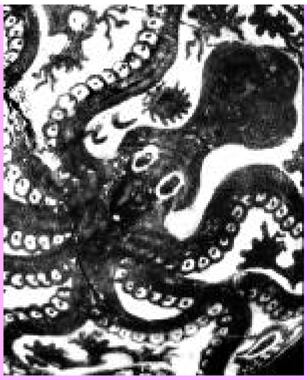

PRIORITY ACTIONS PROGRAMME

MEDITERRANEAN ACTIONPLAN

UNEP

In cooperation with:

IFREMER

INSTITUTE OF MARINE BIOLOGY OF CRETE

APPROACHES

FOR ZONING OF COASTAL AREAS WITH REFERENCE TO MEDITERRANEAN AQUACULTURE

PAP-10/EAM/GL.1

Priority ActionsProgramme
RegionalActivityCentre
Split,Croatia

Note: This document was prepared by the Priority Actions Programme Regional Activity Centre (PAP/RAC) of the Mediterranean Action Plan, UNEP, in collaboration with the French Institute for Sea Exploitation (IFREMER) and the Institute of Marine Biology of Crete (IMBC). The authors of the document are: Antoine Dosdat, Maurice Héral, Ivan Katavic, Marc Kempf, Jean Prou and Chris Smith.

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PREFACE

This document was prepared in the framework of the network on "Environmental Aspects of Aquaculture Management in the Mediterranean" (EAM network). It is implemented by the Regional Activity Centre for the Priority Actions Programme (PAP/RAC) of UNEP's Mediterranean Action Plan (MAP), Split (CROATIA), while overall coordination is provided through General Fisheries Council for the Mediterranean (GFCM) and its Committee on Aquaculture.

On the occasion of a number of seminars organized by UNDP-sponsored Mediterranean Regional Aquaculture Project (MEDRAP II) and PAP/RAC, participants expressed the need for the preparation of document for selection of sites suitable for aquaculture. Discussions centered on the problems of identification of zones suitable for aquaculture, definition of the criteria and methodology for the zoning, as well as the proposal of appropriate protection measures for existing and future aquaculture operations, all as part of the process of integrated coastal area management (ICAM).

In accordance with the recognized need, the purpose of the present document is to provide an efficient and standardized tool for coastal zone planning to ensure a sustainable development of the aquaculture industry whilst minimizing conflicts between different users of coastal resources.

The structure and the content of the document were defined at the expert meeting held in Split, in October 1994. The first draft of the document was reviewed during the meeting held in Toulon, February 1995, and finalized by the individual work of the authors. The second draft was presented and discussed at the workshop on the Selection and Protection of the Sites Suitable for Aquaculture held in Iraklio (Crete), in November 1995.

The preparation of the document benefited from suggestions by PAP/RAC staff, in particular by A. Pavasovic and I. Trumbic. Professional suggestions on the draft text provided by U. Barg (FAO) are greatly appreciated.

CONTENTS

EXECUTIVE SUMMARY

Marine aquaculture as a relatively new sector capable of economic growth and benefits is now moving beyond its traditional stages to the point where it needs to have a recognizable and effective position - both in developmental and regulatory terms. In that context selection of the site is of vital importance since the quality and characteristics of the site are essential for both farming performance and reducing the negative impact on the environment.

Site selection procedures are closely related to the coastal zone planning and management policy, especially in a climate of competition for coastal space and resources use. Aquaculture must be considered as a coastal activity having the right to exist and necessary conditions should be preserved for its development. Environmental management should consider aquaculture as a part of the whole resources system upon which it relies. Relations between aquaculture development and coastal resources and the relations between aquaculture and other users of these resources need to be harmonized.

The document therefore suggests that coastal zonation relevant to aquaculture must be included in the national policy and with the goals it define at every level, mainly the control of developmental activities affecting the sustainability of coastal resources. When the decision of the planning process is taken, a specific procedure is to be set including the delimitation of the areas to be zoned, an extensive collection of data in order to complete the first database on natural and socio-economic environments, an application of the aquaculture specific requirements to the context of a given zone in order to determine its suitability and sustainability. The process is ended when a political decision is taken, indicating the ability for a zone to be utilized, exclusively or not for aquaculture purposes. A necessary updating of the database and of the regulatory measures is often required within the process of decision making.

Regulation is required for the promotion of sustainable aquaculture and its integration into coastal zone planning and management. This covers various fields, which may be complementary: environmental and living resource protection, land use, regional and sectorial development and management, aquaculture itself, including resolution of conflicts.

Environmental and living resources protection applies to environmental quality objectives, living resources, as well as species, biotopes and other natural resources. Regulations exist at international and national levels and may have regional and local implications (quality criteria, conventions, endangered species, protected areas, restrictions on certain activities, ...).

Land use, regional and sectorial development and management calls for effective and realistic regulations and planning tools which are specific to each country and related to its political priorities and administrative organization. According to this, their application may be more or less decentralized (land use plans, master plans for specific territories or activities, planning schemes, ...).

Aquaculture development and protection is concerned by its own regulations, applying to it directly or indirectly: development policy and plans, siting, competition with other coastal zone users, environmental compliance.

Aquaculture, being highly dependent on a healthy environment, is also the best guarantee for its quality. Thus, environmental considerations must be integrated at an early stage in any project. But over-regulation has to be avoided, because it may advantage less environmentally friendly activities. Moreover, aquaculture can be of great value in terms of land use and occupation, population prosperity and stabilization, best use of renewable resources. Therefore, there is an urgent need to integrate it as an important and legitimate activity in coastal zone development, planning and management strategies.

1 BACKGROUND

Marine aquaculture has shown a large expansion in production in a number of Mediterranean countries over the past few decades. It provides an important source of high quality food and could be considered to be an important management tool to limit pressure on wild fish stocks which are heavily stressed due to overfishing and pollution in coastal areas.

Aquacultural activities require good quality water. Degradation of the surrounding environment may result in increased stress and incidence of disease of the culture species and a consequent decline in productivity.

As the aquaculture industry expands, it can create different kinds of environmental and socio-economic problems. Firstly, it comes into conflict with other users of coastal resources, and secondly, if not properly managed and regulated, it can cause environmental harm.

The degree of interaction between aquaculture and the environment depends on the sensitivity of the ecosystem where it is implemented, on the culture system, and on the species. As a result of these interactions and of the growing public concern of environmental problems, the choice of sites for the aquaculture operations is becoming more important.

The future expansion of aquaculture must be based on well balanced interventions through integrated coastal area management plans. This should consider aquaculture in relation to all other existing and planned activities and developments. The careful selection of the sites will minimize specific impacts on the ecosystem and reduce the effects of negative feedback which affect the production potential of the culturing operation.

The purpose of this document is to assist the Mediterranean countries in establishing control over planning the use of coastal and insular zones for aquaculture activities by combining scientifically based principles and a pragmatic approach in positioning the "right activity on the right place".

The specific objectives of the document are defined as follows:

- To ensure the continued development and growth of the aquaculture industry without causing large-scale conflicts with other users;
- To assist in the process of coastal area planning and to achieve effective regulation of the future aquaculture development.

The document is based on relevant published information and currently available experience. It is focusing on the countries bordering the Mediterranean basin. However, it is believed that, if adapted, it could be applicable in other parts such as Black Sea. The document is addressed to decision makers, planners and managers, and all those who are involved in the process of coastal area planning, aquaculture regulation and development. The document is not an exhaustive manual presenting a rigid set of prescribed steps and procedures. It is a flexible approach giving the most suitable options in zoning of coastal areas for aquaculture in the Mediterranean basin. However, the real application is to be adapted to the local relevant conditions, the size, nature and actual circumstances of the area considered.

2 THE ROLE OF AQUACULTURE IN INTEGRATED COASTAL AREA MANAGEMENT

In defining the role of aquaculture in ICAM there is a need to point out that this industry is relatively new and that its development has coincided with a large increase in environmental awareness. Unlike other industries located in the coastal zone, aquaculture relies heavily on natural aquatic resources, and it is characterized by the demand for a very high quality of environment. Because of its specific site requirements and competing interests for coastal space, aquaculture development tends to be forced into disadvantaged regions, sometimes with limited opportunities for success.

To be successful, the aquaculture industry requires many inputs - biophysical, social, economic etc. However, it also may have multiple impacts on the environment, some positive and some negative. For example, it has been blamed for navigational disturbance, pollution of the coastal environment (visual, organic, chemical and genetic pollution), as well as for disease and parasite transfer to natural fish populations. On the positive side it produces a valuable product for consumers. It can also be a promising activity in rural areas. An important positive physical impact is that the presence of a fish or shellfish farm will help discourage pollution and habitat degradation from less environmentally friendly industries. Aquaculture may generally be considered as a kind of guarantee for water quality and integrity of the environment as a whole. It should be noted that where aquaculture projects have resulted in pollution, the principal causes have been improper siting and poor management.

The impacts of aquaculture on social conditions have not been studied enough. In rural areas, in particular, its importance has also been neglected. In addition, most of the rural coastal communities rely heavily on one activity (e.g. agriculture, traditional fisheries or tourism) that may be vulnerable to external financial inputs.

Aquaculture in most cases represents a new activity in an area, and as such has to establish rights of access to coastal areas and resources in the context of the existing. Most legislative systems will act to protect the established activities. In general, legislation and regulation in most countries are often inadequate and non-specific to aquaculture. They are based upon the existing regulators framework for other related sectors and may not be particularly beneficial for integration of aquaculture and other activities in coastal zone management plans.

Since aquaculture uses both terrestrial and aquatic environments, it has experienced much duplication, confusion and uncertainty. This results in conflicts with other coastal users and managers as, for example, the frequent problems with tourism. Each of these users have different requirements and aspirations. Of most relevance to integrating aquaculture into ICAM is the interaction between scientists, ICAM policy planners, economists, general public and neighboring coastal communities. Each of these groups require information in a format understandable to them. The lack of effective transfer of information between these groups is considered a major obstacle in integration of aquaculture into ICAM policies and resource allocation strategies.

The role of aquaculture in ICAM is to develop the industry with a full appreciation of environment/production interdependencies and allow it to become an integral part of the overall ecosystem. ICAM will take advantage of a full integration of aquaculture if techniques, planning and management is harmonized with the natural ecosystem and compatible with other coastal users so that any negative impact is minimized.

3 AQUACULTURE IN RELATION TO COASTAL AREA USES

Site selection for aquaculture is probably one of the main factors that determines the feasibility and sustainability of aquaculture projects. However, the coastal zone is under pressure from many different competing activities which may affect existing and future aquaculture operations.

3.1. Relationships between aquaculture and other coastal area users

Competition for space is one of the most critical factors of the relationships between aquaculture and other activities. Fishing zones, spawning areas, nurseries, artificial reefs, access to harbors, military zones, land reclaiming, protected or reserved zones, dredging, recreative activities such as bathing, sailing or fishing may be submitted to regulations which limit the possibilities for selecting suitable areas for sea-based aquaculture. Land-based aquaculture system interact naturally with all other developed activities on the seashore and especially with urbanization, industry, tourism and agriculture activities.

Aquaculture development is under controlled of quality of the environment, mainly the water quality as well as the bottom conditions. Chemical pollutions are generated by industrial activities, by intensive agriculture with large uses of pesticides (weedkillers) and also by recreative activities with the general use of antifouling and preservative paints (TBT, heavy metals, pesticides..). Bacteriological pollution is more related to permanent urbanization and to tourism which often cause an overpass of the sewage treatment capacities. Biological pollution is connected with the discharge of ballast waters causing invasion of non indigenous species as cholera vibrios, toxic algae and several other pests. Genetic escapes of cultivated strains can present a high risk for the sustainability of wild strains of fish and shellfish. Disease transmission from aquaculture to fisheries can provoke deleterious effects on the wild stock. Industrial and agricultural practices lead often to modify freshwater inputs in the coastal waters. Power plants with warmed water discharges, large settlements with sewage, agriculture with drainage and irrigation, dams with both uses: control of run-off and of dryness can have positive or negative effects (nutrients, salinity, organic matter) function of their intensities and of the dispersion capacity of the coastal areas. Water quality entering an aquaculture system shows a large time-scale variability and should, therefore, be viewed as a dynamic process. For example, pollution reaching the aquaculture system, could have a distant origin, but be transported into the area by local currents. Concentrations of a pollutant could be at very reduced levels, but on a large time scale could contaminate the reared species to a harmful level. Water quality standards are, therefore, often difficult to establish and the source of pollution is difficult to locate because of dispersion processes. Over-urbanized or industrialized areas are often responsible for organic matter discharges leading to eutrophication or oxygen depletion. Although sewage can be depurated, viruses could pass through the depuration plant and be responsible for viral pollution.

Economical facilities for aquaculture development are positively influenced by attraction of investment and of infrastructure (roads, electricity supply) connected with industry, urbanization and tourism. Tourism provides often the development of local markets for aquaculture products. Fishery activity in the vicinity of aquaculture could also have a positive effect by providing aquafeeds and enhancing demand for aquaculture products.

Aquaculture development refers also to social constraints. Urbanization may involve new ways of living where fresh fish and shellfish consumption could be replaced by new standards of human nutrition (frozen and cooked products, high quality). Existing fishery education system could have a positive effect for education for new aquaculturists. However, competition between aquaculturists and fishermen could arise especially in low settlement areas where transfers of employment from fishery to aquaculture occur and lead to social disturbance. Development of wildlife preservation and seascape preservation may lead to major constraints on aquaculture development and social conflicts with local inhabitants and tourists. On the opposite, ecotourism provides mutual benefits between tourism activity, discovery of wildlife and aquaculture practices.

In the coastal zone, the pre-existing activities are protected by large sets of regulations from multi-national level, trough national plans to municipality level. All these regulations are presenting main constraints for the development of new activities such as aquaculture.

Table 1: Relationships between aquaculture and other uses of coastal area

ACTIVITY	INDUSTRY AND HARBOR	URBANIZATION	TOURISM AND RECREATION	AGRICULTURE		FISHERIES
				INTENSIVE	EXTENSIVE	
SPATIAL RESOURCES	- land reclaiming (-) - shipping traffic (-) - military zones (-) - dredging (-)	- land use (-) - land reclaiming (-)	- land reclaiming (-) - harbors (-) - sailing, bathing (-) - fishing (-) - historical sites (-)	- coastal land (-)	- coastal land (-)	- spawning areas (-) - nurseries (-) - artificial reefs (-) - fishing zones (-)
QUALITY OF ENVIRONMENT	- pollutants (-) - ballast water (-) - warmed water (+)	- sewage (-) - organic matter (-) - bacteria and viruses (-) - nutrients (-)	- sewage (-) - antifouling paints (-)	- fertilizers (-) - pesticides (-) - organic matter (-) - suspended solids (-) - freshwater management (-)	- nutrients (+) - organic matter (+) - freshwater management (+/-)	- disease transmission (-) - genetic escape (-)
ECONOMY	- infrastructure (+) - attraction of investment (+/-)	- market (+) - infrastructure (+)	- attraction of investment (+/-) - seasonal employment (+/-) - local market (+) - infrastructure (+)	- infrastructure (+)	- infrastructure (+)	- attraction of investment (+) - market (+) - infrastructure (+) - fish meal for aquafeeds (+)
SOCIAL RESOURCES		- living habitats (-)	- eco tourism (+) - seascape (-) - wildlife (-)			- internal competition (-) - education (+)
REGULATIONS	- areas around (-) - harbors reserved (-) - military zones (-)	- municipality (-) - policy (+/-)	- protected area (-) - wild fauna and flora (-) - environmental standards (+)			- sanctuaries for fisheries (+/-)

(+) in favor of aquaculture development
(-) negative effect relationship to aquaculture development

3.2. Relationships between aquacultural practices

Spatial conflicts could occur between traditional aquaculture system, mainly shellfish cultivation (oysters and mussels) but also finfish as mullets and new aquaculture practices such as fish farm cages and long lines for shellfish. However, the water column could be managed at different levels such as surface, water mass, bottom. Both shellfish cultivation and finfish aquaculture could be damaged by disease due to pathogens. In some cases, pathogens from finfish can be accumulated by the shellfishes cultivated in the vicinity. Furthermore, treatments by drugs as antibiotics and antifouling substances used for finfish cultivation can have deleterious effect on the shellfishes cultivated in association.

Both activities are producing a large amount of biodeposits which can have an adverse effect on the bottom quality causing anoxic conditions when current velocities are too low to avoid stratification.

Carrying capacity for the extensive shellfish culture is a relation between the fluxes of food and the biomass of wild and cultivated animals present in an area. Over a certain biomass, carrying capacity may be over passed and may cause, by trophic limitation, reduced growth rates and increased mortality.

For land-based aquaculture systems, seawater availability can be a serious limiting factor when the farms are using underground seawater or when they are located in wetlands.

The ability of the ecosystem to accept the wastes of the finfish farms is defined as the holding capacity. In some cases, when current are too low or when residence time of water masses are too long, dispersion of wastes may affect the water quality. In land-based farms, with recirculating system, water volumes must be sufficient to allow depuration. In integrated aquaculture systems, shellfish or finfishes could be used for recycling wastes.

Consumption of marine products is very often limited to some restricted areas and species. Development of aquaculture (finfish or shellfish) could enhanced the consumption of new products and correlatively could contribute to the implementation of new ways of marketing and creation of networks for commercialization of marine products.

New aquaculture technique needs qualified skills, provided by special training courses. This education system could benefit to the marine workers (fishermen, traditional aquaculturists). However, in places where manpower is scarce, competition between different activities could occur by transfer of employment from one to the other.

Implementation of license system could promote creation of administrative arrangements, which could be favorable to the management of aquaculture and development of water quality monitoring (bacteriological standards, toxic algae, heavy metals, pesticides...).

Table 2: Relationships between aquacultural practices

ACTIVITY	INTERNAL RELATIONSHIPS		FINFISH/SHELLFISH RELATIONSHIPS
	SHELLFISH	FINFISH	
SPATIAL	- already established activity (-)	- already established activity (-)	- already established activity (-)
QUALITY OF THE ENVIRONMENT	- pathogens (-) - biodiversity (-) - biodeposition (-) - anoxia (-) - genetic (-)	- pathogens (-) - waste (-) - food faeces (-) - treatments (-) - genetic (-)	- pathogens (-) - biodeposition (-) - anoxia (-)
WATER QUANTITY AND DYNAMICS	- carrying capacity under (+) above(-)	- (land-based) wetlands - (land-based) underground seawater (-) - holding capacity under (+) above (-)	- Integrated aquaculture systems (+)
ECONOMY	market (+)		
SOCIAL	internal competition (-) education (+)		
REGULATIONS ADMINISTRATION	licensing or leasing system (+) monitoring (+)		

(+) In favor of aquaculture development
(-) Negative effect relationships to aquaculture development

4 CRITERIA AND PROCEDURE FOR COASTAL ZONING

4.1. Organization of the planning process

In the context of the coastal zone, planning refers to the development of goals and policies in order to optimize the production of goods and services from predefined areas over time.

The first phase of such a planning procedure that is to be managed for every coastal specific use, must be the definition of a national policy. This policy has to define:

- the coastal area involved in the planning decision. Concerning aquaculture, planning can be foreseen at different scales: national, regional, local or farm level. Generally, at this stage of planning, the area is relatively broad;
- the goals and objectives of development and environmental protection.

A legislative action is often necessary, that can give the authorization to launch the planning procedure.

The policy statement will lead to the structuring of actions within the planning procedure: definition of the executive authority, stating the participation of governmental agencies and experts, funding the work to be done and determining the time schedule. Only general directives and goals are required at this level, such as "sustainable development of living resources". There is some danger at this stage however, in becoming locked into specific activity that could restrict the credibility of the process.

The next stage of the planning process involves preliminary data collection that could enable the definition of more precise or smaller zones, and can be described as a management zone. A global data base is the necessary tool to collect information concerning activities, environmental conditions, and existing regulations. The needs of existing or potential future activities must be stated using the existing data.

Concerning specific requirements for aquaculture activities, the first and most important source of information is a bathimetry map, that can subsequently be used for different types of coastal water planning. For example, when there is a need to know which coastal area is the most suitable for cage farming and when data on water turnover and predominant bottom type are lacking, the map can help for making a first rough assessment.

One principal hypothesis, is that morphology has a major impact on the ecological functioning of the water system, since it is both costly and time-consuming to determine the turnover of deep and surface water, and bottom dynamic conditions. It would be advantageous if these parameters could be predicted directly from chart information. If not sufficient, the capability to acquire new data must be foreseen.

The following phase deals only with aquaculture activities and their specific requirements. The objective is to determine the suitability of every type of aquaculture for defined zones. It must lead to definition of smaller areas within the zone (aquaculture site), in which aquaculture can be authorized or restricted on the basis of environmental suitability and availability of essential infrastructures. It requires the building of a specific database.

Lastly, planning must define the necessary measures in order to implement the work and to make available the recommendations from the actual Coastal Plan available. This also concerns the updating of the databases.

4.2. Description of the procedure

The procedure is shown in the flow chart presented in Figure 1. Four phases can be determined.

Phase 1: Definition of the policy

Planning decision

The policy statement should declare in the strongest terms possible that it is the intention of the nation to review and regulate over developmental activities affecting the sustainability of renewable coastal resources. The goal should be maintenance of the optimum sustainable use of coastal resources, in both the economic and social context. The policy should then list specific national coastal concerns and issues to be addressed and state the priorities of the nation toward coastal resource utilization and conservation.

Policy statement: structuring the project

The strategic plan lays the foundation for the legislation or the executive order that is required to authorize the Programme Development phase that follows. The strategic plan should:

1. specifically assign responsibility for the programme to a particular agency, and identify interagency mechanism;
2. authorize the funding necessary for programme development;
3. state clearly the objectives of the programme;
4. recommend a method for collaboration amongst the various sectoral agencies and private interests involved;
5. state the time limits involved for various stages of programme development; and
6. require a specific step-by-step programme development and organizing process.

Delimitation of areas

To establish manageable units for the information base and mapping, the first phase involves the partitioning of coastal boundaries into coastal areas. They may be fixed units following administrative or geographical boundaries (i.e. region, country, prefecture). The registration of suitability for aquaculture involves a rough evaluation of communal and natural limitations of a certain coastal area. At this level, the major problems are identified and decisions are to be taken as regards the initiation of the planning process. Information bases contain existing sources of global data only, supplemented by expected future trends.

Phase 2: Database constitution

The database must be constructed in such a way that it allows analyses to be pursued along the lines of the predefined aims of the planning. Geographic Information System (GIS) are powerful tools in order to achieve this goal. A precise content of such a database is given in Annex B. Schematically, it should proceed from:

- an analysis of the natural environment: physical processes, protection, foreseen dispositions, impact of activities, etc.
- an analysis of the economic systems: existing economic activities, evaluation of the demands for coastal resources, etc.

This data base is not merely dedicated to aquaculture, but should include information on aquaculture activity (existing farms, main requirements..)

Criteria for zoning

Criteria refer to the original data of the database to which thresholds are attached (ex.: the data base gives an extensive bathymetry map, and zoning process states that the isobathes -25m and -50m will be criteria for demarcating the boundaries of the zones). To this level, in addition to the global infrastructural, social and economical considerations, ecological parameters are the most relevant (Annex C).

Zoning

Because of the great diversity of environmental conditions, even within relatively small coastal areas, these may be divided into smaller manageable units (-zones-) depending on topography, productivity and water regime. The principle of this division is that each major water volume is handled separately as either lagoon-like zones, bays, channels or estuaries, so called homogenous zones. Zonal limits should be identified without regard to administrative borders. The idea is that this may lead to co-operation rather than competition between neighboring municipalities on the use of the water bodies which should be seen as common resources. Incentives for such co-operation are often needed.

Phase 3: Identifying zones suitable for aquaculture

The objective of this phase is to determine the suitability for aquaculture within the zone. It is the first phase entirely dedicated to aquaculture operations, even if some aquaculture requirements had been taken into account in Phase 2.

Such an analysis is aimed at:

- protecting existing aquaculture sites;
- ensuring sustainable growth of the aquaculture industry in the future;
- providing responsible authorities with tools to locate optimal and sub-optimal areas suitable for aquaculture in agreement with holding/carrying capacities of the environment and environmental quality objectives;
- advising on opportunities and limitation for minimizing conflicts with other users.

A specific database is necessary to meet the aquaculture needs.

Initial elimination

To restrict the need for data collection, zones of no interest for any kind of aquaculture should be eliminated initially by applying “eliminating” criteria of high risk and incompatible uses (Table 3). A number of zones may be unfavorable either due to natural conditions and/or anthropogenic activities. In addition to unsuitable zones, there will be zones limited by other purposes where aquaculture may be forbidden (i.e. nature reserves, animal protection zones, existing aquaculture, security zones, navigation zones, military zones, etc.). Having eliminated all these zones from the larger area one is left with suitable zones which are to be subjected to further analysis.

Table 3: Eliminating criteria - environmental characteristics that make aquaculture impossible or risky

- Severe pollution (city, harbor, industry)
- Insufficient hygienic conditions
- Unfavorable hydrodynamics
- Eutrophic areas with harmful plankton blooms
- Shipping traffic
- Specially protected areas
- Restricted areas
- Areas for intensive recreational activities
- Areas of high economic interest

Further assessment of the suitability of remaining coastal zones is based on the most common fish farming technology and the species to be cultured.

Selecting technology and species according to site characteristics

In terms of land and water resources two fundamental systems (land based and water based) are used for aquaculture production, each involving different considerations for siting, construction, operation and management. The range of the types of system (i.e. lagoons, tanks, raceways, cages, enclosures, rafts and longlines for molluscs etc.) and species used is very large and for any given set of circumstances there is a range of options. However, a clear relationship exists between these main elements which narrows down the possibilities to a quite small number, allowing the developer to match species, type of system and the main characteristics of the site (Table 4). In some cases, a certain site will suggest particular species. On the other hand, a particular system will support certain species and will require a particular environment.

In considering a particular set of circumstances in a given zone, there would be a need to assess the importance of individual factors and rank these factors according to their significance. Thus if water area is in scarce, a system requiring less water area is a major consideration. In the case of a shortage of skills, a less complex technical design may be a better choice. The analysis of the sites and resources available may indicate whether a polyculture would contribute to the maintenance of the sensitive ecological balance in the site (e.g. integration of molluscs in fish cage culture area).

An analysis of the potential consequences induced is necessary, not only on environmental aspects, but also on social and economic issues.

Concerning these, there are two major tendencies: the first is aquaculture with a higher level of social responsibility, generally by using extensive or semi-intensive rearing of species that can meet the high internal demand for affordable food; and the second tendency is the orientation towards intensive production of higher value organisms, a large part of which may be allocated to foreign markets or touristic involvement. While the first productive strategy is based on rearing species which are direct utilizers of the natural environment for their food supply, the second is using more advanced technology based on economic strategy and utilizes natural environment for folder.

Conclusively, the process results in a classification of a culture site within a zone which is presented to local (municipal) authorities to protect existing aquaculture operations from pollution threats, to promote aquaculture development as well as in evaluation of aquaculture applications. Local authorities should not be necessarily tied to this classification and may make their decision based on other factors (for example: collection of taxes, political agreement...). Finally, the methodology employed will strongly depend on capital and operating availabilities, and hence the socio-economic impact of a project.

A number of different decisions can been made that will allow a zone to be selected for the development of aquaculture.

Table 4: Criteria to be considered in selecting sites for aquaculture in marine environment

BIOPHYSICAL CHARACTERISTICS	SUPPORTING INFRASTRUCTURE	SOCIAL & ECONOMIC CONSIDERATION
Exposure	Road and communications	Local demand and supply
Depth	Electricity	International market
Current (velocity, direction)	Fish-feed manufacture	Cost of basic supply for goods
Wind (fetch, speed and direction)	Slaughtering facilities	Capital cost
Waves	Waste disposal facilities	Risks & Insurance
Topography (slope, threshold)	Health service	Employment
Substrate	Advisory service	Regulations
Suspended matter	Expertise	
Available land	Education	
Water quality-min. max. and variations (T C, %O , ppt Sal.)	Repair and maintenance	
Water quantity		
Space		
Trophic status		
Fouling		
Existing cultivated species		
Predators		

a) The area is reserved exclusively for aquacultural activities. This will occur in very few examples. The area should be protected by legislation so that any other proposed activity that might in any way threaten aquacultural activities must be submitted to the appropriate governing authority and can be refused without appeal. Existing threats should be reduced and controlled.

b) The area has been zoned for aquaculture, but not exclusively, and may also be opened to other activities. Two situations can occur: aquaculture is a priority in the zone or aquaculture is not necessarily a protected interest. In these cases, specific tools for conflict resolution must be foreseen and implemented with graded correction in function of the level of priority.

One of the potential problems is over-development of any particular area which may then have a negative feedback and may lead to conflict of interests. Once an area has been zoned for fish farming development, the carrying/holding capacity of the area should be established with respect to the extent and type of cultural activities proposed or suitable. The area should then be divided into farming units for specific application. Individual farm licenses can then be granted to applicants on the basis of the quoted capacity of the area within the allowable framework. Individual applications would still require researching and environmental impact assessment, depending on perceived potential risks and pre-determined environmental quality objectives. Environmental impact assessment requirements and procedures should be cut to size of the project and of the acceptability of environmental risk. After limited development of the area, allowance should be reviewed again with respect to carrying capacity and the appropriate "licensed quota" to be reset if necessary.

c) The area is not suitable for aquaculture activities through either non-compatible activities, unsuitable characteristics, or political decision not to support these activities in this area. Without suitable characteristics, for example, climatic conditions, the area will never be able to be used. Non-compatible activities may change in the future even in the long term so there could be a need to reassess the area if these activities and/or their effects cease. Political or socio-economic conditions can change remarkably quickly so there may be a possibility of reassessing the area in the short term.

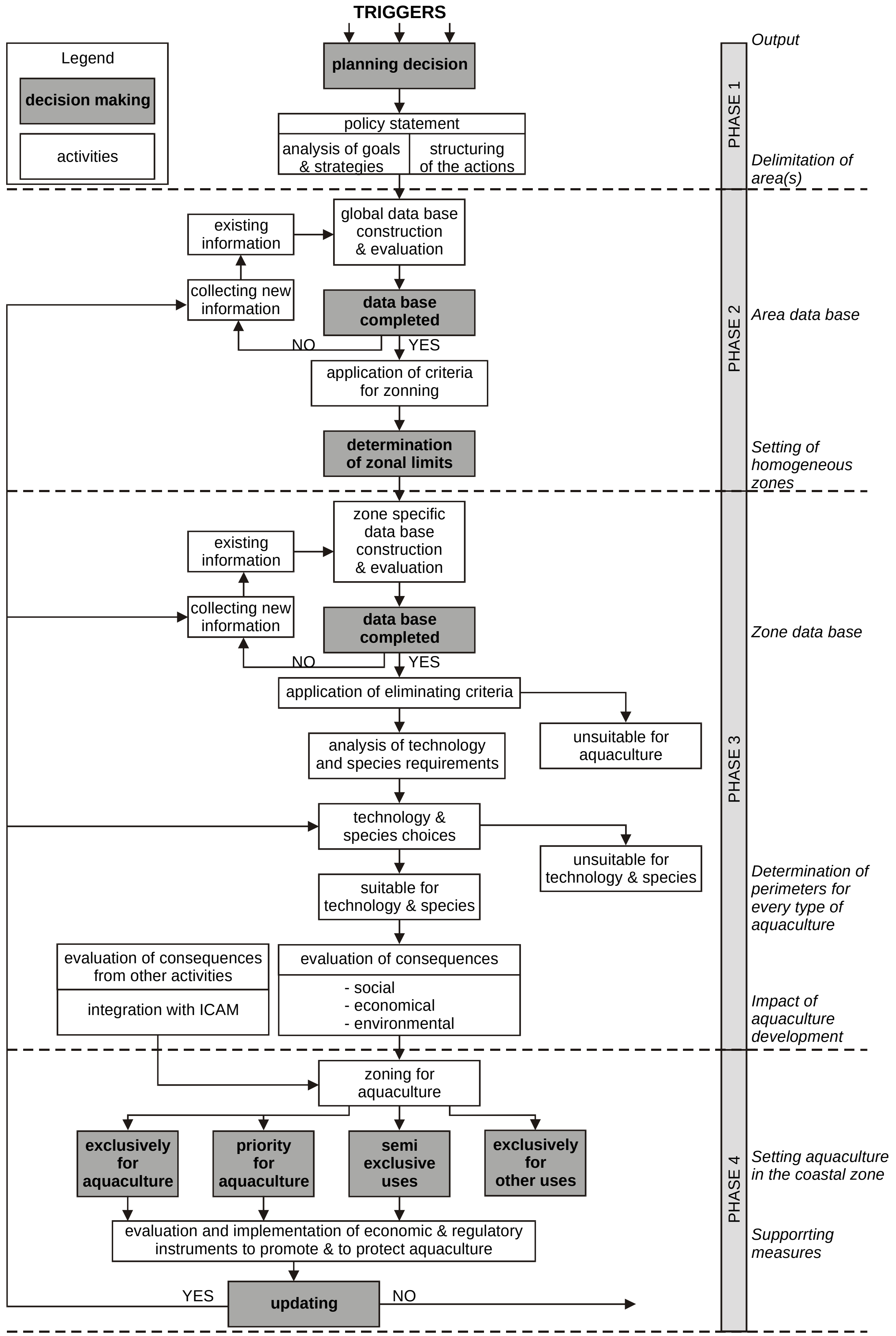
Phase 4: Enabling aquaculture development

In the case where an area has been zoned for aquacultural activities, it should be maintained as far as possible to ensure that its conditions are kept stable and that it does not deteriorate to a situation where those activities are no longer possible at the previously decided level.

In that context, a particular set of regulatory measures have to be undertaken, concerning:

- protection of the sites: e.g. prevention of pollution from other sources;
- up-dating, enforcement and implementation of the legislation;
- monitoring of the development;
- assessment of carrying and/or holding capacity;
- method for conflict resolution, e.g. round table conference, plurisectorial Commissions;
- management tools; e.g. licenses, payable rights.

Both promotion of aquaculture operations and protection of natural environment have to be encouraged through not only control instruments (regulations) but also economic incentives.



Flowchart for ICAM process with reference to aquaculture activities

5 REGULATORY ASPECTS

5.1. Introduction

Marine aquaculture utilizes space and natural resources, such as water, part of the existing food chain, seedlings, and requires as well a good quality environment. As it is confronted with competition from other coastal activities and subject to terrestrial runoff, its maintenance and development must receive the necessary guarantees. To this purpose, it should be included in coastal zone planning and management, with appropriate regulatory tools. This calls for regulations covering various fields, which may be complementary:

- environmental and living resource protection,
- land use, regional and sectorial development and management,
- aquaculture itself, including its environmental compliance.

Any aquaculture development policy will be bound by this context, and should define related opportunities and limitations.

5.2. Protecting environment and living resources

General laws concerning the protection of the environment and living resources aim at the public welfare and are not specific to aquaculture. They often have an universal character and their preoccupations are common to a large number of countries. They may exist at different levels: firstly, national, but also international (conventions for major pollution risks, protection of endangered species and very important sites). They may also have regional or local implications (protected areas, restrictions on certain activities). The main fields covered concern water quality, living resources, species, biotopes and sites.

Water quality

This applies to water preservation in itself or to water use, generally related to marine life or human health. The corresponding regulations concern:

- polluting activities, whether using marine water to dilute or eliminate their outputs, or inducing environmental risk (industry, navigation, urban waste), through emission standards; and
- water use, through quality standards (such as oxygen level compatible with salmon and sea trout life in estuarine water, bathing water criteria, shellfish quality criteria). These may be national or international (e.g., EC water quality criteria for sanitary regulation of shellfish production zones, as shown on Table 5).

Table 5: Sanitary regulation of shellfish production zones - French regulation after EC directive n° 91/492 (15/07/91)

	Zones	Limits CF/100 ml	Exploitation	
			Farming	Natural grounds
A	HEALTHY	300	Authorized (direct consumption)	Authorized (direct consumption)
B	UNHEALTHY	6 000	Authorized after purification or restocking in a healthy zone	Authorized after purification or restocking in a healthy zone
C	EXPLOITABLE	60 000	PROHIBITED (unless special dispensation)	Authorized after purification and/or restocking in a healthy zone
D	UNHEALTHY PROHIBITED		PROHIBITED	PROHIBITED

A complete regulatory sequence normally includes:

1. administrative authorization, generally based on an environmental impact assessment (EIA) for large scale projects;
2. complementary requirements, specific to the activity concerned (e.g. effluent standards, treatment requirements); and
3. monitoring, also requested by the authorization, and including both project-run and administrative control.

Taxes may be collected by local and government authorities or by water boards in compensation for this "right to pollute" or to use the environment as a dispersion facility, in accordance with the so called "polluter pays principle". These taxes are generally based on water consumption by industries and citizens and, directly or indirectly, are reverted to effluent treatment (urban plants, funding applied to research and technology, monitoring).Classification criteria based on faecal coliform bacteria concentration per 100 ml mashed flesh, CF/100 ml.

Monitoring networks may exist for different purposes. Some are devoted to public health and refer directly to water quality (e.g. bathing) or indirectly, through shellfish quality for consumption, using the filtering bivalve as an indicator (shellfish quality as related to bacteria and toxic phytoplankton). These make up an integral part of the regulation, and their official quality criteria can lead to constraining measures when not met: closing of beaches or low ranking in quality classifications, calling for waste water treatment improvements, temporary prohibiting of shellfish trade or requirements for depuration. Another type of monitoring aims at providing information on coastal water quality trends and is not directly related to regulation. The parameters surveyed concern the water itself or, better, the sediment and living organisms, which are more suitable long term indicators, due to their ability to accumulate contaminants.

Living resources

Fisheries management involves a series of rules ultimately aimed at the best use of a natural renewable resource for the benefit of the community or determined human groups. This operates on all levels, from international to local.

Regulations principally apply to the following fields:

1. Fishing effort and access to the resource (fishing gear and techniques, power limitations, seasons, quotas, permits, exclusive zones),
2. Recruitment (protection of nursery areas, minimum mesh size, minimum catch size of commercial species),
3. Biotopes and populations (totally or partially protected zones).

The tendency to full or over-exploitation of many species and fishing grounds results in a general concern about access to the resource and its protection, as well as an internationalization of the problem. Thus, individual licenses have appeared locally for some sedentary species (lobsters, abalones, scallops). Otherwise, international agreements and committees endeavor to manage stocks at a regional or even wider scale (International Code of Conduct for Responsible Fisheries, FAO; "Blue Europe"; GCFM or General Fisheries Council for the Mediterranean; NAFO or North Atlantic Fisheries Organization).

Species, biotopes and natural sites

Some rare or endangered species are protected by international and regional conventions (marine turtles, marine mammals). Others appear on red lists with strong recommendations for protection.

International agreements also apply to certain types of large scale valuable sites in the coastal zone, such as migrating water bird sanctuaries. These and other important areas, due to their landscape, terrestrial or marine flora and fauna, may be classified as parks or reserves, and partially or fully protected by local regulations (with reference to agriculture and forestry, fishery, environmental protection, urban and industrial development).

As regards biotopes, there is a general concern for sea grass beds, principally for *Posidonia* beds, considered to be a highly productive ecological climax community in the Mediterranean. Their presence should be a constraining factor for many activities in the coastal zone, including aquaculture.

5.3. Land use, regional and sectorial development and management

These regulations and planning tools are specific to each country. The guiding principles are set up on a national level: land use and development policy, town and country planning code, general planning and management tools, etc. According to the political and administrative organization, their application may be more or less decentralized: land use at diverse levels, sectorial development (by activity), regional development.

Land use

Land use planning is determined on different levels, with corresponding objectives, time scales and regulatory tools.

A national plan defines a general strategy for the evolution of the country at medium to long-term range, major centres of activity, developing zones, links and fluxes between them, and necessary public incentives.

Regional plans translate these directives to a smaller scale with more details and make them fit regional and local needs.

Local plans exist on a municipal level, regulating land use within the township. Generally they do not apply directly to the sea, but may be important for aquaculture through the necessary land-based infrastructures, as well as through the public concern for this activity when a clear political willingness to promote it appears in the planning document.

Sectorial development

Master plans are set up on a national or regional scale to develop and manage certain activities or basic infrastructures: such as branches of industry, tourism, aquaculture, etc. Naturally, they concern the activity itself, as well as corresponding means and infrastructures, including land use anticipation and reservation, which can be detailed in regional plans and introduced in local documents. To meet this need, surveys may be necessary to identify and select the most suitable sites.

These plans are important for aquaculture, mainly for the purpose of its own development and management, in which case they should be strongly recommended, but also because of potential conflicts with other activities competing for the same space and water usage (e.g., tourism). To prevent such problems, concerted actions are necessary, requiring a multidisciplinary territorial approach involving all interest parties. Opportunities for co-existence with benefits for various activities may also be identified.

Regional development and management

Master plans of this kind are mainly devoted to a specific territory, including a large number of important activities. National, regional and local powers and interests come into play, in accordance with prevailing political and administrative organization. The territory taken into account may coincide with administrative boundaries or correspond to natural homogeneous characteristics. With respect to the coastal zone, these may include catchment basins, estuaries or gulfs.

As different activities are simultaneously concerned, the approach is necessarily multidisciplinary and involves many parties, to allow for harmonization of the master plan. This is also a good opportunity to open the way for smaller scale concerted actions, setting up management schemes able to organize the coexistence of different users of the space and water in a given area. (An example of such a regional development and management scheme, specially designed for coastal zone planning, is provided by the French case exposed in the box enclosed). The natural characteristics and suitabilities of the sites, as well as their best usage, must be defined, if necessary by scientific studies, as a sound basis for discussion, decision making and planning. A wide range of people from different origins will also have to work together for the common interest: public services, professionals, elected bodies, science and technology. This sort of approach is certainly time- and energy-consuming, but can greatly benefit the solving or prevention of conflicts.

COASTAL ZONE PLANNING SCHEMES: THE CASE OF FRANCE

(SMVM , Schémas de Mise en Valeur de la Mer)

Coastal zone planning and management instrument:

- **designed for this specific zone** (and set up for a given area)
- **set up in answer to local request** (conflicts, development, management)
- **worked out after studies and consultation** (decision making on sound bases).

LEGAL BASES

- Law 83.8 (07.01.83) or "decentralization law"
- Law 86.2 (03.01.86) or "littoral law" + decree 86.1252 (05.12.86)

PARTICIPANTS	ORGANIZATION
• Government (Govt. Commissioner) • Public Services • Socio-economic partners (professionals, associations...) • Elected representatives • Technical institutions (publ. serv., research lab)	Plenary Assembly Steering Committee Ad hoc Working Groups (per major activities)
WORKING SEQUENCE	**OFFICIAL ACTS**
REQUEST + initial objectives	Govt Commissioner decree (setting up)
ANALYSIS ⇒ **White Paper** ⇒ **Studies**	
PROPOSAL ⇒ **Options** Working Groups Steering Committee Consultation ⇒ **Draft Scheme**	
DECISION ⇒ **Final Scheme** Steering Committee + Directives Plenary Assembly Govt. Commissioner	Govt Commissioner approval Government acknowledgment (giving the scheme a legal standing)

5.4. Aquaculture development and protection

As with any industry, aquaculture is covered by a number of regulations applying to it directly or indirectly. Some of these have been discussed above (environmental and living resource protection, land use and planning). They concern it own development, protection against external threats and environmental compliance.

Aquaculture development

Aquaculture development is necessarily subject to all levels of sectorial and territorial planning, as demonstrated above. A pro-active policy is also needed to promote this activity, which generally enjoys fewer public and private means than those in direct competition with it (industry, housing, tourism). Sectorial development plans, an appropriate place in territorial development and land use planning, site selection and reservation are elements of this sort of policy, as are diverse financial incentives.

Aquaculture protection

Aquaculture needs adequate sites and relies heavily on good environmental quality. Thus, protecting its practice will basically require that existing regulations for water quality and land use be applied. Existing or potential conflicts with other users of the coastal zone can also be dealt with by harmonizing activities within regional or local planning and management schemes, or by enforcing measures to prevent environmental threats to aquaculture.

Environmental compliance of aquaculture

The specificity of aquaculture is that it is greatly dependent on the environment, and must respect it to ensure its own safeguard. Thus, environmental protection and water quality regulations also apply to aquaculture, sometimes with some specific complementary requirements. These regulations are implemented through permits or licenses generally based on the use of space and water. They may vary depending on the country and the type of activity. (As an example, the French case is simplified in the box enclosed).

Use of space:

Applies to all types of aquaculture located in marine waters or flushed by the tide.

Many countries consider marine space as being for common use or as state property that can only be granted for temporary private use through a permit (which may be subject to payment). Land-based installations on private ground are not concerned by this requirement but, when sea water intake or release is necessary, authorities may intervene by other means.

Water intake:

Applies to land-based installation using pumped or tide-flushed water.

Underground salt water presents a special case which may require specific authorization and, possibly, limits set for quantities used.

Water release or "pollution" outputs:

Applies to on-shore or sea-based installations with inputs (feed, treatment products), as for instance intensive fish (or shrimp) farming, requiring a special permission to operate.

Depending on the project size, this license may be subject to an impact study procedure, including a standard sequence: reference state of the site, project description, expected impact predictions, and corrective or mitigation measures if necessary.

Special requirements may also be set by the license, and eventually adapted to the result of the impact study, such as:

- limitations on space, through distance between farms, on biomass, through stock, production, feed or density, on outputs through emission standards or authorized fluxes,
- restrictions concerning veterinary treatments,
- monitoring and control, by means of both self-monitoring and administrative control.

Other special requirements refer to animal health and wild stock protection, setting limitations about species introduction or transfer, natural seed collecting, etc.

5.5. Recommendations

Regulating aquaculture

Aquaculture is highly dependent on a healthy environment and good water. Because it is the first activity to be affected by any alteration, it is also the best guarantee of quality. Thus, it is obvious that environmental compliance must be a constant preoccupation. On-going dialogue should be stimulated between professionals, public authorities and scientists. Environmental concerns must be integrated at an early stage in any project, and not only appear when the permit is requested.

With respect to regulation, a correct application of the existing laws will generally meet basic needs. To complete these tools, the above mentioned on-going relationship between professions, administration and science, is needed to set up specific requirements and standards and make them evolve according to progress made in scientific knowledge and aquaculture technology. Regulatory simplifications and harmonizations may also be useful to make the task easier for aquaculturists, not necessarily familiar with complex legal procedures. This extends to the administrative parties intervening in aquaculture, often too numerous and unconnected. The scope of their powers varies and should be headed up by one main authority in charge of aquaculture regulation.

On the other hand, environment protection regulation may have considerable financial influence on an activity subject to large-scale risks and competition, along with limited profits, often involving small- to medium-sized farms. Requirements directly related to breeding and outputs obviously concern the farm. But, due to the high cost of marine research and modern technology, a different situation exists for more general needs, such as suitable site selecting, basic knowledge for appropriate impact studies, and even certain environmental quality controls. This calls for a public intervention on these more basic and general aspects: by stimulating applied research on these subjects, funding general models prior to local applications, supporting regional studies to set the necessary bases for project impact assessment, etc.

Integrating aquaculture in the coastal zone planning

Although aquaculture may sometimes be economically risky, with limited profitability, some of its important advantages go far beyond an immediate financial assessment. In fact, provided that some elementary precautions are taken, aquaculture acts as a:

- renewable resource-based activity;
- source of seafood and prime products in demand by the consumer, of income and employment; and
- guarantee of good water quality, the main integrating element in coastal resource systems, and a protection against threats from less environmentally-friendly industries.

This is of great value in developing, planning and managing the coastal zone in terms of:

- land use and occupation;
- population welfare and fixing;
- best use of renewable resources; and
- preserving environmental quality.

Furthermore, complementary interests exist with some other activities competing for the same resources, namely fisheries and tourism, which may increase the advantages if some basic rivalries can be overcome.

There is therefore an urgent need to integrate aquaculture as an important, legitimate, activity in coastal zone development, planning and management strategies. Of course, such plans must be based upon sound scientific principles for the protection of environmental processes which maintain the functional integrity of coastal ecosystems sustaining aquaculture and other renewable resource-dependent activities.

This requires a pro-active policy at all levels for integrating aquaculture into coastal zone planning and management, using appropriate regulatory tools, which already exist in many countries, such as territorial and sectorial plans, land use documents etc. In order to prevent or solve conflicts, a multi-usage approach is needed. If necessary, adequate regional or local development and management schemes should be set up, including procedures for decision-making based on an on-going dialogue between parties: central administration, local authorities, scientific organizations, professional and private users.

ANNEXES

ANNEX A: WORKING DEFINITION OF FUNDAMENTAL NOTIONS RELATED TO DOCUMENT

In the literature related to ICAM and in practice there is significant confusion and inconsistency in defining some of the fundamental notions. The same notions may have quite different meaning when used by scientists, planners, managers, decision makers and/or the general public. To make the use of this document easier, some basic notions relative to ICAM are defined.

The **coastal area** is an interface between land and sea which extends inland and seaward to a variable extent. The term "coastal areas" refers to a geographical space characterized by particular environmental conditions, but with borders which are not necessarily strictly defined. They are a major interest of human populations and a variety of economic activities.

The coastal zone is a part of the coastal area where sea-land interactions are most intensive. **Zoning** is an important part of a process through which a given coastal area is planned and managed. The partitioning of larger areas into smaller units -zones- is based on global environmental conditions such as topography, productivity and water regime, but it will also depend on political, economic and social, administrative, ecological and pragmatic considerations. The number of zones in each coastal area may vary from a few to several dozens.

The main elements of the coastal zone are the following: **coastal waters** (narrow near-shore sea belt with a variable width of approximately 3 miles), **intertidal area** (between the lowest tide line and the shoreline including estuaries and coastal wetlands), **coastline** (contact line dividing the land and the water), **shoreland area** (part of the land up to the highest line of tidal influence, rarely wider than 1,000 m), and **coastal uplands** (space between the shorelands and the highest peak of the closest mountain range.

In addition to the coastal zone elements, the coastal area contains **ocean waters** (largest part of the sea belt, up to 200 nautical miles offshore within the Exclusive Economic Zone), and the **inland area** (any area outside the shoreland belt from which many processes may affect the state of the coastal area).

Integrated coastal area management (ICAM) is process-oriented, and is both a concept and a tool for inter-sectorial coordination. It is a long-term continuous process typically concerned with resolving conflicts among the many users of coastal resources. Its purpose is to try to determine the optimal mix of use over time, achieving a balance between social and economic development in relation to the resources, and demands on those resources. It incorporates modern principles of decision-making in planning and natural resources areal management, interdisciplinary processes and intensive information bases.

ICAM is not a substitute for existing sectorial planning systems, but a kind of linkage between sectorial planning activities in order to achieve more comprehensive goals. It should be designed to allow better coordination and compatibility between planning activities and to encourage public participation, thus following one of most important goals in the planning process.

Aquaculture. It is a generic name that covers a wide range of culture techniques and culture species under different conditions and different geographical localities.

FAO (1990) defined aquaculture as "*the farming of aquatic organisms, including fish, molluscs, crustaceans, and aquatic plants. Farming implies some form of intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators, etc. Farming also implies individual or corporate ownership of the stock being cultivated. For statistical purposes, aquatic organisms which are harvested by an individual or corporate body which has owned them throughout their rearing period contribute to aquaculture, while aquatic organisms which are exploitable by the public as a common property resource, with or without appropriate licenses, are the harves of fisheries*".

An aquaculture site is space within an individual zone which has a requirement for, both land and/or water. The site will determine availability of water, its quality and topographic site characteristics for both land-based and sea-based farms (water exchange and waste dispersal). Ecological characteristics of the site, e.g. population diversity, structure, dynamics, and interrelationships between benthic and pelagic communities may determine the level of intensity and possibilities for expansion of the aquaculture farm.

Aquaculture technology will depend on species selected and site characteristics (water, land, energy, skills, etc.). These two factors will govern aquaculture technology and culturing method either for extensive, semi-intensive or intensive aquaculture. In sea-based farms, water exchange, anchorage, size of the farm, stocking density, nets and their mesh size, distance between culturing units, etc., have to be considered in relation to exposure and prevailing currents, substrate and bottom slope, water depth, and general water quality. When setting land-based units, adaptive design and engineering, type and amount of materials used, are also important factors that have to be considered in relation to water renewal and waste water discharge.

The **species** cultured under control conditions differ significantly in their biological and eco-physiological characteristics. The suitability of a species to be cultured depends very much on feeding habits, food and nutritional requirements, behavior, growth performance, water quality requirements, stress tolerance, susceptibility to parasites and disease etc. Biological interactions between cultured organisms and natural communities may be restricted to the immediate vicinity of the site or could affect wider areas.

For the purpose of ICAM, **carrying capacity** is defined here as the maximum number of users which can be supported by a natural or man-made resources without producing negative environmental consequences to their future productivity, structure and quality. The carrying capacity concept is of considerable importance for ICAM, although it is very difficult to arrive at exact figures.

ANNEX B: SPECIES AND TECHNOLOGY IN MEDITERRANEAN COUNTRIES

B.1. Cultured species

Several different marine organisms are cultured in the Mediterranean, including both fish and shellfish, of which the latter are almost all bivalve species. This includes not only species where the culture method is well known and all aspects of the life cycle can be controlled, but also experimentally cultured organisms where the methods are not fully known or proven in a particular area.

B.1.1. Fish species

The dominant farmed fish in the Mediterranean are the sea bream (*Dicentrarchus labrax*) and sea bass (predominantly *Pagrus* pagrus and *Sparus auratus*). The life cycle for all three species has been well studied and can be fully controlled. There is also significant production from several other species and these are listed below.

Sea Bass	*Dicentrarchus labrax*
Sea Bream	*Sparus aurata*
	Dentex dentex
	Diplodus sargus
	Diplodus vulgaris
	Pagellus acarne
	Pagellus bogaraveo
	Pagrus pagrus
	Pagrus (Chrysophris) major
	Puntazzo puntazzo
Yellowtail	*Seriola dumerilii*
Mullet	*Mugil* spp. (*chelo, saliens, auratus, capito*)
Eel	*Anguilla anguilla*
Turbot	*Scophthalmus maximus*
Sole	*Solea solea*

B.1.2. Invertebrate species

Oyster	*Ostrea edulis*
	Crassostrea gigas
Mussel	*Mytilus galloprovincialis*
	Mytilus edulis
Carpet Shell	*Ruditapes phillippinarum*
	Ruditapes rhomboides
	Ruditapes decussatus
Scallop	*Pecten maximus*
Shrimp	*Peneus* spp.

B.2. Mediterranean specific conditions

The Mediterranean has a number of unique conditions that should be taken into account when planning aquacultural developments in the sea. It is a semi-enclosed sea with a number of basins and distinct geographic areas (encompassing most types of marine habitat - lagoons, estuaries, pelagos, sandy beaches, etc.). As a small sea it has a small tidal regime that is negligible in most areas. Surface currents are predominantly wind-driven with northerly systems generally prevailing. Seasonal differences may be noted by special wind patterns such as the Melteme (northerly, Aegean), Sirocco (southerly, western Mediterranean) and Mistral (northerly, France). Evaporation in the warm sub-tropical environment (temperatures from 14°C winter minimum to in excess of 26°C summer maxima) exceeds precipitation and salinities are high (approximately 39‰). Because the sea is small, swells are less important than wind driven waves which can build up very rapidly and have a relatively short wavelength.

The Mediterranean is considered to be an oligotrophic sea, although it shows great diversity in species composition. Localized high production does occur in areas with major inputs, for example, large rivers/deltas and cities, predominantly in the northwestern zone, the Nile delta (whose present contribution is limited by upstream river management), Atlantic water inputs and in some areas, upwelling phenomena (wind driven or related to divergence). Outwith of these areas, primary production is generally low and any input of nutrients (for example, as a by-product of aquaculture), may easily change the local environment.

Sea grass beds of several species occupy large areas in coastal zones. *Posidonia* in particular constitutes a significant Mediterranean feature and environmental health symbol.

There are some endemic species in the Mediterranean, although mostly all are of an Atlantic origin. In recent years some introduced species have become important, either migrants from the Red Sea through the Suez Canal or accidental introductions, some of which have been due to aquaculture.

Pollution is related to terrestrial inputs, from rivers, atmospheric drift, or direct release from urban and industrial concentrations along the coast, and also due to maritime traffic (oil).

The most important factors affecting aquaculture are the relatively high temperatures (at the upper range of many cultured species), high salinities (combined with temperatures making highly corrosive conditions) and weather patterns. Within a particular area other local factors are also important. An overview of these factors, and their relative limitations are listed in Table B.2.

The Mediterranean is, and will continue to be, an area in which the impacts of activities in one part may significantly affect conditions in another, either economic, social or environmental issues. Experience in ICAM is rather limited because it is a relatively new concept. In some industrialized countries, planning and implementation of ICAM has produced very diverse results, and faced serious difficulties and constraints. The main reasons for failures include: lack of long-term political commitment, institutions and administrative support, definition of coastal zone boundaries, inadequate information bases, lack of compatibility with sectoral development plans, etc. Financial constraints are a serious problem for developing countries. Sources of funds should be identified which may include income from licenses, user fees and taxes under the system of "polluter and user pays", and contributions through national or international grants.

Common policies and coordinated actions could significantly benefit coastal regions, reducing the risk of degradation of resources and strengthening complementarity rather than competitive activities.

B.3. Culture technology

B.3.1. Fish culture

A number of different methodologies are outlined below. However, the most common system currently used for fish production in the Mediterranean consists of intensive hatcheries for fry production, on-growing of the juvenile fish in small tanks then transfer to sea cages for growth up to marketable size. Table B3 outlines typical stages for the culture of breams in the Eastern Mediterranean.

B.3.1.1. Land based

Hatcheries for all species are land-based for maximum control over all the activities. Two systems are currently used: extensive and intensive. In the extensive system, eggs or fry are introduced into large mesocosm tanks (5 - 50 m^3) with a natural plankton system and reduced water flow. The fry grow by feeding on the plankton until they reach a size at density where supplemental plankton must be added or there is a change onto a dry pellet diet. This system requires low levels of maintenance, is low cost, but produces a relatively low number of juveniles and is not easily controlled. Variations of this system include enriched mesocosms which have been seeded with an enriched plankton culture, or have continual plankton addition.

Intensive hatcheries are most commonly used by larger companies. They are easily controlled, at a higher level of maintenance, with fry kept at high densities in smaller tanks (1 - 3 m^3). Initial feed for the fry, usually planktonic species (for example, rotifers and *Artemia*), must be grown as well as the feed for the planktonic species (usually algal monocultures, for example *Chlorella*). The fry are weaned onto a dry pellet feed as soon as possible.

On-growing of juvenile species to marketable size can be undertaken on land as long as there is a suitable source of clean sea water with associated pumping (cost is normally related to the height that water must be lifted from the sea to the gravity storage system) and aeration system. Juvenile fish are transferred from the hatchery to various types of enclosures, either tanks, raceways or ponds. Tanks are constructed from concrete or fiberglass depending on local cost and availability. Systems rely on a continual inflow of water to bring oxygen and an outflow to take away excess feed, faeces and metabolic byproducts. Fish generally swim around the tank heading into the inflow current. Raceways are a particular type of concrete tank, in the form of a canal, with inflow at one end of the tank and outflow at the other end. This form of tank requires a large inflow of water at the head end of the canal and unsuitable conditions for the fish may exist at the outflow end. Recycling systems are currently not thought to be economically viable as they require high capital investment and high level of monitoring.

Ponds are larger enclosures set into the ground and may be in the form of simple dugout pits that are plastic lined, or be more complex in design with a concrete lining.

B.3.1.2. On-growing in the sea

The majority of on-growing of fish is carried out in the sea. The methodology does not require the pumping of water which is one of the principal costs associated with land-based tanks.

B.3.1.2.1. Enclosures

In a few cases in the Mediterranean, lagoonal areas or part of these areas are enclosed and partitioned for aquacultural activities. This is practiced in the lagoons of the Northern Adriatic where it is known as Valli Culture or Valle de Pesca. Migratory fish which periodically move on- and offshore, are trapped in lagoonal or estuarine areas and can be moved through different enclosures by utilizing networks of sluices and gates. The fish involved in this polyculture, particularly mullet, eels, and to a lesser extent, sea bass and sea bream, feed on the natural food chain of the enclosure and can be harvested or fished after the fattening period. It is questionable, however, whether this methodology is aquaculture or enriched fishing. The methodology requires clean lagoonal areas and a supply of migratory fish.

B.3.1.2.2. Cages

The majority of cultured marine fish species are on-grown in cages. Sea cages are floating frames (square, multi-angle or round) of surface area 8-50 m^2, within which nets are suspended down into the water column (3-10 m) to contain the fish. Cages are often linked together in multiple units with central walkways for access and anchored by a fixed mooring system. They should be accessible from a shore station by boat on a daily basis for checking the fish and feeding and also for cage/net maintenance and transfer of fish. There is a wide variety of cages available on the world market, the specification of which will depend on the environment where they will be used, with particular reference to the degree of exposure.

In sheltered coastal areas where meteorological conditions are not very severe, cages can be of light construction, with relatively weak mooring systems. Cages can be close to shore installations with unconstrained access and a high level of security. The major problems in this area will be from reduced water quality from anthropogenic or possibly natural condition (toxic blooms, turbidity, lack of water movement and higher temperatures: the latter two leading to lower oxygen concentrations). The incidence of parasites and predators may be high, and there will be more conflict with other coastal activities.

Offshore areas represent a more unexploited environment, with fewer conflicts (fishing and shipping) and less risk from coastal and self-pollution. Water quality is generally good, leading to better growth and quality of the fish. However, mooring systems and cages need to be sufficiently strong to withstand much higher forces exerted by wind and waves. Several manufacturers supply specialist offshore cages that are resistant by a number of means; inherently strong structures that accept high loads on critical parts or flexible structures that dissipate load throughout the structure. Semi- or submersible cages are also available, where the largest part of the structure is beneath the sea surface and consequently away from the major forces exerted by the sea. Access to offshore sites is weather dependent and will require larger service boats. The technology and quality required for offshore cages means a greater capital investment, although individual cage units can be larger with increased production.

Strengthened mooring systems for exposed conditions can be employed using multiple anchors and angled risers, where the riser (connecting chain or rope between the cage and anchor) is weighted or buoyed at one or more point along its length. This effectively puts angles in the riser that have to be straightened with force before high loads are transmitted to the anchor system. The risers therefore act as dampers or springs. Additional protection may be applied with the use of breakwaters. This can be a fixed type or floating type and will cause waves to break before reaching cage arrays, thus dissipating much of their energy. The capital investment of a fixed system would be prohibitively high but with lower investment, floating breakwaters could be employed, manufactured from waste products, for example used tires.

It should be noted that not all specialist cages are directly applicable to the Mediterranean. Almost all offshore cages have been developed for salmonid culture where the size of individual fish in cages is large with consequently large net mesh size. Sea bream and sea bass are generally cultured in cages at a much smaller size and therefore require a smaller mesh size. Small mesh nets have greater friction to water movement and will transfer a greater load to the supporting cage structure. The cages might therefore have a lower resistance than specified for a particular sea state.

Currently the best area for cage culture in regard of the current state of development of the Mediterranean coastline is a compromise area between the two described above: a semi-offshore area or exposed coastal area, where the conditions are such that the disadvantages of both areas are reduced to minimum whilst maximizing the advantages. Cages to be used in this area would need to strong, but not such that the economic outlay for high technology cages would be necessary (again a variety of suitable cages are available). Access to the site would be reasonable as would water quality and security.

B.3.2. Flat-fish

Two species of flat-fish are cultured to a small extent in the Mediterranean. These are Turbot (*Scophthalmus maximus*) and Sole (*Solea solea*). These two species present a special case in that the fish in adult stages are bottom dwelling spending almost all their time resting on the substrate. In the hatchery, the juveniles are planktonic and swim in the water column. As larger individuals, they spend more time on the bottom and currently on-growing is carried out in tank systems with increasingly larger tanks for increasing size of fish. The fish only swim off the bottom to feed and consequently the volume (depth) of water of a tank is not as important as the surface area of the bottom. Adults are very robust and placid and can, in the case of Turbot, be kept at densities up to 25 kg/m^2. At these high densities, the fish can sit on top of one another in several layers with no marked deleterious effects. In areas where temperatures reach over 22°C the adults may have reduced growth and are more susceptible to disease problems with consequent lower yields. Cage culture in open water is difficult as flat-fish can suffer from sea sickness due to water movement and consequently have reduced growth.

The culture of flat-fish is only economically valid for intensive systems which require very high capital investment.

B.3.3. Invertebrate culture

<u>*B.3.3.1. Bivalve culture*</u>

Hatcheries for spat production of most bivalve species are not economically viable because it is cheaper and easier to collect spat from the wild (with the exception of oysters). All the cultured species of bivalve are filter-feeding organisms and need to be kept in areas of higher levels of nutrification with good primary production (north and western Mediterranean). These are normally areas where adults are naturally occurring. Adequate water depth for suspended cultures is such that the cultures should be above the seabed (>15 m). For laying out or seeding, large surface areas in shallow or tidal zones are required without conflicting activities (almost all other coastal activities). Owing to their filter feeding nature, cultured bivalves are at high risk from anthropogenic pollution and naturally occurring toxic blooms, either directly, causing mortality to the animals or indirectly by bioaccumulating harmful elements and passing them on to their consumers. Water circulation in the area should be adequate for flushing, as excess eutrophication may result from a build up of metabolic products in the water column.

Adult bivalves require little care compared to fish. Suspended cultures on ropes require thinning out with time allowing individuals more space as they grow and for removal of fouling organisms. Bag cultures are thinned out simply by transferring individuals from one bag to another.

Within the EC countries, the law specifies that bivalve species must be cleansed prior to marketing. Harvested adults are brought into land-based purification tanks for periods of time (usually 24 hours) to reduce possible bacterial or other contamination. Local safety authorities/Ministries may require compulsory testing for other contaminants.

Particular culture methodologies for the principal bivalve species are noted below.

Oysters: *Crassostrea gigas, Ostrea edulis*

Spat can be collected from the wild by suspending plastic nets, PVC tubes, dead bivalve shells, lime covered tiles, slates, stones or tree branches in spawning areas. They can also be collected naturally after settlement from spawning adults kept in small tanks and raceways or from more intensive hatcheries.

Adults are laid out directly on the ground, off the bottom on small tables with the oysters bagged, or kept in suspended culture in baskets or cemented on rafts and long lines.

Mussels: *Mytilus galloprovincialis, M. edulis*

Spat are collected from the wild from suspended plastic netting. Adults are on-grown by suspended culture either from rafts or long-lines.

Carpet Shells: *Ruditapes phillippinarum, R. rhomboides, R. decussatus*

Spat were originally produced from hatcheries but are now collected naturally.

Adults are grown out on the sea-bed in areas of muddy sand.

Scallop: *Pecten maximus*

Spat are collected in the hatchery although they can be collected from the wild on suspended plastic netting.

Adults are on-grown on long lines normally in lanterns but also in pocket bags.

B.3.3.2. Penaeid culture

Production of penaeids is very low in the Mediterranean. Exotic species, where culture methodologies are well known, require relatively high and constant temperatures (in excess of 20° C). Hatcheries are normally tank based systems. Females are isolated when gravid or just after moulting and are kept singly or in very low densities in spawning tanks. Culture of the larvae is very difficult owing to the large number of stages and the different feeds and size of feeds required at each stage. Stocking densities are critical as penaeids can be territorial and cannibalistic. Extensive systems are usually pond based with low production. Intensive systems usually require heated water and therefore a relatively high capital investment. Food conversion factors are low because moulting is required for growth.

Table B2: Environmental limitations for aquaculture

FACTOR	GOOD	MEDIUM	POOR
Exposure*	Partially Expos.	Sheltered	Exposed
Waves	1 - 3 m	1 m	> 3 m
Depth	> 30 m	15 - 30 m	< 15 m
Dynamism-Flushing	High	Medium	Low
Water Quality Pollution	Low	Medium	High
Temperature			
Max.	22 - 24	24 - 27	>27
Min.	12	10	<8
Salinity (‰)			
Average	25 - 35	15 - 25	< 15
Fluctuation	< 5	5 - 10	> 10
Dissolved O_2 (%)	100	70 - 100	< 70
Topography (slope)	> 30	10 - 30	<10
Substrate	Sand or gravel	Mixed Rock	Mud
Trophic Status	Oligotrophic	Mesotrophic	Eutrophic
Fouling	Low	Moderate	High
Predators	No	Some	Abundant

* Partially exposed equates to exposed coastal or semi-offshore areas, sheltered equates to coastal areas, and exposed equates to offshore areas.

Table B3: Typical stages in the culture of sea breams in the Eastern Mediterranean

Stage	Age	Weight
Hatchery (egg-sac)	0-40 days	0.001-0.05 g
Hatchery (weaning)	1-2 months	0.05-0.2g
Nursery Tanks	3 months	0.2-2 g
Juvenile Tanks	4-5 months	2-20 g
On-growing Cages	14-30 months	20-400 g

ANNEX C: SUGGESTED INFORMATION BASE FOR ZONING OF AQUACULTURE IN ICAM

Information should be based largely on existing data or those already being collected for other purposes. The most costly and time-consuming tasks are where surveys are required; new surveys should be limited to a minimum.

The unit for data collection should preferably be in geographical terms, especially if they are also administrative units. This is because such units may have relatively homogeneous characteristics. When planning the use of land and water resources these units should be included in the zoning effort.

The data bank can be divided into four basic components of development - spatial, ecological, economic and social, each of which can be further divided. Thus, for example, the total population in a particular geographical unit may be less useful for planning purposes than when combined with the size of the planning area to indicate density of settlement.

The information base should be systematically organized. each subject should be broken into a number of elements. Finally, an indicator should be given for each element and its source of data (see Annex C).

The exact form of the data base will largely depend on environmental and developmental characteristics of the unit concerned and on the availability of finance. Thematic maps, graphically representing factors, may be a helpful tool for data analysis. Computer technology can assist in the development of an information base when it is organized on the following sequence: collection - registration - storage - retrieval - processing.

To identify major problems and initiate integrated planning process such as the overall state of the environment, only existing sources of data should be used, supplemented by indicators of expected future trends.

A more detailed information base (i.e. relying on statistical abstracts, historical records, surveys etc.) is needed for the analysis, definition of goals and objectives, and at the phase of preparing detailed policies and proposals.

CRITERIA	ELEMENTS	INDICATORS	SOURCES
NATURAL ENVIRONMENT	Size of coastal segment	km^2	cartographic maps
	Cultivated land		pedological maps
	Forest area	% of total	
	Other	"	
	Topographic features of	"	
	coastal strip	length	topographic maps,
		width	surveys
		slopes	
		types of soil	
		natural veget.	
		bays, lagoon-like areas	
		exposure	
	Hydrology	no., location and capacity	hydrological maps
	rivers	"	
	springs	"	
	streams	"	
	lakes	"	
	sea	tide, waves	
	Climate		
	temperature	min. max. average	meteorological
	winds	local, periodical, no. of days with strong winds	records
	Environmentally sensitive areas	type, location and size	existing analyses
EXISTING USERS			
LAND USES	Residential	type, location and size	existing land/sea
	Production	"	use maps
	Storage	"	
	Recreation	"	
	Beach	"	
	Tourism	"	
	Industry	"	
	Other	"	
SEA USES	Harbours	"	
	Shipping routes	"	
	Fishing areas	"	
	Touristic areas	"	
	Recreational areas	"	
	Discharge areas	"	
	Aquaculture	"	
	Protected areas	"	
	Other	"	

CRITERIA	ELEMENTS	INDICATORS	SOURCES
POPULATION	Size and distribution	density/km^2	statistical abstracts
		inhabitants per settlement	
	Age structure	population per age group	
	Sex structure	percent of male and female population	
	Family characteristics	no. of members per household	
		no. of urban/rural households	
	Vital statistics	no of births per year	
		no of deaths per year	
		average no. of children family	
		income and wage groups	
	Income	% of unemployed	
	Employment	% of retired population	
		% of dependent population	
		structure of employment per economic activity	
	Patterns of migration		
	temporal	daily	
		seasonal	
		definite	
		temporary	
	activities	economic	
		tourist	
		other	
SETTLEMENTS	Size	no. of settlements	
		no. of population in each	
	Development of settlement system	types of settlements and their gravity areas	
		urbanization processes	
		degradation processes	
INFRASTRUCTURE	Road network	total length (km/km^2)	road transport authority
	Railway network	total length (km/km^2)	railways authority
	Airports	location	air transport authority
		type	
		capacity	
		air corridors	maritime authority
	Harbours	type	
		capacity	
		location	
		shipping routes	water authority
		number of users	electricity authority
	Water supply	capacity	
		location of network	
		level of supply	
		number of users	
	Energy resources	KWh	
	oil		
	gas		
	coal		
	solar		
	other		

CRITERIA	ELEMENTS	INDICATORS	SOURCES
MAJOR ECONOMIC ACTIVITIES	Agriculture	% of each activity in total economy by GDP and employment	statistical abstracts
	Forestry		
	Fisheries		
	Marine aquaculture	"	
	Industry	"	
	Tourism	"	
	Other	"	
INVESTMENT POTENTIAL	International levels	% of total	chamber of economy
	National levels	"	
	Local levels	"	
SOCIAL & PUBLIC SERVICES	Educational facilities	types and number	statistical abstract
	Health fac.	"	
	Social services	"	
	Recreation fac.	"	
	Municipal serv.	"	
	Financial serv.	"	
	Repairs	"	
	Other	"	
	Land ownership pattern	types of land tenure	land register
	Housing	size of plots	
	legal	location	
		no of apartments	
		m^2 per inhabitant	
		level of facilities	
	illegal	(as above)	
	Living conditions	urban population	statistical abstract
		rural population	
		income distribution	
		labor organization - cooperatives	
		institutional aspects	
		infrastructure	
		pollution levels	
EXISTING DOCUMENTS	Research and/or development projects		
	International studies		
	National plans		
	Sectoral plans and studies		
	Infrastructure projects		
	Energy projects		
	Sectoral analyses		
	Other		

ANNEX D: GUIDELINES FOR AN ENVIRONMENTAL IMPACT ASSESSMENT (EIA) IN INTENSIVE AQUACULTURE

1. Introduction

The EIA should contain a short description of the site, description of the planned activities and importance of the project.

2. Description of the proposed project development

The proposed plan of the project should be shown on the appropriate bathymetric map (Scale 1:1000 or 1:2500) together with site plan that presents the location of buildings, land based installations and other structures. The description should include:

a) Details of methods of construction (materials used, transport suitability of roads);

b) Detailed description of the farming operations proposed at the site (methods, species, initial and future production capacity, expected patterns of stock weight and feed input);

c) An estimation of the quality and quantity of waste loads produced by the farm's operations, disposal of wastes, mortalities, disease and other treatments.

3. Reasons for selecting the proposed site and technologies

The reasons for selecting the proposed site, including a short description of alternatives which have been considered.

4. Site description and environment

a) Physical characterization of the local aquatic environment should include information on the following:

- an onshore topographic and offshore bathymetric map of the site at least 1 km beyond the culturing location;
- details of any existing underwater banks which could impact water mass movement. Channels and their communication with the sea;
- description of shore, bottom type.

b) Meteorological, hydrographic and hydrological information:

- wind velocity and intensity (wind roses, extreme events);
- tidal conditions, the seiches and the probability of extreme conditions;
- wave conditions and currents;
- hydrological conditions of natural or artificial water channels and outlets to the sea;
- temperature/oxygen profiles.

c) Typical water chemistry based on the mean of four replicate samples collected at each of three depths (0.5m, 5m and 1m of the bottom) which must include determinations of:

- salinity (ppt)
- pH (units)
- total phosphorus (µg/l)
- orthophosphate (µg/l)
- total nitrogen (µg/l)
- ammonia (µg/l)
- nitrate (µg/l)
- nitrite (µg/l)
- suspended solids/turbidity

Analysis must be carried out by using methods appropriate for sea water samples of low nutrient content.

d) Sediment chemistry, based on the mean of four replicate, grab samples taken below the location of the water samples (see above) which include determination of:

- sediment type on the site and its surroundings;
- redox potential (at 4 cm depth in sediment);
- sediment organic carbon and nitrogen content.

e) Biological characterization of the local aquatic environment:

- phytoplankton community; seasonal changes in composition; occurrence of algal blooms;
- mean summer chlorophyll *a* levels;
- survey of the benthic community;
- fishing areas and species important to commercial fishing.

f) Biological characterization of the local terrestrial environment - existence of particularly sensitive and/or protected species or communities.

g) Present land and sea uses on site and in surroundings:

- location and size of other farming operations;
- location and size of nearby settlements;
- navigation routes;
- location and size of tourism activity nearby the site;
- location and size of nearby marinas;
- proximity of other point sources of nutrient/effluent, including intensity of agriculture.

5. Identification of possible impacts

An assessment of anticipated or forecasted positive or negative impact, using accepted standards wherever possible, should be given, including the following:

a) Topographic and bathymetric changes, and the occurrence of changes during and after construction;

b) Changes in water circulation due to aquaculture construction;

c) Sand movements and where increased sand accumulation and coastal erosion is likely to occur;

d) Hypernutrification/eutrophication - expected response of local biological communities;

e) Physical accumulation and organic enrichment of aquatic sediments - expected response;

f) Impact on bottom flora and fauna, the risk of loss of a habitat, changes likely to occur;

g) Disposal of stock mortalities;

h) Aesthetic impacts of buildings and other structures;

i) Impact on the quality of bathing water and on the cleanliness of beach sand, if any;

j) Interaction with local fishermen;

k) Impact on navigation routes and other activities in the sea.

6. Measures to reduce or prevent negative impacts

This section should describe all measures - whether technical, legal, social, economic or other - to prevent, reduce or mitigate the negative effects of the proposed aquaculture activities.

7. Monitoring

Measures to be used to monitor the effects on a long term basis, including the collection of data, the analysis of data, and the enforcement procedures which are available to ensure implementation of the measures.

8. Bibliography

A list of source materials that are used or consulted in the preparation of the EIA studies.

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PRIORITY ACTIONS PROGRAMME

MEDITERRANEAN ACTIONPLAN

UNEP

In cooperation with:

IFREMER

INSTITUTE OF MARINE BIOLOGY OF CRETE

PAP-10/EAM/GL.1

PriorityActionsProgramme
RegionalActivityCentre
Split,Croatia