen Principles CIPA Action Plan Declaration of Bangkok 2000 (FAO, NACA) Abuja Declaration on Sustainable Fisheries and Aquaculture (NEPAD)	GAA Initiative Responsible Fisheries Code of Conduct Mediterranean Action Plan NEPAD Action Plan IUCN Mediterranean Action Plan Guide for the sustainable development of Mediterranean Aquaculture (UICN) Planning management for sustainable coastal aquaculture development (FAO) Action Plan for Aquaculture Sustainability (NACA, ADB)
High Level of Obligation	FEAP Code of Conduct EurepGAP Quality Standard Code of Conduct for Australian Aquaculture Regional guidelines for responsible aquaculture in southeast Asia (SEAFDEC) New project for promotion of sustainable freshwater aquaculture for rural communities starts (SEAFDEC) Code of Practice of the British Columbia Farmers Association Codes of Conduct and Practice established by the Brazilian Association of Shrimp Producers Code of Practice for the Production of Rainbow Trout of the British Trout Association ICES Code of Practice Code of Good Practice for Scottish Aquaculture Directive for the Sustainable Development and Management of Aquaculture in Shallow Waters, India Code of Practice for Sustainable Use of Mangrove Ecosystems for Aquaculture – SEAFDAC and ASEAN Thai Code of Conduct for Shrimp Farming HACCP Principles – MSC Certification Mangrove Charter drawn up by ISME Code of Practice for the Sustainable Use of Mangrove Ecosystems for Aquaculture in South-East Asia (August 2005)	International principles for Responsible Shrimp Farming (World Bank, NACA, WWF, FAO, UNEP) Japanese Sustainable Aquaculture Law Principles for responsible Tilapia aquaculture (WWF) Canadian Sustainable Aquaculture Programme European Sustainable Aquaculture Strategy

Legend: The main initiatives with a descriptive file are in boldface type.

2.2.2. The situation in the Mediterranean region

Sustainable development of marine activities and costal zones in the Mediterranean began to be taken into account in 1994, within the framework of the PAP/RAC protocol established as part of the Mediterranean Action Plan or MAP (ref.). Since the establishment of the Mediterranean Commission for Sustainable Development in 1996, several evolution steps may be identified. The most important developments have been the construction of sustainability indicators for Mediterranean coastal areas in 1999 and the drafting of a strategy on a Mediterranean-wide scale in 2005, consisting of the Plan Bleu assessment report defining the perspectives for the environment and development.

With regard to aquaculture per se, the only initiative targeting this aspect on a Mediterranean scale was launched by the IUCN in 2005. General initiatives carried out on a national scale (CIPA Action Plan for France) or on a European scale (FEAP Code of Conduct) concerned also European Mediterranean producers. Some regional and local initiatives were undertaken, as for example, the recent initiative carried out by Corsican producers to study the sustainability conditions of their companies, or the study carried out by the Conurbation Committee of Toulon-Provence-Méditerranée within the framework of integrated coastal management. At the local level, such measures should be industry-based to territorially-based initiatives, b coming under the auspices of the sustainable management plans for coastal areas and maritime territories set up by local authorities.

2.2. Joint development of sustainable aquaculture and coastal areas

The territorial integration approach in natural resource management policies has, for aquaculture as well as fisheries, progressively led from a sectoral or industry-based approach to an integrated management approach taking into account all the activities and uses of the seaboard or coastal zones. It gave rise to a new planning concept called ICAM. After development and conservation policies, Integrated Coastal Area Management (ICAM) marks the beginning of a new approach. This management concept aims to harmonise the pillars of sustainable development by taking into account the representations and interests of the stakeholders involved. In addition, the participation imperatives of public policy introduce an additional level of integration [23].

Definitions of Integrated Coastal Area Management emphasise its dynamic and integrative aspects concerning objectives, uses, actors and disciplines within a concern for sustainable development. One of the most commonly cited examples is that of B. Cicin-Sain and R.W. Knecht (1998), who consider ICAM *"a dynamic process that brings together government and society, scientists and decision-makers, and public and private interests for the purpose of protection and development of coastal systems and resources; this process aims to optimise long-term decisions, favouring resources and their reasoned and reasonable use"*. Among the texts with regulatory goals, those of the European Union present integrated management as a public policy allowing the implementation of sustainable development and the improvement of democracy. The emphasis is placed on in-depth knowledge of the mechanisms and local situations, synergy with natural processes and flexibility in decision-making. It is defined as a dynamic, continuous and iterative process designed to promote sustainable management by striking a balance between the advantages of economic development and the protection, conservation and regeneration of coastal areas, while taking into account diverging objectives and opinions (EU, 2002; EU, 1999; IUCN, 2004).

Several conclusions can be drawn from this necessary interrelation of sustainable aquaculture and ICAM:

i) The need for a common perception of the objectives of sustainable development

This new integration approach requires going beyond the stage of cohabitation of uses and implies implementation of consensus processes. For a long time, planning measures were based on measures for the territorial specialisation of activities so as to reduce conflicts. The pluralism of the actors involved requires firstly the development of concerted or common perceptions of a territory. These objectives are quite difficult to achieve, since coastal areas are the object of significant migratory flux leading to a mixed population (residents and tourists, local, long-time residents and newcomers, working and non-working population...) with different expectations and needs with regard to environmental protection, human environment, quality of habitats and landscapes. The prospective study on use conflicts (Manon 2004; Perrier-Cornet and Soulard, 2003) carried out by the

[23]. Integrated management was first defined as part of a rational approach relying on economic evaluation and on measuring the weight and value of activities to provide mediation for use in conflicts. In a second stage, it evolved into a concept of the so-called joint or common management, designed to provide mediation for conflicts of interests, and establish governance plans adapted to the entire structure of actor mobilisation, as well as consultation and negotiation devices that would at once be legitimate, equitable and effective (Rey-Valette, 2002).

Commissariat au Plan (Economic Plan Commission), emphasises these differences in perspective. The preferences of newcomers for heritage and environmental values lead to increasing conflicts with productive activities.

ii) The emergence of a new scale of approach

This developing integrated method is resulting in a new scale of approach to aquaculture sustainability: it is no longer a question of simply promoting sustainable aquaculture, but also of ensuring the sustainability of the territories where aquaculture is practiced. This condition is even more important if we consider that these territories often comprise, among others, fragile habitats such as wetlands, saltwater marshes (as per the Natura 2000 network) and mangroves, among others. The sustainability of territories depends on public planning policies implemented by local management actors, in particular territorial authorities. Therefore, in order to better conform to these management plans, aquaculture actors must adapt the new approach, particularly by diversifying the indicators of sustainable development relative to their activity. Decentralised territorial policies are established by territorial authorities, which implies close relations between the actors of the aquaculture sector, these territorial structures and the projects they are implementing. Concerning sustainable development, local Agenda 21 policies have significant potential putting the sustainable aquaculture project into practice. Nonetheless, the latter policies are as yet little developed and the ICAM policies are therefore based on the ensemble of tools and procedures for territorial planning (SCoT, SAGE, SMVM, Contrat lagune or Lagoon Agreements, etc.).

iii) An approach involving contracting multiple partners

These territorial planning policies arise from a contract and project approach associating several partners, both public and private, generally coming under the frameworks previously established by European Union directives and structural funds. The multiplication of these policies on the local or regional scale calls for the integration of a series of general objectives and principles prescribed by various laws[24] or planning policies in favour of sustainable development, in particular those of the Coastal Law. In the case of France, apart from the SAGEs, highly used on a watershed scale and the less frequent SMVMs, the SRU Act provides new integrated planning tools called SCoTs[25], which tend to multiply and foster the territorial consideration of sustainable development. The most representative priorities that these different policies have in common are the following:

- Reduction of social and environmental inequalities (standard of living, habitat quality, health, security, access to territorial resources, community services)
- Conservation of environments
- Improved management of territories through the implementation of local Agendas 21 in relation to the SCoTs (evaluation of cultural heritage, control of urban sprawl and development, analysis of the vulnerability of specific territories / energy constraints, multi-functional approach to natural and rural areas)

These new policies provide an advantage in terms of conflict resolution, however the procedures implemented, usually involve highly detailed reports and consensus processes often entail significant delays.

iv) Management on the ecosystem level with new zoning rationale

In general, the evaluation of aquaculture sustainability has to be carried out at the level of the territories where aquaculture exists, taking into account all directives, in particular European Union

[24] For France, we can cite: the Act on Town and Country Planning and Sustainable Development (LOADDT Act, from 25/06/99); the Act on the Simplification of Inter-Municipal Co-operation; the Urban Solidarity and Renewal Act (SRU Act); and the Participative Democracy Act

[25] The SCoT or Territorial Coherence Scheme (Act from 13/12/2000, SRU Article L122-1), constitutes a strategic planning document that establishes town planning policy objectives. It harmonises sectoral policies (urban planning, habitat, displacement, commercial facilities) on a conurbation level within a sustainable development perspective and prescribes environmental evaluation.

Directives, in addition to the national legislation on environmental protection. One can therefore cite those directives concerning species and their habitats, water, wild birds and urban waste water, in particular the conservation policies of the Natura 2000 network, which provide an European stamp of approval to the territories implementing them. Thus, we are increasingly moving from programs integrating technical measures to ecosystem management policies establishing conservation measures through the reservation of part of these areas. Hence, halieutic ecosystems are no longer managed solely through the monitoring of stocks and the regulation of fishing efforts, but also through the establishment of marine reserves. These territorial planning policies are therefore complementary to the previous forms of management based on the regulation of environmental impact that led to conventional measures to regulate waste and pressure. The majority of these policies entail a generalisation of diagnostics and impact studies, both ex ante and ex post. Thus aquaculture in France is subject to the obligation of environmental impact studies within the framework of "Installation Classée Pour l'Environnement" (Facility Scheduled for Environmental Protection or ICPE) procedures. With regard to the development of information and observation systems upon which these policies rely, the territorial scale has led to the development of new cartography and modelling tools such as GIS (Geographic Information System), which have the dual advantage of being more operational for spatial planning decisions and facilitating consensus among actors, while they necessarily entail spatialisation of data and therefore of indicators.

The analysis described here primarily concerns France, though the majority of European countries have also enacted national policies that interpret sustainable development goals in a decentralised way. Regardless of the regions or countries, ICAM policies are being developed; in France, for instance an experimental programme devised by the DIACT (Interministerial Delegation for Planning and Competitiveness of Territories, formerly DATAR) was implemented. At the European Union level, a framework directive based on the results of a new European project covering nearly all Member States is being developed.

Moreover, the policies mentioned above, in particular those relating to territorial planning, refer to land resource management tools. Concerning the maritime environment, the same approaches and principles exist, but in a somewhat different context, as such an environment entails additional constraints:

In fact, highly complex procedures can be observed for the marine environment. Despite a lower overlap of uses, tools and policies, the public nature of the maritime domain entails a plurality of supervisory authorities, with a strong ascendancy of maritime Departments. Thus cage aquaculture tends to move increasingly farther from shore in order to avoid use conflicts. Nonetheless, the granting of licences in these zones remains highly restrictive as knowledge concerning currents and interaction processes for instance is lacking at this scale. The definition of the actors concerned is as difficult to isolate as that of the borders of ecosystems and management units. The regulation of space via a mechanism of allocation and licensing is only possible when legitimate management zones have been defined, both on the ecological and the social levels. In the case of France, consideration is being made of the transposition of such tools as the SMVMs or the Lagoon Contracts to a concept such as that of the EGLA (Espace Littoral de Gestion Associé or Jointly Managed Coastal Area (Pary, 2002)), which has yet to be defined.

3. Initiatives relative to sustainability indicators in aquaculture

As with the standards, the inventory of initiatives to develop sustainability indicators has given rise to the creation of a database in the form of standardised files. It is difficult to evaluate how exhaustive this inventory actually is. In any case, the principal initiatives to develop indicators have been ascertained and studied. Only some initiatives for their generalised scale or for the impulse they have provided will be briefly mentioned here.

3.1. Summary of initiatives recorded

3.1.1. The main international initiatives

After the Code of Conduct for Responsible fisheries, the FAO has drawn up a list of criteria and indicators to establish new practices for shrimp production. Forty indicators, some of which are not yet

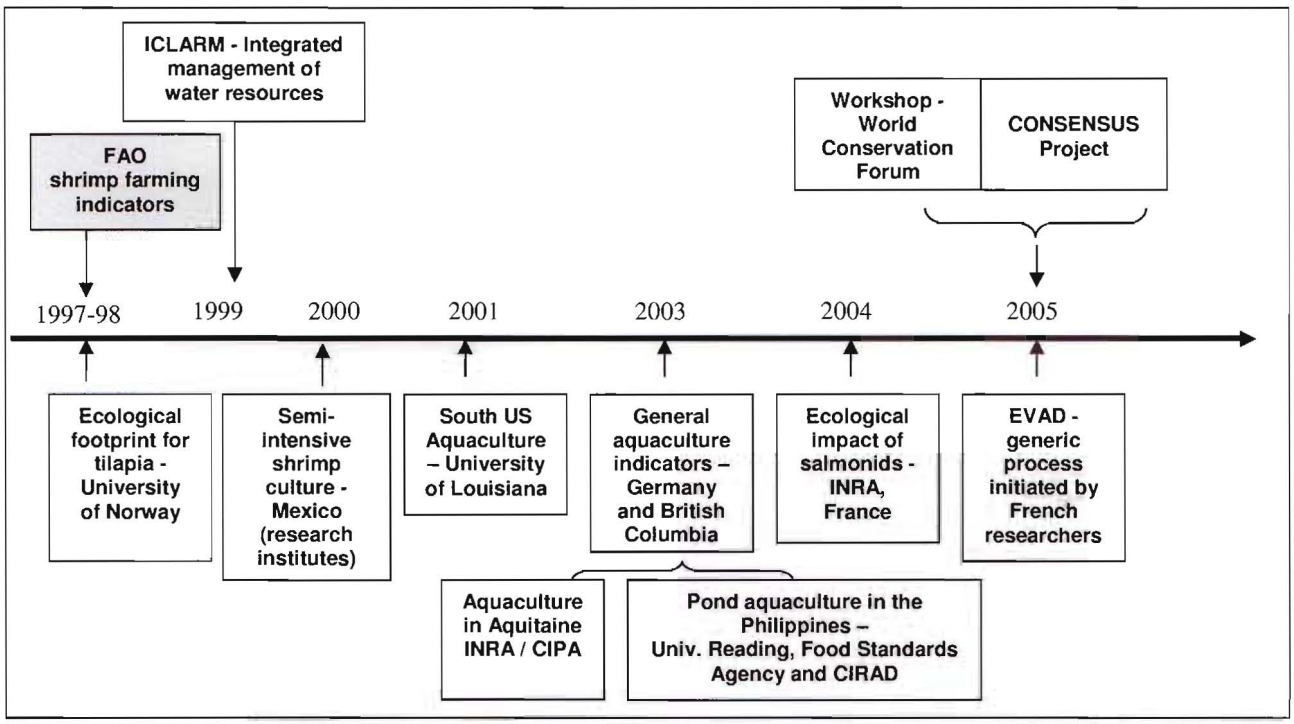
available, were defined through expert research. Some indicators were thereafter expanded and validated by a survey among management entities from different countries. The process was done thematically, in accordance with the sustainable development pillars, the indicator categories being: biophysical and ecosystem-based, economic and social, legal and institutional and those of the producers themselves. Similarly, at the World Conservation Congress held in Bangkok from 17 to 25 November 2005 as part of an IUCN programme promoting improved co-ordination between aquaculture and environmental conservation, a number of international organisations (WWF, NACA, World Bank, SEAFDEC) evaluated the progress of procedures and put forth 26 sustainability indicators based on 8 major principles, the majority of which concerned the environment.

Finally, another significant case is the initiative called CONSENSUS, launched by the European Aquaculture Society (EAS) and the Federation of European Aquaculture Producers (FEAP), which brought together multiple partners of research, professional organisations, consumer organisations and the European Commission. This project aimed to develop sustainability indicators for aquaculture, distinguishing the production systems according to the types of fish aquaculture (freshwater, open-circuit, re-circulated systems, cage systems) and mollusc aquaculture. It aimed at supporting activities and the point of view of consumers. The procedure followed was based on an objective – criteria – indicators approach.

3.1.2. Other initiatives

Twelve initiatives (thirteen counting the indicators included under Japanese law) to develop indicators for sustainable aquaculture were implemented. 46% of them were carried out on an international level, 39.5% of them on the national or local levels, the remaining being initiatives carried out in specific zones.

Figure 2. Timeline of the major initiatives to develop indicators for sustainable aquaculture



Legend: Those international initiatives mentioned above are placed on a grey background.

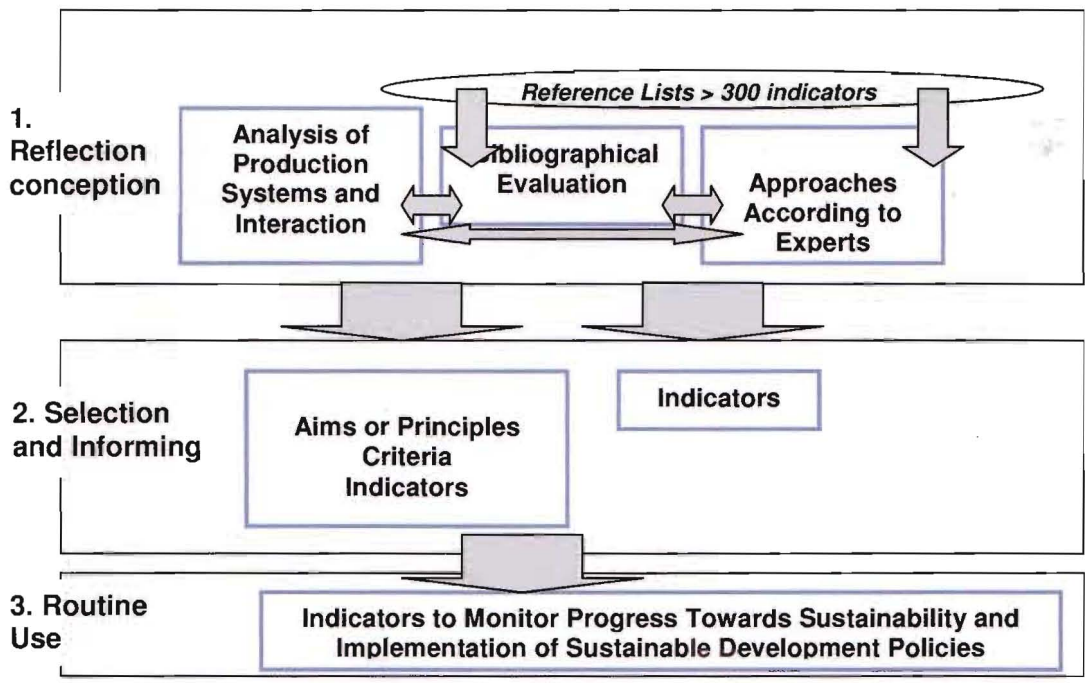
3.2. Analysis of the initiatives with regard to methodology

The procedures for developing sustainability indicators for aquaculture follow the most generalised approach used in building indicators for sustainable development. International organisations and countries produce standards and lists of indicators designed to be adapted to smaller scales and more focussed objectives, thus promoting the adaptation of sustainable development policies. These procedures were already mentioned in the introduction (cf. § 11); they have had a strong influence, both on methodological procedures and on the nature of some indicators.

The procedures may be distinguished firstly according to their aim. The aim of many experiences is simply to produce checklists in the sense of standards and thus to contribute to the convergence of territorial initiatives. In this case, there is no measurement of the indicator. At most, the feasibility of the measure is ascertained by checking existing information systems and the availability of appropriate data. The proposed indicators are accompanied by a technical file which generally covers the following spheres: nature of the indicator, objective sought, precise definition of the concepts and criteria used for developing the indicator, measurement methodology, available or necessary databases and institutional status of these databases, form of comparison, bibliographical references... Each of these methodological files constitutes a sort of metadata set for the proposed indicators. In comparison to Madec's sequential typology (2003), which distinguished between procedures according to their maturity or level of success ((1) reflection and conception, (2) selection and informing of indicators and (3) dissemination and routine use), it seems that certain initiatives, in particular, the standards produced at first by the international institutions, essentially fall under the category, ofreflection and conception stage. The study of the 12 initiatives inventoried according to their level of progress demonstrate a relatively balanced division between the categories, with one third (31%) in the reflection / conception stage and 38% in the selection and informing stage.

From a methodological point of view, concerning **the forms for developing** the indicators, two major types of procedures are traditionally distinguished (IFEN, 1999): (i) those called normative, which can be qualified as "*top down*", where indicators are defined on the basis of expert procedures; and (ii) those called procedural, which arise from interaction among actors in collective definition processes or processes of joint construction of these indicators according to a more *"bottom up"* logic, although the latter are often informed by checklists produced by experts. The participation of scientists is highly structuring in the sense that they intervene in all initiatives. However in two thirds of the cases (66%), this is done through open partnership with the various actors of aquaculture systems (farms, the administration, consumers...). The following chart provides an overview of the types of procedures used in each stage.

Figure 3. Types of procedures followed to develop indicators



Depending on the initiative, **the reflection – conception stage** relies on three major types of procedures (which are not exclusive but often complementary). The development of indicators can proceed from an analysis of the forms of production and their strengths and weaknesses vis-à-vis the sustainability of the activity and of the territory (inductive approach based on observation). Otherwise, it can also proceed from methods relying on bibliography or the mobilisation of experts (deductive approach) based on previously existing lists of indicators that can be quite significant (up to 296 for the INRA / CIPA study in Aquitaine, which is the most exhaustive and whose indicators have been used for the CONSENSUS project), with various selection and classification procedures according to both the philosophies behind each approach and the scale upon which they are carried out. Two formal procedures of consultation with experts or indicator selection are cited: the Delphi Method and multi-criteria analysis. Depending on the procedures used, the pertinence and legitimacy of indicator choice made hinges on the diversity of actors involved (procedural approach) and/or on the level of competence of the experts consulted (normative approach).

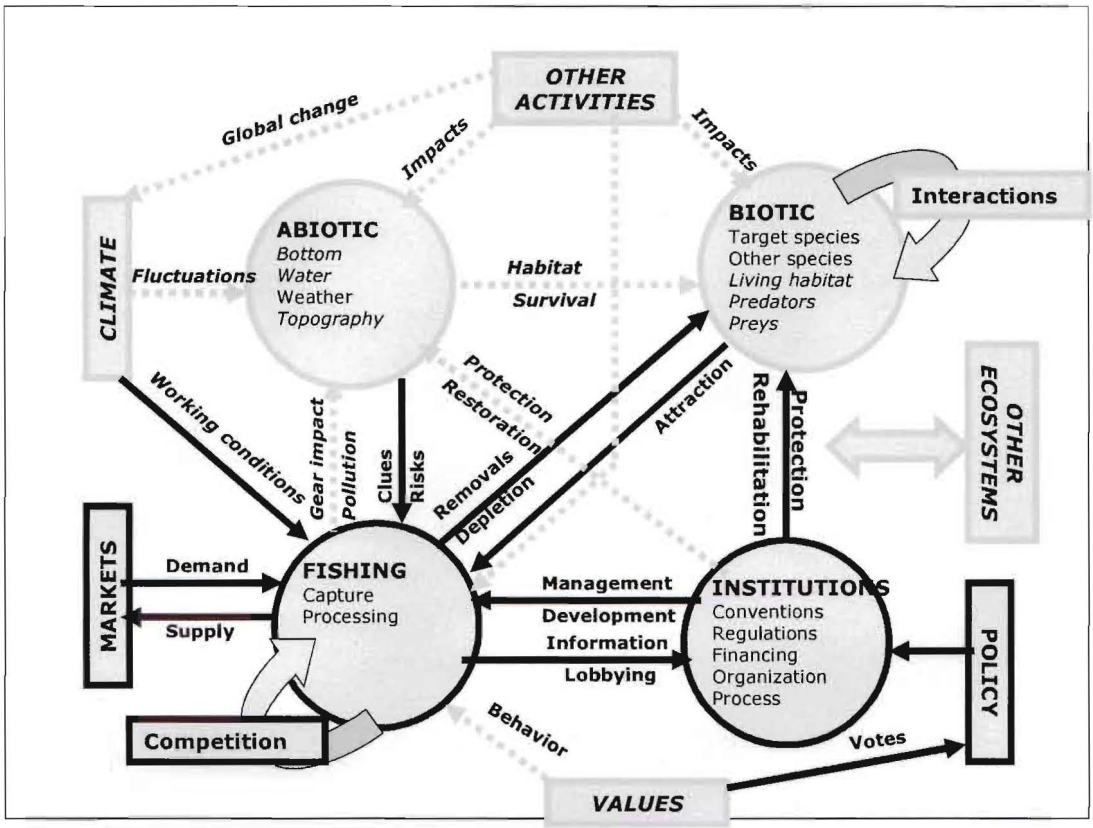
The development of indicators requires a standard allowing the nature of indicators to be precisely defined. The reference framework is most often the one produced by the OECD in 1993 (PER or DPSIR, cf. Table 4), which proposes distinguishing indicators according to their nature, i.e. the type of information they should provide. This approach is quite rare in the case of aquaculture.

Table 4. Nature of indicators according to the DPSIR assessment framework of the OECD

Driving Forces	Pressure	State	Impact	Response
Indicators relative to processes, behaviour and determining factors allowing analysis of pressure exerted		Indicators for monitoring the evolution of the state of ecosystems and social systems		Indicators used to report on management measures and the reaction capacity of society to reverse trends

According to this typology, a strong polarisation of studies and indicators concerning the monitoring of states of affairs and impacts can be observed. A review of the initiatives tends to show that there are few precise, integrated analyses on processes based on the following two main lines: the impact of aquaculture on the environment (approach analysing pressure exerted); and the consequences of environmental change for aquaculture (approach focussing on vulnerability). The definition of pressure criteria or driving forces calls for an extended analysis of the interactions and processes concerned. These are complex processes reflecting the issue of interaction between nature and society and few standards are available in this sphere. One example we could cite is proposed by Garcia and Cochrane (2005) for fishery, which constitutes a benchmark in this domain. This type of approach requires a framework of a more inductive type, with observation-based analyses.

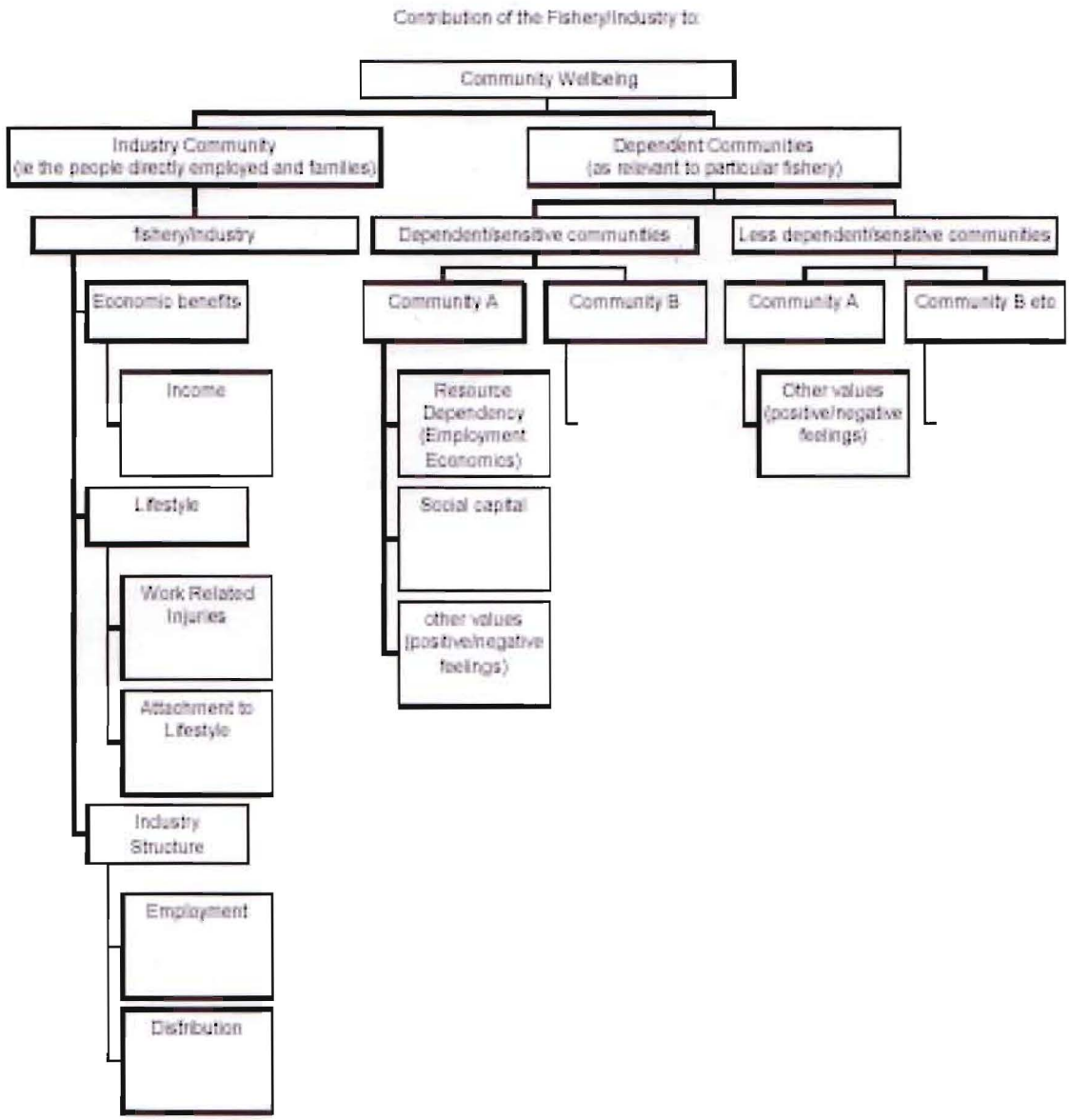
Figure 4. Framework for analysis of processes for fishery pressure indicators



Source: Garcia and Cochrane (2005)

In the case of indicators of state, the methodological needs arise from the classification framework for the variables to be monitored. In the case of fishery, and in particular, ecosystem indicators (Rey-Valette et al. 2005), the standards produced by Fleetcher et al. (2000) for Australia are becoming generalised. The following figure shows an example of a reference analysis grid allowing the categorisation of the elements to be taken into account in monitoring of states.

Figure 5. Example of approach matrices for structuring indicators of state



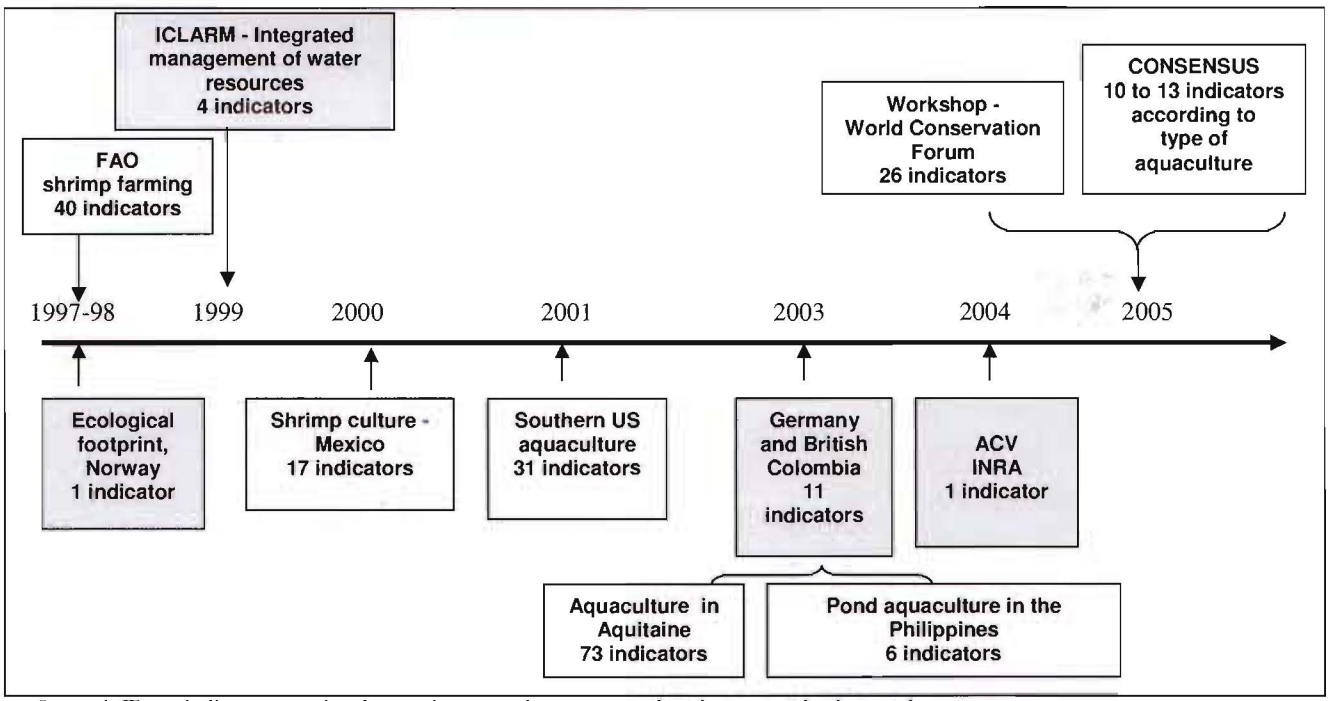
Source: Fleetcher et al. 2000

With regard to the **specific stage of indicator development**, the initiatives studied reveal two types of procedures: either an extant list of indicators directly employed; or indicators defined by iterative deduction according to a sequential form of development consisting of three stages, namely Principles – Criteria – Indicators (PCI).Indicators are used for estimating criteria showing objectives associated with the general principles of sustainable development. One thus moves from principles to criteria and then to indicators, which not only allows a list of indicators to be produced but also allows them to be related to the values making sustainable development adaptable to a sectoral or territorial level. Altogether, the number of stages in the development of indicators varies from 1 to 3, though half of the initiatives studied here only used a single stage, directly defining indicators.

Finally, one must also distinguish **procedures according to their philosophy**, consisting of:

- On the one end, those that seek to produce more or less restricted panels of indicators, generally associating the three major pillars of sustainable development, to which the pillar of governance lately tends to be added.. Over half (54%) of the initiatives studied considered the three pillars of sustainable development in building indicators and 18% added the institutional facet;
- On the other hand, those that seek to produce aggregate synthetic indicators, on the model of the ecological footprint, which expresses human impact in terms in necessary surface area.. The ecological footprint hasbeen applied to various aquaculture systems by Swedish researchers (Kautsky et al. 1997; Roth et al. 1997). They estimated the surface area of ecosystem necessary for a shrimp farm in a mangrove in Colombia, for the cage production of tilapia on a large scale and for semi-intensive pond farming of tilapia on a small scale in Lake Kariba in Zimbabwe.In the same vein, life cycle analysis develops an aggregate indicator of the environmental impact of aquaculture. This analysis has been used, for instance, to study the environmental impact associated with feeding rainbow trout in France. To summarise, **this overview** shows that there is:
- An overabundance of indicators with a multiplication of lists (cf. Figure 6), often difficult to inform and not always suitable to local specificities and the demand of users with a low degree of association. The number of indicators developed within the framework of an initiative varies from 1, for integrated indicators such as ecological footprint or ACVs, and 73 at most, with an average of between 15 and 20, these differences not having any real relation to the scale of application.
- Greatly disproportionate sets of indicators classed according to the pillars of sustainable development, with a predominance of environmental impact indicators, which are either the only ones addressed (cf. initiatives on a grey background in Figure 6) or the most developed and operational.

Figure 6. Number of indicators proposed by different initiatives



Legend: Those indicators restricted to environmental aspects are placed on a grey background.

3.2 Typology and presentation of the indicators inventoried

Comparison of the different lists (cf. Fig. 6) leads to the identification of 142 indicators, some of them having been the object of validation and measurement. . One can obviously classify these indicators according to the pillars of sustainable development to which they refer. We then obtain the following breakdown, which confirms the preponderance of the environmental domain:

Table 5. Breakdown of inventoried indicators according to their domain of reference

Environmental	Economic	Social	Institutional
73	39	22	8

Without making an extended analysis of these indicators, in any case they could be analytically classified according to their position and contribution with regard to the approach to aquaculture sustainability. In this sense, the following figure presents a functional typology of the levels of interaction, allowing types of indicators to be identified according to their functional position with relation to sustainability analysis.

Figure 7. Typological classification of the indicators inventoried

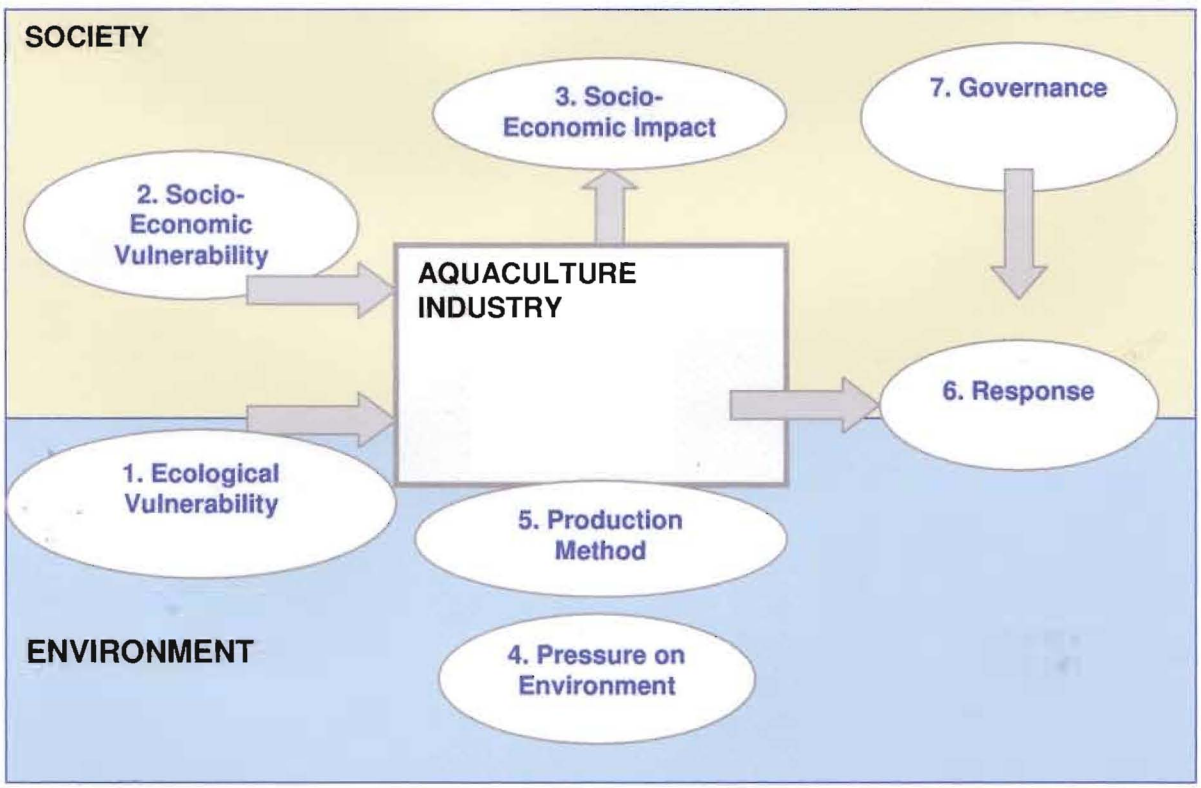


Table 6. Typological classification of the indicators inventoried

N°	type	number of topics	definition
1	ecological vulnerability	2	characteristics of the elements of the natural environment that constitute a constraint to aquaculture sustainability
2	socio-economic vulnerability	3	characteristics of the elements of the socio-economic environment that constitute a constraint to aquaculture sustainability
3	socio-economic impact	2	indicator to monitor the state and impacts on the socio-economic system
4	pressure on environment	3	environmental impact in terms of pressure associated with aquaculture activities
5	production method	5	indicators referring to the aquaculture production method
6	response	2	indicator measuring the efforts implemented (schemes or mechanisms) to attenuate pressure
7	governance	3	indicators regarding processes of steering and regulation of the industry or the territory

On the basis of these categories, the 142 indicators identified can be arranged according to analysed initiatives, some of the indicators being listed several times, others only mentioned by a single initiative.

Table 7. Inventory of indicators according to the types identified

ecological vulnerability	**Availability of inputs**: dependence on fish stock; conflicts / access to water; origin of fry; number of local land owners; net use of primary industry product; **Water quality**: frequency of sale bans; water composition; % protected area; oxygen demand
socio-economic vulnerability	**Training**: dependence on external knowledge; availability of qualified personnel; level of education; literacy rate; **Interaction with other users**: population density; intensity of conflicts; pressure of water demand; weight of recreational fishing; aquaculture image and local perception of the industry; competition among activities; complaints relating to water quality; **Access to information**: knowledge of hydrological resources (water flow...); market studies; specific mapping of risks; weight of local research
socio-economic impact	**Economic impact:** use of fuel; local weight of the sector and of the industry; participation in ecotourism; importance of the revenue distributed; importance of importation and balance of payments for the farms; % of aid to the sector; **Social impact:** number of jobs; % of local employment; job security; income level / local average; connections to medical service; average ages and reemployment rates; inter-sectoral and intra-zone equity; place of residence (distance / urban centres) and access to personal services; social services
pressure on environment	**Pressure on aquatic environments**: stock escape rate; water composition and chemical concentration (ammonia, phosphorus, particles in suspension, pesticides, fertilisers, dissolved oxygen; sulphite, benthos, chemicals...); eutrophication rate; acidification rate; quantity of water and rate of use of water resources, exceeding the water reserve limits; % recycled circuits, % of exotic and imported species; % of water from drilling and diversion; **Pressure on terrestrial environments**: rate of real estate pressure; specific land uses: protected areas, wetlands, natural areas and mangroves; weight of aquaculture farms / zone; **Global pressure and energy consumption:** CO2 emission and contribution to climate change; ecological footprint; energy consumption
production method	**Marketing:** product diversity (types, processing rate...); added value of by-products; share of types of circuits and markets; % consumption and repopulation; % of products with artificial colouring; quality of products; % local sales; % of quality or ecological contracts; number of complaints relating to product quality; Animal **health and welfare** : animal health and welfare ; quantity of antibiotics and medicine; consideration of this notion by producers; **Feed:** addition of proteins; origin of protein; type of feed (pressed or extruded); artificial colouring; % GMOs in feed; food conversion rate and net protein production; **Profitability**: weight of feed expenses; ratio of fixed / variable expenses; economic efficiency; investment returns, profit and profit margin; variability of inter-annual results; weight of taxes and ecological expenses relating to compliance; number of businesses closing, number of farms without buyers, added product value; **Production technique**: diversity, efficiency of technique and productivity; number of recycled flows; weight of recycled circuits; diversity of species; portion of triploid animals; genetic growth potential
response	**Control at the farm level** (individual response): sanitary barriers, technological innovation rate, farming density, treatment of rejects, waste products and wastewater; output rate; energy consumption rate; % control measures on producer's initiative; **Collective management**: number of quality measures; procedures to foster sustainability (guides); link between research and the sector (rate of farms working with external experts or rate of farm openness); sector stability with respect to changes; reuse of products in integrated aquaculture
governance	**Openness of the sector**: % participation of the industry in territorial management schemes; investment in quality communication; transparency of the sector; relations with other actors; **Compliance with regulations**: complaints relating to water quality and non-compliance with decrees; **Institutional maturity**: efficacy and representativeness of socio-professional structures

Conclusion

This analysis demonstrated the existence of significant progress regarding measures fostering sustainable aquaculture, with recent initiatives showing an attempt towards inclusion and standardisation of the results of past measures. Nonetheless, this type of bibliography-based study can only provide a global overview of the situation. It does not provide details on the problems encountered the real state of progress of certain measures, or on local initiatives carried out by producers' associations. Thus, for the Mediterranean, where there is no structure federating producers on a global level (apart from the GFCM's Committee on Aquaculture), it is difficult to gain such an overview. The analysis carried out, above and beyond the bibliography, sought to mobilise intermediary actors such as representatives of national aquaculture federations. The majority of

contacts made by mail have not produced more detailed information. Only on-site surveys will allow the identification of:

- Examples of aquaculture sustainability and determining factors;
- The interest of actors in sustainable aquaculture certification measures;
- The number and knowledge level of existing initiatives.

As a result of this analysis, a number of recommendations can be formulated to encourage greater dissemination and definition of initiatives fostering sustainable aquaculture in this geographical area:

- The adaptation of measures demands the definition of common principles on the basis of which indicators are developed: measures aiming to compile indicators directly from pre-existing check-lists should therefore be avoided or restricted to the early stage of the implementation of the measure; measures to develop policies and / or indicators for sustainable development should be agreed upon by all actors concerned;
- Protocols should be defined that take into account the diversity of the aquaculture systems concerned. Thus in the case of the Mediterranean, the different species and types of aquaculture sites should be taken into account, as well as and above all the differences in farm size so as to consider the issue of maintaining small-scale, businesses;
- The profusion of indicators available limits their usefulness: their use should be considered and their number restricted to few benchmark indicators with a significance that can easily be adapted by the actors involved and that can also serve a communication tools. function should be developed;
- It is important to strike a balance relative to all pillars of sustainable development and, economic, environmental , social and institutional aspects. The last two being currently underrepresented, should be taken into greater account;
- Studies should not be limited to ascertaining impacts and states of affairs, but should also analyse processes and interactions, which requires the availability of analysis grids adapted to aquaculture systems (productive and regulatory systems);
- It would be best to go beyond the sector or industry-based approach to investigate the territorial scale within the framework of more global policies of sustainable development;
- It is important that the issue of adapting information systems be addressed from the start in considering indicator definition procedures, with a view to sharing the existing information on the different sustainable development policies carried out on a territorial level and therefore fostering their effectiveness and durability;
- And finally, it would be best to accompany procedures of important initiatives with communication on several levels, the point being not only to ensure that these procedures contribute to the promotion of the sector and the improvement of its image among different types of public (local decision-makers, the public at large, coastal inhabitants, consumers...), but also to foster the image of sustainable development as an opportunity for action and innovation and not as a constraint among producers and stakeholders in the aquaculture industry.

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