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IUCN-FEAP Guide on Site Selection and Site Management*

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GUIDE ON AQUACULTURE SITE SELECTION AND SITE MANAGEMENT

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Introduction

Aquaculture site selection and site management constitute one of the most important issues for the development of the activity. However, a large number of external aspects such as environmental or socioeconomic, which influence and are in turn influenced by the activity, have to be considered in these processes, not to mention many institutions that are also involved, making therefore site selection and site management a complex subject.

The shared use of Public Domains and the conservation policies for the Mediterranean Sea reduce the availability of sites. But at the same time, demand for aquaculture products is increasing specially due to the capability to offer quality products, with constant supply and price stability, such as those from the Mediterranean aquaculture industry.

However, efforts have still to be done towards the sustainable development of aquaculture in the Mediterranean and for that, site selection and site management are important points to consider and to implement on a sustainable manner.

The availability of suitable zones for aquaculture in the Mediterranean is becoming a major problem for the development of the industry. There is a need of space with appropriate environmental characteristics and a good quality of water. In addition to these natural limiting factors, social aspects relative to interactions with other human activities or the conflicts of use and appropriation of the resources in an often exploited coastal zone have to be considered during the processes of aquaculture site selection and site management. In this framework, the interactions generating conflicts and mutual benefits between aquaculture and capture fisheries have been analysed by the GFCM[1]

However, other aspects such as the institutions as well as the economy are also of special interest to achieve the responsible development of the activity in line with the conservation and sustainability of the environment.

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

Thus, the aim of this document, the second in a series, is to help the sustainable development of Mediterranean aquaculture, providing basic guidelines for a correct implementation of aquaculture site selection and site management. The first Guide was dedicated to *Interactions between Aquaculture and the Environment,* wherein a particular emphasis was put on the fact that most of the potential environmental impacts of aquaculture can be managed and minimized through the understanding of the processes, responsible management and the effective sitting of farms. The third Guide will address issues such as responsible aquaculture practices and certification, pursuing so the objective of encouraging the development of good practices in aquaculture.

Most problems are linked however to the lack of a full vision of the essential elements to be considered in the site selection and site management processes.Wrong decision could be made and could geopardize the sustainable development of aquaculture in the Mediterranean.

Thus, this Guide, pretends to give to the reader a whole set of parameters and ideas to think about on site selection and site management. It provides basic Guidelines for decision makers and other parties interested in order to implement good practices.

Due to the complexity of the subject and the amount of information treated, the guide has been structured in four sections:

- CONCEPTS

  Chapters A to G address fundamental concepts to apply such as the Importance of Knowledge, Participative Approach, Social Acceptability, Precautionary Principle, Scale Approach, Adaptive Approach and the Economic aspects. They have been chosen as those to consider having a broad view of the situation.

- FRAMES

  Chapters H to L mention frameworks to take into account like legal issues, Importance of Governance, Administrative Procedures, Sectoral Planning and Private Sector Organisations. They will set the aims and lead the process of site selection and site management.

- METHODS

Chapters M to O, methods to consider such as the Integrated Coastal Zone Management (ICZM), the Site Selection Process and the Ecosystem Approach that IUCN has made operational through many initiatives undertaken;

- TOOLS

From chapters P to S, tools to utilize all throughout the process, like Carrying Capacity, Indicators and Models, the Environmental Impact Assessment (EIA), the Environmental Monitoring Programme (EMP) and the Geographical Information Systems (GIS).

The structure of each topic or guide is constituted by a short summary of the chapter, definitions, a development of the main subjects and a justification, followed by the Principle and Guidelines. Moreover, a series of Mediterranean examples gives an insight into the current situation in the region.

The present Guide on *Aquaculture site selection and site management* has been made by IUCN / FEAP working group on aquaculture. More than 50 experts from different areas such as socio-economists, biologists, lawyers, producers, and governmental and environmental organization representatives from most of the Mediterranean countries have participated in the different workshops[2]. The Guidelines are the results of extensive debates during these workshops[3] as well as the outcomes of following coordination meetings and e-mail exchanges.

All the texts of this Guide were drafted by the best Mediterranean experts of each topic, the Principles and Guidelines being the results of several concerted discussions. The compilation, revision and structure of the chapters have been made by Sandra Simoes Rubiales (IUCN) and Pablo Ávila Zaragozá (DAP) with the general coordination of François Simard (IUCN) and Javier Ojeda González-Posada (APROMAR / FEAP). The Mediterranean committee of redaction is composed by the following experts:

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[2] All the workshops have been organized in collaboration with the GFCM and activity centers of the MAP (RAC/SPA and PAP/RAC).

[3] Istanbul, October 2007; Alicante, February 2008; Split, March 2008

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This work has been pushed forward since the beginning with unfailing financial support of the General Secretariat of the Sea (SGM) of the Spanish Ministry of the Environment and Rural and Marine Affairs (MARM) in cooperation with the General Fisheries Commission for the Mediterranean (GFCM) of FAO.

Executive Summary

A. Importance of Knowledge

This guide refers to the minimum factors that are considered necessary to know and at least to take into account when dealing with aquaculture site selection and site management, thus contributing to the sustainable development of aquaculture in the Mediterranean.

Principle

Aquaculture site selection and site management should be based on reliable legal, environmental, technical and socioeconomic knowledge to enhance the viability of the process.

Guidelines

- **Information on the legal and environmental aspects of the public domain should be collected by the authorities and be available to the general public.** The collection and dissemination of such information should be the responsibility of the competent authorities, given the public domain nature of most of these areas.
- **The development of aquaculture by means of site selection should be based on scientific knowledge complemented by traditional knowledge.** Research must be continually undergone in order to improve knowledge on aquaculture, which has to be made available in a way that is understandable by all.

About environmental knowledge

- **The study area should be delimited in advance.** The study area should be narrowed without loosing indispensable data, in order to optimize data collection in the fieldwork from a technical and economic point of view.

- **Environmental and culture conditions knowledge should match enough to assure the viability of the project.** Depending on the type of aquaculture to be introduced, the most suitable environmental conditions for its development need to be assessed.

About technical knowledge

- **Decision makers should be familiar with current production and technological systems to ensure that aquaculture sites are appropriately selected.** It's important to know what kinds of aquaculture are suitable to the characteristics of a particular area and to use the most up-to-date techniques to achieve the success of the project.
- **Only proven technologies should be considered in the selection of sites for aquaculture and their subsequent management, especially in offshore locations or in highly sophisticated systems such as land based recirculation systems.** Both types of aquaculture system are complex. It is therefore essential to be familiar with the most applicable technology in order to manage the high risk of aquaculture.
- **Research on the practical implementation of sanitary fallowing of fish farm sites in the Mediterranean should be encouraged.** The consolidation of this knowledge could have important future consequences on aquaculture planning and sitting, especially due to the increment in production and sites concentration.
- **The personnel in aquaculture farms should be provided with lifelong learning.** In order to make sure aquaculture ventures run smoothly, it's important to keep personnel aware of any new technologies or improvements which could improve site selection and site management.

About knowledge of the legal system

- **Aquaculture farmers and the authorities with jurisdiction over the coast should have clear knowledge of the legislation governing aquaculture and the relevant planning rules.** To this end, countries that want to encourage aquaculture development have to have transparent legislation on aquaculture to provide sufficient legal security for aquaculture farmers.
- **Aquaculture and coastal planning legislation should be familiar and accessible to all stakeholders.** In the planning of suitable sites for aquaculture, there should be a

clear and comprehensive understanding of the legislation governing all interests affecting the coastline, in order to avoid conflicts of interest.

About socioeconomic knowledge

- **The process of aquaculture site selection and site management should take reliable local knowledge into consideration.** The views of the people on the area of interest, within the socioeconomic, political, cultural and legal context should be taken into account when assessing aquaculture planning.

Regarding interactions with other activities in the area, synergies and incompatibilities should be taken into consideration. As aquaculture is at present one of the last sectors to arrive to a specific area, it's essential that synergies and incompatibilities with other sectors are emphasised in order to ensure that aquaculture integrates into the local economy and the sites are suitably selected and managed.

B. Participative Approach

This guide presents a straightforward concept, basic on its definition but complex to implement. The relation with site selection is explained and its importance for the success of the aquaculture project shown. Models and examples are given to guide the implementation of this approach on site selection and site management and sustainability of aquaculture.

Principle

Site selection and site management processes should take into account the participation of all stakeholders that share the same coastal region in order to achieve the sustainable development of the activity.

Guidelines

- **The Participative Approach should be considered from the beginning of the project.** It is essential that stakeholders who will be involved in any participative process will feel integrated from the beginning assuring appropriation and therefore success on the process of site selection for aquaculture.
- **The Participative Approach should follow a process of co-construction.** This process, based on the right to have a word at the round table, majority or consensus, will ensure sustainable objectives and will seek common goals that will benefit all the users of a given maritime region.
- **The Participative Approach should take into acount all stakeholders at all levels identifying their roles and abilities.** They must be properly represented and their implication demonstrated according to the degree in which the project may affect them.
- **The Participative Approach should identify a mediator or Pilot Committee**. This figure should be neutral and recognized by all participants with the purpose of organizing the process and directing development and implementation.
- **The Participative Approach should be produced in a common language.** The transmition of information will be homogenous and will ensure the comprehension of all participants, independent of their capacities.

- **The participative process should follow the "in eddy" model and provide periodic feedback.** The continuous evolution to which all processes are subject requires the participative process to go through a revision and continuous restructuring, correcting errors in order to reintroduce the established objectives from the beginning.

C. Social Acceptability

This guide presents the concept of Social Acceptability and the direct relation and importance on the context of site selection and site management. Definition, characterisation and perception of the public, criteria and tools to assess Social Acceptability and finally, guidelines to achieve Social Acceptability are given as they are considered as a key issue to assure the sustainable development of aquaculture in the Mediterranean.

Principle

Social Acceptability should be considered as an aim on site selection and site management process in order to assure the setting and permanence of the aquaculture project in the long term.

Guidelines

- **Social Acceptability is an objective that should be considered from the onset of any aquaculture project.** This general rule is particularly relevant in the Mediterranean region, given the annually ever increasing pressures of coastline occupancy and use.
- **Communication, information and transparency should be established to foster a dialogue amongst stakeholders and ensure Social Acceptability.** Information exchange amongst stakeholders is vital to ensure the correct analysis of the consequences of the acceptance or rejection of a project.
- **Cultural parameters are particular to each Mediterranean region and should be considered individually when building Social Acceptability.** The multicultural nature of the Mediterranean adds complexity to the process of Social Acceptability. The identification, analysis and integration of these parameters in the selection and management of aquaculture sites are considered necessary.
- **Social Acceptability and the consequent sustainability of an aquaculture project should be based in the creation of an "Image of Quality" for aquaculture.** Aquaculture is still unknown by society in general. It is therefore necessary to invest in communication and education to make a better understanding of site selection and all aquaculture processes throughout a quality scheme.

D. Precautionary Principle

This guide presents the concept of Precautionary Principle and its application to the different aspects concerning site selection and site management. Definitions and implementation of the concept are given and a special attention is paid to the limits between benefits and rejections of the Precautionary Principle application.

Principle

The Precautionary Principle should be applied in the aquaculture site selection and site management processes.

Guidelines

- **The Precautionary Principle should be applied in the decision making processes for aquaculture site selection and site management, under the framework of the Ecosystem Approach and in conjunction with Participative and Adaptive Approaches.** It allows the taking of decisions even though not all scientific data are available and help stakeholders to have a straightforward approach.
- **The Precautionary Principle should be applied with certain limits in order to avoid possible rejections.** Precaution has no defined or measurable limits, and this has to be set up mainly by the possible effects of any action, without braking boundaries or reaching the point of no action.
- **Precautionary Principle should consider in an appropriate temporal and spatial scale all forms of relevant information such as scientific and traditional knowledge.** The best informed will be the decision makers, the most adequate the process of site selection will be planed according to the risk incurred.

E. Scale Approach

This guide presents the concept of scale as a factor to be considered in the process of aquaculture site selection and site management where spatial and temporal dimensions influence decision making. Definition of the concept is given as well as the effect of mismatches among scaling factors that affects site selection and site management.

Principle
Site selection and site management in a context of sustainable development of aquaculture should consider the scale approach when studying interactions between several systems.

Guidelines

- **Scale approach should be applied in each step of aquaculture site selection and site management process.** Continuous dimensioning and identification of mismatches can help to achieve the success of aquaculture projects in a given area.
- **Research should be encouraged to understand and resolve scale mismatches in the process of site selection and site management.** The capacity to identify, measure, and compare the effects caused by the different scales at which the varied systems function can help the process to succeed.
- **Potential growth of aquaculture should be considered at the starting point of the site management process**. A long-term vision of the possible future aquaculture farm development will enable to overcome further and expectable mismatches between the activity and the surrounding systems.
- **Tools such as Geographic Information Systems should be used to assess the spatial and temporal scales in aquaculture site selection and site management process.** Strong tools can help to better understand what is happening in a system at different scales in order to manage the situation knowingly.
- **Site selection and site management should be decentralized to the lowest appropriate level.** Government structure and level of decentralization in Mediterranean countries play an important role on the process. Institutions frequently lack the necessary multi-scale

vision and associated flexibility to solve problems that occur at scales that they usually do not consider.

F. Adaptive Approach

This guide refers to the importance of the learning, anticipation and flexibility in the process of site selection and site management at the hands of the dynamic nature of the ecosystem where the activity is implemented.

Principle

In aquaculture site selection and site management, Adaptive Approach should be implemented to allow the activity to develop in a sustainable manner at the hands of an evolving environment.

Guidelines

- **Adaptive Approach should be implemented in an evolving process like aquaculture site selection and site management thanks to the learning, anticipation and flexibility.** Reactive adaptation to changes can become a danger for the sustainability of the aquaculture. A long-term strategy is rather advised.
- **Anticipated and unanticipated risky changes should be considered at the legal, ecological, socio-economical or technological level in order to reduce conflicts through a better flexibility to reach the sustainable aquaculture development.** Long-term solutions to mismatches will depend on knowledge and the further development of flexibility that can enable to reorganize in response to changes in factors influencing aquaculture sector.
- **Research should be encouraged to allow the aquaculture sector to anticipate to changes.** Anticipatory research can influence and improve past and further studies on aquaculture sustainable development as well as help the sector to adapt more easily to a determined change.
- **Close partnerships between citizens, managers and scientists as well as cooperation between members of the same aquaculture sector should be encouraged in order to facilitate adaptation to achieve aquaculture sustainable development.** Through partnership and cooperation, knowledge can be shared and

widened, comparing different strategies used to cope with a given situation. Thus, learning and adaptation can be faster in aquaculture processes.

- **Effective and rapid learning, adaptation and flexibility should be taken into consideration to cope with a change.** Documentation, anticipation, flexibility, comparisons between different approaches and identification of trigger points are essential for the sustainability of the aquaculture. Learning and adaptation are processes that always evolve over the time.
- **Records of successful as well as failed past studies should be accessible to all the stakeholders.** Much can be gained from the creation of a database of retrospective study opportunities in the Mediterranean aquaculture since it represents the same ecoregion.

G. Economic aspects

This guide introduces the basic concepts and tools of environmental economics needed for site selection and site management. Economics provides meaningful indicators and decision support tools. It allows analysts, planners and entrepreneurs to compare different activities and their outcomes using a common monetary benchmark. The guidel focus on the application of Cost Benefit Analysis (CBA) and valuation methods since they are widely recognized and accepted by a range of decision-makers, both private and public.

Principle

Economic factors and in particular the economic dimensions of aquaculture-ecosystem interactions should be considered for effective site selection and site management.

Guidelines

- **Economic tools and indicators in conjunction with others (e.g. Environmental Impact Assessment) should be used to enable decisions based on multiple criteria reflecting a range of societal objectives.** Decision makers often have insufficient information to take decisions aimed at of avoiding biodiversity loss. This can be overcome by the integrated use of economic and other decision support tool. Economic tools are important because they reflect a range of values using widely accepted and understood monetary measures.
- **In order to capture the Total Economic Value of a given type of aquaculture at a given site, the application of economic tools of analysis should consider a comprehensive range of non-market and market sources of value, and direct and indirect impacts.** Economic tools should be used to value the enterprise and related businesses (e.g.: packing, transport and marketing), environmental impacts (e.g.: changing water quality and biodiversity), changes in employment and similar economic aspects. This can be accomplished by using the full range of methods of economic valuation.
- **In order to understand trade offs among candidate users of the same ecosystem, the Total Economic Value (TEV) of aquaculture should be compared to Total Economic Value of other sectors.** This will allow to decision makers to prioritise

among activities and assess aquaculture relative to other uses in relation to its interaction with the ecosystem. Sustainable site selection and management should result in a higher TEV for aquaculture.

- **In order to develop appropriate regulatory incentives at the farms level, externalities should be understood and quantified.** Fish farming is an economic undertaking. If policy is to encourage or discourage certain activities, farmers must be given appropriate incentives (e.g.: fees, fines, subsidies, etc) and these incentives should reflect the externalities caused.

H. Importance of Governance

This guide deals with the concept of Governance and how it should be developed and implemented concerning aquaculture site selection and site management. From definition to new aspects, characteristics of Governance are described which are directly applied to the sustainable development of aquaculture.

Principle

Good Governance practices should be implemented concerning planning and decision-making for aquaculture site selection and site management.

Guidelines

- **Governance should be flexible, dynamic and adaptive.** This capacity of reaction to changes and evolution towards effectiveness will give trust and support to decision makers.
- **Governance should encourage participation and interaction with all stakeholders:** The inclusion of all actors and the trigger of linkages within and among them will reinforce governability increasing success on a shared environment where site selection has to be made.
- **Governance should be applied at all levels.** Because globalisation is becoming a strong driver of change, new forms of Governance should be developed at all scales, from local to global.
- **Aquaculture planning should be developed under the best applicable Governance.** As Governance influence the processes of site selection and site management, rules and implementation should underline guidelines of sustainability.
- **Governance should be considered and implemented on a long-term basis.** Unlike to fisheries where daily decisions may be subject to uncertainties, aquaculture planning has a more long-term steady course that should be taken into account in Governance arrangements.

I. Legal Framework

This guide is intended to offer a series of guidelines for the establishment of appropriate Legal Frameworks for the practice of aquaculture, particularly with regard to site selection. The aim of this guide is to highlight the benefits of adequate regulations for aquaculture. An overview of the current situation is given for the Mediterranean.

Principle
An adequate and propitious Legal Framework should be in place to ensure appropriate site selection and site management.

Guidelines

- **A suitable Legal Framework should be in place, guaranteeing the rights and stating the obligations of holders of aquaculture licences**. That will ensure legal security for both aquaculture operators and the activity itself.
- **Coordination and agreements on Legal Framework for aquaculture site selection and site management should be built among the different administrations**. The lack of clear, concise regulations that specify the division of tasks between administrative authorities may result in overlapping of areas of competence and delays in procedures.
- **Legal Framework should be available and understandable to all stakeholders** Comprehensive aquaculture legislation will provide guarantees of success, in terms of both environmental protection and the development of the aquaculture industry. Furthermore, its Legal Framework will be a way of informing society about the aquaculture industry.
- **The Legal Framework for aquaculture should establish the basic programmes and conditions necessary for the selection of suitable areas for aquaculture.** The designation of appropriate areas for aquaculture, both in maritime and coastal areas, should be reflected in regulations. This will ensure the legal security of aquaculture activities, their future stability and their success and competitiveness.

- **Aquaculture legislation should be integrated on Coastal zone set of jurisdictions** Regulations should be established for the management of coastal areas, covering planning, conservation conditions, protection of coastal resources, and planning of areas to be used for marine aquaculture.
- **The legal system should include requirements that ensure compatibility with other uses.** To achieve this there must be coordination between the competent administrative authorities and agencies, the industry and the general public, as well as legislative action.
- **Aquaculture legislation should address the social and Economic aspects of the area in which aquaculture activities take place**. The lack of regulation may be the cause of the rejection of aquaculture by society or administrative authorities that prioritise other interests.

J. Administrative Procedures

This guide gives a general view of the existing Administrative Procedures in different countries. The main problematic topics, concerning bureaucracy, timing, requirements, rights and duties are explained and possible solutions proposed.

Principle

Adequate Administrative Procedures should be established in order to facilitate the appropriate selection and management of sites for aquaculture.

Guidelines

- **Regulations should be drafted that set out the procedures for granting aquaculture licences**. It is important to have regulations that clearly inform aquaculture operators of the requirements for obtaining a licence, the timeframe of the application process as well as the rights and obligations attached to the licence.
- **Instruments should be prepared to coordinate administrative authorities, agencies involved and procedures for the granting of the various authorisations.** This will ensure the legal security of both the applicant and the granting authority itself, while also simplifying processes for the granting of aquaculture licences.
- **Administrative authorities with responsibilities in aquaculture should develop guidelines for the submission of applications, containing legal and institutional information**. These guidelines would be useful for establishing aquaculture policies, not only for the competent administrative authorities, but also for aquaculture operators and society in general. A simple form accompanied by a checklist to help the applicant ensure that all documents are submitted.
- **The establishment of technical offices that centralise aquaculture procedures in a region or country is recommended**. The creation of one-stop shops should be promoted, to centralise licence-granting procedures, thus reducing procedure timeframes and requirements.

- **Common Administrative Procedures for licensing should be enforced at a Mediterranean level.** Efforts should be made to set up the base for minimum common requirements, to facilitate capital movement within the Mediterranean.
- **The criteria used to calculate the aquaculture fee should be reasonable, transparent and uniform for each type of aquaculture, in order to ensure legal security.** The fee for occupation of the public domain must be proportional to the use thereof, and take into account the specific character of the aquaculture activity in question. Alternatives to purely economic fees should be proposed.
- **The capabilities and human resources of the administrative authorities responsible for aquaculture should be increased** backed up by a political commitment to coordinate the institutions and agencies involved in the regulation and management of aquaculture.

K. Sectoral Planning

This guide presents sectoral plannig as a mean for achieving the sustainable development of the aquaculture sector and how site selection and site management is directly linked to planification. Definition of Sectoral Planning is given as well as the components of the sector. The role of the administration and key aspecs needed for the development of a sectoral plan. Finally, examples of procedures for Sectoral Planning are described.

Principle

The selection and management of areas for aquaculture should take into account a sectoral approach and Sectoral Planning.

Guidelines

- **The potential for growth of the aquaculture sector on each geographic area should be taken into account as the starting point for the selection of areas.** The prospect of growth is an essential factor to ensure that the activity appears and/or remains in a specific geographic area.
- **The growth of the sector should be balanced in respect to other sectors sharing the same public domain**. It is important to find a balance between the development of the aquatic activity and other activities that interact in the public domain, which is why growth of the former must be planned and orderly.
- **Sectoral Planning should balance the sector necesities and the public admnistration purposes.** As principal actors on the process, both parties should interact and develop a co-constructon process supported by other actors such as associatons, research bodies and other organisations.
- **Correct Sectoral Planning should be based on prospective studies.** Empiric knowledge is needed to set up the basis for development of sectoral plans. This in turn requires sufficient economic, material and human resources in order to obtain the information needed and to make it available to the actors involved in the sector's development.

- **Sectoral Planning should be carried out with the help of instruments and tools that make appropriate spatial and temporal analysis possible**. Geographic Information Systems are tools that facilitate the reading, representation and analysis of information.

L. Private Sector Organisations

This guide defines professional organizations and associations as organizational structures developed by the private sector. Their role and commitments are explained as well as their importance on the site selection and site management process. With reference to the Mediterranean organizations, the scale factor is considered as well as the trends observed due to globalization. Finally some examples are given as well as guidelines on how Private Sector Organization can contribute to the sustainable development of aquaculture.

Principle

Professional associations and sectoral organisation should be promoted in order to defend the feasibility of private initiatives in the selection and management of aquacultures sites.

Guidelines

- **Aquaculture companies and professionals should organise themselves in order to defend common interests.** By associating they gain greater social presence and greater capacity to reach top administrative and political levels, which otherwise would remain inaccessible for most companies.
- **Professional associations should establish and implement Codes of Conduct and Better Management Practices amongst all their members.** Implementing these initiatives, even if they are voluntary, contributes to improving both productive practices and Social Acceptability.
- **Public administrations should support professional associations.** Since the weak spot of structures such as professional associations is usually their limited financial capacity, public administrations should have public grants at their disposal.
- **Professional associations should be created at a local level, with the intention of joining organisations at a higher level.** The birth of a professional association at the local level provides an immediate base for the identification of common topics and problems. However, there also exist common problems and challenges at higher territorial levels, like n the Mediterranean, that can only be dealt with effectively through higher ranking organisations such as federations.

- **Access and participation to association should be equitable for all producers** Participation in a professional association must be open to all producers, regardless of their production volume, type of farming or territory they belong and must ensure the participation and right to vote of all members.

M. Integrated Coastal Zone Management (ICZM)

This guide highlights the necessity to take into consideration all the stakeholders involved in a determined coastal area in order to facilitate the coherent implementation of the diverse frameworks and processes occurring in the zone. In this sense, Integrated Coastal Zone Management can help aquaculture site selection and site management and its further sustainable development.

Principle

In the process of site selection and site management for aquaculture, Integrated Coastal Zone Management (ICZM) represents a new form of Governance that should be implemented.

Guidelines

- **A preliminary study exploring each sector needs in a given area should be implemented.** In this sense, aquaculture has also to be considered as an activity among others, user of the same marine ecosystem, and whose development passes through the search of new sites.
- **A thorough understanding of existing and potential interactions that affect different activities and resources in the area and how they are likely to develop over time should be done in order to integrate, among others, aquaculture.** Management efforts cannot be carried out anymore individually by different sector users of the same marine ecosystem. It is necessary to encourage benefits from complementary interactions and ways of limiting the antagonistic one.
- **Costs and benefits of all activities, including aquaculture, should be identified in order to take into account their beneficial as well as harmful effects on other activities.** It is important to be aware, from an economical point of view, of direct and/or indirect impacts that can occur from such a coexistence. Integrated Coastal Zone Management is an adaptive process which never ends up.
- **Relevant Integrated Coastal Zone Management elements in the Legal Framework should be identified and improved.** Pieces of legislation can be traditionally produced for individual sectors. Thus, to integrate the different sectors using the same marine

ecosystem such as aquaculture, it is necessary to give to existing Legal Framework a broader vision to allow their coexistence over a legal base.

- **A better global communication on the national development of such an experimental process like Integrated Coastal Zone Management applied to aquaculture site selection and site management should be promoted.** This information can be helpful on the one hand for countries whose ICZM capabilities are just emerging and on the other hand for countries which already apply ICZM and require, however, information about the process.
- **Integrated Coastal Zone Management activities should be financed in order to uphold and further allow the sustainable development of sectors such as aquaculture.** Effective coastal zone management requires regular financing in order to support its ongoing ICZM process which objective is to take into account all the stakeholders including aquaculture sector.

N. Site Selection Process

This guide pretends to offer a method for site selection, taking into account all necessary aspects to achieve the sustainable development of mediterranean aquaculture. Key aspects, concepts and terminology are explained and special attention is given to the secuenciality of the process itself. Definition of minimun parameters to study and its representation is included as well as a pratical example carried out in the south of Spain.

Principle

A clear and sequential Site Selection Process should be available in order to ensure sustainable aquaculture.

Guidelines

- **The site selection should depend on the aquaculture activity planned and existing environmental conditions.** In designing a process, all constraining factors or priorities that could interfere with the proposed objective of selecting sites for the sustainable development of aquaculture must be taken into account.
- **The scale factor should be applied in order to dimension the project, taking into account the degree of information detail required and the budget available for the process.** The material and economic resources required to carry out a site selection process should be considered in terms of balancing investment and expected results.
- **The methodology to be applied to a site selection process should begin with a sectoral analysis and the identification of needs.** The sectoral analysis must provide information regarding the type and size of aquaculture planned. This information will be essential in order to identify the best parameters for the study, the agents involved and the project's scope.
- **The study methodology should preferably be selective and dynamic.** Administrative factors should be arranged in advance due to the possible incompatibilities with other uses and so select and focus the environmental factors to study. The process should be dynamic, so that information obtained is progressively interpreted and added to allow feedback and updating.

- **The choice of parameters should be directly related to the statutory context in force for the aquatic activity in the area of study.** The parameters selected for the study constitute the major basis to determine the suitability of the area and should include those that interfere directly or indirectly with the planned activity.
- **The site selection method should include the chronological sequence of actions required to carry out the study within the expected timeframe.** Schedule should be established for: collection of information, maps building, consultation and validation by agents, final results and representation.
- **The results of site selection processes should be represented at a scale and with a format that can be easily read and interpreted.** The information obtained and its interpretation, must be represented graphically and be legible to the general public.

O. Ecosystem Approach

This guide promotes the application of Ecosystem Approach for managing the impacts of human activities on the ecosystem with the aim to optimize its use without damaging it. Thus, it is better to talk about Ecosystem-Based Approach to Integrated Management (EBM). It is a step by step management tool based on the best available scientific, traditional and local knowledge on the ecosystem and which complies with the 12 principles recommended by the Conference of the Parties of the Convention on Biological Diversity.

Principle
Site selection and site management should be addressed from an Ecosystem-Based Approach to Integrated Management.

Guidelines

- **Site selection and site management in Ecosystem-Based Approach to Integrated Management should be based on cause-and-effects relationships between stressors, namely the activity, and impacts to inform on the state of the ecosystem.** **A**ssessment tools such as Pathway of Effects or Cumulative Effects can help managers to propose mitigation measures or modifications of the activities that impact negatively the conservation objectives of the ecosystem.
- **Ecosystem-Based Approach to Integrated Management is a management tool which should be implemented at all scales, from local to international, without undergoing changes.** The Ecosystem Approach is a space-based strategy taking into consideration environmental and socio-economical aspects with the aim to promote conservation and sustainable use of the ecosystem in an equitable way.
- **Aquaculture site selection and site management should be focused from the Ecosystem-Based Approach to Integrated Management, once the top-down process carried out.** This will ensure the ecosystem attributes and objectives relative to biodiversity, productivity, health and resilience and therefore the sustainable development of any activity depending on it.

P. Carrying Capacity, Indicators and Models

This guide provides definition and tools for Carrying Capacity measurements. Different dimensions and meanings of Carrying Capacity are given, as well as criteria and variables to be used. Examples and models are proposed and guidelines related to site selection and site management for the sustainability of aquaculture are provided.

Principle

Operational measurements of Carrying Capacity should be taken into account for aquaculture site selection and site management in order to allow sustainable use of marine resources.

Guidelines

- **Carrying Capacity of all measurable parameters should be considered in site selection and site management.** In order to achieve sustainable development of aquaculture it is important to consider the environmental, social, physical, production and Economic aspects of the activity.
- **Evidences of limits of Carrying Capacity should be avoided.** Aquaculture requires good water quality for its implementation, polluted sites or areas with frequent occurrence of harmful algal blooms or oxygen deficits should be avoided**.**
- **The aquaculture activities should adjust their production to the Carrying Capacity of the local environment.** Each ecosystem has a different capacity to absorb and assimilate excess loading of organic compounds and nutrients, therefore low production should be in shallow, near shore and sheltered areas and, increased production in deep, offshore exposed sites.
- **Even in the case of the most favorable environmental conditions an upper limit of production per farm should be established.** Revision of limits should be supported by intensive and regular monitoring, providing sufficient evidence that this maximum production level does not cause irreversible adverse impacts.
- **Assessment should be made for the maximal allowable proportion of space that could be used for aquaculture in each water body taking into account other uses**

and local wildlife. Ecological and socioeconomic indicators as well as models and standards must be used to obtain the best possible integrated assessment of space allocation.

- **Consultation and dialogue should be encouraged among regulators, producers, scientists and relevant stakeholders in order to arrive at generally acceptable terms.** Establishment of common Environmental Quality Standards and regulations among the Mediterranean countries and regions will allow not only equal terms of competition but also a higher degree of environmental protection and an enhanced environmental profile of the aquaculture industry.

Q. Environmental Impact Assessment (EIA)

This guide outlines the Environmental Impact Assessment as an essential tool to implement prior to approving aquaculture site selection and site management. It allows to ensure proper decision-making processes supported with precise data relative to the impacts of the activity and takes into account the socio-environmental acceptability of the project. It should be consistent with both sustainability criteria and best available practices.

Principle

For an appropriate aquaculture site selection and installation, procedures of Environmental Impact Assessment (EIA) should be mandatory and implemented.

Guidelines

- **Environmental Impact Assessment should be mandatory for all the projects, including aquaculture site selection, and integrated in legislation.** The sea is a "public domain" and specific laws have to be implemented in order to ensure appropriate and sustainable use of the ecosystem thereby granting aquaculture sustainable development. Responsibility of EIA costs could be discussed.

- **To facilitate the process of aquaculture site selection, simplification of current Environmental Impact Assessment protocols, standards and models as well as regular review of the statements should be carried out and harmonized in all the Mediterranean.** Proper indicators for Environmental Quality Standards (EQS) and impacts adapted to various production typologies (shellfish/fish culture) must be developed in the Mediterranean.

- **Environmental Impact Assessment should be based on the best and appropriate scientific knowledge including technical, socio-economical and environmental aspects as well as on the Precautionary Principle.** Scientific facts, assumptions and expert judgements, and the consequences for the assessment of the range of error have to be discussed. In this context, the Precautionary Principle or Approach is an important element for an EIA.

- **Innovations concerning Environmental Impact Assessment should be within the range of administration involved in decision-making by means of regular training as well as by the private sector thanks to easy accessibility to information**. Stakeholders are not always aware of recent evolutions and reasons for changes. Therefore, regular updating is required to facilitate proper aquaculture site selection.
- **Research on present issues such as Cumulative Effects or mitigation measures as well as future topics should be promoted and developed in order to achieve the sustainable development of the aquaculture.** Innovative tools such as distances between cages or limits on diseases as in Norway examples on prevention or any activities that take advantage of the nutrient enrichment of the environment caused by aquaculture activity have to be more studied and further exploited.
- **Stronger socio-economical compensation measures in Environmental Impact Assessment should be imposed.** This would allow better integration of aquaculture projects into the local territorial environment and observing/developing synergies.

R. Environmental Monitoring Programme (EMP)

This guide handles the Environmental Monitoring Programme (EMP) which has to be consistent with sustainability criteria. It is a tool used after the Environmental Impact Assessment (EIA) to highlight, through samplings, to what extent the aquaculture management impacts the ecosystem over time comparing current data collected at various points in time with data obtained before its development as well as with those already existing.

Principle

Environmental Monitoring Programme (EMP) needs to be implemented and should be compulsory for sustainable aquaculture site management.

Guidelines

- **A baseline study should be implemented before the Environmental Monitoring Programme and respected**. Deep and proper knowledge of the surrounding environment and aquaculture practices are needed to define the best and specific Environmental Monitoring Programme.
- **Reliable monitoring should be used to detect environmental response to changes in the scale of production and to readjust limits for environmental quality standards.** Due to the continuous development of the industry, monitoring must be adaptive to assess the dynamic linkages between aquaculture and the ecosystem within which it operates.
- **Standardisation and harmonization of Environmental Monitoring Programme should be legally imposed in each country of the Mediterranean**. Supported by research programmes, EMP has to follow the same procedures to reach the sustainability of aquaculture in all the Mediterranean.
- **Environmental Monitoring Programme associated with Environmental Quality Standards should be regularly revised and harmonized by reliable multidisciplinary bodies and communicated in an easy way.** A well conceived EMP is a highly effective method that links environmental changes with activity inputs.

However, there are no set ways of monitoring or interpretation of the data obtained. These are dependent on the aims of the study, the size in case of development, site characteristics and scientific knowledge.

- **The sampling frequency considered on the Environmental Monitoring Programme should be determined by the Environmental Impact Assessment.** Frequency of sampling on sediment and water column should be done, at minimum, during the most impacted period, in summer. EMP could be adapted such as negative effects would increase the level of monitoring, whereas positive effects would reduce it.
- **A regular socio-economic analysis in the Environmental Monitoring Programme should be developed and revised at least every 5 years.** In order to monitor the socio-economical impact and review what was expected for the Environmental Impact Assessment.

S. Geographic Information Systems (GIS)

This guide defines what Geographical Information Systems are and their application to site selection and site management. A brief description of the tool is given, and the characteristics that GIS should has in order to make it useful and effective. Example of a GIS made in Andalusia (South of Spain) is presented.

Principle

Geographical Information Systems (GIS) should be used as a tool for site selection and site management.

Guidelines

- **Geographical Information System should be used as a tool on participative and o-construction processes:** This will help the understanding and focus the discussion on the real problems, providing equilibrium of power to all the stakeholders.

- **The information contained in a Geographical Information System should be objective and based on reliable sources.** Since these are tools for decision makers, the information must be based on good authority and only be open to question by means of empirical demonstration.

- **The information stored in a Geographical Information System should be maintained and kept up to date.** A GIS should be considered a live element in which contained information varies over time and it should therefore avoid decision-making errors resulting from the use of outdated data.

- **Information on the characteristics of the data contained in the Geographical Information System (metadata) should be made available.** The metadata must conform as far as possible to internationally recognised standards providing reliability.

Guide

A. Importance of Knowledge

This guide refers to the minimum factors that are considered necessary to know and at least to take into account when dealing with aquaculture site selection and site management, thus contributing to the sustainable development of aquaculture in the Mediterranean.

Any type of industrial activity requires prior knowledge of all the factors that make it possible to develop and with a certain degree of security, so that it remains predictable and viable.

In the early years of aquaculture development, biological and production aspects were particularly important due to the newness of the activity and the consequent need for knowledge aimed at its improvement. Nowadays, a particular interest is also given to site selection and site management processes and this requires good knowledge on the most recent improvements on coastal or inland aquaculture systems and techniques. But not only technical aspects are indispensable to consider when selecting a site for aquaculture; environmental, legal, as well as socioeconomic aspects are also particularly important in a perspective of aquaculture sustainable development.

This activity is directly linked to the environment, not only because of the natural conditions that will allow or not the settlement of the activity, but also because it affects in turn the environment of which it is dependent on.

In general terms, aquaculture activities take place on public domain areas. These are regulated and controlled by the administration. The multi-user's characteristic of those areas and the pressure on occupation makes legal issues to gain importance among aquaculture farmers and authorities in order to consolidate the activity by guaranteeing the occupation rights of the sites.

Knowledge of the regulations, administrative procedures and on the competent authorities in this field, which may affect aquaculture site selection and site management, can greatly facilitate and simplify these processes. This would lighten the way for aquaculture producers and promote the sustainable development of the activity.

In addition, knowledge of the socioeconomic and cultural characteristics of the surrounding area of a potential site for aquaculture is becoming more and more relevant, the purpose being to achieve the social acceptability of an aquaculture project, as society is part of the decision makers on the process of aquaculture site selection and site management.

Environmental knowledge

Environmental knowledge is doubly important for aquaculture site selection and site management. On one hand it is needed to evaluate the suitability of an area for the implementation and development of marine aquaculture with the most appropriate species; on the other it is important for assessing how the activity may affect the surrounding environment.

To begin a study of the natural surroundings with the aim of improving knowledge about the environment, every oceanographic, physical, chemical and biological variable that may affect production, and in turn may be affected by the activity must be analysed. This is what might be called the environmental characterization of the surroundings, which should be approached from two points of view:

- Environmental suitability for aquaculture: site selection.
- Environmental conditions potentially affected by the activity: environmental monitoring.

In the context of selecting potential sites, it is best to gather environmental knowledge once spatial information on possible conflicting uses has been obtained. Areas can thus be narrowed down and efforts concentrated in places that are ‘free’ or compatible with other uses. Thus, depending on the area where it is intended to locate the project and the type of aquaculture proposed, the most appropriate parameters needed to achieve technical viability can be chosen. In addition the possible environmental effects on the system should be assessed.

a. Key issues

As stated above, spatially delimiting the study area is important for the technical and financial cost of the work and because spatial variations in the behaviour of environmental variables can introduce large errors when the results obtained are collated.

Consideration of the time scale is also important because of the variability in the natural ecosystems studied. This high variability makes it necessary to extend the environmental study over several production cycles, equivalent to several years, in order to obtain a relatively reliable data series on which cause and effect correlations can be established.

Thus, the key aspects to consider when planning work to understand the environmental characteristics of an area where aquaculture facilities can be located are principally:

- The space-time scale, since an area's environmental conditions may differ or vary over space and time and may impose a limit on the type of aquaculture that can be developed as well on the space needed for its development (inland areas (estuaries or wetlands), semi-closed sea areas (bays or fjords) as well as open sea areas, inshore or offshore);
- The characteristics of the aquaculture activities to be undertaken, such as species, production levels and area occupied;
- The hydromorphological and geomorphological features of the anchorage area, such as the bathymetry and type of seabed;
- The type of installations planned, e.g. whether cages, long lines or platforms.

b. Study parameters

The number of parameters and how thoroughly they are studied will depend fundamentally on the area in question, the type of aquaculture to be developed and also the budget available for the work. Broadly speaking, the most relevant parameters, collated into groups, are the following:

Meteorological data

Meteorological data related to the study area are important when analysing the relationship between storms, winds and other natural phenomena and their effects on the marine environment, such as currents and wave patterns.

Oceanographic conditions

A study of the oceanographic conditions and hydrography of the area provides information on both the natural risks to which the installation will be subjected and the properties of currents that will disperse wastes to some extent. Significant wave height (Hs, value and frequency), local currents (prevailing direction and maximum, mean and minimum speeds) and coastal dynamics (local tides and currents) are therefore measured.

Seabed study

In the open sea, the seabed beneath the cultivation facilities will be primarily exposed to the potential effects of aquaculture activities. Thus, to assess the degree of effect on the seabed, the first step is to conduct a baseline assessment to establish normal values and to detect whether any particularly sensitive or protected habitats are present.

Some of the most important indicator parameters are sediment particle size, Redox potential, organic matter, bionomic and benthic fauna in terms of species abundance and diversity.

Water quality

The water quality of the marine environment where the installation is situated is fundamental when analysing the biological viability of the species to be farmed. Some of the most significant parameters to be measured are: the oxygen profile, salinity, chlorophyll, temperature, suspended solids, nutrients, and others possible contaminants.

It is also very important to identify and locate possible external sources of pollution which could affect water quality and therefore the viability of the crop.

All this, when systematically laid out, becomes a fundamental tool for the selection of aquaculture sites, not only for the authorities as data to support decision-making, but also for producers as available information required for successfully making of large and risky investments in aquaculture.

Basically, the environmental data is provided by the public authorities as general knowledge of the areas and public data that might be useful for any activity such as tourism, fisheries or aquaculture.

Technical knowledge

Technical aquaculture knowledge is the collection of practical methods, skills and know-how required for aquaculture production. It brings together both empirical and scientific knowledge.

Traditional aquaculture systems, such as marine finfish production in earthen ponds in estuaries like the Italian 'valli' or Spanish 'esteros', freshwater carp and tench production in ponds and most mollusc production are based on empirical knowledge and skills. Such understanding and skills are generally transmitted in local ecosystems from generation to generation or gained through work experience known as traditional knowledge. Generally, they do not change much with time and are not particularly able to adapt to a changing environment.

Nowadays, modern aquaculture systems, such as cage or tank finfish production are primarily science based. They develop rapidly thanks to constant innovations and to the application of technological improvements imported from other fields.

Technical knowledge is applied to many aspects related to the type of culture and site conditions. Therefore, materials used on the structure, mooring systems, holding capacity, feeding, processing, maintenance, transport, as well as the culture procedures would be improved as technical knowledge is obtained and updated. Especially when site conditions are not the best, technical knowledge could help on reducing risk or improving working conditions.

Referring to aquaculture in cage systems, experience has demonstrated the importance of appropriate site selection and site management when considering fish health. One of the most important experiences from Norwegian salmon farming is that parasites and diseases have been, still are and perhaps will be one of the most serious challenges for worldwide fish farming, and thus a preventive fish health policy sustained by technical and scientific knowledge should be applied for the control of diseases.

Techniques such as fallowing is one of the available tools for mitigation of fish diseases. The concept of sanitary fallowing implies the disposal of several sites for each fish farm in such a way that fish are stocked in each site by year classes and new fingerlings are not stocked in the same site alongside other cages already containing large fish. In case of a disease outbreak in one site the next juveniles to be stocked will be safe in a different site. Also, and as a precautionary measure, periodically each site could be left for some months unused in order to break the life cycle of any possible pathogen. When a site is left fallowing all its floating structures should be removed.

Even though its applicability at present in the Mediterranean is questionable, specially when the environmental and social pressure, are convincing to some of the Mediterranean authorities to concentrate the farms, the implementation of fallowing fish farms has evident implications for the planning of aquaculture areas and the configuration of the future aquaculture industry, so urgent scientific and administrative knowledge on this issue is needed.

In general, knowledge on technical aspects should be transferred and updated for people directly involved on aquaculture production. This could be achieved by academic training and lifelong learning.

The availability and reliability of technological knowledge is also an important issue to be considered by the authorities and public research bodies. Technological knowledge and the development of know-how should be supported by these bodies, acting on demand from the private sector. This combination of efforts will lead to better and quicker development of the activity, which will benefit both sides. Investment in aquaculture technology is highly specific and infrastructures depreciate quickly. All the producers' economic efforts go into their working capital and therefore all the support that the authorities can give will be greatly welcomed by the sector. Moreover, the authorities can direct research towards sustainable development, ensuring compliance with new directives and laws that will apply to aquaculture.

Technical knowledge is a key factor for site selection and site management. Its improvement will be directly related to the increment of suitable sites as well as to assure sustainable development of the activity.

Knowledge of the legal system

Aquaculture is affected by different regulations depending on the special characteristics of the zones it occupies: onshore, inshore or offshore. Different authorities have jurisdiction over these zones and they may draw up diverse and sometimes disparate regulations.

Planning for site selection should stem from knowledge and experience of all this legislation, both the one relating to the substantive and sectoral regulation of aquaculture and the one governing the uses of the public coastal area and the activities which take place there, such as shipping, tourism, urban development, ports, fisheries, heritage or defence. This knowledge makes it possible to contextualize the discussion and focus it in the right direction.

Once planning is completed, a legal status must be given, either by an *ad hoc* piece of legislation or by new legal provisions produced by the authorities with jurisdiction over the coastline.

Knowledge on the applicable legislation thus makes the route to site selection and site management easier, through an awareness of which areas are available and who has the power to decide and modify the established management systems. It also provides the legal certainty that aquaculture entrepreneurs need and ensures adaptability to potential changes in the legislation governing area management.

These aspects are fundamental to investors as they not only make it cheaper to find information but also provide them with a firm basis for decision-making. As a rule of thumb the importance that an administration or government confers to aquaculture can be easily guessed by the existing level of regulation or planning in this field. A country which has not developed any specific rules or clear procedures is not likely to consider aquaculture at present a strategic sector for development.

<u>Socioeconomic knowledge</u>

In addition to environmental, technical and legal knowledge for achieving good practices in aquaculture site selection and site management, it is important to get to know all social and economical matters as well as to understand the culture and tradition, specially the ideas and images locally associated with the practice of aquaculture.

The social tissue, the market as well as the industry structure and availability of services that will be directly or indirectly related to aquaculture sector such as storage and transport facilities, transformation industries or wholesalers, are important aspects to consider. A broad knowledge of them can help in designing the best procedure for site selection and site management, with the aim of gaining the social acceptance as well as other advantages and synergies that will facilitate the sustainability of an aquaculture project.

The socioeconomic situation of a defined region can also be a decisive factor in selecting aquaculture sites, the type of business plan and even the type of crop chosen to cultivate, in terms of the need for the activity to become a source of revenue or even of food. In the Mediterranean there are large socioeconomic variations between countries and thus differences in potential business structures. This ranges, for example, from multinational companies that own facilities (as in Greece or Spain) to many family businesses that sustain large sections of the population (as in Egypt).

Finally, the traditional knowledge, that is to say, the intrinsic knowledge and experience accumulated by the locals, passed down from generation to generation over decades of coexistence with the same environment, represents also an essential source of information, providing it's reliable, and then an added value to the scientific knowledge that can be produced.

Justification

Aquaculture as an economic activity involves large investments and high risk directly related to site selection and site management. Knowledge is needed in environmental, technical, legal and socioeconomic aspects to improve decision-making. The more data are available and the higher their quality is, the better decision will be made. Knowledge helps to improve selection criteria for aquaculture sites and makes it possible to draw up management guidelines to help promoting the sustainable development of aquaculture in the Mediterranean.

Principle

Aquaculture site selection and site management should be based on reliable legal, environmental, technical and socioeconomic knowledge to enhance the viability of the process.

Guidelines

- **Information on the legal and environmental aspects of the public domain should be collected by the authorities and be available to the general public.** The collection and dissemination of such information should be the responsibility of the competent authorities, given the public domain nature of most of these areas.
- **The development of aquaculture by means of site selection should be based on scientific knowledge complemented by traditional knowledge.** Research must be continually undergone in order to improve knowledge on aquaculture, which has to be made available in a way that is understandable by all.

About environmental knowledge

- **The study area should be delimited in advance.** The study area should be narrowed without loosing indispensable data, in order to optimize data collection in the fieldwork from a technical and economic point of view**.**

- **Environmental and culture conditions knowledge should match enough to assure the viability of the project.** Depending on the type of aquaculture to be introduced, the most suitable environmental conditions for its development need to be assessed.

About technical knowledge

- **Decision makers should be familiar with current production and technological systems to ensure that aquaculture sites are appropriately selected.** It's important to know what kinds of aquaculture are suitable to the characteristics of a particular area and to use the most up-to-date techniques to achieve the success of the project.

- **Only proven technologies should be considered in the selection of sites for aquaculture and their subsequent management, especially in offshore locations or in highly sophisticated systems such as land based recirculation systems.** Both types of aquaculture system are complex. It is therefore essential to be familiar with the most applicable technology in order to manage the high risk of aquaculture.
- **Research on the practical implementation of sanitary fallowing of fish farm sites in the Mediterranean should be encouraged.** The consolidation of this knowledge could have important future consequences on aquaculture planning and sitting, especially due to the increment in production and sites concentration.
- **The personnel in aquaculture farms should be provided with lifelong learning.** In order to make sure aquaculture ventures run smoothly, it's important to keep personnel aware of any new technologies or improvements which could improve site selection and site management.

About knowledge of the legal system

- **Aquaculture farmers and the authorities with jurisdiction over the coast should have clear knowledge of the legislation governing aquaculture and the relevant planning rules.** To this end, countries that want to encourage aquaculture development have to have transparent legislation on aquaculture to provide sufficient legal security for aquaculture farmers.
- **Aquaculture and coastal planning legislation should be familiar and accessible to all stakeholders.** In the planning of suitable sites for aquaculture, there should be a clear and comprehensive understanding of the legislation governing all interests affecting the coastline, in order to avoid conflicts of interest.

About socioeconomic knowledge

- **The process of aquaculture site selection and site management should take reliable local knowledge into consideration.** The views of the people on the area of interest, within the socioeconomic, political, cultural and legal context should be taken into account when assessing aquaculture planning.

- **Regarding interactions with other activities in the area, synergies and incompatibilities should be taken into consideration.** As aquaculture is at present one of the last sectors to arrive to a specific area, it's essential that synergies and incompatibilities with other sectors are emphasised in order to ensure that aquaculture integrates into the local economy and the sites are suitably selected and managed.

B. Participative Approach

This guide presents a straightforward concept, basic on its definition but complex to implement. The relation with site selection is explained and its importance for the success of the aquaculture project shown. Models and examples are given to guide the implementation of this approach on site selection and site management and sustainability of aquaculture.

Aquaculture takes part in the common use of marine areas, where its users and distinct activities come together, which will be directly or indirectly affected by aquaculture. The public nature of these marine areas adds complexity to the decision-making process, as a great number of opinion groups have a say on the development of aquaculture activity. Thus, what can we do to help make public or private stakeholders come to an agreement? This partly explains why the Participative Approach is so relevant, because it considers sustainable development a common and shared goal to ensure the long-term feasibility of aquaculture projects.

The participation of all stakeholders in the selection and management of aquaculture sites represents a challenge for decision makers and a strong commitment to research and public authorities, given the system's high level of complexity and fragility. Aquaculture also implies a certain risk to promoters and investors, due to the fact that projects are subject to approval by a certain number of public delegates, technicians, decision holders and social groups. For this reason, Participative Approach should establish a number of clear procedures in its design and implementation, as well as aiming for balanced objectives and obtaining results that benefit the global community.

From a conceptual perspective, participation is applied to a great array of very diverse situations. In this sense, the first task consists in establishing the different steps needed for participation. The use of the term "participative" is explained by taking into account the stakeholders' opinions, views and needs in a given stage of the process. For this purpose, it is essential to define each of the elements involved in the participative process, as well as identifying participants and their roles, the coordination of activities and other steps that will be further described.

Need and management of local knowledge in the participative process

It is necessary to emphasize the need of “knowledge” as an essential element in the participants' opinions and assessments, especially in the case of selecting and managing aquaculture sites, as it encompasses a wide variety of technical, legal, environmental, social and economic features which will be the base of the projects assessment and decision-making process. In this sense, the role of the researcher becomes essential, as he or she will identify and demonstrate the elements that contribute to knowledge as well as explaining the processes involved.

Sustainable development and territory management requires that research is organized to ensure participation of non-scientific staff in the research process (Callon et al., 2001). Research programmes should be negotiated with stakeholders and so efforts will be made as a respond to stakeholders´ demands.

Models of participative research such as research-action, enables the production of applied scientific knowledge through stakeholders’ problem-solving (Argyris y Schön, Avenier y Schmitt, 2007). Therefore, the production of knowledge does not only arise in experimentation laboratories but also in the fields of experimentation, and in organisations and businesses.

The entire participatory process should be based on objective information collected in the field and made available in a transparent manner to all stakeholders. The success of Participative Approach is based on the level of participation, supported by information and knowledge acquired by participants, who should be involved in a process of "co-construction" towards a common goal. The problem therefore lies in organizing the stakeholders' participation in the research process (David, 2000).

Research-Action-in Cooperation as a participative model

Having said this, a model of Research-Action-in Cooperation (Recherche-Action-en Partenariat (RAP) in French) is suggested. It was defined by Lindemperg in 1999 as the situation where a group of stakeholders, such as organisations, institutions, private sector delegates, in collaboration with researchers, bring together human and financial resources in order to work together to achieve common predefined goals.

RAP is defined as a temporary Governance system under the direction of a "pilot committee" which should be as neutral as possible and which enables the effective management of activities, and ensuring the activities take place, defining the necessary adjustments and arbitrating in case of conflict or tension amongst participants. Governance is thus understood as the way decisions are undertaken and implemented. Simultaneously, it is necessary to have a "scientific committee" present that will contemplate the way scientific knowledge is produced and guarantee quality.

RAP (Girin, 1990; Chia, 2004) is a tool which is inspired and based on the results of research-action (Liu, 1997), which has a double goal: to solve problems and to produce and spread applied scientific knowledge.

The implementation of RAP Participative Approach should meet a number of conditions:

- It is vital that researchers have the intention to search for solutions and in-field stakeholders are willing to change. Only if these two elements are complied with, a solution will be possible.
- Simultaneously, the "eddy" work model should be followed, rather than the traditional "linear" model (see figure 1).

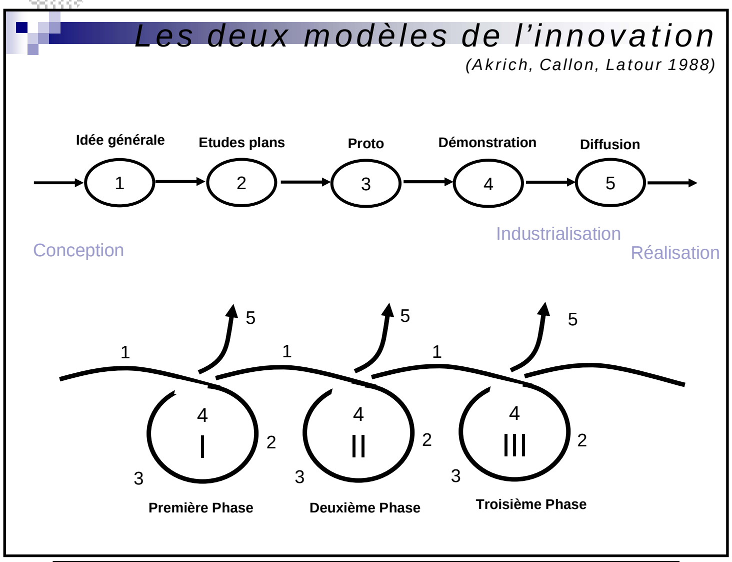

Figure 1: Lineal and eddy work models

This "eddy" model is characterized by the capacity of continuous revision and feedback, which will identify errors, restructure approaches used, and introduce new aspects in the system that reinforces and validates the process. Simultaneously, it generates knowledge which can be transferred to the scientific community and society, in general.

Implementing Research-Action-in Cooperation as a model of Participative Approach in aquaculture site selection and site management

- Situation analysis

  The selection of aquaculture sites is a complex problem that should take into account technical, social, political, cultural and historical coastal features.
- Socioeconomic and technical diagnose

  A reference document will be generated at the time of implementing a site selection and site management project that will allow to identify key stakeholders as well as to identify potential areas and activities which use the marine ecosystem in a physical or symbolic manner. As immediate results, the following can be identified:
  - The territory stakeholders, their logics and action models;
  - The problems and the causes of them;

- Organisations and level of organisation;
- Innovating and/or learning capacities.

- Elaborating a common project

  It is necessary to define the lines of a potential installation project and the conception of aquaculture activities. This work should be carried out by the researchers, not only specialized in a technical level but also in a socio-economic level, also with the promoters of the aquaculture project, working together to establish a leading project group with the capacity to launch works and activities. This project should be defined again once the participating social group is formed.
- Defining participating stakeholders

  Stakeholders to mobilize are defined, taking into account all aspects of involvement with the area and the project, identifying groups of delegates and spokespersons.
- Defining a provisional structure

  It is created to manage relationships between researchers and stakeholders. In this case, this structure can be represented by administrative members at local or state level depending on the decentralisation of the country.
- Elaborating a collaboration agreement

  An agreement that is based on an ethical written or oral framework has to be drawn up, containing project specifications or protocols that specify the terms that will be approved after negotiation. This should ensure two elements of Governance: the stakeholders' training period and the stakeholders´ autonomy. The objective is to consolidate the project leading group and establish project specifications which determine the exact terms of the agreement (the stakeholders´ engagements and responsibilities, what to do in case of conflicts or tensions, and finally, in what terms Governance will be defined).
- Creating a Pilot Committee.

  It is important to create a neutral pilot committee to implement the project where there are representatives from different social or stakeholders groups. Simultaneously, subcommittees can be defined which can deal with more specific aspects in function with the project dimension.

Once these previous stages are finalised, it is necessary to carry out a process of replacing results where the main stakeholders are brought together, including those considered marginal, so that they give their opinions related to the results. This restitution is an important and necessary step in order to channel the process and provide a common project and language amongst the stakeholders. These elements are essential to boost confidence and contemplate change and innovation. It can be considered an intermediary object (Vinck, 1999), such as a material support (graphics, charts, prototypes) which allows agreements to be reached, to build a common project or to facilitate successive translations that will consolidate and stabilize the project. (Callon et al., 2001).

The following step is the stage where all aspects are defined when selecting a potential site for aquaculture. In this process, the aim is to define the direction of the project, exploring different possibilities, evaluating difficulties and identifying coactions.

Through a process of co-construction the decision-making process will be reached through designing simultaneous mechanisms of experimentation as a prior step to the consolidation of the project, offering solutions and leading the process to a phase of stabilisation.

Innovation is considered herein as the result of a co-production process of social and technical elements. The process is consolidated or stabilized (but never finished) when the collective work, revision as well as the regulation of new practices rules have been established, and approved by consensus among the participants.

Justification

It is necessary to recognize that the concept of participation generates empathy in the participants whenever they are consulted and their opinions are taken into consideration. It also enables opposing opinions to be channelled towards a common objective where all stakeholders can benefit through a process of co-construction. The Participative Approach, as a well-structured and implemented strategy and applied to the selection and management of aquaculture sites, offers an opportunity to ensure acceptance and permanence of any aquaculture project, since it allows the involvement of all the stakeholders in the definition and implementation of the process. Governance is then reinforced by a process of ownership, emancipation and responsibility of stakeholders, and by this process, stakeholders feel like the project is their own, thus enjoying in its success or its failure.

Principle
Site selection and site management processes should take into account the participation of all stakeholders that share the same coastal region in order to achieve the sustainable development of the activity.

Guidelines

- **The Participative Approach should be considered from the beginning of the project.** It is essential that stakeholders who will be involved in any participative process will feel integrated from the beginning assuring appropriation and therefore success on the process of site selection for aquaculture.
- **The Participative Approach should follow a process of co-construction.** This process, based on the right to have a word at the round table, majority or consensus, will ensure sustainable objectives and will seek common goals that will benefit all the users of a given maritime region.
- **The Participative Approach should take into acount all stakeholders at all levels identifying their roles and abilities.** They must be properly represented and their implication demonstrated according to the degree in which the project may affect them.
- **The Participative Approach should identify a mediator or Pilot Committee**. This figure should be neutral and recognized by all participants with the purpose of organizing the process and directing development and implementation.
- **The Participative Approach should be produced in a common language.** The transmition of information will be homogenous and will ensure the comprehension of all participants, independent of their capacities.
- **The participative process should follow the "in eddy" model and provide periodic feedback.** The continuous evolution to which all processes are subject requires the participative process to go through a revision and continuous restructuring, correcting errors in order to reintroduce the established objectives from the beginning.

C. Social Acceptability

This guide presents the concept of Social Acceptability and the direct relation and importance on the context of site selection and site management. Definition, characterisation and perception of the public, criteria and tools to assess Social Acceptability and finally, guidelines to achieve Social Acceptability are given as they are considered as a key issue to assure the sustainable development of aquaculture in the Mediterranean.

Social Acceptability applied to site selection and site management for aquaculture in the Mediterranean Sea is a complex issue and its definition varies. In order to set specific guidelines, positive or negative Social Acceptability of a particular change is defined hereafter as the reaction of a significant number of people (at a certain scale) to a significant modification of their environment, their activity, or the sense of their work.

This broad definition comprises five large groups of parameters which include, on one hand, the geopolitical context, the economic and scientific data, and, on the other, the variety of stakeholders and the image through a cultural perspective. The first three will not be considered in this analysis due to their strong specificity and somehow their objectivity. They contribute above all to define the general frame of the aquaculture project. The two latter groups are however the ones playing a major role in the final acceptability of the project by society in general.

Categories of stakeholders

The different reactions of society to an aquaculture project will be at first sight unpredictable and will depend greatly on the people in question, their relationship with the sea and the activities developed. Additionally, the degree of influence in the project will depend upon their organisation and their representativeness.

Thus the following categories of stakeholders can be identified:

<u>Regarding the location as related to the sea</u>

The communities with a permanent residence on the coast are the first ones to detect modifications, but also to get used to the landscape and/or to observe directly the positive or negative effects of the aquaculture facilities.

Temporary users of the coast, namely tourists, have a more idealized view of the desired scenery for which they are paying directly to enjoy during their leisure or resting time.

The rest of the population will only have a global and subjective view of aquaculture in general, perhaps from the point of view of consumers of the by-products.

Regarding the activity

The interests of certain social groups will also play an important role in creating a negative or positive opinion, which will be more influential as the group approaches the decision centres.

Depending on the activity, we can mention:

- Fishermen and other users of the continental platform, who will be the first to notice the invasion of their traditional working area;
- People practicing water sports and tourists whose main concern will be economical and the conservation of the natural surrounding as found and chosen for their activities, rejecting any "sea industrialization", especially if this is visible;
- All people involved in industrial (dredging, etc.), military (restricted zone for test, etc.), or trading (harbour transit, etc.) activities who need space for navigation or extracting resources;
- Those who earn their living from tourism and protect their customers;
- Pressure groups worried about unexpected consequences which might alter the environment;
- Those who admit certain changes in favour of a better supply of sea products;
- Local companies and groups which will perceive the activity as a source of revenue and employment.

All of them will somehow have their own opinion regarding the acceptance or rejection of a particular aquaculture project, and largely influence its continuity.

The image through the cultural perception

Generally speaking, the image perceived is one of the main aspects that create states of opinion on a particular issue on which there is no specific knowledge. Several studies (mad cow crisis, avian influenza, etc.) show that acceptability conflicts are more linked to the context and the institutions that are responsible for the issue than to the issue itself (Marris, 2001). On the other hand, in 1998, A. Skakolczai showed in his study on 24 countries that the values defining the perceptions of an individual depend less on political or economical contexts than on their degree of development and expression, as it happens with the conditions to reinforce responsibility at local level. This notion was already mentioned in the studies coordinated by T. Gaudin in 1990. Introducing a wrong idea or image can be very costly to rectify.

The public perception in the Mediterranean can vary and be linked to:

- Cultural diversity. Cultural parameters can support positively or negatively the occupation and exploitation initiatives of marine locations as food providers in so far as these initiatives are rooted in the traditions of a particular area;
- Political and administrative diversity. Political strategies and administrative structures can influence Social Acceptability. The level of decentralization of a country brings decision making closer to different opinion groups at local level, where perception of reality becomes more evident due to the proximity to the issue;
- The differences in development. The level of development and especially of knowledge plays a crucial role in the acceptability or rejection of an aquaculture project. Information and knowledge provide assessment criteria that are different from opinion;
- Differences on needs. Acceptability also depends greatly on the needs of a particular region. The capacity to set priorities is emphasized when those needs are basic.

The sociological works carried out by Jamieson in 2005 indicate that the necessary adaptation of humankind to future changes (technological, climate, etc.) should be accompanied by ethics to avoid negative effects.

Furthermore, the World Value Survey conducts a survey within 80 countries about the characterization and classification of values every 5 years. In 2006 it suggested a graphic synthesis contrasting the values of survival and expression of oneself (individualism), with those of tradition and rational modernity.

Thus, acceptability of aquaculture in the Northern shore of the Mediterranean mobilizes mainly values of individualism (companies, market, benefits) and rational modernity (availability of technology). This can apply to certain countries like Spain, Greece, Croatia, Israel, Italy and France among others. The block of ex-communist countries also tend towards rational modernity values but with survival values probably due to their recent appearance. In the case of Southern shore countries, the situation can be different due to the prevalence of collective values and local needs as in the case of Egypt, Morocco and Algeria, and Turkey in-between.

It is clear that multiculturalism in the Mediterranean region results in a more complex situation when establishing criteria or tools to assess and consider Social Acceptability.

The simple theoretical solution in case of opposition to an aquaculture project would be the assessment of the socioeconomic value of those against (fishermen for instance) and their compensation (Tixerant 2006). But this measure does not provide solutions in the long term and moreover it endures the discordance between those who oppose and those who lead the project. This situation creates conflicts and lack of understanding that should be corrected by establishing a debate from the beginning and associating the main stakeholders from the definition to the final commitment (Callon 1998; Pesarosos 2001).

The participation of local communities in the entire planning of the project as well as in its funding might favour Social Acceptability. The feeling of participation to the construction of the project could help eliminating criticism and even turn those into praise (Breukers 2007), especially if the stakeholders' opinion is taken early into account, if the project provides local employment and support tourism and if the potential reversibility of facilities is demonstrated (Gueorguieva-Faye 2006). Keeping this in mind to reach the sustainable development and consolidation of aquaculture activities, an effort will be required to transform negative perceptions into positive ones and disadvantages into potential advantages through synergies.

It is therefore essential to use agreement to enhance social changes, and establish collective rules and organizations. The process can be summarized in four stages: (i) justifications of project stakeholders, (ii) identification of disagreement areas, (iii) interpretation of opinions, (iv) facts and concepts to end with the final establishment of an evaluation frame (Beuret 2006). During all the process, the State plays a crucial role as administrator and arbitrator.

Mediterranean States are however very diverse, which leads to differences in the level of intervention and in their strategies. State intervention ranges from strict enforcement of the Legal Framework (Turkey, France) to accompanying measures (Spain, Cyprus).

Synthesis

A synthesis of the surveys conducted on the reactions by different categories of stakeholders to aquaculture or to similar projects in the sea, for instance wind generators, shows that Social Acceptability:

- varies between rejection and agreement, depending on the sensitivity of impacted areas, especially during the initial stage;
- is easier when positive effects are demonstrated (aqua tourism, complementary production through artificial reefs, etc.). Alternatively, it slows down when the risks of negative impacts are higher or obvious;
- depends greatly on the initial project management. Main achievements are: 1) the commitment of all stakeholders from the beginning, including if possible, from the financial point of view, 2) the possibility of multiple uses in an integrated management of natural resources by different sectors, 3) the increase of local employment levels, and 4) the quality of information and its distribution;
- should be always based on education, training and communication;
- is reinforced by spreading the image of an aquaculture that pays attention to society's opinions on sustainability and product quality. Generalization of international rules could help in this process.

Justification

The shared use and exploitation of marine resources generate very different interests, causing the direct or indirect intervention of different social stakeholders affected by a particular activity. The public nature of Mediterranean coasts adds an element of uncertainty to aquaculture projects, as the decisions made by the administration could and should consider the opinions and potential conceptions of the different users. This is the reason why, in order to select and manage areas of interest for aquaculture, Social Acceptability should be a key objective to be considered at the very origin of a project. The feasibility and sustainability in the long term of the aquaculture activity would thus be made easier.

Principle
Social Acceptability should be considered as an aim on site selection and site management process in order to assure the setting and permanence of the aquaculture project in the long term.

Guidelines

- **Social Acceptability is an objective that should be considered from the onset of any aquaculture project.** This general rule is particularly relevant in the Mediterranean region, given the annually ever increasing pressures of coastline occupancy and use.
- **Communication, information and transparency should be established to foster a dialogue amongst stakeholders and ensure Social Acceptability.** Information exchange amongst stakeholders is vital to ensure the correct analysis of the consequences of the acceptance or rejection of a project.
- **Cultural parameters are particular to each Mediterranean region and should be considered individually when building Social Acceptability.** The multicultural nature of the Mediterranean adds complexity to the process of Social Acceptability. The identification, analysis and integration of these parameters in the selection and management of aquaculture sites are considered necessary.
- **Social Acceptability and the consequent sustainability of an aquaculture project should be based in the creation of an "Image of Quality" for aquaculture.** Aquaculture is still unknown by society in general. It is therefore necessary to invest in communication and education to make a better understanding of site selection and all aquaculture processes throughout a quality scheme.

D. Precautionary Principle

This guide presents the concept of Precautionary Principle and its application to the different aspects concerning site selection and site management. Definitions and implementation of the concept are given and a special attention is paid to the limits between benefits and rejections of the Precautionary Principle application.

The Precautionary Principle definition is "*Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation*." (Principle 15 of the Rio Declaration on Environment and Development, 1992). It is a basic principle allowing the taking of decisions even though not all scientific data are available. When used, for example, within the framework of the Ecosystem Approach, during participative and adaptive processes, and within the framework of good Governance it represents a strong and efficient principle.

The Precautionary Principle, or precautionary approach, has emerged over recent decades as a widely and increasingly accepted general principle of environmental policy, law, and management. It is an approach to uncertainty, and provides for action to avoid serious or irreversible environmental harm in advance of scientific certainty of such harm (R. Cooney, 2004). While an important and intuitively sensible principle, the acceptance of the Precautionary Principle into law and policy and its implementation in practice has been marked by controversy and confusion.

The Precautionary Principle is used in a variety of ways, and a wide range of formulations exists. The core concept of precaution can be viewed as a mechanism to counter a widespread regulatory presumption in favor of allowing development/economic activity to proceed when there is a lack of clear evidence about its impacts.

Formulations of the Precautionary Principle vary from weak to strong, and from those that impose obligations to those that empower decision-makers to take precautionary action. Features common to most of these formulations include the use of language that limits the operation of the principle to circumstances in which there are threats of serious or irreversible harm, consideration of the cost-effectiveness of precautionary actions, and a shift of the burden of proof to demonstrate lack of harm to proponents of activities.

Acceptance of precaution as a Governance/management tool is highly inconsistent across biodiversity-related policy sectors, and in general remains contentious. Many countries have incorporated the principle into general environmental, biodiversity or natural resource law and policy. However, at a multilateral level, it is very widely incorporated in biodiversity conservation and fisheries management instruments. It appears only a limited form of precaution is provided for under relevant international trade agreements. This poses challenges for coherent environmental policy at both international and national levels.

There are some important features of the biodiversity and natural resources sector that are different from the industrial contexts in which precaution is usually discussed. Uncertainty in Natural Resources Management (NRM) and biodiversity conservation is fundamental and persistent, and surrounds not only underlying natural systems but the socio-economic and political context which shapes the impact of conservation and resource decisions.

Threats to biodiversity are often posed not by a new, poorly understood technology or process, but by the expansion or intensification of well-understood activities such as harvesting of wild species or aquaculture settlements. Threats often derive from multiple rather than singular sources, with different courses of action each raising potential risks. The costs or burdens of precautionary measures may fall on poor or subsistence natural resource users and communities, rather than industrial interests. However, there are often close linkages between biodiversity conservation and the long-term interests of those resource users whose actions raise threats of harm, and precaution can also support local livelihoods and communities.

Precaution is commonly equated with restrictive, “protectionist” conservation approaches, and assumed to be inconsistent with sustainable use. However, determining the precautionary strategy is likely to require assessment of the relative conservation threats and benefits posed by alternative strategies. Such assessments will benefit from taking into account not just scientific knowledge, but traditional and local knowledge, and incorporating understanding of the socio/economic/political contexts that will determine the impact of conservation decisions.

The frequent automatic link made in legislation and policy between biological indicators of threat such as species status, and specific management responses such as prohibitions on use or trade, often justified on precautionary grounds, should be questioned.

Implementation of precaution involves a political and values-based balancing between the interests of biodiversity/resource conservation, and other countervailing pressures such as economic or livelihood interests. The more extreme or highly prohibitive versions of precaution, the "when in doubt, don't" approach, are problematic for reasons of both pragmatism and equity, although they may be appropriate in specific circumstances. Many versions of precaution incorporate the concept of proportionality between level of risk and measures adopted, and include some form of analysis of the various costs and benefits involved. Different decision-making instruments, arenas and contexts may demonstrate varying levels of risk averseness, due in part to their different objectives and the varying strength of different interest groups reflected therein. Where the same issue is addressed by different policy or decision-making arenas, this can pose potential conflicts.

Precaution raises significant equity issues in biodiversity conservation and NRM. The livelihood and socio-economic impacts of the principle can be negative, particularly for those dependent on utilization of biological resources to support livelihoods. Highly restrictive or protectionist approaches raise particular problems in this respect. Attention should be paid to which groups bear the burdens of precautionary restrictions, including who bears the burden of proof, and who participates in and influences decision-making.

Precaution be used by various groups in illegitimate ways, and can be misused to disguise objections to utilization based on, for instance, animal rights concerns.

Concerning aquaculture site selection and site management, the Precautionary Principle would be applicable on a certain way to all the aspects related to the process. Aquaculture is an activity that could be defined as highly dependent on the environment which holds it and open to foreign sources of positive or negative effects. So Precautionary Principle should be applied to aspects of the site selection and site management such as:

- Environmental aspects. Effects on both directions, from the surrounding environment to the activity and vice versa. Dimensioning and progressive evolution of the activity together with monitoring should be based on precaution to avoid possible harms. The Precautionary Principle should be present on the Environmental Impact Assessment and Environmental Monitoring Programme as well as in the analysis of environmental data collected for the selection of suitable sites for aquaculture.

- Economic aspects. The investment and risk balance of aquaculture, as an economic activity, is very high. Even in the process of site selection and site management, the economic point of view plays an important role and expenses has to be treated carefully. This makes precaution an important issue to be considered from the very beginning of the process.

  Investments and risk evaluation should be carried out prior to the process of site selection and site management itself. Aquaculture as an economic and production activity should grow gradually and in parallel to the adaptation to the environment and to the market. At the same time, the effects and costs of the no application of Precautionary Principle should be considered.

- Social aspects. Social Acceptability is a key aspect for site selection, the influence that aquaculture could have on the surrounding populations will influence the fail or success of the project. Precaution on those aspects provides a better vision of the situation avoiding possible conflicts with other users and general public. Broad participation and co-construction as tools of precaution are needed during the process, especially when dealing with activities dependent on the same resources such as fisheries.

- Legal aspects. Site selection and site management are submitted to laws and regulations. Although this is a more empiric rather than unexpected matter, laws and regulations can change, especially on a public domain shared and managed by different administrations. Precautionary Principle should be applied supported by a wide and prospective view of other countries or of examples of organization between countries such as the EU, which may give guidelines on future situations.

Precautionary Principle is a very wide concept and it is applicable to any aspect on its just measure to avoid conflicts derived from over dimensioned restrictions.

Justification

The Precautionary Principle raises issues that are central to current international debates around environment, poverty, sustainable development and biodiversity, including the relationship between biodiversity conservation and sustainable development; conservation for biodiversity *vs.* conservation for people, protectionist approaches *vs.* sustainable use; and regulatory *vs.* incentive-based conservation approaches.

The Precautionary Principle provides guidance for Governance and management in responding to uncertainty. It provides for action to avert risks of serious or irreversible harm to the environment or human health in the absence of scientific certainty about that harm. It is now widely and increasingly accepted in sustainable development and environmental policy at multilateral and national levels. The principle represents a formalization of the intuitively attractive idea that delaying action until harm is certain will often mean delaying until it is too late or too costly to avert it. However, the potential for controversy is obvious. Applying precaution will usually involve restrictions on human actions. Such restrictions, by definition, cannot be fully justified by unambiguous scientific evidence, yet may impose substantial costs.

Principle

The Precautionary Principle should be applied in the aquaculture site selection and site management processes.

Guidelines

- **The Precautionary Principle should be applied in the decision making processes for aquaculture site selection and site management, under the framework of the**

Ecosystem Approach and in conjunction with Participative and Adaptive Approaches. It allows the taking of decisions even though not all scientific data are available and help stakeholders to have a straightforward approach.

- **The Precautionary Principle should be applied with certain limits in order to avoid possible rejections.** Precaution has no defined or measurable limits, and this has to be set up mainly by the possible effects of any action, without braking boundaries or reaching the point of no action.
- **Precautionary Principle should consider in an appropriate temporal and spatial scale all forms of relevant information such as scientific and traditional knowledge.** The best informed will be the decision makers, the most adequate the process of site selection will be planed according to the risk incurred.

E. Scale Approach

This guide presents the concept of scale as a factor to be considered in the process of aquaculture site selection and site management where spatial and temporal dimensions influence decision making. Definition of the concept is given as well as the effect of mismatches among scaling factors that affects site selection and site management.

Scale refers to any measurable dimension such as space and time. When we consider the cause-and-effect relationship between aquaculture and the environment, or the administrative procedures or the socio-economical aspects, on a spatial and temporal scale, we are faced with the problem of understanding how scale influences the number and nature of those interactions, especially when mismatches are found between them.

From the ecosystem point of view, spatial scale is quite variable and usually refers to the boundaries among different ecosystems. Ecosystem's dimensions usually differ from aquaculture projects' dimensions. However, the interaction between the ecosystem and the activity is evident and therefore both aspects have to be considered, measured, and compared in order to minimize possible mismatches and further undesirable effects.

As the ecosystem characteristics determine site selection, scaling is important from the point of view of the occupation of space by the aquaculture activity. Scaling will help to diminish the costs of data collection from the ecosystem, reducing the study to the minimum necessary space to be characterized for a given aquaculture site selection process.

Temporal scale deals with the evolution over time of the aquaculture activity and the dynamic of the ecosystem. Mismatches can appear and should be corrected. Interactions depend on the way of the activity develops and on the willingness to achieve the sustainability of the aquaculture project. It is essential to have a short, medium and long-term vision checking how the activity influences and in turn is influenced by the ecosystem.

Scale is also important when we speak about the possible effects that natural events can cause on a possible site for aquaculture. Within ecological systems there is a relationship between spatial and temporal scales, namely at large scale slow changes arise (e.g. climate change) whereas at small scale fast changes occur (e.g. storms). Environmental changes, expectable or not, have direct consequences on the fragile relationship between the ecosystem and the activity which is nowadays still difficult to understand and address. Importance should be given to the promotion of research in this domain in order to increase the adaptability of the aquaculture sector in a multiple uses context.

In relation to legal and administrative procedures, scale approach should be considered due to the close relation of these aspects to site selection and site management. The localization of an installation involves the participation of different administrative bodies so much so that agreements and decisions are taken at different levels. Moreover, mismatches can be found even among administrations belonging to the same country. This complex situation affects aquaculture site selection and site management on a temporal scale. The more administrations take part in the process, the longer the latter will be, affecting the planification of the activity, especially when the final decision comes from the central administration which is normally far away from the zone of interest. Thus, depending on the complexity of the political structure, the decision taking over time scale can be more or less long. Scaling is needed to allow predictions for investments. Focusing the scale through decentralization to the lowest appropriate administration level will trigger the interest evinced by authorities simplifying procedures for aquaculture site selection and site management.

Concerning social aspects, depending on the dimension of the groups affected by a given process of site selection, the way to reach social acceptability in order to achieve aquaculture sustainability will be different in time scale. The organization and representation of the groups of stakeholders, whose actions depend on their own perception and are conditioned by institutions, is a social issue that takes place within given space and time scales and that has to be taken into account in the site selection process. Therefore, such positive or negative determinants in regard to the social construction as well as the time lag in achieving social acceptability should be assessed in order to avoid possible mismatches.

From an economical point of view, scale is related to the economic value of the investment and the recovery time. As an economic activity, all processes influence the economy, in terms of losses, recovery period and amortizations. Scale approach to these aspects could help to minimize costs or to maximize profits, adjusting investments to the dimension of the business or the carrying capacity of the system.

Scale Approach relative to a given marine area is therefore complex. Even if the primary interest is managing a particular local system like a bay where farming could take place, one have to understand the ways in which surrounding systems, such as ecological, administrative and socio-economical, influence the activity and vice-versa. Moreover, how the activity is itself influenced by the smaller systems it comprises when considering nutrient cycling or individual farmers' behaviour has to be taken into consideration. Then, a more complete understanding can be gained by examining different ranges of scales around a given aquaculture activity.

Justification

Scale approach is applicable to any aspect. In aquaculture, when interactions occur between ecological or social systems, the mismatches on a temporal, spatial or functional scale can affect the success of the coexistence and therefore the sustainability of the process. Site selection and site management for aquaculture integrates many different aspects concerning sociology, ecology and economics. The capability to identify mismatches and apply appropriate scale factors should lead to the sustainable development of aquaculture.

Principle
Site selection and site management in a context of sustainable development of aquaculture should consider the scale approach when studying interactions between several systems.

Guidelines

- **Scale approach should be applied in each step of aquaculture site selection and site management process.** Continuous dimensioning and identification of mismatches can help to achieve the success of aquaculture projects in a given area.
- **Research should be encouraged to understand and resolve scale mismatches in the process of site selection and site management.** The capacity to identify, measure, and compare the effects caused by the different scales at which the varied systems function can help the process to succeed.

- **Potential growth of aquaculture should be considered at the starting point of the site management process**. A long-term vision of the possible future aquaculture farm development will enable to overcome further and expectable mismatches between the activity and the surrounding systems.
- **Tools such as Geographic Information Systems should be used to assess the spatial and temporal scales in aquaculture site selection and site management process.** Strong tools can help to better understand what is happening in a system at different scales in order to manage the situation knowingly.
- **Site selection and site management should be decentralized to the lowest appropriate level.** Government structure and level of decentralization in Mediterranean countries play an important role on the process. Institutions frequently lack the necessary multi-scale vision and associated flexibility to solve problems that occur at scales that they usually do not consider.

F. Adaptive Approach

This guide refers to the importance of the learning, anticipation and flexibility in the process of site selection and site management at the hands of the dynamic nature of the ecosystem where the activity is implemented.

In an evolving environment characterized by fast and deep changes often unpredictable, aquaculture has to develop and maintain long-term strategies in order to adapt and subsist in such a dynamic system. Changes can occur as well in the ecosystem due to the impacts of rapid development of world population or through natural disasters as in the society with circumstances such as the increasing expectations of a world more and more demanding about food quality and global trends in biodiversity care.

Thus, to make sustainable the aquaculture sector, this one has to be able to adapt to new situations and, at the same time, try to pursue the sustainable development of the activity. When achieved, adaptation can be defined as positive response to change. It affords to create and maintain sustainable ecosystems that can support human needs durably. To do this requires that both human and ecological processes as well as their influences over the time have to be understood. Increasing knowledge of societal values and environmental aspects through learning enhances the chances that ecosystems can be sustained and sectors such as aquaculture can be sustainable. However, the process of learning and adapting is not an aim by itself but has also to evolve over the time.

Learning to achieve sustainable development despite changes requires a diversity of strategies and needs the close partnership between managers, citizens and scientists as well as cooperation between members of the same aquaculture sector to provide a whole view of expectations and responses to change. In a context where rates of change are increasing, comparing alternative practices adopted to cope with a determined situation can lead to faster learning and adaptation with the purpose of achieving a reliable long-term strategy which doesn’t rest on a reaction in view of external stimuli but rather on anticipation. Anticipatory research can supply new information that can influence and improve past and further studies on aquaculture sustainable development as well as help the sector to adapt more easily to a determined change, reducing efforts and uncertainty of management and avoiding reaching crisis situation that could put in jeopardy the subsistence of the activity.

In aquaculture as in other sectors, adaptation to changes depends on the degree of flexibility, which is the capacity of developing strategies in order to maintain the competitiveness and possibly the growth of the activity. There are different types of flexibility to answer to an environmental, social or economical change. For instance, the relational flexibility is the capacity to develop the activity by means of durable alliances, cooperation or participation to a net in order to go past individual action and favour partnership to better cope with possible changes in the system. Static flexibility rather refers to potentialities of an activity to face predictable changes in a more or less stable environment, while dynamic flexibility is implemented at the hands of a possible changing system and is based on anticipation or rapid reaction processes.

For an economical activity such as aquaculture, responses and adaptation to a change can occur at the production level by means of the supply of a broad diversity of products or the shunning of stocks apparition as well as at the organisational level through the implementation of an improved learning capacity or the development of partnerships. The aim is that the producer can adapt over the time the functioning and the structure of the activity to an evolving environment in order to reach as far as possible the determined objectives of sustainable development.

Therefore, at the hands of a dynamic system often unpredictable, to learn and adapt actively and continuously thanks to a better knowledge of a determined situation comparing different alternative practices, to favour partnership and flexibility or as well to anticipate outcomes in advance can allow to better cope with uncertainty with the purpose to facilitate adaptation and further development of the activity.

Regarding site selection for aquaculture, Adaptive Approach is also essential in all evolving processes. For instance, in Governance or Participative Approach, a continuous redefining and adaptation of the stakeholders' roles and responsibilities to find common ground and building incentives are necessary to achieve development objectives. About legal aspects, adaptability of policies is important in a world where the scrutiny of an increasingly critical citizenry becomes more and more significant. Laws and regulations as well as administrative procedures should consider also the Adaptive Approach. Flexibility and capacity of change in accordance to the evolution of the aquaculture sector and society demand will make legal frameworks a useful tool towards sustainability.

Adaptive Approach is also related to aquaculture technology and its capacity to adapt to different and new sites for aquaculture. In fact, there is a direct relationship between the availability of new sites and the performance of technology to cope with site conditions as well as the capacity to change within the occupied sites. Large possibilities will be open if technology applies Adaptive Approach and search for offshore sites, where users are fewer and environmental hazards are reduced.

Justification

Adaptive Approach is essential in the process of site selection as well as in aquaculture management due to the dynamic nature of the system where the activity is implemented. Changes can be fast and deep and can directly affect the activity subsistence if it is not prepared to adapt to a new environment. Learning based on broad and continuous knowledge, anticipation and flexibility are the main pillars for a better adaptation.

Principle
In aquaculture site selection and site management, Adaptive Approach should be implemented to allow the activity to develop in a sustainable manner at the hands of an evolving environment.

Guidelines

- **Adaptive Approach should be implemented in an evolving process like aquaculture site selection and site management thanks to the learning, anticipation and flexibility.** Reactive adaptation to changes can become a danger for the sustainability of the aquaculture. A long-term strategy is rather advised.
- **Anticipated and unanticipated risky changes should be considered at the legal, ecological, socio-economical or technological level in order to reduce conflicts through a better flexibility to reach the sustainable aquaculture development.**

Long-term solutions to mismatches will depend on knowledge and the further development of flexibility that can enable to reorganize in response to changes in factors influencing aquaculture sector.

- **Research should be encouraged to allow the aquaculture sector to anticipate to changes.** Anticipatory research can influence and improve past and further studies on aquaculture sustainable development as well as help the sector to adapt more easily to a determined change.
- **Close partnerships between citizens, managers and scientists as well as cooperation between members of the same aquaculture sector should be encouraged in order to facilitate adaptation to achieve aquaculture sustainable development.** Through partnership and cooperation, knowledge can be shared and widened, comparing different strategies used to cope with a given situation. Thus, learning and adaptation can be faster in aquaculture processes.
- **Effective and rapid learning, adaptation and flexibility should be taken into consideration to cope with a change.** Documentation, anticipation, flexibility, comparisons between different approaches and identification of trigger points are essential for the sustainability of the aquaculture. Learning and adaptation are processes that always evolve over the time.
- **Records of successful as well as failed past studies should be accessible to all the stakeholders.** Much can be gained from the creation of a database of retrospective study opportunities in the Mediterranean aquaculture since it represents the same ecoregion.

G. Economic aspects

This guide introduces the basic concepts and tools of environmental economics needed for site selection and site management. Economics provides meaningful indicators and decision support tools. It allows analysts, planners and entrepreneurs to compare different activities and their outcomes using a common monetary benchmark. The guidel focus on the application of Cost Benefit Analysis (CBA) and valuation methods since they are widely recognized and accepted by a range of decision-makers, both private and public.

The spectacular growth and development in Mediterranean aquaculture over the past thirty years has largely been driven by market forces. On the demand side, population growth and changing tastes have caused dramatic increases in the demand for fish protein and derivative products. On the supply side, overfishing has stressed many, if not most wild fish stocks to the point where the viability of capture fisheries is threatened (Andersen, 2002). Farmed fish now provide a complement for increasingly scarce of wild stocks, offering an homogeneous and constant supply of good quality products within a small flutuations of prices.

This brief history demonstrates the importance of economic factors in the evolution of aquaculture. It also highlights critical links between natural and ecological resource systems and economic impacts (Turner et. al. 2001). Economic incentives and poorly defined/enforced property rights led to overfishing and its consequences. This in turn increased the costs of capture fisheries and coupled with rising demand and prices for fish, transformed aquaculture from a set of backstop technologies[4] to a mainstream and essential production method.

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[3] The concept of backstop technology was introduced by Hotelling. In the original conceptualization, it referred to alternative sources for the services from scarce exhaustible natural resources but is also applicable to cases in which the demand for renewable resource such as fish outstrips supply. In general, a backstop technology is an alternative source of supply for the scarce commodity and becomes economically viable when the cost of securing the commodity using conventional means rises to the point at which it equals (or exceeds) the cost of securing the same commodity using the backstop technology. In many cases, aquaculture conforms to this definition, as wildstock biomass falls, the cost of capture fisheries rises and demand outstrips supply forcing up the market price of fish. The higher price justifies investment in aquaculture and there is a proliferation as enterprises are attracted by potential profits.

At the same time, the proliferation of aquaculture installations, in particular in coastal areas has brought the sector into competition with a range of other stakeholders and subjects it to a range of environmental pressures.

Aquaculture's economic prospects cannot be divorced from the ecosystems within which it operates. For this reason, economic factors and in particular, the economic dimensions of aquaculture-ecosystem interactions must be considered for effective site selection and site management.

The economic value of a site expresses the benefits of site services in monetary terms. In some cases these values are obtained directly from the market. In other cases, specialised valuation techniques must used.

Table 1 provides an overview of some of the more significant linkages. Each is a chain joining ecosystem functions, the services or benefits provided by the functions and the economic value associated with the benefit. Functions define the structure and dynamic of a potential site at the ecological and physical level. Services are defined by the human uses made of the site. These can be consumptive (eg: provision of fish), non-consumptive (eg: recreational bathing) and may or may not be exchanged through market mechanisms.

TABLE 1

Main impacts and interactions pertinent to Mediterranean mariculture practice (Main sources: EEA 2006; FAO 2007; GESAMP 2001, 1997, 1996; Naylor et al., 2000; Shang and Tisdell, 1997)			
OPERATIONAL ASPECT	**NEGATIVE IMPACT**	**POSITIVE IMPACT**	**ECONOMIC ASPECT**
EFFLUENT *(discharge of organic particulate, dissolved nitrogen and phosphorous, pharmaceutical and other chemicals)*	Nutrification/Eutrophication/ Turbidity of water column Benthic changes		• Public health risks • Self pollution of farm • Impairment of other economic activities that rely on the water body (e.g.: tourism, recreation)
INTERACTION BETWEEN WILD FISH STOCKS AND FARM CULTURE *(Escapes/pathogen transfer/juveniles, fish attraction/ manufactured feed)*	• Escapes and potential genetic contamination • Pathogen transfer • Increased pressure on wild stocks from poorly managed capture of fry • Fish attraction to farm structures and food sources lead to uncertain an possibly detrimental changes in local biodiversity • Pressure on wild stocks from demand for manufactured fish feed	• Relief of pressure on stressed wild stocks with properly managed life-cycle (hatchery to mature landing of cultured species) • Fish attraction to farm structures and food sources lead to uncertain and possibly positive changes in local biodiversity	• Negative impacts potentially add pressure to already stressed wild fish stocks. Economic effects will be at the industry and farm level (e.g.: increased scarcity of fry and manufactured feed) outside the aquaculture, in fisheries and other sectors • Positive impacts may improve prospects for capture fisheries and other sectors (e.g.: recreational diving and fishing)

INTERACTION WTH BIRDS	• Presence of food in and around farm sites attracts a variety of predatory species		• Fish losses within the farm • Positive effect for recreational bird watching
FOOD SAFETY AND SECURITY	• If poorly manager, risk of pathogen and/or chemical exposure for consumers	• Reliable source of fish protein	• Economic costs of morbidity caused by consumption of contaminated fish • Economic benefits of improved nutrition
INTERACTION WITH OTHER USERS OF COASTAL AND MARINE RESOURCES *(Spillovers among stakeholders)*	• Susceptibility of farms to point and non-point sources of pollution (e.g.: sewage, industrial pollution, agricultural runoff, accidental spills) • Physical limitations of a single site in accommodating different activities	• Complementarities between activities at a single site (e.g.: integration of cages with artificial reefs to reduce net effluent and enhance opportunities for recreational diving)	• Contamination of cultured fish from non-farm pollution sources • Conflict among existing users may lead difficulty in obtaining permits and licenses • Economic benefits from aquaculture plus a complementary activity such as recreation can increase welfare over and above each activity in isolation • Trade-offs between aquaculture and other activities in terms of employment creation/maintenance, investment opportunity, opportunity for creating new business opportunities
ENTERPRISE	• Large corporations may export profits • Relatively small number of farm workers; most employment benefits accrue off site	• Potential for local investment • Potentially large employment benefits in operations related to the farm (e.g.: packing, transport, marketing) with spillovers to the local community • Potential to rejuvenate communities reliant on capture fisheries and other remote communities • Creation of new opportunities (e.g.: hatcheries, non-conventional markets)	• Investment revenues • Employment income • Local tax base • Export earnings • Community welfare

Main concepts

Three main concepts underlie decision support tools such as Cost Benefit Analysis (CBA) and valuation methods. These are: Total Economic Value (TEV), environmental externalities and monetization (Freeman, 2003).

Total Economic Value (TEV)

Aquaculture sites use a variety of ecosystem services. These services are valuable to the aquaculturalist and to all other actual and potential users of the same site. The economic approach to ecosystem functions regards them as providing a flow of goods and services. In some cases, the value derives from direct uses in consumption or production but it may also come from non-consumptive and indirect uses. In some cases ecosystem functions are valued on intrinsic and moral grounds as well. Although many of these benefits are not the result of market activity, techniques of valuation exist and are used to determine the value of ecosystem services in monetary terms (OECD 2001; Pearce and Turner, 1990).

Environmental Externality

Many of the interactions and feedbacks between aquaculture and the ecosystem in which it operates are what economists call environmental externalities. Pearce and Turner (1990) define an externality as an activity by one agent that causes a loss/gain to welfare of another agent and the loss/gain is uncompensated. If a fish farm produces unpleasant odors and people living nearby suffer as a result, these odors are a negative externality. Resident's welfare is affected and the disamenity may result in lower real estate prices in affected areas. Similarly, if untreated urban sewage contaminates a fish farm, the lost revenues to the farm are a negative externality stemming from urban activity.

Externalities can operate in two directions. For example, fish farms are both fish attracting devices and sources of nutrients for migrating species. In some places, the migrating organisms have been shown to both reduce net waste discharges from fish cages and increase fish landings. This is especially true if an artificial reef is placed in proximity to the farm. In this way, fish farms and recreational activities such as diving and fishing may actually complement each other.

Monetization

The economic approach restricts itself to values that can be expressed in monetary terms. The rationalization is that money is a widely accepted and familiar measuring rod for welfare. Not all values can (or should) be expressed in this way. This does not mean that they are unimportant,

rather that they are best represented by other indicators and used in conjunction with monetary values in a multi-criteria framework for assessing a site's suitability for aquaculture (Millennium Ecosystem Assessment, 2003).

Cost Benefit Analysis (CBA)

Cost Benefit Analysis provides a means of determining the net benefit of a specific project and decision-making criteria. This type of accounting was first put forward by Jules Dupuis in 1848 and formalized by Alfred Marshall. It has become the dominant framework used in the assessment of public projects worldwide. The objective is to estimate the TEV of projects in order to select the one with the highest net benefit. In the case of site selection and management it tallies the equivalent money value of all the costs and benefits of a specific type (i.e. species cultivated, design and engineering, etc.) and size of farming operation at a particular site. This total includes the economic value of externalities (Randall, 2002). There are three aspects of CBA to consider:

Financial

The financial aspect of CBA is widely used at the enterprise level to assess different investment or operational options. In this case the decision-maker considers revenues, production and investment costs, all determined by the market. Taxes, subsidies and other transfers between the enterprise and government are also included in the computation. It provides information on contributions in aggregate, such as returns to investment as well as information on employment revenues, contribution to the tax base and foreign exchange.

Economic

This aspect reflects concerns of government planning agencies for the net benefits of individual enterprises as well as industries, sectors or geo-political jurisdictions. The purpose is generally the identification of the combination of activities that yields the highest return in aggregate. It accounts for spillovers among projects as well as aggregate affects in the market. For example, a financial CBA on a single farm would take the price of fish feed as a given.

A sectoral analysis of farms would consider the effect of changing aggregate demand for feed on the market price of feed. Similarly, a single farm would not consider changing costs of transport infrastructure in its analysis whereas a planner considering the expansion of local aquaculture would need to consider the costs of modifying existing roads.

An economic analysis would also consider the opportunity cost of different options if the expansion of aquaculture restricts opportunities for industrial expansion in the same area and vice-versa. The trade-offs between the two must be quantified in order to assess which activity contributes the most to overall welfare.

Environmental

An environmental CBA extends the economic CBA to include environmental impacts. The issues of concern and the decision-maker are essentially the same, that is, a planner with the objective of maximizing social welfare. The difference is that a range of values, not traditionally determined in the market, are considered. An environmental CBA would therefore consider the TEV of an aquaculture site, including a comparison over different activities of the economic value of changes in pollution, biodiversity and risks profiles.

Although the environmental CBA is traditionally carried out by a planner, it has clear implications for the enterprise. If the economic value of the environmental impact caused by aquaculture can be transferred to the operator, in the form of a tax or fee, then the firm can and should include these impacts in its financial CBA. In this way, CBA can be used in the implementation of important policy options such as the Polluter Pays Principle (PPP).

The implications for site selection and management are clear. Firms will internalize the environmental costs of their activities, choosing sites and technologies that are more consistent with the costs they must pay for inappropriate practices.

Valuation of Ecosystem Services

Because most of the ecosystem services that need to be included in an environmental Cost Benefit Analysis for a particular site do not have conventional prices, alternative forms of economic valuation are needed (Turner, 2000). Several of the main methods of valuation methods and their relevance to site selection and management are reviewed here.

Direct uses of a site include its potential for aquaculture, urban and industrial expansion, tourism and recreation. Each of these has a market element and can be evaluated in terms of profits, taxes employment. In addition, there are other categories of value from direct use that do not pass through the market. These include human health effects of environmental pollution and recreational activities in open access areas such as public beaches. The two main methods of valuation of these types of uses are the travel cost and averting behaviour methods. The first measures the amount that recreational users actually pay in order to make use of the site, including the cost of travel, fees and other expenses incurred at the site together with the opportunity cost of time. The second measures the amount needed in order to prevent or remediate contamination in order to eliminate threats, for example, organic pollution from aquaculture.

If property prices are affected by the presence of fish farms these can be measured by the hedonic price method which measures the difference in property prices for sites situated near fish farms and similar sites further away.

The production function approach can be used for a number of ecosystem functions such as maintenance of biodiversity. In many cases, the cost of replacing or remediating damage at a site is used as a proxy for the value of environmental change. Most commonly, this type of calculation is used to measure the cost of cleaning pollution and could include the cost to the firm of enforce fallow periods to allow regeneration of an affected site.

Finally, stated preference methods based on questionnaire surveys can be used to assess peoples' stakeholders and the general public's value for a range of services, including all of the ones mentioned above as well as the values that people place on preserving ecosystem attributes for future generations and other reasons unrelated to their own direct use (Heal et al., 2005).

Justification

Aquaculture is primarily an economic activity that interacts with ecosystem. Many, if not most of the changes at the farm and industry level have economic dimensions. Consideration of these dimensions and the application of tools of economic analysis to site selection and site management are therefore an important element in effective decision-making. Used in conjunction with other measures, for example ecological and Social Acceptability, economic indicators facilitate comparisons between aquaculture and other uses (competing and complementary) of a given site and can be key inputs into the design of tools for environmental protection.

The economic viability of a project is one of the requirenments for an aquaculture project to be acepted on the demand for licesing for a choosen site, at the same time, is one of the three pilars of sustainability. These aspects make economic approach a key issue and indicators are essential to be developed and applied for the sustainable development of aquaculture.

Principle
Economic factors and in particular the economic dimensions of aquaculture-ecosystem interactions should be considered for effective site selection and site management.

Guidelines

- **Economic tools and indicators in conjunction with others (e.g. Environmental Impact Assessment) should be used to enable decisions based on multiple criteria reflecting a range of societal objectives.** Decision makers often have insufficient information to take decisions aimed at of avoiding biodiversity loss. This can be overcome by the integrated use of economic and other decision support tool. Economic tools are important because they reflect a range of values using widely accepted and understood monetary measures.
- **In order to capture the Total Economic Value of a given type of aquaculture at a given site, the application of economic tools of analysis should consider a comprehensive range of non-market and market sources of value, and direct and indirect impacts.** Economic tools should be used to value the enterprise and related

businesses (e.g.: packing, transport and marketing), environmental impacts (e.g.: changing water quality and biodiversity), changes in employment and similar economic aspects. This can be accomplished by using the full range of methods of economic valuation.

- **In order to understand trade offs among candidate users of the same ecosystem, the Total Economic Value (TEV) of aquaculture should be compared to Total Economic Value of other sectors.** This will allow to decision makers to prioritise among activities and assess aquaculture relative to other uses in relation to its interaction with the ecosystem. Sustainable site selection and management should result in a higher TEV for aquaculture.
- **In order to develop appropriate regulatory incentives at the farms level, externalities should be understood and quantified.** Fish farming is an economic undertaking. If policy is to encourage or discourage certain activities, farmers must be given appropriate incentives (e.g.: fees, fines, subsidies, etc) and these incentives should reflect the externalities caused.

H. Importance of Governance

This guide deals with the concept of Governance and how it should be developed and implemented concerning aquaculture site selection and site management. From definition to new aspects, characteristics of Governance are described which are directly applied to the sustainable development of aquaculture.

Governance on general terms refers to the quality, efficacy and good orientation of the activities of the governing structures, giving legitimacy to their actions. At the same time, Governance refers to the values, policies, laws and institutions by which sets of issues are addressed.

Good Governance supports the fundamental goals and the institutional processes and structures that are the basis for planning and decision-making. Management, in contrast, is the process by which human and material resources are harnessed to achieve a known goal within a known institutional structure (Olsen, 2003). Governance sets the stage within which management occurs.

Governance thus encompasses the formal and informal arrangements that structure and influence topics such as: how resources or an ecosystem are utilized; how problems and opportunities are analysed and evaluated; what behaviour is deemed acceptable or forbidden; what rules and sanctions are applied to affect the pattern of use.

Governance implies finding solutions of problems, creating opportunities and guiding the development of sectors towards specific goals. Governance is considered to be the most inclusive term, involving policy, public administration and management. It goes for long-term societal trends and needs.

Governance is a key issue on Site selection and site management,. Aquaculture development has a direct dependence on the administration, due to the occupation and use of Public Domain. The licensing, the management of the site, the interference with other uses, the rights and obligations, the policies applied to it, the economic interests, the close relation to the environment and its preservation, all form a part of a whole changeable system that needs to be manage and from which decisions have to be made. Governance has to cope with all those aspects and therefore apply new concepts and characteristics in order to respond under criteria's of sustainability.

Aquaculture systems are complex and dynamic as well as the activities that take place around, even more when new aspects and concerns have to be taken into account such as ecosystem health, social justice, food security, food safety and employment. These aspects make Governance to adapt to continuous changes.

But this adaptability of Governance has to be built from learning through feedback gained from observation, perception and understanding of the nature of the problems. Governance has to deal with the real problems on real time and be aware of what is happening on the field. Usually private sectors develop rapidly and the reaction of the administration goes afterwards. Aquaculture is one of the examples, and the rapid growth of the activity implies decision makers to react on time on the process of site selection and site management, incrementing the risk of not so correct decisions which could drive to damage the sustainable development of the activity.

From this, another definition of Governance could be made; "Governance is the whole of public as well as private interactions that are initiated to solve societal problems and create societal opportunities". **FROM WHO?**

This definition leads to a new concept of "interactive Governance approach" in which diversity is addressed through inclusiveness, complexity through rational, holistic and integrative approaches, and dynamics through an interactive and adaptive framework (M. Bavinck, 2005). This approach combines several aspects that help Governance to be updated and respond on time to real situations, although it brings complexity at first sight due to the participation of many stakeholders or actors. Actors are any social group that has power of action, in this sense concerning site selection and site management, many stakeholders would participate on the Governance system, that is; producers associations, social groups, other uses of the public domain, other administrative bodies and so on But it is not a matter of reducing participation, but find ways to bring participants together in an equitable, just and workable manner.

Governance also needs instruments to be used and applied to achieve goals and means. For aquaculture, it is clear that Aquaculture Management Plans are the most powerful instrument for drawing actors into a commonly accepted system. But not only aquaculture plans, for Site Selection and Management, other systems instruments are needed as aquaculture share space, therefore, Coastal Zone Planning is needed to be included in Governance. In any case and coming back to the previous aspects of interactive and participative Governance, it is required that the identified actors are informed and involved in the development or choice of Aquaculture Planning, assuring the effectiveness of Governance.

Other elements, considering Governance, are the actions to be taken in order to implement the rules and policies. Laws can be directly imposed, although it is a relatively hard way, so other means to achieve the same goals on a sustainable manner should be considered like the participation of the sector on the building up and implementation of laws.

The scale is another aspect to be considered in the Governance process. Governance could reach any level of implementation depending on the country's administrative structure. From national to local, competences are shared and feed back processes can help to adapt Governance. But because of globalisation, the ability of local actors to cope with situations is more limited. This could be the case on the Mediterranean where a global vision is getting strength, especially when it is considered from the ecosystem point of view, so Governance should aim for a global scale as well.

Justification

Site selection and site management depend on public domain where occupation and sharing of space among a variety of stakeholders make Governance a key issue. Governance as a concept is actually nothing new but its application and the way it is run nowadays is taking new paths and evolves towards better practices based on co-construction and participation, adapting new visions and ways of implementation. These, among others, are issues that provide Governance with tools to achieve sustainability. As an example, a good understanding between the aquaculture sector and governments concerning site selection and site management is part of good Governance hence contributing to the sustainable development of aquaculture in the Mediterranean.

Principle

Good Governance practices should be implemented concerning planning and decision-making for aquaculture site selection and site management.

Guidelines

- **Governance should be flexible, dynamic and adaptive.** This capacity of reaction to changes and evolution towards effectiveness will give trust and support to decision makers.
- **Governance should encourage participation and interaction with all stakeholders:** The inclusion of all actors and the trigger of linkages within and among them will reinforce governability increasing success on a shared environment where site selection has to be made.
- **Governance should be applied at all levels.** Because globalisation is becoming a strong driver of change, new forms of Governance should be developed at all scales, from local to global.
- **Aquaculture planning should be developed under the best applicable Governance.** As Governance influence the processes of site selection and site management, rules and implementation should underline guidelines of sustainability.
- **Governance should be considered and implemented on a long-term basis.** Unlike to fisheries where daily decisions may be subject to uncertainties, aquaculture planning has a more long-term steady course that should be taken into account in Governance arrangements.

I. Legal Framework

This guide is intended to offer a series of guidelines for the establishment of appropriate Legal Frameworks for the practice of aquaculture, particularly with regard to site selection. The aim of this guide is to highlight the benefits of adequate regulations for aquaculture. An overview of the current situation is given for the Mediterranean.

Current situation

Once the main technical problems related to aquaculture production have been overcome, one of the factors that may jeopardise the development of aquaculture in a given country is the lack of an appropriate Legal Framework that promotes the aquaculture industry.

Some of the legal aspects that currently have a great impact on the development of marine aquaculture in the Mediterranean are:

- The large amount of diverse and, in some cases, disparate legislation applicable to procedures for setting up and managing aquaculture facilities;
- The involvement of so many different authorities at different levels;
- The long and sometimes confusing procedures for the granting of aquaculture licences.

Added to these aspects are the extent of the influence and intervention of administrative authorities depending on the degree of decentralisation and the impact of various regulations at different administrative levels: local, regional, European and, in some cases, international.

Aquaculture is an economic operation that entails a risk and requires high levels of investment; aquaculture operators must be informed of and clearly understand the legal requirements and associated costs, and be fully informed about matters relating to appropriate places for setting up aquaculture establishments. This information includes: the conditions and requirements that will be demanded, the agencies involved and which of them have decision-making powers, the criteria used to calculate the taxes and fees, and the sums that operators can expect to pay, the environmental protection measures required, as well as, finally, the rights that operators will acquire and the guarantees in place to protect those rights vis-à-vis third parties.

Not all the countries of the Mediterranean have aquaculture legislation. The legal situation is very heterogeneous, with regard to both the existence of regulations for aquaculture and the content of those regulations.

However, most Mediterranean countries have developed a complex Legal Framework for aquaculture. Some, such as Spain, Algeria and Egypt, have a specific Act for aquaculture, although the majority regulate fishing and aquaculture jointly (Malta, Turkey, Croatia, Greece, Morocco and many of Spain's Autonomous Communities). Finally, other countries, like France, regulate aquaculture through lower-level regulations such as Decrees.

Nearly all of these regulations contain numerous gaps, and it is widely agreed that there is overlapping and a lack of coordination between administrative authorities, resulting in over-bureaucratisation. Therefore, it is necessary to find mechanisms for coordination between them, as the absence of such mechanisms could have negative consequences on the development of aquaculture.

There are no homogeneous or common criteria that make it possible to perform a common legal analysis for the whole of the Mediterranean; on the contrary, the legislation of each country is primarily based on criteria of local regulation, depending on the type of aquaculture, its legal tradition and the greater or lesser importance of aquaculture in that country.

Areas of regulation

The Legal Framework for aquaculture is not just limited to the sectoral regulation of this activity, i.e. the conditions and characteristics of access to the activity in the form of licences and permits, validity periods, the rights and duties of establishment operators, the characteristics of aquaculture facilities and their production systems, etc. In addition, many more extremely important rules must be added that, although not issued by the administrative authority responsible for aquaculture, directly affect the development of this industry.

Here, we are referring to important, wide-ranging legislation on the occupation and exploitation of the marine public domain or coastal public domain, which are described by different names depending on the country. This legislation refers to state-owned coastal areas that must be granted for the practice of aquaculture. This applies to the majority of Mediterranean aquaculture regulations (Spain, Greece, France, Italy, Egypt, Algeria, Turkey, etc.), which are normally issued by a different administrative authority to that which grants aquaculture licences.

In addition to these aspects, there are other areas of regulation that also affect the industry, particularly: legislation on heath, environmental impact and management, marketing in the field of aquaculture, and so on. To be precise, at the EU level there are more than three hundred rules that affect this industry. However, for the purposes of this guide, we will focus on legislation concerning licences, and the spatial planning and use of the public domain, which has the greatest influence on site selection.

Improvement mechanisms within the Legal Framework

Of interest in this respect are aquaculture laws that establish criteria for determining suitable sites for aquaculture or that require aquaculture activities to be grouped together and concentrated in sea farming centres or areas, this is the case of the autonomous regional governments in Spain. For example, in Galicia, Law 6/1993 on Fishing in Galicia, and its implementing regulations, provides for the organisation of mussel farming facilities in specially designated centres and the development of mussel beds in areas delimited by the regional government (Articles 58 and 62 of the Galician Fishing Act).

Also in Galicia, Decree 406/1996 on aquaculture provides for the management of designated sea farming areas within the framework of the integral planning of coastal uses (Article 20) and the Galician Aquaculture Plan, as a sectoral territorial plan, will be the legislation that regulates the areas delimited for practising aquaculture in coastal terrestrial areas. Law 2/2007 on Fishing and Aquaculture in Murcia regulates designated sea farming sites, which it defines as areas suitable for anchoring floating cages within zones declared as being of interest for aquaculture by the regional government, "after assessment of their environmental impact". This Law adds that the rules establishing such designated sites must specify both their maximum production capacity and the species that may be farmed (Article 75).

Other regulations, instead of imposing mandatory rules on planning and management, simply recommend "areas of interest for marine aquaculture", which are most appropriate for aquaculture operations. This is the case of the Spanish Aquaculture Act and the laws of the Autonomous Communities (Galicia, Murcia, Asturias, etc.).

The importance of an adequate Legal Framework was highlighted in the 10-Year Plan for Marine Aquaculture, published by the NOAA in the United States in October 2007. Its main objective is to establish a legal and administrative framework to encourage the sustainable development of aquaculture. On the basis of this Plan, the National Offshore Aquaculture Act of 2007 and other legislation has been approved, thus promoting a type of aquaculture that had previously been paralysed due to the lack of a Legal Framework within which to develop. Said Plan proposes the implementation of regulations to coordinate licence-granting procedures, Environmental Impact Statements (EIS), the zoning of areas suitable for offshore aquaculture and the establishment of consultations between government bodies and the general public as part of the legislative process.

The Norwegian legal system is another good example of how the legislative process has contributed to the development of aquaculture. Through the new Aquaculture Act of 17 June 2005, Norway has resolved problems generated by the previous Act, in force for 20 years, which hindered the development of aquaculture. The new Act increases the legal security and competitive advantage of Norwegian aquaculture operators. The main changes introduced by the new Act concerned simplification of the licensing procedure and the administrative authorities involved. The Act was based on four fundamental areas:

- Growth of the industry.
- Simplification of procedures for industry and the administrative authorities, increasing the efficiency and familiarity of said procedures.
- A more modern and comprehensive environmental management system.
- Efficient use of the coast, attempting to reconcile coastal interests.

All these principles can be summed up by the mandate established by Law of improving coordination and administrative efficiency.

In Chile, the Aquaculture Concession and Licence Regulations of 28 May 1993 represented a firm commitment from the Chilean government to develop aquaculture in the country. Other countries that have been keen to establish a Legal Framework for the development of aquaculture and guarantee the legal security of aquaculture operators include Canada with the Aquaculture Act of 1988, and the USA with the National Aquaculture Act of 1980.

In Europe there have been commendable efforts to establish a synthesis between existing legislation and best practice guidelines for the regulation of aquaculture through the MARAQUA project (Monitoring and Regulation of Marine Aquaculture in Europe) and based on other documents of interest (Cullinan & van Houtte, 1997, Pickering, 1998). The FAO, meanwhile, has prepared a report entitled "Aquaculture Policy, Administration and Legislation" (FAO, 1999), in the document about Article 9 of the FAO Code of Conduct, as well as other legal content in different documents and the National Legislation Overview prepared by the FAO Legal Department, which contains legal information about a large number of countries. However, the harmonisation of legislation is a complex task that is beyond the remit of the EU, insofar as it affects the competence of the Member States. Thus, this guide may serve to stimulate debate about seeking solutions and proposals for common guidelines with regard to preparing European aquaculture regulations.

The legislation regulating aquaculture should include a definition of the activity and a minimum level of content: the various aquaculture systems, the areas in which aquaculture may be carried out, plans or areas of interest for aquaculture and characteristics for the establishment of aquaculture facilities; the authorities competent for the development of aquaculture regulations, environmental protection criteria, EIA management systems, EMASs, etc.; rights and duties, concession procedure; authorities involved and mechanisms for coordination between them for the granting of permits, licences and granting systems; land use, registration of licences, transfer, inheritance, licence mortgages; control and sanction mechanisms; causes of revocation, expiry and cancellation; fees and charges.

In any event, the legal structure must regulate aquaculture within a framework of sustainability, balance between the various uses, protection of the environment and resources, and regulations that, in short, make society aware of the economic and social importance of this industry.

Justification

The development of aquaculture in a given country directly depends on the degree of effectiveness and simplification of its regulation, and how favourable that regulation is for the development of aquaculture in coastal areas, in the face of other activities that share its space. Thus, restrictive legislation may act as a break on the development of aquaculture, and the flexibility, effectiveness and simplicity of legislation will be translated into the development of the aquaculture industry in the country in question.

The existence of an effective, simplified legislative framework for aquaculture is also key to determining suitable sites for and managing this activity. We must work from the basis of a legislative structure that coordinates all the administrative authorities with coastal responsibilities and, therefore, has powers in the planning of such areas through the issuance of reports on the viability and acceptability of aquaculture as an activity that is compatible with other activities, as well as through spatial planning.

The preparation of appropriate legislation for aquaculture will give it greater legal security, consolidating it as an industry and securing its place when it comes to planning coastal uses.

Principle
An adequate and propitious Legal Framework should be in place to ensure appropriate site selection and site management.

Guidelines

- **A suitable Legal Framework should be in place, guaranteeing the rights and stating the obligations of holders of aquaculture licences**. That will ensure legal security for both aquaculture operators and the activity itself.
- **Coordination and agreements on Legal Framework for aquaculture site selection and site management should be built among the different administrations**. The lack of clear, concise regulations that specify the division of tasks between administrative authorities may result in overlapping of areas of competence and delays in procedures.

- **Legal Framework should be available and understandable to all stakeholders** Comprehensive aquaculture legislation will provide guarantees of success, in terms of both environmental protection and the development of the aquaculture industry. Furthermore, its Legal Framework will be a way of informing society about the aquaculture industry
- **The Legal Framework for aquaculture should establish the basic programmes and conditions necessary for the selection of suitable areas for aquaculture.** The designation of appropriate areas for aquaculture, both in maritime and coastal areas, should be reflected in regulations. This will ensure the legal security of aquaculture activities, their future stability and their success and competitiveness.
- **Aquaculture legislation should be integrated on Coastal zone set of jurisdictions** Regulations should be established for the management of coastal areas, covering planning, conservation conditions, protection of coastal resources, and planning of areas to be used for marine aquaculture.
- **The legal system should include requirements that ensure compatibility with other uses.** To achieve this there must be coordination between the competent administrative authorities and agencies, the industry and the general public, as well as legislative action.
- **Aquaculture legislation should address the social and Economic aspects of the area in which aquaculture activities take place**. The lack of regulation may be the cause of the rejection of aquaculture by society or administrative authorities that prioritise other interests.

J. Administrative Procedures: licences, authorisation and concessions

This guide gives a general view of the existing Administrative Procedures in different countries. The main problematic topics, concerning bureaucracy, timing, requirements, rights and duties are explained and possible solutions proposed.

The selection of sites for the establishment of aquaculture activities is closely linked to mandatory Administrative Procedures, as the areas to be occupied are public. More precisely, as these areas are defined as "marine public domain", their occupation must be authorised by the competent administrative authorities.

The licensing system is a control procedure that allows the authorities to verify the viability of the installation site and the potential environmental impact of the operation in question. Licences establish aquaculture sites, the conditions and operating period, environmental requirements and the Carrying Capacity of each aquaculture facility, i.e. the conditions that affect the specific area where aquaculture will be practised.

There are various types of licences, depending on the type of activity or the legal status of the aquatic resource used. They have different names, such as: authorisation, concession, licence, permit or lease. In nearly all countries, the mostly commonly used terms are: licence, referring to the activity, and concession, referring to the occupation of the public domain.

Current procedures in the Mediterranean region

As mentioned above, the legislation of most countries provides for two types of authorisation for aquaculture: the operating licence and the concession to occupy the public domain.

In the case of Spain, the regional government departments responsible for aquaculture grant the operating licences. However, in addition to these licences, potential operators must also obtain the concession or a binding report on the occupation of the marine public domain, which must be granted or issued by the Ministry of the Environment.

In France, there is a similar system based on two separate forms of authorisation: a mariculture licence (autorisation d'exploitation des cultures marines) granted by the

Maritime Affairs Office, and a licence required for facilities producing more than 5 tonnes/year, "Installations Classified for the Protection of the Environment (ICPE)", the legal status of which depends on the capacity of the facility[5].

In Malta, for offshore aquaculture, two permits are required: an operational permit granted by the Fisheries Conservation and Control Division, and an occupancy permit granted by the Malta Environmental and Planning Authority.

Similarly, Algeria also has an operating licence granted by the territorial authority in charge of fishing and, if the activity involves occupation of the public domain, a public concession agreement. In accordance with the Decree of 21 November 2004, a Committee is formed to assess the granting of this concession. Various administrative authorities are represented on this Committee: Fisheries Agency, Public Domain Management, Aquatic Resources Agency, Agricultural Services, Tourism, Transport and Forest Conservation Authorities, Environment Agency and Public Works Authority.

A similar dual system is in place in Morocco: an operating licence (authorisation of exploitation) granted by the Marine Fisheries Department, and a permit for temporary occupation of the public domain, granted by the Ministry of Public Works.

Two forms of authorisation are also required in Turkey: a fish farmer certificate, granted by the Ministry of Agriculture and Rural Affairs for a period of three years, and permission to occupy the maritime area or maritime space for the aquaculture facility, which is granted by the provincial authorities. This occupancy permit is the main permit for practising aquaculture in Turkey, and is associated with important aspects of legal insecurity that complicate aquaculture licence-granting procedures: for example, its uncertain duration – permits may be granted for 3 years or even 15 years – and the lack of unambiguous criteria.

In short, in addition to any other bodies involved in the procedure, the concurrence of two main administrative authorities is required: one that is responsible for the actual activity of aquaculture and grants the licence to begin operations, and another that manages the marine and coastal public domain and authorises the occupation of a public area for a specified time. It is the granting of this second authorisation that generates most problems.

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[5] Facilities producing more than 5 t/y require a "declaration" while those producing more than 20 t/y must apply for a "licence", with the application being dealt with by the Veterinary Department.

Often, these two main agencies belong to different departments or ministries, which means that they must liaise with each other in order to speed up the process. This makes institutional coordination and cooperation all the more necessary. A step forward in this direction has been the recent integration in Spain of responsibility for management of the coasts (public domain) and the bodies that represent Spanish marine aquaculture, through the creation of the Ministry of the Environment and Rural and Marine Affairs. However, power to authorise aquaculture operations remains in the hands of the regional governments, which makes the system more complex.

This analysis of the current state of play shows that the main problems tending to characterise aquaculture in practically all Mediterranean countries concern:

- The lack of simplification and clarity in Administrative Procedures for the granting of aquaculture licences;
- The numerous authorities involved in said procedures;
- The resulting over-bureaucratisation and lengthiness of licence granting procedures.

The involvement of other administrative authorities

The procedure becomes even more complicated when other permits, licences and reports are required from other authorities with responsibilities for coastal and maritime areas. This is another source of difficulty: the large number of agencies and authorities involved and, in the majority of cases, the lack of a real plan for coordination between them.

All this is due to the fact that marine aquaculture is carried out in the special, fragile area that is the coast; an area where numerous powers and economic interests are at play, a special environmental protection area. Consequently, the various administrative authorities must issue an opinion regarding the location of new facilities, to ensure that they do not harm or negatively affect the interests that each authority defends or represents.

In Spain, the procedures vary from one Autonomous Community to the next, although in nearly all of them, it is the administrative authority responsible for aquaculture that receives the application and gathers all the reports from the authorities with coastal responsibilities: Regional Planning, Defence, Tourism, Environment (the regional governments), Navigation, Ports, Culture and Heritage, and local councils. Once all the reports have been obtained, the application is publicly announced and the corresponding Environmental Impact Assessment is requested from the Environment Agency. Finally, the application is forwarded to the State Agency that manages the public domain, which must issue a binding report or the concession for occupation of the public domain.

In Greece, the competent administrative authorities are the Ministry of Agriculture, Merchant Shipping Ministry, Ministry of Development, and Ministry of the Environment, Physical Planning and Public Works. However, when the use of marine waters is concerned, as well as the aforementioned ministries, the intervention of the Ministry of Culture, Ministry of National Defence, and Ministry of Health and Welfare is required. In Turkey, licences are granted by the Ministry of Agriculture, with input from other administrative authorities: Tourism, Navigation, Health, Ministry of the Environment, local and provincial authorities. Finally, the use of maritime areas must be authorised by the provincial authority.

If the public domain is to be occupied, a greater number of administrative authorities are involved in the process (Spain, Greece, Turkey, Morocco, Algeria, etc.), precisely due to the special nature and specific protection requirements of maritime and coastal areas.

Duration of the procedures

The involvement of so many agencies and authorities results in lengthy procedures that may take between two and three years, as is the case in Greece, some Autonomous Communities in Spain and Turkey. The timeframe varies from six months to three years in Algeria, and can take up to four years in Egypt, where a particularly high number of administrative authorities are involved, with it sometimes being necessary to acquire as many as 12 licences from different Egyptian agencies.

In Greece and some Spanish Autonomous Communities, the number of documents required and copies of those document can exceed 8 copies for the Ministry of Fisheries and Agriculture, 3 copies for the Land Use Planning Office of the Ministry of the Environment, and a third application with 3 copies for the Environmental Impact Assessment.

In Spain, the timeframe for aquaculture procedures varies substantially depending on whether the facility occupies the maritime public domain managed by the Directorate-General of

Coasts of the Ministry of the Environment, or the port public domain managed by the Ministry of Development. In the first case, the duration of the procedure also depends on the Autonomous Communities, and ranges from 6 months to 2 years. In the case of aquaculture in a port area, the average timeframe is around 6 months. The heterogeneous and casuistic nature of licence-granting procedures in Mediterranean countries is clear.

Possible procedural improvements

Procedural timeframes can be reduced by enhancing coordination between the authorities and agencies involved in said procedures.

In the case of Norway, alternative models that improve the coordination and efficiency of procedures between all the administrative authorities involved have been sought through the new Aquaculture Act of 17 June 2005. The result has been the simplification of procedures and a dramatic reduction in timeframes, from the 20 months prior to the Act to less than 6 months.

One of the most interesting measures that contributed to achieving these results was the introduction of much shorter timeframes at every phase of the procedure, by giving each agency a short deadline within which to issue its reports.

Another important new feature is the central place given to the creation of an agency that leads the procedure within the Directorate of Fisheries, increasing its resources and powers in the assessment of applications.

Another possible route for improving the coordination of agencies and administrative authorities is the creation of inter-institutional agencies or one-stop shops that centralise and coordinate all the permits, licences and reports from the various agencies and authorities that have responsibilities in aquaculture. This one-stop shop is responsible for processing all licences and reports from other agencies, acting as the sole authority.

Although the majority of European countries have not completely resolved their coordination problems, countries such as the USA and Canada have opted for the creation of inter-institutional coordination offices or agencies.

In its 10-Year Plan for Marine Aquaculture (2007), one of the NOAA's priorities is to coordinate procedures for aquaculture licences in costal areas, ensuring both internal coordination and coordination with other federal agencies. This will make the NOAA responsible for granting licences for aquaculture in federal waters and coordinating the actions of other agencies that grant aquaculture licences.

In the State of Florida, an Aquaculture Division has been created to act as a one-stop shop for marine and continental aquaculture, centralising all legislative activities and issues the Aquaculture Certificate of Registration. Moreover, in this State, an Aquaculture Interagency Coordinating Council has been created, which serves as a forum for the discussion of aquaculture policies and coordinates the five departments involved in the aquaculture sector, preparing proposals to foster the development of aquaculture.

In Florida, producers have agreed to adopt a document setting out Best Management Practices for Aquaculture (BMP), designed to eliminate overlapping between the agencies and authorities involved, duplication of licences, etc.

The State of Maine, meanwhile, has set up an Aquaculture Policy Ombudsman in the Department of Marine Resources which, among other duties, is in charge of coordinating State policies in aquaculture and coordinating the Interagency Committee on Aquaculture.

The development of aquaculture in Canada is the responsibility of the Aquaculture Task Group, whose objective is to create a one-stop shop for the development of aquaculture. In addition, the Interdepartmental Committee on Aquaculture (ICA) seeks to harmonise the activities of all federal agencies by holding periodic federal inter-agency meetings to enhance communication and cooperation among federal departments, improve inspection and the development of harmonised policies and regulatory frameworks.

For its part, the Nova Scotia Aquaculture Development Committee coordinates the agencies with competence in aquaculture, in a coordinated effort to enhance the promotion and development of aquaculture.

In the Mediterranean, the most similar case of a coordination body is perhaps the Spanish Mariculture Advisory Board (JACUMAR): a coordination and consultation body made up of representatives of all the regional governments with competences in aquaculture and the Ministry of the Environment and Rural and Marine Affairs.

But in any case, the regulatory framework of the procedure should stipulate procedural timeframes that are binding on the administrative authorities. The main body responsible for managing and coordinating the procedure must set the deadlines for information and responses from the other agencies or authorities that must issue opinions on different aspects: navigation, tourism, cultural heritage, ports, the environment, etc. Similarly, it must specify the legal consequences of failing to issue the permit or report by the set deadline, in order to avoid the indefinite paralysis of procedures.

Legislation should establish the validity period of licences. This will ensure the legal security of aquaculture and the sustainability of aquaculture businesses. Periods may vary according to the legislation of each country and depending on whether or not the aquaculture facility occupies the public domain

At the same time, coordination policies should be developed by setting up inter-agency task groups charged with seeking the harmonisation and coordination of all competences related to aquaculture, that are regulated and under the competence of various agencies or administrative authorities. This inter-agency group will not only coordinate and harmonise aspects related to licences and their procedures, but also issues linked to product health, aquaculture research, environmental aspects and impact management, coastal planning, etc. Likewise, it should act as an office for the promotion of aquaculture, in the style of the bodies set up in Canada and the USA.

Another factor that contributes to simplifying and shortening Administrative Procedures is the prior establishment of suitable sites for aquaculture. In order to achieve this status, a process of gathering information, analysis and consensus between administrative authorities must be carried out, based on rules of use and coordination. If the aquaculture operator and the administrative authority know in advance what documentation is required for that site, the licences will be granted within a reasonable timeframe and there will be fewer requirements.

A similar improvement has been made with another important element of the aquaculture licence, the Environmental Impact Assessment, which can now be issued just once, when the aquaculture sites are declared, and not each time an individual application is submitted. This considerably reduces administrative paperwork.

In short, a lack of definition or delimitation of aquaculture sites can lead to an increase in the number of requirements, licences or reports, with the resulting delay in Administrative Procedures and, therefore, the start of investments.

Other requirements

- **Environmental Impact Assessment (EIA)**

In general, applications for aquaculture projects are submitted with a technical study, a biological study and other required documents such as the Environmental Impact Assessment. For aquaculture licences, the EIA is an important element for supervising protection of the environment where the aquaculture activity will take place.

It is here that the regulations of the different countries differ in terms of their content and the standards required. Although Community rules have attempted to harmonise the legislation of the EU Member States, EIA requirements still differ from one Mediterranean country to the next. While in EU countries, the EIA criteria are based on production, in other countries, like Egypt, they are based on the site where the facility will be located (for example, if it is in a protected area).

- **Operator selection criteria**

Some legislations, such as those of the Spanish Autonomous Communities, establish operator selection criteria to determine, based on a series of indicators, the advisability of granting aquaculture licences that involve occupation of the public domain. These criteria include:

- The socio-economic importance of the project;
- Experience in aquaculture;
- The introduction of new technologies and limited environmental impact;
- The creation of employment, especially for fishermen and women;
- The food contribution to European markets;
- Preferences over groups related to traditional fishing activities, such as fishermen's associations.

Elsewhere, as in Croatia, the evaluation criteria include the concession fee offered, the total investment, social criteria such as the number of jobs created, and environmental aspects such as the amount invested in environmental protection.

Rights and obligations of aquaculture licence holders

Aquaculture licences grant their holders rights and obligations, especially in the case of concessions that confer the right to occupy the public domain.

- **Rights**

Very briefly, licences grant exclusive exploitation rights and a right to occupy the public domain that cannot be violated by third parties or administrative authorities, which would have to indemnify the concession holder were they to revoke the licences in question. Licences are granted for limited, though relatively long, periods of time, which range from ten to thirty years, depending on the country.

The occupation rights contained in a concession are usually transferable and may be covered by a mortgage, thus strengthening the legal and economic security of concessions. In any case, regulations must guarantee that the new licence holder fulfils the capacity requirements demanded of the previous licence holder, as well as the operating conditions.

- **Obligations: payment of fees and charges**

Aquaculture licences are usually linked to the payment of fee or charges, either for occupation of the public domain or for performing the actual aquaculture activity. Payment of the fee to occupy the public domain is viewed as a pecuniary consideration that the State receives for the private or special use of property in the public domain.

The payment of charges and fees also means that aquaculture will contribute to covering costs linked to the monitoring and inspection of aquaculture establishments, environmental monitoring and water quality assessments, as well as any costs related to Carrying Capacity and the restoration of the public domain to its original state, if necessary. These types of fees are usually paid annually and are calculated based on the criteria adopted by each country, trying to combine criteria regarding surface area or volume of water occupied with criteria related to the annual production of the facility.

An example of the calculation of occupation fees according to clear and fair criteria is the negotiation begun by the Spanish association of mariculture operators, APROMAR, in 2004, with the Spanish Ministry of the Environment. The changes came about with the approval of Law 42/2007 on Natural Heritage and Biodiversity, which led to the setting of flat-rate calculation criteria for all types of aquaculture, applying a single annual charge of 8% of the taxable amount consisting of the value of the land in the public domain, and a variable coefficient on the anticipated revenue generated from the occupation of the public domain. In addition, as a new feature intended to "encourage better environmental practices in the aquaculture sector", this new Law provides for the fee to be reduced by 40% for concession holders that join the EMAS Eco-Management and Audit Scheme, and by 25% for those that become ISO 14001 certified.

However, the situation is very different on the Mediterranean coast in countries like Turkey, where the issue of calculating fees has yet to be resolved: there are no standard rates or common criteria for their calculation, and prices and charges are very high.

In any event, in order to ensure the legal security of operators, the criteria used must be reasonable, transparent and uniform for each type of aquaculture.

Justification

Given the public nature of the space to be occupied in the selection and management of aquaculture sites, and having identified the hindrances in Administrative Procedures for licensing aquaculture activities and authorising occupation of the public domain, it is considered necessary to revise those procedures for the Mediterranean as a whole, so that they contribute to the correct selection and management of areas and, therefore, the sustainable development of the industry.

Principle
Adequate Administrative Procedures should be established in order to facilitate the appropriate selection and management of sites for aquaculture.

Guidelines

- **Regulations should be drafted that set out the procedures for granting aquaculture licences**. It is important to have regulations that clearly inform aquaculture operators of the requirements for obtaining a licence, the timeframe of the application process as well as the rights and obligations attached to the licence.
- **Instruments should be prepared to coordinate administrative authorities, agencies involved and procedures for the granting of the various authorisations.** This will ensure the legal security of both the applicant and the granting authority itself, while also simplifying processes for the granting of aquaculture licences.
- **Administrative authorities with responsibilities in aquaculture should develop guidelines for the submission of applications, containing legal and institutional information**. These guidelines would be useful for establishing aquaculture policies, not only for the competent administrative authorities, but also for aquaculture operators and society in general. A simple form accompanied by a checklist to help the applicant ensure that all documents are submitted.
- **The establishment of technical offices that centralise aquaculture procedures in a region or country is recommended**. The creation of one-stop shops should be promoted, to centralise licence-granting procedures, thus reducing procedure timeframes and requirements.
- **Common Administrative Procedures for licensing should be enforced at a Mediterranean level.** Efforts should be made to set up the base for minimum common requirements, to facilitate capital movement within the Mediterranean.
- **The criteria used to calculate the aquaculture fee should be reasonable, transparent and uniform for each type of aquaculture, in order to ensure legal security.** The fee for occupation of the public domain must be proportional to the use thereof, and take into account the specific character of the aquaculture activity in question. Alternatives to purely economic fees should be proposed.
- **The capabilities and human resources of the administrative authorities responsible for aquaculture should be increased** backed up by a political

commitment to coordinate the institutions and agencies involved in the regulation and management of aquaculture.

Specific examples on Legal Framework and Administrative Procedures in the Mediterranean

- **In Turkey**

In Turkey the aquaculture sector is still experiencing a time of rapid growth. Over the last decade the volume of aquaculture production has increased by 250% reaching 128,943 tones in 2006. This corresponds to 22% of the total fisheries production. Currently, there are 1,470 fish farms, out of which 1,159 are fresh water fish farms and 311 are marine fish farms. The Turkish aquaculture sector has a large number of family-operated small and medium scale units (Turkish Fisheries, 2007). 92% of marine aquaculture takes place in the Aegean, of which 63% is in the Muğla area, 23% in Izmir Province and 5% in the Province of Aydın (Candan et al., 2007).

Aquaculture Legislation: Licensing and site selection

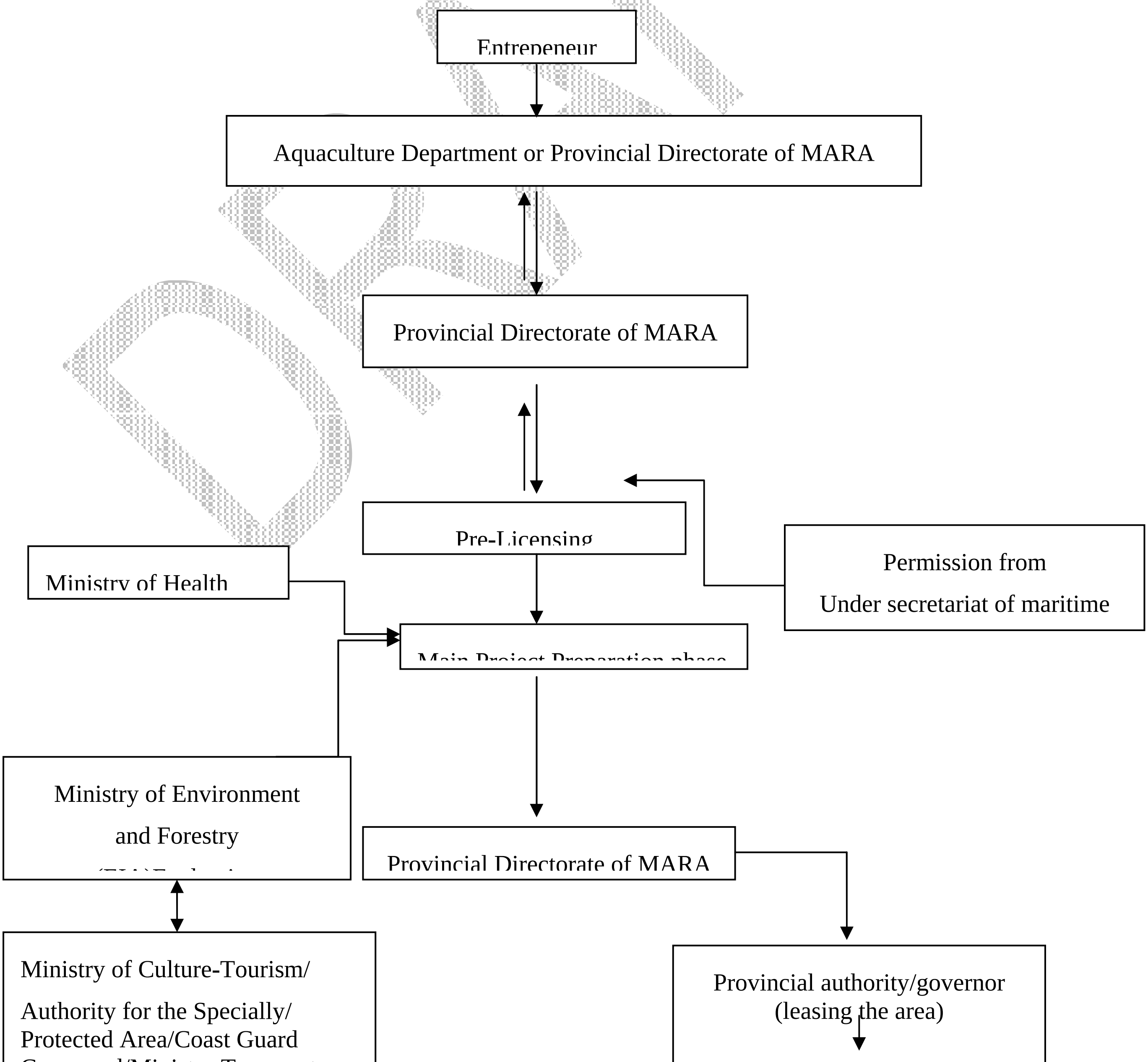
Fisheries Lawn no. 1380 of 1971, as amended by *laws* 3288 of 1986 and 4950 of 2003 is the framework law for all fisheries and aquaculture (Fisheries Law no: 1380, 1971). The basic authority responsible for aquaculture is the Ministry of Agriculture and Rural Affairs (MARA). These laws provide the basic instrument for regulation. Circulars are issued from time to time under the authority of the Minister. These are also used to regulate aquaculture. Aquaculture is further managed through the *Implementing Regulation of Aquaculture* of 2004 as revised in 2005 and 2007 (Regulation on Aquaculture no: 25507, 2007). The regulations include:

- Site selection for inland and marine farms;
- Approving projects and issuing licenses;
- Monitoring and control of farming activities;
- Improving production, closing down farms, site changes and farms sales.

All aquaculture producers must have an aquaculture license of registration from the Ministry of Agriculture and Rural Affairs. Figure 1 shows the leasing procedures for marine fish farms. The entrepreneur can then prepare the full project documentation, which includes a feasibility report and an Environmental Impact Assessment (EIA) report, given by the Ministry of Environment and Forestry. Approval is also needed from other relevant institutions such as the Ministry of Culture and Tourism, the Authority for Specially Protected Areas, the Coast Guard Command and the Ministry of Transport.

In 2006 Environmental Law 2872 was further amended as Law 5491 (Environmental Law, 1983). According to this, "fish farms in the seas can not be established in such enclosed bays or gulfs as are sensitive natural or archeological sites". The enforcement of this law is the responsibility of the Ministry of Environment and Forestry. According to a further amendment of this law, farms in contravention of these new criteria must relocate within the years 2007-2008.

Figure 1: Licensing and Leasing Procedures for Marine Fish Farms



- **In Croatia**

The main legal basis for spatial (or physical) planning in Croatia is provided by the Physical Planning Act, under the responsibility of the Ministry of Environmental Protection, Physical Planning and Construction (MEPPPC). This basic document provides the main elements of the planning procedure and sets the general lines for all activities that shall be actually performed in a given area. The Act draws on the general guidelines set forth in the Physical Planning Strategy, and calls for detailed plans at county level. There are 21 counties in Croatia, out of which 7 are coastal ones, potentially interesting for marine aquaculture industry. All coastal counties have drafted their physical plans, but since the general provisions allow rather broad definitions, most plans do not contain direct allocations of space for marine aquaculture.

Another important basic document is the Ports and Maritime Estate Act, under the responsibility of Ministry of Sea, Transportation and Infrastructure (MSTI). This Act provides for the concessioning procedure, and detailed implementing regulations have been adopted pursuant to this Act. Further legal basis is given by the Environmental Protection Act, again under the responsibility of the MEP. This document is the basis for environmental issues, in particular the Environmental Impact Assessment requirements and procedures. All food safety and animal health and welfare issues are governed by relevant provisions of food and veterinary laws, under the responsibility of the Ministry of Agriculture, Fishery and Rural Development (MAFRD).

Finally, the basic instrument for the actual commercial activity is the Marine Fisheries Act under the responsibility of the MAFRD, which stipulates the conditions under which an aquaculture license may be given to a physical or a legal person. Detailed implementing regulations governing the requirements for marine aquaculture have been adopted pursuant to this Act, including issues of data collection, contents of the license, environmental requirements from the point of view of best farming conditions and so forth.

In terms of planning and licensing procedure, both central and local level administrations are included and have their respective responsibilities. The central level government provides for the general stipulations in planning, assesses the environmental impact studies and issues the licenses, whereas the actual concessioning procedure is implemented at a local level.

Each county in Croatia has to have a general physical plan, which needs to be in line with the national physical plan. The national physical plan is a very broad document, so a lot of autonomy is left with the local authorities. The county physical plans provide for overall spatial definitions, allocating areas and zones to different activities. In most cases, areas have been allocated for human settlements, recreation zones and commercial activities, without actual definition of what a *commercial activity* in a given area is. In some cases, more detailed plans have been drafted, for example in Zadar County, where an in-depth study was undertaken in order to actually determine which areas would be suitable for marine aquaculture. Having such a detailed plan greatly helps in development of an activity, and takes care of environmental requirements at the same time. When undertaking this study, the County took into account all available spatial users, their impact and development potentials. Then it took into account the geographical and bio-physical characteristics of the area, implementing the specific criteria for different aquaculture technologies and species. An implementing regulation, brought pursuant to the Marine Fisheries Act, was used in this procedure. This regulation contains numerous environmental criteria, including depth, temperature, wave height, salinity and similar indicators which would be desirable for certain species (bass, bream, tuna, shellfish). Although having an environmental character, this regulation takes care both of the protection of the environment as well as of the best conditions for farmed organisms.

After a county plan was defined, a more detailed municipality plans are brought, which again have to be in line with the county plans. In these, smaller-scale plans, locations are often allocated for a specific activity, but most are still left under a general «commercial» purpose.

When applying for an aquaculture license, the potential investor submits a letter of interest to the local authorities, stipulating the area in question and the commercial activity. The authorities then check for availability and allocation of the area, and if the location is «available», a public tender is issued. All potential investors may bid for the concession, and all have to submit several important documents. For a marine aquaculture plant, an Environmental Impact Assessment (EIA) needs to be submitted, together with a detailed investment plan and a financial offer for the concession. The EIA has to contain all relevant information on the environment, activity and modeled impact with all the mitigation elements. The EIA is subject to an assessment and a public debate, and if it is accepted, the bidder submits the full documentation for the concession. Once the concession has been issued, the bidder applies for an aquaculture license, which in turn contains all relevant data on the area in question, species and quantities that may be farmed, and other data from the concession contract. The concession is usually issued for a period of 5 years.

As there is no general level plan for marine aquaculture, the planning instruments as well as licensing procedures are mainly left to local authorities and are governed by numerous regulations. According to the National Strategy for Development of Fisheries, development of aquaculture while respecting high environmental standards is a strategic goal, and the activity is foreseen to grow in the future. Croatia has great geographical advantages in terms of potential locations and areas suitable for marine aquaculture.

K. Sectoral Planning

This guide presents sectoral plannig as a mean for achieving the sustainable development of the aquaculture sector and how site selection and site management is directly linked to planification. Definition of Sectoral Planning is given as well as the components of the sector. The role of the administration and key aspecs needed for the development of a sectoral plan. Finally, examples of procedures for Sectoral Planning are described

The selection of areas of interest for aquaculture is currently one of the most important processes for the orderly development of aquaculture in all regions, countries or geographic zones.

Bearing in mind, however, that the final objective is the sustainable development of marine aquaculture in the Mediterranean, it is also essential to consider the issue from the point of view of the sector, its prospects plans of growth and needs as well as the manner in which this is all regulated, programmemed and supported by public administrations through Sectoral Plans.

Sectoral Planning refers to the set of guidelines or strategic lines proposed and adopted by the sector's different agents for the purpose of ensuring the orderly and sustainable development of the activity, so as to generate development models within a logical regulatory context for each country's legal and economic framework.

Actors Involved: Sector Components

The sector consists of the following agents:

a. Companies and Producers

Companies are devoted to production, seeking to be profitable, in order to survive in a multidisciplinary context, influenced by a large number of controls, laws, etc.

b. Associations

Producers, traders and/or auxiliary companies join to collectively defend their common interests. The objectives are usually similar to those of private companies, although they seek to achieve them in a collective manner. (FEAP, GFCM).

c. Research and Study Centres (Researchers)

Research bodies are devoted to the study of physical, chemical and biological processes related to production, and their interaction with the environment, for the purpose of increasing knowledge needed for the development of the activity.

d. The Public Administration or Managers

They process applications, handle permits, provide statistics, and analyse the environmental and sanitary monitoring. In other words, they authorise, control and manage the activity. Normally, these control and management actions are carried out taking into account a "political objective". Aquaculture would be supported by the adminitration depending on the influence on the economical and social tissues and on the availability of space in a certain region.

e. Others

National and international non-governmental organisations that carry out certain actions whose purpose affects the development of aquaculture in a positive manner (UICN, ICES).

Sectoral Approach and Perspectives

Sectoral Plans generally arise for different reasons: either as a demand of the sector for support and planning, or as an initiative of the administration acting as a driving force or as a result of both. Indeed, the greater the role of aquaculture as a sector, the greater the demand for planning will be.

Thus, in the context of a sectoral approach, there exist two different, complementary perspectives:

a. From the administration towards companies, with the objective of Sector Planning.

b. From companies towards the administration, with the objective of Growth.

The main actor or driving force behind this planning is usually a public administration with authority in the matter.

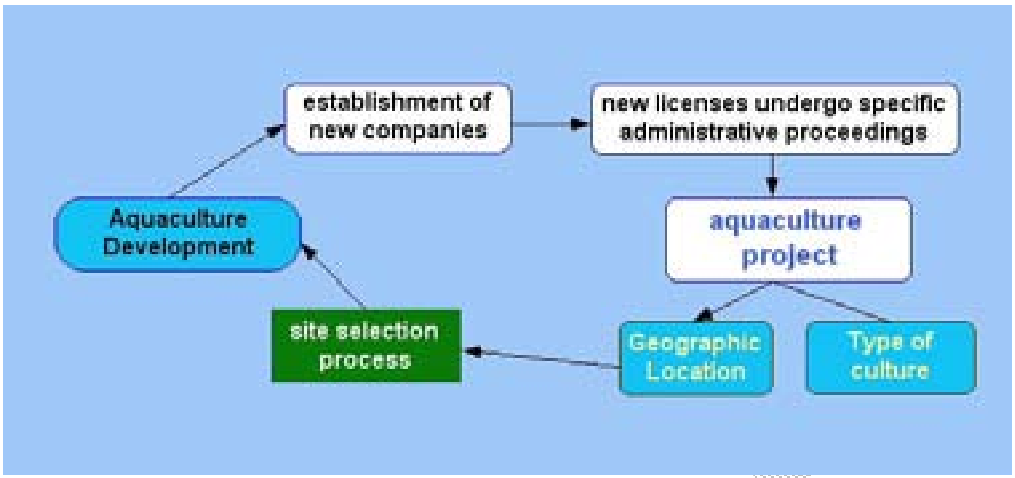
In consequence, the selection of areas of interest for aquaculture can be seen as support for Sectoral Planning, to the same extent that the sectoral approach must be taken into account for the selection and management of areas of interest. This two-way direction benefits all the agents of the sector: on one hand it facilitates the orderly growth of facilities for companies and producers. On the other, it entails important information for the Associations, for the purpose of supporting the sector's sustainable development.

In respect to Research and Study Centres, the selection of areas represents a source of employment and a decision-making support tool. Lastly, it allows Public Administrations and Managers to arrange, plan and manage aquaculture as a productive sector.

Key Aspects

The approach is based on the diagnosis of key factors for the sector's development, such as production, marketing, socioeconomic aspects, administrative aspects, the environment and spatial organisation. This requires prior availability of human, material and economic resources with which to perform the diagnosis, which should take into account the following priorities:

- Knowledge of the sector and its possibilities or potential;
- Knowledge of potentially useful areas (suitable or of interest);
- Establishing specific development objectives (Strategic Plans);
- Availability of an appropriate administrative system and useful statutory context.



Sectoral Planning is thus a key element for the development of the activity. In this context, an explanation of the scope of the sectoral approach must briefly highlight the role of the selection of areas of interest by means of the following analysis:

- What is the basis of aquaculture development? The creation of new companies, which will need new licences or authorisations to carry out the activity.
- These new licences or authorisations for farming are handled by means of a specific administrative process in which the key element of applications is the aquaculture project.
- The two most important aspects of an aquaculture project are the activity to be carried out, in other words the type of crop, and where it is carried out, in other words the geographic location.

In addition, Sectoral Planning is closely linked to the socio-economic, political and administrative context of each region, in which different situations exist depending on the degree of development of the sector and the characteristics of the country or region.

Countries like Norway or the United Kingdom (Scotland), where aquatic activity is far more developed that in the south of Europe, have sector planning guidelines and tools that support its orderly development.

In other countries like Greece or Turkey the rapid development of the sector is urgently demanding spatial and Sectoral Planning, given the high degree of occupation and dispersion of aquaculture facilities.

In between, there are other countries such as Italy, France and Spain in which the sector has grown in a progressive and relatively orderly manner. Even though at times there is no real and objective planning, there are other instruments, such as Strategic Plans, White Papers, or other documents of intention, which have contributed to a slower evolution by indicating the policies to be followed for the advance of the activity.

However, in general terms, there are currently few countries that have Sectoral Planning and organisation based strictly speaking on the selection of areas of interest.

Justification

The development of aquaculture over the next few years is one of the main topics of discussion in different international forums related to coastal area management, fishing, the environment and the supply of marine products. In consequence, the prospects of growth in the short and mid-term are good and tend to increase always improving aspects such as improving diversification, technologies, sanitary and environmental management, etc..
This expected development entails growth of the sector and of all activities that take advantage of the synergies it generates. The selection of areas for aquaculture and sector planning are thus key elements for the activity's sustainable development.

Principle

The selection and management of areas for aquaculture should take into account a sectoral approach and Sectoral Planning.

Guidelines

- **The potential for growth of the aquaculture sector on each geographic area should be taken into account as the starting point for the selection of areas.** The prospect of growth is an essential factor to ensure that the activity appears and/or remains in a specific geographic area.
- **The growth of the sector should be balanced in respect to other sectors sharing the same public domain**. It is important to find a balance between the development of the

aquatic activity and other activities that interact in the public domain, which is why growth of the former must be planned and orderly.

- **Sectoral Planning should balance the sector necesities and the public admnistration purposes.** As principal actors on the process, both parties should interact and develop a co-constructon process supported by other actors such as associatons, research bodies and other organisations.

- **Correct Sectoral Planning should be based on prospective studies.** Empiric knowledge is needed to set up the basis for development of sectoral plans. This in turn requires sufficient economic, material and human resources in order to obtain the information needed and to make it available to the actors involved in the sector's development.

- **Sectoral Planning should be carried out with the help of instruments and tools that make appropriate spatial and temporal analysis possible**. Geographic Information Systems are tools that facilitate the reading, representation and analysis of information.

Examples of linkage between Sectoral Planning and site selection and site management In Southern Spain

In Andalusia, in the south of Spain, the Regional Department of Agriculture and Fisheries, through the Public Company for Agrarian and Fishing Development, has in recent years carried out a series of studies based on spatial analysis in order to develop a Sectoral Planning for the aquaculture sector. The studies carried out are the following:

1. *Study to locate suitable areas for the development of aquaculture along the Andalusian coast*. The study analyses the technical and administrative framework of the maritime strip going from the coastline to a depth of 50 metres. On the basis of the study, all the uses, activities and occupations that could interfere with aquaculture were mapped, thus indicating the areas with the potential of being used for aquaculture.
2. *Study to locate suitable areas for aquaculture along the public foreshore of Andalusia.* In this second study, the technical and administrative sphere of the

foreshore area was analysed and again all the uses, activities and occupations that could interfere with aquaculture were represented.

3. *Second phase of the study to locate suitable areas for the development of aquaculture along the Andalusian coast: study of the physical environment*. This third study dealt with the technical and environmental factors of the foreshore, in other words with the environmental conditions of the 18 areas pre-selected in the first phase. The result of the study is a map series for each one of the 18 areas with zoning, depending on the degree of interest for the development of aquaculture, on the basis of environmental criteria.

4. *Pilot project regarding the organisation and potential of aquaculture in areas of Andalusia and Galicia*. In this case, starting with information generated in previous stages, a local scale study was developed for a coastal municipality in Andalusia and in Galicia that depends on fishing. In this phase, in addition to identifying suitable areas in greater depth, other socio-economic and sectoral fishing aspects were analysed, and specific proposals of action with aquaculture projects were made for the areas selected.

As a result of these studies, a review of regulations as well as planification and distribution of the public domain has been made to ensure suitable zones for aquaculture, with the aim of encouraging private investments and the sustainable development of aquaculture in andalucia.

In aquaculture parks in Murcia (Spain)

Another example of direct linkage between Sectoral Planning and site selection and site management is found on the development of aquaculture parks in the East of Spain, region of Murcia.

In 2002, the Ministry of Agriculture and Water of the Region of Murcia decided to create three aquaculture parks as an aquaculture planning and management tool to bring together most of the marine aquaculture companies operating in the Region. For this, laws were developed and definitions made, such as:

- Law 2/2007 of 12 March on Marine Fisheries and Aquaculture of the Region of Murcia provides the following definition of a Marine Aquaculture Park: a set of aquaculture facilities located within a duly demarcated area declared to be suitable for marine aquaculture, which can therefore be subject to specific management rules.

- Article 74 – Areas suitable for marine aquaculture.

  The regional ministry responsible may declare as areas suitable for marine aquaculture those areas that are considered appropriate for the installation of this type of establishment, pursuant to a mandatory, binding report by the government body responsible for areas in the public domain. The bodies responsible for defense, navigation safety, tourism, ports, environment and coastal management as well as the municipal councils involved shall also issue reports.

Driven by conservation purposes of existing seabed of great ecological value, the establishment of these parks searched for the benefit of both; the administration and the private sector. Facilitating all Administrative Procedures and supervision in the first case and reducing production costs on shared activities in the second.

For the creation of these parks, tenders were invited for the technical projects and the corresponding environmental impact studies, incorporating the following phases:

Phase 1 – Development of initial studies to determine the appropriate areas for locating the parks. For this, the guidelines given in the ‘Protocol for identifying areas suitable for the installation of aquaculture cages at sea’, published by the National Marine Aquaculture Advisory Board (JACUMAR) shall be followed.

Phase 2 – Preparation of projects to accommodate the target facilities.

Phase 3 – Design and development of environmental impact studies and the corresponding design of an environmental monitoring plan depending on the results of the study. The guidelines given in the ‘Protocol for the environmental management of cage aquaculture facilities,” published by the National Marine Aquaculture Advisory Board shall be followed.

Decisions were made to locate the correct sites. Obligations and rights of the users were developed as well as the procedures to follow in order to apply for a site. The implementation was made through regulations and laws considering both senses, that is protection of the environment and maritime traffic from the culture activity as well as protecting the culture from external activities. Together with a whole set of regulations were made for the management of the marine aquaculture parks.

Finally, three Marine aquaculture parks where declared: San Pedro del Pinatar, Puntas de Calnegre, El Gorguel (Cartagena). Except for the second, the others are currently working. One park is off La Llana beach, in the municipality of San Pedro del Pinatar, where there are seven facilities, and the other is off El Gorguel in Cartagena, where there are four facilities. These two parks cover approximately six million square meters, and currently produce between 7,000 and 7,500 tones per year, which may rise to 12,000 tones.

In Algeria

In Algeria, fishing produces around 126,000 tonnes a year (FAO, 2006), which allows an average individual consumption of 3.8 kg/year. Additional production of approximately 190,000 tones/year would be needed to meet the average consumption of the 5 countries of North Africa (9.5 kg/person/year). Thus, despite under-production of 80,000 tonnes of exploitable biomass, aquaculture is indispensable.

Aquaculture is a relatively new industry in Algeria. Its history can be broken down into three main phases: (1) an old phase of extensive aquaculture in the Mellah lagoon (8°20’E, 36°54’N), (2) a more recent phase of extensive fish farming based on the stocking and restocking of inland water bodies with imported species, and (3) a current phase of intensive fish farming and shellfish farming. Aquaculture production is only currently 370 tonnes and essentially consists of lagoon and inland fishing. Shellfish farming, practised by two private operators, only produces a few dozen tonnes of mussels and is limited by the supply of spat.

The recent creation of a ministry responsible for fisheries and aquaculture reflects the commitment to develop this sector. Public aquaculture projects have been planned for demonstration purposes and to support production. Private projects are also underway for the establishment of marine and inland shellfish and fish farming businesses. These are subsidised by between 40% and 80%, and are currently between 20% and 90% complete.

In March 2005, the relevant ministry published a master plan for the development of aquaculture through to 2025, with a production target of 53,000 tonnes a year. This master plan divides the country into 9 regions of activity, according to geographic and environmental criteria (Fig. 1). Within these regions, 53 areas of aquaculture activity have been established, defined as the most favourable places for sustainable development. For the spatial delimitation of these 53 areas, a specific techno-economic study of each one will be carried out, based on its legal status and the existing or planned multisectoral activities to be performed there.

A total of 450 favourable sites have been identified (112 coastal sites, 52 river mouths, 159 dams and hill dams, 115 semi-arid and Saharan sites, 12 chotts and sebkahs), distributed across 9 branches of aquaculture: inland fishing, lagoon fishing, shellfish farming, freshwater fishing, marine fishing, crustacean culture, algae culture, tuna fattening and ornamental fish farming.

Although still at the initial stage of mastering the technical and Economic aspects of aquaculture, the master plan addresses environmental considerations, as well as possible land use conflicts that could quickly come to dominate the concerns of managers. Indeed, several of the selected sites of interest for aquaculture are located in tourism development areas and protected areas (marine parks, marine reserves), or near hydraulic structures. Therefore, it is envisaged that implementation of the master plan will be based on identifying intersectoral relationships with the aim of harmonising land use to ensure the sustainable development of the industry. The necessary legal and regulatory framework has been strengthened with the passing of new laws, particularly concerning the terms and conditions of granting concessions for the establishment of aquaculture facilities.

At present, a concession for the establishment of an aquaculture facility requires the approval of the authority responsible for fisheries, following examination of the application by a committee established at the province level and made up of representatives of different administrative bodies (state property, water resources, agricultural services, tourism, transport, forests, and environment).

Only three concessions had been officially awarded directly by the State Property Department before the regulatory legislation came into force. These concessions can remain in place provided they are brought into conformity with the new regulations; once compliant, a new concession agreement is issued by the State Property Department. The concession agreement grants the concession holder the exclusive right to establish its aquaculture facility on the plot assigned to it in the maritime, hydraulic or inland public domain, in order to perform its breeding and farming activities.

In practice, the new procedure is based on specifications whose technical aspects include: (1) a feasibility study, (2) a layout plan of the facility, (3) an assessment of the environmental impact of setting up the facility, and (4) a pre-established list of physicochemical and bacteriological analyses. Once authorisation has been given, the concession is granted against the payment of an annual fee, the amount of which is specified in the Finance Act. The duration of the concession is 25 years, which can be renewed by tacit agreement. A recent specific law defines the conditions for performing breeding activities, the different types of establishments, the conditions for their creation and the rules for their operation (Executive Decree No. 07-208 of 30 June 2007).

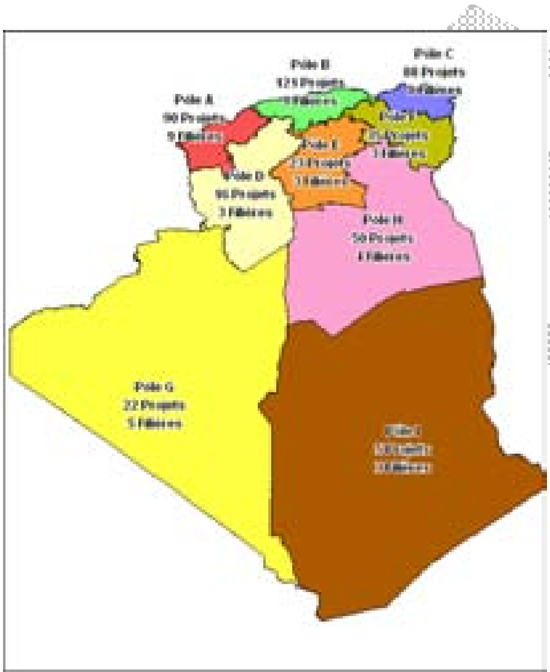


Figure 1: Division of the country into aquaculture activity regions

In Morocco

From an administrative and institutional point of view, aquaculture in Morocco is relevant from two different public administrations. The "Haut Commissariat aux Eaux et Forêts et à la

Lutte Contre la Désertification" (HCEFLCD) under the PM (Prime Minister) is responsible for fresh aquaculture while the Marine Fisheries Department (DPM) under the Ministry of Agriculture and Marine Fisheries (MAPM) is responsible for marine aquaculture. Both types of aquaculture have known different histories of development with different development strategies.

Concerning marine aquaculture, it began in Morocco in the fifties. Oyster farming represents the first marine aquaculture activity, originally practiced in Oualidia's lagoon located in Moroccan Atlantic coast, in the south of Casablanca City. Then, it was spread to other coastal sites such Nador's lagoon, Khnifiss's lagoon and Dakhla's bay. Some oyster companies are still operational with a total annual production maintained around 200 to 300 tons since several years ago. During the 2000s, mussel's culture began to develop in some coastal areas, mainly in Imessouane's bay (Atlantic coast) and M'diq's bay (Mediterranean coast). While marine fish aquaculture production was initiated during the 80s and focused only on Mediterranean coast. It was developed first in Nador's lagoon before being spread to others sites such as Saidia, M'diq and Azla. Among the four fish farms being created, only one of them is still operational and producing an annual amount less than 100 tons.

National aquaculture production reached in 2006 a total amount of 1,161 tons, registering a great decline of about 48% compared to 2005 (2,239 tons). This decrease was caused by marine aquaculture production which showed a very high decrease of about 80% (291 tons in 2006 against 1,449 tons in 2005) while fresh aquaculture has shown a little increase of about 9% (870 tons in 2006 against 790 tons in 2005). The national total aquaculture production represents only 0.2% of total national fisheries production.

In Morocco, the administrative procedures complexity affects the development of aquaculture. Indeed, the management of the aquaculture sector is shared between several administrations:

- The High Commissioner for Water, Forests and the Fight Against Desertification (HCEFLCD) manages the development of inland fish culture and control its operations;
- The Marine Fisheries Department manages marine aquaculture and issues permits for aquaculture activity in marine locations, and authorisations for import and marketing

of marine aquaculture products, in close consultation with the Livestock (veterinary) Direction;

- The Ministry of Infrastructure is responsible for issuing permits to occupy marine public domain;
- The Livestock Direction (relevant from Ministry of Agriculture, Rural Development and Fisheries) is responsible for enforcing health regulations.

The development of aquaculture in Morocco relies on sequential development plans, which are integrated in national plans and established as action programmes for periods of three or five years. These programmes are developed on the basis of the fisheries development plan relating to priorities, mainly fisheries resources preservation, social promotion, the updating of the fisheries and aquaculture sector and incentives. However, Moroccan aquaculture suffers from a lack of clear vision and strategy of Publics Powers. The current thinking seems to converge towards a real resurgence of interest with an actual desire to alleviate the constraints, including administrative, institutional, legislative and regulatory environment, according to new rules of socio-economic viability and trade competitiveness in the Euro – Mediterranean context.

The development of the marine aquaculture activity is seen as a vision based on creating regional development poles, consisting of aquaculture activities including type, technology and species to be cultured will be determined according to local conditions, including environmental and socioeconomic characteristics. The establishment of local plans for areas suitable to aquaculture based on eco-systemic study and approach for environmental and socio-economic integration, is considered as one the main of fundamental rules.

Generally speaking, Moroccan aquaculture is going through a critical period that requires collective and coordinated efforts of all public and private bodies to harmonize and standardize basic structural foundations and to ensure and strengthen the conditions for integrated and sustainable development of aquaculture activities. There is no doubt that all administrative, scientist and professional actors are aware of the need for a new strategy for aquaculture development which should be concerted, credible and long-term established. An action programme for marine and fresh aquaculture development, effective and compatible with the reality of challenges at local, national and regional levels, is therefore an appropriate imperative for the promotion of aquaculture production and fishing based on aquaculture. It will contribute to create regional poles of integrated development beneficial to local economy and may encourage local and foreign investment under a collective supervision of the activity and with a common organization of marketing and a collective insurance system.

L. Private Sector Organisations

This guide defines professional organizations and associations as organizational structures developed by the private sector. Their role and commitments are explained as well as their importance on the site selection and site management process. With reference to the Mediterranean organizations, the scale factor is considered as well as the trends observed due to globalization. Finally some examples are given as well as guidelines on how Private Sector Organization can contribute to the sustainable development of aquaculture.

Professional organisations and associations are non-profit entities managed by professionals and devoted to the promotion and defence of the interests of specific economic sectors. They are the driving force, from a private perspective, of planning in the sector.

These organisations support their members and represent them before public administrations and other entities with which they have relations, defending members' interests and demanding enforcement of their rights.

They carry out the following activities, amongst others:

- Promoting the sector and its products, seeking to improve quality;
- Promoting good environmental and social practices;
- Influencing the establishment of policies that directly affect the sector's development and intervening in participative processes;
- Improving transparency and traceability of products in respect to the market;
- Supporting continuous training for professionals;
- Encouraging contacts and exchange of information amongst professionals, acting as a point of encounter;
- Promoting company research and innovation.

Even though aquaculture is an emerging productive activity, in the Mediterranean the sector is fairly well structured and organised. Given the special features of this activity, aquaculture companies share a large number of common technical and management factors, and in consequence have similar needs and requirements, irrespective of the country in which they are located.

The selection and management of areas for aquaculture is a common denominator affecting all producers in the same manner, and is of crucial importance for the development of this activity.

The organisational capacity of any sector in order to defend common interests and take advantage of synergies is essential for its development, in particular when the activity involved is one that shares the use of public domain areas with other sectors.

The degree of establishment and development of aquaculture in the Mediterranean region, and the business structure of aquaculture enterprises, varies greatly from one country to another.

Different situations are easily identified: there are countries with numerous mid and large sized company facilities, countries with a large number of small family-owned facilities, and even countries with very few facilities, where aquaculture is an emerging activity.

It is important to stress the role that professional associations can have in this last scenario, not only to intervene as mediators for the defense of the sector's rights and opportunities, but also to support small companies that usually lack the capacity to access to both professional and legal information regarding organization, the environment, certification and decision making.

In any case, the aquaculture business, irrespective of the capital involved, is aware of the need to organise in order to achieve common objectives especially within the context of globalisation. Indeed, the trend followed by Mediterranean aquaculture initiatives is the current globalised economic model in which a smaller number of multinational companies own increasingly larger numbers of local production sites. In recent years, this trend has been observed in companies devoted to the production of giltheads and sea bass in the Mediterranean following the case of northern European salmon producers: initially there were many small and medium sized producers and now there are only a few multinational companies that own most of the production facilities.

This scale factor is essential in respect to the features and scope of action of associations, whether they are constituted at a local, regional or national level. Several associations are active in the Mediterranean area, including the Muðla Fish Farmer’s Association in Turkey, Asociación Empresarial de Productores de Cultivos Marinos (APROMAR) in Spain, Federation of Greek Maricultures, Associazione Piscicoltori Italiani, Malta Aquaculture Producers' Association, Association Marocaine de l'Aquaculture (AMA), The Egyptian Aquaculture Association (EgAS) and The Fish Breeders Association in Israel.

At a more global level, the national associations of aquaculture producers of the European Union member states have joined together to form the European Federation of Aquaculture Producers (FEAP). The Federation’s main objectives are geared at developing and establishing a common policy regarding matters pertaining to the production and commercialisation of aquatic species and to transmitting to competent authorities its interests and the rules and regulations it has established.

The geopolitical structure of countries favours, in turn, the organisation of the business framework, such as in the case of the European Union with the FEAP as an example. However, this situation does not exist in the Mediterranean, although it may be time to foment or propose at a global level an organisation or association of producers for the entire Mediterranean area.

Common interests are constantly increasing, in particular in respect to the common use and availability of space, which will eventually be globally managed as facilities are increasingly located furder away from the coastal line. This fact, together with the globalisation of markets and competitiveness for fish protein in the world, may constitute the appropriate framework for the future “Federation of Mediterranean Producers”.

Justification

Professional organisations are the most suitable tool for defending the common interests of any sector. Heavily regulated sectors, such as aquaculture, have a greater need to create organisations in order have more influence in society and amongst policy makers. In general, public administrations prefer to address professional organisations rather than individual companies, as a way of promoting more transparent and unbiased actions.

In the field of aquaculture site selection and management, professional associations play a fundamental role as interlocutors defending the sector's interests. Knowledge of the sector's economic and business situation enables these organisations to establish growth and planning criteria. Their experience and points of view are essential when it comes to choosing sites, not only from a technical point of view but also in respect to the scale of occupation.

Associations facilitate and foment a Participative Approach to the selection and management of sites for aquaculture. It is essential that associations act as forums for companies to meet and to echo their needs in connection with said selection and management process, mainly within the framework of Integrated Coastal Area Management, representing aquaculture in an adequate manner.

Principle
Professional associations and sectoral organisation should be promoted in order to defend the feasibility of private initiatives in the selection and management of aquacultures sites.

Guidelines

- **Aquaculture companies and professionals should organise themselves in order to defend common interests.** By associating they gain greater social presence and greater capacity to reach top administrative and political levels, which otherwise would remain inaccessible for most companies.
- **Professional associations should establish and implement Codes of Conduct and Better Management Practices amongst all their members.** Implementing these initiatives, even if they are voluntary, contributes to improving both productive practices and Social Acceptability.
- **Public administrations should support professional associations.** Since the weak spot of structures such as professional associations is usually their limited financial capacity, public administrations should have public grants at their disposal.

- **Professional associations should be created at a local level, with the intention of joining organisations at a higher level.** The birth of a professional association at the local level provides an immediate base for the identification of common topics and problems. However, there also exist common problems and challenges at higher territorial levels, like n the Mediterranean, that can only be dealt with effectively through higher ranking organisations such as federations.
- **Access and participation to association should be equitable for all producers** Participation in a professional association must be open to all producers, regardless of their production volume, type of farming or territory they belong and must ensure the participation and right to vote of all members.

Sectoral overview by the Aquaculture Producers Organizations

In Turkey

This summary expresses the views of The Official Union of Aquaculture Producers, at Ankara Central Office and at the Izmir branch; of The Muğla Fish Farmer's Association and The Federation of Aquaculture and Fisheries of Turkey.

However, whilst governments have been applying modern strategies to improve aquaculture in Turkey, there is much still to do regarding the establishment of negotiated aquaculture zones. Although permission for new sites is being given to the aquaculture sector by the authorities concerned, there are still some problems of legal permanence. It is not unknown for newly developing farms to be asked to relocate a second time. These problems mostly come from lack of proper preliminary scientific information and planning. Further, fish farmers are often eventually exposed to conflicts with the tourism sector, with owners of summer holiday villas, with environmentalists and with badly informed public opinion. Much of this problematic situation is the consequence of insufficient Integrated Coastal Zone Planning and Management. Frequently aquaculture suffers more than other users of the coastal zone. Certainly with regard to sustainability, environmental sensitivity and the protection of natural resources, initial good planning and site selection is vital. Further, more effective monitoring and enforcement are very important. In this, both self monitoring by the farmers and regional Integrated Coastal Zone Management (ICZM) are of equal and complementary importance. Also, by law, the relevant Ministries are required to monitor all fish farm.

But more importantly, scientifically-defined parameters must be built into the frame work of the law. Resulting from this monitoring and assessment, precautionary measures may be taken to prevent or correct negative effects.

The expectations of the aquaculture sector about site selection and the establishment of marine aquaculture zones are as follows:

- 1- Integrated Coastal Zone Management plans should be negotiated between all stakeholders;

- 2- Zones for establishing aquaculture and potential sites for this sector should be decided within ICZM parameters and formalized in an ICZM Master Plan;

- 3- These plans should be negotiated and announced. They shouldn't be changed or abolished unless absolutely necessary, and then with the agreement of all parties. Once an aquaculture zone has been defined there should be no further need for bureaucratic impediment or licensing. It should be a long-term contract;

- 4- Sites for aquaculture should be determined by criteria of a scientific nature. Data from all fields should be collected, but in general, the depth of water should be considered the basic criterion;

- 5- Zonal environmental plans which encompass Environmental Impact Assessment (EIA) studies should be made and this process should be conducted in a shorter time and in a less complicated manner than at present;

- 6- In Turkey, sites for aquaculture are currently leased for 15 years. During this period of time, fish farms shouldn't be required to move to another location. Furthermore the sector wants 15 years to be the minimum lease;

- 7- Cost of rents for marine aquaculture activities should be reasonable;

- 8- Environmental monitoring should not only be required for aquaculture sites but also for such other sectors as may have a negative impact on the environment;

- 9- If fish farms are required to move off-shore for environmental reasons, support in the form of credits as well as technological and other planning advice should be provided by the government;

- 10- In an organized aquaculture zone the following requirements are important:
  - a- For reasons of security and monitoring (EIA), the close packing of farms is good practice.
  - b- When an aquaculture zone is at the planning stage, it is essential to designate an on-land base, for logistic reasons.

c- At the fry stage (approximately 2-10 grams weight) it is essential to have protected, inshore nursery cages;

- 11- At the outset of change a new on-land site for hatcheries should also be marked on the ICZM Master Plan.

In Algeria

In Algeria, aquaculture producers and fishermen are organised in the Algerian Chamber of Fishing and Aquaculture (CAPA). At the local level, CAPA is represented by 21 provincial or inter-provincial fishing and aquaculture chambers. These are public industrial and commercial establishments with legal status and financial autonomy. They are placed under the supervision of the minister responsible for fisheries. Their organisation, functioning and missions are governed by an Executive Decree (No. 02-304).

The role of this chamber includes:

- Representing and defending the social and professional interests of its members;
- Submitting proposals and opinions regarding the development of fishing and aquaculture activities to the administrative authority responsible for fisheries;
- Organising and developing various forms of dialogue, coordination and information-sharing between its members;
- Working to build closer links between its members and institutions and bodies active in the production, financing, supply, distribution, marketing and processing of fishing and aquaculture products;
- Establishing relations and undertaking cooperation and exchange activities with foreign organisations of a similar nature or that pursue the same objectives;
- Creating, developing and managing commercial and industrial infrastructures.

The structure of the Algerian Chamber of Fishing and Aquaculture comprises: (1) the general meeting, (2) the President, (3) the board, (4) technical committees, (5) the Executive Director. The provincial or inter-provincial chambers are formed by full members and associate members. Full members (representatives of fishing and aquaculture cooperatives, representatives of trade associations, and professionals) have voting rights. Associate members participate in the work of the bodies of the Chamber, without having voting rights; they are local-level representatives of the administrative authorities and organisations whose work is related to the activities of the CAPA. The list of members is fixed by an order of the minister responsible for fisheries.

M. Integrated Coastal Zone Management (ICZM)

This guide highlights the necessity to take into consideration all the stakeholders involved in a determined coastal area in order to facilitate the coherent implementation of the diverse frameworks and processes occurring in the zone. In this sense, Integrated Coastal Zone Management can help aquaculture site selection and site management and its further sustainable development.

In a number of sectors such as fisheries and aquaculture, existing management efforts do not respond adequately to the scope and speed of changes induced by environmental events like climate change or natural disasters. Furthermore, the increasing concentration of urban conglomerations, industry and tourism development lead to coastal modification as well as water quality changes. Consequent environmental degradation and resource depletion in coastal areas will have economic repercussions for sectors directly related with marine ecosystem, threatening, at the same time, human health and well-being.

When coming to aquaculture development , such an environmental pressure can make the process of site selection and site management quite tough and be an hindrance to its sutainable development because of the activity high dependency on ecosystem good health.

Individual efforts of management undertaken by sectors depending directly on marine ecosystem like fisheries or aquaculture don’t afford anymore to respond to the fast changes ocurring in catchment area or coastal zones. Thus, when the usual ways of doing things no longer result in desired outcomes, it makes sense to look for new approaches and preferably with a comprehensive and adaptive perspective.

In this sense, Integrated Coastal Zone Management (ICZM) is at the cross-road of different management strategies and could facilitate the coherent implementation of diverse frameworks and processes within a specific area. ICZM is a dynamic process which promotes the sustainable management of coastal zones and seeks to balance between the environmental, social and economical dimensions of the sustainable development within the limits set by natural characteristics and load capacity. However, the basis of life for fish, birds, marine mammals and humanity itself that provide the ecosystem services are transboundary in character, typically cutting across existing political and jurisdictional boundaries and, thus, subject to multiple management systems.

The objective of Integrated Coastal Zone Management is to properly take into consideration all policies, sectors and, as far as possible, individual interests, involving all coastal stakeholders in a participative way. Aspects like conservation of the ecosystem and the economic development are also taken into account.

In such a process, Governance and reliable knowledge to support decision-making are considered as the two main pillars. Past experiences have demonstrated that the development of new Governance methods for coastal ecosystems can not be anymore the object of a unique and isolated strategy, but rather the result of an ensemble of them linked to ecological, socio-economical and cultural aspects of the region. The strength of Governance not only resides in its right plurality but also in its adaptability to a changing process in a given area as well as management has to adapt to permanent changes exerced by a socio-economic system with its consequent impacts in the ecosystem. Such capacities can only been reached through stakeholders'sense of accountability whatever the scale of Governance (from local to global).

ICZM is a learning process which needs, moreover, precaution due to its experimental character as well as a good diffusion in order to be globally implemented in a more and more effective way.

Whatever the issue, including aquaculture development, the process will be efficient and effective when it is grounded upon sustained learning that connects current and proposed actions to a thorough appreciation of what has succeeded and what has failed in previous management cycles in a given place. However, experiments must have controls. Without them, it is difficult to prove if the variables that are being probed are the cause of the outcomes observed.

In the Mediterranean, among the major ICZM issues of regional concern there are:

- Uncontrolled urban growing in areas near the coast. Constructions impact natural coastal habitats and completely modify the land use structure as well as the catchment area or coastal zone directly linked;

- Impact of tourism. The Mediterranean is an appreciated place for holidays, attracting approximately one-third of global tourism with the consequences that such an appraisal suppose;
- Impact on coastal waters from land-based and coastal activities. Rivers bring a load of polluting elements from upstream urban, industrial and agricultural discharges which add up to pollution and pressure generated by activities directly linked to the coastal and marine area;
- Loss of marine and coastal biodiversity. In the Mediterranean Basin, it has a direct linkage with habitat destruction, pollution, intensive exploitation and the introduction of alien species.

Coastal zones are of main importance for economic growth, livelihood and quality of life and must therefore be managed sustainably. Despite this, policy and legislation often lack an integrated vision of the coastal resources and uses, affecting, the development of aquaculture sector.

Implementation of ICZM should be a long-term process, facilitating the integration of aquaculture in a given area whose resources are already employed by other sectors. This process should be clear and transparent taking into account social, environmental and economical aspects. However, it is worth noting that the lack of financing mechanisms to secure contributions from stakeholders and beneficiaries is often an hindrance to sustaining any ICZM process.

Considering the urgent need of action, the Barcelona Convention Contracting Parties have prepared a comprehensive ICZM Protocol with principles, objectives and actions to be applied at regional, national and local levels. As of August 2008, 14 Mediterranean countries have already signed this protocol.

On the European side, the 2002 ICZM Recommendation has recently been reinforced in the framework of the European Maritime Policy and its new Marine Strategy Directive promoting an ecosystem-based scientific approach and management.

There is an increasing awareness of the necessity of Integrated Coastal Zone Management for socio-ecosystem sustainable development, where environment, society and economy will be more balanced for the benefit of human well-being.

Justification

Individual efforts of management undertaken by sectors have shown that sustainable development can't be anymore reached in that way, especially for recent activities such as aquaculture that need to be integrated in an already pressured ecosystem to follow its objective of development. Aquaculture site selection and site management can be facilitated through Integrated Coastal Zone Management (ICZM), which is an adaptive process that lean on two main pillars, namely a clear and transparent Governance and a good knowledge for decision-making.

Principle
In the process of site selection and site management for aquaculture, Integrated Coastal Zone Management (ICZM) represents a new form of Governance that should be implemented.

Guidelines

- **A preliminary study exploring each sector needs in a given area should be implemented.** In this sense, aquaculture has also to be considered as an activity among others, user of the same marine ecosystem, and whose development passes through the search of new sites.
- **A thorough understanding of existing and potential interactions that affect different activities and resources in the area and how they are likely to develop over time should be done in order to integrate, among others, aquaculture.** Management efforts cannot be carried out anymore individually by different sector users of the same marine ecosystem. It is necessary to encourage benefits from complementary interactions and ways of limiting the antagonistic one.
- **Costs and benefits of all activities, including aquaculture, should be identified in order to take into account their beneficial as well as harmful effects on other activities.** It is important to be aware, from an economical point of view, of direct and/or indirect impacts that can occur from such a coexistence. Integrated Coastal Zone Management is an adaptive process which never ends up.

- **Relevant Integrated Coastal Zone Management elements in the Legal Framework should be identified and improved.** Pieces of legislation can be traditionally produced for individual sectors. Thus, to integrate the different sectors using the same marine ecosystem such as aquaculture, it is necessary to give to existing Legal Framework a broader vision to allow their coexistence over a legal base.
- **A better global communication on the national development of such an experimental process like Integrated Coastal Zone Management applied to aquaculture site selection and site management should be promoted.** This information can be helpful on the one hand for countries whose ICZM capabilities are just emerging and on the other hand for countries which already apply ICZM and require, however, information about the process.
- **Integrated Coastal Zone Management activities should be financed in order to uphold and further allow the sustainable development of sectors such as aquaculture.** Effective coastal zone management requires regular financing in order to support its ongoing ICZM process which objective is to take into account all the stakeholders including aquaculture sector.

Integrated Coastal Zone Management Protocol for the Mediterranean[6]

A new Protocol on Integrated Coastal Zone Management (ICZM) was signed in Madrid on 21 January 2008 at the Conference of the Plenipotentiaries on the Integrated Coastal Zone Management Protocol. Fourteen Contracting Parties to the Barcelona Convention signed the Protocol at the Conference, and the others announced to do so in very near future. The Parties are now urged to ratify the Protocol so that it enters into force as soon as possible. The signing of the Protocol came after a six-year process of consultation, negotiation and refinement on the Protocol layout and dedicated work of all the Parties.

The ICZM Protocol is the seventh Protocol in the framework of the Barcelona Convention and represents a crucial milestone in the history of MAP. It completes the set of Protocols for the Protection of the Marine Environment and the Coastal Mediterranean Region. It will allow the Mediterranean countries to better manage and protect their coastal zones, as well as to deal with the emerging coastal environmental challenges, such as the climate change.

[6]The Protocol on Integrated Coastal Zone Management in the Mediterranean is available at the PAP/RAC web site http://www.pap-thecoastcentre.org/itl_public.php?public_id=314&lang=en.

This Protocol is a unique legal instrument on ICZM in the entire international community and could serve as model for other regional seas.

The ICZM Protocol text is:

- precursory, representing innovation in international law, since there is no precedent of regional initiatives;
- forward-looking and proactive, aiming at preventing and not only reacting to coastal problems;
- comprehensive, covering all issues crucial for coastal environment and its protection in the 21st century;
- integrated, ensuring institutional coordination at national, regional and local levels, involving non-governmental organizations and other competent organizations as well as integring sea and land areas.

The text of the Protocol emphasizes that the Parties shall define common regional framework for Integrated Management of the Mediterranean coastal zone and shall take necessary measures to strengthen regional cooperation for this purpose. Responsibility of the Mediterranean countries is to ratify and implement the ICZM Protocol. Mediterranean Action Plan (MAP) is ready to assist them in that endeavour. Countries should develop their national ICZM strategies as an outset for all other ICZM activities, and prepare coastal implementation plans and programmes.

The Protocol should ensure sustainable development of coastal zone, sustainable use of natural resources and integrity of coastal ecosystems, landscapes and geomorphology. It should protect coastal zone and prevent the effects of natural hazards, and achieve coherence between public and private initiatives.

The Protocol is very precise on:

- defining of the coastal zone where it means "...the geomorphologic area either side of the seashore in which the interaction between the marine and land parts occurs in the form of complex ecological and resource systems made up of biotic and abiotic components coexisting and interacting with human communities and relevant socio-economic activities";

- defining of the setback as "...a zone where construction is not allowed. Taking into account the areas directly and negatively affected by climate change and natural risks, this zone may not be less than 100 meters in width, but it leaves possibility to adapt";

- formulation and development of coastal strategies, but also land-use strategies, plans and programmes covering urban development and socio-economic activities, as well as other relevant sectoral policies;

- formulation of Environmental Impact Assessment for public and private projects, and Strategic Environmental Assessment for plans and programmes which affect the coastal zone;

- developing policies for preventing natural hazards, particularly those resulting from the climate change;

- applying the ecosystems approach to coastal planning and management so as to ensure the sustainable development of coastal zones, taking into account specificities of coastal ecosystems, in order to preserve coastal natural habitats, natural resources and ecosystems, as well as landscapes;

- reporting on the implementation of the Protocol, including measures taken, their effectiveness and the problems encountered upon their implementation.

STRUCTURE OF THE PROTOCOL

PART I GENERAL PROVISIONS

Article 1: GENERAL OBLIGATIONS

Article 2: DEFINITIONS

Article 3: GEOGRAPHICAL COVERAGE

Article 4: PRESERVATION OF RIGHTS

Article 5: OBJECTIVES OF INTEGRATED COASTAL ZONE MANAGEMENT

Article 6: GENERAL PRINCIPLES OF INTEGRATED COASTAL ZONE MANAGEMENT

Article 7: COORDINATION

PART II ELEMENTS OF INTEGRATED COASTAL ZONE MANAGEMENT

Article 8: PROTECTION AND SUSTAINABLE USE OF THE COASTAL ZONE

Article 9: ECONOMIC ACTIVITIES

Article 10: SPECIFIC COASTAL ECOSYSTEMS

Article 11: COASTAL LANDSCAPES

Article 12: ISLANDS

Article 13: CULTURAL HERITAGE

Article 14: PARTICIPATION

Article 15: AWARENESS-RAISING, TRAINING, EDUCATION AND RESEARCH

PART III INSTRUMENTS FOR INTEGRATED COASTAL ZONE MANAGEMENT

Article 16: MONITORING AND OBSERVATION MECHANISMS AND NETWORKS

Article 17: MEDITERRANEAN STRATEGY FOR INTEGRATED COASTAL ZONE MANAGEMENT

Article 18: NATIONAL COASTAL STRATEGIES, PLANS AND PROGRAMMES

Article 19: ENVIRONMENTAL ASSESSMENT

Article 20: LAND POLICY

Article 21: ECONOMIC, FINANCIAL AND FISCAL INSTRUMENTS

Part IV RISKS AFFECTING THE COASTAL ZONE

Article 22: NATURAL HAZARDS

Article 23: COASTAL EROSION

Article 24: RESPONSE TO NATURAL DISASTERS

PART V INTERNATIONAL COOPERATION

Article 25: TRAINING AND RESEARCH

Article 26: SCIENTIFIC AND TECHNICAL ASSISTANCE

Article 27: EXCHANGE OF INFORMATION AND ACTIVITIES OF COMMON INTEREST

Article 28: TRANSBOUNDARY COOPERATION

Article 29: TRANSBOUNDARY ENVIRONMENTAL ASSESSMENT

PART VI INSTITUTIONAL PROVISIONS

Article 30: FOCAL POINTS

Article 31: REPORTS

Article 32: INSTITUTIONAL COORDINATION

Article 33: MEETINGS OF THE PARTIES

PART VII FINAL PROVISIONS

Article 34: RELATIONSHIP WITH THE CONVENTION

Article 35: RELATIONS WITH THIRD PARTIES

Article 36: SIGNATURE

Article 37: RATIFICATION, ACCEPTANCE OR APPROVAL
Article 38: ACCESSION
Article 39: ENTRY INTO FORCE
Article 40: AUTHENTIC TEXTS

Integrated Coastal Zone Management Protocol milestones

2002 - 2003 - Preparation of the Feasibility Study, which demonstrated the need for a new regional legal instrument on coastal zone management in a form of the ICZM Protocol.

2003 - 13th Ordinary Meeting of the Contracting Parties (Catania, November 2003) recommended that PAP/RAC prepare the draft Protocol on the basis of a broad process of consultation among experts and other stakeholders.

2004 - Regional Stakeholders Forum: "ICZM in the Mediterranean: Towards Regional Protocol" (Cagliari, May 2004) provided guidelines for drafting the text of the Protocol.

2005 - 14th Ordinary Meeting of the Contracting Parties (Portoroz, November 2005) decided to establish a Working Group to develop and finalize the draft text of the Protocol, with a view of its consideration and possible approval by the Contracting Parties at their 15th Ordinary Meeting.

2006 - 2007 - The negotiation stage and drafting of the text of the Protocol. After five meetings of the Working Group, the Parties reached consensus on the text.

2008 - The final text of the Protocol was presented at the 15th Ordinary meeting of the Contracting Parties (Almeria, January 2008), where it was approved and prepared for signing. The Protocol was signed at the Conference of the Plenipotentiaries (Madrid, January 21, 2008).

N. Site Selection Process

This guide pretends to offer a method for site selection, taking into account all necessary aspects to achieve the sustainable development of mediterranean aquaculture. Key aspects, concepts and terminology are explained and special attention is given to the secuenciality of the process itself. Definition of minimun parameters to study and its representation is included as well as a pratical example carried out in the south of Spain.

The selection of sites for aquaculture constitutes a technical and administrative procedure aimed at establishing areas of interest for the development of this activity on the basis of sectoral and spatial analysis. By technical procedure we are referring to those matters, whether socio-economic, environmental or technological, that require scientific applications.

An area of interest for aquaculture is one that is appropriate to install an aquatic activity that is compatible with the ecosystem, which is socially acceptable and economically feasible, thus complying with the objectives established for Sustainable Development. To achieve this goal, in addition to appropriate environmental conditions for the development of marine farming, possible administrative incompatibilities or interference with other activities must also be taken into account.

A positive aspect of the development of aquaculture entails the supply of marine projects, and as a productive activity it has special requirements which include technological evolution, optimisation of production procedures, improvement of commercialisation, but above all the need for suitable available areas in which to establish the activity.

Marine aquaculture activities are usually established in coastal areas, which are considered public domain foreshore, in other words areas that are state owned. These coastal areas, where aquaculture seeks sites in which to expand its activities, are also areas that are subject to a great deal of pressure due to the existence of many different interests and other priorities in respect to their use.

In consequence, in the Mediterranean basin, the scenario for the selection of sites for aquaculture is varied due to the circumstances of each region. The relatively recent development of aquaculture, the need to integrate it with existing activities, the availability of natural resources, and governmental priorities based on sources of wealth and employment constitute limiting factors that make the process more difficult.

These aspects were highlighted back in 2000 in the Recommendation of the European Parliament and Council regarding the application of Integrated Coastal Zone Management, which analysed the strategic importance of coastal planning for Europe and the rest of the world. The document analysed the physical and biological problems of coastal areas and pointed out that in many cases these problems gave rise to others of a social nature, stressing, amongst others, that ”the scarcity of areas for aquaculture as a result of allocations for other uses constitutes a significant restriction for the expansion of this activity.”

In the European context, the Communication from the Commission to the Council and European Parliament regarding the Strategy for the Sustainable Development of European Aquaculture was published in 2002. In this Communication, the challenges that are highlighted as the most important include “problems of space”. The recent growth of aquaculture, particularly in coastal regions in which large numbers of activities already exist, has converted it into a newcomer that is disrupting the status quo established by traditional users.

Studies geared at locating, identifying and determining areas of interest for marine farming must be carried out on the basis of the principles established by the European Commission for said Integrated Management.

One of the objectives highlighted is sustainable economic development, and in this sense coastal areas that depend on fishing currently require new activities that generate wealth and employment as a result of the constant decline of extractive fishing activities.

In consequence, the problem of space for aquaculture is a real one that must be dealt with in a comprehensive, sustainable and orderly manner.

The purpose of area selection is to obtain complete and relevant information to enable the orderly and adequate development of aquaculture. This information will supplement other information that companies and entrepreneurs have, enabling them to find the best sites in which to install their aquaculture facilities. In addition, it will be a tool for administrations to plan the activity and establish areas of interest.

Thus, the general objective of the Site Selection Process is to provide a knowledge-based instrument to help administrations and bodies involved in making decisions geared at planning and developing this activity.

Methodology: Key Aspects and Concepts

In the process of site selection, decisions have to be made bearing in mind certain basic aspects, including the following parameters.

Scope

In location studies, the spatial context is an aspect that must be taken into account because it will determine how deeply the study parameters are analysed and the suitability or not of making specific aquaculture proposals for said areas, in other words, of establishing development plans.

Thus, from a spatial point of view, the selection of sites of interest for aquaculture can be dealt with as follows:

- At a Regional level, where most of the information will be of a technical-administrative nature, in other words identification of uses, activities and occupations, without too much detail regarding the socio-economic and environmental analysis or in connection with farming proposals;
- At a Provincial or Sub-regional level, where more abundant environmental and socio-economic information should be obtained to enable more detailed site selection. However, depending on the size of the areas studied, certain parameters may be studied with greater detail than others. In this case farming proposals may be general, non-specific ones;
- At a local level, where the technical-administrative and environmental spheres must be analysed in detail in order to know all the limiting factors or priorities that will determine if the area under consideration is suitable for different types of farming. In addition, in

this case farming proposals or proposals of use will be suitable, objective and appropriate in accordance with real measurements.

In addition, other aspects that should also be taken into account in the Site Selection Process are the following:

- To identify information needs regarding areas and activities to be carried out;
- To define the appropriate spatial and temporal context;
- To design a plan to obtain information that is appropriate in connection with existing needs and available resources.

Terminology Used

In respect to the terminology to be used in work geared at locating and selecting sites for aquaculture, the terms to be used should be defined before starting. These terms are the following:

- Suitable areas, excluded areas, or areas with limitations;
- Suitable or unsuitable areas;
- Area of interest: high, average or low.

Of all these terms, the most appropriate one to define the areas we are looking for in the Site Selection Process is "area of interest", since the others could lead to misunderstandings on the part of the final users of the information.

Spatial Analysis

Current aquaculture activities in Mediterranean countries are usually carried out in three different types of locations, and the selection of areas of interest must bear in mind the difficulties inherent in each location:

a. Mainland Aquaculture (wetlands, estuaries, mainland)

The analysis of this type of area is more complex due to the large number of uses and occupations that may exist, together with the different urban development plans of the different administrations under whose authority said areas may be subject.

b. Coastal Aquaculture: Marine Facilities near the Coast

The greatest concentration of use of the coast is found in these areas, although normally the number of activities is lower than on the mainland. This coastal area comprises depths that range from 20 to 50 metres. Closeness to the shore and depth imply a larger concentration of uses, as this is the area traditionally used for tourism, coastal navigation, etc.

c. Open Sea Aquaculture

This is aquaculture carried out in the sea in exposed areas far from the coast (more than 3 nautical miles), and also includes floating or semi-submerged shellfish and fish farming systems.

In these areas there is much less interference from other uses, since they are more difficult to reach (distance) and have more complex environmental and oceanographic conditions.

On the other hand, obtaining environmental information about these areas is more difficult and more expensive, which is why they are often less well known.

Study of Parameters

In view of the scarcity of information regarding marine environments, and the costs involved, the idea is to carry out the study of the parameters of two spheres:

- The technical-administrative sphere, in which all the interferences of use which may arise in the area in which we seek to develop aquaculture are analysed;
- The technical-environmental sphere, in which the water mass and seabed where the aquaculture activity is to be located are studied.

This division, which enables us to have a more complete vision of what happens in the area under study, also helps us to optimise the in-depth analysis of certain aspects, since a pre-selection can be made once the analysis of the administrative sphere has finished.

In addition, there are other general or basic descriptive parameters that intervene in the process.

In any case a minimum number of appropriate study parameters should be selected. Once the study area and type of aquaculture to be developed have been decided, it's important to select the best parameters while weighing the material and financial resources needed to do the work with them against the benefits or the quantity and quality of information to be obtained from them.

The most important parameters to study are going to depend directly on the characteristics of the site in question, on how urgently the data are required and on the type of aquaculture to be developed. The site characteristics to be examined, aside from those relating to the environment, include the traditional activities carried out in the area, interference with other activities in terms of use, and the particular socioeconomic elements present.

The parameters to take into account will depend on the area chosen for the site location and selection study, but in general terms, the most important ones to be considered in most cases are the following:

a. Basic Information

The description of the area of study will be based on basic information, to which other information or parameters of study in connection with the area of study will be subsequently added. In general terms, this basic information is:

- Bathymetry;
- Coastline;
- Basic infrastructures;
- Population centres, cities, villages and provinces.

b. Administrative Sphere

Once the basic information has been obtained, parameters are analysed from an administrative point of view; in other words, the uses, activities or occupations in the area that could interfere with aquaculture are studied. These parameters will depend directly on the special features of the area of study. In general terms, the following can be considered:

- Port areas or infrastructures;
- Protected areas: Nature Parks, Communitarian Places of Interest;
- Dumping points and underwater outlets along the coast;
- Areas with underwater cables or conduits;
- Areas of interest for tourism: beaches;
- Underwater archaeological interest areas;

- Traditional fishing areas;
- Artificial reefs;
- Other aquaculture facilities;
- Vessel anchorage areas;
- Military interest areas.

Others: in some Mediterranean countries such as Spain, areas with sand deposits are delimited so that the sand can be used to regenerate eroded beaches.

c. Environmental Sphere

In this second stage, once sufficient information has been obtained regarding possible use interferences, it will be easier to demarcate the area where the aquaculture facilities are to be located. At this stage it is essential to have information regarding current environmental conditions, for two major reasons:

- To assess the technical and biological feasibility of the farming
- To know the natural surroundings and its values in order to objectively assess potential effects on the farming

Furthermore, this will enable us to design objective environmental surveillance programmes that are appropriate for the type of environment we have described.

The number of parameters to be studied, and the detail with which they are analysed, will mainly depend on the area under consideration, on the type of aquaculture to be carried out and obviously, on the economic budget available for the study.

In general, the most interesting parameters are the following, grouped in categories:

CLIMATE ANALYSIS	STUDY OF SEABED	WATER QUALITY	OCEANOGRAPHIC CONDITIONS
Temperatures (Max., Min., Average) Speed of wind: average values	Granulometry Organic Matter Concentrations Biological analysis of	Oxygen Profile Salinity Chlorophyll	Significant wave height and period of recurrence Currents (Intensity and direction) Coastal dynamics

Wind direction: average values Precipitations Evaporation	seabed: benthic fauna Redox Potential	Average Temperature Solids in Suspension Nutrients (NH4, ...)	Hydrodynamic model

Obviously, this series of parameters will have to be adapted to what is foreseen for the area under study, in other words to the type and level of aquaculture farming to be developed.

Demarcation of the area of study

Once the previous information has been obtained, it is important to spatially delimit the area of study, bearing in mind what type of facilities and production you plan to develop, the type of aquaculture existing in the area, the statutory context, the environmental conditions and the social and economic context.

In the last case, the analysis of how aquaculture can contribute socially to the development of coastal areas that depend on fishing, generating employment and activities connected to the traditional exploitation of the sea, is extremely interesting. Furthermore, aquaculture has been usually considered as an activity that can and must absorb employment from extractive fishing, reason why this analysis is of great importance.

This spatial demarcation will also be affected by the interests of the administration or body that carries out the site selection study and by the presence of different geomorphologic units, and in one way or another by all the previous parameters.

This stage of the study can be divided into three groups, as follows:

a. Methodological Aspects

The main methodological aspects are related to the Geographic Information System (GIS) tool, and it is necessary to know how the system works, its applications and the possibilities it offers to represent the information.

A GIS is very useful as a tool to locate, describe, identify and select areas of interest for aquaculture. It is relatively easy to use, but during the construction process other aspects are going to have a direct impact on the applicability of the maps obtained.

b. Establishing Criteria

Establishing criteria for the representation is as important as knowing the GIS technique. These criteria are going to be directly related with the information provided by the different administrations, together with the project's objectives and the procedure's determining factors. The criteria will be divided into two groups: administrative criteria and environmental criteria.

c. Thematic Cartography

This is the construction phase of the maps and can be a relatively easy process, or a very complex one, depending on the level of information provided by the agents involved, but above all on the manner in which said information is provided.

In this sense, necessary information must be collected or generated. In the first case, it can be found as follows:

- On paper without georeferencing (it thus needs to be georeferenced and digitalised)
- On paper and georeferenced (it will have to be digitalised)
- In digital format and georeferenced (layers ready for the GIS)

In the second case, if the information has to be generated, work guidelines will have to be well established and the collection and georeferencing (establishing the system of coordinates, etc.) of data will have to be well planned.

Farming Proposals and Management Programmes

The project or aquaculture site location and selection study finishes with a series of data and cartographic information that will be used to plan and organise the activity in a specific geographic area.

This information can be used in different ways: by publishing and disseminating the results, or by developing regulations governing the occupation of the areas selected.

In both cases, whether it is by regulation or dissemination, this information must be supplemented with Development and Management Plans for these areas, geared at the orderly occupation of the site and the planned development of the activity.

This type of Plan must take into account the type of aquaculture and species (including carrying capacity), environmental surveillance programmes, marking with buoys and signs, the collective management of services (changing nets, feeding, surveillance, etc.) and sanitary management.

Justification

Locating and identifying areas of interest, or areas that are suitable for aquaculture is a key aspect for the sustainable development of this sector in the Mediterranean. It would facilitate administratives procedures, safe time and money, it would allow better management and prevision of growth. For this, an adecuate methodology should be developed, taking into account all necessary aspects to be treated on a secuential way.

A large amount of spatial, environmental and sectoral information is collected throughout the process which can be represented and interpreted by means of GIS to facilitate the analysis of the potential and possibilities for growth and interaction with other uses. The amount and the quality of the information collected and represented must comply with the expected results and the needs established.

This converts the process in a management and information tool for public administrations and for the sector.

Principle
A clear and sequential Site Selection Process should be available in order to ensure sustainable aquaculture.

Guidelines

- **The site selection should depend on the aquaculture activity planned and existing environmental conditions.** In designing a process, all constraining factors or priorities that could interfere with the proposed objective of selecting sites for the sustainable development of aquaculture must be taken into account.
- **The scale factor should be applied in order to dimension the project, taking into account the degree of information detail required and the budget available for the process.** The material and economic resources required to carry out a site selection process should be considered in terms of balancing investment and expected results.

- **The methodology to be applied to a site selection process should begin with a sectoral analysis and the identification of needs.** The sectoral analysis must provide information regarding the type and size of aquaculture planned. This information will be essential in order to identify the best parameters for the study, the agents involved and the project's scope.
- **The study methodology should preferably be selective and dynamic.** Administrative factors should be arranged in advance due to the possible incompatibilities with other uses and so select and focus the environmental factors to study. The process should be dynamic, so that information obtained is progressively interpreted and added to allow feedback and updating.
- **The choice of parameters should be directly related to the statutory context in force for the aquatic activity in the area of study.** The parameters selected for the study constitute the major basis to determine the suitability of the area and should include those that interfere directly or indirectly with the planned activity.
- **The site selection method should include the chronological sequence of actions required to carry out the study within the expected timeframe.** Schedule should be established for: collection of information, maps building, consultation and validation by agents, final results and representation.
- **The results of site selection processes should be represented at a scale and with a format that can be easily read and interpreted.** The information obtained and its interpretation, must be represented graphically and be legible to the general public.

Example of Barbate and Costa da Morte

The geographical context of the project comprises two different regions of Spain, the municipality of Barbate, located in the Cadiz province, on the South Atlantic coast of Andalusia, and the municipalities included in the Costa da Morte, located in the A Coruña province, on the north-western Atlantic coast of Galicia. The places selected for the study are areas that have traditionally depended on fishing and have strong links with the sea, and where new activity proposals such as aquaculture could entail new employment opportunities and socioeconomic progress for the local population.

The general aim of the project is the creation of local employment and business development by promoting the sustainable growth of the aquaculture sector through the identification of suitable areas for aquaculture development by means of the integrated planning of coastal areas supported by Geographical Information Systems (GIS).

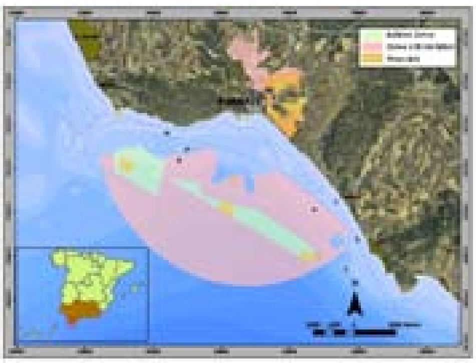
The identification and location of areas of interest for aquaculture activities seeks to obtain a large amount of spatial, environmental and sectoral information that will allows us, once it has been mapped and interpreted, to analyse the different possibilities of sectoral development. To support and complement the spatial analysis we have described the environment of the areas studied, analysed the socio-economic context and have also examined current and recent aquaculture experiences.

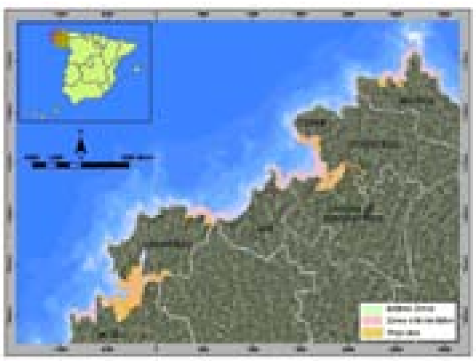
The methodology used in this pilot project has been structured as follows:

1. Identification of needs
2. Analysis of the aquaculture sector
3. Analysis of the statutory context
4. Environmental description of the surroundings
5. Description of the socioeconomic context
6. Spatial analysis and delimitation of the area of study
7. Selection of study parameters
8. Identification of agents involved
9. Field work and information collection
10. Preparation of preliminary maps
11. Consultations and validation of areas
12. Definite maps
13. Aquatic activity proposals
14. Drafting a Management and Monitoring Plan

The cartographical information generated takes into account the aquaculture activity, available spaces, uses and activities, Legal Framework, together with the criteria obtained from the interviews.

In the identification of areas of interest, we found some different locations where aquaculture activity could be developed since they complied with technical-environmental requirements and showed no incompatibilities with administrative or other uses.





posals

In addition, a series of specific aquaculture proposals were made for those areas, including the most appropriate type of activity, different levels of investment and production and different types of development, the objective being to offer different types of activities for different types of potential entrepreneurs.

O. Ecosystem Approach

This guide promotes the application of Ecosystem Approach for managing the impacts of human activities on the ecosystem with the aim to optimize its use without damaging it. Thus, it is better to talk about Ecosystem-Based Approach to Integrated Management (EBM). It is a step by step management tool based on the best available scientific, traditional and local knowledge on the ecosystem and which complies with the 12 principles recommended by the Conference of the Parties of the Convention on Biological Diversity.

The Ecosystem Approach is a tool for the integrated management of human activities based on the protection of land, water and living resources; it is a strategy that promotes conservation and sustainable use of the ecosystem in an equitable way. It has been asked for by decision-makers as a result from the failure of previous strategies to manage human activities, because most of humankind depends upon the ecosystem for their livelihood, whichever ecosystem component might be (lands, forests, wetlands, seas and oceans).

The Ecosystem Approach is based on the best available scientific knowledge on the ecosystem in order to identify and take action on stressors which are critical to the health of the marine ecosystems (EU Marine Strategy Stakeholder Workshop, Denmark, 2002). Accordingly the precautionary approach and its operational tool, the Risk Management Framework (RMF) are nested within the strategy. Therefore, it does not aim for short-term economic gains, but aims to optimize the use of an ecosystem without damaging it by means of the management of human activities impacts, achieving sustainable use of ecosystem goods and services and maintenance of ecosystem health and integrity.

In 1972, the United Nations Conference on the Human Environment (UNCHE or Stockholm's Conference, 1972)[7] already quoted the notion that environmental aspects are a right for humanity, focusing on the great ability of the humanking to modify the natural environment through development with a major risk related to the appearance of Genetically Modified Organisms (GMO).

6Conference on the Human Environment. United Nations Environment Programme. http://www.unep.org/Documents/Default.asp?DocumentID=97

As for the Ecosystem Approach, it was pointed out as a management tool within the United Nations Convention on Biological Diversity in 1992[8] with a particular focus on actions related to the marine environment during the Jakarta meeting in 1995[9], addressing the issue of species decline, in terms of both abundance and richness. The importance of ecosystem considerations was forcefully recalled at the Johannesburg World Summit on Sustainable Development (WSSD, chapter IV of the Johannesburg Plan of Implementation, 2002)[10], during which the recommended timelines for the implementation of the Ecosystem Approach covered the 2005 – 2012 period of time.

There is a need to address all the impacts of human activities within the marine environment at the same time, whatever they are, land-based or strictly marine to maintain the role of the marine ecosystem to support the development of all these activities. Accordingly, Integrated Ocean (or broadly Marine) Management (IM), which is based on protecting ecosystem targets, certainly represents an improvement to managing human activities in a sustainable manner. However, this is not a panacea and the process entails further development. Prior to specifically addressing the Ecosystem Approach, one must recall that the Ecosystem Approach doesn't mean managing the ecosystem, but managing the impacts of human activities on the ecosystem. Thus, and to avoid any confusion, it is better to talk about an Ecosystem-Based Approach to Integrated Management (EBM) rather than just Ecosystem Management.

The EBM approach aims to achieve sustainability, and particularly how to deal with ecosystem considerations related to:

- Health of the ecosystem in order to preserve its own functions;
- Resistance as a capacity to overcome alterations;
- Resilience as a capacity of recovering its previous state after alterations.

Ecosystem-Based Approach to Integrated Management (EBM)

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[8] CBD: http://www.cbd.int/

[9] The Jakarta Mandate Marine and Coastal Biodiversit
http://www.biodiv.org/programmes/areas/marine/default.asp

[10] World Summit on Sustainable Development WSSD. Johannesburg Plan of Implementation. Chapter IV, Protecting and managing the natural resource base of economic and social development. United NationsUN.
http://www.un.org/esa/sustdev/documents/WSSD_POI_PD/English/POIChapter4.htm

Ecosystem-Based Approach to Integrated Management (EBM) considers all activities together as a body, in order to take into account interactions between activities as well as cumulative effects. In the classical framework, the process should first identify key ecosystem components that need particular attention, and then address activities that potentially impact these components.

The EBM complies with the 12 principles recommended by the Conference of the Parties of the Convention on Biological Diversity:

1. The management of land, water and living resources should be determined through negotiations and trade-offs among all the stakeholders involved with their different perceptions, interests and intentions;

2. Decisions should be made by those who represent the appropriate communities of interest and management undertaken by those with the capacity to implement the decisions in a decentralized system. The closer management and decisions are to the ecosystem, the greater are the responsibility, ownership, participation, and use of local knowledge. It is a matter of balance between local interests and the wider public interest;

3. As ecosystems are not closed systems, but rather open and often connected to others, ecosystem managers should consider the impacts of their activities from local to broader scale;

4. Many ecosystems provide for human beings economically valuable goods and services. Because often those who benefit from conservation do not pay the costs associated with conservation and, similarly, those who generate environmental costs such as polluters escape responsibility, alignment of incentives should promote biodiversity conservation and sustainable use;

5. The priority target of the Ecosystem Approach should be the conservation of ecosystem structure and functioning and if necessary its restoration in order to maintain for the long-term the ecosystem goods and services;

6. Ecosystems must be managed within the natural limits of their functioning. Attention should be given to the environmental conditions that limit natural productivity, ecosystem structure, functioning and diversity, through an appropriate cautious management in order to preserve a sustainable ecosystem;

7. The Ecosystem Approach should be undertaken at the appropriate spatial and temporal scales in order to address issues relative to the dynamic character of ecosystems;

8. The ecosystem management should require a long-term vision because of the varying temporal scales and lag-effects that characterize ecosystem processes. Ecosystems goods and services should not be perceived as short-term gains;

9. Management must recognize that change in the ecosystem is both natural and inevitable and must utilize adaptive management in order to anticipate and cope with such changes being cautious in remaining opened to different options;

10. The Ecosystem Approach should be balanced between conservation and wise use of ecosystem goods and services;

11. The Ecosystem Approach needs to be catered and thus it should consider all forms of relevant information such as scientific, indigenous and local knowledge as much as innovative practices;

12. The Ecosystem Approach should involve all relevant sectors of the society and scientific disciplines at all levels; local, national, regional and international.

Though its principles are very attractive, their implementation raises some serious concerns. To this end, the IUCN has undertaken many initiatives to make the EBM strategy operational, particularly in merging five steps bringing together the 12 principles:

1. Area and key stakeholders (principles 1, 7, 11, and 12)
2. Ecosystem structure, function, health and management (principles 2, 5, 6, and 10)
3. Economic issues (principle 4)
4. Adaptive management over space: impact on adjacent ecosystems (principles 3 and 7)

5. Adaptive management over time: long term goals, flexible ways of reaching them (principles 7, 8, and 9).

Whatever the process implemented to achieve the EBM approach, its principles and main rules are similar, particularly the need for information, and accordingly the involvement of scientists to feed the process. Moreover, because EBM is a management tool, it entails several necessary procedures like:

- The participation of all stakeholders in order to share both the onus of the decisions and the potential benefits derived from good management practices;
- A technical mechanism to inform all stakeholders in a transparent way;
- An adaptive ("learning by doing") process based on feedback provided from monitoring (once implemented);
- A communication tool to seek for consensual decisions or fair decision-making process;
- The use of the Precautionary approach built on the Risk Management Framework (RMF) which enables a risk assessment within a risk matrix and leads to mitigation measures if necessary.

Operationalizing the EBM approach entails the implementation of several steps, chronological most of the time, and simultaneous as well in specific cases. Once the area and stakeholders identified thanks to overlaying geological, biological and social and administrative considerations, the State-of-the-Art in terms of knowledge, based on the best science available and the traditional and local ecological knowledge should be issued. Therefore, the identification of ecosystem and/or conservation objectives could be set. This part of the analysis represents the top-down (ecosystem-property based) process. Once these tools set, activities, actual or on projects, are addressed to assess their impact on the ecosystem attributes; it is the bottom-up process (activity-based) and both have to merge and comply with ecosystem attributes (see Figure 1).

Once ecosystem objectives set, functionally important areas identified, activities can be planned and/or assessed if already existing. Aquaculture site selection often raises problems because much of the time this space is already used for other activities. Moreover, aquaculture needs (ecological as well as practical and operational ones) are specific and limit the space availability. When it is possible, it is better to devote specific areas to aquaculture, which is cost-effective as well for managers as for producers; however this practice is limited by the Carrying Capacity of the site, and depends on the level of technology available. From the financial and investment point of view, there are thresholds (minimum and maximum) that can help guide aquaculture site selection and assess the number of farms.

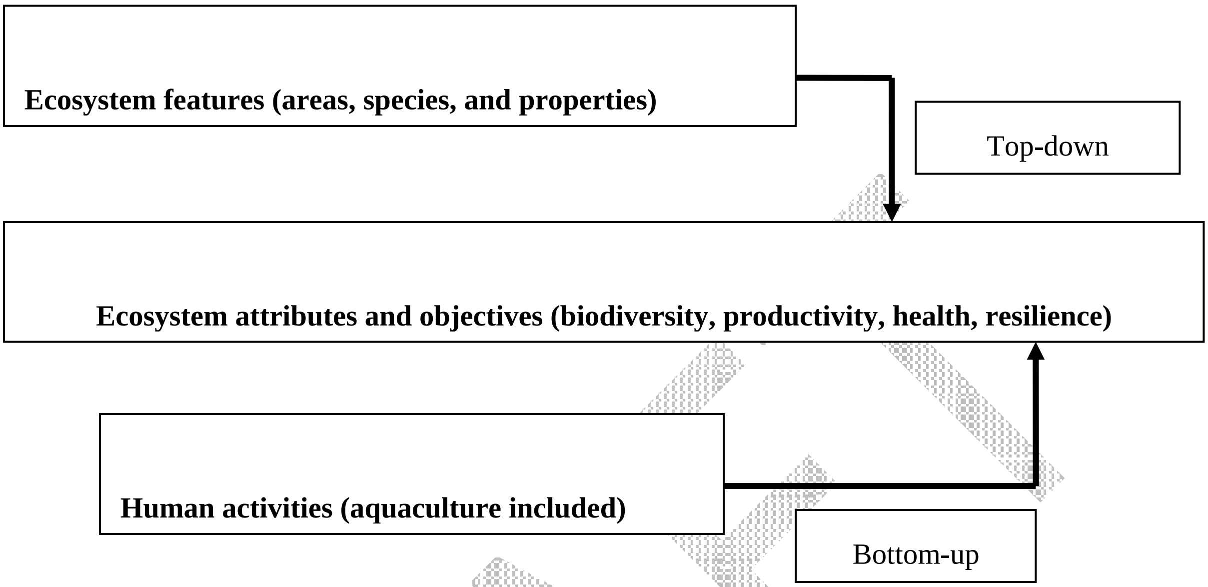

Figure 1: The Top-down and Bottom-up processes of the EBM approach

It doesn't seem very realistic to undertake a large aquaculture planning process for many reasons; first of all, doing that way can lead to conflicting situations with other users, especially when for strategic reasons there may be stronger imperatives (such as military or energy providers, harbors managers) or historical reasons, such as fisheries; moreover, some activities are better supported by the public and can develop detrimentally to aquaculture, such as tourism. All those approaches are valid but can difficult the aim of the project.

From this point, it seems more relevant to plan aquaculture sites using other arguments such as the value added or the lesser harm to the ecosystem, especially because aquaculture can also improve the quality of a specific site and increase its value. Indeed, these considerations refer to the Principles of the CBD related to the cost-effective decision. Accordingly, aquaculture site selection can be carried out in many ways, with the most important being that managers have to check compliance with ecosystem requirements, specified with sustainable objectives. Thus, any solution is welcome as soon as ecosystem objectives are set and achieved, because the maintenance of the ecosystem is a global interest.

Conclusion

The EBM approach is becoming incontrovertible as classical compartmental marine management fails. It is however critical to understand EBM is not merely a way to protect some ecological features (though that would be enough to justify its use), but it is becoming a way to optimize objectives and achieve sustainability. The EBM framework is useful while data is available. In this context, one important issue is the nature of information and its format, in order to be able to merge many sources of information. Most of the time, information provided is a blend of quantitative and qualitative data, and it seems easier to modify in semi-quantitative variables, because precision within the quantitative data is not mandatory and more often tricky and oftentimes illusory.

Addressing aquaculture in a sustainable fashion can be difficult because it is usual to have no room available for new activities in a busy marine and coastal environment. EBM ensures a voice for the aquaculture industry, placing them on the same level as all other aquatic practitioners, and links the interactions between land-based and marine activities, at the watershed level.

The EBM approach will certainly lead to improved management and reducing footprint of human activities; besides, it is the best way to involve local communities and make them more responsible for their future.

Justification

EBM is a strong tool which takes into account every human activity including aquaculture, due to their possible impact on the ecosystem which can be strong or light and therefore need to be assessed. Moreover, aquaculture becomes an integral user of environment goods and services and its development depends on the health of the aquatic ecosystem: the more the ecosystem is healthy, the more aquaculture can thrive. This may mean that aquaculture, when well managed, not only can serve to provide protection to the ecosystem but to improve its status and increase the overall value added of the ecosystem.

Accordingly, the EBM approach is not a frozen dogmatic framework to protect useless ecosystem components, but on the contrary, it is a living process that enables people to live and benefit from ecosystems.

Principle

Site selection and site management should be addressed from an Ecosystem-Based Approach to Integrated Management.

Guidelines

- **Site selection and site management in Ecosystem-Based Approach to Integrated Management should be based on cause-and-effects relationships between stressors, namely the activity, and impacts to inform on the state of the ecosystem. A**ssessment tools such as Pathway of Effects or Cumulative Effects can help managers to propose mitigation measures or modifications of the activities that impact negatively the conservation objectives of the ecosystem.
- **Ecosystem-Based Approach to Integrated Management is a management tool which should be implemented at all scales, from local to international, without undergoing changes.** The Ecosystem Approach is a space-based strategy taking into consideration environmental and socio-economical aspects with the aim to promote conservation and sustainable use of the ecosystem in an equitable way..
- **Aquaculture site selection and site management should be focused from the Ecosystem-Based Approach to Integrated Management, once the top-down process carried out.** This will ensure the ecosystem attributes and objectives relative to biodiversity, productivity, health and resilience and therefore the sustainable development of any activity depending on it.

Ecosystem-Based Approach to Integrated Management as a strategy

Operational framework

Implementing an EBM approach entails providing management tools, i.e. social and economical tools, based on ecosystem considerations. Both aspects should be addressed concomitantly but in two separate sets, with bridges and connections between the ecosystem and socioeconomic features (including cultural considerations). The summary of the process is explained on Figure 2.

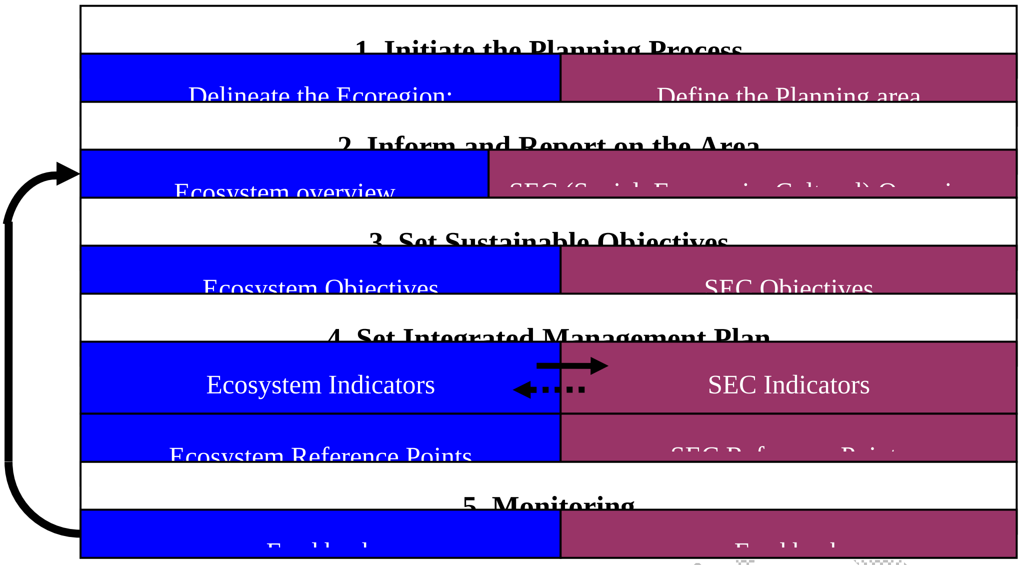

Figure 2: Main steps of the EBM approach

1. Initiate the Planning Process

Decision-makers initiate the EBM process because there is a need to consider all activities that are going on in a specific area and address the interactions therein. Once the decision has been made, this starts the spatial process based on scientific principles (geological, geographical, and ecological criteria) that allow the identification of ecoregions. These ecosystem units are further divided in management units which overlap administrative boundaries.

Once delineated, ecoregions limits or part of them, have to fit administrative and management boundaries. For this purpose, the most important criteria are the continuity of ecological (physical, chemical, biological) processes in one hand and the ability to share information for management on the other hand.

2. Inform and Report on the Area.

Informing and reporting is a specific scientific task in nature, including any additional knowledge as traditional or informal knowledge. All information collected would be summarized on a Report containing:

- Geological, biological and ecological characteristics of the area;
- Human activities that impact the marine ecosystem, including aquaculture.

The Report table of content is a guide to inform the EBM process on how to set up the information in order to describe ecosystem features and discuss environmental issues that may be observed in a given ecoregion. It should be adapted according to the study area. From the information gathered, the ecosystem state is assessed. However, the informative process is generally lengthy and some areas need more urgent conservation measures. To this end Marine Protected Areas (MPAs) can be established prior to any supplementary investigation to protect endangered species and its habitat or specific functions of the ecosystem (spawning grounds or spaces, growth areas, migratory routes). As well, particularly interesting areas can receive a specific protective status using the MPA framework straightaway (that doesn't mean there won't be any human activity, but because of their ecological interest, these areas will be managed in a more stringent manner).

The same process is undertaken to identifying Significant species which play a particular ecological role (forage species, nutrient importers/exporters, iconic species). The ecosystem descriptors that would be used for this are the ecological indexes, supported by scientific ecological knowledge.

The most important goal at this stage is to identify particular areas and species that play a critical role within the ecosystem (see Figure 3). Once these areas and species identified, those that continue to be of environmental concern will perhaps deserve further particular attention (Areas of Concern, Species of Concern).

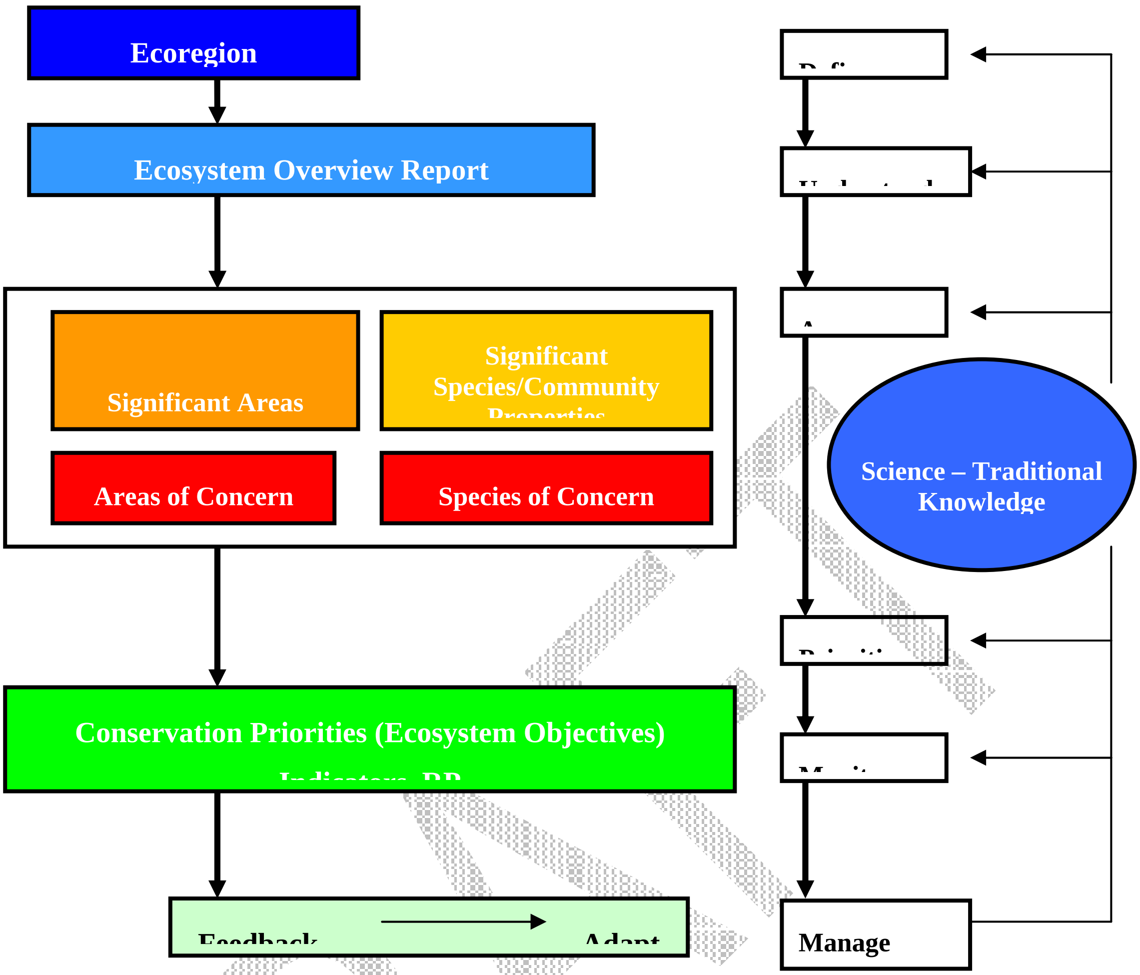

Figure 3: Main tools to implement the EBM approach related to ecosystem

Rather than focusing on quantitative parameters, the process is based on qualitative assessment of the importance of each parameter. This procedure introduces a high subjectivity and variability in scoring a given area; indeed, it aims to achieve a consensus between practitioners and other interest groups - whoever they are, scientist, local communities having a traditional knowledge, decision-makers aware of the stake. Finally, using a rate varying between low and high can help reduce uncertainty, each criteria being scored a semi-quantitative variable. However, this approach entails first weighting each parameter.

3. Set Sustainable Objectives

Once these particular and priority areas are identified, the following step will address the establishment of Ecosystem (or Conservation) Objectives. Though this step of establishing objectives will certainly be based on scientific knowledge, it would be relevant to include social and economical considerations at the same time. However, merging ecosystem and social/economic considerations is still difficult and pending the provisions of such tools, the setting will be carried out separately; founded on the modern and traditional available knowledge, setting conservation objectives is a critical step to further address sustainability.

Conservation objectives are comprised of three main ecological themes:

- Biodiversity, to conserve sufficient ecosystem components (coastal landscapes, habitats, species, populations, genetic features) so as to maintain the natural resilience of the ecosystem;
- Productivity, to conserve each component of the ecosystem so that it can play its historic role in the food web;
- Ecosystem characteristics, to conserve the physical and chemical properties of the ecosystem.

Indeed, those themes will be addressed at several levels, from the large-scale as landscape/seascape down to local habitats.

Once objectives have been set, Indicators and Reference Points should be established to validate the process in a way the Risk Management Framework should be applied to reduce uncertainty caused by natural variability within the ecosystem, taking into consideration indirect causes of ecosystem-level change, particularly climate change as well.

Impacts of aquaculture on the aquatic environment are well known (Interactions between Aquaculture and the Environment, IUCN, 2007) and certain aspects related to the effects on biodiversity, substratum characteristics, and water quality should be revised as well as the food supply from fisheries and the species balance. Aquaculture that rely on reduced (of concern, threatened or collapsed) aquatic resources cannot be considered sustainable. Food ingredients in aquaculture are the most often provided by fishmeal, produced in some cases in an unsustainable way. This unbalanced situation in not acceptable, unless species used as food for fish aquaculture are not consumed otherwise. In other words, aquaculture must be a value added for capture fish that are not directly targeted by the market.

Addressing cause and effect relationship

Many ways and methods have been explored to address cause-and-effect relationships between stressors and impacts. The main tool is the Driver-Pressure-State-Impact-Response DPSIR model (see Figure 4). It is a complex model addressing many stressors at the same time, but it needs a large supply of information and therefore it is difficult to manage. For that reason, it would be better to use other tools likely lesser powerful but stronger enough to inform on the state of the ecosystem such as the Pathway of Effects (PoE) which will standardize the process and thus lead to the same conclusions for any given activity. PoEs identify the impact of human activities using three levels. The first level describes the activity responsible for the effect; the second level refers to the stressor, while the final level relates to the impact. To address cumulative impacts a fourth level is added, merging several pathways having the same impacts. The PoE model is a part of the Risk Management Framework. At this stage, it becomes critical to carefully engage all stakeholders and define procedures to share the information and the burden of the proof.

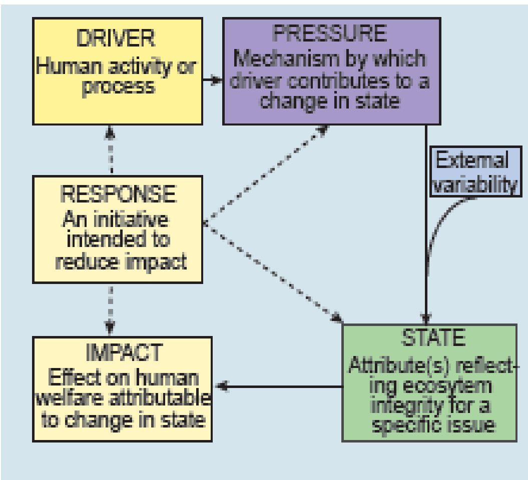

Figure 4: DPSIR model

4. Set Integrated Management Plan

This step is both technical and political at the same time. Once impacts have been assessed and solutions identified, the contribution and the support of all stakeholders since the beginning is critical, without which the policy options cannot be implemented. In this context, the following general principles must be applied (see referred chapters):

- Participative Approach
- Adaptive Approach
- Social Acceptability
- Scale Approach
- Use of Knowledge
- Governance Principle

Implementing an integrated management plan will depend on the current situation and frameworks developed by each region/state. There is no unique solution, and the process must melt with existing settings and use them as a support mechanism.

5. Monitoring

The following steps will focus on the monitoring and ways to adapt the process to the actual evolution of the ecosystem.

The main issue at this time is to link the ecosystem process to the social, cultural and economical aspects. Much work remains on this field to build bridges between the two sets to make them consistent. Ideas related to this field are still in development, and the process is even a little bit delayed. Some decision-makers would like to focus on cultural considerations while other would favor to give more importance to economic and marketing issues. The way that seems suitable is wider and refers to societal considerations. Accordingly, there is a need to come up with synthetic indicators and reference points, such as the Human well-being indicator. Moreover, connection between society and ecosystem will involve a specific measurement provided by the ecological footprint.

To be efficient, monitoring will have to comply with two main requirements:

- Ensure a feedback from management measures already implemented;
- Draw a framework allowing adaptive management, i.e. forecast procedures to make adaptive management operational (who does what? When? What are the triggers that initiate the process? Who will responsible for? How to consult? How long? How often?).

Site Selection and Aquaculture Management within the Ecosystem-Based Approach to Integrated Management framework

Aquaculture is addressed within the EBM process using the bottom-up process. The main spatial management tool used in aquaculture is via bay management (spatial planning) and the search for oceanographic and biological information of a specific area suitable for aquaculture has been focused from the marine culture point of view, looking at those optimum parameters that allow the activity to be developed. Therefore, the focus has to be shifted from the aquaculture point of view to the ecosystem one.

In order to include aquaculture on the EBM framework, some steps should be taken into account, particularly:

- Merging of all aquaculture activities within the EBM spatial ecosystem unit;
- Including interactions between aquaculture and other human activities;
- Addressing interactions between activities and their cumulative impacts on a specific area/objective.

The main challenge to fit aquaculture management areas within the EBM framework is a matter of spatial scale. That doesn't mean only the broader scale, but also implies implementing aquaculture management tools compatible with the Ecosystem Report, based on ecosystem properties and how they are potentially impacted by aquaculture.

Decision-makers can devote a specific area to aquaculture, based on the Ecosystem Report, once Ecologically Significant Features (areas and/or species) protected. Nevertheless, though aquaculture needs planning, site selection should include other considerations, and especially mechanisms to merge different activities in a complementary way. Achieving a balance between activities in terms of spatial use and synergetic strengths remains critical for successful planning. The PoE or more broadly the DPSIR model can help more meaningfully at this stage. The aim of the exercise is to address ecosystem objectives in the context of aquaculture itself (See table).

Aquaculture site selection often raises problems because much of the time the space required to the activity is already used for other activities. Moreover, aquaculture needs (ecological as well as practical and operational ones) are specific and limit the space availability. From a planning standpoint solutions are many and the principle held is based on pragmatism. When it is possible, it is better to devote specific areas to aquaculture, which is cost-effective as well for managers as for producers; however this practice is limited by the Carrying Capacity of the site, and depends on the level of technology available. From the financial and investment point of view, there are thresholds (minimum and maximum) that can help guide aquaculture site selection and assess the number of farms.

It seems not very realistic to undertake a large aquaculture planning process for many reasons. First of all, doing that way can lead to conflicting situations with other users, especially when for strategic reasons there may be stronger imperatives (such as military or energy providers, harbors operators) or historical reasons (such as fishers). Moreover, some activities are better supported by the public and can develop detrimentally to aquaculture, such as tourism. It could be more relevant to plan aquaculture sites using other arguments such as the value added (in terms of sustainability for instance), or the lesser harm to the ecosystem, especially because aquaculture can also improve the quality of a specific site and increase its value. Accordingly, aquaculture site selection can be carried out in many ways, with the most important being that managers have to check out compliance with ecosystem requirements, specified with sustainable objectives. Thus, any solution is welcome as soon as ecosystem objectives are set and achieved.

Ecosystem-Based Approach to Integrated Management EBM is a management strategy that helps managers to achieve and comply with sustainability; it helps proponents to figure out how to set their activity while they merge ecosystem and technical requirements. For the latter, there are many guides and manuals to inform investors.

EBM Objectives	**Aquaculture issues**	**Ways of investigation**
Productivity	Larvae and juveniles from the wild	This practice is common for species that are not artificially reproduced; the principle is to harvest a negligible amount comparatively to natural mortality which is very high at early stages, which is not the case for cultured tunas fished at later stages.
	Adults from the wild	Harvesting adults can raise concerns, and this technique is allowed only when the species are not threatened, except when it is for recovery purpose.
		Other considerations have to be taken, from genetic standpoint to balance genetic diversity between different populations/stocks.
	Food ingredients	Most of the food provided for aquaculture comes from fisheries. Because fisheries harm several species, aquaculture wouldn't be sustainable if it worsens the situation. This matter relates partially to the socio-economic regulations that can influence the demand.
		Sustainable aquaculture needs food diversification to reduce the pressure on fisheries; and sustainable aquaculture implies sustainable fisheries.
Biodiversity	Escapes and genetic issues	Domestication represents the best answer to avoid risk of genetic pollution. The aim is to produce sterile and/or hybrid or domesticated species that are not able neither to cross with wild species nor to survive into wild environment.
	Non native species	This concern can be addressed different ways, depending on the current situation of the area. If the new species can provide a value added while using an ecological niche which is available (for various reasons), then the introduction would be acceptable under some stringent conditions. If species introduction are unintentional and harmful for the ecosystem (invasive species for example), all means to fight against them in a sustainable way will be required. In all cases, previous quarantine is mandatory.
	Therapeutic products	The use of therapeutic products can lead to loss of biodiversity; they can make some populations more vulnerable to pathogens and pollute other links of the trophic network

		Several avenues are currently under investigation, and more science is required.
Habitat	Effects on the substratum	Cages and other rearing devices alter the substratum in different ways. The shadow coming from the net divests the area from light and leads to a damaging cascade effects. This matter is very local and relates to Carrying Capacity as well. Spatial planning taking into account Ecologically Significant ecosystem Features helps meaningfully avoid this matter.
	Anti-fouling products	Anti-fouling and other chemicals have local effects than can spread along the site. Alternative products and quantities related to Carrying Capacity can represent solutions.

Table 1: Examples of relationship between aquaculture issues and Ecosystem Objectives

Examples of cases studies

Once ecosystem management tools are identified, the next step should address actual cases for validation purposes. To this end, two different case studies have been chosen in the Mediterranean. The objective was to check whether the EBM approach could be implemented in the specific situation of South Mediterranean Sea. A survey has been carried out to test the feasibility of the study, describing the situation and the settings that could support the EBM framework. Two countries with very different site-specific situations have been selected to this purpose:

- Algeria, an emerging country in terms of aquaculture potential; this case study will specifically target marine mollusks and fish;
- Egypt, a country with a strong experience in finfish aquaculture, especially in brine and freshwater ponds.

Cases studies

According to the production trends, aquaculture will likely exceed fisheries over the medium to long term. However, in order to thrive, aquaculture will have to address some serious growth and cross-cutting issues related to its environment. Since 2002, fisheries and aquaculture management has evolved to an integrated view, so as to take into account the other activities, the non-targeted species, and the ecosystem as a whole, commonly called "Ecosystem-Based Approach to integrated Management EBM". Although this was defined by the United Nations Convention on Biological Diversity (CBD) in 2000, this management strategy still raises several interpretation and application issues. The IUCN Commission on Ecosystem Management (CEM) drafted a document, including 5 steps, in order to help to the implementation of this approach which has lacked so far practical assistance in applying Ecosystem Approach in the field.

In the frame of the CBD, the IUCN Center of Cooperation for the Mediterranean has undertaken an analysis to assess two different aquaculture situations in North African countries (Triangle Area - Egypt and Wilaya of Tipaza - Algeria), in order to validate the Ecosystem Approach for aquaculture, based on the implementation of the theoretical method. Algeria is still an emergent country concerning this activity while Egypt benefits from a traditionally well developed aquaculture. This study should assist stakeholders in improving and/or setting up a more robust management framework in order to shift to a consensual approach between activities, based on charge capacity, from biological, social, economic and knowledge standpoints. Funded by the Spanish Agency of International Cooperation for the Development (AECID) through its Nauta Programme, this project would contribute meaningfully to prepare guidelines and management tools to implementing the EBM.

The results obtained during the two field studies and the two workshops in Egypt and Algeria were classified according to the methodology previously identified and set.

The stakeholders were identified and sorted out according to their relation with the ecosystem. The assessment of their management capacities and their relative motivation in relation with the ecosystem pointed out that the two regions suffer from a lack of communication between the stakeholders and the absence of scientists and civil society implication. Land planning issues have also been raised, several land-tenure conflicts (tourism, agriculture, fisheries and aquaculture in Algeria; urbanization, road and port facilities and aquaculture in Egypt) and an inappropriate planning hamper seriously the sustainable development of aquaculture in the region. Thus, the setting of a stakeholder's forum will enable to make management decisions sustainable.

The delineation of the ecosystem includes partially geological, physical chemistry, biological and ecological considerations while socioeconomic and administrative limits outline the management area. However, the case studies have shown that the ecosystem limits don't fit administrative limits. If only these limits were taken into account, some essential components of the ecosystem functioning (for instance, incomplete hydraulic system) don’t benefit from a coherent management analysis. The harmonization of the management structures seems necessary, even compulsory within the ecosystem.

Concerning the relation between the stakeholders and the area, the role of each stakeholder in relation with the management of an ecosystem subsection should be clarified beforehand. Identifying the ecosystem structure and function constitutes the second step of the method. The lack of information on the ecosystem, the activities (particularly aquaculture and fisheries production, resource assessment) and the lack of socioeconomic data, especially in Egypt, has been underlined.

In order to set up a management system, it’s necessary to involve the different ministries and to support all the actions at local level. Concerning the ministry of environment, a protection programme of the area should be defined with identification of conservation objectives and including concrete mechanisms (for example, definition of a programme to improve the Triangle hydraulic in Egypt). They should establish cooperation with fisheries ministry. A resource and production assessment has to be led by the ministry of fisheries. In Algeria, the procedures to have access to a concession should be simplified and in Egypt, the development of hatcheries should be fostered to limit the pressure on wild resource. The ministry of tourism should collaborate with the ones of environment and fisheries to solve land planning problems. In both cases, transparent processes leading to decision-making deserve a strong improvement.

Concerning economic issues, subsidies granted by these countries benefit fisheries and are detrimental to sustainable development. Moreover support programmes, financial monitoring, investment security within aquaculture activity are indigent and should be improved. The information available on the internalization of the costs and benefits within the ecosystem is not sufficient to conduct a complete analysis.

The adaptive management over space is essential within the two regions; management should take into account the functioning of the ecosystem as a whole (harmonization of decisional structure within the ecosystem). The adaptive management overtime, although already implemented within the activity, will be efficient following the launching of the ecosystem-based management approach.

Thus these two cases studies enabled to validate the method; nevertheless some criticisms could be expressed concerning the setting of the method and its implementation. The definition of the stakeholders could be undertaken in relation to the studied area. The case studies have underlined the importance of specifying the limits of the ecosystem first, followed by that of the management area, and then taking into account the stakeholders interacting with the area. Moreover, the definition of the stakeholders and the area requires an important work in terms of identification of the stakeholders, and the understanding of their respective role in the management of the area. In order to apply this management method, it is necessary to establish structures which enable the representation of the stakeholders. The structural deficiency should be mitigated through the support of this operation.

P. Carrying Capacity, Indicators and Models

This guide provides definition and tools for Carrying Capacity measurements. Different dimensions and meanings of Carrying Capacity are given, as well as criteria and variables to be used. Examples and models are proposed and guidelines related to site selection and site management for the sustainability of aquaculture are provided.

Environmental Carrying Capacity may be defined as the maximum numbers of animals or biomass that can be supported by a given ecosystem for a given period of time. The term "Carrying Capacity" is often used in the context of coastal management or planning, with regard to human activities such as industry or aquaculture. In the case of extractive shellfish aquaculture which relies on natural resources such as micro algae to feed the shellfish, this term is appropriate.

However, when considering other forms of aquaculture, such as finfish cultivation in net pens, which provides allochthonous food to the farmed organisms, it is more accurate to speak of "holding" rather than "carrying" capacity. In such cases our concerns focus on the ability of the environment to absorb and assimilate excess loading of organic compounds and nutrients. If the receiving environment cannot efficiently 'metabolize' or assimilate the load of nutrients and organic matter, we observe negative effects, for instance deterioration in water or sediment quality that may jeopardize the integrity and health of the ecosystem.

A recent assessment of the sustainability of bivalve farming by McKindsey et al. (2006) established the following break-down of "carrying capacities":

- Physical Carrying Capacity: the total area of marine farms that can be accommodated in the available physical space;
- Production Carrying Capacity: the stocking density of bivalves at which harvests are maximized;
- Ecological Carrying Capacity: the stocking or farm density which causes unacceptable ecological impacts;
- Social Carrying Capacity: the level of farm development that causes unacceptable social impacts.

Speaking in term of “unacceptable impacts” implies that it is something that is defined by policy makers rather than by scientists, and some arbitrariness is to be expected. In order to minimize the arbitrariness, there is a need to achieve consensus between stakeholders’ parties and among countries in order to ensure harmonization with respect to acceptable aquaculture impacts across the Mediterranean.

One way to define acceptable impacts is by establishing criteria and variables to be used for estimating carrying and holding capacity. In this case, some of the most difficult issues that need to be considered include:

- The ecological component of Carrying Capacity, that’s to say what are the unacceptable ecological impacts. A series of environmental variables like low Oxygen in the water (hypoxia), high Chlorophyll a or particulate Organic Carbon (eutrophication) as well as damage to important habitats or species.One example includes the use of “exclusion criteria” such as protected habitats or species, for example *Posidonia oceanica* meadows (distance > 800m) or maerl beds as well as activities that could be harmful for aquaculture causing occurrence of harmful algal blooms (HABs) or polluted sites;
- Cumulative effects of aquaculture farms in water bodies or coastlines of limited space;
- Synergistic or antagonistic effects with other uses or other sources of nutrients;
- Unbalanced regulation, using, for example, a rigid regulation to reduce nutrient emissions from aquaculture in areas where it contributes a minor proportion of the total nutrient discharge.

Another approach that has been tested in Greece is to use variables related to the characteristics of the receiving environment as:

- Depth (minimal effect on fragile coastal ecosystems);
- Openness/exposure (maximal water renewal and removal of wastes);
- Distance from shore (minimal conflict with other users of the coastal zone).

Moreover, we could use variables related to environmental quality/standards such as primary production levels, sediment oxygen levels or the status of benthic communities and compare measured values to established threshold values to determine when the impacts of the activity cause “unacceptable” effects. Examples of this last approach include, for instance, standards of the EU Water Framework Directive (WFD).

The role of environmental and coastal managers is to plan human activities so that the risks of unacceptable ecological, social and economic impacts to the environment of concern are minimized. One of the tools that have been developed to help managers protect the environment is the Environmental Quality Standard (EQS). These standards are generally concentrations in the environment for certain compounds, beyond which unacceptable effects are expected not to occur. Some standards are legally enforced limits, such as “List 1” chemicals under the Water Framework Directive, whereas others are specified in guidelines and codes of practice. Most Mediterranean countries have currently no specific EQSs for marine aquaculture.. Furthermore the use of EQS is still problematic because they are locally disputed and thus, as an alternative, standards of the Water Framework Directive could be employed.

One of the first steps towards development of environmental standards is the selection of indicators of environmental status. Ecological indicators are quantifiable variables that enable us to assess changes in habitat characteristics and ecological function and structure. Indicators may also be used to characterize the effect of the environment on aquaculture, as well as social and economic changes related to aquaculture. An examination of the commonly used indicators in European aquaculture was undertaken in the EU FP6 project ECASA in order to establish which of these are most useful and practical for managers and for aqua culturists. The ecological indicators consisted of variables that characterize the status of the water column, sediments and benthos, whereas the socio-economic indicators dealt with various public preference and site selection issues.

Indicators provide useful information on the status of the environment before, during or after an event such as the start of the aquaculture growing cycle. Because there is often bias in the use of indicators, it is recommended to use several different indicators to describe the impacts on the marine environment. Indicators are therefore very useful in monitoring programmes that continuously probe the state of the environment.

If we want to assess the suitability of a site for aquaculture, we need to predict potential future impacts of the planned activity and for this, we need to employ models. Validated models can predict future conditions without any further measurements since they have been field tested before use. Models are increasingly more flexible and precise, mainly due to increasing computer power, but their quality and applicability depends on the validity of the underlying assumptions and testing across a large range of environmental conditions. Using both indicators and models greatly increases the ability of scientists, regulators, producers and environmental consultants to carefully assess the potential impact of new aquaculture operations, to characterize and evaluate any actual impact, and to define areas where the impact of marine aquaculture could minimized.

Indicators have also been developed for other purposes. CONSENSUS was a European project dedicated to the sustainable development of aquaculture in Europe. Its strategic objective was to demonstrate to consumers the benefits of high quality, safe and nutritious farmed fish and shellfish grown in sustainable conditions. This analysis led to the production and assessment of a list of 78 indicators for sustainable aquaculture, including economic viability, public image, resource use, health management and welfare, environmental standards, human resources and finally biodiversity.

Example of models: ECASA

Benthic macro fauna is the traditional measure of benthic impact; yet it is time-consuming, expensive and requires skill/experience to identify quantitatively. Thus, considerable effort has been invested in an attempt to identify simple, universal biogeochemical sediment indicators that may be used as a proxy. In some cases (e.g. Greece, Israel) the concentration of organic matter in the sediment has been successfully used to indicate the ‘degree’ and spatial extent of fish farm impact, but in general, most countries require macro benthic as well as geochemical indicators to be determined for monitoring purposes.

In the ECASA project data were collected at 58 stations including biological variables (abundance or species richness), location variables (current velocity, depth, distance to the cage or latitude), sediment variables (grain size, redox potential or Total Organic Carbon TOC), and farm activity (years of functioning and production). The most important factors explaining variability in biological indicators were those related to the activity of the farms (production, years operating, distance to the cages) and the hydrographical characteristics of the area (current speed, water depth); these factors together explained 29% of the variability for all locations.

When these factors were analyzed together with the sediment characteristics (grain size, redox, TOC), this explained 21% of the variability; whereas sediment alone explained only 5% of the total variability. Hence, the selected biological indicators represent well the extent of the impact of aquaculture, although it is important to consider the high percentage of unexplained variability (45%), which is probably due to intra-site specific characteristics that were not studied in this project.

Water column indicators

Although the full list of water quality indicators was longer, the four indicators evaluated at nine ECASA Study Sites, were ammonium, reactive phosphorus, Chlorophyll a (Chl a) and Secchi disk depth, used primarily as an indicator of phytoplankton abundance/biomass. These 4 indicators did not provide conclusive evidence of the impact of finfish and shellfish farms and, in particular, about potential adverse effects on the pelagic ecosystem. Monitoring of ammonium and reactive phosphorus provides evidence on average of nutrient enrichment near the farms. However, deviations of Chlorophyll a and Secchi disk depth from the reference values observed at those sites were not correlated with those of the nutrients.

Several previous studies have failed to find clear links between local primary production and water column nutrient concentrations. In many cases this is because the timescale of biological response is greater than the residence time of the receiving water body. This therefore leads to broader scale considerations and cumulative effect assessment and this is best considered by models.

However, models require validation data and we do not therefore suggest that collecting data on water column indicators has no value but rather that the objectives in collecting such data need to be clear. From the fish/shellfish health perspective, water column oxygen concentration is clearly a key indicator which is routinely measured at many culture sites.

Therefore, data collected within the ECASA project suggest that nutrient enrichment is not correlated with high phytoplankton concentration in the "impacted" areas, as also demonstrated in various other studies (Pitta et al. 1999, 2006; Karakassis et al. 2001; Dalsgaard and Krause-Jensen 2006; Sara 2007). Instantaneous sampling and measurements do not enable monitoring of nutrient fluxes, and in the case of nutrients released to the water column from point sources, the flux is more important than the "standing stock" nutrient concentration.

To get around the shortcomings of the standard methods, Dalsgaard and Krause-Jensen (2006) devised a method to assay the flux of nutrients and their potential impact on local algal populations. This 5-day "bioassay" was employed at several of the ECASA study sites to study the nutrient fluxes emanating from the aquaculture activity. In all cases, there was a very significant increase in concentration of Chl a over the 5 day incubation, as compared to initial values (in sharp contrast to most findings which show practically no difference in standing stock of phytoplankton around or away from fish farms), and at most sites, there was a clear decrease in concentration of Chl a with distance from the point source (farms) corresponding to a reduced flux of nutrients.

Justification

The industry strives to increase the size of fish farms in order to achieve the benefits of the economy of scale. Under the present status of knowledge it is not safe to assume that a change in the scale of development will be environmentally acceptable, socially equitable and economically viable, as defined for the "sustainable development of aquaculture". Thus, there is a need to establish criteria for maximal aquaculture production at each site in order to avoid degradation of the marine environment, and particularly the coastal zone which is already under considerable human pressure in most parts of the world. However, at the moment there is little consensus as to what these standards should be for Mediterranean aquaculture.

Principle
Operational measurements of Carrying Capacity should be taken into account for aquaculture site selection and site management in order to allow sustainable use of marine resources.

Guidelines

- **Carrying Capacity of all measurable parameters should be considered in site selection and site management.** In order to achieve sustainable development of aquaculture it is important to consider the environmental, social, physical, production and Economic aspects of the activity.
- **Evidences of limits of Carrying Capacity should be avoided.** Aquaculture requires good water quality for its implementation, polluted sites or areas with frequent occurrence of harmful algal blooms or oxygen deficits should be avoided**.**
- **The aquaculture activities should adjust their production to the Carrying Capacity of the local environment.** Each ecosystem has a different capacity to absorb and assimilate excess loading of organic compounds and nutrients, therefore low production should be in shallow, near shore and sheltered areas and, increased production in deep, offshore exposed sites.
- **Even in the case of the most favorable environmental conditions an upper limit of production per farm should be established.** Revision of limits should be supported by intensive and regular monitoring, providing sufficient evidence that this maximum production level does not cause irreversible adverse impacts.
- **Assessment should be made for the maximal allowable proportion of space that could be used for aquaculture in each water body taking into account other uses and local wildlife.** Ecological and socioeconomic indicators as well as models and standards must be used to obtain the best possible integrated assessment of space allocation.
- **Consultation and dialogue should be encouraged among regulators, producers, scientists and relevant stakeholders in order to arrive at generally acceptable terms.** Establishment of common Environmental Quality Standards and regulations among the Mediterranean countries and regions will allow not only equal terms of competition but also a higher degree of environmental protection and an enhanced environmental profile of the aquaculture industry.

Models

Model name	Scale	Brief description
MERAMOD DEPOMOD AutoDEPOMOD	A	Particle tracking models used for predicting the impact of particulate waste material (and special components such as medicines) from fish farms and the benthic community impact of that flux. MERAMOD was developed for Sea bass and bream in Mediterranean farms, DEPOMOD and AutoDEPOMOD for salmon farms in the North Atlantic.
CSTT model	B	CSTT is a single-box model that predicts the maximum phytoplankton chlorophyll that can result from nutrient enrichment. CSTT refers to the UK 'Comprehensive Studies Task Team'. The model also exists in a dynamic version (dCSTT) using the same ACExR physical model as LESV.
LESV	B	Loch (fjord) ecosystem state vector model, a development of the CSTT model including oxygen and phytoplankton type and able to simulate seasonal change; includes a 3-layer physical model (ACExR) derived fro FjordEnv
ShellSIM	Ib	Dynamic model for feeding, biodeposition, metabolism, excretion, and growth among bivalve shellfish as a function of temperature, salinity, and sexton availability and composition. Bivalves include: mussels (*Mytilus edulis, M. galloprovincialis, Perna canaliculus*), oysters (*Crassostrea gigas, Ostrea plicatula*), scallops (*Chlamys farreri*) and clams (*Tapes philippinarum, Tegillarca granosa, Sinonvacula constricta*).
EcoWin	B, C	An object-oriented programming system for implementing aquatic ecosystem models, using a spatial (1D, 2D or 3D) framework of boxes, within each of which the relevant biogeochemistry and population dynamics can be resolved
FARM	A	A web-based model for modeling of shellfish farms in coastal and estuarine waters, including waste transport, shellfish individual growth for several species, population dynamics and dissolved oxygen balance. FARM makes use of the ASSETS procedure to assess environmental impact.
Long lines	B	Combined ecophysiology and box model for simulating growth of mussels reared in long lines
DEB	Ib	Dynamic Energy Budget model which can simulate individual organism's growth rate and reproduction as a function of varying food densities and water temperature.
DDP	Ib	Model to assess temporal variations in the

		demographic structure of the standing stock of oysters and mussels as a function of the mortality rate and the growth rate (represented by an empirical function of water temperature and food concentration) in the Thau lagoon.
Hydro	3-H: B, C	Solves the three dimensional Reynolds-averaged Navier-Stokes equations with hydrostatic approximation and free surface boundary condition. Density evolution is allowed and related to temperature and salinity variations through a state relationship. Horizontal computational domain is a regular grid.
TRIMODENA	3-H: A, B	Includes a 3D finite element hydrodynamical model for the numerical simulation of dispersive processes, and a 3D Lagrangian Particle Tracking model to simulate particle dispersion; both have been applied to maricultural pollution
EDMA	1-S	Uses BNRS (Biogeochemical Reaction Network Simulator, for organic decay and oxidation processes in sediment): a general programming environment made freely available by the Geochemistry Department of Utrecht University.
BREAMOD Tapes-IBM MG-IBM	Ib	Bioenergetic individual-based models that describe the growth of: Gilthead sea bream *Sparus aurata* Clam *Tapes phillippinarum* Mussel *Mytilus galloprovincialis* (somatic weight and gonadic dry weight)
KK3D	B	Particle tracking model used to predict the impact of particulate waste from fish farms including hypoxia on the bottom. Model has been parametrized for finfish.
FjordEnv	B	Three-layer model for fjord exchange parameterizing many physical processes and including simple pelagic biology and light penetration.
MOM	A	The MOM model can be used to calculate the holding capacity (TPF-Total Fish Production) of an area for fish farming containing four sub-models: a fish model, a cage water quality model, a dispersion model, and a benthic model.

Scales: A, B, C refer to spatial scales: A is local to the cage, B is water body scale, and C is regional. Ib is an individual based model, and 1-S and 3-H refer to 1-dimensional (vertical) sediment and 3-dimensional hydrodynamic models whose scale is to some extent set by the application

Resources needed to use a model

Developing and documenting a model is expensive. The following costs should be considered when planning to use a model for the purposes described in this toolbox:

1. Licensing costs - for computer programme used to run model. In some cases this programme is proprietary to ECASA partner institutions. In other cases the programme might be 'open source' but needs a proprietary software, such as Matlab (link) to run. Some of the ECASA models can be assessed through web sites, but a password may be needed;
2. costs of running the programme and interpreting the results: computing sosts negligible in most cases, but users may need to develope some skills in using the programme and model;
3. costs of obtaining and preparing the information on the 'specified conditions' relevant to the site or water body; detailed information on sea-bed topography (needed for hydrodynamical models), and boundary condition data, are often difficult or expensive to acquire;
4. Some of ECASA's models use standard software such as a spreadsheet or web browser, thereby minimizing costs 1 and 2; however there always remains the cost of getting the information needed.

Q. Environmental Impact Assessment (EIA)

This guide outlines the Environmental Impact Assessment as an essential tool to implement prior to approving aquaculture site selection and site management. It allows to ensure proper decision-making processes supported with precise data relative to the impacts of the activity and takes into account the socio-environmental acceptability of the project. It should be consistent with both sustainability criteria and best available practices.

Environmental Impact Assessment (EIA) is a decision-making process for reducing impacts on the environment resulting from human activities. It consists of identifying, predicting, evaluating, and mitigating the biophysical, social, and other relevant effects of development proposals prior to making major decisions and commitments[11].

EIA was introduced, and its requirements were formulated, firstly in the USA National Environmental Policy Act (NEPA) in 1969 (Fischer, 2003). Nowadays it is extended all over the world, in countries where different administrative and political procedures are followed, for most of the activities which are potentially harmful to the environment such as aquaculture, fisheries or tourism. The Strategic Environmental Assessment (SEA) is the term used to describe the environmental assessment process for policies, plans, and programmes (De Boer and Sadler, 1996).

In an EIA, decisions are supported with precise data and the socio-environmental acceptability of the project is measured. An EIA is implemented by making changes to: i) a project (private company); ii) activity plans (aquaculture regional/national planning); iii) a strategic action (national/regional/local strategy) or, if necessary, by preventing a project from going ahead at all.

For aquaculture, EIA is undertaken in most countries prior to approving a new aquaculture site or prior to increasing an existing one. The different objectives for the EIA in aquaculture

[11] Principles of Environmental Impact Assessment Best Practice (www.iaia.org)

are established by GESAMP (Group of Experts on the Scientific Aspects of Marine Environmental Protection, 1996), and include the following:

- Identify the positive and negative impacts, including direct and indirect impacts;
- Establish mitigation measures and ways to reduce negative impacts on all environmental, social and economical areas and all phases (installation of the farm, operation time or decommission time, in case the activity has been stopped);
- Identify residual impacts that can be neither corrected nor attenuated;
- Develop strategies to monitor the impacts;
- Aid site selection.

EIA is a process consisting of three stages:

- Screening, in order to filter the projects that need pass to the EIA process;
- Scoping, to define which risks should be assessed and in which terms, depending on any predictable environmental impacts and public concerns;
- Preparation of a written EIA report to produce the called Environmental Impact Statement (EIS), which will be reviewed by stakeholders and general public and followed by a phase of administration and/or independent entities overall review. The final decision-making will be done by the competent authority. The EIS should include a presentation of the environmental monitoring strategy and protocol that will be developed during the environmental monitoring of the production phase to ensure the assessment of risk has been effective.

EIA statement description

The Espoo Convention, signed in 1991, establish statements in their appendix as the minimum content of an EIA, which are listed below slightly modified and expanded:

- The purpose of the project;
- A technical description of the operation proposed: species, quantity, site description, staff, tools and infrastructure at land and sea such as mooring, cages or boats;
- A description of the possible process and operational alternatives which are relevant for the location and functioning of the activity;
- A non-technical summary;

- A description of the environment of the proposed project: geomorphology, currents, climate, wind, waves, sea grass beds and other natural habitats), transport and infrastructure, administration organisation, sensitive and environmental areas, as well as protected areas, existence of other aquaculture activities in the vicinity and other sources of activity/pollution, and existence of other coastal users description such as fisheries, tourism and navigation;
- A description of the potential environmental and socioeconomic impacts, for each step of the proposed activity and its alternatives, and an estimation of its potential harmful effects significance: It concerns different stages of the production: installation (land used for cage preparation, disturbance in traffic, impacts of mooring), production phase (benthos/water column, traffic on land and at sea, etc.), decommission phase (for example, taking off the mooring system), and estimation of its potential harmful significance (difference between the situation with and without the activity) and magnitude (importance that is given to that difference);
- A description of possible mitigation measures and its expected effects to keep adverse environmental impact to a minimum;
- An explicit indication of predictive methods and underlying assumptions as well as the relevant environmental data used;
- An identification of gaps in knowledge and uncertainties encountered in compiling the required information;
- A control system, with a monitoring plan including the design and methodology description.

A concern encountered in EIA is to deal with uncertainties in data and methods. In this context, the Precautionary Principle or Approach is an important element for an EIA. In general the EIA is developed with support of consultancy (consulting offices) and is based on a field study supported by literature-based analysis and site/area specific conditions. It often corresponds to specific national requirements in terms of presentation and standards, and takes into consideration the following topics:

a. Local environmental impacts

Aquaculture impacts represent less than one percent of nutrient loads in the Mediterranean Sea while the larger contribution comes from agriculture and sewage (Karakassis, Pitta and

Krom, 2005). Such a global outcome does not prevent the local impact of aquaculture as a human activity and has been studied by EIA and monitored by specific monitoring protocols.

The collection of data and study of local environment situation prior to installation is the costliest and most important part of the EIA. A field analysis is required under a baseline protocol to be done underwater on key sampling stations (below cages, across the current pattern: see Environmental Monitoring Programmeme chapter). It will produce data to be used to establish the "baseline" in order to be able to compare it with data collected 'after', once the business is running.

The impacts are different between species, which can lead to a complicated EIA and licensing process. For example, the impact of sea bream and sea bass is different as sea bream has a wider or less concentrated distribution, whereas sea bass is principally located below cages and with a denser concentration. Their faeces also differ in size, density and chemical composition.

In order to measure environmental impacts two main aspects should be considered: significance and magnitude. The impact "Significance" is related with the level of the changes introduced in environmental quality as a result of the settle of a new project that is, the difference between the situation with and without the activity. Magnitude relates with the importance that is given to that difference.

The significance of environmental impacts is largely dependent on the spatial distribution of the effects of the proposed action and of the affected receptors. However, in current EIA practice, this spatial dimension of impacts is often ignored or hidden in the overall decision-making process. The information generated by the use of Geographical Information Systems (GIS) in impact identification and prediction stages of Environmental Impact Assessment (EIA) could be used in the assessment of impact significance by the computation of a set of impact indices (Antunes et al, 2001).

The prediction of the magnitude of impacts is often undertaken by the application of simulation models (Fedra, 1993) (see below point "dispersion of organic matters").

The following elements are usually assessed:

- Water column quality, which includes levels of dissolved oxygen and nutrients (ammonia, nitrate, nitrite and phosphate), pH, salinity, Chlorophyll A, and turbidity. Many studies in the Mediterranean[12] conclude that at short spatial scales there is no systematic effect on water column variables by fish farming;
- Sediment quality. In particular, organic matter and Redox are measured to evaluate oxygenation of sediments and the impacts on benthic populations, such as those of Nematodes or Polychaets, granulometry/particle size, organic/mineral contents, free sulphide and percentage cover of Beggiatoa. An indication of presence/absence of pellets and food is also presented, and in some countries heavy metals and pollutant levels are required or can be measured. It shows the significance of sediment type, coarse or fine, as being largely a factor of site exposure, and can suffer from sedimentation;
- Benthos quality. This is used to establish benthic diversity and appropriate benthos quality indicators. Specific species can be indicators of organic pollution and benthos is of importance for the food chain as well. It shows the biological quality and evolution of benthic fauna;
- *Posidonia oceanica* and other sensitive sea grass meadows present. Aquaculture is often expected to be developed close to the shore where sensitive protected species like *Posidonia oceanica* or *Cymodocea nodosa* sea grass are present. The state of *P. oceanica* meadows are established by measuring shoot density, shoot morphological characteristics, and the volume and nutrient composition of epiphytes such as seaweeds, hydrozoans and bryozoans;
- Mammals, seabirds and endangered species in the site, as well as other endangered Mediterranean species, such as coral or maerl habitat have to be assessed. Other impacts on sea mammals and seabirds should especially be presented;
- Dispersion of organic matter and nutrient patterns of the future new production. Ecological Models could be used in order to evaluate quantitative and qualitative relationships between habitat attributes (pollution gradient, organic particles sedimented in this case) and fauna or vegetation properties. This is based on the expected production, the species and knowledge on faeces particles and metabolism of each species, and the current patterns, information of which is obtained from literature and hydrodynamic models. Modelling plays an important, perhaps essential, role in determining acceptable limits of aquaculture or any other anthropogenic impacts, since without predictive models

[12] Some Aspects of the Environmental Impact of Aquaculture in Sensitive Areas (Fish/2004/15)

we cannot assess whether the impacts are acceptable until they have occurred and been observed, which is almost always too late (Silvert, 2001). Hydrodynamic and transport models can predict dispersion of particulate and dissolved wastes from the aquaculture facilities. They are presented to explain levels of dilution and the size of the particle/faeces/nutrient impacts around the cages. To reduce the cost of such models, simple ones have been developed, such as the Trimodena in Spain or Bardau in France, but despite the quality and usefulness of such visual tools, in practice, the use of models to predict ecosystem impacts from pressures is complicated and difficult. They give, at minimum, a vision of the size of sedimented particles and organic matter on the bottom. There are some sophisticated models which coupled the results of hydrodynamic and dispersion simulations with different ecological models in order of simulate the biological effects of the wastes (COHERENS, MOHID, etc.), but they need a high level of expertise to be run correctly.

Provisional impacts and analysis corresponding to each measurement are presented in table 1 with reference to Mediterranean literature for the existing habitats and species located around the site. Some of them have been summarized in MedWeg/ACCESS European programme and, in spite of differences from one country to another they are more or less similar.

Habitat / Species	**Pressure Categories**													
	Smothering		**Change in Biogeochemistry**											
	Smothering	*Turbidity*	*Dissolved 02*	*Nutrients*	Change in coastal processes	Infrastructure	Visual land & Seascape	Disturbance	Predator	Chemical Use	Pathogen	Inter-breeding with wild organisms	Introduction of alien species	Indirect ecosystem pressure
Reefs: Mussel Bed Communities														
Reefs: Polychaete Worm Communities				?						?	?			
Sea grass Beds on Sub littoral Sediments														
Sandbanks, Mudflats & Sandflats														

Maerl Beds	High	Moderate	High	High	Moderate	High				?			High	
Kelp and Seaweed Communities	High	High	High	High		Moderate	Low			?			High	
Salt marsh Communities	Low		Low	Low	Low	Moderate	Moderate	Moderate	Low	High	?			
Sand Dune Communities					Moderate	Moderate	Moderate	Moderate	Moderate	Low				
Shingle Communities	Low					Moderate	Moderate	Moderate	Low		?			
Cetaceans								Moderate	High	Moderate				
Pinnipeds								Moderate	Low	Moderate				
Otters	Low					Low		Low	Low	Low				
Fish	Low		Low					Low		Low	High	High	Low	High
Birds	High	Moderate	High			High		Low	Low	Moderate				High

High ti Moderate bi Low s Negligible e pres ? Uncertain n et al., 2006)

As an example of mitigation measures, the elements provided by all measurements and by the producer/consultant analysis, can indicate ways to reduce impacts, such as changing the position of the cages in a specific current and appropriate depth, improving feeding procedures, integrating production, creating artificial reefs associated with aquaculture to increase filtration capacity and improvement and enrichment of the water column. With regards to endangered or sensitive species, the general recommendation is to place the cage far from the Posidonia/maerl.

b. Physical Impacts on land and at sea

This section corresponds to the description of cage anchorage and impacts on mooring systems, and transport from the sea (plant to harbour, etc). It presents the impacts at all stages, including during the installation and desinstallation period.

The mooring system improvements are usually presented as well as short-term transport perturbation in public areas, technical sites on land and security harbour locations, which are all examples of mitigation measures.

c. Impacts of farm practice and management

This corresponds to describing each step of production and its impacts: from larvae production and fingerlings production to transfer to the cages and feeding process (pellets and artificial food origin and quantity, fresh fish quantity and impacts) as well as the killing and processing procedures and impacts on animal welfare. It also shows the expected size of organic wastes from transformation plants and the process and management of solid wastes.

All mitigation measures presented are to improve, among others, farm management, the feeding process or animal welfare.

d. Impacts and relation to protected areas on endangered species

This topic usually presents specific impacts, if any, on Natura 2000 areas, protected areas, protected species or sea traffic (Poseidon *et. al*., 2006).

Mitigation measures could be a presentation of clear mapping or Geographical Information Systems GIS of the area. Delimitation of the production site and sensitive areas are required to show the distance to each protected area, as well as legislation elements that should be taken into account. The distance from the installation to *Posidonia oceanica* meadows should match the guidelines indicated by international recommendations[13].

e. Chemical inputs, sanitary impacts and safety at sea and on land

This takes into consideration pathology risks and the potential transfer to wild fish populations, and also the processing system and all concerns relative to public health. In general, chemical inputs to the environment are connected with pathology prevention. When chemical are added to the environment, a specific item can be retained in the environment and it should be estimated.

Some examples of mitigation measures are those developed to reduce the pathology risks, such as larvae and broodstock quality certification, prophylaxy and use of natural chemicals measures, densities of the cages and reduction of stress, removal of dead animal frequency,

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[13] http://www.gea.com.uy/relacionados/Mediterranean_marine_aquaculture.pdf

killing and development of a conditioning process and quality certification measures as well as ice infrastructure.

f. Wild stocks, interbreeding and indirect ecosystem impacts

Aquaculture is one of the causes of fish biodiversity loss on farmed species (Naylor *et al*., 2005). A specific item is usually rapidly developed with regards to their wild stock impacts in relation to genetic interactions or genetic competition, as well as pathology aspects. Another aspect is the consumption of wild stocks for feeding since aquaculture is a consumer of 50% of fish food sources in the world. Impacts on species of commercial interest are usually shortly presented as well as on fish populations under or around the cages (attraction phenomenon and Fish Attraction Device effect, change in biodiversity, impacts on fisheries). This concerns all species including Blue fin Tuna (BFT) ranching actual production. Lastly, the Environmental Impact Statement (EIS) or Environmental Impact Assessment (EIA) document should present the relation between the production, the species produced and the risk of introduction of alien species. Usually only Mediterranean species are proposed for farming.

Mitigation measures usually take into account the feeding process, the quality of the food proposed and the hatchery quality standards in order to avoid the introduction of alien species. For Blue fin Tuna, aquaculture describes the aspect of BFT quotas, the quality standards for fresh feed origin, the dependence and impact on local fisheries. For other aquaculture species, it presents as well the positive impact on local commercial and small scale fisheries that are coming to fish close to cages (G. Giannoulaki *et. al*., 2005).

g. Predator impacts

The fish and shellfish stocks held by aquaculture operations will inevitably attract the attention of wild predators like marine mammals or seabirds. Predator control is more challenging when considering many predators are protected by Member States and EU legislation, especially within designed sites of conservation interest (under Article 9 of Council Directive 79/409/EEC31).

As an example of mitigation measure, long term results are usually achieved by using a combination of methods and by frequently alternating the devices used. These include frightening techniques, devices and the regular change of their position, as well as positioning nets above the cages to prevent predation by birds.

h. Visual land and seascape, and disturbances (sound and air pollution) impacts

For visibility, it concerns mostly, how cages are visible from the shore and what are the landscape impacts when talking about on land installations. For some Blue fin tuna ranching, the harvesting process often relies on killing the fish at the cage site with guns, which corresponds to temporary noise impacts. Usually there is no air pollution.

Mitigation measures can relate to the size and colour of the cages, developing black or blue cages, as well as reducing the size of above-water physical elements in order to reduce seascape impact, but always without prejudicing the regulations for proper display of the facilities by boaters. It can also lead to the establishment of cages far from the shore or by using submersible cages.

i. Socio-economical impacts

This topic is often not well addressed. It presents the production impacts on the number of new direct and indirect employment, and its relation to local employment. Its impacts towards other coastal users is also developed and especially the ones linked to fisheries, tourism, transport and diving. Local economy impact, such as income, taxes and exportation, are also a key element.

Usually, socio-economical impacts are positive, adding a permanent marine professional actor to a more tourist-influenced coast, however, some conflicts with fisheries may arise. As a mitigation measure, various initiatives can be proposed, like mobilizing the fishery actors, developing local partnerships with local companies, as well as training local people to improve their qualifications and presenting positive economical impacts on the local economy (employment, income, taxes, exportation trends, transportation and harbour infrastructure). It can also present initiatives to support sustainable coastal zone development through artificial reefs associated with the cages, integrated aquaculture, and scientific research or education programmes on marine environment.

Thus, EIA is a preventive instrument related to sustainable management of aquaculture on the context of site selection. Therefore, the environmental assessment should be extended to earlier stages of the policymaking and planning process, when the strategic decisions (such as location or type of project) have not been made yet (Arce & Gullón, 2000; Scholten et al, 2001). In addition, to be comprehensive and effective in providing information, the decision making process must provide opportunities for public consultation and encourage communication between the public and the operator (Scholten et al, 2001). So in the context of aquaculture site selection and sustainable development, and taking into account the concepts of Integrated Coastal Zone Management (ICZM) and Ecosystem Based Management (EBM), EIA provides the framework for the articulation of projects in a way that is coherent and respectful with the environmental, social, political, and economic conditions. It contributes to a better planning and monitoring process and is a potential tool for decision making as well as for producers to reduce their impacts and improve their activity and project planning, supporting them to integrate their project better into a local socio-economical environment.

Why carry out an Environmental Impact Assessment?

An Environmental Impact Assessment (EIA) is necessary to precise to the public and local authorities, what could be the potential footprint of a new human activity on any environment and ecosystem. It helps to precise what is the level of integration of the project within the environment where and what are the measures developed to reduce the impacts.

Justification

Economic studies (Katranidis, 2001) have shown that Social Acceptability of aquaculture depends, among others, on the size of the industry, the effects on local economy, and the time elapsed after the investment. However, negative effects such as aesthetic degradation of the scenery, have often caused conflicts with other uses of the coastal zone and particularly with land-owners in the vicinity of an aquaculture site, which have yielded a large number of court cases.

At the same time, and looking into an Ecosystem Approach, all economic activities proposed or taking place on the sea should go through a previous study on the possible impacts that could affect the surrounding environment, not only to preserve it but to assure the sustainable development of the activity.

Principle

For an appropriate aquaculture site selection and installation, procedures of Environmental Impact Assessment (EIA) should be mandatory and implemented.

Guidelines

- **Environmental Impact Assessment should be mandatory for all the projects, including aquaculture site selection, and integrated in legislation.** The sea is a "public domain" and specific laws have to be implemented in order to ensure appropriate and sustainable use of the ecosystem thereby granting aquaculture sustainable development. Responsibility of EIA costs could be discussed.

- **To facilitate the process of aquaculture site selection, simplification of current Environmental Impact Assessment protocols, standards and models as well as regular review of the statements should be carried out and harmonized in all the Mediterranean.** Proper indicators for Environmental Quality Standards (EQS) and impacts adapted to various production typologies (shellfish/fish culture) must be developed in the Mediterranean.

- **Environmental Impact Assessment should be based on the best and appropriate scientific knowledge including technical, socio-economical and environmental aspects as well as on the Precautionary Principle.** Scientific facts, assumptions and expert judgements, and the consequences for the assessment of the range of error have to be discussed. In this context, the Precautionary Principle or Approach is an important element for an EIA.

- **Innovations concerning Environmental Impact Assessment should be within the range of administration involved in decision-making by means of regular training as well as by the private sector thanks to easy accessibility to information**. Stakeholders are not always aware of recent evolutions and reasons for changes. Therefore, regular updating is required to facilitate proper aquaculture site selection.

- **Research on present issues such as Cumulative Effects or mitigation measures as well as future topics should be promoted and developed in order to achieve the sustainable development of the aquaculture.** Innovative tools such as distances between cages or limits on diseases as in Norway examples on prevention or any activities that take advantage of the nutrient enrichment of the environment caused by aquaculture activity have to be more studied and further exploited.

- **Stronger socio-economical compensation measures in Environmental Impact Assessment should be imposed.** This would allow better integration of aquaculture projects into the local territorial environment and observing/developing synergies.

Examples of Mediterranean Environmental Impact Assessment situation

When it is not compulsory and imposed by a legal or administrative body, EIA is not used.

In most European countries, EIA is developed prior to installation or extension. However, the quality and level of requirements are different from one country to another. The need for harmonisation of regulatory, control and monitoring procedures has been reinforced in a number of reports (Cowey, 1995; GESAMP, 1996). However, not much progress has been made and in general, EU countries have continued to proceed independently. An EC Directive 97/11/EC of 3 March 1997, amending Directive 85/337/EEC on the assessment of the effects of certain public and private projects on the environment (EC, 1985), which includes aquaculture in Annex II, emphasises the need for certain projects to undergo compulsory EIA, depending on scale, intensity and local conditions (EC, 1997).

The EC Water Framework Directive (WFD) has already had an automatic strong impact on aquaculture as marine and coastal waters will be specifically designed in different classes up to a distance of 1 mile from the shoreline. Different special protection levels for shellfish areas, bathing areas, sailing areas, and sensitive areas are related to habitats/species protection. This last classification will have strong impact on aquaculture that is located close to the shore. Finally the WFD states the following: *"protection of water status within river basins will provide economic benefits by contributing towards the protection of fish populations, including coastal fish populations"*. Nowadays all constraints of WFD are not established on aquaculture and there is a need for anticipation.

Although there is a standard requirement for an EIA, there is little common consideration of regulatory issues among Mediterranean countries. A proposal for a common site selection protocol (PAP/RAC, 1996) has not been uniformly adopted by Mediterranean countries. Mainly regional initiatives are developed and no analysis of past experiences is completed in order to propose appropriate measurements and procedures based on learned experiences.

- Malta: To our knowledge, The EIA process is requested and guided by the Malta Environment and Planning Authority (a Government al organisation), and undertaken by private independent consultancies, which are hired by the applicant, on approval by the Malta Environment and Planning Authority. The role of the National Aquaculture Centre is to guide the applicant on Administrative Procedures and site selection and issue the license to operate
- France and Spain: Each company/project has to provide the EIA and monitoring results. In France, it follows the ICPE procedure (Installations Classified for the Protection of the Environment) (E. Roque d'Orbcastel *et al.*, 2004). In Spain, some regional administrative bodies and researchers support the evaluation, and regional protocols are defined for EIA in cases where aquaculture strategy is well established. However due to regional council power and autonomy, the lack of harmonization lead to differences in Environmental Quality Standards (EQS) and protocols. For example, in one region there are 13 parameters, and in another there are 16.
- Turkey: EIA studies are now starting to be requested, and one of the main difficulties is the high number of administrative bodies with responsibilities in the subject.
- Greece: In the leading country in terms of production, the administrative body imposes a series of procedures for the approval of a farming site, but there are no precise requirements for data to be included in the EIA. The practice is far from satisfying European Commission (EC) requirements, since situations are very different between regions. Many farms were developed and extended without proper EIA. A recent change in the regulatory framework provides the establishment of Areas for Organised Development of Aquaculture (AODA), previously assessed for environmental issues.
- Cyprus has become, since its entry in EC, a good example of strong regulation on EIA, where specific criteria and protocols are developed and followed. A more strict regulation imposing minimal depth and distance from the coast and the regulatory framework, called Strategy for the Development of Aquaculture, is periodically revised by external panels of experts.
- Southern countries of the Mediterranean usually impose EIA without strong national scientific knowledge of the protocols, due perhaps to the high cost and technology needed, as well as EQS limits. Hence, there is a lack of elements for decision-making.

Most of the time, the EIA is accepted with reluctance and, therefore, loses its importance. It does not sufficiently take into account the national Competencies and capacity to undertake several types of measures and analysis. There is a strong need for harmonization and understanding of marine environmental issues and their importance for productive activities.

The Environmental Impact Assessment procedure as part of the licensing process

Usually the EIA follows a preliminary site analysis and a rapid coastal assessment based on expert opinion or producer knowledge who studies the key factors, key actors and key supporting constraints, which define the best sites for aquaculture. The EIA is nowadays requested by legislation in most countries and will determine the baseline environmental conditions (through, for instance, desktop research or field surveys). The EIA process can take 4-6 months and the results are then presented to a public inquest and follow an administrative procedure, which is still not harmonized at a Mediterranean level.

In the case of France, it can take between one to two years depending on administrative constraint.

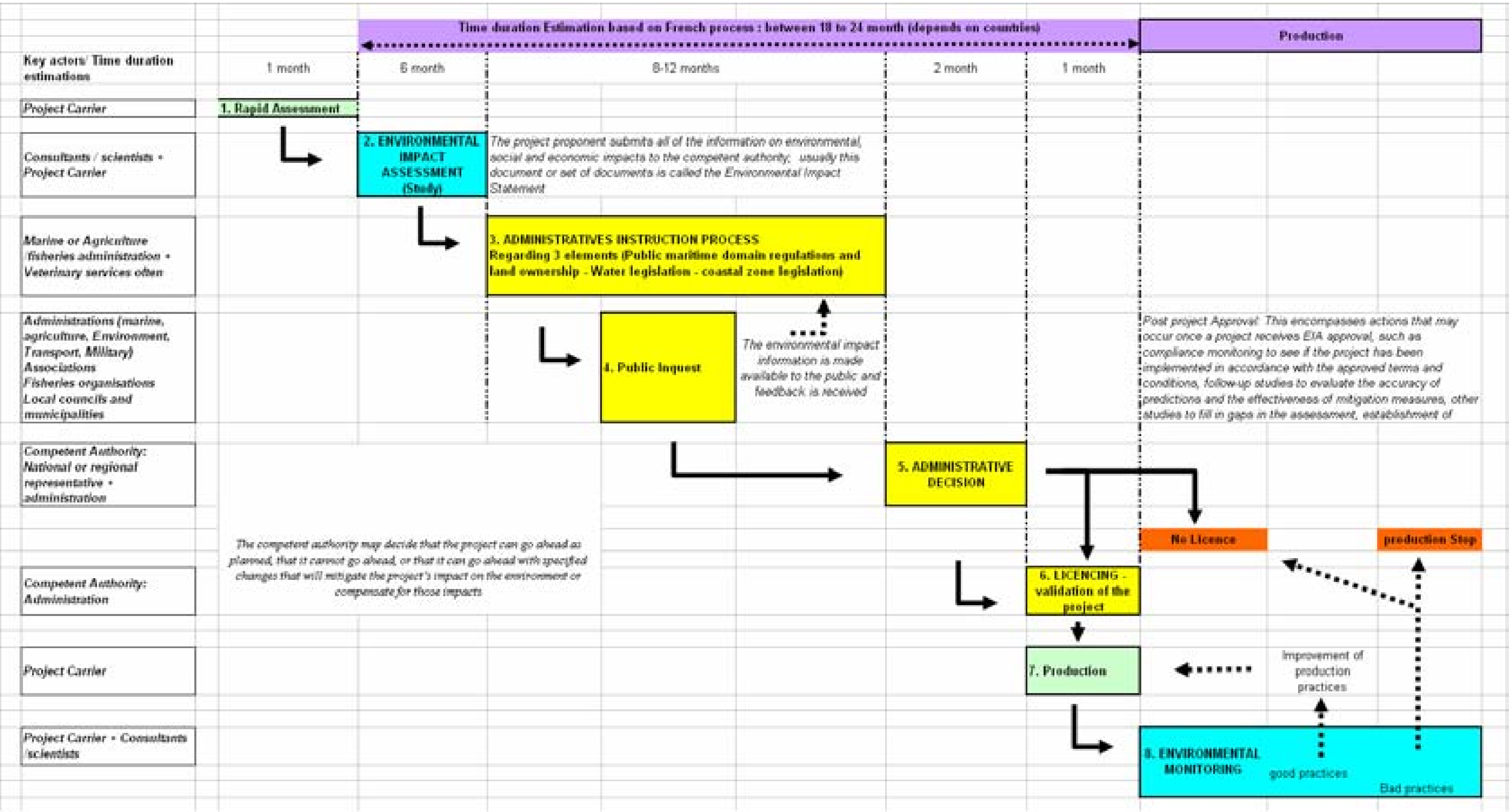

Time duration Estimation based on French process : between 18 to 24 month (depends on countries)
Production
Key actors/ Time duration estimations
1 month
6 month
8-12 months
2 month
1 month
Project Carrier
1. Rapid Assessment
Consultants / scientists + Project Carrier
2. ENVIRONMENTAL IMPACT ASSESSMENT (Study)
The project proponent submits all of the information on environmental, social and economic impacts to the competent authority; usually this document or set of documents is called the Environmental Impact Statement
Marine or Agriculture /fisheries administration + Veterinary services often
3. ADMINISTRATIVES INSTRUCTION PROCESS
Regarding 3 elements (Public maritime domain regulations and land ownership - Water legislation - coastal zone legislation)
Administrations (marine, agriculture, Environment, Transport, Military)
Associations
Fisheries organisations
Local councils and municipalities
4. Public Inquest
The environmental impact information is made available to the public and feedback is received
Post project Approval: This encompasses actions that may occur once a project receives EIA approval, such as compliance monitoring to see if the project has been implemented in accordance with the approved terms and conditions, follow-up studies to evaluate the accuracy of predictions and the effectiveness of mitigation measures, other studies to fill in gaps in the assessment, establishment of
Competent Authority: National or regional representative + administration
5. ADMINISTRATIVE DECISION
No Licence
production Stop
The competent authority may decide that the project can go ahead as planned, that it cannot go ahead, or that it can go ahead with specified changes that will mitigate the project's impact on the environment or compensate for those impacts
Competent Authority: Administration
6. LICENCING - validation of the project
Project Carrier
7. Production
Improvement of production practices
Project Carrier + Consultants /scientists
8. ENVIRONMENTAL MONITORING
good practices
Bad practices

Table 2: Summary description of the EIA and public inquest process based on French situation

Case of Egypt

This example shows how the Egyptian authorities took extreme correction measures to avoid impacts of the aquaculture activity on the environment of the Nile delta. This situation has been reached by the rapid growth of the sector and probably the lack of previous Environmental Impact Assessment and further Monitoring.

The 1986 aquaculture Egyptian production of 36,078 tons, which is 16.5% of total fish production for that year, rose to 595,029 tons in 2006, which is 61% of the year's total. The Egyptian aquaculture map showed that fish farming activities are more concentrated in sub-regions of the Nile delta, where the water resources are available and non-agricultural lands. Other very few projects are located in Upper Egypt region, the Mediterranean Sea coast and the Red Sea coasts.

Extensive and semi intensive earthen ponds for a total surface of around 140 thousands hectares practiced in Egypt are characterized by medium stocking densities and limited water exchange rate. The private sector is producing 98.6 % of the total aquaculture production, and the public sector contributes only with 1.4%.

Intensive culture is also practiced using mainly Nile cages and limited tank farms in the desert. In the 1985 the first eight tilapia cages were established in Damietta Nile branch with a yearly production 1.92 tons, since this date there was a rapid increase in the cage numbers and cage production, reaching 12,495 cages and 80 thousands tons in 2006. Most of the tilapia cage projects were located in five different provinces in the northern delta figuring about 98% of the total volume of tilapia cages in Egypt and the rest are located in three different governorates in Upper Egypt. Due to the pollution problems of the Nile cages in the end of the two Nile branches, the Egyptian authorities have removed completely the Nile cages in 2007, before the last two dames, which are controlling the fresh water flow to the Mediterranean.

In Egypt the water resources both fresh and brackish water are the major constraints on further development, with use for potable water and land crop production having priority over aquaculture activities. For a such reason the Egyptian authorities are planning to take off all the Nile cages and reuse an important volume of the available drainage agriculture water. Due to the legislation and environmental pressures of the cages, plus a conflict with other activities, had cut the number in 2007. For such reason, Damietta and Kafr El-Sheik governorates have removed completely the tilapia cages.

A key policy issue in Egypt is planning to increase the reused agriculture drainage water for the delta region in year 2014 to reach 1.4 times the actual quantity reuse in 2002 3,219 million m3/year. In three Nile delta regions, the Integrated Irrigation Improvement and Management Project (IIIMP) is actually implementing an irrigation system improvement almost 235 thousand ha would be the focus for irrigation improvement in four different governorates. It is perceived that drainage water quantity and salinity would negatively be impacted (-12 % and 4%, respectively). Different environmental impacts will effect on the aquaculture ecosystem production in the Nile delta regions as water available for fish earthen ponds will be not adequate and the increase of salinity could effect on both production capacity and production composition. In addition, paddy field and spreading grass carps in drainage water channels could be negatively be affected. A such security life policy of Egyptians, could retard the development of the aquaculture, taking into consideration that the Nile cage culture contribute for around of 11% of the total Egyptian aquaculture production and the new policy of irrigation strategy could effect with 60% of the actual aquaculture production.

Actually the Egyptian government is studying different strategy proposals to maintain a sustainable Egyptian aquaculture, from any retardation.

The analysis of different Mediterranean studies on Environmental Impact Assessment (EIA) (Italy, Greece and Spain) present the following conclusions (L. Molina Domínguez and J. M. Vergara Martín, 2005):

- No impact on the water column is observed (i.e., dilution does not allow the detection of any impact at distances greater than 50 m from the cages).
- The only negative impacts shown are on the sediments and benthos in the area located directly below the cages, mostly due to sedimentation.
- The quality of the sediments is indicated by the organic carbon and total nitrogen content, as well as by the biomass of benthic macro fauna.

Consequently, researchers are proposing to simplify the protocols for EIA and harmonize the standards based on such arguments.

In addition, many EIA are now including aspects of the Carrying Capacity linked to hydrodynamic models, but the lack of knowledge on models, marine ecosystems and cumulative effects do not provide sound results and clear criteria on these issues (see chapter on the Concept of Carrying Capacity and the Use of Indicators and Models).

R. Environmental Monitoring Programme (EMP)

This guide handles the Environmental Monitoring Programme (EMP) which has to be consistent with sustainability criteria. It is a tool used after the Environmental Impact Assessment (EIA) to highlight, through samplings, to what extent the aquaculture management impacts the ecosystem over time comparing current data collected at various points in time with data obtained before its development as well as with those already existing.

Monitoring is often designed at the end of the EIA and is part of the EIA statement document. The monitoring protocol proposes what type of indicators should be used to monitor the impact of the farm at various periods of time. It usually focuses on environmental parameters.

Monitoring looks at many topics and levels including the scale of impacts, general ecological change, and implementation of acceptable limits or acceptable zones of effect over a defined timeframe. The latter is achieved using environmental quality standards (EQSs) set out either within an Environmental Impact Assessment (EIA) or by environmental bodies and governmental authorities as part of a regulatory plan. These EQSs are usually based on data derived from laboratory study and field investigation and often include a "safety" factor, using a Precautionary Principle or Approach (SEPA, 1999) (Tefler and Beveridge, 2001).

Environmental Monitoring Programme content

The monitoring results support decision makers as well as the producer himself with the size of impacts and the ways to improve management and regulate the activity. The contribution of phosphate and nitrate to the environment and the environmental impact of a farm will depend on three factors, namely:

- The frequency, sense and intensity of water currents in the area, for example the rate of water mass renovates around the installation. A 1000-ton fish farm can have less impact than a 100 ton fish farm if placed in a position where currents and depth support best dispersion by the environment;

- The phase of the production cycle. In summer, Mediterranean species develop the highest need for food during the year hence the spillage at this time will be higher than in January;
- The management practices. A good feeding and prophylaxis process support low impacts on the environment.

In monitoring environmental effects of aquaculture, as in all studies on environmental change, data is collected at various points in time and are compared with original pre-development data as well as with contemporary reference data. This will show changes over time due to the impacts, and natural environmental change will be taken into consideration. Survey techniques vary but generally require:

- A baseline definition: based on collected data before development. This provides essential background ecosystem data for subsequent comparison. The survey may be both spatial and temporal giving pre-development data on the natural environment and its changes throughout the proposed development area. This data can aid in the design of an appropriate monitoring study, for example, focusing on the areas which are most relevant for investigating change in any particular environment. The survey will also answer important management questions for the developer. In this case, will the site hold aquaculture? There are several types of experimental design incorporating the baseline survey. One of the most commonly used is the BACI or BACUP systems (Underwood, 1991).

- A monitoring survey: a collection of post-development data provides data on the actual impacts, in relation to the contemporary reference and baseline data. Once interpreted, the results may be used directly for management decisions by both fish farmers and environmental regulators by ensuring adherence to Environmental Quality Standards (EQSs) and Acceptable Zones of Effect (AZEs). Care should be taken in designing the monitoring study so that data is generated to answer the questions posed by all users of the data. For the environmental regulator – are AZEs and EQSs or the original conditions of the EIA being adhered to? For the fish farmer – is our environmental resource being damaged?

In general, the protocol for monitoring is based on previous knowledge of the existing zone and will take into consideration:

- Frequency of sampling
- Position of sampling stations
- Method of sampling water or sediments
- Method of analysis of the samples taken to measure the determinants.

Sample strategies usually attempt to maximise data collection per expended effort, which normally entails the use of transects aligned with the direction of principle current flow rather than a less efficient but more statistically rigorous random sample or grid approach.

Transects and specific station protocol are particularly good at allowing detailed investigation of gradients from a discharge point, as illustrated in Figure 1 (T.C. Telfer and M.C.M. Beveridge, 2001).

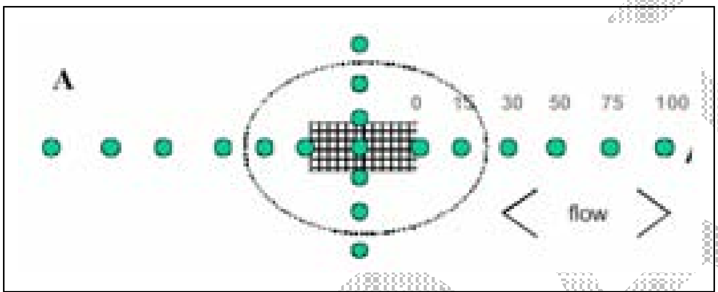


Figure 1: Gradients from a discharge point.

If no previous knowledge is available, the minimum required is based on AZTI (Technological, Fishing and Food Institute) and Spanish private consulting offices which have developed in Spain nowadays with the following protocol:

- Two samplings in extreme seasons: one at the end of winter, after strong wind and currents removal presenting the situation of the site at recovery or under minimum impact and in summer, presenting the site at maximum impacts conditions such as highest production phase and densities in the cages, lowest oxygenation, highest water temperatures and best conditions for pathogens;
- Five sampling points, whose design should be based on the main dispersal of the waste from the cages. Out of these points, at least one should be below the point where the cages are to be installed and another should serve as a reference point for the future in an area unlikely to be affected;

- The sampling depths are left to the criterion of the specialist carrying out the work, in accordance with the project that is presented.

The analysis can be done through:

- Unvaried indicators to show changes in community composition by statistical comparison between time point data with baseline and reference values or by comparing calculated values with an EQS value of diversity set for a particular site by regulatory authorities. If an EQS approach is used, the standard should be site specific and set in relation to the background level, for example Hs as a percentage of background level at any particular time;
- Multivariate indicators are usually used for benthos (Shanon biodiversity analysis);

The different monitored elements are still in strong concordance with the ones realized during the EIA. Most often these items consist of the following:

- Visual observations;
- Water column measurements;
- Sediments and bottom communities' measurements;
- Cumulative effects measurements;
- Interference with other users.

a. Visual observations

Based on special transect sections in situ and/or video transect analysis, these observations describe the following:

- Real distance of impacts of sedimentation (faeces, rest of feeding pellets or trash fish);
- Superficial situation of the sediment through organic concentration below or around the cages;
- Indications on the ecosystem evolution below or around the farm through presence/absence of *Beggiatoa* bacteria on anoxic sediments, number and type of wild species below/around the cages (fishes, octopus, pelagic/benthic fishes, detritic invertebrates) or reduction of macroscopic life;
- Situation of Posidonia meadows (quality and quantity).

b. Water column measurements

Measures are done for temperature, salinity, dissolved oxygen, optical properties (turbidity, suspended solids, Secchi disk transparency), nutrients (phosphorus, ammonium and nitrogen) and Chlorophyll A.

Various studies show that the follow-up of dissolved oxygen and other elements in the water are not very useful since no measurable item is identifiable after 50 m from the cage and the high capacity of dispersion of the water does not reflect the impact of the farm in the Mediterranean.

c. Sediments and bottom communities' measurements

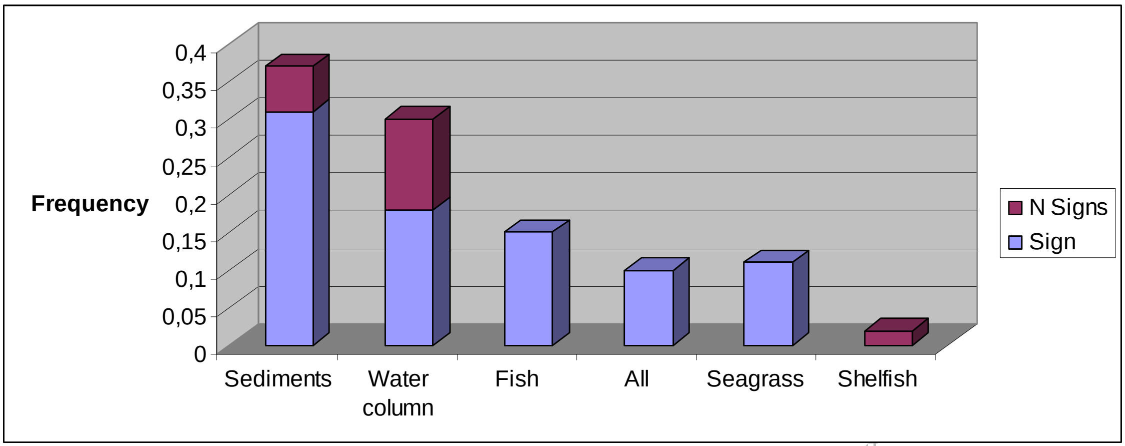
Particulate wastes tend to settle to the sediments creating a "footprint" effect usually distributed in the direction of the main current flow (Beveridge, 1996).

Distribution of the soft substrate in the area with data on granulometry, potential.Redox, organic/mineral contents, free sulphide and Beggiatoa percentage, presence/absence of pellets and food are presented. In this case, if relevant, pollutants could be studied based on EIA results. In addition Phanerogams quality and density are presented based on specific transect protocols.

Benthos communities' description is usually done using bio indicators as key elements to analyse the bottom reactivity of the farm since they are the species or groups of species that place evidence on a specific environmental factor. Besides identification, data on richness of species, abundance, biomass and diversity (Shannon calculations) should also be available.

Measures of sediment and bottom communities' species are much more relevant since it integrates all elements from the production farm such as impact on photosynthesis for Phanerogams, biotransformation into the sediment or tendencies to anoxia. Due to this factor it is also the topic most studied up to now (GFCM report, 2005).

Figure 2, below, shows the Frequency distribution of affected components of the ecosystem according to results and conclusions of reviewed publications. Blue portion of the bar represent the proportion of effects detected as significant.



d. Cumulative effects measurements

In some cases, but rare up to now due to the complexity and cost of the task and the lack of knowledge, cumulative studies are requested. For these reasons the first attempt studies are often developed by regional/government offices to analyse possible synergies or accumulative effects as the maximum stocking rate, from simulation data of the previous EIA.

e. Interference with other users

A small chapter presents monitoring regarding conflicts and relations with other users. In general this chapter is not very complete or informed by the Monitoring consultancy or researchers.

Indicator species

The "Monitoring Document" can present different areas supported by indicator species:

- No impacted area, where the number of species and diversity are high;
- Stress area, where the minimum pollution level shows a high diversity value, abundance and species richness. We find a high number of indicator species of organic pollution such as Polychaeta, *Notomastus latericerus, Nicolea venustula, Nematonereis unicornis or Lumbrineris latreilli*. Species such as *Hyalonoecia bilineata* could be very dominant in this situation;
- Very polluted area of second order, where the number of species decrease and the community is dominated by high organic pollution indicator species like *Capitella capitata* or *Capitomatus minimus* linked to another species with a low abundance;

- Very polluted area of first order, where the richness of species and diversity have minimum values. Only indicators of strong pollution species survive such as *Capitella capitata*, *Capitomatus minimus* or *Cirratulus cirratus*;
- Area of extreme pollution, where the whole macro fauna disappears. Even opportunistic species are not able to survive in this area.

Recent Monitoring improvements – Developing Adaptive Approach

In terms of monitoring, the best examples to be followed in the future could be the MOM (Modelling-On growing fish farms-Monitoring) example of Norway that allows adaptive monitoring measures depending on aquaculture producer management as well as environmental size of impacts (see example on MOM below).

Spanish adaptation of monitoring protocol based on MOM has also developed in large production areas and local farms (see Figure 3: Polygons monitoring).

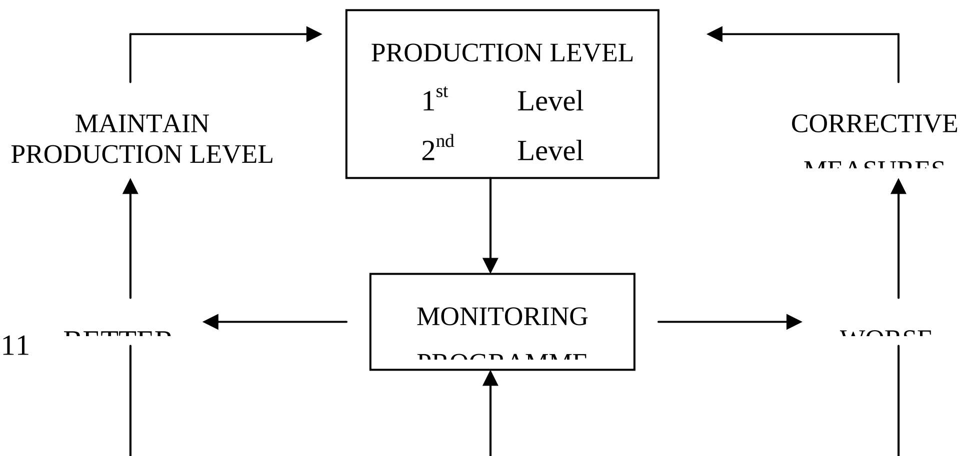


Figure 3: Adaptative Monitoring diagram developed for pre-selected aquaculture sites in Murcia and Canary Island (Spain) (Source: Perán et al, 2003; Taxon Estudios Ambientales, 2007)

This system is the target for all future EMP. It allows diminishing the level of sampling protocols and monitoring efforts to a minimum when management is efficient and impacts are standards or reduced. It allows increasing the pressure (sampling stations, type of measures, etc.) on the producer when production is not well managed, impacts are increasing or a specific crisis needs a close monitoring.

Environmental Monitoring Programme into licensing and site management

Together with the EIA required for licensing, EMP is usually demanded. Proposed by the companies or established by the administration, these programmes need to be considered into the initial project in order to evaluate and control the progress of the activity concerning the surrounding environment.

Another aspect is the decision of who has to pay for this. In any case, and from the data observed, monitoring has been presented as a low cost compared to private companies incomes; about 2% of the total cost of the installation of the sea bream and sea bass farms and 1.3% in the case of tuna (Belmonte et. al., 2001). However the requisite level of monitoring in some countries such as France, does not comply with the small producer capacity.

Why perform an Environmental Monitoring Programme?

The interest of the monitoring programmes have been underlined, not only from the environmental point of view but also from the point of view of farming, as the waste produced from the farm can be harmful to the farm itself.

Monitoring fulfils its mission when it facilitates the establishment of management objectives such as:

- The determination of acceptable areas or the installation of aquaculture farms;
- The establishment of environmental quality objectives or standards (EQS).

Among the reasons presented for monitoring, the following have been stated:

- Establishment of a legal regulation;
- Farm management (optimisation of resources);
- Human health;
- Research (identification of impacts and model validation, development of methods, etc.);
- Another important aspect of monitoring is its relationship with feedback processes in EIA.

Justification

For an established or new aquaculture project Environmental Monitoring Programmes (EMP) are needed and should be compulsory for site management. It is not logical to make an Environmental Impact Assessment (EIA) without posterior monitoring of the changing situation due to the development of the farm.

Principle
Environmental Monitoring Programme (EMP) needs to be implemented and should be compulsory for sustainable aquaculture site management.

Guidelines

- **A baseline study should be implemented before the Environmental Monitoring Programme and respected**. Deep and proper knowledge of the surrounding environment and aquaculture practices are needed to define the best and specific Environmental Monitoring Programme.
- **Reliable monitoring should be used to detect environmental response to changes in the scale of production and to readjust limits for environmental quality standards.** Due to the continuous development of the industry, monitoring must be adaptive to assess the dynamic linkages between aquaculture and the ecosystem within which it operates.
- **Standardisation and harmonization of Environmental Monitoring Programme should be legally imposed in each country of the Mediterranean**. Supported by research programmes, EMP has to follow the same procedures to reach the sustainability of aquaculture in all the Mediterranean.
- **Environmental Monitoring Programme associated with Environmental Quality Standards should be regularly revised and harmonized by reliable multidisciplinary bodies and communicated in an easy way.** A well conceived EMP is a highly effective method that links environmental changes with activity inputs. However, there are no set ways of monitoring or interpretation of the data obtained. These are dependent on the aims of the study, the size in case of development, site characteristics and scientific knowledge.
- **The sampling frequency considered on the Environmental Monitoring Programme should be determined by the Environmental Impact Assessment.** Frequency of sampling on sediment and water column should be done, at minimum, during the most impacted period, in summer. EMP could be adapted such as negative effects would increase the level of monitoring, whereas positive effects would reduce it.
- **A regular socio-economic analysis in the Environmental Monitoring Programme should be developed and revised at least every 5 years.** In order to monitor the socio-economical impact and review what was expected for the Environmental Impact Assessment.

Examples of the Mediterranean monitoring situation

When not compulsory and imposed by a legal or administrative body, monitoring is not used.

With regards to EIA, the quality and level of requirements of Environmental Monitoring Programmes (EMP) are different from one country to the other. There are few common considerations of regulatory issues among Mediterranean countries. Some countries are not imposing EMP on the farms. In addition, none of the Mediterranean countries develop a regular socio-economical monitoring at all.

- Malta: The Malta Environment and Planning Authority (MEPA) is the responsible body which ensures that monitoring of farms is carried out regularly, as per permit conditions. Most environmental monitoring is undertaken by Independent Consultants that must be approved by the MEPA. The National Centre of Aquaculture also undertakes some environmental monitoring of the farms.
- France and Spain: EMP has to be proposed and implemented by each company. In France, the Veterinary Service evaluates the quality of the reports and Ifremer, a research institute, is often a member of the advisory committee since they are in charge of monitoring general environment quality of the coastal area in France. In Spain, EMP are developed where regional reserved areas for aquaculture (like polygons) have been defined. But again, differences are found between regions, especially on parameters criteria.
- Turkey: with regards to EIA, EMP is demanded but there is no consensus between the administrative bodies that take part on the technical aspects and criteria that are to be implemented.
- Greece: in spite of the high production rate, there is no precise EMP and no requirements, and the lack of public information and risk assessment is high. Only the recent change in the regulatory framework of Areas for Organised Aquaculture Development (AODA) includes monitoring and control.
- Cyprus: it has a strong regulation and EMP is well developed and implemented following specific criteria and protocols. All farms are regularly monitored during the last few years using the recommendations of GESAMP 1996[14].
- Southern countries of the Mediterranean: with regards to EIA, there is no strong EMP, nor defined parameters or homogeneous guidelines.

[14] Some Aspects of the Environmental Impact of Aquaculture in Sensitive Areas (Fish/2004/15)

As it has been seen, EMP is subject to be developed all along the Mediterranean. In consequence, the researchers are proposing to simplify the protocols for EIA and monitor and harmonize the standards based on such arguments.

Monitoring and management of local environmental impacts of fish farming in Norway

In Norway, aquaculture in marine net pens is a large and expanding industry. Culture of salmonids accounts for the bulk of the fish farming in Norway, with 1198 salmon and trout farms producing 689 000 tons of fish in 2007. In addition to salmonid farming, 415 concessions farmed other species such as cod, halibut and arctic char. During the more than 30 years of commercial fish farming in Norwegian coastal waters, the industry has evolved greatly with respect to both optimisation of production efficiency and reduction of environmental impacts. In this context, prevention of over-exploitation of farm sites and maintenance of good rearing conditions has been emphasised.

As an effort to avoid over-exploitation of farm sites and to ensure good rearing conditions a management system called MOM (Modelling-On growing fish farms-Monitoring) has been developed. In parts this concept has been made mandatory for establishment and operation of fish farms, and negative results or insufficient monitoring might result in fallowing or relocation of farms.

The MOM concept is based on the appreciation that marine areas are more or less sensitive for effluents from fish farms and therefore have varying capacities for fish production. The concept represents a system that integrates Environmental Impact Assessment and monitoring which apply to a set of environmental standards (EQS). The amount of monitoring depends on the degree of environmental impact and a high degree of exploitation (DEX) calls for a high level of monitoring.

The MOM system focuses primarily on prevention of accumulation of organic matter in the sediments, which in turn might have negative effects on the benthic fauna. At present, other types of environmental impacts such as genetic effects of escaped farmed fish and propagation of parasites, diseases and chemicals are not addressed by MOM. In the MOM system, the holding capacity of a site is this defined as the maximum production that allows viable benthic macro fauna under and around farms.

The monitoring programme in MOM consists of three types of investigations (A, B and C) of increasing elaboration and accuracy. In general, sites with a low DEX are less monitored than sites with a high DEX. The A-investigation monitors the organic output from farms by sampling particles in sediment traps and is not mandatory.

The B-investigation is the core of the monitoring and involves that sediments collected primarily under farms are analyses with respect to occurrence of macro fauna, pH, Redox potential thickness of organic material, smell, colour, consistency and gas bubbles. The B-investigation is designed to be simple and inexpensive. The results from the different parts of the B-investigation are assessed using a score system which allows simple categorisation of the environmental status under and around farms and which finally allows determination of the DEX in accordance with a set of EQS. The B-investigation is mandatory both for establishment of new farms and for monitoring of the status for existing farms. This investigation should be carried out during periods where the DEX is expected to be highest, i.e. in periods with maximum production/biomass. If the DEX as defined from the results of the B-investigation indicates a high DEX the monitoring activity will be intensified and visa versa. In addition, results indicating a high DEX might also lead to that the management authorities instruct the fish farmers to carry out the more comprehensive C-investigation.

The C-investigation involves studies of the benthic macro fauna communities in larger areas than covered by the B-investigation. The C-investigation deals with long-term environmental changes in the sediment in transects from the local impact zone into an intermediate impact zone and in areas where waste is expected to accumulate.

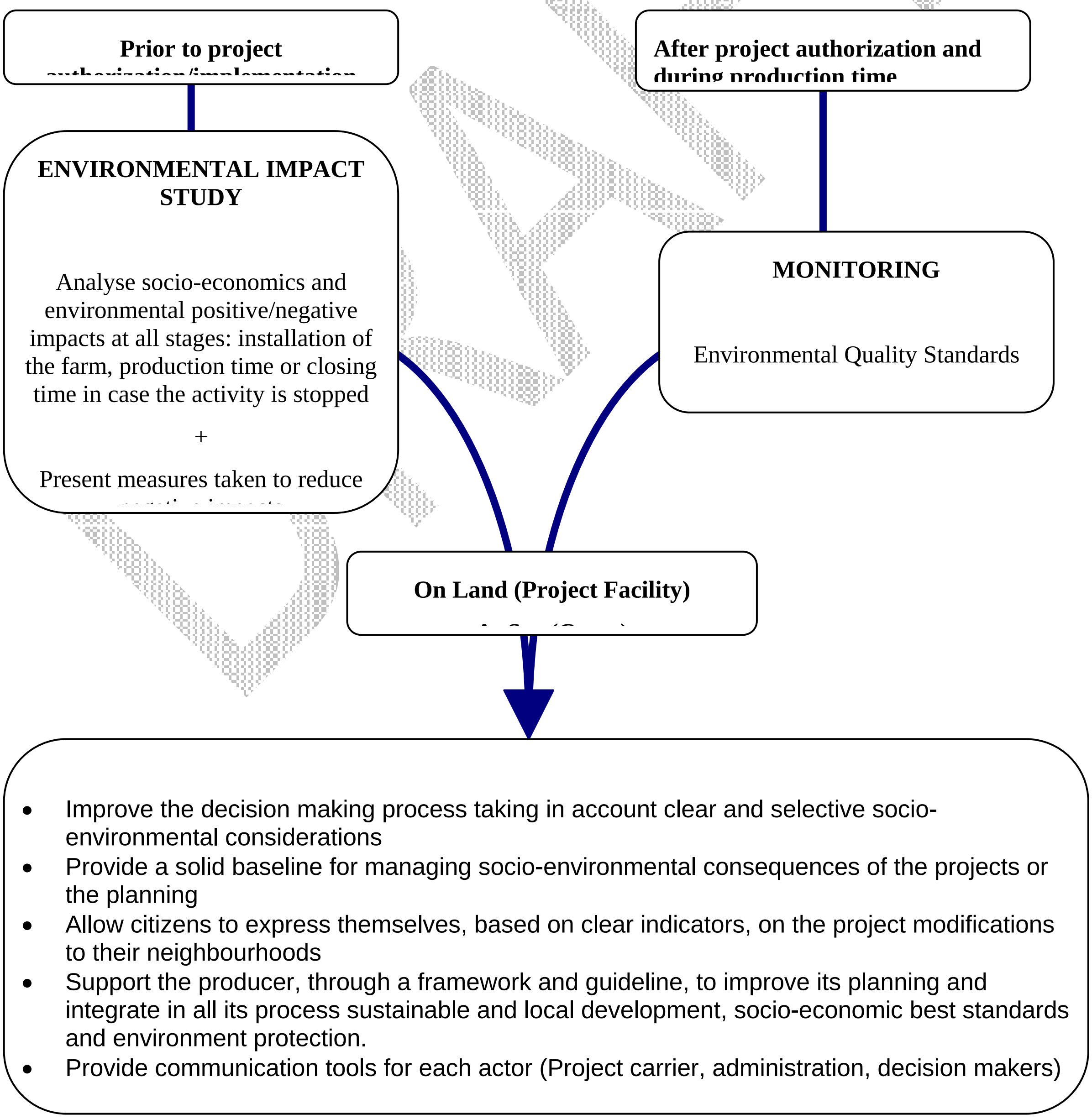
The Norwegian MOM concept is aimed to ensure that the farming activity not exceed the capacity of the site. In cases where the faming activity exceeds the capacity of the site optimisation of feeding schedules or selection of other sites with stronger current of greater depth might be necessary. A weakness with the MOM system is that it involves benthic impacts only. A gathering body of evidence, not only for salmonids, suggest that fish farming also involve other and serious environmental impacts (e.g. fish escape distribution of diseases and chemicals). In future monitoring of environmental impacts of aquaculture an explicit goal should thus be to cover a larger range of impacts than embraced by MOM.

For more detailed information about MOM the reader should consult Ervik et al. 1997, Hansen et al. 2001 and Stigebrandt et al. 2004.

Summary of Environmental Impact Assessment and Monitoring in aquaculture

Three tools are needed for appropriate site selection and site management:

- EIA presents the project in detail, with its positive/negative potential, direct and indirect impacts and how to mitigate them. It shall take into account all uses and interest in order to reduce risks and conflict.
- Environmental Quality Standards (EQS), based on Precautionary Principle, other countries experience, the Commission for the Protection of the Marine Environment for the North East Atlantic (OSPAR recommendations) and EC directives as well as local experience should be established to set the limits between production and societal values for environmental integrity.
- Environmental Monitoring Programmes (EMP), to ensure compliance with EQS and to assess and support effectiveness of management and validate models and prediction.



S. Geographic Information Systems (GIS)

This guide defines what Geographical Information Systems are and their application to site selection and site management. A brief description of the tool is given, and the characteristics that GIS should has in order to make it useful and effective. Example of a GIS made in Andalusia (South of Spain) is presented.

Many definitions have been offered to describe what a geographic information system (GIS) is, depending on the context in which it is used and the purpose or viewpoint that the author is trying to put across.

In any case, regardless of the focus intended in the definition of a GIS, all definitions include a reference to a feature that is invariably present. This feature is the spatial component of the processed data.

It is important to highlight, therefore, that the main difference between a GIS and other information systems is its ability to work with spatial information, i.e. all the data used can be situated at a point in space.

What are the main characteristics of a GIS that make it different from other information systems? The following stand out:

- Complex geographic information can be visualized in maps (Figure 1);
- A GIS works as a sophisticated database in which spatial and thematic information is stored and referenced (Figure 2);
- The difference from conventional databases lies in the fact that all the information contained in a GIS is tied to geographically located entities. That is why in a GIS the position of the entities is the backbone for data storage, retrieval and analysis;
- It is an information integration technology;
- It has been developed from technological innovations in specialised fields of geography and other sciences, such as image processing, photogrammetric analysis

and automatic mapping, forming a single system that is more powerful than the sum of its parts;

- Information in a GIS can be unified in coherent structures, and a wide variety of functions, such as analysis, display or editing, can be applied to it;

- This integrating and open nature of GIS makes them an area of contact between various types of computer applications designed to manage information for various purposes and in various forms. They include, for example, statistical programmes, database management applications, graphics programmes, spreadsheets and word processors.

How does a GIS work? A GIS splits the subject into distinct themes, i.e. information layers or strata from the area we want to study. As they are superimposed on each other, these information layers create a graphic representation of reality, the final result of which takes shape as a map (Figure 3).

Parallel to this, the technical analyst can process information separately, if so required at the time, or relate the various layers or themes to each other—an important capability in data analysis.

The spatial database of a GIS (a geodatabase) is nothing more than a model of the real world, a digital representation based on discrete objects. A geodatabase is, in the end, a collection of data referenced in space which serves as a model of reality. The rules by which the real world is modelled by means of discrete objects make up the data model.

Two main methods exist for modelling spatial reality: according to properties (vector models) or location (raster models).

Vector models

In vector models real entities can be represented by means of points, lines or polygons. The combination of these entities produces a graphical representation of reality (Figure 4).

In general, the vector data model is suitable when working with geographical objects with well-established limits, such as farms, roads, etc.

Raster models

Space is split into portions of equal size and shape (cells) by superimposing a grid. Each cell contains information, generating a grid of rows and columns with associated values depending on the features they represent. Thus, raster models do not explicitly record geographical boundaries between elements, although these can be inferred approximately from the cell values (Figure 5).

Obviously, to obtain a precise description of the geographic objects contained in the raster database the cell size has to be small at the scale in question, which produces a high-resolution grid. However, the greater the number of rows and columns in the grid, and hence the higher the resolution, the greater the effort required to capture the information and the greater the time required for its analysis.

The raster data model is especially useful for describing geographic objects with diffuse boundaries, for example the dispersion gradient of a pollutant cloud or the surface temperature of an ocean, where the outlines are not absolutely clear; in these cases, the raster model is more appropriate than the vector.

So as an example, vector models are very suitable for delimiting protected areas, administrative boundaries, prohibited areas, etc., while raster models are more suitable for representing surface temperatures, currents, pollutant dispersion areas, etc.

Comparison of raster and vector models.

	raster	vectorial
Allows for greater graphic precision	−	+
Used in traditional cartography	−	+
Can cope with a greater volume of data	−	+
Topology can be implemented	−	+
Calculations are more easily performed	+	−
Data update is simpler	+	−
Allows for representation of continuous spatial variation	+	−

Data from different contexts are more easily integrated	+	–
Discontinuous spatial variation is more easily represented	–	+

– Disadvantage compared to the other model + Advantage compared to the other model

Data and parameters to be assessed

Technically speaking, GIS as a data storage tool shouldn't have limits. But when considering data management, understanding and representation the selection of the parameters and the amount of data is important to be defined in advance. This is especially important for site selection and site management processes.

Data contained on GIS is going to be the information for decision makers and should be the most appropriate for the objectives to be met.

When assessments are made based on different parameters a weighting factor should be set for each one. So, in the final assessment parameters which are more important to the development of aquaculture activities carry more weight. For example, water quality is a more important factor for aquaculture than the bathymetry of the area, so when the suitability of an area is assessed on these parameters, the former must outweigh the latter in the final outcome. For this weighting, it is essential to be clear about the importance of each parameter considered in the study in relation to the others. This will guide the process of obtaining and introducing the information in the system.

Data should be obtained through prospective work and validated. For this purpose, professional independent working teams should be defined to assure the quality of the data. Another type of data defined is the metadata. This is the data of the data, or the information of the data, such as the source of the information, coordinate system used, validity of the information, body which updates it, degree of confidentiality, etc.

Output and understanding.

It is important to highlight that a GIS is not just a computer system for drawing maps, although it can produce maps to various scales, on different projections and in several colours. A GIS is an analysis tool for identifying spatial relationships between the distinct pieces of information contained in a map. A GIS does not store a map in a conventional manner. It stores data from which it can create the appropriate representation for a specific purpose or generate new maps using the system's analysis tools.

But in all this process, simplicity without loosing quality should be a characteristic in order to assure understanding and correct interpretation. In this sense, when assessing potential aquaculture areas, three levels of suitability (high, medium and low) should be defined**.** That is sufficient for establishing space management benchmarks for aquaculture development. It is not a good idea to distinguish too many degrees of suitability, which may ultimately prove difficult to interpret.

In any case, this tool has special characteristics such as flexibility and adaptation that allows the development and evolution of the tool to the changing environment, administrative and socio-economic situation.

All these components together with, perhaps the most important one, the reliability of the information, helps the process of site selection and site management. At the same time it gives support to the sustainable development of aquaculture from its own characteristics and for its inputs to knowledge, participative processes, and so.

Justification

When deciding whether a zone is suitable for aquaculture large number of factors has to be taken into account, ranging from the purely administrative to physical, chemical and environmental parameters.

The pieces of information processed to obtain a criterion of suitability are of so many different types that interrelating them all is very complicated. In this regard, the use of a geographic information system as an information integration tool is extremely useful in the selection and management of areas for aquaculture.

Once the spatial component has been included in the information held (georeferencing), a model of the area can be produced and the data processed on the basis of their common component (their position in space). Because of its ability to integrate information, a GIS should be used to characterize a potentially suitable area for aquaculture, since it is an extremely useful tool for multi-criteria decision-making.

Principle

Geographical Information Systems (GIS) should be used as a tool for site selection and site management.

Guidelines

- **Geographical Information System should be used as a tool on participative and o-construction processes:** This will help the understanding and focus the discussion on the real problems, providing equilibrium of power to all the stakeholders.

- **The information contained in a Geographical Information System should be objective and based on reliable sources.** Since these are tools for decision makers, the information must be based on good authority and only be open to question by means of empirical demonstration.

- **The information stored in a Geographical Information System should be maintained and kept up to date.** A GIS should be considered a live element in which contained information varies over time and it should therefore avoid decision-making errors resulting from the use of outdated data.

- **Information on the characteristics of the data contained in the Geographical Information System (metadata) should be made available.** The metadata must conform as far as possible to internationally recognised standards providing reliability.

Example: Location of suitable areas for the development of aquaculture in Andalusia

Between 2000 and 2003, the Directorate General for Fisheries and Aquaculture, part of the Regional Ministry of Agriculture and Fisheries of the Andalusian Junta, conducted the study called ‘Location of suitable areas for the development of aquaculture in Andalusia’, the main objective of which was to create a tool to support Sectoral Planning for the aquaculture sector in Andalusia.

For the selection of areas, as much information as possible on the Andalusian coast was collected during the first phase. This focused on administrative aspects relating essentially to the uses, activities and occupations of the public shoreline that might interfere with aquaculture due to competition for space. Thus, in the second phase, work could focus on the analysis of the technical environmental aspects of those areas that had been identified as being of interest in the previous stage of the study.

The use of GIS as a working tool was decided upon for the storage, processing and analysis of all the data collected throughout the study; this system proved really essential for achieving the desired results.

For the first phase it was decided to store the administrative information using a vector model, as the parameters to be represented had well-defined geographical locations (primarily polygons and lines), so that the final result could be represented using this model (Figure 6).

The criterion used for evaluating the suitability of areas for aquaculture development was based on the compatibility of this activity with existing uses of the same area. The suitability of areas was considered high where their current uses were fully compatible with aquaculture, medium where their existing uses, while not incompatible with aquaculture, might impose some limitations to its development, and low where their existing activities were incompatible with the development of aquaculture activities.

For the second phase of the study, the various physical, chemical and environmental parameters that were used in assessing the areas were stored in the GIS using raster models. This was because the parameters to be represented, obtained from sampling campaigns, were mostly numerical values that varied continuously in space (surface water temperature, average current speed, salinity, etc.).

Once the raster model had been set up, each parameter was given a score depending on its suitability (-1 for low suitability, 0 for medium suitability and 1 for high suitability). This score was assigned in a reclassification operation in which different value ranges were grouped according to their suitability for aquaculture activities.

For example, in the case of the bathymetry of the area, the study considered the best depths for locating aquaculture facilities to be between 20 and 50m, while shallower depths were not considered appropriate. Although facilities can be located where depths are greater than 50m, such depths are not the most suitable because of the high cost of maintenance. Thus, bathymetry values of less than 15m were assigned low suitability (-1), bathymetry values between 20 and 50m high suitability (1) and depths exceeding 50m medium suitability (0) (Figure 7).

In the case of the area’s environmental value parameter several factors were considered, such as existing communities, species diversity and abundance, etc. These variables were combined in an overall score derived from the weighted scores for each of the factors considered. This final overall score was used to rate the suitability of an area based on this parameter (Figure 8). A similar method was used to assess the suitability of an area in terms of water quality, in which a water quality score was used that was derived from factors such as temperature, salinity, dissolved oxygen, turbidity, chlorophyll, etc.

Finally, all the scores for all the parameters considered were used to produce a final weighted suitability score for the various areas studied (Figure 9).

Lastly, the evaluations made in the first and second phases were combined to provide the final assessment of the suitability of the various areas studied for aquaculture development. Areas of low suitability in either phase retained that level of suitability. Those of medium suitability in either phase remained as such provided they were not rated low in the other phase. Finally, areas of high suitability for the development of aquaculture were defined as all those which were not rated medium or low in either of the study phases (Figure 10).

The end result of this work is a useful tool for the management of aquaculture activities, not only for the authorities with jurisdiction in the field, but also for entrepreneurs, who gain some initial guidance on potential locations for their future facilities.

Glossary

Aquaculture license fee (Rosa Chapela)

It is a fee that must be paid for holding an aquaculture license. Normally this fee is paid because of the use and/or occupation of public domain areas (water or land).

Aquaculture license (Rosa Chapela)

Permit and legal document giving official authorization to develop aquaculture. This kind of permit can be represented in different ways: permit of aquaculture -the availability for develop the activity- and Authorization or concession: the permit for public domain occupation when the applicant comply with the requirements of the regulation (environmental and aquaculture).

Area of interest

In site selection for aquaculture it refers to coastal and maritime areas which are free of incompatibilities or interference of uses from the administrative point of view and are selected by governments to encourage the development of aquaculture.

Aquaculture site fallowing

Refers to leaving an aquaculture site empty of fish stock and all removable production structures during a certain period of time. It can be done for environmental or sanitary reasons. For an aquaculture company fallowing implies the disposal of several sites in order to maintain production capacity year round.

Carrying capacity

According to FAO, *"Carrying capacity is the amount of a given activity that can be accommodated within the environmental capacity of a defined area"*. In aquaculture: *"usually considered to be the maximum quantity of fish that any particular body of water can support over a long period without negative effects to the fish and to the environment"*.

Coastal Zone Management

Costal zone management can be defined as *“the management of the coastal and marine areas and resources in order to have a sustainable use, development and protection”*.

Cost Benefit Anlaysis (Shirra Freeman)

A decision-support framework that compares the costs and benefits of a project or an action. Generally, cost-benefit analyses are comparative, that is, they are used to compare alternative project proposals on the basis of their net benefit. The Cost-Benefit Decision rule is that no project with a net benefit of less than zero should be implemented and the project with the highest net benefit of all candidate projects should be accepted. Various types of Cost Benefit Analyses are recognized. These include financial, socio-economic and environmental.

Decision-maker

Person, group or organization whose judgments can be translated into binding commitments.

Economic/Monetary Valuation (Shirra Freeman)

Determining an economic value to environmental factors and considerations. This helps give weight to such considerations where they might otherwise not be taken into account. Full valuation requires significant information, time and resources. Valuation methodologies may be based on actual markets, surrogate markets or non-market techniques.

Ecosystem objective

Ecosystem attribute which is a particular aim stakeholders agreed upon; it can relate to the protection of a specific species, specific area or function the ecosystem provides locally.

Environmental Externality (Shirra Freeman)

An activity by one agent that causes a loss/gain to welfare of another agent and the loss/gain is uncompensated.

Exposed Aquaculture

Aquaculture is usually defined as “exposed aquaculture” when “*cage aquaculture is developed in marine areas not protected by the coastline from adverse marine conditions*”.

One-stop office (Rosa Chapela)

The agency or department that provides combined services from different areas or competences. In terms of aquaculture procedures, this kind of office acts like a central register receiving all information provided coordinated services. It is like a primary hub for service delivery referrals.

Public domain (maritime and terrestrial zones) (Rosa Chapela)

Areas that are public property. They are managed by the State and in general are available for the public. The State determines the particular uses of each of these areas, and may offer concessions or authorization to private or public organizations for exclusive uses.

Production cycle

It is considered as the time necessary to grow any aquaculture specie to marketable size.

Sheltered Aquaculture

Aquaculture is usually defined as “sheltered aquaculture” when “*cage aquaculture is developing in marine areas protected by the coastline from adverse marine conditions*”.

Site selection and site management

Site selection is the process of selecting a certain space in the marine environment, considering related aspects such as: environmental, technical, legal, administrative, social and economical, in order to set up an aquaculture project. Site management refers to all the aspects related to the on going of the site taking into account, environmental, legal, administrative and managerial considerations of the activity.

Stakeholder

Person, group, or organization that has direct or indirect stake in an organization because it can affect or be affected by the organization's actions, objectives, and policies.

Stressor

It points out the part of the activity that will affect the ecosystem component.

Total Economic Value (Shirra Freeman)

The sum of all function-based values provided by a given ecosystem and measure in monetary units. The values may stem from direct uses of the ecosystem services or from benefits derived by people who make no direct use of them. Measurement may be based on market activity or elicited through a variety of methods for valuing goods and services for which there is no market.

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List of Acronyms

ACO:	Aquaculture Consultant Office
APROMAR:	Spanish Marine Aquaculture Producers Association (Asociación Empresarial de Productores de Cultivos Marinos)
BRLi / SECA:	French Consulting Office on Environment
CBD:	Convention on Biological Diversity
CETMAR:	Technological Centre of the Sea (Centro Tecnológico del Mar)
COHERENS:	Coupled Hydrodynamical-Ecological Model for Regional and Shelf Seas
DAP:	Public Entreprise Agricultural and Fishing Development (Empresa Pública Desarrollo Agrario y Pesquero)
EC:	European Commission
ECASA:	An Ecosystem Approach to Sustainable Aquaculture. European Union FP 6 (Sixth Framework Programme)
EEA:	European Environment Agency
EMAS:	Eco-Management and Audit Scheme
EU:	European Union
FAO:	Food and Agriculture Organization of the United Nations
FEAP:	Federation of European Aquaculture Producers
GESAMP:	Group of Experts on the Scientific Aspects of Marine Environmental Protection
GFCM:	General Fisheries Commission for the Mediterranean
ICES:	International Council for the Exploration of the Sea
ICPE:	Installations Classified for the Protection of the Environment
IEO:	Spanish Institute of Oceanography (Instituto Español de Oceanografía)
INRA:	National Institute of the Agronomical Research (Institut National de la Recherche Agronomique)
IUCN:	The World Conservation Union

ISO:	International Organization for Standardization
JACUMAR:	National Marine Aquaculture Advisory Board
MAP:	Mediterranean Action Plan
MOHID:	Water Modeling System
NINA:	Norwegian Institute for Nature Research
NOAA:	National Offshore Aquaculture Act
OECD:	Organisation for Economic Co-operation and Development
OSPAR:	Oslo/Paris Convention (for the Protection of the Marine Environment of the North-East Atlantic)
PAP/RAC:	Priority Actions Programme Regional Activity Centre
RAC/SPA:	Regional Activity Centre for Specially Protected Areas
SEPA:	Scottish Environmental Protection Agency