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INDICATORS FOR SUSTAINABLE DEVELOPMENT OF AQUACULTURE (WGSA-InDAM first year)*

*DRAFT BEFORE EDITING

Preparation of this document

This document is the draft version of the first year report of the InDAM Project "Indicators for Sustainable Development of Aquaculture and Guidelines for their use in the Mediterranean", funded by the EU DG Mare and carried out in support to the GFCM CAQ Working Group on Sustainability in Aquaculture (WGSA).

It includes a first part containing the project rationale and the description of the activities carried out during the first year, including the results of two pilot studies, and a second part of annexes reporting selected papers by Mediterranean experts useful for the InDAM Project purposes.

ABSTRACT

The document reports the first version of the first year activities of the InDAM Project "*Indicators for Sustainable Development of Aquaculture and Guidelines for their use in the Mediterranean*", funded by the EU DG Mare, and carried out in support to the GFCM CAQ Working Group on Sustainability in Aquaculture (WGSA). The project focuses on the practical use of the indicators for sustainable aquaculture and their adaptation to the Mediterranean Sea. The methodology applied for the identification of the preliminary list of indicators was based on the PCI (Principle, Criteria and Indicators) approach and took into consideration the main outcomes and achievements of the recent projects carried out in the Mediterranean on the identification of indicators for sustainable aquaculture. The principles of sustainability and standards, in their four dimensions, governance, economic, social and environmental, and their relationship with aquaculture and its sustainable development in the coastal areas are hightlithed. In addition, the document also reports the results of the workshop on the *Selection of indicators for the sustainable development of aquaculture in the Mediterranean Sea*, the expert meeting on *Indicators for the sustainable development of aquaculture in the Mediterranean Sea* (the 27-28 November 2008, and 24-26 February 2009, Montpellier, France, respectively) and the workshop on *Guidelines and application of indicators for sustainable development of aquaculture* (19-20 November 2009, Salambo Tunisia). The reccomendations given by the WGSA are also included. The results of the two first pilot studies developed in Mugla (Turkey) and Monastir (Tunisia) are also included. The online data base on relevant indicators for sustainable aquaculture and the web portal on the InDAM project activities hosted on the SIPAM website are described.

Table of Contents

Preparation of this document
Abstract

1. Introduction and background

Mediterranean aquaculture sustainability: problems and issues to be addressed

The world-wide expansion of aquaculture has brought a number of environmental and socio-economic issues, which impact the sustainability of the sector. Reaching the status of stable aquaculture industry means insuring that aquaculture is economically, environmentally but also socially sustainable, i.e. includes issues such as integrated coastal zone management or consumer confidence in aquaculture products.

Mediterranean aquaculture is already facing difficulties related to several factors such as scant production, interaction and space competition with other users of the coastal zone, negative image of its impact on the environment and quality of its product, lack of legislation framework, market competition from imported products and among Mediterranean countries. Indeed sustainability principles and standards, in their four dimensions, governance, economic, social and environmental, differ from one country to another, making it difficult to establish the position of Mediterranean aquaculture in terms of marketing and social acceptability, and questioning its sustainable development in the coastal areas at regional and national scales.

The importance of the development of sustainable marine and brackish aquaculture within coastal zone management has been discussed at different levels and its relative integration has become one of the major issues in Mediterranean aquaculture. Criteria are needed to describe an agreed level of sustainability of aquaculture activities and to meet economic, social and environmental demands. In this respect the identification of indicators and relative reference points and standards is considered a priority in the process of harmonising strategy for Mediterranean aquaculture management and development.

Background

The adoption of the Code of Conduct for Responsible Fisheries (CCRF) during the 28th Session of the FAO Conference (1995) provided the essential framework for the management of fisheries and aquaculture in a sustainable manner. During 1999 (Rome, FAO) a Consultation[1] was carried out in order to discuss the Applications of principles of the Art. 9 of the CCRF in Mediterranean countries.

This consultation generated 14 national reports and action plans elements for the development of sustainable aquaculture in the GFCM area. Among the actions proposed, a series of activities was identified in support of a better understanding of the criteria and techniques for sustainable aquaculture, such as the design of indicators of sustainability for production systems. The Consultation recognised the GFCM Committee on Aquaculture (CAQ) as the proper body to coordinate the follow up of the activities identified.

In the GFCM region, raising interest in aquaculture sustainability has led to a number of initiatives, all related to aquaculture sustainability issues. In 2003, a specific consultation on "Interaction between aquaculture and capture fisheries" was held in Rome (5-7 November 2003)[2] under the FAO AdriaMed project. The expert consultation provided the opportunity to develop a preliminary matrix for the identification of indicators, a first step towards the definition of a set of indicators to monitor the relationship between aquaculture and capture fisheries in the Adriatic region according to the criteria for sustainability.

The CAQ identified the sustainable development of Mediterranean aquaculture as a priority and to address it in 2007 the CAQ was reorganised in three working groups, one focusing on marketing

[1] FAO (1999) Report of the Consultation on the Application of article 9 oft he FAO Code of Conduct for Responsible Fisheries in the Mediterranean Region, Rome, 19-13 July 1999. FAO Fisheries Report, No 606, Rome, FAO, 208p

[2] Cataudella, S.; Massa, F.; Crosetti, D. (eds.) (2005) Interactions between aquaculture and capture fisheries: a methodological perspective. *Studies and Reviews*. General Fisheries Commission for the Mediterranean. No. 78. Rome, FAO.,229p.

priorities, one on the interaction of aquaculture with the environment, and one focussing specifically on sustainability. A consensus definition of aquaculture sustainability in the Mediterranean region is a priority on which to develop indicators and relative reference points for a targeted audience (farmers, decision-makers, etc) with the aim of facilitating individual and collective choices toward a sustainable development of Mediterranean aquaculture.

1.1. THE InDAM PROJECT FRAMEWORK

InDAM was designed and developed within the Working Group on Sustainable Aquaculture (WGSA) of the GFCM Committee on Aquaculture. The project focuses on the practical use of the indicators for sustainable aquaculture, their adaptation to the Mediterranean Sea, and on the development of appropriate guidelines.

The first formulation of InDAM was prepared in November 2006 during the first meeting of the GFCM-CAQ WGSA and represents the follow up of the request made by the CAQ during its fifth session (June, 2006). The project proposal was approved during the 31st session of the GFCM (January 2007). The Project InDAM "Indicators for Sustainable Development of Aquaculture and Guidelines for Their Use in the Mediterranean" is operative since November 2008, is funded with the contribution of the European Union (EU), DG MARE, and has a duration of 4 years.

The InDAM Project aims to provide countries with a comprehensive decision-support tool for the development of sustainable aquaculture based on a set of indicators, reference points and guidelines adapted to the Mediterranean region. A further aim of the InDAM project is to establish a regional sustainable reference system for the development of marine aquaculture in the Mediterranean by intergrading the governance, economic, social and environmental dimensions into coastal zone management and by using the ecosystem approach for aquaculture (EAA) in the selection of indicators.

The workplan of the project is yearly based and a strategic revision should be done every year, also on the basis of the priorities gaps that will be identified.

1.1.1. Project objectives

The InDAM project specifically focuses on Mediterranean finfish species, with the aim of developing practical indicators and relative reference points and standards for direct and concrete use by the various stakeholders (farmers, users of the coastal zone, decision-makers, NGOs, etc.) within a shared definition and framework of the sustainable development of Mediterranean aquaculture. To reach such objective, InDAM used a participatory methodology involving relevant stakeholders in the process of screening and selecting the indicators[3].

InDAM also aimed at providing the opportunity to establish proper links between the GFCM and current and future projects pertaining to aquaculture sustainability to ensure a) that the GFCM benefits from the most recent results from research and innovation in the field and b) coherence between the different initiatives (including the SHoCMed and MedAquaMarket projects).
The InDAM development goal was to support and facilitate decision-making toward the sustainable development of Mediterranean aquaculture at a all range of scales, from individual to collective, and for a large range of stakeholders (decision-makers, producers, coastal zones users, NGOs, etc.).

1.1.2. Strategy and methodology

The strategy of the project is to assist the GFCM countries in the elaboration of a consensus definition of and guidance toward aquaculture sustainability in the Mediterranean region. This included the use of a multi-disciplinary and participatory methodology for the selection of sets of indicators. The tool to develop and select indicators is to elaborate and to take advantages of selected methodologies applied

[3] FAO (1999). Indicators for sustainable development of marine capture fisheries. FAO Technical guidelines for responsible fisheries. No 8, Rome, FAO, 68p.

in other similar situations and adapted to the Mediterranean context taking into account multiple stakeholders, targeted uses of indicators and existing aquaculture systems.

The InDAM project took advantage of the outputs of several projects and initiatives dealing with European/Mediterranean aquaculture sustainability, with the identification of indicators at different levels, the main ones being EVAD[4] (Evaluation of sustainability of aquaculture systems) and the IUCN[5] initiative in the preparation of guidelines for sustainable aquaculture in the Mediterranean Region. SEACASE[6] (Sustainable extensive and semi-extensive coastal aquaculture in Southern Europe), ECASA[7] (An ecosystem approach for sustainable aquaculture), CONSENSUS[8] (Defining indicators for sustainable aquaculture development in Europe) and others were also considered.

Pilot studies for the determination of the different indicators for each dimension will be performed in various Mediterranean sites with different aquaculture typologies, in order to refine the definition of indicators, to prioritize them and to receive feed-back from the different stakeholders.

The project is structured in two phases: a methodological phase (Phase I) and an extension phase (Phase II).

- Phase I includes the development, refinement and test of the methodology and sets of indicators. At the end of Phase I, a draft guideline for the use of indicators, including feasibility, practicality, expertise-requirement, cost-effectiveness, etc. will be released. Results will be presented and examined in a workshop where the activities of Phase II would be discussed and planned.
- Phase II is an extension phase where indicators will be concretely applied in test sites in order to cover the diversity of situations in the Mediterranean region and ensure a good adaptation of indicators to the field and to local needs. This strategy should also ensure a high degree of participation of the countries. Outputs from the test sites will allow the revision, the completion and the refinement of tools and the selection of indicators.

1.1.3. Outcome and expected outputs

The *final outcome* of InDAM is to provide policy makers with a comprehensive decision support tool regarding sustainable aquaculture development in the Mediterranean. This tool is based on the production of sets of indicators and relative reference points and standards to guide, evaluate and provide incentives towards the sustainable development of Mediterranean aquaculture in its four dimensions (Governance, Economic, Social, and Environmental). Sets of indicators will be produced using a multi-stakeholder, participatory and multi-disciplinary methodology adapted to the

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[4] EVAD is a research programme (CIRAD, INRA, IFREMER, IRD, University Montpellier 1) focusing on methodological questions regarding the evaluation of aquaculture sustainability. It aims at developing a tool to evaluate sustainability based on indicators and taking into account issues shared in aquaculture as well as local specificity related to the territorial dimension (environmental, economic, social and governance context) of aquaculture (annexe 1).

[5] IUCN *Guides for the sustainable development of Mediterranean aquaculture: 1. Interactions between aquaculture and the environment, http://data.iucn.org/dbtw-wpd/edocs/2007-008.pdf - 2. Aquaculture site selection and site management, http://data.iucn.org/dbtw-wpd/edocs/2009-032.pdf - 3. Responsible aquaculture practices and certification*, http://data.iucn.org/dbtw-wpd/edocs/2009-061.pdf - and *Analysis of the standards and indicators for sustainable development of aquaculture* (annexe 3)

[6] SEACASE is an EU funded FP6 project; with the goal to provide "added-value" to the extensive and semi-extensive sector aquaculture in Southern Europe, by optimising systems and promoting differentiation in the marketed product maintaining sound environmental conditions in coastal zones. Its activities focus on the promotion of new production systems (e.g. polyculture), developing environmental friendly protocols, quality markers and certification.

[7] ECASA is an EU funded FP6 project following up several previous programs of the 4th and 5th EU research framework on the effects of aquaculture activities on the environment, with particular reference to the Mediterranean Sea. The objective of the current program is to support the industry in providing guidance and tested tools to minimise environmental impacts whilst maximising productivity.

[8] CONSENSUS is an initiative that works towards sustainable European aquaculture by building sustainable aquaculture protocols that are based on low environmental impact, high competitiveness and ethical responsibility with regard to biodiversity and animal welfare. It was funded by the Commission of European Communities under the 6th Framework Programme, thematic priority "Food Quality and Safety".

Mediterranean context. These indicators should be practical and should provide concrete guidance for multiple stakeholders and different aquaculture systems.

InDAM will produce three main outputs, described below, as a result of the activities carried out in four years and two phases: a methodological phase (Phase I) and an extension phase (Phase II). Following-up activities of years two to four will be reviewed and detailed yearly on the basis of advanced results and multi-stakeholder workshop outputs in order to secure the achievement of expected outputs.

Output 1- A consensus definition of "sustainability" of aquaculture development in the Mediterranean within the framework of an ecosystem approach to aquaculture is established

Output 2 - Relevant documentation on aquaculture sustainability is gathered and regularly updated and proper synergies between other projects related to sustainable development of aquaculture and the Working Group on Aquaculture Sustainability of the GFCM are identified and developed

Output 3 - The most suitable and workable sets of indicators and reference points guiding the sustainable development of Mediterranean aquaculture are established as a results of regional multidisciplinary cooperation and as also following the feedback from expert input and stakeholders

1.2 InDAM ACTIVITIES

The InDAM Project is operative since November 2008. This report is referred to the first year of the project.. During this period, expert meetings and stakeholders meetings were organized, taking into consideration the contribution and outputs of the different projects and initiatives dealing with the Mediterranean region and taking advantage of the selected methodologies. Reviews were prepared and existing documentation on sustainable aquaculture gathered. The following activities were carried out:

- the methodologies for the implementation of the project as well as the definition of sustainable aquaculture were discussed and agreed by the WGSA, the preliminary list of indicators for each one of the four dimensions (governance, economic, social and environmental) of sustainable aquaculture was identified, based on the input from the experts,
- the two first pilot studies were developed and implemented in order to receive feedback from stakeholders based on the attribution of priorities among the indicators identified,
- an online data base on relevant indicators for sustainable aquaculture was implemented and a web portal on the InDAM project activities was prepared and is at present hosted in the SIPAM website.

Within the InDAM project, the CAQ-WGSA organized a series of meetings and events:

- The workshop on the *Selection of indicators for the sustainable development of aquaculture in the Mediterranean Sea* was held in Montpellier (France) from 27 to 28 November 2008, with support from IFREMER and from the Faculty of Economic Sciences, University of Montpellier.
- The expert meeting on *Indicators for the sustainable development of aquaculture in the Mediterranean Sea* was also held in Montpellier (France) from 24 to 26 February 2009 with the support of IFREMER and was hosted by the Faculty of Economic Sciences, University of Montpellier.
- The workshop on *Guidelines and application of indicators for sustainable development of aquaculture* was held in Salambo (Tunisia) from 19 to 20 November 2009 and was hosted by the INSTM (Institute National des Sciences et Technologies de la Mer).
- Two technical meetings were organized to finalize the two pilot studies, respectively in Turkey and in Tunisia. The technical meeting of the Pilot Study in Turkey was held from 28 to 29 September 2009 at the Provincial Directorate of Agriculture in Mugla, Turkey. The

technical meeting of the Pilot Study in Tunisia was held from 13 to 14 October 2009 in Monastir, Tunisia.

A selected bibliography and a data base on indicators for the sustainable development of Mediterranean aquaculture were prepared (see chapter 5 and annexe 5). A series of documents were also prepared by experts (Annexes 1-2) and other two, one on case studies in France and Cyprus, the other on the governance dimension, are being finalised. An analysis of the standards and indicators for sustainable development of aquaculture (Annexe 3) was prepared by IUCN in 2006, and is considered relevant to the InDAM Project.

1.2.1 Identification of methodology: the PCI approach

This activity was carried out mainly at the workshop on the *Selection of indicators for the sustainable development of aquaculture in the Mediterranean Sea*[9].
The workshop aimed to review the experience of recent research initiatives and methodologies in the development of aquaculture indicators. Sixteen experts participated to the workshop. Eleven presentations were made on recent experience gained from research and cooperation programmes on the identification and development of sustainable aquaculture indicators.

During the meeting the methodological approach and time frame were also discussed and agreed by the experts, as well as the pre-identification of the principles representing the conceptual framework in which sustainable aquaculture should developed, following the Principles-Criteria-Indicators (PCI) approach.

Methodological aspects related to the implementation of sustainable development and in particular to some aspects on the PCI method were discussed during the meeting, recalling the experience carried out by EVAD (Box 1)[10]. The PCI method is essential to link the indicators to the Principles of sustainable aquaculture. Reference was made to the selection of the objectives for the establishment of a reference system for the indicators and for their application at local level in the InDAM context.

Methodology to identify indicators was agreed. The principles and criteria identified for each of the relevant dimensions of sustainable development (Governance, Economic, Social and Environmental) were presented.

Box 1
The Working Group on Sustainable Aquaculture[1] agreed and adopted with minor changes the terms reported in the EVAD document[2].

Principles	are associated to the different dimensions (or pillars) of sustainable aquaculture (Governance, Economic, Social, and Environmental).
Criteria	break down the principle into specific themes or characteristics and specify the issue to be addressed through the relevant variables to be monitored.
Indicators	allow the criteria to be (qualitatively or quantitatively) measured, and are essential to monitor or assess the behaviours of the criteria over time.
Reference points	indicate the particular state of the issue to be monitored. Once an indicator is associated with its standard it is possible to have a reference point indicating the particular state of the issue to be monitored.

The main topics mentioned during the discussion and the main aspects related to the workshop are hereunder summarized:

[9] The outcome of the workshop on the *Selection of indicators for the sustainable development of aquaculture in the Mediterranean* Sea is available at http://151.1.154.86/faosipam/htm/content/Workshop_Montpellier_Nov_2008.pdf
[10] Hélène REY-VALETTE et al. (2008). Guide to the co-construction of sustainable development indicators in aquaculture, EVAD. Cirad, Ifremer, INRA, IRD, UM1 November 2008. 144p.

- there is the necessity of common criteria and relative indicators to describe the level of aquaculture sustainability in the Mediterranean and the Black Sea areas. Meeting economic, social and environmental demands with common reference systems is an essential condition for the responsible development of marine aquaculture in the GFCM region,
- the joint exercise on selecting both principles and criteria made by participants following a multidisciplinary approach was important for generating discussion and for achieving the appropriation of the correct terminology and was considered essential toward the implementation of the InDAM project activities,
- the definition of indicators should continue in a cooperative manner and according to the different level of expertise, taking into account the recent progresses made and the outputs obtained by the various research projects and programmes; the involvement of the stakeholders is fundamental to harmonise the strategies for the management of aquaculture,
- cooperation and exchange of knowledge and experience represent the base in designing indicators for the purposes of the WGSA. Reviewing and taking advantages from the outputs of the different initiatives will avoid duplication and will help countries and stakeholders to design a development strategy for sustainable aquaculture,
- environmental and marketing aspects are the most critical issues presently to be addressed for sustainable aquaculture. Therefore, cooperation and synergy with the CAQ Working Groups on *Siting and Carrying Capacity* and *on Marketing*, as well as the proper acknowledgment of their outputs, is fundamental when selecting indicators,
- indicators should also be considered for the communication between farmers and society. The criteria should respond to the public's and consumers concerns about aquaculture and serve to communicate the positive aspects of a responsible sector managed in a sustainable way. The targets beneficiaries of InDAM are the farmers themselves and decision makers who will benefit from the use of sustainability indicators.

1.2.2 Selection of indicators for sustainable aquaculture in the Mediterranean region

The identification and selection of indicators for sustainable aquaculture represent an integral part of the InDAM programme and were carried out at the expert meeting held in Montpellier in February 2009, with the participation of twelve experts.

According to their expertise, the participants were organised into three sub-groups (Social-Governance, Economic and Environmental) to define the agreed Principles for sustainable aquaculture, the Criteria, the Indicators and whenever possible the definition of measurement parameters and reference points (Table 1). Based on the EVAD approach, a first list of Indicators was proposed and discussed individually. The indicators were associated to the selected Principles for one of each of the pillars of sustainability (Governance, Economic, Social and Environmental).

The selection of the indicators was not limited to the fishery sector level but was also considered within a more integrated approach at territorial level and consequently with the vision of a method such as ICZM (Integrated Coastal Zone Management) . In this context, sustainability should be considered globally otherwise the identification of indicators could be limited solely to an expert's vision.

Dimension	*Principles*	*Criteria*	*Indicators*
Governance	4	19	34
Economic	4	20	52
Social	3	13	18
Environmental	3	15	52

Table 1. Number of selected principles, criteria and indicators for each dimension

The participants commented that the number of indicators identified could appear numerous and this could represent a limit when indicators are applied at local scale. Efforts should be made to reduce the number. In any case for the local community the indicators should not represent an additional overload of work or commitment that must be added to the existing monitoring schemes; efforts should be made to take advantage of the already existing ones and adapt them to the concepts of sustainability. The list of indicators is the result of the cooperative discussion and exchange of points of view among the experts, as initiated during the previous meeting, and was considered by the experts as appropriate for the description of aquaculture sustainability at regional level. Any kind of simplification should be considered as part of the progress of the project and it could be performed only after having tested these indicators at local level.

Participants also recalled that InDAM was also designed to focus attention on the practical use of the indicators and that further definition and finalisation of the indicators identified should continue in a cooperative manner and within the pilot case studies.
The participants agreed on the following:

- the objectives for the use of indicators should be considered within the sustainable reference system identified (Principles, Criteria, Indicators), as well as being specified in a multidisciplinary context of aquaculture development. The indicators selected also take stocks of the different experiences and projects carried out at Mediterranean level as reported during the previous meeting held in Montpellier 1, including the methodological experience coming from other projects such as EVAD;
- for the operational aspects of the objectives, their adaptation to the Mediterranean should take into consideration the peculiarity of this aquaculture context Ministry of Agriculture and Rural Affairs, Aquaculture (species reared, technology applied, local and cultural heritage, etc) and some indicators could be considered valid for the whole region. The indicators selected should be assessed when the standards are set and within the context of an operational objective;
- there are a certain number of indicators that give information on certain areas and should be adapted to the appropriate scale within the coastal community and area (socioeconomic and environmental aspects); if sustainable aquaculture is considered within the context of coastal zone management then multi-stakeholder consensus should be reached a local level. The objective can be different depending on the local community and the final adaptation of these indicators should be made within the InDAM project on the basis of pilot actions implemented at local level.

1.2.3. Identification of the methodology for the pilot studies

The participants to the Montpellier 2nd meeting agreed that two pilot studies should be planned for better finalize the table of indicators. The pilot studies should be performed in two selected coastal areas, at different level of aquaculture development. After some discussion the participants agreed on the proposal to make one pilot case study in Turkey and one in Tunisia.

Selection criteria should be chosen and agreed upon (such as: data availability, statistical robustness; local acceptability) for the selection of indicators at local level. The pilot studies should consist mainly in one or two local multi-stakeholder technical meetings, following a bottom-up approach, which should be attended by representatives of the different interested parties and should aim to discuss and appraise the work done.

In particular the pilot studies should be articulated as follows:

- every pilot case study should be lead at local level by a coordinator who should have the responsibility to involve the different stakeholders in a technical meeting in which the indicators

will be discussed. The meeting should be attended at least by a representative of the administration, local authorities involved in aquaculture activities, scientists from different disciplines, representatives of the aquaculture sector and if possible representative from small scale fisheries. Other local stakeholders such as representatives from NGOs or other sectors could be invited as appropriate;

- during the technical meetings participants should be informed about the activities of InDAM and should be introduced to the issue of Indicators for sustainable aquaculture, as well as on the purposes of the pilot studies specified. The outcome of the meetings held in Montpellier should be presented, including the methodology, and the indicators should be discussed for the full consultation of the stakeholders;
- for each indicator a selection process with the different stakeholders should be implemented; selection criteria should be chosen and agreement should be reached (such as: data availability, statistical robustness; local acceptability);
- the outcome of the technical meetings should be presented at a meeting to be held at the end of InDAM Phase I, aimed to discuss the outputs and the methodology implemented and to define the activities of Phase II, which should be focused on the duplication of the pilot studies, on draft guidelines for the use of indicators and on the steps towards an adoption and consensus phase for the implementation of the use of sustainable indicators at local level.

1.2.4. Guidelines and application of indicators for sustainable development of aquaculture

The guidelines were discussed at a workshop held in Salambo (Tunisia) in November 2009. The workshop aimed to review the experience of recent research initiatives and methodologies in the development of aquaculture indicators. This workshop also represented the final meeting of the first year of the InDAM Project. Sixteen experts participated to the workshop. The following main aspects were underlined:

- The application and use of indicators for sustainable aquaculture are the most appropriate tools to ensure and to create conditions for sustainable growth of aquaculture and that these are necessary to assess and monitor aquaculture activities. The indicators have different functions, not only for aquaculture activities but also as a tool for communication between the different stakeholders. Participants highlighted that the principle of the co-construction of the indicators means the collective involvement of the civil society and the main involved stakeholders, and is the correct way toward a common vision of sustainability that should be contextualised at the appropriate level and geographic scale.
- Such activities may often have difficulties to be accepted by society and this behaviour can also be generated by the lack of knowledge on aquaculture and/or by incorrect information. The image of aquaculture should be improved and the indicators could be considered also as essential tools for communication between farmers and society. In this respect the urgency for the application of indicators to be shared among the international community in support of aquaculture development was stressed.
- The indicators should always take into consideration the four dimensions of sustainability (governance, economic, social and environmental). For a practical use, standards and when possible reference points should be associated to each indicator. The latter will serve not only for those countries in which aquaculture is well developed and in which conflicts exist also for increasing competition for space (such as in Turkey) but also for those countries in which aquaculture is further developing at national level (Tunisia and Morocco). For these reasons the necessity to develop guidelines for the application and use of indicators on sustainable aquaculture remains a priority at Mediterranean level.
- The participatory approach is also essential for the aspects related to the governance dimension of aquaculture that represents the key to sustainability, though sometimes the definition and quantification of the indicators are not so evident. Some aspects related to the

governance are different from country to country or from south to north of the Mediterranean Sea, and the same concept can have different sensibility, such as welfare for example.

- New general rules for aquaculture could impact at local level and sometimes could affect global sustainability. Difference should be made between small and large farms, in particular the role played by small farms on sustainability and the concept of artisanal fish farms should be thoroughly discussed and taken into consideration for the conservation of local traditions and to support the local community such as in the case of artisanal fisheries. The issues related to the certification of traditional, organic and environmental productions should be considered within the governance dimension.

1.3. CONCLUSIONS AND RECOMMENDATIONS OF THE INDAM FIRST YEAR

On the basis of the methodology implemented by the WGSA and the sustainable development reference systems established within the InDAM Project (Montpellier, France) meetings held in November 2008 and February 2009) and on the technical contributions made in Turkey and in Tunisia, the participants to the the InDAM one-year final meeting discussed on the achievements of the pilot studies and identified priorities for the InDAM second year, including some aspects related to the content of the "Guidelines for the application and use of the indicators for the sustainable development of aquaculture in Mediterranean countries".

The main topics addressed during the discussion as well as the main conclusions of the workshop are hereunder summarized:

a) Pilot projects

- *pilot projects* are essential to establish a local reference system for the development of aquaculture sustainability and its integration into coastal zone management, and to have a common understanding between the different local stakeholders on the concept of sustainable aquaculture. Participants also considered that additional pilot case studies should be implemented in other Mediterranean countries with the aim of strengthening the co-construction of indicators and their application;
- the results of the *pilot projects* could be considered as relevant for the purposes of InDAM and in particular to generate discussion and to test the methodologies applied on the identification of sustainable indicators at local level;
- the use of indicators for aquaculture should be considered within the sustainable reference system identified (PCI: Principles, Criteria, Indicators), as well as being specified in a multidisciplinary context of aquaculture development;
- when carrying out *pilot projects,* multi-stakeholder participation and bottom-up approach should remain a priority. The involvement of different local stakeholders (administration, farmers and farmers associations, NGOs, scientists) was considered as essential for having a common understanding of the sustainable aquaculture concept, and this could be considered also one of the major added values towards the identification and the application of indicators for sustainable aquaculture at local scale;
- the information on PCI provided to participants of the *pilot projects*, as well as the identification of the attributes for the indicators, were essential during the process of indicators selection that was considered more transparent;
- during the *pilot projects,* the work performed with the different actors enabled to have different perspectives of aquaculture development. Aquaculture itself is not considered only from the farm point of view but also from the civil society in the wider territorial context of coastal areas;

- in the implementation of *pilot projects*, the identification and prioritization of attributes for indicators is a crucial issue. It should be considered as the first logical and methodological step in the selection process of the indicators;
- common understanding and perception of attributes for the indicators for sustainable aquaculture at local level are required in order to achieve consensus on the identification and prioritization of the same indicators. The preparation of a "*Glossary on attributes for selection of indicators"* would facilitate this process**;**
- functionality and practicability of the PCI approach within the concept of sustainable aquaculture will remain a challenge point (reliable reference points at local level for monitoring purposes) for further *pilot projects*;
- a weighting and scoring table system for the evaluation and contribution of the indicators identified will help also in the usefulness of sustainable aquaculture management. A tool-based traffic-light approach on a significant index should be used in the application of indicators and in the monitoring of aquaculture activities. This would allow the evaluation of the sustainability scale of aquaculture activities at different local scales.

b) The following main activities should be considered for the workplan of the second year of InDAM:

- *Guidelines on the application of indicators for sustainable aquaculture*

  Guidelines on the application of the indicators for sustainable marine aquaculture in the Mediterranean should be drafted according to the methodologies applied and to the agreed schemes. A Glossary of the terms used for the different indicators should also be included in the Guidelines. The number of indicators should also be revised for a better and more comprehensive application.

- *The indicators reference systems for sustainable development of aquaculture disseminated in the Mediterranean also as results of regional cooperation*

  Based also on the interest created in some Mediterranean areas, additional new *pilot projects* should be implemented. A preliminary interest was suggested that the further case studies should be carried out at local level in Morocco, Italy, Spain and Greece and or in other interested countries. The new *pilot projects* should take advantage from the Tunisian and the Turkish experience respectively, and should be supported by a multidisciplinary cooperation framework.

- *Indicators reference system tested at local level*

  As follow up of the pilot case studies carried out in Tunisia and Turkey the reference system of indicators should be tested with the participation and involvement of the different stakeholders already involved in the selection process. The activities that will be carried out should serve also to make a first practical evaluation of the selected indicators based on the data available and collected at local level and for the evaluation of the drafted guidelines.

- *Preparation of a programme for the implantation and /or the establishment of a Mediterranean observatory on sustainable aquaculture*

  A general preliminary content for a document on "*Guidelines for the use of indicators for the sustainable development of aquaculture and related standard and reference points*" was adopted. The workshop agreed that the Guidelines document would need to be simple and concise and the use of graphics and drawings would be appropriate to illustrate certain concepts and for their easy grasping.

The guidelines should include the following points:

- <u>Background</u>

In this chapter information should explain the context in which the Guidelines were developed. Detailed information should be given on how the document was conceived and on the process leading to its preparation;

- Target users

  The target users of the guidelines would need to be well defined, indicating for each user group the purpose and the advantages derived from the use of such indicators as well as the different level of utilisation of the indicators (regional, national, local);

- Selection of indicators

  The guidelines would provide a series of main governance, economic, social and environmental indicators identified in the various country pilot projects supported through InDAM. However, the guidelines would clearly state that other indicators, not included in the list provided, could be of more relevance to certain countries, regions or areas. The guidelines would hence provide information on how such indicators are selected and prioritized. The PCI and co-construction methodology developed and recommended for the identification of the indicators would be included as an appendix to the guidelines document;

- Value of a single indicator

  The importance of determining the value of a single indicator (standards and when possible reference points) should be indicated in order to ensure its proper use and interpretation in determining the level of sustainability of any given aquaculture activity; including feasibility, practicability, expertise-requirement and cost effectiveness.

- Pilot case studies

  To increase clarity in and usability of the guidelines, one or more pilot case studies could be annexed (or i.e. box tools) to the guidelines in order to provide practical examples on how indicators were identified and prioritized.

A series of additional appendices will be also annexed to the guidelines, such as:

- *List of indicators*

  A list of top indicators identified through the project and the various pilot studies should be including the guidelines. Each indicator should be provided in the form of a data sheet where the following information, where appropriate, should be provided: definition, relevance to sustainability, rationale, methodological aspect (i.e. measurement of the indicator), reference value, constraints, implementation level, measurement frequency, information and data required (i.e. data source, availability), references.

- *Full methodology*

  This annex should describe in details, but concisely, the methodology developed in order to allow replicability.

2. The pilot study in Turkey[11]

2.1 INTRODUCTION

The Turkish pilot study was carried out during 2009 and culminated in the technical meeting held at the Provincial Directorate of Agriculture in Mugla, Turkey, from 28 to 29 September 2009. The technical meeting was organized by the Ministry of Agriculture and Rural Affairs of Turkey (MARA) through the General Fisheries Commission for the Mediterranean (GFCM) Committee on Aquaculture (CAQ) support project (InDAM).

The Mugla technical meeting was attended by 36 participants: namely 18 experts (economists, biologists, aquaculturists and environmental engineers from 4 different national institutions: Ministry of Environment, Ministry of Tourism and Culture, Ministry of Agriculture and Rural Affairs, MARA Research Institutes), 6 fish farmers, 6 academicians, 2 representatives from civil society organizations and 4 from aquaculture's professional organizations. The list of participants is given in Annexes 4a and 4b.

The technical meeting was held to encourage communication between various stakeholders including ministries and government institutions, fish farmers, fishermen, local communities and NGOs and provides countries with comprehensive decision-support tools for the development of sustainable aquaculture based on a set of indicators, reference points and guidelines adapted to the Mediterranean region.

In particular, it aimed:

- to share the outcomes of Montpellier I and II meetings on PCI approach (Principles, Criteria and Indicators) and use of indicators for the development of sustainable aquaculture in the Mediterranean with the stakeholders at local level,
- to initiate an indicator selection process based on identification and prioritization of attributes for selection of indicators at local level and
- to locally appraise the selection of indicators for environmental, economic, governance and social dimensions of sustainable aquaculture in the Mediterranean.

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2.2 METHODOLOGY APPLIED FOR THE SELECTION OF INDICATORS

The methodology and process for the selection of indicators was discussed during the technical meeting with the stakeholders with different background and expertise. It was agreed that before selecting any indicator it was a logical and methodological necessity to identify the attributes that an indicator should possess, and that these attributes should be prioritized by stakeholders at local level and according to the peculiarity and priorities of targeted locations, following a bottom up approach.

A three step process for selection of indicators was then endorsed by the participants, namely:

- Step 1: Identification and prioritization of attributes to be used in the selection of indicators
- Step 2: A rapid appraisal method for the selection of indicators
- Step 3: A selection process based upon attributes endorsed and prioritized by stakeholders

Accordingly, three different questionnaires were prepared and distributed for application at each stage.

2.2.1 Identification and prioritization of attributes to be used in selection of indicators

Questionnaire 1 was focused on the scoring of 10 commonly used attributes (OECD, EC, World Bank and related scientific literature) for the selection of indicators. The purpose was a) to facilitate the participation of every stakeholder from different backgrounds in the evaluation process (including the

[11] Prepared by H.Deniz (MARA, Turkey), F.Rad (University of Mersin, Turkey), G. Yucel-Gier (University of Izmir, Turkey)

silent ones), b) to convert qualitative assessments on attributes to quantifiable assessments and c) to objectively identify priorities.

The following 10 attributes (Table 1) were introduced and participants were invited to allocate a total of 100 points to attributes according to their preference for the use of each attribute in indicator selection process using Questionnaire 1 (Appendix 1).

2.2.2 A rapid appraisal method for the selection of indicators ("Acceptability" as only one attribute)

Questionnaire 2 was focused on a rapid appraisal of indicators for each dimension (Ecological, Economic, Social and Governance), using only one attribute, namely "Acceptability". The purpose was to conduct an exercise towards an early, overall assessment. To this end, participants were divided into three sub-groups based on their backgrounds and expertise (social-governance, economic and ecological), respectively coordinated by Mr. Deniz, Mr. Rad and Ms. Yucel-Gier, and were asked to fill the dimension-oriented version of Questionnaire 2.

Table 1. Ten attributes for the selection of indicators[12]

N°	attribute	definition[1]
1	relevance to criteria and principle	it is relevant to goals of endorsed criteria and principle.
2	understandability	it is clear and perceived by all stakeholders in the same manner and is easily communicated.
3	reliability	it has a sound scientific base and methodology. with successful previous use.
4	reproducibility/verifiability	it is capable of being reproducible at different time and places with verifiable results.
5	data availability	it is estimated/produced using available information/data or can be estimated/produced with reasonable cost/effort.
6	international compatibility	it is compatible with other indicators developed by other countries, regions or bodies.
7	transparency	it is accessible by all stakeholders.
8	availability of reference values	it can be compared/monitored with some readily available reference points.
9	acceptability	it is endorsed by different stakeholders.
10	robustness	it is difficult to manipulate

2.2.3 Selection of indicators (appraisal) based on prioritized attributes

Questionnaire 3 was focused on the selection of indicators for each dimension, using four attributes identified and prioritized during the first stage assessment (Questionnaire 1). Questionnaire 3 was structured for using descriptive statistical assessments. Participants were asked to score each attribute for every indicator using a scale from "1 to 9" modified from Saaty (2008) and Kumar et. al (2009)[13]

[12] European Commission. 2001. A framework for indicators for the economic and social dimension of sustainable agriculture and rural development.

Liu, W.H. and Ou, C., H., 2007. A comparative analysis of sustainable fishery development indicator system in Australia and Canada, Sustainable Development, 15: 28-40.

Parris, T.M. and Kates, R. W. 2003. Characterizing and measuring sustainable development. Annual. Rev. Environ. Resour. 28: 559-86.

Reed, M. S., and Dougill, A.J. 2003. Facilitating grass-roots sustainable development through sustainability indicators: a Kalahari case study. Presented at "Frontiers 2: European applications in the ecological economics"

The Word Bank, 2004. Selecting indicators, Poverty monitoring guidance note1.

[13] Kumar, S., Parashar, N. and Halem, A., 2009. Analytical Hierarchy Process Applied to Vendor Selection Problem. Business Intelligence Journal, 2 (2)

Saaty, T., L., 2008. Relative Measurement and its Generalization in Decision Making, Why Pairwise Comparisons Are Central in Mathematics for the Measurement of Intangible Factors. Rev. R. Acad. Scientific Series. A. Mat., 102 (2), p.258.

as below:

score	*definition*
1	weak
3	moderate
5	good
7	very good
9	excellent
2,4, 6 and 8	intermediate values

Questionnaire 3 was prepared according to outcomes of Questionnaire 1 regarding identification and prioritization of attributes for selection of indicators. Following discussion on quantitative outcomes of Questionnaire 1 and consensus among stakeholders; understandability, relevance to criteria and principle, data availability and reliability, were used as attributes for selection of indicators in Questionnaire 3. Participants were divided into three sub-groups, as before and were asked to fill the dimension-oriented version of Questionnaire 3 (Appendix 3).

2.3 RESULTS

2.3.1 Identification and prioritization of attributes to be used in the selection of indicators

Statistical results of Questionnaire-1 on prioritization of identified attributes for selection of indicators are presented in Table 2. Scores are the mean values for 28 participants completing Questionnaire 1.

The mean scores of ten attributes were found to be more or less similar and within the range of 7-14 points. Relevance to criteria and principle (14 points) was regarded as the most significant attribute for selection of indicators by participants while availability of reference values and acceptability (7 points) were found to be the least significant attributes for selection of indicators.

Table 2. Ranking of indicator selection attributes

rank	attribute	mean score (out of 100)
1	relevance to criteria and principle	14
2	reliability	13
3	data availability	11
4	understandability	10
4	transparency	10
4	reproducibility/verifiability	10
4	international compatibility	10
5	robustness	8
6	acceptability	7
6	availability of reference values	7
total		*100*

Scores allocated to different attributes in Questionnaire 1 reveal that stakeholders with different background and expertise had different priorities and preferences with regard to attributes and their use in selection of indicators. During discussions representatives of civil societies (environment) regarded “transparency” as a fundamental attribute for selection of indicators whereas fish farmers saw “reproducibility/verifiability” as a significant attribute.

However the overall assessment and distribution of mean scores for ten identified attributes also demonstrate that to varying degrees stakeholders have dedicated importance to all ten attributes and have seen them as important tools in selection of indicators for sustainable aquaculture.

The quantitative approach adapted in the Pilot Study and use of Questionnaire 1 proved to a reliable tool in prioritization of attributes for selection of indicators. Open ended debates and discussions do not always allow and encourage the participation of every opinion in the decision-making process especially the contribution of “silent ones” cannot be assured. However participation of every stakeholder and their contribution is assured by the use of the questionnaires and quantitative assessments.

2.3.2 Governance dimension - DGo

A rapid appraisal method for the selection of indicators ("Acceptability" as only one attribute)

The results of rapid appraisal (Questionnaire 2) using "acceptability" as a single attribute for selection of indicators for each principle in governance dimension are given in Table 3.

The sub-group on governance dimension is composed of seven participants with different background ranging from fish farmers, public administrators, fisherman and NGO's for aquaculture and environmental. Results are presented as percentage of "yes" answers for each indicator, showing the percentage acceptability of indicator by participants.

Table 3. Results of rapid appraisal for the governance dimension

DGo/ PRINCIPLE 1: Strengthen integration of aquaculture in local development

N° DGo/	INDICATORS	Acceptability (%)
1	number of area allocated for aquaculture	70
2	age and historical role of the activity and contribution to the traditional landscape of the area	40
3	number of workers (direct and indirect)	100
4	percentage of permanent (and seasonal) full time equivalent workers	85
5	percentage of seasonal workers in aquaculture compare to seasonal workers in tourism	70
6	conflicts and opportunities with other activities and uses	85
7	recycling rate of by-product	85
8	existence of subsidies for aquaculture ecologic services	100
9	number of reports on environmental crises in five years	85
10	participation rate to the socio-professional political organizations and in local assemblies	85

DGo/ PRINCIPLE 2: Promote participation in decision making process

N° DGo/	INDICATORS	Acceptability (%)
11	percentage of fish-farmers and technicians who know the regulations	85
12	number of control officer	100
13	percentage of fish-farmers in breach of the law	100
14	number of participants at consultative meetings	85
15	number of new measures co-construct	100
16	number of fish-farmers taking part in consultative bodies	85
17	number of conflicts solved at local level	85
18	number of conflicts due to contradictions between traditional and constitutional legislation	55
19	number of authorizations granted compared to the number of requests	86
20	number of new sites created	70
21	existence of ICZM plan for coastal areas, including aquaculture under head state authority, taking account future evolution of industry	85

DGo/ PRINCIPLE 3: Strengthen research, information systems and extension services

N° DGo/	INDICATORS	Acceptability (%)
22	existence of research funds	85
23	existence of bodies in support to aquaculture training	85
24	number of partnership contracts	70
25	existence of an information system	70
26	existence of extension and dissemination services	70

DGo/ PRINCIPLE 4: Strengthen institutional capacities in relation with sustainable development

N° DGo/	INDICATORS	Acceptability (%)
27	existence of a national sustainable development strategy	100
28	existence of rules and regulations in favour of sustainable development	85
29	rate of state financial aid compared to other sectors	55
30	existence of a public plan to support aquaculture development	70
31	number of concessions and license for aquaculture	70
32	existence of competent State services	40
33	existence of funds allocated for training	85
34	existence of legal recourses	70

Only few indicators (6 corresponding to 18 percent) were full accepted by participants. Most of the indicators (24) were regarded as 70-85 percent acceptable by participants. Indicators DGo/2, 18, 29, 32 had the lowest rate of acceptability among the 40-55 indicators. The outcomes of Questionnaire 2 state obviously that "acceptability" as a single attribute for selection of indicators does not satisfy very significant results. The "acceptability" itself is a concept which needs to be associated with some complementary attributes to be defined and dedicated.

Selection of indicators (Appraisal) based on prioritized attributes

Results of statistical assessments for selection of indicators using prioritized attributes (Questionnaire 3) are presented in Table 10. Questionnaire 3 was distributed in the sub-group on governance dimension and was filled by ten participants with different background. Results indicate the weighed mean score for each indicator in terms of four attributes namely, understandability, relevance to criteria and principle, data availability and reliability.

Table 4 . Results of selection of indicators using prioritized attributes for the governance dimension

DGo/PRINCIPLE 1: Strengthen integration of aquaculture in local development

CODE	CRITERIA	N°	INDICATORS	WEIGHED MEAN SCORE
P1C1	importance of development initiatives	1	number of area allocated for aquaculture	6.61
P1C2	integration of local culture and landscape	2	age and historical role of the activity and contribution to the traditional landscape of the area	4.24
P1C3	level of contribution to local employment and to poverty alleviation	3	number of workers (direct and indirect)	7.83
		4	percentage of permanent (and seasonal) full time equivalent workers	7.06
		5	percentage of seasonal workers in aquaculture compare to seasonal workers in tourism	6.23
P1C4	interactions with other sector at local level	6	conflicts and opportunities with other activities and uses	5.81
P1C5	contribution of the sector's to improve the environment.	7	recycling rate of by-product	5.04
P1C6	capacity of aquaculture to improve environmental monitoring capacity	8	existence of subsidies for aquaculture ecologic services	6.61
		9	number of reports on environmental crises in five years	6.41
P1C7	level of social recognition	10	participation rate to the socio-professional political organizations and in local assemblies	6.60

DGo/ PRINCIPLE 2: Promote participation in decision making process

CODE	CRITERIA	N°	INDICATORS	WEIGHED MEAN SCORE
P2C1	level of understanding in the industry	11	percentage of fish-farmers and technicians who know the regulations	7.01
P2C2	existence of control systems	12	number of control officers	7.23
		13	percentage of fish-farmers in breach of the law	7.05
P2C3	level of participation	14	number of participants at consultative meetings	7.00
		15	number of new measures co-construct	7.05
		16	number of fish-farmers taking part in consultative bodies	7.45
		17	number of conflicts solved at local level	6.21
P2C4	level of decentralization of decision-making	18	number of conflicts due to contradictions between traditional and constitutional legislation	4.66
		19	number of authorizations granted compared to the number of requests	7.00
P2C5	level of management and regional planning	20	number of new sites created	7.19
		21	existence of ICZM plan for coastal areas, including aquaculture under head state authority, taking account future evolution of industry.	7.83

DGo/ PRINCIPLE 3: Strengthen research, information systems and extension services

CODE	CRITERIA	N°	INDICATORS	WEIGHED MEAN SCORE
P3C1	importance of research and training in aquaculture	22	existence of research funds	7.25
		23	existence of bodies in support to aquaculture training	7.44
P3C2	level of interaction between research, industry and administration	24	number of partnership contracts	6.64
P3C3	access to aquaculture information systems	25	existence of an information system	7.12
P3C4	access to scientific, administrative and technique data	26	existence of extension and dissemination services	7.32

DGo/ PRINCIPLE 4: Strengthen institutional capacities in relation with sustainable development

CODE	CRITERIA	N°	INDICATORS	WEIGHED MEAN SCORE
P4C1	level of national recognition of sustainable development	27	existence of a national sustainable development strategy	7.00
		28	existence of rules and regulations in favour of sustainable development	6.68
P4C2	level of involvement of the state in the implementation of sustainable development	29	rate of state financial aid compared to other sectors	6.56
		30	existence of a public plan to support aquaculture development	7.32
		31	number of concessions and license for aquaculture	6.23
		32	existence of competent state services	6.60
P4C3	level of commitment of the state towards the industry	33	existence of funds allocated for training	7.09
		34	existence of legal recourses	5.46

Ranking of indicators based on their weighed mean scores are presented in Table 5. Indicator DGo/21 "number of workers" was found to have the highest mean (7.83) in terms of four prioritized attributes and consequently the highest rank among 34 indicators for governance dimension. Indicator DGo/2 "age and historical role of the activity and contribution to the traditional landscape of the area" had the lowest mean score (4.24) and the lowest rank.

Table 5. Ranking of indicators based on their weighed mean score in terms of prioritized attributes for the governance dimension

N° DGo/	INDICATORS	WEIGHED MEAN SCORE	RANK
21	existence of ICZM plan for coastal areas, including aquaculture under head state authority, taking account future evolution of industry	7.83	1
3	number of workers (direct and indirect)	7.83	2
16	number of fish-farmers taking part in consultative bodies	7.45	3
8	existence of bodies in support to aquaculture training	7.44	4
30	existence of a public plan to support aquaculture development	7.32	5
26	existence of extension and dissemination services	7.32	6
22	existence of research funds	7.25	7
12	number of control officers	7.23	8
20	number of new sites created	7.19	9
25	existence of an information system	7.12	10
33	existence of funds allocated for training	7.09	11
4	percentage of permanent (and seasonal) full time equivalent workers	7.06	12
15	number of new measures co-construct	7.05	13
13	percentage of fish-farmers in breach of the law	7.05	14
11	percentage of fish-farmers and technicians who know the regulations	7.01	15
14	number of participants at consultative meetings	7.00	16
19	number of authorizations granted compared to the number of requests	7.00	17
27	existence of a national sustainable development strategy	7.00	18
28	existence of rules and regulations in favour of sustainable development	6.68	19
24	number of partnership contracts	6.64	20
8	existence of subsidies for aquaculture ecologic services	6.62	21
1	number of area allocated for aquaculture	6.60	22
10	participation rate to the socio-professional political organizations and in local assemblies	6.60	23
32	existence of competent state services	6.60	24
29	rate of state financial aid compared to other sectors	6.58	25
31	number of concessions and license for aquaculture	6.24	26
5	percentage of seasonal workers in aquaculture compare to seasonal workers in tourism	6.23	27
17	number of conflicts solved at local level	6.21	28
9	number of reports on environmental crises in five years	6.07	29
6	conflicts and opportunities with other activities and uses	5.81	30
34	existence of legal recourses	5.46	31
7	recycling rate of by-product	5.04	32
18	number of conflicts due to contradictions between traditional and constitutional legislation	4.66	33
2	age and historical role of the activity and contribution to the traditional landscape of the area	4.24	34

Outcome of discussions for the governance dimension

It was expressly accord that governance compatibility between responsible institutions is very important for sustainable aquaculture. All over sustainability is impossible without coherent laws and regulations even if environmentally, economic and social dimensions are well-organised.

It was stressed that lack of consensus or unsatisfactory coordination among authorities has adverse effect on sustainable aquaculture development. For instance, in 2006 there was a change in the Turkish Environmental Law 2872 amended as Law 5491 without having an agreement among institutions.

According to this law "Marine aquaculture facilities should not be constructed in sensitive areas such as enclosed bays and gulfs and in natural and archeologically protected areas". Fish farms existing in contravention of this article will be closed after 1 year of the publishing of this law. In connection with this law, the notification which describes criteria for aquaculture site selection in enclosed bays and gulfs was published in 2007. If these sensitive areas have high eutrophication risk, marine aquaculture facilities will not be constructed. Fish farms found to be contravening this notice were under threat to be closed.

It was highlighted that Integrated Coastal Management plan for coastal areas, including aquaculture under head state authority is one of key component to take into account for the future evolution of the marine aquaculture sector.

In addition, the following specific issues regarding indicators were also underlined:

- Indicators DGo/3, 8, 12, 13, 14, 27 ("number of workers", "existence of subsidies for aquaculture ecologic services*", "percentage of fish-farmers and technicians who know the regulations", "number of control officer", "percentage of fish-farmers in breach of the law", "existence of extension and dissemination services*") were acceptable by 100% participants.
- Indicators DGo/2 and 9 "*age and historical role of the activity and contribution to the traditional landscape of the area"* and "*participation rate to the socio-professional political organizations and in local assemblies*" were found to be irrelative with Principle 1 on strengthening integration of aquaculture in local development.

2.3.3 Economic dimension - DEc

A rapid appraisal method for the selection of indicators

The results of rapid appraisal (Questionnaire 2) using "acceptability" as a single attribute for selection of indicators for each principle in economic dimension are given in Table 6.

The sub-group on economic dimension consisted of ten participants with different backgrounds ranging from fish farmers, public administrators, and farmer's organizations to suppliers of logistics and equipments. Results are presented as percentage of "yes" answers for each indicator, showing the percentage acceptability of indicator by participants.

Table 6 . Results of rapid appraisal for the economic dimension

DEc/ PRINCIPLE 1. Strengthen consumer responsive and market oriented aquaculture

N° DEc/	INDICATORS	Acceptability (%)
1	existence of own-label (y/n and %)	100
2	existence of quality certification schemes (independent bodies) (y/n and %)	100
3	existence of a traceability system	100
4	percentage of value-added products	100
5	price differential with respect to quality (y/n)	85
6	availability of processing capacity for the sector	85
7	company customer surveys	100
8	sector market studies	100
9	existence of company marketing plan	100
10	marketing costs/total revenue	85

DEc/ PRINCIPLE 2. Strengthen risk assessment and crisis management capabilities

N° DEc/	INDICATORS	Acceptability (%)
11	number of products (i.e. species, size categories, value-added)	100
12	integration of core business with complementary activities (eco-tourism, recreational fishing, restaurant)	100
13	geographic market diversification (number and % share of each market of total sales)	100
14	share of each customer in total sales	60
15	number of national feed suppliers (also % imported)	100
16	number of national hatcheries (also % of fry imported)	100
17	existence of biosecurity system	100
18	existence of legislation on biological waste disposal	100
19	existence of farm health management system (including vaccination program)	100
20	ratio of R&D expenditure/total sales	85
21	ratio of national expenditure on R&D/GDP	85
22	duration of lease of the site	100
23	no. of site lease renewals per year	85
24	existence of national legislation for zoning	85
25	existence national emergency funds (natural disasters)	100
26	ratio of insurance costs/total sales	100
27	existence of legislation for monitoring of environmental parameters	100
28	use of iso 14000 (or other certified system)	100
29	existence of producer's organizations or cooperatives for sales	100
30	supply and sales by contract or by market	100

DEc/ PRINCIPLE 3. Strengthen financial management of enterprises

N° DEc/	INDICATORS	Acceptability (%)
31	gross profit margin (gross profit/revenue x100)	85
32	rate of return on farm assets	70
33	feed cost/kg fish produced (and % of total cost/kg)	100
34	fry cost/kg (and % of total cost/kg)	100
35	labour cost/kg fish produced (and % of total cost/kg)	100
36	unit production cost (total variable and fixed costs/kg fish produced/operating costs)	100
37	energy cost/kg fish produced (and % of total cost/kg)	100
38	transportation cost/kg (and % of total cost/kg)	100
39	financial costs/kg fish produced (and % of total cost/kg)	100
40	current ratio (total current farm assets/total current farm liabilities)	70
41	debt/asset ratio (total farm liabilities/total farm assets)	85
42	debt/equity ratio (total farm liabilities/total farm equity)	85
43	environmental monitoring costs/kg fish produced (and as % of total cost/kg)	85
44	capital investments for environmental protection/kg (and as % of total cost/kg)	85
45	existence of incentives, direct or indirect, for environmental protection actions	100
46	existence of national mechanism supporting start-ups (tax-break, subsidies, financing)	100

DEc/ PRINCIPLE 4. Strengthen the role of professional organizations for the economic sustainability of aquaculture

N° DEc/	INDICATORS	Acceptability (%)
47	sector market studies	100
48	market data dissemination (annual seminars by federations or authorities)	100
49	% of annual national federations (producer's organizations) budget allocated to marketing and promotion	85
50	annual national budget allocated for marketing and promotion of the sector	100
51	existence of a permanent information/communication program at sector level	85
52	existence of training program for sector employees on financial aspects of activity	85
53	existence of training program for sector employees on environmental aspects of activity	85
54	existence of emergency fund	85
55	existence of crisis management manual (strategy)	85

Most of the indicators were regarded as acceptable (100 percent) by participants. Indicator DEc/14 "share of each customers in total sales" had the lowest rate of acceptability among 55 indicators. Indicators DEc/32 and DEc/40 had also low rate (70 percent) of acceptability.

The outcomes of Questionnaire 2 clearly indicate that "acceptability" as a single attribute for selection of indicators does not provide very meaningful results. The "acceptability" itself is a concept which needs to be associated with some attributes to be definable and judged. The outcomes of Questionnaire 1 regarding prioritization of attributes also support this assertion. Acceptability as an attribute for selection of indicators had one of the lowest score in terms of its significance for use in the indicator selection process.

Selection of indicators (Appraisal) based on prioritized attributes

Results of statistical assessments for selection of indicators using prioritized attributes (Questionnaire 3) are presented in Table 7. Questionnaire 3 was distributed in the sub-group on economic dimension and was filled by ten participants with different backgrounds ranging from fish farmers, public administrators, and farmer's organizations to suppliers of logistics and equipments.

Results indicate the weighed mean score for each indicator in terms of four attributes namely, understandability, relevance to criteria and principle, data availability and reliability.

Table 7. Results of selection of indicators using prioritized attributes for the economic dimension

DEc/ PRINCIPLE 1 . Strengthen consumer responsive and market oriented aquaculture

CODE	CRITERIA	N°	INDICATORS	WEIGHED MEAN SCORE
P1C1	use of branding or quality assurance schemes/labels	1	existence of own-label (y/n and %)	5.86
		2	existence of quality certification schemes (independent bodies) (y/n and %)	7.15
P1C2	traceable products	3	existence of a traceability system	6.30
P1C3	level of value enhancement	4	percentage of value-added products	5.55
		5	price differential with respect to quality (y/n)	4.57
P1C4	processing capacity	6	availability of processing capacity for the sector	5.39
P1C5	level of knowledge management	7	company customer surveys	4.80
		8	sector market studies	5.91
		9	existence of company marketing plan	5.16
P1C6	level of market promotion activities	10	marketing costs/total revenue	4.38

DEc/ PRINCIPLE 2: Strengthen risk assessment and crisis management capabilities

CODE	CRITERIA	N°	INDICATORS	WEIGHED MEAN SCORE
P2C1	level of diversification	11	number of products (i.e. species, size categories, value-added)	5.60
		12	integration of core business with complementary activities (eco-tourism, recreational fishing, restaurant)	5.16
		13	geographic market diversification (number and % share of each market of total sales)	4.81
		14	share of each customer in total sales	2.31
P2C2	level of input self-sufficiency	15	number of national feed suppliers (also % imported)	5.14
		16	number of national hatcheries (also % of fry imported)	5.98
P2C3	capability to monitor and challenge pathological hazards	17	existence of biosecurity system	4.62
		18	existence of legislation on biological waste disposal	4.55
		19	existence of farm health management system (including vaccination program)	6.60
P2C4	increased research & development capabilities and innovation	20	ratio of R&D expenditure/total sales	4.62
		21	ratio of national expenditure on R&D/GDP	4.04
P2C5	level of property rights over production sites	22	duration of lease of the site	5.82
		23	no. of site lease renewals per year	4.28
		24	existence of national legislation for zoning	5.37
P2C6	level of awareness of natural hazards	25	existence national emergency funds (natural disasters)	4.70
		26	ratio of insurance costs/total sales	4.62
		27	existence of legislation for monitoring of environmental parameters	5.24
		28	use of ISO 14000 (or other certified system)	4.27
P2C7	level of market maturity	29	existence of producer's organizations or cooperatives for sales	5.43
		30	supply and sales by contract or by market	6.70

DEc/ PRINCIPLE 3: Strengthen financial management of enterprises

CODE	CRITERIA	N°	INDICATORS	WEIGHED MEAN SCORE
P3C1	level of profitability	31	gross profit margin (gross profit/revenue x100)	5.94
		32	rate of return on farm assets	5.38
P3C2	level of input efficiency	33	feed cost/kg fish produced (and % of total cost/kg)	7.01
		34	fry cost/kg (and % of total cost/kg)	6.96
		35	labour cost/kg fish produced (and % of total cost/kg)	6.46
		36	unit production cost (total variable and fixed costs/kg fish produced/operating costs) (ex-cage)	5.95
		37	energy cost/kg fish produced (and % of total cost/kg)	6.11
		38	transportation cost/kg (and % of total cost/kg)	5.81
		39	financial costs/kg fish produced (and % of total cost/kg)	5.42
P3C3	level of financial strength	40	current ratio (total current farm assets/total current farm liabilities)	4.67
		41	debt/asset ratio (total farm liabilities/total farm assets)	4.82
		42	debt/equity ratio (total farm liabilities/total farm equity)	5.17
P3C4	level of environmental protection costs	43	environmental monitoring costs/kg fish produced (and as % of total cost/kg)	3.99
		44	capital investments for environmental protection/kg (and as % of total cost/kg)	2.81
		45	existence of incentives, direct or indirect, for environmental protection actions	3.69
P3C5	ease of entry into industry	46	existence of national mechanism supporting start-ups (tax-break, subsidies, financing)	4.81

DEc/ PRINCIPLE 4 : Strengthen the role of professional organizations for the economic sustainability of aquaculture

CODE	CRITERIA	N°	INDICATORS	WEIGHED MEAN SCORE
P4C1	level of knowledge management	47	sector market studies	5.70
		48	market data dissemination (annual seminars by federations or authorities)	5.80
P4C2	level of collective marketing and actions	49	% of annual national federations (producer's organizations) budget allocated to marketing and promotion	4.67
		50	annual national budget allocated for marketing and promotion of the sector	4.91
		51	existence of a permanent information/communication program at sector level	4.91
P4C3	promotion of training and awareness building	52	existence of training program for sector employees on financial aspects of activity	5.18
		53	existence of training program for sector employees on environmental aspects of activity	5.31
P4C4	increased capability for crisis management	54	existence of emergency fund	4.09
		55	existence of crisis management manual (strategy)	4.40

Ranking of indicators based on their weighed mean scores are presented in Table 8. Indicator DEc/2 "*existence of quality certification schemes*" was found to have the highest mean (7.15) in terms of four prioritized attributes and consequently the highest rank among 55 indicators for the economic dimension. Indicator DEc/14 "*share of each customer in total sales*" had the lowest mean score (2.31) and the lowest rank.

Table 8. Ranking of indicators based on their weighed average score in terms of prioritized attributes for the economic dimension

N° DEc/	INDICATORS	WEIGHED MEAN SCORE	RANK
2	existence of quality certification schemes (independent bodies) (y/n and %)	7.15	1
33	feed cost/kg fish produced (and % of total cost/kg)	7.01	2
34	fry cost/kg (and % of total cost/kg)	6.96	3
30	supply and sales by contract or by market	6.70	4
19	existence of farm health management system (including vaccination program)	6.60	5
35	labour cost/kg fish produced (and % of total cost/kg)	6.46	6
3	existence of a traceability system	6.30	7
37	energy cost/kg fish produced (and % of total cost/kg)	6.11	8
16	number of national hatcheries (also % of fry imported)	5.98	9
36	unit production cost (total variable and fixed costs/kg fish produced/operating costs) (ex-cage)	5.95	10
31	gross profit margin (gross profit/revenue x100)	5.94	11
8	sector market studies	5.91	12
1	existence of own-label (y/n and %)	5.86	13
22	duration of lease of the site	5.82	14
38	transportation cost/kg (and % of total cost/kg)	5.81	15
48	market data dissemination (annual seminars by federations or authorities)	5.80	16
47	sector market studies	5.70	17
11	number of products (i.e. species, size categories, value-added)	5.60	18
4	percentage of value-added products	5.55	19
29	existence of producer's organizations or cooperatives for sales	5.43	20
39	financial costs/kg fish produced (and % of total cost/kg)	5.42	21
6	availability of processing capacity for the sector	5.39	22
32	rate of return on farm assets	5.38	23
24	existence of national legislation for zoning	5.38	24
53	existence of training program for sector employees on environmental aspects of activity	5.31	25
27	existence of legislation for monitoring of environmental parameters	5.24	26
52	existence of training program for sector employees on financial aspects of activity	5.18	27
42	debt/equity ratio (total farm liabilities/total farm equity)	5.17	28
12	integration of core business with complementary activities (eco-tourism, recreational fishing, restaurant)	5.16	29
9	existence of company marketing plan	5.16	30
15	number of national feed suppliers (also % imported)	5.14	31
50	annual national budget allocated for marketing and promotion of the sector	4.91	32
51	existence of a permanent information/communication program at sector level	4.91	33
41	debt/asset ratio (total farm liabilities/total farm assets)	4.82	34
13	geographic market diversification (number and % share of each market of total sales)	4.81	35
46	existence of national mechanism supporting start-ups (tax-break, subsidies, financing)	4.81	36
7	company customer surveys	4.80	37

N° DEc/	INDICATORS	WEIGHED MEAN SCORE	RANK
25	existence national emergency funds (natural disasters)	4.70	38
40	current ratio (total current farm assets/total current farm liabilities)	4.67	39
49	% of annual national federations (producer's organizations) budget allocated to marketing and promotion	4.67	40
17	existence of biosecurity system	4.63	41
20	ratio of R&D expenditure/total sales	4.62	42
26	ratio of insurance costs/total sales	4.62	43
5	price differential with respect to quality (y/n)	4.57	44
18	existence of legislation on biological waste disposal	4.55	45
55	existence of crisis management manual (strategy)	4.40	46
10	marketing costs/total revenue	4.38	47
23	no. of site lease renewals per year	4.28	48
28	use of ISO14000 (or other certified system)	4.27	49
54	existence of emergency fund	4.09	50
21	ratio of national expenditure on R&D/GDP	4.04	51
43	environmental monitoring costs/kg fish produced (and as % of total cost/kg)	3.99	52
45	existence of incentives, direct or indirect, for environmental protection actions	3.69	53
44	capital investments for environmental protection/kg (and as % of total cost/kg)	2.81	54
14	share of each customer in total sales	2.31	55

With respect to scale (1 to 9) used for the evaluation of attributes of indicators and outcomes of Questionnaire 3, it can be concluded that 31 indicators with a mean score of 5 and above should be regarded as "acceptable" indicators from point of view of Turkish stakeholders during the technic meeting held a Mugla..

Outcome of discussions for the economic dimension

It was widely agreed that economic viability is an essential component of sustainable aquaculture. An environmentally sound aquaculture without economic viability would not generate the anticipated benefits with respect to income, employment and food security.

It was stressed that access of financial data at farm level remains to be a challenge for implementation of many indicators for the economic dimension. Even market data regarding sales and customers could be a constraint since many farms regard such data as confidential and would be willing to share.

The fact that the rapid development of Turkish aquaculture has been supply oriented and lacked the marketing side was widely acknowledged. It was further argued that even though aquaculture products enjoyed a positive image at local level among customers, the general perception towards farms was negative and needs to be improved. The close link between image of producer and consequent product image was underlined. Meaning that negative image towards farms would not yield a positive product image and that both need to be improved.

The role and functionality of producers organization at local level was also a topic of debate. The lack of interest in membership and constraints with regard to national legislation on PO's were also underlined.

The most urgent issue which threaten sustainability of Turkish mariculture were said to be feed costs, finance, and relocation of farms to off-shore sites and negative image of farms.

The following specific issues regarding indicators were considered::

- Indicators DEc/ 13 and 14: "data availability", "willingness to share the data" would be a constraint at local level.

- Indicators 1 DEc/ 5 and 16: "percentage of imported feed" and "percentage of imported juveniles" as mentioned in indicators should be regarded as separate indicators.
- Indicators DEc/ 43 and 44: were regarded as irrelative to principle 3.
- Indicator DEc/ 55: was found to be irrelative to principle 4.
- Indicator DEc/ 15: production of fish meal and oil should also be considered as indicators for sustainable aquaculture.
- Indicator DEc/ 30 and 36 need further clarification.

2.3.4 Social dimension - DSo

A rapid appraisal method for the selection of indicators

The results of rapid appraisal (Questionnaire 2) using "acceptability" as a single attribute for selection of indicators for each principle in the social dimension are given in Table 9.

The sub-group on social dimension is composed of seven participants with different background Results are presented as percentage of "yes" answers for each indicator, showing the percentage acceptability of the indicator by participants.

Table 9. DSo/ Results of rapid appraisal

DSo/ PRINCIPLE 1: Contribute to food security and healthy nutritional needs

N° DSo/	INDICATORS	Acceptability (%)
1	annual production	100
2	quantity of fish produced for domestic markets (self-consumption) and apparent consumption	100
3	fish price compared with the national minimum wage	30
4	percentage of innovative products proposed each year	30

DSo/ PRINCIPLE 2: Strengthen the role of the Producer Organizations and NGO's to improve image of aquaculture, social awareness and responsibilities

N° DSo/	INDICATORS	Acceptability (%)
5	minimum wage of employees compared to national minimum wage	40
6	percentage of fish-farmers with specialized aquaculture training and certificate	70
7	number of professional associations	85
8	existence of a professional status	85
9	existence of ecolabels and product specifications	85
10	effective participation to decision making process	85

DSo/ PRINCIPLE 3: Strengthen corporate social responsibility

N° DSo/	INDICATORS	Acceptability (%)
11	number of monthly hours currently worked by aquaculture workers	100
12	number of occupational accidents	85
13	percentage of trade union members among workers	85
14	percentage of women fish-farmers	85
15	existence and importance of inter-professional organizations	70
16	unmarketable fish ratio	85
17	number of declared pathologies	85
18	percentage of premium quality fish	55

Only few indicators (3) were accepted by 100 percent participants. Most indicators (19) were regarded as 85 percent acceptable by participants. Indicators DSo/3, 4, 5, 18 had the lowest rate of acceptability among 30-55 indicators. The outcomes of Questionnaire 2 expressly state that "acceptability" as a single attribute for selection of indicators does not satisfy very significant results. The "acceptability" itself is a concept which needs to be associated with some complementary attributes to be defined and dedicated.

Selection of indicators (Appraisal) based on prioritized attributes

Results of statistical assessments for selection of indicators using prioritized attributes (Questionnaire 3) are presented in Table 10. Questionnaire 3 was distributed in the sub-group on economic dimension and was filled up by ten participants

Results indicate the weighed mean score for each indicator in terms of four attributes, namely: understandability, relevance to criteria and principle, data availability and reliability.

Table 10. Results of selection of indicators using prioritized attributes for the social dimension

DSo/ PRINCIPLE 1: Contribute to food security and healthy nutritional needs

CODE	CRITERIA	N°	INDICATORS	WEIGHED MEAN SCORE
P1C1	Importance of fish availability	1	Annual production	7.23
P1C2	Accessibility for local consumers	2	Quantity of fish produced for domestic markets (self-consumption) and apparent consumption	6.67
		3	Fish price compared with the national minimum wage	3.16
P1C3	Commitment to and type of quality-based approach adopted by the farms.	4	Percentage of innovative products proposed each year	4.33

DSo/ PRINCIPLE 2: Strengthen the role of the Producer Organizations and NGO's to improve image of aquaculture, social awareness and responsibilities

CODE	CRITERIA	N°	INDICATORS	WEIGHED MEAN SCORE
P2C1	average salary levels	5	minimum wage of employees compared to national minimum wage	6.32
P2C2	level of qualification	6	percentage of fish-farmers with specialized aquaculture training and certificate	6.34
P2C3	importance of fish farmer organizations	7	number of professional associations	7.66
		8	existence of a professional status	4.65
P2C4	image of aquaculture	9	existence of ecolabels and product specifications	5.67
P2C5	capacity to take part in decision-making	10	effective participation to decision making process	4.67

DSo/ PRINCIPLE 3: Strengthen corporate social responsibility

CODE	CRITERIA	N°	INDICATORS	WEIGHED MEAN SCORE
P3C1	working conditions (hours and security)	11	number of monthly hours currently worked by aquaculture workers	6.34
		12	number of occupational accidents	6.33
P3C2	level of protection and participation to trade union.	13	percentage of trade union members among workers	6.35
P3C3	women's access to the industry, including salary level	14	percentage of women fish-farmers	6.33
P3C4	access to information	15	existence and importance of interprofessional organizations	6.38
P3C4	fish welfare	16	unmarketable fish ratio	5.17
		17	number of declared pathologies	4.67
		18	percentage of premium quality fish	3.67

Ranking of indicators based on their weighed mean scores are presented in Table 11. Indicator DSo/7 "number of professional associations" was found to have the highest mean (7.66) in terms of four prioritized attributes and consequently the highest rank among 18 indicators for social dimension. Indicator DSo/3 "fish price compared with the national minimum wage" had the lowest mean score (3.16) and the lowest rank.

Table 11. Ranking of indicators based on their weighed average score in terms of prioritized attributes for the social dimension

N° DSo/	INDICATORS	WEIGHED MEAN SCORE	RANK
7	number of professional associations	7.66	1
1	annual production	7.23	2
2	quantity of fish produced for domestic markets (self-consumption) and apparent consumption	6.67	3
15	existence and importance of interprofessional organizations	6.38	4
11	number of monthly hours currently worked by aquaculture workers	6.34	5
6	percentage of fish-farmers with specialized aquaculture training and certificate	6.34	6
13	percentage of trade union members among workers	6.35	7
12	number of occupational accidents	6.34	8
14	percentage of women fish-farmers	6.33	9
5	minimum wage of employees compared to national minimum wage	6.32	10
9	existence of ecolabels and product specifications	5.67	11
16	unmarketable fish ratio	5.17	12
10	effective participation to decision making process	4.67	13
17	number of declared pathologies	4.67	14
8	existence of a professional status	4.65	15
4	percentage of innovative products proposed each year	4.33	16
18	percentage of premium quality fish	3.67	17
3	fish price compared with the minimum wage	3.16	18

With respect to scale (1 to 9) used for evaluation of attributes of indicators and outcome of Questionnaire 3 it can be concluded that indicators with a mean score of 5 and above should be regarded as "acceptable" indicators.

Outcomes of discussions for the social dimension

- It was overemphasized that social acceptability is a key component of sustainable aquaculture. An environmentally and economic sound aquaculture without social agreement would not continue in the long time.
- It was highlighted that "continuous of production", "quantity of fish produced for domestic markets" and "apparent consumption" are the main indicators to contribute for food supply and food security.
- It was also stressed that the "number of workers in aquaculture" is essential to strengthen corporate social responsibility.
- Aquaculture has developed to such an extent that Turkey is currently the third largest finfish aquaculture producer in the world and the second largest producer of sea bass, sea bream and rainbow trout. On the other hand, there is a big conflict between marine aquaculture and other coasts related sectors such as tourism, urbanisation, recreation, protection, yachting, navigation etc. There are wrong understanding and competition among sectors. At present, the aquaculture sector and aquaculture products have bad image in the media. Some environmentalist and tourism lobbies are against aquaculture and some NGO's have waging smear campaign saying that aquaculture is polluting the environment and that aquaculture products are not quality and safety enough, without having any significant scientific data proving it.
- Aquaculture is an important economic activity in the coastal and rural areas in Turkey. It offers opportunities to create employment, helps community development, reduces overexploitation of natural aquatic resources, and contributes to enhance food security. It is estimated that the aquaculture sector in Turkey provides employment for around 25,000 people.
- In conclusion, social acceptability and responsibility are two key components for sustainable aquaculture in Turkey. Aquaculture sector should complain to opposite sectors and consensus should be provided among aquaculture and other coastal sectors for the future of aquaculture.

The following significant points regarding indicators were also accentuated:

- Indicator DSo/4 "percentage of innovative products proposed each year" was found irrelative 70% with criteria on commitment to and type of quality-based approach adopted by the farms. It should be redefined to be well connected with the criterion.
- Indicator DSo/5: minimum wage of employees compared to national minimum wage was found irrelative 60 % to the criterion on average salary levels.

2.3.5 Environmental dimension - DEn

In many ways the harmonization of mariculture with environment focuses on the selection and application of consensus indicators. The communication of basic, and sometimes complex, aquaculture notions to the general public and to stakeholders, as well as within the sector and its governance is vital. This would seem to be best facilitated by the further development of open, transparent, and clearly understood indicators. A number of projects have emerged from Pan-European cooperative structures related to sustainable aquaculture development in the environmental dimension. By the use of jointly negotiated indicators, we can encapsulate and better apply project findings.

The following is an outline of major European research events concerning the interaction in the environmental dimension in the Mediterranean between 2003 and 2009.

- A matrix for indicators of interaction between fisheries and fish farmers was identified by the FAO AdriaMed Project.
- ECASA evolved, with indicators, an ecosystem approach to aquaculture and a tool box to show links between environment and aquaculture together with an effective EIA. (www.ecasa.org.uk)

- SEACASE developed environmentally friendly protocols, quality markers and certification to enhance product value (www.seacase.org)

An environmentally based case study was undertaken in Mugla for the negotiation and development of a commonly agreed system of indicators. This is to be applied for guidance in the sustainable development of aquaculture in Turkey and in the Mediterranean in the framework of coastal zone management. Such case studies could also serve as a technical contribution to the establishment of a local reference system for the development of aquaculture sustainability and its integration into coastal zone management.

A rapid appraisal method for the selection of indicators

The results of having applied the rapid appraisal (Questionnaire 2) using "acceptability" as a single attribute for selection of indicators for each principle in the ecological dimension are given in Table 12. Questionnaire 2 was distributed in the sub-group on environmental dimensions and was filled in by ten participants with different backgrounds, ranging from fish farmers, public administrators, and members of farmer's organizations to suppliers of logistics and equipment. Results are presented as percentage of "yes" answers for each indicator, showing the percentage acceptability of indicator by participants.

Table 12. Results of rapid appraisal for the environmental dimension

DEn/ PRINCIPLE 1: Minimizing the global impact of aquaculture

N° DEn/	INDICATORS	Acceptability (%)
1	food conversion ratio (kg food/ kg fish)	100
2	demand of pelagic fish (tons years)	100
3	demand of vegetable products (tons/year)	80
4	footprint (Hc)	60
5	life-cycle assessment formula	80
6	tropic level of production (index)	80
7	number of introduced species (n)	100
8	capture versus quota (tons/year)	100

DEn/ PRINCIPLE 2: Respect the ecological service of ecosystem

N° DEn/	INDICATORS	Acceptability (%)
9	turbidity/transparency (Secchi disk cm)	100
10	microbiological indicators (total coliform)	100
11	algae bloom (n.cell/ml)	100
12	lost of nursery and spawning grounds (yes/no) recruitment index and spawning stock biomass)	80
13	capture modification of target species in the area (monitoring fisheries activities)	80
14	increase the fishing activities around the farm cages (landing and biomass index)	80
15	presence of hatchery with native brood stocks (yes/no)	80
16	monitoring the quality of fish larvae produced	80
17	carrying/holding capacity of the ecosystem	80
18	hydrodynamic (cm/sec)	100
19	depth (m)	100
20	interchange with open sea (offshore) (distance)	100
21	percentage of used space %	100
22	volume of water occupied per kg of product (kg/mc)	100
23	oxygen saturation (%)	100
24	relationship between exogenous and endogenous nutrient	90

DEn/ PRINCIPLE 3: Minimizing the local impact on environmental conditions and biodiversity

N° DEn/	INDICATORS	Acceptability (%)
25	faeces sedimentation (g/day)	80
26	lost food versus total (%)	80
27	nutrient balance (kg)	80
28	kg of antibiotics per tonne fish kg	100
29	antifouling use (y/n)	100
30	kg of anti-parasites per tonne fish (kg)	100
31	kg of disinfectant per tonne fish (kg)	100
32	use of food with chemical antioxidant (y/n)	100
33	use of organic certified fish food (y/n)	100
34	redox potential and pH	80
35	total P (kg)	100
36	sediment structure (%)	100
37	heavy metal accumulation (microgram)	100
38	benthic community structure modification (benthic index)	100
39	total organic carbon (TOC mg/m2)	100
40	level of degradation of sensitive habitats (monitoring)	100
41	turbidity (Secchi disk cm)	100
42	total particle organic matter (mg/m3)	100
43	total dissolved organic matter (mg/m3)	100
44	chlorophyll (mg/m3)	100
45	zooplankton biomass (mg/m3)	100
46	aggregation of pelagic fish (ind/m2)	100
47	escapees (ind)	100
48	use of indigenous species (y/n)	100
49	use of GMO species (y/n)	100
50	level of spawning	100
51	use of native broodstocks (y/n)	100
52	escapees /number	80
53	presence of pathogens from farm pathogens	100

Most indicators were regarded as 100 percent acceptable by participants. Indicator DEn/ 4 “foot print” had the lowest rate 60 percent of acceptability among 53 indicators, probably because the notion was not fully understood. Indicators DEn/3, 5, 6, 12, 13,14, 15, 16, 17, 25, 26, 27, 34 and 52 also had relatively low rates, 80 percent of acceptability. Indicator DEn/24 scored 90 percent. The outcomes of Questionnaire 2 clearly show that the use of term “acceptability” as a single attribute for the selection of indicators provides less than fully meaningful results. This is because “acceptability” in itself is a concept which needs to be associated with some attributes in order for them to be definable and judged. The outcome of Questionnaire 1 regarding prioritization of attributes also supports this assertion.

Selection of indicators (Appraisal) based on prioritized attributes

Results of statistical assessments for selection of indicators using the prioritized attributes, measured by Questionnaire 3, are presented in Table 13. Results show the weighed mean score for each indicator in terms of four attributes namely, “understandability”, “relevance to criteria and principle”, “data availability” and “reliability”.

Table 13. Results of selection of indicators using prioritized attributes for the environmental dimension

DEn/ PRINCIPLE 1: Minimizing the global impact of aquaculture

CODE	CRITERIA	N°	INDICATORS	WEIGHED MEAN SCORE
P1C1	needs of natural resource (pelagic fish and vegetables)	1	food conversion ratio (kg food/kg fish)	6.62
		2	demand of pelagic fish (t/year)	5.58
		3	demand of vegetable products (ton/year)	4.65
P1C2	consume of energy	4	footprint index (Hc)	3.85
		5	life-cycle assessment (formula)	4.40
		6	tropic level of production (index)	4.15
P1C3	alien species	7	number of introduced species (n)	5.10
P1C4	capture-based aquaculture	8	capture versus quota (t/year)	5.75

DEn/ PRINCIPLE 2: Respect the ecological service of ecosystem

CODE	CRITERIA	N°	INDICATORS	WEIGHED MEAN SCORE
P2C1	water quality	9	turbidity/transparency (Secchi disk)	6.38
		10	microbiological indicators (total coliform)	6.63
		11	algae bloom (n. cells / ml)	6.23
P2C2	fisheries and nursery areas	12	lost of nursery and spawning grounds (yes / no) recruitment index and spawning stock biomass)	5.65
		13	capture modification of target species in the area (monitoring fisheries activities)	4.60
		14	increase the fishing activities around the farm cages (landing and biomass index)	4.95
		15	presence of hatchery with native brood stocks (yes/no)	5.30
		16	monitoring the quality of the fish larvae produced	4.30
P2C3	carrying/holding capacity of the ecosystem	17	na	5.15
P2C4	oceanographic conditions	18	hydrodynamic (cm /s)	6.40
		19	depth (m)	6.70
		20	interchange with open sea (offshore) (distance in m)	6.40
		21	percentage of the used space (%)	6.45
P2C5	trophic conditions	22	volume of water occupied per kg of product (kg / m^3)	5.75
		23	oxygen saturation (%)	6.30
		24	relationship between exogenous and endogenous nutrients	5.83

DEn/ PRINCIPLE 3: Minimizing the local impact on environmental conditions and biodiversity

CODE	CRITERIA	N°	INDICATORS	WEIGHED MEAN SCORE
P3C1	input of organic and inorganic wastes	25	faeces sedimentation rates (g/day)	4.85
		26	lost food versus total (%)	5.13
		27	nutrient balance (kg)	4.43
P3C2	use of chemical products and drugs	28	kg of antibiotics per ton ne fish (kg)	5.98
		29	antifouling use (y /n)	5.83
		30	kg of anti-parasites per tonne fish (kg)	5.80
		31	kg of disinfectant per ton fish (kg)	5.75
		32	use of food with chemical antioxidants (y/n)	5.08
		33	use of organic certified fish food (y/n)	6.13
P3C3	impact on benthic habitat and communities	34	redox potential and pH (pH)	4.68
		35	total P (kg)	5.73
		36	sediment structure (%)	5.73
		37	heavy metal accumulation (micrograms)	5.70
		38	benthic community structure modification (benthic index)	5.30
		39	total organic carbon (TOC, mg/m^2)	5.43
		40	level of degradation of sensitive habitats (monitoring)	5.83
P3C4	impact on pelagic habitat and communities	41	turbidity (Secchi disk cm)	6.08
		42	total particulate organic matter (mg/m^3)	6.03
		43	total dissolved organic matter (mg/ m^3))	5.95
		44	chlorophyll (mg/m^3)	5.98
		45	zooplankton biomass (mg/m^3)	6.00
		46	aggregation of pelagic fish (ind/m^2)	4.98
		47	escapees (ind)	5.23
P3C5	genetic impact	48	use of non indigenous species (y/n)	5.68
		49	use of GMO species (y/n)	5.20
		50	level of spawning	5.15
		51	use of native broodstocks (y/n)	5.23
		52	escapees (numbers)	4.45
P3C6		53	presence of pathogens from farm pathogens (y/n)	5.08

A ranking of indicators based on their weighed mean scores are presented in Table 14. Indicators DEn/19, 1 and 10 (“depth”, “food conversion ratio”, “microbiological indicators”), were found to have the highest means (6.7-6.6), in terms of four prioritized attributes, and consequently the highest rank among the 53 indicators within the ecological dimension. Indicator DEn/16, 6, 4 [“monitoring the quality of the fish larvae produced”, ”trophic level of production (index)”,”footprint (Hc)”] had the lowest mean score.

Table 14. Ranking of indicators, based on their weighed average score in terms of prioritized attributes for the environmental dimension

N° DEn/	INDICATORS	WEIGHED MEAN SCORE	RANK
19	depth (m)	6.70	1
1	food conversion ratio (kg food/kg fish)	6.63	2
10	microbiological indicators (total)	6.63	3
21	percentage of the used space (%)	6.45	4
18	hydrodynamic (cm/s)	6.40	5
20	interchange with open sea (offshore) distance in m	6.40	6
9	turbidity/transparency (Secchi disk cm)	6.38	7
23	oxygen saturation (%)	6.30	8
11	turbidity/transparency (Secchi disk cm)	6.23	9
33	kg of antibiotics per tonne fish (kg)	6.13	10
41	turbidity (Secchi disk cm)	6.08	11
42	total particulate organic matter (mg/m^3)	6.03	12
45	zooplankton biomass (mg/m^3)	6.00	13
44	chlorophyll (mg/m^3)	5.97	14
28	kg of antibiotics per tonne fish (kg)	5.97	15
43	total dissolved organic matter (mg/m^3)	5.95	16
24	relationship between exogenous and endogenous	5.83	17
29	antifouling use (y /n)	5.83	18
40	level of degradation of sensitive habitats (monitoring)	5.83	19
30	kg of anti-parasites per tonne fish (kg)	5.80	20
31	kg of disinfectant per tonne fish (kg)	5.75	21
22	volume of water occupied per kg of product(kg/m^3)	5.75	22
8	capture versus quota (t/year)	5.75	23
35	total P (kg)	5.73	24
36	sediment structure (%)	5.73	25
37	heavy metal accumulation (micrograms)	5.70	26
48	use of non indigenous species (y/n)	5.68	27
12	lost of nursery and spawning grounds (yes/no) recruitment index and spawning stock biomass)	5.65	28
2	demand of pelagic fish (t/year)	5.58	29
39	total organic carbon (TOC mg/m^2)	5.43	30
15	presence of hatchery with native brood	5.30	31
38	benthic community structure modification (benthic index)	5.30	32
47	escapees (ind)	5.23	33
51	use of native broodstocks (y/n)	5.23	34
49	use of GMO species (y/n)	5.20	35
50	level of spawning	5.15	36
17	carrying/holding capacity of the ecosystem	5.15	37
26	lost food versus total (%)	5.13	38
7	number of introduced species (n)	5.10	39
32	use of food with chemical antioxidants (y/n)	5.08	40
53	presence of pathogens from farm pathogens (y/n)	5.08	41
46	aggregation of pelagic fish (ind/m^2)	4.98	42
14	increase the fishing activities around the farm cages (landing and biomass index)	4.95	43
25	faeces sedimentation rates (g/ day)	4.85	44
3	demand of vegetable. products (t/year)	4.65	45

N° DEn/	INDICATORS	WEIGHED MEAN SCORE	RANK
34	redox potential and pH (pH)	4.68	46
13	capture modification of target species in the area (monitoring fisheries activities)	4.60	47
52	escapees (numbers)	4.45	48
27	nutrient balance (kg)	4.43	49
5	life-cycle assessment (formula)	4.40	50
16	monitoring the quality of the fish larvae produced	4.04	51
6	tropic level of production (index)	4.15	52
4	footprint index (Hc)	3.85	53

With respect to the scale (1 to 9) used for an evaluation of the attributes of indicators and outcomes of Questionnaire 3, it can be concluded that indicators with a mean score of 5 and above should be regarded as generally "acceptable" indicators from the point of view of Turkish stakeholders.

In connection with DEn/Principle 2, "respect the ecological service of the ecosystem", the criterion DEn/C1 "water quality" and DEn/C4 "oceanographic conditions", were selected as the most valuable by the participants. Participants also found the indicator "food conversion ratio" of great value (6.7-6). This probably indicates a preoccupation for clean seas and awareness that uneaten fish feed is a major cause of pollution.

With DEn/P3C2, the participants were very interested in applying indicators to help minimize the effect on the local environment of the "use of chemical products and drugs" and they ranked it 5.9-5.5. Moreover, notions such as "footprint", "trophic level of production (index)", the "relationship between exogenous and endogenous nutrients" and "nutrient balance (kg)" were not immediately clear to everyone and, perhaps for this reason, were not given high scores.

Outcome of discussions for the environmental dimension

- In the course of the discussion on the selection of indicators, it became clear that many of those present had a real desire to learn much more about the scientific and technical concepts important to evaluating the interactions of aquaculture with the environment.
- It was clear that there is a need to develop a glossary at two levels about the indicators. The first should be very scientific and quantifiable. The second should be able to be understood by everybody. This will be facilitated by further development of open transparent and clearly understood indicators of the principles and criteria of aquaculture analysis under the headings governance, socio-economic matters and environmental notions.
- Participants were clearly most interested in water quality, oceanographic condition and protection from improper use of chemical products and drugs as criteria with attached indicators.
- Whilst everyone was interested in the criteria "carrying/holding capacity of the ecosystem", it was very clear that much work is still needed in developing suitable indicators for this.
- The use of "turbidity" and of "oxygen" occurs more than ones in the above analytical table of principles, criteria and indicators. This needs further investigation and clarification.
- There is currently a multi-level image problem for Turkish Marine Aquaculture as a whole, and especially with regard to environmental interaction and human health. It is possible that a close symbiosis of the aquaculture sector and ecological NGOs might be mutually beneficial. In this, environmental indicators, piloted at the InDAM Mugla Technical Meeting, suggest new developmental directions both for the image of aquaculture and for the protection and sustainability of the ecosystem. Great educative effort is needed to correct image problems and to positively market aquaculture in general, and specifically for individual brands. The role of

consumer associations and TV and other media in broadcasting features and documentaries is very necessary.

2.4 GENERAL CONCLUSIONS AND RECOMMENDATIONS

Constructive discussions on every aspect of the indicator selection process were made during the two day meeting. After wide ranging discussions on methodology it was agreed by all the stakeholders that the first step in the indicator selection process is to find a consensus on identification and prioritization of attributes. These will then be used in the selection of indicators. There are many commonly known attributes to be found in related literature on the selection of indicators. A common understanding and perception of these attributes, followed by the prioritization process with the contribution of local stakeholders and a consensus together is a necessity for the selection of indicators for sustainable development. This process should take into consideration local particularities and conditions. Different stakeholders can have different perceptions of attributes and priorities. For example some participants stressed that "Transparency" as an attribute should be a priority for selection of indicators for sustainable aquaculture, while others focused on "Reproducibility/verifiability" as the main attributes. It was widely accepted that a consensus on the prioritization of these attributes would be a must for developing a consensus on the selection of indicators.

It was also underlined that the process of identifying and prioritizing attributes for selection of indicators during the meeting created interaction between stakeholders. This contributed to building awareness on the concept of sustainable aquaculture. It was also recalled that the use of indicators should and could enhance the communication between farmers and society.

During the last session of the meeting several other issues were opened. These included the clarity of some of principles, criteria and indicators: the number of indicators for each dimension; the availability of reference points and the use of monitoring tools as in the "traffic light approach". Enhancement of institutional capabilities, the use of indicators as a tool for promoting the image of aquaculture and of aquaculture products, the use of indicators for evaluating sufficiency in terms of fish feed ingredients, within the concept of sustainable aquaculture were also discussed.

The main outcome of the pilot study technical meeting could be summarized as follows:

- Identification and prioritization of attributes of indicators is a crucial issue. It should be considered as the first logical and methodological step in the selection process of the indicators for the development of sustainable aquaculture in the Mediterranean.
- A consensus on identification and prioritization of attributes for selection of indicators by stakeholders at local level is crucial.
- A consensus on identification and prioritization of attributes firstly requires a common understanding and perception of attributes at local level. The preparation of a "Glossary on attributes for selection of indicators" would facilitate this process.
- Carrying capacity is a crucial issue within the sustainable aquaculture, but the complexity of the concept means that it is not easy to use it as a criteria.
- The number of indicators in each dimension is an issue which needs to be addressed as far as practicality and cost-effectiveness of PCI approach is concerned.
- Functionality and practicability of PCI approach within the concept of sustainable aquaculture will remain a challenge. that should be linked with reliable reference points at local level for monitoring purposes. However such reference points are not always readily and / or available
- The use of monitoring tools such as the "Traffic Light Approach" within the concept of sustainable aquaculture should also be addressed.
- At local level the emerging issues, which need to be addressed, are: siting and site allocation, environment, the image of aquaculture and of aquaculture products, marketing, transparency and the institutional capabilities of public organizations.

Recommendations included the follow-up actions:

- The process of indicator selection should be further supported and deepened with pilot studies at local level. A second technical meeting or a pilot case study at local level would be useful.
- A common understanding and perception regarding attributes of indicators is a crucial issue to be addressed. Preparation of a glossary on attributes of indicators is a fundamental target for the PCI approach and needs to be addressed within the activities of an InDAM project.
- A common quantitative methodology for selection of indicators by stakeholders needs to be addressed within the activities of the InDAM project.

APPENDIX 1
Questionnaire 1 - Indicator's attributes

Allocate 100 points to below mentioned attributes according to your preference for their use in indicator selection process.

Profession:

Field of expertise:

N°	*Attribute*	*Definition*	*Score*
1	relevance to criteria and principle	is relevant to goals of endorsed criteria and principle.	
2	understandability	is clear and perceived by all stakeholders in the same manner and is easily communicated.	
3	reliability	has a sound scientific base and methodology. with successful previous use.	
4	reproducibility/verifiability	is capable of being reproducible at different time and places with verifiable results.	
5	data availability	is estimated/produced using available information/data or can be estimated/produced with reasonable cost/effort.	
6	international compatibility	is compatible with other indicators developed by other countries, regions or bodies.	
7	transparency	is accessible by all stakeholders.	
8	availability of reference values	can be compared/monitored with some readily available reference points.	
9	acceptability	is endorsed by different stakeholders.	
10	robustness	is difficult to manipulate.	
		total	100

Note: New attributes can be proposed:

1:

APPENDIX 2
Part of Questionnaire 2 (Rapid Appraisal) for Social Dimension

(3 Principles, 13 Criteria and 18 Indicators)

Evaluate the indicators in terms of "Acceptability" as Yes/No

DSo/ PRINCIPLE 1: Contribute to food security and healthy nutritional needs

CODE	CRITERIA	N°	INDICATORS	Acceptability		
				Yes	No	If no, why?
P1C1	importance of fish availability	1	annual production			
P1C2	accessibility for local consumers	2	quantity of fish produced for domestic markets (self-consumption) and apparent consumption			
		3	fish price compared with the minimum wage			
P1C3	commitment to and type of quality-based approach adopted by the farms	4	percentage of innovative products proposed each year			

APPENDIX 3
Part of Questionnaire 3 (Indicator Appraisal)

The application of the selected attributes to the final selection of indicators - Social dimension, Principle 1

Evaluate/Score indicators in columns in terms of attributes from 1 to 9 as following:

1 (weak-insufficient), 3 (middle), 5 (good), 7 (very good) and 9 (perfect), 2,4, 6 and 8 (intermediate values)

DSo/ PRINCIPLE 1: Contribute to food security and healthy nutritional needs

CODE	Criteria	N°	Indicator	Attribute			
				Relevance	Data availability	Data reliability	Understandability
P1C1	importance of fish availability	1	annual production				
P1C2	accessibility for local consumers	2	quantity of fish produced for domestic markets (self-consumption) and apparent consumption				
		3	fish price compared with the minimum wage				
P1C3	commitment to and type of quality-based approach adopted by the farms.	4	percentage of innovative products proposed each year				

Allocate 100 points to below mentioned attributes according to your preference/ranking

relevance to criteria and principle	
understandability	
data availability	
reliability	
total	**100**

3. The pilot study in Tunisia[14]

3.1 INTRODUCTION

The Tunisian pilot study was carried out during 2009 and culminated in the technical meeting held in Monastir, Tunisia, from 13 to 14 October 2009. Thirty-nine aquaculture stakeholders (representatives of national and regional administration of fisheries and aquaculture of the Ministry for agriculture and marine resources, the Ministry of environment and sustainable development, interprofessional groups, scientists in aquaculture, university members, the World Wildlife Found-WWF) participated to the meeting.

The meeting was organised also on basis of results from the first InDAM technical meeting held at Mugla, Turkey in September, 2009.

3.2 METHODOLOGY APPLIED FOR THE SELECTION OF INDICATORS

The process for the selection of indicators was discussed during the technical meeting with the stakeholders with different background and expertise, following the methodology adopted in the Turkish pilot study (collective discussion and compilation of questionnaires).

As results, for the selection of indicators the following attributes were used by the stakeholders:

- data availability (the indicator can be compared/monitored with some readily available reference points); this indicators was considered the most determinant attribute for the selection of indicators in Tunisia.
- reliability (the indicator has a sound scientific base and methodology);
- relevance to criteria and principle (the indicator is relevant to goal of endorsed criteria and principles);
- understandability (the indicator is clear and perceived by all stakeholders in the same manner and easily communicated).

Based on the above attributes the indicators selected were prioritized for each one of the 4 dimensions (governance, economic, social and environmental) of sustainable aquaculture.

3.3 RESULTS OF THE QUESTIONNAIRES ON THE EVALUATION OF INDICATORS

3.3.1 Identification and prioritization of the attributes to be used in the selection of indicators

The high number of indicators could represent a constraint in their construction and application at local scale, hence the wish to reduce as far as possible the number of indicators. The absence of a glossary and/or directives for the comprehension of indicators and the algorithm necessary to estimate several of them was at the origin of long discussions. The sustainability of the aquaculture sector and the impact of all management measures taken by the administration could be perceived by the trend analysis of the selected indicators.

It is very important to define reliable reference points for each indicator. For most of the other indicators, the reference points have relative values (in relation to the mean, the median, etc..). In both cases debate should go on, as data are not always available at local level.

The results of the scores to attributes from the 18 participants who filled up the questionnaire show that data availability (36.9 percent) is the most determinant attribute for the selection of indicators in Tunisia. It is followed by reliability, relevance to criteria and principles, and understandability.

[14] Prepared by S.Ben Salem, A.Elouar, M.Hadjali Salem, M.Zouari

attribute	mean score (out of 100)
relevance to criteria and principles	19.2
understandability	18.6
reliability	25.3
data availability	36.9

3.3.2 Governance dimension – DGo

A rich debate took place among the different stakeholders, in particular fish farmers, representatives of the local regional and central administrations.

Indicators evaluation

The statistical analysis was carried out on the scores given to each attribute on the 17 questionnaires compiled, and the mean score is reported in the tables below.

Table 1. Results of selection of indicators using prioritized attributes for the governance dimension

DGo/PRINCIPLE 1: Strengthen integration of aquaculture in local development

CODE	CRITERIA	N°	INDICATORS	WEIGHED MEAN SCORE
P1C1	importance of development initiatives	1	number of area allocated for aquaculture	7.33
P1C2	integration of local culture and landscape	2	age and historical role of the activity and contribution to the traditional landscape of the area	5.91
P1C3	level of contribution to local employment and to poverty alleviation	3	number of workers (direct and indirect)	8.43
		4	percentage of permanent (and seasonal) full time equivalent workers	6.00
		5	percentage of seasonal workers in aquaculture compare to seasonal workers in tourism	5.45
P1C4	interactions with other sector at local level	6	conflicts and opportunities with other activities and uses	6.31
P1C5	contribution of the sector's to improve the environment.	7	recycling rate of by-product	4.53
P1C6	capacity of aquaculture to improve environmental monitoring capacity	8	existence of subsidies for aquaculture ecologic services	5.97
		9	number of reports on environmental crises in five years	7.49
P1C7	level of social recognition	10	participation rate to the socio-professional political organizations and in local assemblies	4.90

DGo/ PRINCIPLE 2: Promote participation in decision making process

CODE	CRITERIA	N°	INDICATORS	WEIGHED MEAN SCORE
P2C1	level of understanding in the industry	11	percentage of fish-farmers and technicians who know the regulations	6.20
P2C2	existence of control systems	12	number of control officers	5.89
		13	percentage of fish-farmers in breach of the law	4.75
P2C3	level of participation	14	number of participants at consultative meetings	5.52
		15	number of new measures co-construct	5.13
		16	number of fish-farmers taking part in consultative bodies	5.16
		17	number of conflicts solved at local level	4.16
P2C4	level of decentralization of decision-making	18	number of conflicts due to contradictions between traditional and constitutional legislation	3.00

		19	number of authorizations granted compared to the number of requests	5.29
P2C5	level of management and regional planning	20	number of new sites created	7.10
		21	existence of ICZM plan for coastal areas, including aquaculture under head state authority, taking account future evolution of industry.	6.10

DGo/ PRINCIPLE 3: Strengthen research, information systems and extension services

CODE	CRITERIA	N°	INDICATORS	WEIGHED MEAN SCORE
P3C1	importance of research and training in aquaculture	22	existence of research funds	8.39
		23	existence of bodies in support to aquaculture training	8.82
P3C2	level of interaction between research, industry and administration	24	number of partnership contracts	7.76
P3C3	access to aquaculture information systems	25	existence of an information system	7.65
P3C4	access to scientific, administrative and technique data	26	existence of extension and dissemination services	8.20

DGo/ PRINCIPLE 4: Strengthen institutional capacities in relation with sustainable development

CODE	CRITERIA	N°	INDICATORS	WEIGHED MEAN SCORE
P4C1	level of national recognition of sustainable development	27	existence of a national sustainable development strategy	9.23
		28	existence of rules and regulations in favour of sustainable development	8.61
P4C2	level of involvement of the state in the implementation of sustainable development	29	rate of state financial aid compared to other sectors	8.17
		30	existence of a public plan to support aquaculture development	8.54
		31	number of concessions and license for aquaculture	8.92
		32	existence of competent state services	8.37
P4C3	level of commitment of the state towards the industry	33	existence of funds allocated for training	7.76
		34	existence of legal recourses	7.27

The classification of the indicators for the governance dimension on their weighed mean scores is reported in Table 2.

It is important to report that for all four dimensions of sustainable aquaculture, the indicators were ranked in 3 groups, as follows:

- Group 1 (green): highly acceptable indicators, weighed mean score > 66th percentile
- Group 2 (yellow): acceptable indicators, 33rd percentile ≤ weighed mean score ≤ 66th percentile
- Group 3 (orange): weakly acceptable indicators, weighed mean score < 33rd percentile

Indicator DGo/27 "*existence of a national sustainable development strate*gy" was considered as the most important as it had the highest score (9.23). The indicator with the lowest score was DGo/ 18 "*number of conflicts due to contradictions between traditional and constitutional legislation* " with 3.

Among the 34 indicators of the governance dimension, 12 of them (DGo/27, 31, 23, 28, 30, 3, 22, 32, 26, 29, 24 et 33) could be qualified as highly acceptable.

Table 2. Ranking of indicators based on their weighed mean score in terms of prioritized attributes for the governance dimension

No	*INDICATORS*	*WEIGHED MEAN SCORE*	*RANK*
27	existence of a national sustainable development strategy	**9.23**	**1**
31	number of concessions and license for aquaculture	**8.92**	**2**
23	existence of bodies in support to aquaculture training	**8.82**	**3**
28	existence of rules and regulations in favour of sustainable development	**8.61**	**4**
30	existence of a public plan to support aquaculture development	**8.54**	**5**
3	number of workers (direct and indirect)	**8.43**	**6**
22	existence of research funds	**8.39**	**7**
32	existence of competent state services	**8.37**	**8**
26	existence of extension and dissemination services	**8.20**	**9**
29	rate of state financial aid compared to other sectors	**8.17**	**10**
33	existence of funds allocated for training	**7.76**	**12**
24	number of partnership contracts	**7.76**	**11**
25	existence of an information system	**7.65**	**13**
9	number of reports on environmental crises in five years	**7.49**	**14**
1	number of area allocated for aquaculture	**7.33**	**15**
34	existence of legal recourses	**7.27**	**16**
20	number of new sites created	**7.10**	**17**
6	conflicts and opportunities with other activities and uses	**6.31**	**18**
11	percentage of fish-farmers and technicians who know the regulations	**6.20**	**19**
21	existence of ICZM plan for coastal areas, including aquaculture under head state authority, taking account future evolution of industry.	**6.10**	**20**
4	percentage of permanent (and seasonal) full time equivalent workers	**6.00**	**21**
8	existence of subsidies for aquaculture ecologic services	**5.97**	**22**
2	age and historical role of the activity and contribution to the traditional landscape of the area	**5.91**	**23**
12	number of control officer	**5.89**	**24**
14	number of participants at consultative meetings	**5.52**	**25**
5	percentage of seasonal workers in aquaculture compare to seasonal workers in tourism	**5.45**	**26**
19	number of authorizations granted compared to the number of requests	**5.29**	**27**
16	number of fish-farmers taking part in consultative bodies	**5.16**	**28**
15	number of new measures co-construct	**5.13**	**29**
10	participation rate to the socio-professional political organizations and in local assemblies	**4.90**	**30**
13	percentage of fish-farmers in breach of the law	**4.75**	**31**
7	recycling rate of by-product	**4.53**	**32**
17	number of conflicts solved at local level	**4.16**	**33**
18	number of conflicts due to contradictions between traditional and constitutional legislation	**3.00**	**34**

33rd percentile = 5.91 & 66th percentile = 7.73

Discussion

The remarks which emerged from the debate were as follows:

- indicator DGo/7 "recycling rate of by-product" is not clear, more explanations are required as far as the relationship between the indicator and the corresponding criteria is concerned.
- indicator DGo/8 "existence of subsidies for aquaculture ecologic services": it should be specified that if it is ecological or organic aquaculture.
- there is no connection between indicator DGo/12 "number of control officers" and DGo/13 "percentage of fish-farmers in breach of the law" with the criterion DGo/P2C2 "existence of control systems" nor with the principle DGo/P2 "promote participation in decision making process".
- the two indicators DGo/14 "number of participants at consultative meetings" and DGo/16 "number of fish-farmers taking part in consultative bodies" could be merged in one single indicator "number of fish farmers in relation to the number of participants taking part in consultative organisms".

3.3.3 Economic dimension – DEc[15]

The recent settlement of several aquaculture farms in cages, the issue of the economic sustainability of these farms and their contribution in the environmental sustainability in sites where these farms are located, should be seriously be considered. Indeed, the experience of other Mediterranean systems shows that several environmental, social, economic, institutional and regulation constraints have seriously affected aquaculture farms and could threaten the sustainability of the Tunisian aquaculture sector.

Indicator evaluation

The statistical analysis was carried out on the scores given to each attribute on the 17 questionnaires compiled, and the mean score is reported in the tables below.

Table 3. Results of selection of indicators using prioritized attributes for the economic dimension

DEc/ PRINCIPLE 1 . Strengthen consumer responsive and market oriented aquaculture

CODE	CRITERIA	N°	INDICATORS	WEIGHED MEAN SCORE
P1C1	use of branding or quality assurance schemes/labels	1	existence of own-label (y/n and %)	n.a
		2	existence of quality certification schemes (independent bodies) (y/n and %)	6.91
P1C2	traceable products	3	existence of a traceability system	6.88
P1C3	level of value enhancement	4	percentage of value-added products	5.02
		5	price differential with respect to quality (y/n)	5.00
P1C4	processing capacity	6	availability of processing capacity for the sector	5.22
P1C5	level of knowledge management	7	company customer surveys	5.26
		8	sector market studies	5.14
		9	existence of company marketing plan	5.50
P1C6	level of market promotion activities	10	marketing costs/total revenue	5.33

DEc/ PRINCIPLE 2: Strengthen risk assessment and crisis management capabilities

CODE	CRITERIA	N°	INDICATORS	WEIGHED

[15] This section was chaired by M. Scander BEN SALEM, Institut National des Sciences et Techniques de la Mer.

				MEAN SCORE
P2C1	level of diversification	11	number of products (i.e. species, size categories, value-added)	n.a
		12	integration of core business with complementary activities (eco-tourism, recreational fishing, restaurant)	5.43
		13	geographic market diversification (number and % share of each market of total sales)	5.16
		14	share of each customer in total sales	5.11
P2C2	level of input self-sufficiency	15	number of national feed suppliers (also % imported)	8.12
		16	number of national hatcheries (also % of fry imported)	8.70
P2C3	capability to monitor and challenge pathological hazards	17	existence of biosecurity system	6.17
		18	existence of legislation on biological waste disposal	5.68
		19	existence of farm health management system (including vaccination program)	6.61
P2C4	increased research & development capabilities and innovation	20	ratio of R&D expenditure/total sales	6.02
		21	ratio of national expenditure on R&D/GDP	7.09
P2C5	level of property rights over production sites	22	duration of lease of the site	9.07
		23	no. of site lease renewals per year	8.38
		24	existence of national legislation for zoning	6.19
P2C6	level of awareness of natural hazards	25	existence national emergency funds (natural disasters)	6.38
		26	ratio of insurance costs/total sales	6.17
		27	existence of legislation for monitoring of environmental parameters	6.90
		28	use of ISO 14000 (or other certified system)	7.07
P2C7	level of market maturity	29	existence of producer's organizations or cooperatives for sales	6.68
		30	supply and sales by contract or by market	5.89

DEc/ PRINCIPLE 2: Strengthen risk assessment and crisis management capabilities

CODE	CRITERIA	N°	INDICATORS	WEIGHED MEAN SCORE
P3C1	level of profitability	31	gross profit margin (gross profit/revenue x100)	n.a
		32	rate of return on farm assets	5.85
P3C2	level of input efficiency	33	feed cost/kg fish produced (and % of total cost/kg)	6.58
		34	fry cost/kg (and % of total cost/kg)	6.38
		35	labour cost/kg fish produced (and % of total cost/kg)	6.04
		36	unit production cost (total variable and fixed costs/kg fish produced/operating costs) (ex-cage)	6.00
		37	energy cost/kg fish produced (and % of total cost/kg)	5.92
		38	transportation cost/kg (and % of total cost/kg)	6.02
		39	financial costs/kg fish produced (and % of total cost/kg)	5.78
P3C3	level of financial strength	40	current ratio (total current farm assets/total current farm liabilities)	5.85
		41	debt/asset ratio (total farm liabilities/total farm assets)	5.65
		42	debt/equity ratio (total farm liabilities/total farm equity)	5.53
P3C4	level of environmental protection costs	43	environmental monitoring costs/kg fish produced (and as % of total cost/kg)	5.12
		44	capital investments for environmental protection/kg (and as % of total cost/kg)	5.87
		45	existence of incentives, direct or indirect, for environmental protection actions	5.38
P3C5	ease of entry into industry	46	existence of national mechanism supporting start-ups (tax-break, subsidies, financing)	8.49

DEc/ PRINCIPLE 4 : Strengthen the role of professional organizations for the economic sustainability of aquaculture

CODE	*CRITERIA*	*N°*	*INDICATORS*	*WEIGHED MEAN SCORE*
P4C1	level of knowledge management	47	sector market studies	6.06
		48	market data dissemination (annual seminars by federations or authorities)	5.82
P4C2	level of collective marketing and actions	49	% of annual national federations (producer's organizations) budget allocated to marketing and promotion	5.54
		50	annual national budget allocated for marketing and promotion of the sector	6.40
		51	existence of a permanent information/communication program at sector level	6.05
P4C3	promotion of training and awareness building	52	existence of training program for sector employees on financial aspects of activity	5.02
		53	existence of training program for sector employees on environmental aspects of activity	5.72
P4C4	increased capability for crisis management	54	existence of emergency fund	5.87

The classification of the indicators for the economic dimension on their mean scores is reported in Table 4.

Indicator DEc/22 "duration of lease of the site" was considered as the most important for the economic dimension as it had the highest score (9.07).

The indicator with the lowest score is DEc/5 "price differential with respect to quality (y/n)" with a score of 5.

Among the 52 indicators for the economic dimension, 17 (DEc/22, 16, 46, 23, 15, 21, 28, 2, 27, 3, 29, 19, 33, 50, 25, 34 and 24, ordered by score priority) are among the highly acceptable ones.

Table 4. Ranking of indicators based on their weighed average score in terms of prioritized attributes for the economic dimension

N° DEc/	INDICATORS	WEIGHED MEAN SCORE	RANK
22	duration of lease of the site	9.07	1
16	number of national hatcheries (also % of fry imported)	8.70	2
46	existence of national mechanism supporting start-ups (tax-break, subsidies, financing)	8.49	3
23	no. of site lease renewals per year	8.38	4
15	number of national feed suppliers (also % imported)	8.12	5
21	ratio of national expenditure on R&D/GDP	7.09	6
28	use of ISO 14000 (or other certified system)	7.07	7
2	existence of quality certification schemes (independent bodies) (y/n and %)	6.91	8
27	existence of legislation for monitoring of environmental parameters	6.90	9
3	existence of a traceability system	6.88	10
29	existence of producer's organizations or cooperatives for sales	6.68	11
19	existence of farm health management system (including vaccination program)	6.61	12
33	feed cost/kg fish produced (and % of total cost/kg)	6.58	13
50	annual national budget allocated for marketing and promotion of the sector	6.40	14

N° DEc/	INDICATORS	WEIGHED MEAN SCORE	RANK
25	existence national emergency funds (natural disasters)	6.38	15
34	fry cost/kg (and % of total cost/kg)	6.38	16
24	existence of national legislation for zoning	6.19	17
17	existence of biosecurity system	6.17	18
26	ratio of insurance costs/total sales	6.17	19
47	sector market studies	6.06	20
51	existence of a permanent information/communication program at sector level	6.05	21
35	labour cost/kg fish produced (and % of total cost/kg)	6.04	22
20	ratio of R&D expenditure/total sales	6.02	23
38	transportation cost/kg (and % of total cost/kg)	6.02	24
36	unit production cost (total variable and fixed costs/kg fish produced/operating costs) (ex-cage)	6.00	25
37	energy cost/kg fish produced (and % of total cost/kg)	5.92	26
30	supply and sales by contract or by market	5.89	27
44	capital investments for environmental protection/kg (and as % of total cost/kg)	5.87	28
54	existence of emergency fund	5.87	29
32	rate of return on farm assets	5.85	30
40	current ratio (total current farm assets/total current farm liabilities)	5.85	31
55	existence of crisis management manual (strategy)	5.85	32
48	market data dissemination (annual seminars by federations or authorities)	5.82	33
39	financial costs/kg fish produced (and % of total cost/kg)	5.78	34
53	existence of training program for sector employees on environmental aspects of activity	5.72	34
18	existence of legislation on biological waste disposal	5.68	36
41	debt/asset ratio (total farm liabilities/total farm assets)	5.65	37
49	% of annual national federations (producer's organizations) budget allocated to marketing and promotion	5.54	38
42	debt/equity ratio (total farm liabilities/total farm equity)	5.53	39
9	existence of company marketing plan	5.50	40
12	integration of core business with complementary activities (eco-tourism, recreational fishing, restaurant)	5.43	41
45	existence of incentives, direct or indirect, for environmental protection actions	5.38	42
10	marketing costs/total revenue	5.33	43
7	company customer surveys	5.26	44
6	availability of processing capacity for the sector	5.22	45
13	geographic market diversification (number and % share of each market of total sales)	5.16	46
8	sector market studies	5.14	47
43	environmental monitoring costs/kg fish produced (and as % of total cost/kg)	5.12	48
14	share of each customer in total sales	5.11	49
4	percentage of value-added products	5.02	50
52	existence of training program for sector employees on financial aspects of activity	5.02	51
5	price differential with respect to quality (y/n)	5.00	52
1	existence of own-label (y/n and %)	na	na
11	number of products (i.e. species, size categories, value-added)	na	na
31	gross profit margin (gross profit/revenue x100)	na	na

Discussion

The remarks which emerged from the debate were as follows:

- indicators DEc/10,11,12: it was suggested to include another indicator relative to the number of species with a closed life cycle in captivity, according to criterion DEc/P2C1 "level of diversification",
- indicator DEc/38 "transportation cost/kg (and % of total cost/kg)": the participants, especially representatives of fish farms, said that transport costs are often included in fry or food costs. They wished to clarify the advantage of these costs.
- it is important to signal two repetitions of indicators:
  - indicators DEc/7 and DEc/44 both concern the realisation of sector based market studies,
  - indicators DEc/23 and DEc/51 both concern the existence of emergency funds for crisis management,
- the participants suggested to eliminate indicator DEc/48 "market data dissemination (annual seminars by federations or authorities)" as another indicator (DEc/51 "existence of a permanent information/communication program at sector level" has the same meaning.

3.3.4 Social dimension - DSo

The participants indicated that the most important principle is contribution of aquaculture to food security and safety.

Indicator evaluation

The statistical analysis was carried out on the scores given to each attribute on the 18 questionnaires compiled, and the weighed mean score is reported in the tables below.

Table 5. Results of selection of indicators using prioritized attributes for the social dimension

DSo/ PRINCIPE 1 : Contribute to food security and healthy nutritional needs

CODE	CRITERIA	N°	INDICATORS	WEIGHED MEAN SCORE
P1C1	importance of fish availability	1	annual production	7.54
P1C2	accessibility for local consumers	2	quantity of fish produced for domestic markets (self-consumption) and apparent consumption	6.47
		3	fish price compared with the national minimum wage	6.89
P1C3	commitment to and type of quality-based approach adopted by the farms.	4	percentage of innovative products proposed each year	4.88

DSo/ PRINCIPLE 2: Strengthen the role of the Producer Organizations and NGO's to improve image of aquaculture, social awareness and responsibilities

CODE	CRITERIA	N°	INDICATORS	WEIGHED MEAN SCORE
P2C1	average salary levels	5	minimum wage of employees compared to national minimum wage	4.82
P2C2	level of qualification	6	percentage of fish-farmers with specialized aquaculture training and certificate	6.63
P2C3	importance of fish farmer organizations	7	number of professional associations	6.09
		8	existence of a professional status	5.45
P2C4	image of aquaculture	9	existence of ecolabels and product specifications	5.71
P2C5	capacity to take part in decision-making	10	effective participation to decision making process	5.40

DSo/ PRINCIPLE 3: Strengthen corporate social responsibility

CODE	CRITERIA	N°	INDICATORS	WEIGHED MEAN SCORE
P3C1	working conditions (hours and security)	11	number of monthly hours currently worked by aquaculture workers	6.52
		12	number of occupational accidents	6.32
P3C2	level of protection and participation to trade union.	13	percentage of trade union members among workers	5.06
P3C3	women's access to the industry, including salary level	14	percentage of women fish-farmers	5.91
P3C4	access to information	15	existence and importance of interprofessional organizations	5.14
P3C5	fish welfare	16	unmarketable fish ratio	4.33
		17	number of declared pathologies	4.64
		18	percentage of premium quality fish	5.28

The classification of the indicators for the social dimension on their weighed mean scores is reported in Table 6.

Through the local perception of the indicators for the social dimension, indicator GSo/1 "annual production " has the highest score (7.54) and it is therefore the most important among the 18 indicators in this dimension. The indicator GSo/16 "unmarketable fish ratio " has the lowest score 4.33.

The indicators considered highly acceptable are 6: GSo/1, 2, 3, 6, 11, and 12.

Table 6. Ranking of indicators based on their weighed average score in terms of prioritized attributes for the social dimension

N° DSo/	INDICATORS	WEIGHED MEAN SCORE	RANK
1	annual production	7.54	1
3	fish price compared with the minimum wage	6.89	2
6	percentage of fish-farmers with specialized aquaculture training and certificate	6.63	3
11	number of monthly hours currently worked by aquaculture workers	6.52	4
2	quantity of fish produced for domestic markets (self-consumption) and apparent consumption	6.47	5

N° DSo/	INDICATORS	WEIGHED MEAN SCORE	RANK
12	number of occupational accidents	6.32	6
7	number of professional associations	6.09	7
14	percentage of women fish-farmers	5.91	8
9	existence of ecolabels and product specifications	5.71	9
8	existence of a professional status	5.45	10
10	effective participation to decision making process	5.40	11
18	percentage of premium quality fish	5.28	12
15	existence and importance of interprofessional organizations	5.14	13
13	percentage of trade union members among workers	5.06	14
4	percentage of innovative products proposed each year	4.88	15
5	minimum wage of employees compared to national minimum wage	4.82	16
17	number of declared pathologies	4.64	17
16	unmarketable fish ratio	4.33	18

33rd percentile = 5.22 and 66th percentile = 6.14

Discussion

The remarks which emerged from the debate were as follows:

- indicator DSo/2 "*quantity of fish produced for domestic markets (self-consumption) and apparent consumption*"**:** it is necessary to clarify the formula for the apparent consumption and the data required for its calculation.
- indicator DSo/5 "*minimum wage of employees compared to national minimum wage***"**: this indicator should be replaced by **"***minimum wage of employees to be compared to national minimum wage"*
- indicator DSo/9 *"existence of ecolabels and product specifications*" : it is recommended to split this indicator in two, one relative to the existence of ecolabels, the other to the existence of product specifications.
- indicator DSo/14 "*percentage of women fish-farmers***"** : women in aquaculture should include managers, technicians and clerks, workers.
- indicators DSo/16,17,18 : there is no agreement between criterion DSo/P3C5 "*fish welfare*" [and the indicators associated to it (DSo/16,17,18)] and the principle DSo/P3 "*strengthen corporate social responsibility*".

3.3.5 Environmental dimension - DEn [16]

The participants showed a great interest for this subject. They stressed the importance of the interactions between aquaculture activities and the ecosystem components (biotopes, biological diversity, anthropic activities) in which they are located.

Indicator evaluation

The statistical analysis was carried out on the scores given to each attribute on the 18 questionnaires compiled, and the mean score is reported in the tables below.

[16] This section was chaired by M. Ali EL OUAER, research scientist in aquaculture

Table 7. Results of selection of indicators using prioritized attributes for the environmental dimension

DEn/ PRINCIPLE 1: Minimizing the global impact of aquaculture

CODE	*CRITERIA*	*N°*	*INDICATORS*	*WEIGHED MEAN SCORE*
P1C1	needs of natural resource (pelagic fish and vegetables)	1	food conversion ratio (kg food/kg fish)	8.30
		2	demand of pelagic fish (t/year)	7.24
		3	demand of vegetable products (t/year)	6.37
P1C2	consume of energy	4	footprint index (Hc)	5.11
		5	life-cycle assessment (formula)	3.84
		6	tropic level of production (index)	3.86
P1C3	alien species	7	number of introduced species (n)	6.43
P1C4	capture-based aquaculture	8	capture versus quota (t/year)	6.03

DEn/ PRINCIPLE 2: Respect the ecological service of ecosystem

CODE	*CRITERIA*	*N°*	*INDICATORS*	*WEIGHED MEAN SCORE*
P2C1	water quality	9	turbidity/transparency (Secchi disk)	6.56
		10	microbiological indicators (total coliform)	6.75
		11	algae bloom (n. cells / ml)	4.69
P2C2	fisheries and nursery areas	12	lost of nursery and spawning grounds (yes / no) recruitment index and spawning stock biomass)	4.12
		13	capture modification of target species in the area (monitoring fisheries activities)	5.05
		14	increase the fishing activities around the farm cages (landing and biomass index)	5.08
		15	presence of hatchery with native brood stocks (yes/no)	7.45
		16	monitoring the quality of the fish larvae produced	6.11
P2C3	carrying/holding capacity of the ecosystem	17	na	na
P2C4	oceanographic conditions	18	hydrodynamic (cm /s)	7.48
		19	depth (m)	8.65
		20	interchange with open sea (offshore) (distance in m)	6.21
		21	percentage of the used space (%)	3.85
P2C5	trophic conditions	22	volume of water occupied per kg of product (kg / m^3)	8.21
		23	oxygen saturation (%)	8.65
		24	relationship between exogenous and endogenous nutrients	5.09

DEn/ PRINCIPLE 3: Minimizing the local impact on environmental conditions and biodiversity

CODE	*CRITERIA*	*N°*	*INDICATORS*	*WEIGHED MEAN SCORE*
P3C1	input of organic and inorganic wastes	25	faeces sedimentation rates (g/day)	4.74
		26	lost food versus total (%)	6.06
		27	nutrient balance (kg)	4.33
P3C2	use of chemical products and drugs	28	kg of antibiotics per tonne fish (kg)	6.60
		29	antifouling use (y /n)	6.22
		30	kg of anti-parasites per tonne fish (kg)	6.39
		31	kg of disinfectant per ton fish (kg)	6.65
		32	use of food with chemical antioxidants (y/n)	6.99
		33	use of organic certified fish food (y/n)	6.25
P3C3	impact on benthic habitat and communities	34	redox potential and pH (pH)	7.60
		35	total P (kg)	7.33
		36	sediment structure (%)	6.81
		37	heavy metal accumulation (micrograms)	5.99
		38	benthic community structure modification (benthic index)	4.09
		39	total organic carbon (TOC mg/m^2)	4.47
		40	level of degradation of sensitive habitats (monitoring)	3.19
P3C4	impact on pelagic habitat and communities	41	turbidity (Secchi disk cm)	6.21
		42	total particulate organic matter (mg/m^3)	6.38
		43	total dissolved organic matter (mg/mc)	6.03
		44	chlorophyll (mg/m^3)	7.08
		45	zooplankton biomass (mg/m^3)	6.20
		46	aggregation of pelagic fish (ind/m^2)	3.96
		47	escapees (ind)	3.93
P3C5	genetic impact	48	use of non indigenous species (y/n)	7.18
		49	use of GMO species (y/n)	6.87
		50	level of spawning	3.76
		51	use of native broodstocks (y/n)	6.70
		52	escapees (numbers)	3.76
P3C6	disease spread from farms	53	presence of pathogens from farm pathogens (y/n)	6.08

The classification of the indicators for the environmental dimension on their weighed mean scores is reported in Table 8.

Indicator DEn/19 “depth (m)” » is considered as the most important with a score of 8.65. The indicator with the lowest score is DEn/40 “level of degradation of sensitive habitats (monitoring)” with a score of 3.19.

Indicator DEn/17 relative to the criterion DEn/P2C3 “carrying/holding capacity of the ecosystem”, a very important factor for aquaculture sustainability, was not defined, and participants did not score this indicator. It is a priority to define coherent indicators linked to this criterion.

Among the 53 indicators of the environmental dimension, 18 (DEn/19, 23, 1, 22, 34, 18, 15, 35, 2, 48, 44, 32, 49, 36, 10, 51, 31 et 28) could be qualified as highly acceptable.

Table 8. Ranking of indicators, based on their weighed average score in terms of prioritized attributes for the environmental dimension

No DSo/	*INDICATORS*	*WEIGHED MEAN SCORE*	*RANK*
19	depth (m)	8.65	1
23	oxygen saturation (%)	8.65	2
1	food conversion ratio (kg food/kg fish)	8.3	3
22	volume of water occupied per kg of product(kg/m^3)	8.21	4
18	hydrodynamic (cm/s)	7.48	5
34	redox potential and pH (pH)	7.60	5
15	presence of hatchery with native brood	7.45	7
35	kg of anti-parasites per tonne fish (kg)	7.33	8
2	demand of pelagic fish (t/year)	7.24	9
48	use of non indigenous species (y/n)	7.18	10
44	chlorophyll (mg/m^3)	7.08	11
32	use of food with chemical antioxidants (y/n)	6.99	12
49	use of gmo species (y/n)	6.87	13
36	sediment structure (%)	6.81	14
10	microbiological indicators (total)	6.75	15
51	use of native broodstocks (y/n)	6.7	16
31	kg of disinfectant per ton fish (kg)	6.65	17
28	kg of antibiotics per ton fish (kg)	6.6	18
9	turbidity/transparency (Secchi disk cm)	6.56	19
7	number of introduced species (n)	6.43	20
30	kg of anti-parasites per ton fish (kg)	6.39	21
42	total particulate organic matter (mg/m^3)	6.38	22
3	demand of vegetable products (t/year)	6.37	23
33	use of organic certified fish food (y/n)	6.25	24
29	antifouling use (y /n)	6.22	25
20	interchange with open sea (offshore) distance in m	6.21	26
9	turbidity/transparency (Secchi disk cm)	6.21	27
41	turbidity (Secchi disk cm)	6.21	27
45	zooplankton biomass (mg/m^3)	6.2	28
16	monitoring the quality of the fish larvae produced	6.11	29
53	presence of pathogens from farm pathogens (y/n)	6.08	30
26	lost food versus total (%)	6.06	31
8	capture versus quota (t/year)	6.03	32
43	total dissolved organic matter (mg/m^3)	6.03	33
4	footprint index (Hc)	5.11	35
24	relationship between exogenous and endogenous	5.09	36
14	increase the fishing activities around the farm cages (landing and biomass index)	5.08	37

No DSo/	INDICATORS	WEIGHED MEAN SCORE	RANK
13	capture modification of target species in the area (monitoring fisheries activities)	5.05	38
25	faeces sedimentation rates (g/ day)	4.74	39
39	total organic carbon (TOC mg/m^2)	4.47	41
27	nutrient balance (kg)	4.33	42
12	lost of nursery and spawning grounds (yes/no) recruitment index and spawning stock biomass)	4.12	43
38	benthic community structure modification (benthic index)	4.09	44
46	aggregation of pelagic fish (ind/m^2)	3.96	45
47	escapees (ind)	3.93	46
6	tropic level of production (index)	3.86	47
21	percentage of the used space (%)	3.85	48
50	level of spawning	3.84	49
5	life-cycle assessment (formula)	3.84	49
52	escapees (numbers)	3.76	51
40	level of degradation of sensitive habitats (monitoring)	3.19	52
17		na	na

33rd percentile = 5.10 & 66th percentile = 6.58

Discussion

The remarks which emerged from the debate were as follows:

- oxygen % saturation should be added as indicator for criterion DEn/P2C1 "water quality",
- indicator DEn/18 should be called "current" instead of "hydrodynamic (cm /s)"
- indicator DEn/22 should be called "rearing density" instead of "volume of water occupied per kg of product (kg/m3)"
- the unit in indicator DEn/46 "aggregation of pelagic fish (ind/m2)" should be replaced by "individuals/m2",
- indicator DEn/52 "escapees (number) " repeats indicator DEn/47 "escapees(ind.)",
- indicator DEn/17 "carrying/holding capacity of the ecosystem" of the criterion DEn/P2C2 called "carrying/holding capacity of the ecosystem" should be described in more details.

3.4 GENERAL CONCLUSIONS

Constructive discussions on every aspect of the indicators selection process were made during the two days meeting. The process of identifying and prioritizing attributes for the selection of indicators during the meeting and discussion on the priorities of the indicators, as in the case of Mugla (Turkey), represented an important moment of debate and of interaction among stakeholders (from farms, administration, research institutions, NGOs). This assumes a great relevance in Tunisian areas such as Monastir where aquaculture has been recently (and will be further) developed.

In particular the following considerations and conclusions were made by the participants:

- For having a consensus and a common perception on sustainable aquaculture among the different stakeholders, indicators should be understandable. The lack of a glossary and/or directives for the comprehension of indicators and the algorithm necessary to estimate several of them was at the origin of long discussions and represent a limiting factor during the discussion.

- The sustainability of the aquaculture sector and the impact of all management measures taken by the administration and other stakeholders could be also perceived by the analysis of the trends of the selected indicators. It should therefore be necessary for many indicators to have a data series to make any comparison and determinate reference points.
- For some indicators data are not always available or are not available at local level. However the high number of indicators could represent a constraint in the application at local scale in terms of data availability, time consuming and cost effectiveness. The number of indicators should be reduced and analysis should be made to evaluate any redundancy.
- The participants suggested the preparation of a glossary and/or directives for the explanation of indicators with a protocol of their measurement including the references values.
- For each indicator, reference point indication should be given on the identification of reference points for quantitative indicators and of a methodology for the use of indicators in the process of sustainable development, such as trend analysis, traffic light methods, etc...
- Participants stressed that discussion on indicators for sustainable aquaculture should continue also to strengthen the cooperation among the different stakeholders created during the Monastir technical meeting, and suggested to organise other technical meetings in Tunisia and in other Mediterranean countries to refine the process of selection and evaluation of indicators for sustainable aquaculture at local scale.

The results of the Turkish and Tunisian pilot projects were presented and discussed at the final meeting of the InDAM project first-year of activities (19-20 November 2009, Salammbo', Tunis, Tunisia).

4. Indicators for aquaculture sustainability for the Mediterranean

(as identified in the Montpellier II meeting and the InDAM pilot projects)

4.1 GOVERNANCE DIMENSION

(4 principles, 19 criteria, 34 indicators)

DGo/ PRINCIPLE 1: Strengthen integration of aquaculture in local development

CODE	CRITERIA	N°	INDICATORS	farm/sector level	local level	national level
P1C1	importance of development initiatives	1	number of area allocated for aquaculture		x	x
P1C2	integration of local culture and landscape	2	age and historical role of the activity and contribution to the traditional landscape of the area		x	x
P1C3	level of contribution to local employment and to poverty alleviation	3	number of workers (direct and indirect)	x	x	x
		4	percentage of permanent (and seasonal) full time equivalent workers	x	x	x
		5	percentage of seasonal workers in aquaculture compare to seasonal workers in tourism	x	x	x
P1C4	interactions with other sector at local level	6	conflicts and opportunities with other activities and uses	x	x	x
P1C5	contribution of the sector's to improve the environment	7	recycling rate of by-product	x	x	x
P1C6	capacity of aquaculture to improve environmental monitoring capacity	8	existence of subsidies for aquaculture ecologic services	x	x	x
		9	number of reports on environmental crises in five years	x	x	x
P1C7	level of social recognition	10	participation rate to the socio-professional political organizations and in local assemblies	x	x	x

DGo/ PRINCIPLE 2: Promote participation in decision making process

CODE	CRITERIA	N°	INDICATORS	farm/sector level	local level	national level
P2C1	level of understanding in the industry	11	percentage of fish-farmers and technicians who know the regulations		x	x
P2C2	existence of control systems	12	number of control officers		x	x
		13	percentage of fish-farmers in breach of the law		x	x
P2C3	level of participation	14	number of participants at consultative meetings		x	x
		15	number of new measures co-construct		x	x
		16	number of fish-farmers taking part in consultative bodies		x	x
		17	number of conflicts solved at local level		x	x
P2C4	level of decentralization of decision-making	18	number of conflicts due to contradictions between traditional and constitutional legislation		x	x
		19	number of authorizations granted compared to the number of requests		x	x
P2C5	level of management and regional planning	20	number of new sites created		x	x
		21	existence of ICZM plan for coastal areas, including aquaculture under head state authority, taking account future evolution of industry.		x	x

DGo/ PRINCIPLE 3: Strengthen research, information systems and extension services

CODE	CRITERIA	N°	INDICATORS	farm/sector level	local level	national level
P3C1	importance of research and training in aquaculture	22	existence of research funds			x
		23	existence of bodies in support to aquaculture training		x	x
P3C2	level of interaction between research, industry and administration	24	number of partnership contracts		x	x
P3C3	access to aquaculture information systems	25	existence of an information system	x	x	x
P3C4	access to scientific, administrative and technique data	26	existence of extension and dissemination services		x	x

DGo/ PRINCIPLE 4: Strengthen institutional capacities in relation with sustainable development

CODE	CRITERIA	Nº	INDICATORS	farm/sector level	local level	national level
P4C1	level of national recognition of sustainable development	27	existence of a national sustainable development strategy			x
		28	existence of rules and regulations in favour of sustainable development			x
P4C2	level of involvement of the state in the implementation of sustainable development	29	rate of state financial aid compared to other sectors			x
		30	existence of a public plan to support aquaculture development		x	x
		31	number of concessions and license for aquaculture		x	x
		32	existence of competent state services		x	x
P4C3	level of commitment of the state towards the industry	33	existence of funds allocated for training		x	x
		34	existence of legal recourses		x	x

4.2 ECONOMIC DIMENSION

(4 principles, 23 criteria*, 55 indicators*[17])

DEc/ PRINCIPLE 1: Strengthen consumer responsive and market oriented aquaculture

CODE	CRITERIA	Nº	INDICATORS	farm level	sector level	national level
P1C1*	use of branding or quality assurance schemes/labels	1*	existence of own-label (y/n and %)*	x		
		2	existence of quality certification schemes (independent bodies) (y/n and %)	x		
P1C2	traceable products	3	existence of a traceability system	x		
P1C3	level of value enhancement	4	percentage of value-added products	x		
		5	price differential with respect to quality (y/n)	x		
P1C4	processing capacity	6	availability of processing capacity for the sector			x
P1C5	level of knowledge management	7	company customer surveys	x		
		8	sector market studies	x	x	
		9	existence of company marketing plan	x		
P1C6	level of market promotion activities	10	marketing costs/total revenue	x		

[17] * 1 criteria and 3 indicators were added in the Turkish pilot study

DEc/ PRINCIPLE 2: Strengthen risk assessment and crisis management capabilities

CODE	CRITERIA	N°	INDICATORS	farm level	sector level	national level
P2C1	level of diversification	11	number of products (i.e. species, size categories, value-added)*	x		
		12	integration of core business with complementary activities (eco-tourism, recreational fishing, restaurant)	x		
		13	geographic market diversification (number and % share of each market of total sales)	x		
		14	share of each customer in total sales	x		
P2C2	level of input self-sufficiency	15	number of national feed suppliers (also % imported)			x
		16	number of national hatcheries (also % of fry imported)			x
P2C3	capability to monitor and challenge pathological hazards	17	existence of biosecurity system	x		x
		18	existence of legislation on biological waste disposal			x
		19	existence of farm health management system (including vaccination program)	x		
P2C4	increased research & development capabilities and innovation	20	ratio of R&D expenditure/total sales	x		
		21	ratio of national expenditure on R&D/GDP			x
P2C5	level of property rights over production sites	22	duration of lease of the site			x
		23	no. of site lease renewals per year			x
		24	existence of national legislation for zoning			x
P2C6	level of awareness of natural hazards	25	existence national emergency funds (natural disasters)			x
		26	ratio of insurance costs/total sales	x		
		27	existence of legislation for monitoring of environmental parameters			x
		28	use of ISO 14000 (or other certified system)	x		
P2C7	level of market maturity	29	existence of producer's organizations or cooperatives for sales		x	
		30	supply and sales by contract or by market	x		

DEc/ PRINCIPLE 3: Strengthen financial management of enterprises

CODE	CRITERIA	N°	INDICATORS	farm level	sector level	national level
P3C1	level of profitability	31	gross profit margin (gross profit/revenue x100)*	x		
		32	rate of return on farm assets	x		
P3C2	level of input efficiency	33	feed cost/kg fish produced (and % of total cost/kg)	x		
		34	fry cost/kg (and % of total cost/kg)	x		
		35	labour cost/kg fish produced (and % of total cost/kg)	x		
		36	unit production cost (total variable and fixed costs/kg fish produced/operating costs) (ex-cage)	x		
		37	energy cost/kg fish produced (and % of total cost/kg)	x		
		38	transportation cost/kg (and % of total cost/kg)	x		
		39	financial costs/kg fish produced (and % of total cost/kg)	x		
P3C3	level of financial strength	40	current ratio (total current farm assets/total current farm liabilities)	x		
		41	debt/asset ratio (total farm liabilities/total farm assets)	x		
		42	debt/equity ratio (total farm liabilities/total farm equity)	x		
P3C4	level of environmental protection costs	43	environmental monitoring costs/kg fish produced (and as % of total cost/kg)	x		
		44	capital investments for environmental protection/kg (and as % of total cost/kg)	x		
		45	existence of incentives, direct or indirect, for environmental protection actions			x
P3C5	ease of entry into industry	46	existence of national mechanism supporting start-ups (tax-break, subsidies, financing)			x

DEc/ PRINCIPLE 4 : Strengthen the role of professional organizations for the economic sustainability of aquaculture

CODE	CRITERIA	N°	INDICATORS	farm level	sector level	national level
P4C1	level of knowledge management	47	sector market studies		x	x
		48	market data dissemination (annual seminars by federations or authorities)		x	x
P4C2	level of collective marketing and actions	49	% of annual national federations (producer's organizations) budget allocated to marketing and promotion		x	
		50	annual national budget allocated for marketing and promotion of the sector			x
		51	existence of a permanent information/communication program at sector level		x	
P4C3	promotion of training and awareness building	52	existence of training program for sector employees on financial aspects of activity		x	
		53	existence of training program for sector employees on environmental aspects of activity		x	
P4C4	increased capability for crisis management	54	existence of emergency funds		x	x
		55	existence of crisis management manual (strategy)		x	

4.3 SOCIAL DIMENSION

(3 principles, 13 criteria, 18 indicators)

DSo/ PRINCIPLE 1: Contribute to food security and healthy nutritional needs

CODE	CRITERIA	Nº	INDICATORS	farm/sector level	local level	national level
P1C1	importance of fish availability	1	annual production		x	x
P1C2	accessibility for local consumers	2	quantity of fish produced for domestic markets (self-consumption) and apparent consumption		x	x
		3	fish price compared with the national minimum wage		x	x
P1C3	commitment to and type of quality-based approach adopted by the farms.	4	percentage of innovative products proposed each year	x	x	

DSo/ PRINCIPLE 2: Strengthen the role of the Producer Organizations and NGO's to improve image of aquaculture, social awareness and responsibilities

CODE	CRITERIA	Nº	INDICATORS	farm/sector level	local level	national level
P2C1	average salary levels	5	minimum wage of employees compared to national minimum wage		x	x
P2C2	level of qualification	6	percentage of fish-farmers with specialized aquaculture training and certificate	x		x
P2C3	importance of fish farmer organizations	7	number of professional associations		x	x
		8	existence of a professional status			x
P2C4	image of aquaculture	9	existence of ecolabels and product specifications			x
P2C5	capacity to take part in decision-making	10	effective participation to decision making process		x	x

DSo/ PRINCIPLE 3: Strengthen corporate social responsibility

CODE	CRITERIA	Nº	INDICATORS	farm/sector level	local level	national level
P3C1	working conditions (hours and security)	11	number of monthly hours currently worked by aquaculture workers	x		x
		12	number of occupational accidents	x		x
P3C2	level of protection and participation to trade union.	13	percentage of trade union members among workers			x
P3C3	women's access to the industry, including salary level	14	percentage of women fish-farmers	x	x	x
P3C4	access to information	15	existence and importance of interprofessional organizations		x	x
P3C4	fish welfare	16	unmarketable fish ratio	x		
		17	number of declared pathologies	x		
		18	percentage of premium quality fish	x		

4.4 ENVIRONMENTAL DIMENSION

(3 principles, 14 criteria, 53 indicators)

DEn/ PRINCIPLE 1: Minimizing the global impact of aquaculture

CODE	CRITERIA	N°	INDICATORS	farm/sector level	local level	national level
P1C1	needs of natural resource (pelagic fish and vegetables)	1	food conversion ratio (kg food/kg fish)			
		2	demand of pelagic fish (t/year)			
		3	demand of vegetable products (t/year)			
P1C2	consume of energy	4	footprint index (Hc)			
		5	life-cycle assessment (formula)			
		6	tropic level of production (index)			
P1C3	alien species	7	number of introduced species (n)			
P1C4	capture-based aquaculture	8	capture versus quota (tons/year)			

DEn/ PRINCIPLE 2: Respect the ecological service of ecosystem

CODE	CRITERIA	N°	INDICATORS	farm/sector level	local level	national level
P2C1	water quality	9	turbidity/transparency (Secchi disk)			
		10	microbiological indicators (total coliform)			
		11	algae bloom (n. cells / ml)			
P2C2	fisheries and nursery areas	12	lost of nursery and spawning grounds (yes / no) recruitment index and spawning stock biomass)			
		13	capture modification of target species in the area (monitoring fisheries activities)			
		14	increase the fishing activities around the farm cages (landing and biomass index)			
		15	presence of hatchery with native brood stocks (yes/no)			
		16	monitoring the quality of the fish larvae produced			
P2C3	carrying/holding capacity of the ecosystem	17	na			
P2C4	oceanographic conditions	18	hydrodynamic (cm /s)			
		19	depth (m)			
		20	interchange with open sea (offshore) (distance in m)			
		21	percentage of the used space (%)			
P2C5	trophic conditions	22	volume of water occupied per kg of product (kg / m^3)			
		23	oxygen saturation (%)			
		24	relationship between exogenous and endogenous nutrients			

DEn/ PRINCIPLE 3: Minimizing the local impact on environmental conditions and biodiversity

CODE	CRITERIA	N°	INDICATORS	farm/sector level	local level	national level
P3C1	input of organic and inorganic wastes	25	faeces sedimentation rates (g/day)			
		26	lost food versus total (%)			
		27	nutrient balance (kg)			
P3C2	use of chemical products and drugs	28	kg of antibiotics per tonne fish (kg)			
		29	antifouling use (y /n)			
		30	kg of anti-parasites per tonne fish (kg)			
		31	kg of disinfectant per tonne fish (kg)			
		32	use of food with chemical antioxidants (y/n)			
		33	kg of antibiotics per tonne fish (kg)			
P3C3	impact on benthic habitat and communities	34	redox potential and pH (pH)			
		35	total P (kg)			
		36	sediment structure (%)			
		37	heavy metal accumulation (micrograms)			
		38	benthic community structure modification (benthic index)			
		39	total organic carbon (TOC, mg/m^2)			
		40	level of degradation of sensitive habitats (monitoring)			
P3C4	impact on pelagic habitat and communities	41	turbidity (Secchi disk cm)			
		42	total particulate organic matter (mg/m^3)			
		43	total dissolved organic matter (mg/m^3))			
		44	chlorophyll (mg/m^3)			
		45	zooplankton biomass (mg/m^3)			
		46	aggregation of pelagic fish (ind/m^2)			
		47	escapees (ind)			
P3C5	genetic impact	48	use of non indigenous species (y/n)			
		49	use of GMO species (y/n)			
		50	level of spawning			
		51	use of native broodstocks (y/n)			
		52	escapees (numbers)			
P3C6	disease spread from farms	53	presence of pathogens from farm pathogens (y/n)			

5. Bibliographic references and database on indicators for the sustainable development of Mediterranean aquaculture

5.1 INTRODUCTION

The activities of the WGSA (Working Group on Sustainability on aquaculture) and the WGSC (Working Group on Siting and carrying capacity) enabled the collection of a large amount of information from bibliographic references that has been used for the realisation of two databases, InDAM-db and SHoCMed-db.

The first database, InDAM-db, created within the framework of the InDAM Project "Indicators for sustainable development of aquaculture and guidelines for their use in the Mediterranean", stores the most significant scientific documents on indicators of sustainable aquaculture related to the Mediterranean Region. An annotated selected bibliography on the same topics was also prepared.

The second database, SHoCMed-db, created in the framework of the SHoCMed project ("Developing siting and carrying capacity for Mediterranean aquaculture") is restricted to the environmental dimension of the InDAM-db, with more fields and detailed information on site selection and carrying capacity of aquaculture activities.

5.2 METHODOLOGY

5.2.1 Design and design and development of a databank InDAM - SHoCMed

A databank was designed by the GFCM Secretariat, and prepared by referring to the most significant scientific literature, collecting and compiling the information from various sources (documents and projects). Data were organized according to the four dimensions of sustainable aquaculture (Governance, Economic, Social and Environmental), referring to the most important scientific literature of the last decade and to the most relevant scientific issues on the subject.

The process was developed in two steps.

i). The first step was to collect the most important scientific literature on the InDAM and SHoCMed topics. References were searched in the database: ASFA (Aquatic Sciences and Fisheries Abstracts), ABAFR (Aquatic Biology, Aquaculture & Fisheries Resources) and through the search engines Google and Google Scholar and selected according to the content of the abstract/article. The list of references is reported in Annexe 6.

The key words and queries used for searching references were:

- indicator, sustainable, aquaculture
- indicator, aquaculture, med
- indicator, aquaculture, economics.

References were also collected from the reference list in reviews and/or key publications.

ii) The selected references were then inserted as records in MS-ACCESS, a new multi-use data access into Structure Query Language server environment, divided into fields, containing the following information:

- Title
- Author
- Year
- Publication type
- Source
- Abstract
- Issue (keywords from the ASFA thesaurus and term list)
- Cultured species (scientific and common name)
- Group of species
- Structure of culture (cages, ponds, raceways, hatchery, etc.)

- Country
- Geographical Area
- GSA (Geographical Sub-Areas)
- Indicators.

In the InDAM-db the field of indicators were divided into the four dimensions of sustainability:

- Governance
- Economics
- Social
- Environmental.

The field of environmental indicators forms the SHoCMed-db, with the addition the following information/fields:

- Oxygen
- Turbidity
- Nutrient
- Sediment Organic Matter
- Macrofauna
- Redox Potential
- Sediment.

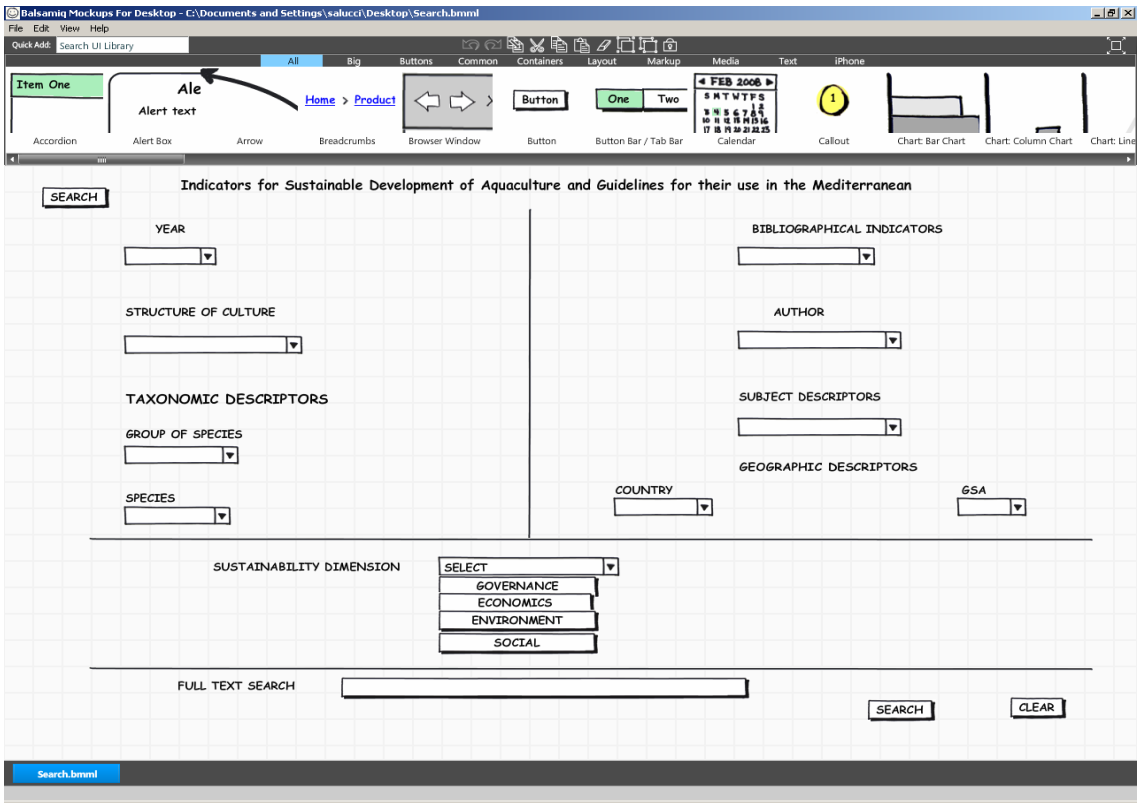
The db also provides data, if available, relating to standards and reference points for each parameter considered.

5.2.2 Designing and implementing a web search engine[18]

During the preliminary phase of the development process, a thorough analysis concerning the User Interface and the features to be included has been undertaken (Fig.1). As a result, a UI mock-up has been realised using the program “Balsamic Mockups”. The web application being referred was intended to provide the user with an accurate search engine for the reference/bibliographic data collected.

Following the development of the core features, a complete beta-testing phase has been run in order to apply the necessary optimisations. User Interface and Usability have been improved while taking in consideration the items emerged during the Beta-Testing phase.

Fig. 6.1. InDAMdb: draft search page



5.3 OUTPUTS

5.3.1 The InDAM databank

239 records were inserted in the InDAM databank, divided into the four dimensions of sustainability:

- Governance (31 records)
- Economics (24 records)
- Social (32 records)
- Environmental (231 records).

Each record can provide information on more than one dimension. Fig.2. shows an example of the information reported for each record. The main indicators used for the analysis and description of each dimension of sustainability are reported in Table 1.The indicators are not to be considered as final. They can be subject to modifications and/or other indicators can be added in the future.

Some of the 231 records reported in the InDAM-db environmental dimension were inserted in the SHoCMed-db, and represents a starting test with different functional characters to be futherly implemented.

Table 1. Indicators of aquaculture sustainability within the 4 dimensions

Governance Indicators	**Social Indicators**
Territorial integration	Worker safety
Performance indicator	Social acceptability
Governmental policy recommendations	Job availability
Aquaculture policy, administration, legislation	Consensus building
Management actions	Compensation rates benefits
	Eating habits
Economic Indicators	**Environmental Indicators**
Market	Benthos
Price	Nutrients
Risk assessment	Posidonia oceanica
Supply vs demand	Oxygen
Capacity	Genetic structure
Efficiency	Plankton
	Mortality
	Biomass
	Environment Impact Assessment (EIA)
	Stock dynamics
	Chlorophyll
	Ammonium
	Suspended solids

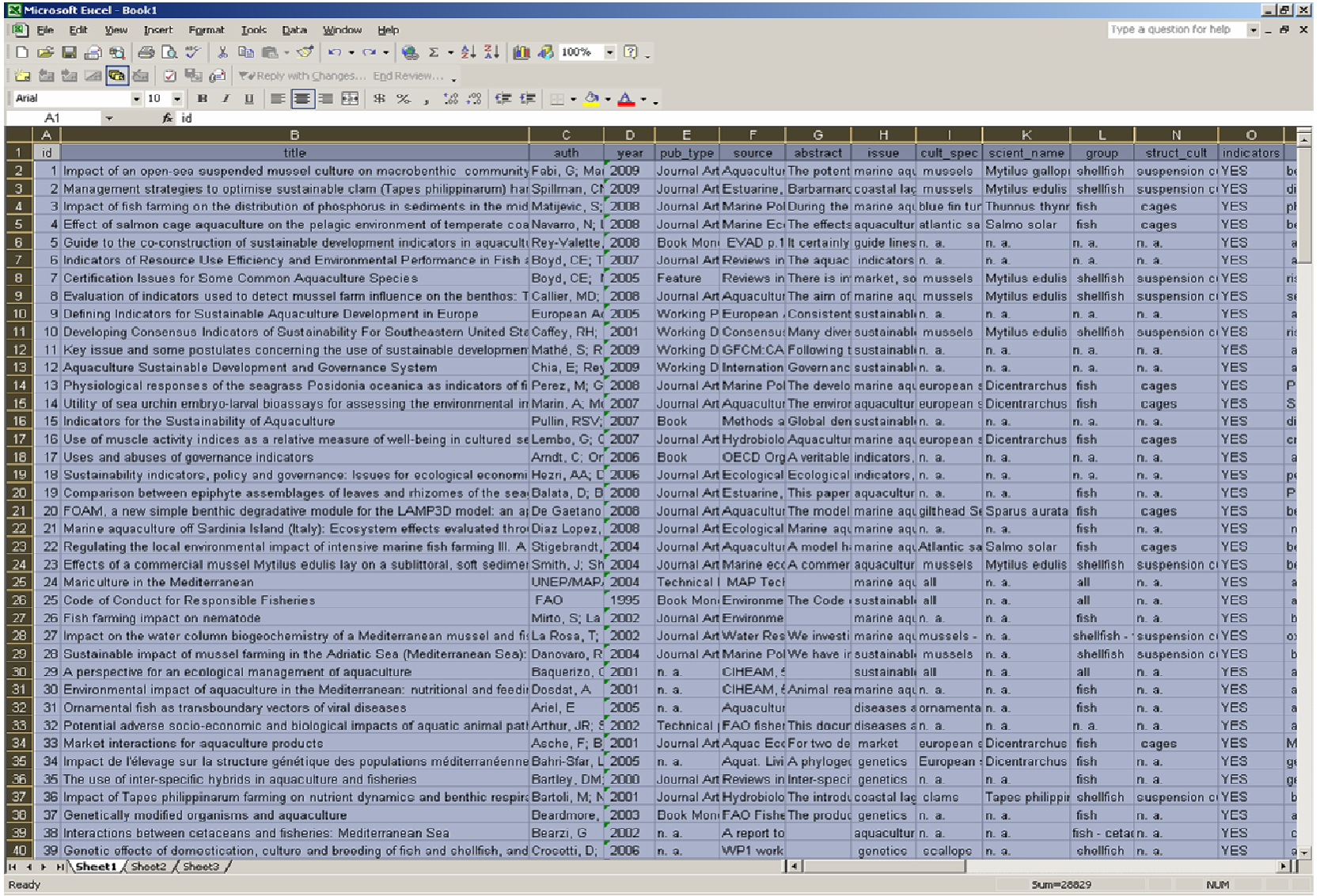
5.3.2 The InDAM database (InDAMdb)

The InDAMdb can be accessed through the InDAM web page[19] which describes InDAM activities, and is been continuously updated to help users to find related and useful information on Sustainability on Mediterranean Aquaculture (Fig. 2).

The result of this project was the creation of InDAM-db, a database on the **"**Indicators for sustainable development of aquaculture and guidelines for their use in the Mediterranean". It is possible to search references for: *Sustainability dimension* (Governance, Social, Economics, Environmental), *Cultured species* and related *Structure of culture* (cages, ponds, raceways, hatchery, etc.), *Country*, *GSA* (Geographical Sub-Areas), *Bibliographical Indicators* (fig. 3).

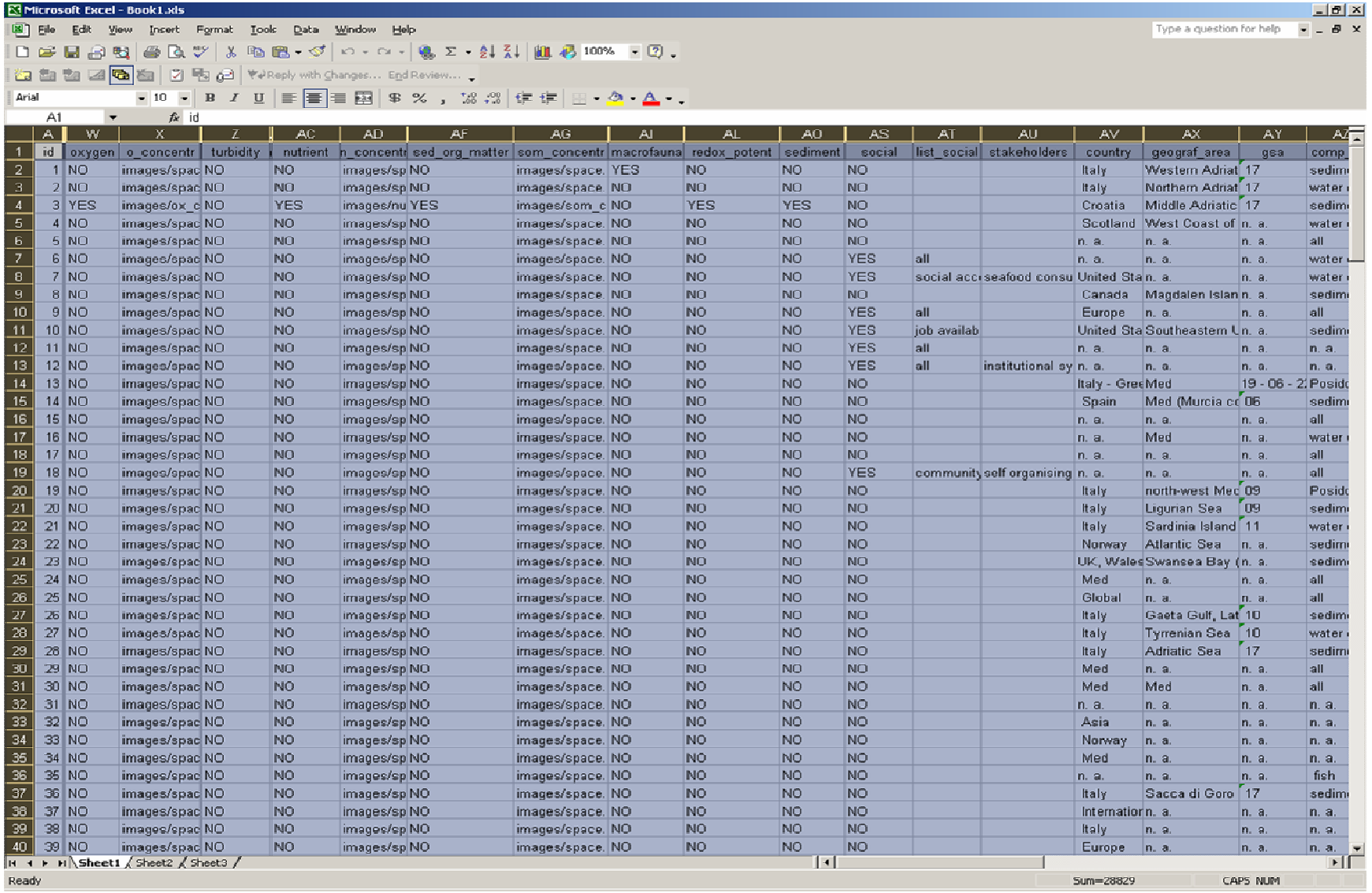
[19] *http://www.faosipam.org/?pag=content/_ShowPortal&Portal=INDAM*

Fig. 1. The InDAM databank



	A	B	C	D	E	F	G	H	I	K	L	N	O
1	id	title	auth	year	pub_type	source	abstract	issue	cult_spec	scient_name	group	struct_cult	indicators
2	1	Impact of an open-sea suspended mussel culture on macrobenthic community	Fabi, G; Ma	2009	Journal Art	Aquacultur	The potent	marine aqu	mussels	Mytilus gallopr	shellfish	suspension c	YES
3	2	Management strategies to optimise sustainable clam (Tapes philippinarum) har	Spillman, CI	2009	Journal Art	Estuarine,	Barbamarc	coastal lag	mussels	Mytilus edulis	shellfish	suspension c	YES
4	3	Impact of fish farming on the distribution of phosphorus in sediments in the mid	Matijevic, S;	2008	Journal Art	Marine Pol	During the	marine aqu	blue fin tur	Thunnus thynr	fish	cages	YES
5	4	Effect of salmon cage aquaculture on the pelagic environment of temperate coa	Navarro, N; I	2008	Journal Art	Marine Ec	The effects	aquacultur	atlantic sa	Salmo solar	fish	cages	YES
6	5	Guide to the co-construction of sustainable development indicators in aquacult	Rey-Valette,	2008	Book Mon	EVAD p.1	It certainly	guide lines	n. a.	n. a.	n. a.	n. a.	YES
7	6	Indicators of Resource Use Efficiency and Environmental Performance in Fish a	Boyd, CE; T	2007	Journal Art	Reviews in	The aquac	indicators	n. a.	n. a.	n. a.	n. a.	YES
8	7	Certification Issues for Some Common Aquaculture Species	Boyd, CE; I	2005	Feature	Reviews in	There is in	market, so	mussels	Mytilus edulis	shellfish	suspension c	YES
9	8	Evaluation of indicators used to detect mussel farm influence on the benthos: T	Callier, MD;	2008	Journal Art	Aquacultur	The aim of	marine aqu	mussels	Mytilus edulis	shellfish	suspension c	YES
10	9	Defining Indicators for Sustainable Aquaculture Development in Europe	European Ac	2005	Working P	European	Consistent	sustainabl	n. a.	n. a.	n. a.	n. a.	YES
11	10	Developing Consensus Indicators of Sustainability For Southeastern United Ste	Caffey, RH;	2001	Working D	Consensus	Many diver	sustainabl	mussels	Mytilus edulis	shellfish	suspension c	YES
12	11	Key issue and some postulates concerning the use of sustainable developmen	Mathé, S; R	2009	Working D	GFCM:CA	Following t	sustainabl	n. a.	n. a.	n. a.	n. a.	YES
13	12	Aquaculture Sustainable Development and Governance System	Chia, E; Rey	2009	Working D	Internation	Governanc	sustainabl	n. a.	n. a.	n. a.	n. a.	YES
14	13	Physiological responses of the seagrass Posidonia oceanica as indicators of fi	Perez, M; G	2008	Journal Art	Marine Pol	The develo	marine aqu	european s	Dicentrarchus	fish	cages	YES
15	14	Utility of sea urchin embryo-larval bioassays for assessing the environmental in	Marin, A; M	2007	Journal Art	Aquacultur	The enviror	aquacultur	european s	Dicentrarchus	fish	cages	YES
16	15	Indicators for the Sustainability of Aquaculture	Pullin, RSV;	2007	Book	Methods a	Global den	sustainabl	n. a.	n. a.	n. a.	n. a.	YES
17	16	Use of muscle activity indices as a relative measure of well-being in cultured se	Lembo, G; C	2007	Journal Art	Hydrobiolo	Aquacultur	marine aqu	european s	Dicentrarchus	fish	cages	YES
18	17	Uses and abuses of governance indicators	Arndt, C; Or	2006	Book	OECD Org	A veritable	indicators,	n. a.	n. a.	n. a.	n. a.	YES
19	18	Sustainability indicators, policy and governance: Issues for ecological economi	Hezri, AA; D	2006	Journal Art	Ecological	Ecological	indicators,	n. a.	n. a.	n. a.	n. a.	YES
20	19	Comparison between epiphyte assemblages of leaves and rhizomes of the sea	Balata, D; B	2008	Journal Art	Estuarine,	This paper	aquacultur	n. a.	n. a.	fish	n. a.	YES
21	20	FOAM, a new simple benthic degradative module for the LAMP3D model: an ap	De Gaetano	2008	Journal Art	Aquacultur	The model	marine aqu	gilthead Se	Sparus aurata	fish	cages	YES
22	21	Marine aquaculture off Sardinia Island (Italy): Ecosystem effects evaluated thro	Diaz Lopez,	2008	Journal Art	Ecological	Marine aqu	marine aqu	n. a.	n. a.	fish	n. a.	YES
23	22	Regulating the local environmental impact of intensive marine fish farming III. A	Stigebrandt,	2004	Journal Art	Aquacultur	A model h	marine aqu	Atlantic sa	Salmo solar	fish	cages	YES
24	23	Effects of a commercial mussel Mytilus edulis lay on a sublittoral, soft sedimer	Smith, J; Sh	2004	Journal Art	Marine ecc	A commer	aquacultur	mussels	Mytilus edulis	shellfish	suspension c	YES
25	24	Mariculture in the Mediterranean	UNEP/MAP,	2004	Technical I	MAP Tech		marine aqu	all	n. a.	all	n. a.	YES
26	25	Code of Conduct for Responsible Fisheries	FAO	1995	Book Mon	Environme	The Code	sustainabl	all	n. a.	all	n. a.	YES
27	26	Fish farming impact on nematode	Mirto, S; La	2002	Journal Art	Environme		marine aqu	n. a.	n. a.	fish	n. a.	YES
28	27	Impact on the water column biogeochemistry of a Mediterranean mussel and fi	La Rosa, T;	2002	Journal Art	Water Res	We investi	marine aqu	mussels -	n. a.	shellfish -	suspension c	YES
29	28	Sustainable impact of mussel farming in the Adriatic Sea (Mediterranean Sea):	Danovaro, R	2004	Journal Art	Marine Pol	We have ir	sustainabl	mussels	n. a.	shellfish	suspension c	YES
30	29	A perspective for an ecological management of aquaculture	Baquerizo, C	2001	n. a.	CIHEAM,		sustainabl	all	n. a.	all	n. a.	YES
31	30	Environmental impact of aquaculture in the Mediterranean: nutritional and feedi	Dosdat, A	2001	n. a.	CIHEAM,	Animal rea	marine aqu	n. a.	n. a.	fish	n. a.	YES
32	31	Ornamental fish as transboundary vectors of viral diseases	Ariel, E	2005	n. a.	Aquacultur		diseases a	ornamenta	n. a.	fish	n. a.	YES
33	32	Potential adverse socio-economic and biological impacts of aquatic animal patl	Arthur, JR;	2002	Technical	FAO fisher	This docur	diseases a	n. a.	n. a.	n. a.	n. a.	YES
34	33	Market interactions for aquaculture products	Asche, F; B	2001	Journal Art	Aquac Eco	For two de	market	european s	Dicentrarchus	fish	cages	YES
35	34	Impact de l'élevage sur la structure génétique des populations méditerranéenne	Bahri-Sfar, L	2005	n. a.	Aquat. Livi	A phyloge	genetics	European	Dicentrarchus	fish	n. a.	YES
36	35	The use of inter-specific hybrids in aquaculture and fisheries	Bartley, DM;	2000	Journal Art	Reviews in	Inter-speci	genetics	n. a.	n. a.	fish	n. a.	YES
37	36	Impact of Tapes philippinarum farming on nutrient dynamics and benthic respir	Bartoli, M; N	2001	Journal Art	Hydrobiolo	The introdu	coastal lag	clams	Tapes philippir	shellfish	suspension c	YES
38	37	Genetically modified organisms and aquaculture	Beardmore,	2003	Book Mon	FAO Fishe	The produc	genetics	n. a.	n. a.	fish	n. a.	YES
39	38	Interactions between cetaceans and fisheries: Mediterranean Sea	Bearzi, G	2002	n. a.	A report to		aquacultur	n. a.	n. a.	fish - cetac	n. a.	YES
40	39	Genetic effects of domestication, culture and breeding of fish and shellfish, and	Crosetti, D;	2006	n. a.	WP1 work		genetics	scallops	n. a.	shellfish	n. a.	YES

Fig. 1 (cont.d)

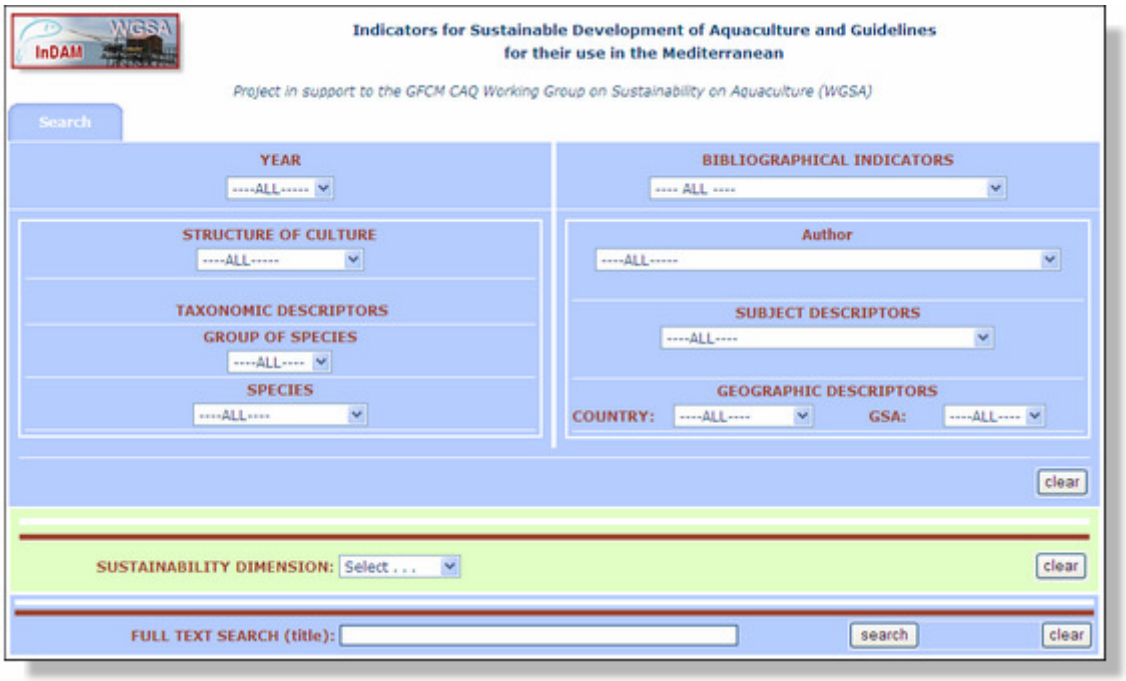


id	oxygen	o_concentr	turbidity	nutrient	n_concentr	sed_org_matter	som_concentr	macrofauna	redox_potent	sediment	social	list_social	stakeholders	country	geograf_area	gsa	comp
1	NO	images/spac	NO	NO	images/sp	NO	images/space.	YES	NO	NO	NO			Italy	Western Adriat	17	sedim
2	NO	images/spac	NO	NO	images/sp	NO	images/space.	NO	NO	NO	NO			Italy	Northern Adriat	17	water
3	YES	images/ox_c	NO	YES	images/nu	YES	images/som_c	NO	YES	YES	NO			Croatia	Middle Adriatic	17	sedim
4	NO	images/spac	NO	NO	images/sp	NO	images/space.	NO	NO	NO	NO			Scotland	West Coast of	n. a.	water
5	NO	images/spac	NO	NO	images/sp	NO	images/space.	NO	NO	NO	NO			n. a.	n. a.	n. a.	all
6	NO	images/spac	NO	NO	images/sp	NO	images/space.	NO	NO	NO	YES	all		n. a.	n. a.	n. a.	water
7	NO	images/spac	NO	NO	images/sp	NO	images/space.	NO	NO	NO	YES	social acc	seafood consu	United Sta	n. a.	n. a.	water
8	NO	images/spac	NO	NO	images/sp	NO	images/space.	NO	NO	NO	NO			Canada	Magdalen Islan	n. a.	sedim
9	NO	images/spac	NO	NO	images/sp	NO	images/space.	NO	NO	NO	YES	all		Europe	n. a.	n. a.	all
10	NO	images/spac	NO	NO	images/sp	NO	images/space.	NO	NO	NO	YES	job availab		United Sta	Southeastern U	n. a.	sedim
11	NO	images/spac	NO	NO	images/sp	NO	images/space.	NO	NO	NO	YES	all		n. a.	n. a.	n. a.	n. a.
12	NO	images/spac	NO	NO	images/sp	NO	images/space.	NO	NO	NO	YES	all	institutional sy	n. a.	n. a.	n. a.	n. a.
13	NO	images/spac	NO	NO	images/sp	NO	images/space.	NO	NO	NO	NO			Italy - Gree	Med	19 - 06 - 2	Posid
14	NO	images/spac	NO	NO	images/sp	NO	images/space.	NO	NO	NO	NO			Spain	Med (Murcia co	06	sedim
15	NO	images/spac	NO	NO	images/sp	NO	images/space.	NO	NO	NO	NO			n. a.	n. a.	n. a.	all
16	NO	images/spac	NO	NO	images/sp	NO	images/space.	NO	NO	NO	NO			n. a.	Med	n. a.	water
17	NO	images/spac	NO	NO	images/sp	NO	images/space.	NO	NO	NO	NO			n. a.	n. a.	n. a.	all
18	NO	images/spac	NO	NO	images/sp	NO	images/space.	NO	NO	NO	YES	community	self organising	n. a.	n. a.	n. a.	all
19	NO	images/spac	NO	NO	images/sp	NO	images/space.	NO	NO	NO	NO			Italy	north-west Med	09	Posid
20	NO	images/spac	NO	NO	images/sp	NO	images/space.	NO	NO	NO	NO			Italy	Ligurian Sea	09	sedim
21	NO	images/spac	NO	NO	images/sp	NO	images/space.	NO	NO	NO	NO			Italy	Sardinia Island	11	water
22	NO	images/spac	NO	NO	images/sp	NO	images/space.	NO	NO	NO	NO			Norway	Atlantic Sea	n. a.	sedim
23	NO	images/spac	NO	NO	images/sp	NO	images/space.	NO	NO	NO	NO			UK, Wales	Swansea Bay (	n. a.	sedim
24	NO	images/spac	NO	NO	images/sp	NO	images/space.	NO	NO	NO	NO			Med	n. a.	n. a.	all
25	NO	images/spac	NO	NO	images/sp	NO	images/space.	NO	NO	NO	NO			Global	n. a.	n. a.	all
26	NO	images/spac	NO	NO	images/sp	NO	images/space.	NO	NO	NO	NO			Italy	Gaeta Gulf, Lat	10	sedim
27	NO	images/spac	NO	NO	images/sp	NO	images/space.	NO	NO	NO	NO			Italy	Tyrrenian Sea	10	water
28	NO	images/spac	NO	NO	images/sp	NO	images/space.	NO	NO	NO	NO			Italy	Adriatic Sea	17	sedim
29	NO	images/spac	NO	NO	images/sp	NO	images/space.	NO	NO	NO	NO			Med	n. a.	n. a.	all
30	NO	images/spac	NO	NO	images/sp	NO	images/space.	NO	NO	NO	NO			Med	Med	n. a.	all
31	NO	images/spac	NO	NO	images/sp	NO	images/space.	NO	NO	NO	NO			n. a.	n. a.	n. a.	n. a.
32	NO	images/spac	NO	NO	images/sp	NO	images/space.	NO	NO	NO	NO			Asia	n. a.	n. a.	n. a.
33	NO	images/spac	NO	NO	images/sp	NO	images/space.	NO	NO	NO	NO			Norway	n. a.	n. a.	n. a.
34	NO	images/spac	NO	NO	images/sp	NO	images/space.	NO	NO	NO	NO			Med	n. a.	n. a.	n. a.
35	NO	images/spac	NO	NO	images/sp	NO	images/space.	NO	NO	NO	NO			n. a.	n. a.	n. a.	fish
36	NO	images/spac	NO	NO	images/sp	NO	images/space.	NO	NO	NO	NO			Italy	Sacca di Goro	17	sedim
37	NO	images/spac	NO	NO	images/sp	NO	images/space.	NO	NO	NO	NO			Internatior	n. a.	n. a.	n. a.
38	NO	images/spac	NO	NO	images/sp	NO	images/space.	NO	NO	NO	NO			Italy	n. a.	n. a.	n. a.
39	NO	images/spac	NO	NO	images/sp	NO	images/space.	NO	NO	NO	NO			Europe	n. a.	n. a.	n. a.

Fig. 2 InDAM webpage

http://www.faosipam.org/?pag=content/_ShowPortal&Portal=InDAM

Fig. 3 The InDAM database (InDAMdb) layout



http://www.faosipam.org/indam/

ANNEXE 1

Key issue and some postulates concerning the use of indicators for sustainable development: the example of aquaculture

Syndhia Mathé*, Hélène Rey-Valette* and Eduardo Chia#

*Montpellier 1 University, #INRA-Cirad

1. Introduction

Following the numerous studies on the effects of sustainable development, interest is now focusing on its appropriation, in particular as regards governance of sustainable development. After having addressed scientific conditions for the elaboration of indicators for sustainable development, current studies now deal with the use of these indicators, their informative and normative nature, as well as their contribution to learning processes related to the appropriation of sustainable development (Rey-Valette et al., 2007). The objectives of this document are to illustrate the importance of learning and governance systems and processes for the appropriation of sustainable development. Example is given of a research project on the elaboration of a set of indicators on sustainability of aquaculture systems.

The document

- addresses the elaboration and use of indicators,
- analyses the profusion of reference systems and of initiatives to elaborate sustainable development indicators for aquaculture,
- discusses the advantage of implementing co-construction, and
- presents 4 postulates related to conditions of and modalities of sustainable development appropriation.

2. « Construction » and use of indicators for sustainable development

The concept of sustainable development has become an essential reference, which concerns all public policies, and which is becoming increasingly assimilated by actors and firms. At the same time, a profusion of institutional initiatives were implemented by international organisations in order to set up indicators for sustainable development, by means of working groups made of experts .

This abundance of initiatives and associated “lists” will grow while studies at national, regional, as well as sectorial or local scales are multiplying. These applications will provide a diversity of approaches, in particular in the context of local Agendas 21 or urban ecology charters. These different approaches of sustainable development relay on the elaboration of reference systems or sustainable development indicators or sometimes both. The use of indicators may be carried out with either composite indicators or a set of indicators.

Composite indicators provide a synthetic view of sustainability, however they are subjective. Moreover, because they are synthetic, there may be the disadvantage of losing information.

The elaboration of sets of indicators is more common, however the excess of information could prevent from having a global vision. Reducing the number of indicators is sound, however the question of providing an optimal list of indicators is widely discussed and appears as a scientific mirage. These remarks underline the complex problem of the use of indicators. It is complex, as it depends on the diversity of exerted functions, in a more or less simultaneous manner, in response to several generic types of requests: coordination, communication, crisis management, warning, monitoring of conditions and pressures, evaluation of reaction capacities, etc. The indicator is also

used to generate a problem or an issue, and thus has a summarising function which is fulfilled by indicators elaborated on the basis of pillars.

Initially, indicators are especially designed according to sustainable development pillars (Environmental, Economic, Social, and then Institutional pillars), based on a relatively exhaustive approach. Nowadays, interactions occurring between pillars are favoured by considering key issues, thus enabling to account for the values and priorities of relevant populations. The indicator will act as a mediation tool towards other audiences.

It is possible to assume that the use of indicators may be considered as a problem of supply and demand. Consequently, this relationship can be examined from two points of view (Rey-Valette et al., 2007):

- From demand to supply: in a rather procedural logic, by considering various questions that groups of actors and decision makers may ask, in order to provide the most appropriate indicators (according to available knowledge and data as well as needs identified beforehand). This logic involves all questions related to indicator social demand, types of actors, users and needs, as well as governance methods, etc.
- From supply to demand: in a rather normative logic, by considering representations (models) available or under development, and by considering that indicators are the parameters of these models (or a limited number of "simple" functions of these parameters, for example current points of reference). This dimension of the question corresponds to a set of more technical research issues, for which knowledge has to be quantified, and which refers to a set of questions related to quantification; thus, satisfying the demand often appears as a secondary issue.

Most experiences underline the lack of expression of sustainable development indicator demand. Users are unaware of the "products" which can be provided by scientists; this restricts the expression of their needs, particularly when new types of information are involved. Therefore, in most cases it is the supply which creates the demand. Crisis management situations represent a favourable opportunity for expressing a demand, which is then generally targeted. Most papers concerning these questions point out that the plurality of actors formulating the demand complicates the elaboration of a common integrated representation. Difficulties related to knowledge plurality, and to the diversity of media and knowledge access routes, should be taken into account.

The co-elaboration, participative approach and research-action may also lead to developing an indicator based on a consensus or coordination between the supply and demand. Associating or comparing indicators proposed by researchers and other co-products based on a process shared by researchers and actors, is a common practice; this leads to approaches aiming to combine the respective advantages of both types of logics that can be considered as mixed (*top-down* and *bottom-up)* in order to take into account the fact that generic models (representations) must be adapted to local specificities (Chamaret et al., 2007).

Furthermore, elaborating and evaluating indicators becomes an increasingly complex and difficult task. Thus, the indicator may contribute to creating a speech, making a policy operational, and enable to assess / justify public policies, and even become a "manipulation tool"**.** Reflections about the social role played by indicators lead to considering indicators as a tool for government policies, which is necessarily related to the development of these policies. Initially, indicator supply is "taken over" by the government and the great supranational institutions: indicators are a government attribute and a way for expressing its power as well as being a management tool for its policies.

3. The abundance of reference systems and initiatives in aquaculture

Several recommendations, suggestions, codes of conduct were issued to promote the implementation of sustainable development principles as new reference system. A reference system is defined as being able to report on public policy as societal "intellectual production of common images" that contributes to the evolution of social and ideological representations and as analysis tool of the mediation processes between global society and its components (Faure et al., 1995). Several forms of reference

systems coexist and are reported here specifically for aquaculture. First initiated by Reference International Institutions, actions generalised following diverse approaches.

The analysis of the reference systems for aquaculture (Mahé et al., 2006) allows classifying the approaches according to 2 criteria: degree of constraint and decentralisation of decisions. Together with the reference systems, various initiatives to elaborate sustainable development indicators were undertaken. Numerous simple, composites, sectorial or territorial sustainable indicators were therefore created and more or less used.

From the operational point of view, the variety of indicators is rather a constraint, as it does not provide a synthetic enough overview for the actors to understand and use. Yet, the principles of indicators parsimony and of stakeholders participation in the definition of indicators condition the efficiency of any information system. Indeed, according to Boulanger (2006), the legitimacy of an indicator that measures an evolution towards a political objective depends on the definition of that objective through a transparent and democratic procedure that allows for participation. Along the same line, Gadrey and Jany-Catrice (2005) underline that an indicator is likely to eventually become the keystone of a sustainable and unprescribed convention if it is transparent (values, criteria, sources, methods) and if it can generate variants that can be discussed beyond the narrow circle of its designers.

Thirty-two reference systems for sustainable development of aquaculture were studied[20]. An evaluation grid was designed to compare their adaptation to conditions and principles of sustainable development. The criteria chosen to evaluate the indicators partly correspond to those proposed by Gadrey and Janey-Catrice (2005), in particular as regards the institutional origin, application scales, types of approach, forms of participation and completeness of dimensions seized (Table 1). Information on reference systems and experiences carried out was analyzed at meta data level. Qualitative analysis of each criteria was made along 3 modalities that correspond to increasing agreement with sustainable development.

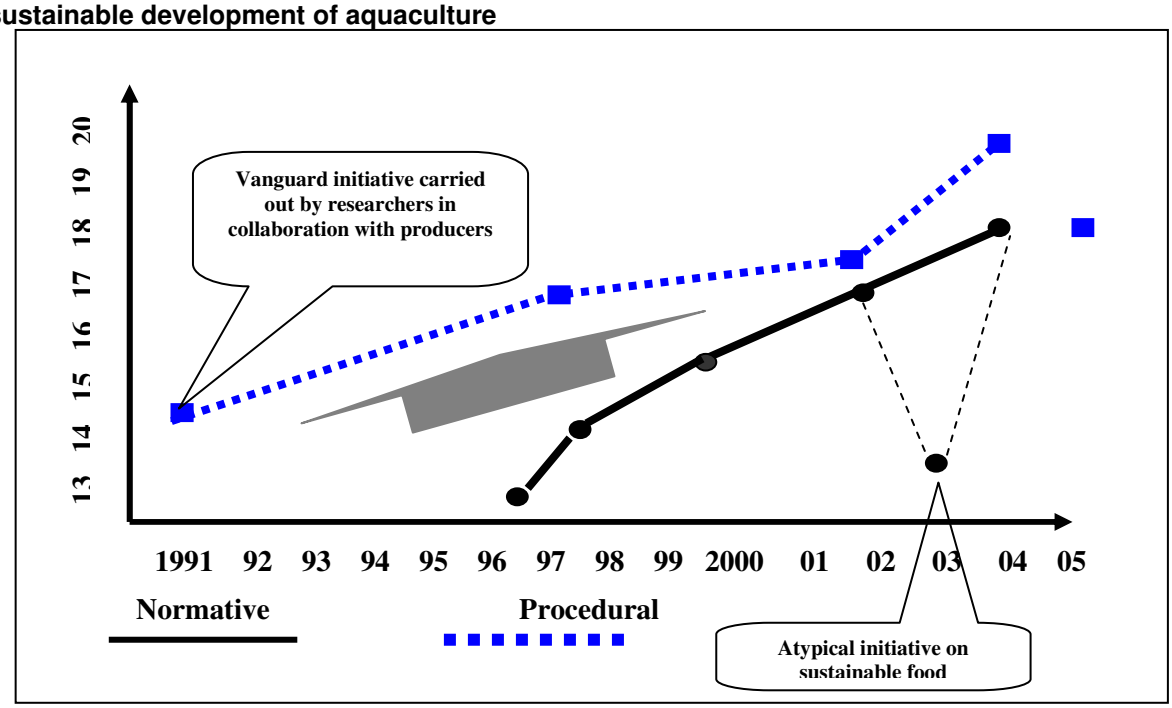
Table 1. Analysis grid for reference systems claiming to be in line with sustainable development of aquaculture

Topics	1	Environment
	2	Socio-economics
	3	≥ 3 dimensions
Type of institution originating the approach	1	Institution or international community
	2	Institution or national organism, regional networks
	3	Institutions, local organisms (OP) or organisations
Type of approach	1	Normative
	2	Procedures
	3	Normative and procedures
Action mode	1	Centralised initiative (Government or central institution)
	2	Decentralised initiative with low level of constraint
	3	Decentralised initiative with high level of constraint
Topic of the reference system	1	Production factors (real, work...)
	2	Production (marketing, price…)
	3	Both
Participating stakeholders	1	Scientific (or institutional)
	2	Scientific and producers
	3	Scientific and stakeholders
Participation mode of stakeholders	1	Consultation
	2	Survey
	3	Dialogue
Level of application	1	by Sector
	2	Territorial
	3	Both

[20] This research was carried out within the Project «Évaluation de la Durabilité des Systèmes Aquacoles » (EVAD), funded by the ANR in the framework of the French *Programme Fédérateur Agriculture et Développement Durable*

This analysis allowed scoring the reference systems for each criterion to identify the field that needs to be to be strengthened and calculating a global score without weighting the scores. It was then possible to calculate annual averages for the global score to analyze the qualitative temporal trend and identify a possible learning effect (Fig. 1).

Fig. 1. Evolution of average annual scores of reference systems claiming to be in line with sustainable development of aquaculture



The analysis of the reference systems' trend shows a global increase of the scores between 1991 and 2006 (from 13 to 20 with a maximum of 24). Specific trajectories according to the types of approaches show a higher scoring for procedures (iterative and adaptative as defined by Clément and Madec, 2006). The trend shows that reference systems increasingly take into account the multidimensional and complex feature of sustainable development, in particular social and territorial aspects. However, despite this conceptual improvement in the approaches, it is to be underlined that the durability and efficiency of sustainable aquaculture, as well as the use of indicators for monitoring are weak. This highlights a need of appropriation and professionalism of the approaches.

4. Inventory of conditions and procedures for the appropriation of sustainable development

According to Aggeri et al. (2005), there are 3 ways of adopting sustainable development:

(i) coercion when change is imposed by a hierarchical authority,

(ii) mimetism pertaining to an endogen process, and

(iii) professionalism related to internal voluntary process of a community and that depends on its structure and professional cohesion.

Sustainable development, as reference and value system, implies a gradual change, "on the way thanks to an infinite number of small changes, on the margins of the system and following percolation logic" (Loinger, 2006) that should come along with translating process to make the appropriation easier (Rudlof, 2006). New knowledge should have a certain familiarity with common knowledge. This notion of familiarity takes back to gradual learning advocated by Droz and Lavigne (2006) as translating mode that they describe as "specification". It is a qualitative adjustment of norms to

particular cases; this approach seems the most appropriate to sustainable development. These statements testify that the implementation of sustainable development should be thought of as a hybridizing process with the co-construction of durability indicators. For professionalism sake (type (iii) mentioned above) advocated by Aggeri et al. (2005) and without substituting for stakeholders, it would be relevant to create a framework to facilitate the implementation of co-production situations and collective learning requested for the appropriation of sustainable development. The logic of the process favouring a territorialized approach of sustainable development takes into account the durability of shared objectives that are clearly identified, as well as their contribution to the emerging culture of sustainable development.

We propose 4 postulates allowing generalizing the conceptualisation and the logic of co-construction of indicators for sustainable development through recommendations for the appropriation of sustainable development.

POSTULATE 1: An indicator is not just a measuring tool

The driving force of the approach suggested here is to integrate the multiple functions of the indicators which are the key tools of any evaluation approach in sustainable development. These indicators give the situation (state) or the trend of a variable. Hence, they are traditionally considered as **a measuring tool.** However, looking at the definition of an indicator shows that all indicators also fulfil an inventory function, highlighting the variable, amongst other possibilities, that must be monitored. It establishes priorities between variables and identifies "models" or "representations" of the important factors to be taken into consideration. The history of statistical systems (such as the development of national accounts) is a reminder that the choice of indicators is the result of negotiations between actors. The fact that these indicators can become promotional tools in the hands of certain lobbies through strategic communication approaches should also be noted. Once selected, an indicator becomes the standard which symbolically determines positive and negative situations thereby designating "the guilty" and "the innocent". It then becomes the signal that may lead to penalties for situations which, beyond some threshold, are considered negative.

Taken together these functions imply that an indicator system may be considered not only as a technical but also as a social arrangement, which reflects a social structure and a compromise at a given time. If the diversity of the indicators' functions is taken into account:

- controversies between actors around the standard that these indicators define can be better understood and managed,
- opportunities to re-discuss and further agree on standards can be taken,
- multiple constraints related to information, whether its access or presentation, that determine their dissemination and their use can be integrated.

POSTULATE 2: As implementing sustainable development is an innovative process, it is based on organisational learning and a specific joint approach.

The implementation of sustainable development implies profound changes in production and consumption methods, in ways of thinking and in the objectives to be achieved. A new way of representing society is being developed and therefore a new frame of reference must be adopted. Innovations originate from learning processes which differ according to the nature of these innovations. Argyris and Schön (1996) in their book on organisational learning distinguish between simple changes related to practices or actions (single loop learning) and those which involve changes to the fundamental rules and norms underlying action and behaviour (double loop learning). This distinction is useful to highlight the specific pace and needs of the double loop learning process. The changes in values brought about by sustainable development imply a development of the profession which concerns not only the way of working but also the objectives and the image of the activity.

For the indicators of sustainable aquaculture development produced by the approach to be adopted and used by the actors, the working methods and the forms of relationships between actors must be adapted to take into account the significant changes introduced by sustainable development. These changes also imply new coordination arrangements and a wider range of stakeholders. It is therefore

important to promote openness and participation as a broader range of stakeholders increases the multiplicity of representations and, in order to facilitate their convergence, requires that the implicit reference frameworks adopted by the actors be transparent. This process may be a strategic opportunity facilitating change in the relationships between actors and their relative strengths.

Generally speaking, professionals who are already committed to quality schemes such as AFNOR or ISO are more likely to think of indicators as norms and therefore to extend this type of approach to new variables expressing sustainability. Small-scale operators are more suspicious of norms and have a more inward-looking approach seeking primarily to use indicators as internal management tools for their farming. Broadening the debate to all the dimensions of sustainable development (environmental, economic, social and institutional) has always been a new approach for producers who have often limited sustainable development to its environmental dimension. The inclusion of the social and institutional dimensions is often a novelty and requires clarification and examples. In Southern countries, professionals are more aware of these aspects but are used to approach them separately through specific programmes (for example the poverty reduction programme).

POSTULATE 3: The joint approach to building indicators promotes organisational learning and helps dialogue.

It should be recalled that the distinctive innovative nature of sustainable development as a new mode of production implies a learning process to build a new related reference framework and related norms. This learning process requires a reflexivity process between actors. By reflexivity, we mean here the fact that actors learn from the action from the moment that they are able to view it in perspective and draw some lessons. These conditions require the organized participation of actors, for example through a joint approach. Many evaluations of sustainable development indicators stress the role of dialogue support and of mediation in the collective development of these indicators. In some cases, this property is in fact the main objective being sought. Indeed, the technical debate about the criteria for, and indicators of, sustainability naturally leads to in-depth discussions about the objectives and the content of sustainable development. The joint approach to building indicators can then constitute a "*deliberative and participatory construction"* system (Rudlof, 2006) where the lists of indicators are not only end-products of information systems but also "intermediate objects"[21] (Vinck, 2000) used to define a reference framework and a common project for sustainable development, in the sense that they are progressively created and that they promote dialogue.

Any joint approach to building indicators implies a break from the "expert opinion" approach, where science defines the lines of action or from the hierarchical approach, where "institutional authorities" impose a procedure. On the contrary, the aim is to implement an approach based on the sharing of information, knowledge and points of view. The joint approach to building indicators for sustainable development is a shared approach based on several conditions:

- to create a discussion mechanism bringing together several categories of key actors (researchers, producers and producer groups, administrators - managers, NGOs, associations, consumers and other resource users);
- to include the "future" users of indicators as much as possible and more generally the stakeholders in various ways (depending on the phase) in order to compare different opinions according to the type of actor or the different scales (national, regional or local);
- to organize the dialogue phases using various methods (surveys, interviews, focus groups, role-play, participatory multi-criteria techniques, etc.) in order to create suitable conditions for dialogue and mutual learning.

[21] This notion originates from work on the sociology of science and innovation. It conveys the idea of a collective process in building objects which promotes the learning process within a group. The main function of an intermediate object is thus to facilitate exchanges between actors and to shape the dynamics of the collective action. Hence, a table, a list of indicators, a plan, a map, a diagram might, , constitute intermediate objects during the joint-building process as they can be used to specify and define objectives or rules for the group, i.e. they can help to "create sense ". In this way, an intermediate object may be a significant component within a management or governance mechanism.

The most elaborate form of joint-building approach implies a shared vision of issues resulting from a discussion and mediation process between the actors.

POSTULATE 4: The joint-building approach is an opportunity and often generates organisational innovation.

The joint approach to building a system of sustainable development indicators is a way to create new standards in a decentralised way within a group of actors. It is no longer the optimum which is sought but a compromise and this is reached by a dynamic process of progressive adjustment. This type of approach where practices which are considered to be positive or innovative are institutionalised is more likely to suit the diversity of actors' values (Cheron and Ermisse, 2008). They then have an opportunity to communicate their specificities and their constraints and improve the design of the standard. This also provides an opportunity to develop the image of the profession, for example by suggesting codes of behaviour and good practice. Such a pro-active approach to sustainable development can also help to place the industry within more global approaches to sustainable development implementation, such as national sector based approaches, international ecolabels or local agenda 21 strategies.

However, the implementation of these positive outlooks depends on the evolution of governance systems. Hence, the proximity between actors which has developed progressively during the joint process can be institutionalized within a system or an institution (organizational and institutional innovation). However, in order to achieve this it is necessary that:

- the pioneering group have legitimacy with respect to the entire group of actors as well as the appropriate skills and resources,
- the professional organizations, whether associations or regional in nature, must have sufficient institutional capacity (notion of "*empowerment*").

The fact that the suggested approach takes into account not only the sustainability of aquaculture systems but also the evaluation of their contribution to local sustainable development is of interest in several ways. It provides producers and professional groups with pro-active approaches as well as the means for dialogue with local managers. Moreover, it also provides a means to communicate about the positive outcomes of the activity. In this way, this approach constitutes a facilitating element for the inclusion of the activity into integrated management systems and local planning.

In any case, the mere fact of putting into place a group working jointly to produce principles, criteria and indicators and the accompanying learning process that it implies, helps to structure and institutionalize this system. This is an essential contribution to stronger governance and sustainable development.

The recommended "local-global" linkage of the Bellagio principles rejects any fractal or homothetic method of operation preferring the local application of the common principles established by the Rio convention in 1992. This local focus in response to specific challenges is favoured over an automatic application regardless of the place and over the use of fixed standards whether international, national or related to the certification approach.

5. Conclusion: towards the use of indicators by the sector

Learning and appropriation processes of sustainable development appear to be endogenous to a group (of variable size) and/or a territory (at variable scales). However, for comparison sake, there is a need of common indicators at larger scales, **requesting that request** that approaches convergence. This can be achieved *a posteriori,* according to comparison needs and through a gradual mimetic reconciliation. This process can be strengthened by going to consultants and experts who share the same vision of sustainable development.

Convergence could also be sought a priori and following the "professionalism" logic as defined by Aggeri et al. (2005). In this case, the implementation is supported by guidelines providing a set of references from which the stakeholders select and chose the most appropriate to the issues they deal

with. Therefore, not only know-how should be transformed, but this should be done consistently with communication so as to inform on what is carried out and hence gradually broaden the application field of new standards. This approach represents a break respect to traditional scientific experience, as it favours an inductive approach. Comparison and harmonization of local approaches show a hybridising process occurring at a larger scale and where local approaches are spreading.

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ANNEXE 2

Aquaculture sustainable development and governance system

Eduardo Chia*, Hélène Rey-Valette# and Syndhia Mathé#

*Inra-Cirad, # Montpellier 1 University

1. Introduction - Sustainable development: problems of coordination between actors

Taking into account sustainable development objectives and principles involves changing the rules and coordination procedures between actors, in particular within the operation of "institutions" included in local regulation and governance systems.

Sustainable development and governance are closely related. Governance methods are defined as a series of devices the organization of which depends not only on rules and subsidiary mechanisms but also on convergences and divergences between representations. Studying these divergences helps to understand the causes, intensity and types of conflicts related to institutional changes due to the introduction of sustainable development. From this point, the implementation of sustainable development includes a collective action learning dimension based on an increased participation of stakeholders and a greater transparency in collective decision-making, in particular for defining the principles and local issues related to sustainable development. These learning elements partly address the "empowerment" issue. Institutional devices and incentive structures are to be modified for this type of association between private and public actors during the different decision-making stages. This change concerns all of the rules and institutions involved in the regulation process. As a result, if actors implement sustainable development at local and/or sector level, taking into account normative rules at a local scale would be an interesting solution for analyzing the governance process (tools, devices, instruments, and processes) according to the regulatory system structure in which these normative principles are applied.

Based on the example of aquaculture farms[22], we will describe the construction of an appropriate grid for analyzing governance implementation conditions and devices. Then, as the aim is to obtain a specific vision of the harmonization of principles, norms and criteria developed by political decision-makers and of the representations of stakeholders and "citizen" actors, we will determine how to take into account actors' representations and how these representations change according to contexts, type of actors and, in the case of actors involved in institutional systems, according to the role and position of their own institution in the institutional network (centralized or decentralized administration, producer organizations, Research, NGOs).

Particular attention will be given to territorial governance by analyzing aquaculture territorial integration procedures based on potential synergies between action routes promoting sustainable aquaculture and the contribution of this activity to territory sustainability. The proposal is to study aquaculture according to Integrated Coastal Zone Management (ICZM). These synergies provide conditions favoring the integration and participation of the aquaculture sector to territorial governance systems and processes, which have been analyzed in this paper. The conclusion will include a discussion about the idea that the development of aquaculture sustainability represents a good opportunity for its territorial integration. This would be possible if this activity can structure the necessary changes of its reference systems at an internal level and its integration in the governance mechanisms at an external level.

[22] These aquaculture farms were involved in the *Aquaculture System Sustainability Assessment* (EVAD) project funded by the *Agriculture and Sustainable Development* program of the ANR (French *National research Agency*) between 2005 and 2008.

2. The conditions for sustainable development implementation: regulatory systems and governance as institutional

2.1. The role of regulatory system and governance analysis in the appropriation of Sustainable Development

As sustainable development is a value system, a progressive change process is necessary. As it represents a "vision of things and the world, its transposition into operating principles is not obvious" and involves "an infinite number of small changes at the borders of the system according to a percolation approach" (Loinger, 2006). This is the condition of incremental change suggested by North (2005) concerning institutional change. This progressive implementation must be associated to a translation process, as developed in the Sociology of translation, involving the development of correspondences (equivalences/similarities) between distinct realities in aim of constructing common goals (Akrich et al., 2006). This is possible based on a reflexive approach or the position of actors in the justification of their actions. In 1996, Lafferty underlined the need for transforming global constraints and objectives into sectorial and local actions and policies by using a language and general format which can be understood by actors according to general social needs and not to the needs of a particular institution or actor. It is necessary to develop new knowledge for the translation process conditioning appropriation. New knowledge must comply with common knowledge so that it can be easily understood by actors. This determines sustainable development learning and training procedures.

The compliance concept is related to a step-by-step learning process based on the creation of hybrid worlds. Sustainable development implementation must therefore be considered both as a "fabricated" hybridization process and as a progressive step-by-step construction process related to different fields. Both processes mutually reinforce each other and appeal to actors as citizens, stakeholders, renewable resource users, consumers, workers, inhabitants, etc., relate. This approach refers to the institutionalization process conditions defined by Aoki (2006) as "belief convergence processes generating a dynamic equilibrium which in turn reinforces these beliefs". According to Aoki (2006), as a meta-rule or meta-standard, sustainable development institutionalization involves a specific process due to the fact that meta-rules are difficult to change. These propositions are similar to those developed by Godelier (2002) for explaining the change affecting organizations, i.e. the construction of "organizational myths" to which agents can refer without questioning the relevance of their actions. These propositions refer both to the property of collective cognitive devices proposed by Favereau (1989) for describing the convention coordination function and to the definition of institutions provided by Aoki (2006) as collective beliefs. These devices are considered as cognitive insofar as they represent knowledge, in particular tacit knowledge. On this account, they facilitate individual action ability and behavior convergence. Furthermore, these devices are collective in the sense that they are generally based on a collective behavior framework. This is a procedure knowledge which is constructed collectively based on the accumulation of experiences and which is transferred as common knowledge for society in which it represents a collective good.

In order to implement sustainable development, it is necessary for objectives to be defined at a collective level. For this purpose, the general principles of the approach are to be determined on a common basis (in relation to a territory and/or actor group) according to the specific stakes of the intervention scale at which actions have to be implemented. Consequently, sustainable development is obviously related to territory governance and is used as a tool for increasing participation and opening conditions which are co-substantial with the sustainable development logic. Accounting for sustainable development requires re-defining conditions and methods as regards decision-making assistance and assessment (Rey-Valette and Roussel, 2006) in order to rise above the rational trade-off based on a scientific and technocratic logic defined by a superior rational and abstract interest in favor of a general interest currently defined as "*a compromise between private interests*" (Calame and Talmant, 1997). In this type of context, governance has to take into account and improve the various points of view and situations while ensuring their interdependence. This involves two conditions (whatever the fields and scales under study): defining a partnership and combining areas and

temporalities. Such a stake centralizes the mediation issue and obviously contributes to increasing the range of actors which are involved, interviewed or considered. Thus it appears that the familiarization process with the new reference system, which is introduced by sustainable development, is a complex process (Rey-Valette and Chia, 2007) and involves various information, familiarization and institutionalization phases. Analyzing this process requires understanding the actors' training and information conditions (human capital), and how they are integrated in social networks (social capital). It also requires understanding the transmission and impacts of normative frameworks and general rules, which depend on regulatory tools and directives and more generally on the epistemic community.

It is then necessary to construct an institutional analysis and assessment grid for public policies which can be used for describing the role and situation of these various factors within a systemic logic. In this logic, figure 1 shows a structural representation of regulatory systems which contribute to the governance process analysis. This figure particularly emphasizes on the combination of the various elements and three components are defined: decision process, implementation device(s) and information system. It partly represents the distinction introduced by Institutional Economics between the institutional environment level (formal and informal) defining the rules of the game (standards, representations, formal rules in the decision-making process) and the institutional arrangement level enabling to understand implemented "instruments" and practices. However, it should be noted that aquaculture regulatory systems are superimposed or linked with other regulatory systems developed in close or more general sectors. In the case of fish farming, the regulatory system is often linked to that of fishing, agriculture, protected marine areas, etc., and to the national or even international regulatory system, including more or less formal dimensions according to fields of study.

This analysis grid underlines regulatory measure implementation conditions, in particular the nature, legitimacy and efficiency of institutions which are at the origin or in charge of applying theses measures. Consequently, this grid refers to Ostrom's work (1990) and in particular to the structural representation of the management process (*Institutional Analysis and Development framework* » (IAD)) applied by Rudd (2004) to fishing management. During the 90s, public policy assessment works have shown that the efficiency and impact of policies and measures depend on the conditions in which they are designed and applied. A management measure is not systematically efficient as its efficiency depends on its adaptation to local conditions and on what institutional arrangement it is based on. The legitimacy of the institution in charge of its implementation and construction process is as relevant as its results regarding efficiency. Consequently, participating in these processes and considering institutional devices in which these policies are designed and managed are key steps in the governance issue. This leads to analyzing the behavior of groups of actors, their history, how they are mobilized, their organizational and institutional learning abilities, their proximity and familiarity with objects and reference systems.

This type of approach is used for taking into account the role played by actors' networks (whether it is structured or not). Actors are located on a given territory and are directly or indirectly involved in the management process whatever their legitimacy. In this aim, the analysis grid schedule focuses on the following points:

Morphology of the actors' system: the aim is to identify the actors which are involved and how they are integrated in the decision-making process (rule construction) and in regulatory mechanisms (application and supervision). Actors' legitimacy is a decisive factor for applying measures.

Interactions between actors' dynamics and information. The interactions existing between actors are organized based on agreements, rules and more generally institutional devices. The structure of information transmission (general, technical and strategic information) is partly based on these devices and vice-versa.

2.2. The role of representations in sustainable development appropriation

Social representations have a decisive role in regulatory systems. They may act as filters both for constructing and applying regulatory devices. This action depends on the type of governance being implemented as sustainable development requires the implementation of governance structures based

on actors' participation. This implies a new political partnership between private actors and public authorities. The fact that actors applying measures are not involved in the decision-making process generates conflicts at the implementation level due to the potential gap existing between the management measure content and its mode of application. As a result, the choice of actors involved in decision-making is of great importance. In reality, each of them must comply with the common representations of the group which they represent. However, based on general sustainable development reference systems, private and public actors have their own views regarding this concept and a different understanding of the hierarchy of objectives, implementation procedures and possible solutions. The actors' participation in decision-making processes is more or less active and gives social representations a significant role as the decision which is to be made will include the transposition of general reference systems resulting from the convergence (more or less significant) of the stakeholders' social representations (assessment of constraints, risks, issues, etc.). Moreover, the application of national and local decisions depends on representations and also on the governance system implemented upstream, i.e. at the decision-making level.

The speed at which new regulations will be applied and above all make up a new reference system not only depends on their "fairness" or legitimacy but also on how actors will view them (as action guidelines and as a reference system). For example, some regulations will encounter a certain opposition from agents responsible for their application or implementation insofar as they modify their practices, positions, etc. As a result, defensive routines (Argyris and Schön, 1996) will develop. These behaviors depend on the situation of agents and above all on the representations they have of regulations and their position in the new situation.

This underlines the need for understanding the speed at which sustainable development is accepted and implemented and for studying representations that actors have of sustainable development and of its application. We have assumed that the representation analysis will contribute to exploring the relationships and conflicts existing within a regulatory system as well as the adaptation conditions of governance to new sustainable development issues. These relationships and conflicts are *a priori* expressed at every level, they are diversified and have various and complex origins. Representations are defined as "*forms of knowledge, which have been socially constructed and shared, with practical designs and which are employed for the construction of a reality shared by a social group*" (Jodelet, 1989). This definition refers to a form of practical common knowledge allowing actors to act according their personal views of the world. They include opinions, information, beliefs, pictures, etc., i.e. a combination of semantic and cognitive references which are activated in a specific context according to the goals and interests of social actors for communication, understanding and environmental control purposes. Social representations constructed by individuals are shared by more or less large groups and give these groups collective identity cohesion. They represent understanding and interpretation systems for the social environment as well as behavior assessment systems which are employed for developing reference action models.

Particular attention is given to the way sustainable development can increase the territory and social identity of the fish farming sector in its operating areas. This local and territorial sustainable development appropriation process requires specific translation, participation and involvement procedures for the actors (Callon and al., 2001). As noted by Jodelet (1989), the aim is to "create new from old", i.e. modifying representations required for the convergence between actors involves a prior deconstruction phase. The following figure is a brief description of the four-step process which involves specific research issues at each stage.

Thus, the first construction phase entails studying existing reference systems, how the sustainable development application initiative is introduced and where (scale and status of the source organization) in the regulatory system, and lastly, what are actors' representations. These different knowledge characteristics and elements can then contribute to developing representations towards sustainable development objectives which will have been discussed and confronted during the first phase.

Fig. 1: Structural organization of regulatory systems

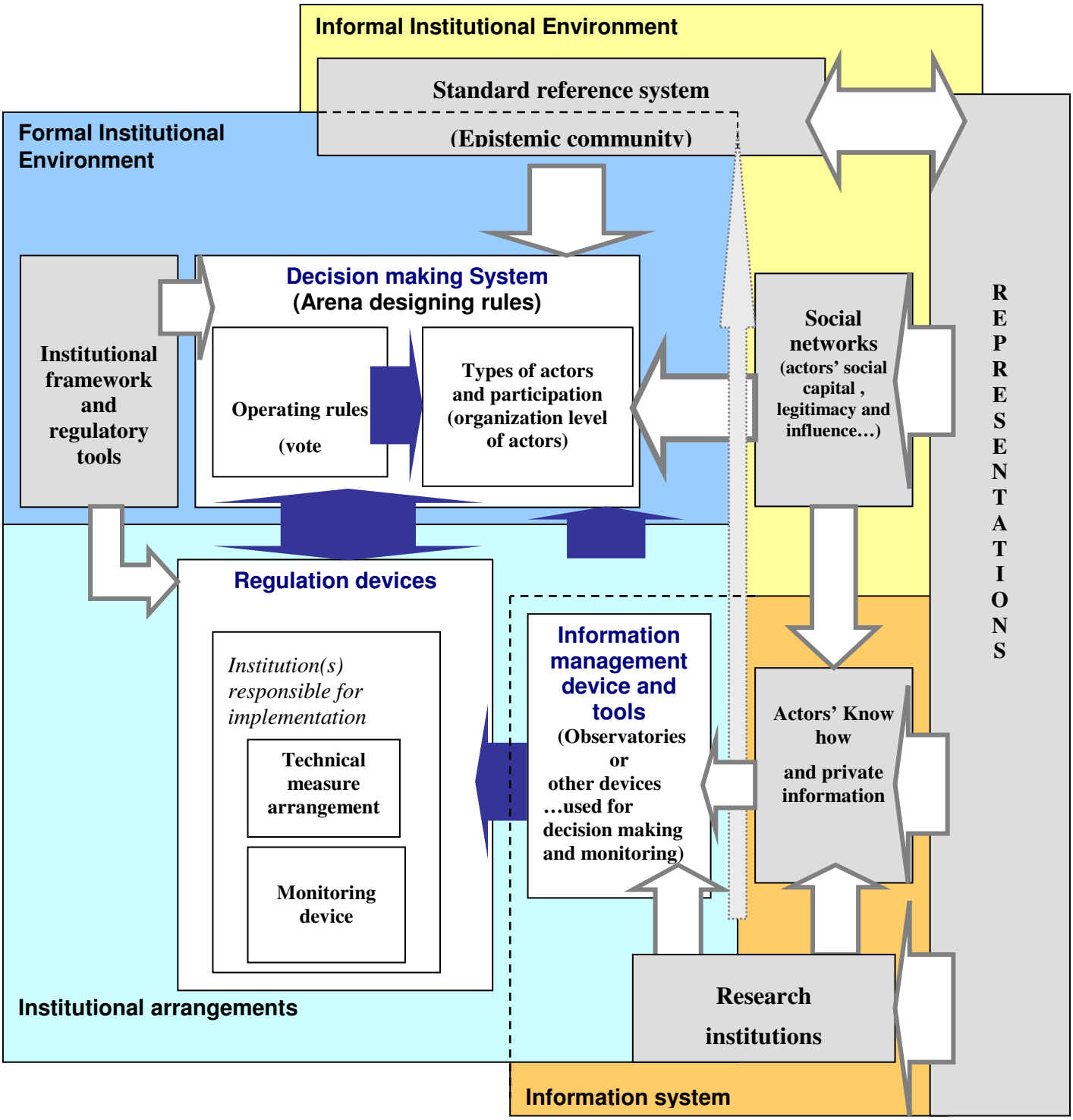
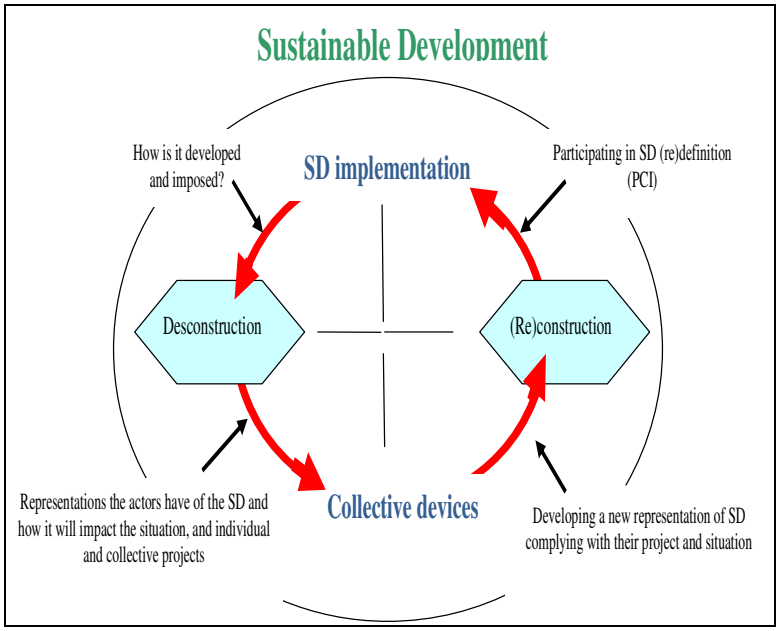


Fig. 2: Sustainable development reference system appropriation process



3. Application to aquaculture systems

The proposed analysis grid is used for identifying key subjects for sustainable development appropriation and for organizing surveys into several complementary components concerning the analysis of regulatory systems and representations. The number of surveys has been determined according to the significance of aquaculture systems at the scale of each site. Face-to-face interviews were conducted based on surveys which gave rise to various statistical data analysis processing operations as well as to textual analysis (only for representations).

3.1. Governance and aquaculture regulatory system analysis

The structure of regulatory systems has been analyzed according to (formal and informal) arrangements, the degree of constraints as well as to the role and origin of information. A specific section of the survey for agriculture farms has been used for understanding this problem. For all of the sites, 128 surveys have been conducted overall for different types and sizes of agricultural farms. A reference classification has been defined previously based on an expert opinion, by researchers and local project partners (national research centers in aquaculture or professional organizations). Three to four categories have been identified overall on each site. As these surveys are framework surveys carried out over a relatively long period and due to organizational and financial constraints, the number of surveys has been restricted. Each reference category has been completed and the variability within each of these categories has been taken into account. Thus, a high sampling rate on sites with a relatively low number of farms shows the existence of significant particularities.

Table 1. Description of farms surveys by country

	Brittany	Cameroon	Indonesia	Mediterranean area	Philippines
Number of fish farms	46	150	4 010	18	1 771
Number of surveyed farms	8	13	56	12	30

Data collected from surveys have been used for determining a typology for regulatory devices based on Multiple Correspondence Analyses (MCA) (Lazard et al., 2009). Based on 32 initial qualitative variables characterizing regulatory systems (constraint level, organization level, social networks,

conflicts, access to information), the statistical analysis was used for identifying 4 key variables according to which the typology of regulatory systems was determined (Table 2).

Table 2. Characterization of aquaculture systems according to regulatory procedures

Unregulated systems (liberal logic)	*Regulated systems (in an informal manner)*	*Regulated systems (in a formal manner)*	*Strong formal regulation*
1. Farms do not belong to cooperative or professional organizations 2. No formal or informal constraints 3. No inspection	1. No formal constraints 2. A few inspections 3. Low informal constraints 4. Farms do not belong to cooperative or professional organizations	1. An average number of farms belong to cooperative or professional organizations 2. Low or average formal constraints 3. A few inspections 4. No informal constraints	1. High formal constraints 2. Many farms belong to cooperative or professional organizations 3. Regular inspections

The four types of regulatory systems are differentiated based on their size related to the increasing involvement of formal devices as well as by the level of professional organization of the sector by formal institutions acting as formal regulatory tools. It should be noted that the distribution of farms included in the survey from the different groups shows that they are transversal regarding divisions per site and the distinction between developing countries and developed countries.

Table 3. Distribution of farms according to the type of regulatory systems identified

Unregulated systems (liberal logic)	*Regulated systems (in an informal manner)*	*Regulated systems (in a formal manner)*	*Strong formal regulation*
75 exploitations (50% of exploitations)	25 exploitations (8% of exploitations)	10 exploitations (12% of exploitations)	30 exploitations (30% of exploitations)
Cameroon: from 10 to 13 Philippines: from 30 to 30 Indonesia: from 35 to 56	Cameroon: from 2 to 13 Mediterranean area: from 3 to 21 Indonesia: from 8 to 56	Mediterranean area: from 8 to 21 Brittany: from 2 to 8	Mediterranean area: from 10 to 21 Cameroon: from 1 to 13 Brittany: from 6 to 8 Indonesia: from 13 to 56

3.2. Representation analysis

The analysis of actors' representations has been completed by characterizing current reference systems concerning sustainable aquaculture. Accessing representations is difficult because it requires understanding actors' "action modalities" and not the "justification model" which they tend to underline at first during interviews (Argyris and Schön, 1996). In order to analyze aquaculture systems, specific surveys have been carried out. These surveys have taken into account the actors' representations regarding (i) their current activity and perception of the aquaculture sector, (ii) their definition of sustainable development and (iii) the means to be implemented for developing a sustainable aquaculture branch. Overall, 168 surveys were carried out in different countries (Table 4). All stakeholders involved in aquaculture have been surveyed.

A large sample of actors belonging to the production industry and to various institutions related to the implementation and application of sustainable development (Ministries, administrative services, NGOs, producer organizations, local governments, trade unions, etc.) have been surveyed. The aim was to underline representation differences based on the type of actors and on a functional typology according to the institutional position of actors and their familiarity with the industry and sustainable development. Only a few fish farms, which had been surveyed initially, have been included in this second survey. The most representative and receptive farms were chosen. The aim was to understand the actors' position and action logics: Who are they? What are they talking about? These surveys were followed by a textual analysis enabling to characterize the perceptions expressed by surveyed actors using key notions. The different types of perceptions were accounted for by classifying these notions

in several synthetic categories. Then a statistical analysis was conducted with the data used for identifying general types of representation in each country and for all countries under study. Lastly, based on correlation analyses, a study was carried out on the relationships existing between these types of representation and actors' statuses.

Table 4. Description of representation surveys by country and type of actor

	Brittany	Cameroon	Indonesia	Mediterranean Sea	Philippines	Total
Industry actors	8	2	16	9	14	49
Institutional actors	18	8	18	24	15	83
Fish farmers	4	5	14	7	6	36
Total	30	15	48	40	35	168

These analyses have been used for accounting for representations that actors have of aquaculture and their profession, thus of the routes via which aquaculture could be developed towards sustainable aquaculture. However, questions regarding their perception of sustainable development could not be used due to a very high non-response rate. On average, only 65 percent of actors answered the survey which shows that they do not know very much about sustainable development and that they are not very familiar with it. However, it is interesting to underline that the non-response rate distribution is strongly linked to actor categories. It only varies between 20 percent for farmers and 80 percent or institutional actors whereas professional aquaculture actors (suppliers and distributors) have an intermediate position (63 percent of them have answered the survey).

Concerning sustainable aquaculture, three main types of representation have been identified and they cover the three pillar of sustainable development:

- a socially and territorially integrated aquaculture focusing on aquaculture nutritional and landscape functions,
- a "managed" economic vision of the industry focusing on activity durability conditions, product quality and environmental impact control,
- an ecological view of the activity which participates in water quality preservation and in the multi-functionality based on the environmental "supervisor" role played by producers.

Survey results show that fish farmers have diverse points of view: they do not have (or do not share) a common representation of their activity. This situation could be due to cultural and historical individualism and/or to the geographical dispersion of the activity and/or even to a lack of professional organization. These representation differences increase when professional responses are compared with the responses of other stakeholders.

Representation differences between actors involve divergences in coordination devices (forums, arenas, institutions, etc.) aiming to define decentralized institutionalization modalities for sustainable development. Due to the significance of representations in decision-making, their convergence or combination is positive for actor coordination. In the case of aquaculture, actors are positioned in relatively conflict arenas (Mediterranean area and Brittany) or in cohesion areas (Indonesia, Cameroon, and the Philippines). Based on these distinctions, developing and developed countries are divided according to the different significance levels of formal regulatory systems and to the conflicts existing between techniques employed in aquaculture areas. As noted before, it is obvious that these perceptions depend on the status of stakeholders. For example, in Brittany, institutional actors and producers have conflicting points of view about the environmental impacts of aquaculture. Institutional actors consider aquaculture as a polluting activity with use conflicts (resources and areas) and producers consider it as part of landscape and water quality (monitoring). However, actors share a common representation in which aquaculture plays a significant social role in food security and social cohesion.

The analysis of these results underlines that there is no common vision and/or professional cohesion between producers. However these two fully interactive factors are decisive conditions for sustainable

development appropriation. The fact that industry is insufficiently structured is a constraint as regards information transparency; information is often incomplete and rarely shared. From a dynamic point of view, actors' participation to these arenas can contribute to changing their individual representations (if they are not conflicting) and to creating a progressive coordination process favoring the convergence of individual representations with respect to a median representation constructed collectively. Information production and training may also contribute to collective learning processes and provide a common diagnosis for a problem of global interest.

4. Integrated coastal zone management and aquaculture

The sustainable development aquaculture must also be analyzed according to implementation territories based on an integrated ecosystem management approach by considering all current uses and activities. The local scale is the most operational level for implementing sustainable development (Piraux et al., 2006). This is due to the fact that sector interactions, relationships existing between nature and society, synergies and links between various public policies are easier to analyze at a local scale. This particularly applies to economic incentives and legislations favoring species, habitat or water resource conservation, for example Natura 2000 network conservation policies which provides a European eco-label to territories implementing these policies. As regards coastal zones, since the Rio Summit, Integrated Coastal Zone Management (ICZM) approaches aiming to apply sustainable development principles to coastal zones have been promoted.

ICZM policies are an opportunity to define and to make relationships between aquaculture activities and other activities on the territory evolve. Indeed aquaculture farms have severe constraints for the access to sites wherever there is strong request for land.

Request for the creation or the extension of a farm are examined case by case, according to procedures where aquaculture is considered as a conflicting and polluting activity. At the same time, looking at the excessive development of urbanisation and of a residential economy on the coast, strategic schemes for sustainable development elaborated at different scales give rise to the interest to maintain productive activities and the need to consider ecosystemic services produced by primary activities.

Some application initiatives of this approach in aquaculture have been realised, giving rise to the concept of 'Ecosystem Approach for Aquaculture (EAA)', which requires an enlargement of research fields and a renewal of practices towards an interdisciplinary approach, co-construction methods which integrate traditional and scientific know-how, and a multiscale approach.

These initiatives are still few and recent (Fleetcher et al., 2004, FAO-UIB, 2007) and too often thought in a sector-based way, independently from the perspectives offered by the ICZM policies. Indeed, as soon as a sector evolves towards sustainable aquaculture, the realisation of a ICZM constitutes a strategic opportunity to rebuild the image of aquaculture and its contribution to the territories where farms are located, and therefore to remove the present blocks to land access, within a concerted spatial planning.

It is therefore important to define the logics and the means for ICZM policies in which sustainable aquaculture should be integrated.

4.1. Brief synthesis on Integrated Coastal Zone Management (ICZM) and its implementation in the Mediterranean

Several initiatives were undertaken and recommendations were provided the realisation of the ICZM, under the push of international organisations who defined its key principles.

Several methodological guides were published to favour their adoption (UE 1999, UNESCO 2001, UE, 2002, IUCN 2004). In France, following a report by DATAR (2004) in parallel to thought from the Ministry of Ecology and Sustainable Development and an evaluation of the Commission Environnement Littoral in 2002, a report was prepared by DIACT (2006), following the Consultation of member states on the application budget for the Recommendation of the European Parliament and Council dated 30 May 2002 relative to the realisation of an integrated management strategy of European costal zones.

In the Mediterranean, concerns on sustainable development started in 1994, with the PAP/CAR protocol, realised by the PAM and the Mediterranean Commission for sustainable development since 1996. Several initiatives followed the elaboration of directives for the ICZM in the Mediterranean by the PNUE in 1995, the evaluation of experiences of ICZM of the METAP and of the PAM in 1997, a practical guide for the PAC projects in 2000 and a White Book on the management of coastal zones in the Mediterranean in 2001 (PNUE/PAM/PAP, 2001).

More generally, a trend for the construction of sustainability indicators for the Mediterranean coastal zones in 1999 and the elaboration of a management strategy at Mediterranean level in 2005, associated to the budget of the Blue Plan (Plan bleu) defining the perspectives for the environment and the development, could be seen. In 2001, an evaluation of the ICZM experiences was performed with the project « Principles of best practices for the integrated management of coastal zones in the Mediterranean » of the Mediterranean Action Plan. Finally following various working groups (PAM/PNUE, 2006), a protocol relative to the ICZM in the Mediterranean was elaborated by the PAP/RAC (Priority Actions Programme/Regional Activity Centre) (UNEP/PAP/RAC, 2008), with the aim of establishing a guide to help Mediterranean countries to define their national strategies for ICZM.

4.2 Land planning and the voluntary agreements for the realisation of ICZM

ICZM cannot be associated to a standard definition, it is defined as an integrated and concerted management, the coherence of which should be thought of at territorial scale and that necessitates the pooling of experiences from experimentations with guidelines for good practices rather than standardised regulation. It is a land policy the realisation of which has an experimental character following the principle: 'think globally, act locally', which favours local arrangements within the respect of general principles. There is an important pluralism of the definition produced and taken as references according to the areas (Bodiguel et Rey-Valette, 2006; Rolland, 2005, Rey-Valette et al., 2005).

In all cases, the accent is placed on the importance of dynamic, adaptive, participative and interactive aspects; the integrated character applies to the aims, the tools, the action domains, the spaces and naturally the different topics in order to adapt the analysis grids (CEL, 2002). In the Mediterranean the collection of principles for the ICZM policies apprehends it as a *«permanent, proactive and adaptive process of management of resources for the sustainable development in coastal zones »* (PNUE/PAM/PAP, 2001).

In order to be realised, ICZM policies require to respect the following properties:

As integrated policy and in the long term, ICZM should be developed within a conceptual framework of spatial planning. The DATAR (2004) definition locates ICZM as a policy for land management which enables the protection of certain areas, as response to environment conservation aims.

The entrance through the land enables:

(i) to push inter-sector synergies while beneficiating from positive externalities linked to the proximity and to locally coordinate public policies measures,

(ii) to manage conflicts between uses and/or populations, the increasing mobility of which leads to divergent perceptions and expectations, and

(iii) to consider the plurality of the stakeholders and of the present interests while favouring the participation of population to the policies.

The work prior to the Mediterranean ICZM protocol (PAM/PNUE, 2006) identified two constraints or conditions prior to a good functioning of the ICZM:

(i) capacities of realisation laying on an experience of land management and

(ii) the absence of a too strong pression of the local lobbies.

Two operational tools were presented for their contribution to these ICZM policies and local planning, that is:

(i) integration of the obligation of the environmental evaluation in all projects and

(ii) use of traditional tools for land management.

The accent placed on spatial planning leads to favour the tools for land management in various situations. As concerted policy, ICZM implies processes of engagement and voluntary agreement. The pluralism of the present expectations and values calls into question the management fore ideas of the conflicts for a functional specialization of space. ICZM policies are affected by a second generation of land management tools based on the elaboration of a chart for sustainable development for a collective and sustainable project for the areas concerned and which necessitates voluntary agreements.

This dynamic is inscribed in a more general framework of the transformation of the 'philosophy' of areas development tools and more generally of environment management that evolved towards more pragmatic tools from the collective action, with a particular development of procedures from voluntary agreements, in particular in the process emerged from negotiation actions. The devices for voluntary engagement cover different forms of devices according to which the industry voluntarily agrees to improve the environmental performance, though voluntary agreements, environmental charts, codes of good practices, progress contracts... This type of tool often derives from an engagement on a common principle by creating obligations and duties among members of a group. Also in the case of ICZM in the Mediterranean, practices based on voluntary agreements of the stakeholders are presented by the evaluation of pilot projects (PNUE/PAM/PAP, 2001), as a path favourable to the realisation of ICZM procedures.

Various projects therefore propose to favour the evolution of activities toward sustainable practices, especially sustainable tourism (training for the project relative to Venice Lagoon, realisation of a guide book for sustainable tourism for the Project Ulixes 21), ecotourism, or organic agriculture within the SFAX project. The accent set on the participation requires tools to share information and suitable institutional governance devices. As far as the realisation of the ICZM is concerned, the institutional context represents the main factor, often as a constraint conditioning actions coordination, whereas issues on access to information, insufficiency of local authorities coordination and balance of sector representations are considered as decisive.

Though still very few, the evaluation steps for the realisation of the ICZM which have been realised (UE, 1999, PNUE/PAM/PAP, 2001, CEL, 2002, Hénocque et Billé, 2005, Hénocque, 2006) stress the weakness of the institutional dimension of the realisation. The report of the Commission Environnement Littoral (CEL) (2002) puts forward the institutional dimension of the ICZM. Some ICZM projects in the Mediterranean, such as the PAC Syria, evoke the need to create favourable conditions for the introduction of tools and techniques of ICZM and underline the difficulty of the administrations to introduce innovative tools and actions. Exchange of and access to information is also a strategic and determinant issue. The elaboration of suitable information tools also represents one of the essential tools for ICZM.

The protocol relative to ICZM in the Mediterranean (UNEP/PAP/RAC, 2008) puts forwards some balance notions (cautious exploitation of natural resources and environments), of equity (harmonious sharing of uses) and anticipation (beforehand risk identification). It stresses the need to establish a common base of necessary information, the need to establish guidelines and codes of practices for all the sectors and on the realisation of a suitable governance facilitating the participation, the strengthening of inter-sector organisations and more generally the recourse to policies of local planning.

The conditions for the realisation of a suitable governance were debated within the working groups, especially three articles of the project (PAM/PNUE, 2006) protocol relative to the institutional coordination (article 6), to the participation (article 12) and to the awareness and training actions (article 13). Table 15 reports in details the recommendations and the discussions about these recommendations.

Table 5. Recommendations and discussion relative to the realization of ICZM in the Mediterranean.

Institutional coordination	Participation	Sensibilisation training and extension
Recommendations of the project for the ICZM protocol		
- develop a global approach enabling a inter-sector coordination - reinforce the coordination between land and marine domains - push towards the coordination between steps	- secure the participation of populations in th elaboration and the realisation of the ICZM, - create consultative organs, public enquires, partner making - realise means of access to the information, of the procedures of intermediation and conciliation - check and protect the existence of resort	- foresee communication and research actions - foresee training of the public at different scales - favour multidisciplinary research
Synthesis of discussions fro the realisation of recommendations		
- to control the applicability while considering political structures in the different countries - to strengthen experience. - to extend the coordination measures to the civil society and ONGs - to be stock-taking of the issues concerned and to avoid the creation of new institutions - to develop an institutional culture on the steps to be undertaken and the recommendations to be followed while avoiding normative measures.	-to reactivate Barcelona Convention of the public participation to decision making (strengthened by the Aarhus convention and the Maputo protocol) -to accompany the recommendations with examples in order to facilitate the appropriation of these steps and not to scare off -to help in the definition of the stakeholders -to spur on the innovation in the process of partnership, especially with the public	-to favour cooperation between research and stakeholders -to favour the sharing of data with accessible synthesis for the complex processes. -to restructure existing research centres with ICZM issues

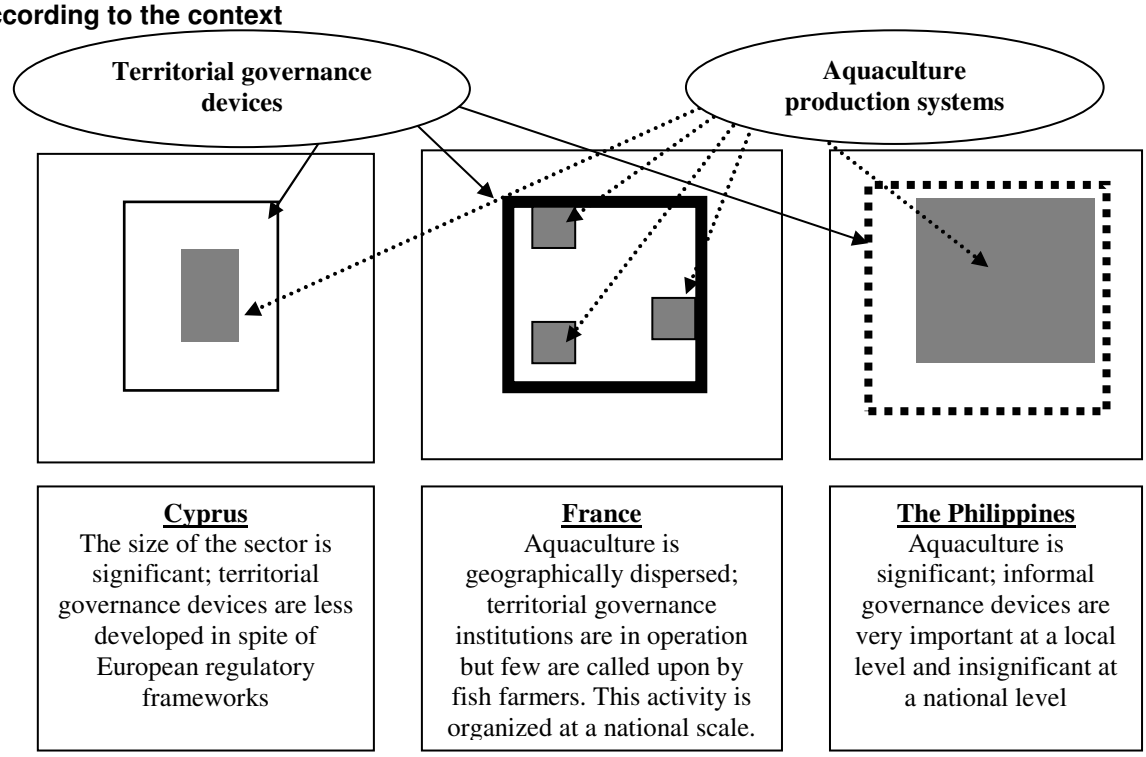
4.3 Consequence for aquaculture: example of EVAD's results

With this new integrated territorial management approach, aquaculture (as well as fishing and other industries) is moving from a sector logic to an industry-based logic. The aim is then to determine how aquaculture can be integrated in these devices (in countries where these orientations have given rise to formal regulations for territorial management) or more generally to analyze territorial dialogue conditions of the activity with other activities and uses.

Our survey results show contrasting situations according to the various contexts (see Figure 3) depending on restrictive dialogue factors. Whatever the situations, a lack of sector (and industry) transparency and integration is observed in these new arenas and local governance systems.

Three cases are described in the following diagram showing the diversity of constraints encountered: in the case of France and Cyprus, a low participation of fish farmers to ICZM devices was observed. In Cyprus, this is due to the lack of real and institutional organizations. As regards integrated management approach, European regulations are more a prescription than a reality. In France, the geographical distribution of professionals is too significant for impacting local arenas. Furthermore, their environmental image viewed by public and local institutions is not good even though it is often unfairly overrated. This territorial division is due to legal constraints relative to the environmental impact assessment obligation in the context of "Environment Classified Facilities" procedures limiting farm extensions and new installations when there are significant urban and tourist conflicts. In France, professional organization and dialogue with institutions remain at national and sector-based levels. Professional representation modes at the local scale must be discovered. In the Philippines, regulatory systems are less developed and/or remain informal. Due to its significance, the sector could impact area planning. However, the outlines and territorial dialogue devices likely to support area planning policies are non-existent. Each case shows the need for collective action on local governance devices and professional organization levels and forms.

Fig. 3. Comparative analysis of interactions between sectorial and territorial organizations according to the context



5. Conclusions

Analyzing sustainable development appropriation conditions and procedures in the case of aquaculture underlines the significance of socio-technical and organizational learning processes. In this paper, governance seems to be closely related to sustainable development and can be considered as its 4th pillar. Various methods, approaches and procedures facilitating this translation mechanism can be considered for sustainable development. These approaches must be supported by groups of actors at a territorial scale based on general reference systems. The specificities of the learning process described above are based on the assumption that there are interactions between down normative reference systems distribution and bottom up appropriation actions via the progressive integration of this process in various projects. By studying the representations that fish farmers have of sustainable development and its impacts on their production system, we have attempted to understand the contextualization process, and in particular, the governance devices of sustainable development. Our first results show that fish farmers have not often heard about sustainable development and that national strategies and regulations are either non-operational or unknown to fish farmers. Thus, they do not yet represent an action framework for the implementation of sustainable development. Actors are to determine collectively what should be done at a collective, as well as individual, level at which they shall decide how this (re)definiton of "values" and strategies (Argyris and Schön 1996) will prompt them to modify their practices and action models. The aim is to verify the collective character of the governance process, and in particular that devices favor the equity and representativeness of actors subject to a collective organization and the construction of a common vision of the fish farming activity. If this is not implemented, local governance shall remain a vain dream.

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ANNEXE 3

Analysis of the standards and indicators for sustainable development of aquaculture

Syndhia MATHE, Hélène REY-VALETTE, Olivier BRUNEL, Olivier CLEMENT, François RENE, Jean-Paul BLANCHETON

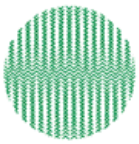


TABLE OF CONTENTS

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

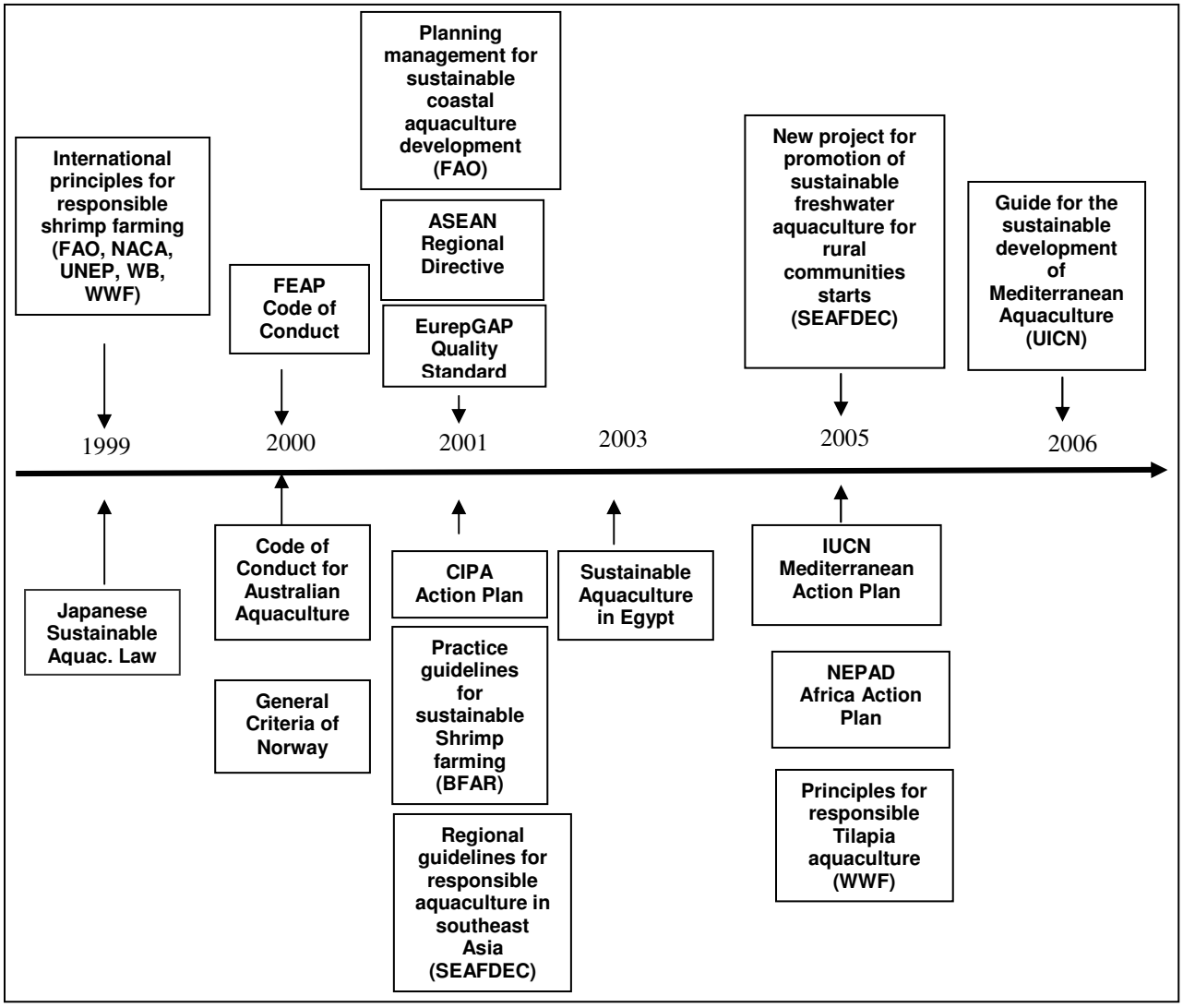


Table 3. The principal standards according to obligation and decentralisation levels

	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

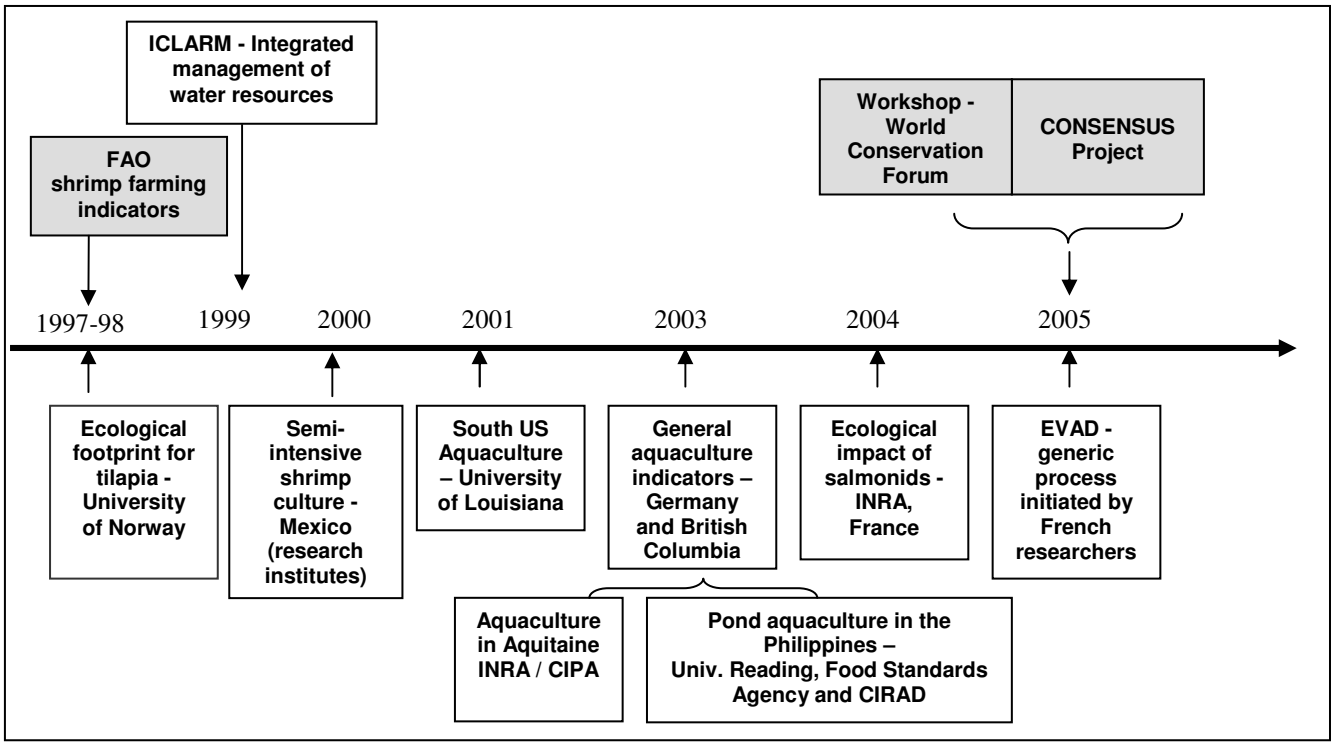
available, were defined through expert research. Some indicators were thereafter expanded and validated by a survey among management entities from different countries. The process was done thematically, in accordance with the sustainable development pillars, the indicator categories being: biophysical 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.

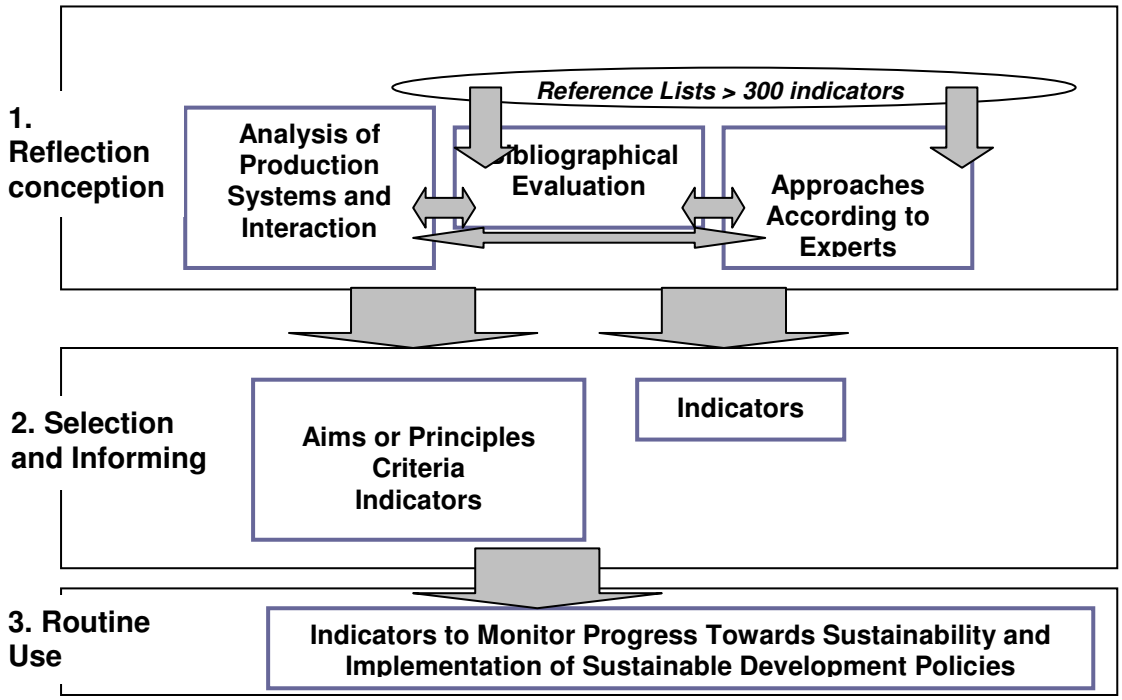
3.2. Analysis of the initiatives with regard to methodology

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).

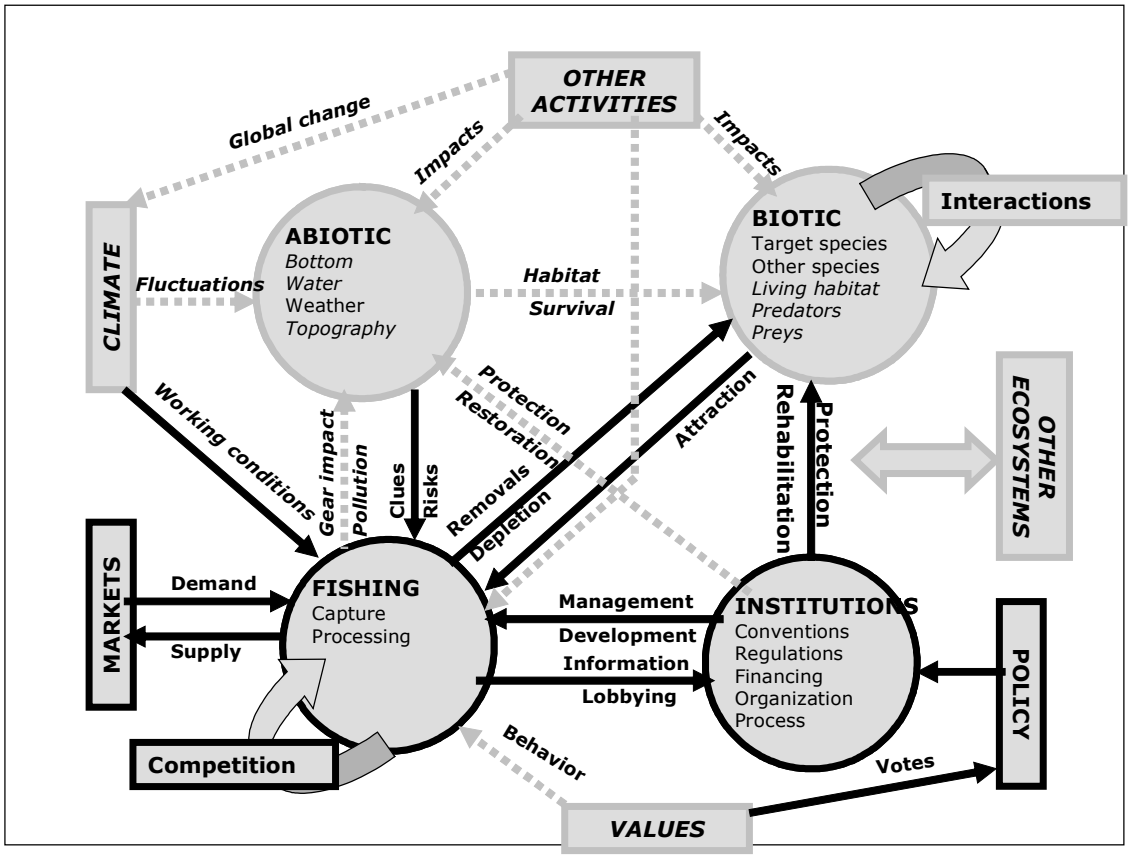
The development of indicators requires a standard allowing the nature of indicators to be precisely defined. The reference framework is most often the one produced by the OECD in 1993 (PER or DPSIR, cf. Table 4), which proposes distinguishing indicators according to their nature, i.e. the type of information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

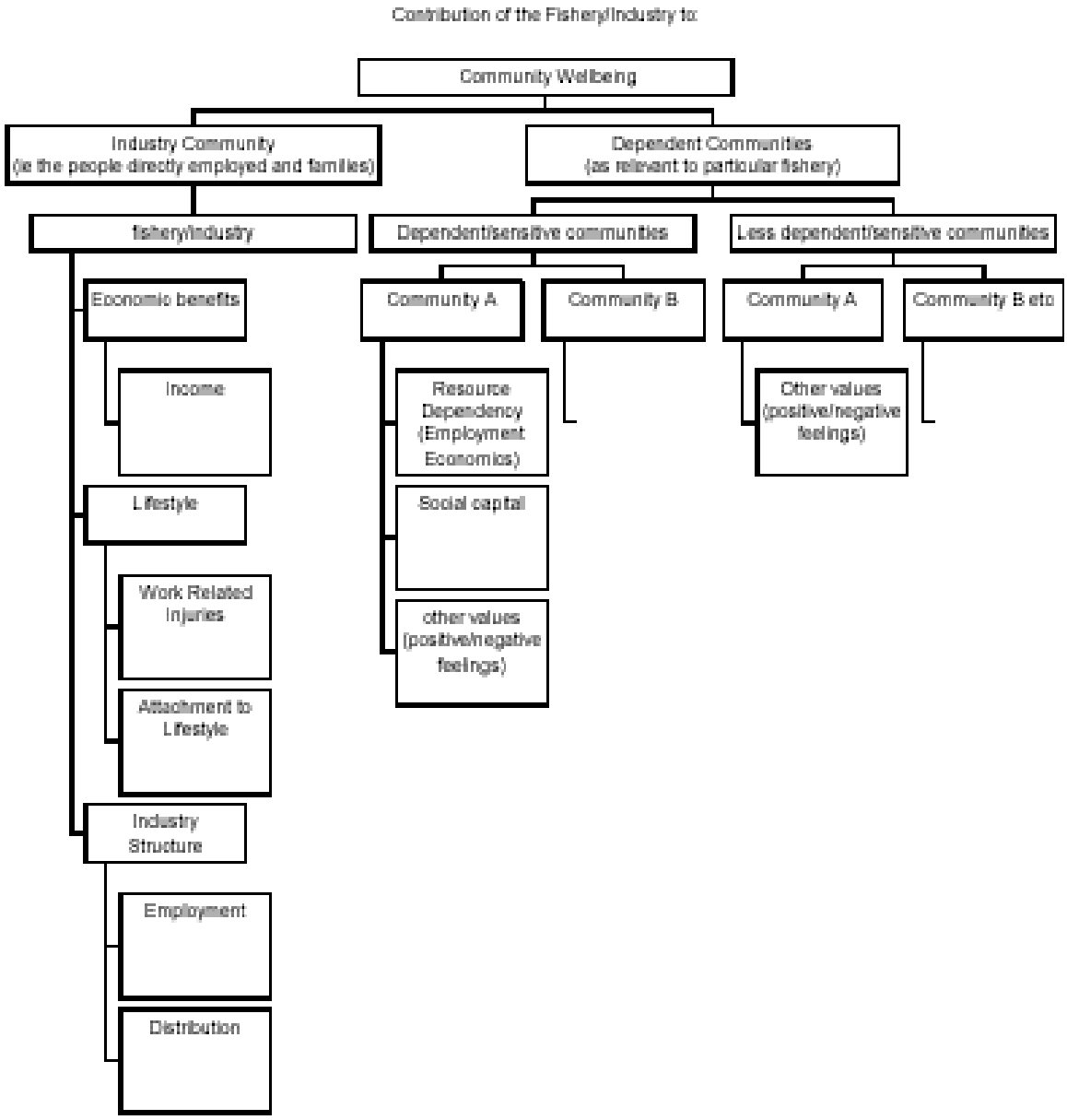
Figure 4. Framework for analysis of processes for fishery pressure indicators



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



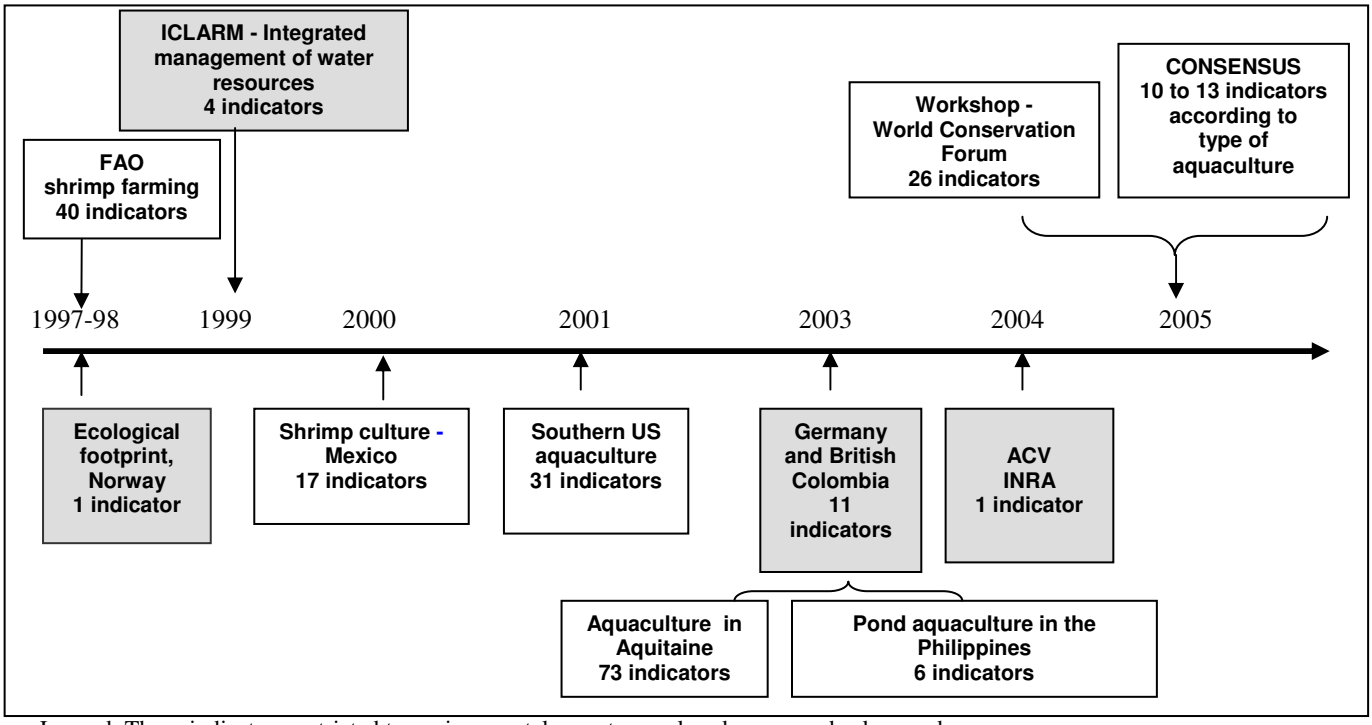
Source: Fleetcher et al. 2000

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

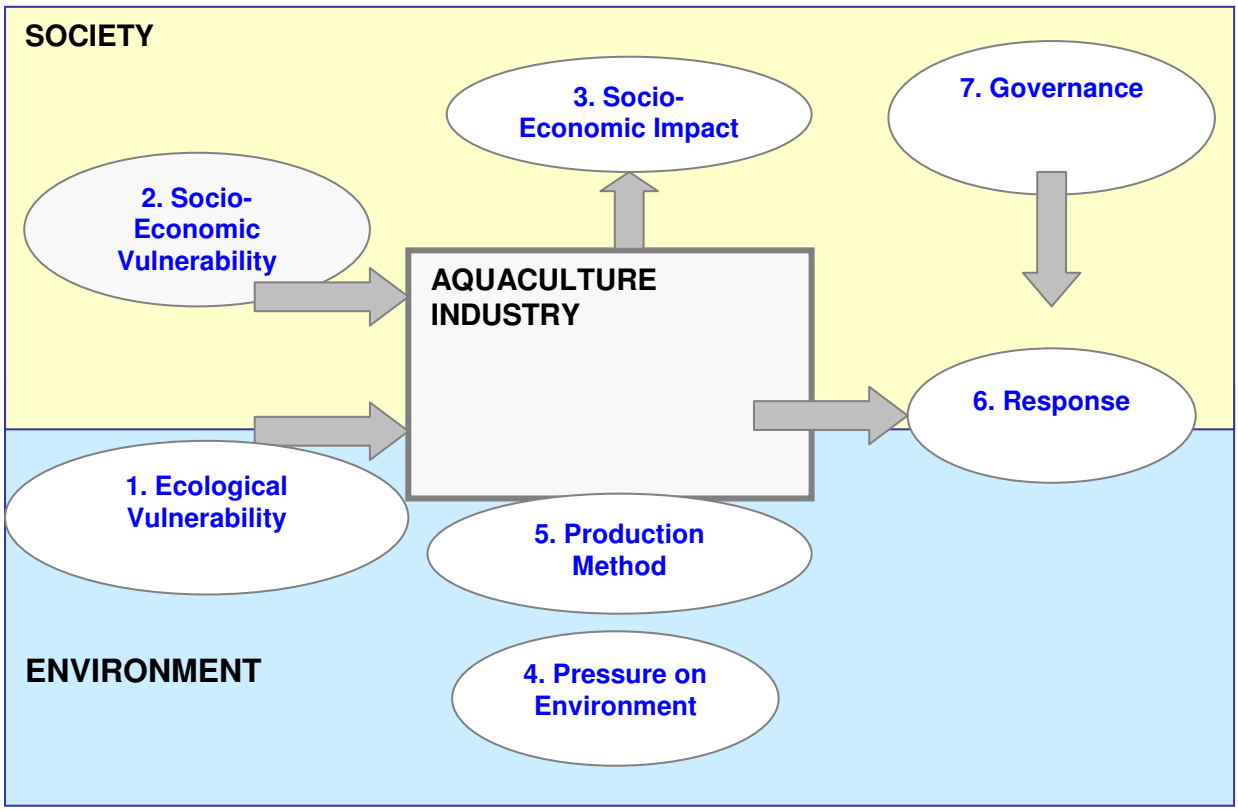


Table 6. Typological classification of the indicators inventoried

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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ANNEXE 4a
Participants to the InDAM project

	Name	Affiliation	Country	Montpellier I meeting	Montpellier II meeting	Pilot study in Turkey technical meeting	Pilot study in Tunisia technical meeting	Salambo 1 year of activities final meeting
1	Evi ABADZITHOU	Kefalonia Fisheries S.A.	Greece		x			
2	Safa ABDOULI	CNA	Tunisia				x	
3	Hüseyin AKBAS	MARA Izmir Province	Turkey			x		
4	Ayça AKSOY	WWF Turkey Office	Turkey			x		
5	Joël AUBIN	INRA/UMR SAS	France	x				
6	Pablo AVILA ZARAGOZA	Empresa Pública Desarrollo Agrario y Pesquero	Spain					x
7	Zouheir BADER	CRDA (MONASTIR)	Tunisia				x	
8	Ibrahim BALKAS	Gulluk Fishery Cooperative	Turkey			x		
9	Lara BARAZI	Kefalonia Fisheries S.A.	Greece	x	x			
10	Bahadır BASARAN	Derin Aquaculture Equipment Inc.	Turkey			x		
11	Mohmed BECHINA	APAL	Tunisia				x	
12	Hamadi BELAÏBA	ART FIMED/COPEMED	Tunisia				x	
13	Nejla BEN CHICKH	ANPE	Tunisia				x	
14	Mohamed BEN ESSGHAIER	SOGEA / Environnement	Tunisia				x	
15	Wafa BEN HAMADI	CNA	Tunisia				x	
16	Scander BEN SALEM	Institut National Sciences Technologies de la Mer	Tunisia				x	x
17	Mustapha BENDAG	Ministère de l'Agriculture	Tunisia				x	x
18	Ümit BIRKOL	Izmir Fish Farmer Union	Turkey			x		
19	Jean-Paul BLANCHETON	IFREMER	France	x	x			
20	Abir BLANCO	CNA	Tunisia				x	
21	Alain BODOY	IFREMER	France	x				
22	Zied CHAYAH	PRIMA AZURE SOUSSE	Tunisia				x	
23	Hüseyin CAKIR	CAKIR Aquaculture & Fishery Equipment Inc	Turkey			x		
24	Mehmet CATALKAYA	MARA Mugla Province	Turkey			x		
25	Intissar CHARGUI	GIPP	Tunisia				x	

	Name	Affiliation	Country	Montpellier I meeting	Montpellier II meeting	Pilot study in Turkey technical meeting	Pilot study in Tunisia technical meeting	Salambo 1 year of activities final meeting
26	Zied CHAYAH	PRIMA AZURE SOUSSE	Tunisia				x	
27	Hamadi CHTIOUI	CRDA, MONASTIR	Tunisia				x	
28	Maria COZZOLINO	IREPA	Italy	x	x			x
29	Asiye Arzu DELICAN	Akuvatur Mediterranean Sea Foods Inc.	Turkey			x		
30	Abdelkader DABABI	S.A.T	Tunisia				x	
31	Filiz DEMİRAYAK	WWF Turkey Office	Turkey			x		
32	Hayal DEMIRHAN	MARA Mugla Province	Turkey			x		
33	Hayri DENIZ	MARA	Turkey	x	x	x		x
34	Hakki DERELI	MARA Mugla Province	Turkey			x		
35	Sami DHOUIB	WWF	Tunisia				x	
36	Ali EL OUAER	Institut National Sciences Technologies de la Mer	Tunisia				x	x
37	Hüseyin ERDEM	Kılıç Seafood Inc.	Turkey			x		
38	Ahmet ERYIGIT	Ministry of Environment and Forest	Turkey			x		
39	Esen ERGIN	MARA Mugla Province	Turkey			x		
40	Mohamed BEN ESSGHAIER	SOGEA / Environnement	Tunisia				x	
41	Zied GHEDIRA	Master Aquaculture, Association Environnementale locale	Tunisia				x	
42	Hamadi GUERBAJ	CNA	Tunisia				x	
43	Erkan GUMUS	Fisheries Faculty of Akdeniz University	Turkey			x		
44	Mohamed Rochd HADDAR	LUC SONO	Tunisia				x	
45	Mohamed HADJALI SALEM	SIPAM	Tunisia				x	x
46	Houssem HAMZA	DGPA / TUNIS	Tunisia				x	
47	Kürşat IMGA	Dept of EU and Foreign Affairs, MARA	Turkey			x		
48	Boukthir KADRI	G.I.P.P	Tunisia				x	
49	Fethi KAMOUN	CNA	Tunisia				x	
50	Mehmet KARA	Fish farm, Mugla	Turkey			x		
51	Ozge KARDAS	Ministry of Environment and Forest	Turkey			x		
52	Spyros KLAOUDATOS	University Thessaly	Greece	x	x			
53	Abdullah KOKEN	Provincial Directorate of Ministry of Culture	Turkey			x		
54	Mejdi LAHMAR	Ste Aquaculture RUSPINA	Tunisia				x	

	Name	Affiliation	Country	Montpellier I meeting	Montpellier II meeting	Pilot study in Turkey technical meeting	Pilot study in Tunisia technical meeting	Salambo 1 year of activities final meeting
55	Néjib LAROUSSI	CRDA MAHDIA	Tunisia				x	
56	Jérôme LAZARD	and Tourism	France	x				
57	Atef LETAIEF	CNA	Tunisia				x	
58	Alessandro LOVATELLI	FAO FIMA	FAO					x
59	Ahmed MAAMOURI	T.S. Aquaculture. Maîtrise Bio marine	Tunisia				x	
60	Chokri MABROUK	Gouvernorat de Monastir	Tunisia				x	
61	Emrah MANAP	Ministry of Environment and Forest	Turkey			x		
62	Fabio MASSA	FAO GFCM	FAO	x	x	x		x
63	Néjib MEHDIOUB	CNA	Tunisia				x	
64	Leila MGAÏDI	CNA Tabarka	Tunisia				x	
65	Ridha M'RABET	Institut National des Sciences et Technologies de la Mer	Morocco					x
66	Syndhia MATHE	Univ Monpellier	France	x	x			x
67	Hamadi MEJRI	GIPP	Tunisia				x	
68	Foued MESTIRI	GIPP	Tunisia				x	
69	Hechmi MISSAOUI	D.G/P.A	Tunisia				x	
70	Néjiba MISSAOUI	CTA	Tunisia			x	x	
72	Abdellah MOUSTATIR	Ministere de Pêches Maritimes-DPNA	Morocco					x
73	Celalettin MULKUT	Ministry of Environment and Forest	Turkey			x		
74	Noureddine NSIBI	CRDA, Bizerte	Tunisia				x	
75	Abdellatif ORBI	Institut National de Recherche Halieutique INRH	Morocco					x
76	Cengiz ÖNDER	Kılıç Seafood Inc.	Turkey			x		
77	Atilla OZDEMIR	Central Fisheries Research Institute Kasüstü Beldesi	Turkey			x		
78	Ramazan OZKAYA	Central Union for Fishery Cooperatives	Turkey			x		
79	Kamuran PATRONA	Mugla Fish Farmers Association	Turkey			x		
80	Ferit RAD	University of Mersin	Turkey	x	x	x		
81	Francois RENE	IFREMER	France	x	x			x
82	Hélène REY-VALETTE	Univ Monpellier	France	x	x			
83	Pablo SÁNCHEZ JEREZ	Univ. Alicante	Spain		x			
84	Moez SHAÏER	Tunisie Cultimer	Tunisia				x	

	Name	Affiliation	Country	Montpellier I meeting	Montpellier II meeting	Pilot study in Turkey technical meeting	Pilot study in Tunisia technical meeting	Salambo 1 year of activities final meeting
85	Abdelmajid S'HEL	CRDA (MEDNINE)	Tunisia				x	
86	François SIMARD	IUCN	IUCN	x				
87	Biken TANIR	Ministry of Environment and Forest	Turkey			x		
88	Ridha TELILI	D. G./ P A	Tunisia				x	
89	Gulsen ULUKOY	Fisheries Faculty of Mugla University	Turkey			x		
90	Hülya UNAL KORKMAZ	Ministry of Public Works and Settlement	Turkey			x		
91	Marc VANDEPUTTE	INRA/IFREMER	France	x				
92	Aylin VELIOGLU	Aquaculture Dept, Ministry of Agriculture and Rural Affairs	Turkey			x		
93	Omer Hakan YALCIN	Aquaculture Dept, Ministry of Agriculture and Rural Affairs	Turkey			x		
94	Güzel YÜCEL GIER	Dokuz Eylül Universitesi	Turkey	x		x		x
95	Othmane ZOGHLAMI	CRDA / SOUSSE	Tunisia				x	
96	Mourad ZOUARI	Direction Generale des Peches et de l'Aquaculture	Tunisia				x	x
			n. participants	**16**	**12**	**34**	**39**	**16**

ANNEXE 4b
Participants to the InDAM project meetings and events

Evi ABADZITHOU (Ms)
Kefalonia Fisheries S.A.
Livadi, Lixouri
28200 Kefalonia, Greece
Tel: + 30 694-805-9115
Fax: + 30 26710-94171

Safa ABDOULI
Technician
Groupement Interprofessionnel des Produits de la Pêche (GIPP)
Fisheries harbour Tabarka, Tunisia
Tel: + 216 78 674088
Fax: + 216 78 674088
E-mail: wafik.abdouli@gmail.com

Hüseyin AKBAS
Aquaculture Officer
MARA Izmir Province
Universite Cad. No 47, Izmir, Turkey
Tel: + 90 232 3154103
Fax: + 90 232 4622493
E-mail: akbashuseyin@gmail.com

Ayça AKSOY (Ms)
Project Representative
WWF Turkey Office
Büyük Postane Caddesi No: 43-45 Kat:5
34420 Bahçekapı Istanbul, Turkey
Tel: + 90 212 528 20 30
Fax: + 90 212 528 20 40
E-mail: aaksoy@wwf.org.tr

Joël AUBIN
INRA/UMR SAS
Equipe Fields
CS 84215
65 rue de St Brieuc,
042 Rennes cedex 35, France
E-mail: Joel.Aubin@rennes.inra.fr

Pablo AVILA ZARAGOZA
Area de Estructuras Pesqueras y Acuícolas.
SubDir. Recuros Pesqueros y Acuícolas
Empresa Pública Desarrollo Agrario y Pesquero
C/Severo Ochoa 38 Pta Campanillas
29590 Malaga, Spain
Tel:+34 67094450 - +34 951042150
Fax: +34 951042151
E-mail: pavila@dap.es

Zouheir BADER
Chief of Fisheries *Arrondissement*
Commissariat Régional au Développement Agricole (CRDA)
Monastir, Tunisia
Tel: + 216 73 464610
Fax: + 216 73 468127
E-mail: crda.monastir@iresa.agrinet

Ibrahim BALKAS
Fisherman
Gulluk Fishery Cooperative
Gulluk, Mugla, Turkey
Tel:+ 90 5326144809

Lara BARAZI (Ms)
Chief Executive Officer
Kefalonia Fisheries
Livadi, Lixouri
28200 Kefalonia, Greece
Tel: + 30 694 8059115
Fax: + 30 26710-94171
E-mail: yer@otenet.gr

Bahadır BASARAN
Aquaculture Equipment Supplier
Derin Aquaculture Equipment Inc.
Mithatpaşa Cad. No 425/B
Güzelbahçe, Izmir, Turkey
Tel: + 90 532 2725688
Fax: + 90 252 5222851
E-mail: bahadır.basaran@derinsu.com

Mohamed BECHINA
Agence de Protection et d'Aménagement du Littoral (APAL), Tunisia
Tel: + 216 73 907 444
Fax: + 216 73 907 444
Hamadi BELAIBA
Projet Expert Art FiMed
Commissariat Régional au Développement Agricole (CRDA)
Gabes, Nahal, Tunisia
Tel: + 216 75 282 262
Fax: + 216 75 227 899

Nejla BEN CHEIKH
Agence Nationale de Protection de l'Environnement
Tunis, Tunisia
Tel: + 216 71 233600
Fax: + 216 71 848660

Mohamed BEN ESSGHAIER
SOGEA / Environnement (Bureau d'études)
Sousse, Tunisia
Tel: + 216 73 203955
Fax: + 216 73 203956
E-mail : sogea.environnement@topnet.tn

Wafa BEN HAMADI
Technician
Groupement Interprofessionnel des Produits de la Pêche (GIPP)
Fisheries harbour Tabarka, Tunisia
Tel: + 216 78 674088
Fax: + 216 78 674088
E-mail: wafa.benhamouda@gmail.com

Scander BEN SALEM
Research scientist
Institut National des Sciences et Technologies de la Mer (INSTM)
Fisheries harbour,
2060 la Goulette, Tunisia
Tel. + 216 71 735848
Fax : + 216 71 735 848
Email: scander.bensalem@instm.rnrt.tn

Mustapha BENDAG
Res.ponsible for Aquaculture
General Directorate for Fisheries and Aquaculture
Ministry of agriculture and water resources
30 rue Alain Savary
1002 Tunis, Tunisia
Tel: + 216 71 784 979
Tel + 216 71 892 253
Fax: + 216 71 799 401
E- mail: Mustapha.bendag@topnet.tn
mustapha.bendag@fao.org

Ümit BIRKOL
Union Secretary
Izmir Fish Farmer Union
Gaziosmanpasa Bulvarı No 8/4
Alsancak, Izmir, Turkey
Tel: + 90 232 4256261
Fax: + 90 232 4256259
E-mail: info@isub.org.tr

Jean-Paul BLANCHETON
Station expérimentale de l'IFREMER
Chemin de Maguelone
34110 Palavas les Flots, France
Tel: + 33 4 67504100
Fax: + 33 4 67682885
E-mail: jpblancheton@ifremer.fr

Abir BLANCO
Technician
Groupement Interprofessionnel des Produits de la pêche
Fisheries harbour Tabarka, Tunisia
Tel: + 216 78 674088
Fax: + 216 78674088
E-mail: blanco-abir@hotmail.fr

Alain BODOY
IFREMER La ROCHELLE
E-mail:alain.bodoy@ifremer.fr

Hüseyin CAKIR
Owner of Company
CAKIR Aquaculture & Fishery Equipment Inc.
Mithatpaşa Cad. No 425/B
Güzelbahçe, Izmir,Turkey
Tel: + 90 533 7785090
Fax: + 90 232 2341844
E-mail: huseyın@cakir-fishing.com

Mehmet CATALKAYA
Aquaculture Officer
MARA Mugla Province
Muslihiddin Mah. Sakarya Sok.
No 8 Mugla, Turkey
Tel: + 90 252 2141250
Fax: + 90 252 2141242
E-mail: m.catalkaya@mynet.com

Intissar CHARGUI
Technician
Groupement Interprofessionnel des Produits de la Pêche (GIPP)
Fisheries harbour Tabarka, Tunisia
Tel: + 216 78 674 088
Fax: + 216 78674 088
E-mail: intissarchargui@yahoo.fr

Zied CHAYAH
Prime Azur (Aquaculture Society)
Sousse, Tunisia
Tel: + 216 73 200063
Fax: + 216 73 200072
E-mail: zied_chayah@voila.fr

Hmadi CHTIOUI
Regional Commissary for Agriculture Development
Commissariat Régional au Développement Agricole
Monastir, Tunisia
Tel:+ 216 73 460328
Fax: + 216 73 461807
E-mail: crda.monastir@iresa.agrinet

Maria COZZOLINO (Ms)
IREPA, Via San Leonardo
84131 Salerno, Italy
Tel: + 39 089 338978
E-mail: cozzolino@irepa.org

Belgacem DABABI
Société Aquaculture du Sud Tunisien (S.AT)
Rue Midoun, B.P 475
4100 Mednine, Tunisia
Tel: + 216 75 631562
Fax: + 216 75 631561

Asiye Arzu DELICAN (Ms)
Akuvatur Mediterranean Sea Foods Inc.
Eczane Mah. 113 Sok. No 30
35050 Bornova, Izmir, Turkey
Tel: + 90 232 3756880
Fax: + 90 232 756800
E-mail: arzudelican@akuvatur.com

Filiz DEMİRAYAK (Ms)
CEO
WWF Turkey Office
Büyük Postane Caddesi No: 43-45 Kat:5
34420 Bahçekapı Istanbul, Turkey
Tel: + 90 212 5282030
Fax: + 90 212 5282040
E-mail: fdemirayak@wwf.org.tr

Hayal DEMIRHAN (Ms)
Aquaculture Officer
MARA Mugla Province
Muslihiddin Mah. Sakarya Sok.
No 8 Mugla, Turkey
Tel: + 90 252 2141250
Fax: + 90 252 2141242
E-mail: hayaldemirhan@hotmail.com

Hayri DENIZ
Director of Marine Aquaculture Ministry of Agriculture and Rural Affairs, Aquaculture Department
Eskisehir Yolu 9 Km 06275 Lodumlu
Çankaya, Ankara, Turkey
Tel: + 90 312 2864901
Fax: + 90 312 2867592
GSM: + 90 505 8311093
E-mail: hayri.deniz@tarim.gov.tr
hayrideniz@hotmail.com

Hakkı DERELI
Fishery Officer
MARA Mugla Province
Muslihiddin Mah. Sakarya Sok.
No 8 Mugla, Turkey
Tel: + 90 535 5492292
Fax: + 90 252 2141242
E-mail: hakkıdereli@gmail.com

Sami DHOUIB
WWF (World Wildlife Fund)
Av. Ahmed Khabthani immeuble. Ben Sassi
2080 Ariana, Tunisia
Tel : + 216 71 707238
Fax : + 216 71 701750
E-mail : sdhouib@wwftunis.org

Ali ELOUAR
Director
INSTM – Route de Khnis
Monastir, Tunisia
Tel: + 216 73 531867
Fax: + 216 73 531650
E-mail : ali.elouaer@instm.rnrt.tn

Hüseyin ERDEM
Aquaculture Engineer
Kılıç Seafood Inc.
Milas Bodrum Karayolu 18 km
Kemikler Köyü Mevkii
48200 Milas, Mugla, Turkey
Tel: + 90 2525590283
Fax: + 90 2525590287
E-mail: homardem@hotmail.com

Esen ERGIN (Ms)
Aquaculture Officer
MARA Mugla Province
Muslihiddin Mah. Sakarya Sok.
No 8 Mugla, Turkey
Tel: + 90 535 5492292
Fax: + 90 252 2141242
E-mail: Esenergin48@hotmail.com

Ahmet ERYIGIT
Officer of Environmental Protection
Ministry of Environment and Forest,
Authority of Special Environmental Protection
Mugla, Turkey
Tel: +90 538 8895031
E-mail: eryigitahmet@gmail.com

Hamadi GUERBEJ
Institut National Sciences et Technologie de la mer (INSTM)
Route de khnis
Monastir, Tunisia
Tel: + 216 73 531867
Fax: + 216 73 531650
E-mail: hamadi.guerbej@instm.rnrt.tn

Erkan GUMUS
Associate Professor
Fisheries Faculty of Akdeniz University
Dumlupınar Bulvarı, 07059 Yerleşke
Antalya, Turkey
Tel: + 90 242 3106636
Fax: + 90 2422262013
E-mail: egumus@akdeniz.edu.tr

Rochd HADDAR MOHAMED
Societé Luc Sono d'Aquaculture
CD Monsatrir, Tunisia
Tel: +216 97 256526

Mohamed HADJALI SALEM
Director
SIPAM regional centre
Ministry of agriculture and water resources
30 rue Alain Savary
1002 Tunis, Tunisia
Tel.: +216 71784979
Fax: +216 71 793962
E-mail: Hajali.salem@fao.org

Houssem HAMZA
Service Head
General Directorate for Fisheries and Aquaculture
Ministry of agriculture and water resources
30, rue Alain Savary,
1002 Tunis, Tunisia
Tel: + 216 71 892 253
Fax: + 216 71 799 401
E-mail: houssemhamza@yahoo.fr

Kürşat IMGA
MARA EU Expert
Department of EU and Foreign Affairs
Ministry of Agriculture and Rural Affairs.
Eskisehir Yolu 9 Km 06275 Lodumlu
Cankaya, Ankara, Turkey
Tel: + 90 312 2873360/2190
Fax: + 90 312 286 38 30
E-mail: kusatimga@tarim.gov.tr

Fathi KAMOUN
Research scientist
INSTM - Centre de Monastir
BP 59, Monastir 5000, Tunisia
Tel : + 216 97 773911
Fax : + 216 73531867
E-mail: kamounfathi@yahoo.fr

Mehmet KARA
Owner of Small Scale Farm
Land based Fish Farming
Milas, Mugla, Turkey
Tel: + 90 05326467164

Ozge KARDAS (Ms)
Assistant Expert
Ministry of Environment and Forest
DG of Environmental Impact Assessment
Sogutozu Cad. No 14/17 Kat
Ankara, Turkey
Tel: + 90 312 2076764
Fax: + 90 312 2076446
E-mail: ozgekardas82@hotmail.com

Spyros KLAOUDATOS
University Thessaly
Dept Ichthyology and Aquatic Environment
Aquaculture Laboratory
Fitocou Str New Ionia
38446 Magnissia, Greece
Tel; + 30 2421-0-93145
Fax: + 30 210 8991738
E-mail: sklaoudat@uth.gr, sklaouda@hol.gr

Abdullah KOKEN
Section Director
Provincial Directorat of Ministry of Culture and Tourism. Mugla (Turkey)
Tel: + 90 2522141261/135
Fax: + 90 2522141244

Mejdi LAHMAR
Manager
Société Aquaculture Ruspina,
B.P. 985080
Fisheries harbour Teboulba, Tunisia
Tel: + 216 73 447
Fax:+ 216 73 479 405

Néjib LAROUSSI
Head of *Arrondissement*
Commissariat Régional au Développement Agricole
5111 Mahdia, Tunisia
Tel: +216 73 680 857
Fax:+216 73 680 857
E-mail : nejiblaroussi@yahoo.fr

Jérôme LAZARD
Unité de Recherche "Aquaculture et gestion des ressources aquatiques"
Département Persyst
Centre de coopération internationale en recherche agronomique pour le développement (Cirad)
TA B-20/01, Avenue Agropolis
34398 Montpellier cedex 5, France
E-mail: jerome.lazard@cirad.fr

Atef LETAIEF
Technician
Groupement Interprofessionnel des Produits de la Pêche (GIPP)
Fisheries harbour Tabarka, Tunisia
Tel: +216 78 674088
Fax: +216 78674088
E-mail: letaief_atef@hotmail.com

Alessandro LOVATELLI
Fishery Resources Officer (Aquaculture)
Aquaculture Management and Conservation Service (FIMA)
Fishery and Aquaculture Management Division
Fisheries and Aquaculture Department
Via delle Terme di Caracalla
00153 Roma, Italy
Tel: + 39 06 57056448
Fax: + 39 06 57053020
E-mail: alessandro.lovatelli@fao.org

Ahmed MAAMOURI
Technician
Groupement Interprofessionnel des Produits de la Pêche (GIPP)
Fisheries harbour Tabarka, Tunisia
Tel: 216 78 674088
Fax: 216 78 674088

Chokri MABROUK
Delegate for Economics
Gouvernorat de Monastir
5000 Monastir, Tunisia
Tel: +216 73 461433
Fax: +216 73 464600

Emrah MANAP
Biologist
Ministry of Environment and Forest
Authority of Special Environmental Protection, Mugla, Turkey
Tel: +90 392 2221234
Fax: +90 392 2222661
E-mail: e.manap@occkkb.gov.tr

Fabio MASSA
GFCM Aquaculture Officer
CAQ Technical Secretary
International Institutions and Liaison Service
Fisheries and Aquaculture Economics and Policy Division (FIEL)
Fisheries and Aquaculture Department
Viale delle Terme di Caracalla
00153 Roma, Italy
Tel.: +39 06 57053885
Fax: +39 06 57053020
Email: fabio.massa@fao.org

Syndhia MATHE
Université of Montpellier
Faculté de Sciences Economiques
Avenue de la Mer - Site de Richter
CS 79606
34960 Montpellier cedex 2, France
Tel: +33 (0)4 6715839
E-mail: syndhia.mathe@univ-montp1.fr

Néjib MEDHIOUB
Institut National Sciences et Technologie de la mer (INSTM)
Route de khnis
Monastir, Tunisia
Tel : + 216 73 531 867
Fax : + 216 73 531 650
E-mail: mednejib.medhioub@instm.rnrt.tn

Hamadi MEJRI
Ingeneer
Groupement Interprofessionnel des Produits de la Pêche (GIPP)
Fisheries harbour Tabarka, Tunisia
Tel: + 216 78 674088
Fax: + 216 78 674088
E-mail : hamadi.mejri@lycos.com

Foued MESTIRI
Director General
Groupement Interprofessionnel des Produits de la Pêche (GIPP)
Tunis, Tunisia
Tel: + 216 71 788925
Fax: + 216 71 802082
E-mail: gip.peche@planet.tn

Leila MGAIDI
Technician
Groupement Interprofessionnel des Produits de la Pêche (GIPP)
Fisheries harbour
Tabarka, Tunisia
Tel: + 216 78 674 088
Fax: + 216 78674 088
E-mail: leilamgaidi@yahoo.fr

Hechmi MISSAOUI
General Director
General Directorate for Fisheries and Aquaculture
Ministry of agriculture and water resources
30 rue Alain Savary,
1002 Tunis, Tunisia
Tel: + 216 71 892253
Fax: + 216 71 799401
E-mail: missaoui.hechmi@inat.agrinet.tn

Néjiba MISSAOUI
Centre Technique d'Aquaculture
Tunis, Tunisia
Tel: + 216 71 492 012
Fax: + 216 71 491 108
E-mail: missaoui.nejiba@iresagrinet.tn

Abdellah MOUSTATIR
Ministere des Pêches Maritimes - DPNA
Rabat, Morocco
Tel: + 212 53 688217
E-mail: moustatir@mpm.gov.ma

Ridha M'RABET
Director
Institut National des Sciences et Technologies de la Mer (INSTM)
28 Rue 2 mars 1934
2025 Salammbô, Tunisia
Tel: + 216 71 730548
Fax: + 216 71 732622
Email: ridha.mrabet@instm.rnrt.tn

Celalettin MULKUT
Environment Officer
Ministry of Environment and Forest
DG of Environment Management
Sogutozu Cad. No 14/17 Kat 21
Ankara, Turkey
Tel: + 90 312 2076777
Fax: + 90 312 2076446
E-mail: cmulkut@cevreorman.gov.tr

Noureddine NSIBI
Chef d'arrondissement des pêches
Commissariat Régional au Développement Agricole
Fisheries harbour Bizerte, Tunisia
Tel: + 216 72 591322
Fax: + 216 72 490391

Cengiz ÖNDER
Aquaculture Engineer
Kılıç Seafood Inc.
Milas Bodrum Karayolu 18 km
Kemikler Köyü Mevkii
48200 Milas, Mugla, Turkey
Tel: + 90 5324541013
Fax: + 90 2565575065
E-mail: cengizonder@kilicdeniz.com.tr

Abdellatif ORBI
Institut National de Recherche Halieutique INRH
2 Rue De Tiznit,
Casablanca, Morocco
Tel:+ 212 5 22298534
E-mail: orbi@inrh.org.ma

Atilla OZDEMIR
Institute Director
Central Fisheries Research Institute Kasüstü Beldesi, 61250, Yomra,
Trabzon, Turkey
Tel: + 90 4623411054
Fax: + 90 4623411152
E-mail: aozdenir@sumea.gov.tr

Ramazan OZKAYA
President of Central Union
Central Union for Fishery Cooperatives
Konur Sok. No 54/8 Bakanlıklar,
Ankara, Turkey
Tel: + 90 312 4192288
Fax: +90 312 4192289
E-mail: info@surkoop.org

Kamuran PATRONA
Association Secretary
Mugla Fish Farmers Association
Ataturk Mah. 270 Sok. No 5 Kat 1
Gulluk, Mugla, Turkey
Tel: + 90 312 2325590
Fax: +90 312 2325590
E-mail: kamuranpatrona@ttmail.com

Ferit RAD
Associate Professor
Fisheries Faculty of Mersin University
Cıftlikkoy Merkez Kampusu 33343
Mersin, Turkey
Tel: +90 3243411914
Fax: +90 324 3610015
E-mail: frad@mersin.edu.tr

François RENÉ
Station expérimentale de l'IFREMER
Chemin de Maguelone
34110 Palavas les Flots, France
Tel: + 33 4 67504100
Fax: + 33 4 67682885
E-mail: francois.rene@ifremer.fr

Hélène REY-VALETTE
University of Montpellier
Faculté de Sciences Economiques
Avenue de la Mer - Site de Richter
CS 79606
34960 Montpellier cedex 2, France
E-mail: helene.rey-valette@univ-montp1.fr

Pablo SÁNCHEZ JEREZ
Senior Lecture
Univeristy of Alicante
Dept. of Marine Science and Applied Biology.
Edf. Ciencias 5 Ap. C. 99 03080
Alicante, Spain
Tel:+ 34 965903400, ext 2977
Fax:+ 34 965909897
E-mail: psanchez@ua.es

Moez SHAIER
Tunisie Cultimer
BP 62, Manzel abderrahmen
7035 Bizerte, Tunisia
Tel + 261 20 405606
+ 216 24 305 606
Fax: + 216 72 590 487
E-mail: tunisie-cultimer@gnat.tn

Abdelmagid S'HEL
Head of Fisheries *Arrondissement*
Commissariat Régional au Développement
Agricole (CRDA)
Medenine, Tunisia
Tel: + 216 75 684370
Fax: + 216 75 684370
E-mail: magidshel@yahoo.fr

François SIMARD
Marine Programme Coordinator
IUCN Centre for Mediterranean Cooperation
Parque Tecnológico de Andalucía
Calle Marie Curie, 35, Campanillas
29590 Málaga, Spain
Tel: + 34 952 028430
Fax: + 34 952 028145
E-mail: francois.simard@iucn.org

Biken TANIR (Ms)
Urban Planner
Ministry of Environment and Forest
DG of Environmental Impact Assessment
Sogutozu Cad. No 14/17 Kat
Ankara, Turkey
Tel: +90 312 2076764
Fax: +90 312 2076446
E-mail: btanir@cevreorman.gov.tr

Gulsen ULUKOY (Ms)
Associate Professor
Fisheries Faculty of Mugla University
48000 Kötekli, Mugla, Turkey
Tel: +90 252 2111519
Fax: +90 252 2237584
E-mail: gulukoy@gmail.com

Hülya UNAL KORKMAZ (Ms)
Officer of Planning
Ministry of Public Works and Settlement
DG of Technical research and Application
Ankara, Turkey
Tel: + 90 3124102453
Fax: + 90 3122303666
E-mail: hulyauk@bayindirlik.gov.tr

Marc VANDEPUTTE
INRA/IFREMER
E-mail: marc.vandeputte@jouy.inra.fr

Aylin VELIOGLU (Ms)
MARA Aquaculture Officer
Aquaculture Department of Ministry of Agriculture and Rural Affairs
Eskisehir Yolu 9 Km 06275 Lodumlu
Cankaya, Ankara, Turkey
Tel: + 90 312 287 33 60
Fax: + 90 312 28638 30
E-mail: velioglu.aylin@gmail.com

Omer Hakan YALCIN
MARA Aquaculture Officer
Aquaculture Department, Ministry of Agriculture and Rural Affairs
Eskisehir Yolu 9 Km 06275 Lodumlu
Cankaya, Ankara, Turkey
Tel: + 90 312 2873360
Fax: + 90 312 2863830
E-mail: akdaghakan66@hotmail.com

Güzel YÜCEL GIER (Ms)
Dokuz Eylül University
Institute of Marine Sciences and Technology
Bakü Bulverı No: 100 35340
İnciralti – İzmir, Turkey
Tel: + 90 232 278 6515 - 2786525/140
Fax: + 90 232 2785082
E-mail: yucel.gier@deu.edu.tr

Othmane ZOGHLAMI
Head of Fisheries *Arrondissement*
Commissariat Régional au Développement Agricole (CRDA)
1 Rue d'Algérie 4029
Sousse, Tunisia
Tel: + 216 73 225355
Fax: + 216 73 227830
E-mail: othmanzoghlami@yahoo.fr

Mourad ZOUARI
Ingeneer /Aquaculture
General Directorate for Fisheries and Aquaculture
Commissariat Régional Développement Agricole (CRDA)
Monastir, Tunisia
Tel: + 216 73 466188
Fax: + 216 73 465330
E-mail: iwachi@jicapeche.com

ANNEXE 5
InDAM-db bibliographic references

Aguado-Gimenez, F., Marin, A., Montoya, S., Marin-Guirao, L., Piedecausa, A. & Garcia-Garcia, B. 2007. Comparison between some procedures for monitoring offshore cage culture in western Mediterranean Sea: Sampling methods and impact indicators in soft substrata. *Aquaculture,* 271: 357-370.

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ANNEXE 6
Projects on aquaculture sustainability in the Mediterranean region and related issues

EVAD : Evaluation de la durabilité des systèmes de production aquacoles. Elaboration d'une méthode et application dans différents contextes en zones tropicales et tempérée (Assessment of sustainable development of Aquaculture)

Project funded by: ANR, French National Research Agency. Agriculture and sustainable development programme

Duration: 11-2005/ 11-2008

- Project Coordinator: Lazard Jérôme (CIRAD, Montpellier)
- Partners: CIRAD -Centre de coopération internationale en recherche agronomique pour le développement- Montpellier; Ifremer, Laboratoire de Palavas; INRA -Institut National pour la Recherche agronomique- Rennes (Dépt Environnement Agronomie); IRD -Institut de recherche pour le développement- Montpellier; Université Montpellier 1 (UFR Sciences Économiques); INRA -Institut National pour la Recherche agronomique- Saint Pee Sur Nivelle (Dépt. Physiologie Animale et Systèmes d'Elevage).

Aims of the project

The objective of this project was to propose a generic method of analysis of development factors in aquaculture to evaluate its sustainability, and to adapt it to the local contexts through the perception of the different actors involved in aquaculture (producers, regulating institutions, tradesmen, distributors, consumers).

This step implied the construction of a common framework of analysis of the aquaculture systems, in order to organize the implementation of the sustainability factors. One of the intermediate products of the project was to propose a representation framework of the aquaculture systems. These representations were to be completed for agriculture and for terrestrial animal husbandry, but also for fisheries and aquaculture.

The method adopted in the project aimed at conceiving and putting into practice principles, criteria and indicators for the development of sustainable aquaculture. These indicators were built with the participation of the various groups of actors in the environmental, social and economic contexts of 5 case studies, reflecting different aquaculture realities:

- Brittany (France): its intensive production of freshwater trouts is decreasing parallel to the increase of strict environmental regulations, and in a phase of market stagnation,
- Mediterranean region: with a concentration of aquaculture facilities in certain areas and a strong touristic pressure on the coastal areas which pushes aquaculture production facilities away from the shore,
- Philippines: coastal brackish water production systems where the intensification level evolves according to the national economic context,

- Cameroun: fish farm innovation and development are linked to strong diversification dynamics of the agriculture system in the framework of important radical socio-economic changes,
- Indonesia (Java and Sumatra): village fish farming generally integrated with other agriculture or non agriculture activities; quick development of aquaculture can raise serious issues of environmental impact.

The final meeting of the project "EVAD: Evaluer le développement durable des systèmes de production en aquaculture" was held in Montpellier (France), 24-25 November 2008.

Deliverables:

Guide de co-construction d'indicateurs de développement durable en aquaculture Rey-Valette H., Clément O., Aubin J., Mathé S., Chia E., Legendre M., Caruso D., Mikolasek O., Blancheton J-P., Slembrouck J., Baruthio A., René F., Levang P., Morissens P., Lazard J. Cirad, Ifremer, INRA, IRD, Université Montpellier 1 2008, *in French and in English*

EVAD is at www.evad.fr

L'outil IDAqua : Indicateurs de Durabilité pour l'Aquaculture

(IDAqua: Sustainability indicators for French Aquaculture)

Duration: 4-2006 / 2008

The IDAqua project aims at defining a set of sustainability indicators for trout farming in France. It is run by CIPA (Comité Interprofessionnel des Produits de l'Aquaculture- Paris). and ITAVI (Institut Technique de l'Aviculture et de l'élevage des petits animaux- Paris)

It aims at comparing the tradition physical and chemical water analysis data with biological indicators for water quality and an integrated approach to environmental analysis: the life cycle analysis. This approach was applied to a dozen French trout farms, and tailored within the new French regulation on water (*Directive Cadre sur l'eau*).

IDAqua is www.idaqua.fr (not available yet)

CONSENSUS: a Multi-stakeholder Platform for Sustainable Aquaculture

Project funded by: Commission of European Communities under the 6th Framework Programme, thematic priority "Food Quality and Safety", Project N°: FOOD-CT-2005-513998.

CONSENSUS is an initiative that works towards sustainable European aquaculture by building sustainable aquaculture protocols that are based on low environmental impact, high competitiveness and ethical responsibility with regard to biodiversity and animal welfare.

CONSENSUS is steered by the principal European stakeholders - theEuropean Consumers' Organisation (BEUC), the European Bureau for Conservation and Development (EBCD), the Federation of European Aquaculture Producers (FEAP), the European Mollusc Producers Association (AEPM/EMPA), the European Feed Manufacturers Federation (FEFAC) and the European Aquaculture Society (EAS). It groups together 21 partners from 9 European countries.

CONSENSUS is at www.euraquaculture.info

Marine Conservation Society (MCS)

MCS has made a wide consultation of professional and other stakeholders to prepare principles and indicators of sustainable fish farming, with a focus on UK marine aquaculture.

The core principles are the responsible siting of fish farms; the use of sustainable sources of feed, minimising the effects of marine pollutants; minimising the wider eco-system effects; optimal welfare standards and environmental management and continuous improvement though research.

MCS provides information to consumers about the sustainability of the seafood choices they make from both wild and farmed sources via the website www.fishonline.org, where over 150 species of fish and shellfish are listed with specific advice for each. The Society has also developed its own Principles and Criteria for Sustainable Fish Farming that can be accessed at the web site.

The Marine Conservation Society (MCS) is at www.mcsuk.org

SustainAqua - Integrated approach for a sustainable and healthy freshwater aquaculture.

Project funded by: the Commission of European Communities under the 6th Framework Programme, Collective research programme, Project N°: COLL-CT-2006-030384

Duration: 9-2006 / 10-2009.

Project coordinator: Ing. Alexandra Oberdieck

Partners: The SustainAqua consortium comprises 10 Industrial Associations/Groupings (IAG), 6 Small and Medium Enterprises (SME) and 7 Research and Technological Departments (RTD) including coordinator TTZ, which together cover all relevant fields of knowledge and experience which are necessary to accomplish the different research, training and management tasks of the project. Below is a list of the consortium members:

Aims of the project: The Project will carry out specific research, training and dissemination activities in the field of producing healthy and tasty freshwater fish and other economical valuable by-products mainly by optimising nutrient chains, water management and energy efficiency. The overall objectives are:

- To encourage the development towards an environmental sound and healthy, and at the same time economic viable and social accepted freshwater aquaculture.
- To expand the knowledge base and the commercial image of the European freshwater aquaculture farmers by training
- To improve farmers' ability to compete with low-cost aquaculture products from Asia, Latin America and the Caribbean.
- To respond to European and national legal and customers' (supermarkets, individuals) requirements related to product quality, and environmental and health issues.
- To provide a high nutrition value for the consumer (fish quality).
- To create more employment especially in rural areas, and throughout the whole aquaculture production chain.
- To strengthening a sustainable development of rural areas.

In the project 7 RTD performers will provide the required know-how in cooperation with the participating 10 IAGs and the SME core group consisting of 6 enterprises from different European countries. The gained knowledge will be the base for certain IAG training activities about sustainable freshwater aquaculture management contributing to spread the knowledge throughout Europe.

Outputs: A substantial output from the project has been a handbook for aquaculture farmers, a practical guide to sustainable freshwater fish farming. Over 110 pages long the handbook details the core of the project, the five case studies that were carried out on different species.

The handbook is intended as a manual for the fish farmer and each of the chapters on the case studies ends in a section that describes how the methods developed in the case study to achieve specific results can be scaled up to actual farm proportions. The handbook also includes an overview on production methods and technologies used in the main freshwater farming systems in Europe and a review of European legislation in the field. Information based on the case studies on techniques to

improve product quality, to diversify production into potentially valuable wetland crops, as well as to grow fruit and vegetable in combination with fish, is also provided in the handbook.

The book was distributed at the training courses in the local languages (12 different languages) and is available for download on the SustainAqua web site.

SustainAqua is at http://www.sustainaqua.org/