REPORTS AND STUDIES No. 68

IMO/FAO/UNESCO-IOC/WMO/WHO/IAEA/UN/UNEP
Joint Group of Experts on the
Scientific Aspects of Marine Environmental Protection
(GESAMP)

PLANNING AND MANAGEMENT

FOR

SUSTAINABLE COASTAL AQUACULTURE DEVELOPMENT

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

Rome, 2001

NOTES

1. GESAMP is an advisory body consisting of specialized experts nominated by the Sponsoring Agencies (IMO, FAO, UNESCO-IOC, WMO, WHO, IAEA, UN, UNEP). Its principal task is to provide scientific advice concerning the prevention, reduction and control of the degradation of the marine environment to the Sponsoring Agencies.

2. This study is available in English only from any of the Sponsoring Agencies.

3. The report contains views expressed by members of GESAMP who act in their individual capacities; their views may not necessarily correspond with those of the Sponsoring Agencies.

4. Permission may be granted by any one of the Sponsoring Agencies for the report to be wholly or partly reproduced in publications by any individual who is not a staff member of a Sponsoring Agency of GESAMP, or by any organization that is not a sponsor of GESAMP, provided that the source of the extract and the condition mentioned in 3 above are indicated.

5. Information about GESAMP and its reports and studies can be found at :

   http://gesamp.imo.org/
   http://gesamp.imo.org/publicat.htm
   http://www.fao.org/fi/publ/ficatpub/report/gesamp.asp

Cover photo : Shrimp aquaculture ponds in Mexico.
Courtesy of Mr José Aguilar-Manjarrez, Fisheries Department, FAO, Rome.

ISBN 92-5-104634-4
ISSN 1020-4873

For bibliographic purposes, this document should be cited as:

GESAMP (IMO/FAO/UNESCO-IOC/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection), 2001. Planning and management for sustainable coastal aquaculture development. Rep.Stud.GESAMP, (68): 90 p.

PREPARATION OF THIS STUDY

This report is based on a review of literature and experience relating to the integration of aquaculture into coastal area management. It is divided into two parts:

1. **Guidelines**, designed for both policy makers and technical specialists, which provides broad guidance on the principles and practice of more integrated planning to promote sustainable coastal aquaculture development;
2. **Tools**, designed primarily for scientists and technical specialists, or those closely associated with aquaculture development, which provides a more detailed scientific review of the tools and methods which can be used to facilitate and inform the planning process.

The Guidelines (Part 1) are "stand alone" and can be read by policy makers, planners and stakeholders without reference to Part 2. The guidance is necessarily general: the most effective approaches will vary significantly between locations. Our review of planning approaches world-wide revealed no models that were simple, effective and widely applicable. However, we were able to identify broadly agreed principles, and a common framework for more integrated approaches. The procedures and tools which can be used in support of better planning are also introduced in Part 1, with some discussion of their application, strengths and weaknesses.

Part 2 (Tools) should be read in conjunction with Part 1, since the latter provides the context and rationale for the former. The most important tools and methods that can be used to facilitate more integrated planning are reviewed, particularly as they relate to aquaculture. It was beyond the scope of this report to review all these tools in detail, and emphasis was therefore placed on those that have been applied in practice to aquaculture development planning. Where appropriate the reader is directed to other more comprehensive reviews and guidelines.

This report should not be considered a simple tool box. The complexity of the issues, and the variety of circumstances, precludes a standardised approach. Instead, the report provides realistic advice based on practical experience made in the field of planning of coastal aquaculture development and integrated coastal management throughout the world. Practitioners are encouraged to select, modify and continuously adapt their own approaches and tools to specific circumstances. The report calls for pragmatic, systematic and flexible planning and management efforts, which may need to be supported with patience, endurance and adequate funding, for the benefit of sustainable aquaculture development in coastal areas.

This document is an output from Working Group 31 of GESAMP, which met in Bangkok, Thailand, from 1-5 December 1997. Contributions to the work of the Working Group by the following experts are acknowledged with appreciation: John Hambrey (Chair), Piamsak Menasveta, Don Morrisey, Arthur Neiland, Ong Jin-Eong, Michael Phillips, John Radull, Marguerite Rasolofo, Peter Saenger, Siri Tookwinas, and Uwe Barg (Secretariat). The Working Group prepared the document "Integration of Aquaculture into Coastal Management" (GESAMP/XXVIII/5 and XXVIII/5.1). Valuable comments and suggestions on the draft study were received from Malcolm Beveridge, Dan Fegan, James Tobey and Rolf Willmann. The document was presented to the 28th Session of GESAMP in Geneva, 1998, and to the 29th Session in London, 1999, (as GESAMP/XXIX/5) for discussion and comments. The final version was endorsed at the 30th Session of GESAMP held in Monaco, 22-26 May 2000.

The report complements previous Reports and Studies by GESAMP which focus on the environmental impacts of coastal aquaculture and coastal management issues. They include: **Environmental Capacity:** an Approach to Marine Pollution Prevention (1986); **Global Strategies for Marine Environmental Protection** (1991). **Reducing Environmental Impacts of Coastal Aquaculture** (1991); **Biological Indicators and their Use in the Measurement of the Condition of the Marine Environment** (1995); **Monitoring the Ecological Effects of Coastal Aquaculture Wastes** (1996); **The Contributions of Science to Integrated Coastal Management** (1996), and **Towards Safe and Effective Use of Chemicals in Coastal Aquaculture** (1997). The work of the Working Group was jointly sponsored by the United Nations Environment Programme (UNEP), the Food and Agriculture Organization of the United Nations (FAO), the United Nations Educational, Scientific and Cultural Organization of the United Nations - Intergovernmental Oceanographic Commission (UNESCO-IOC), the World Health Organization (WHO) and the IUCN-The World Conservation Union. The Secretariat was provided by FAO.

ABSTRACT

GESAMP (IMO/FAO/UNESCO-IOC/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection), 2001. Planning and management for sustainable coastal aquaculture development. Rep.Stud.GESAMP, (68): 90 p.

The coastal zone is characterized by ambiguities of resource ownership, and complex interactions between resources, ecosystems and resource users. It has been widely recognised that to address these complexities, and to promote sustainable development in the coastal zone, a more integrated approach is needed, ideally within the framework of Integrated Coastal Management (ICM).

The rationale for more integrated approaches to aquaculture development is powerful: coastal aquaculture has brought significant economic and employment benefits to both national economies and coastal people throughout the world; aquaculture is highly vulnerable to pollution caused by other resource users; if poorly designed or managed it may cause pollution or the spread of disease; its impacts are often limited but incremental and cumulative; and it often takes place in areas where resource ownership or use rights are ill defined and ambiguous. Efforts to integrate aquaculture into coastal management can contribute to improvements in selection, protection and allocation of sites and other resources for existing and future aquaculture developments.

This report is based on a review of literature and experience relating to the planning and management of aquaculture development and its integration into coastal area management. It explores in detail how more planned and integrated approaches can be applied to aquaculture development. These approaches range from “enhanced sectoral” initiatives, to incorporation within comprehensive ICM programmes.

No simple, effective, and widely applicable models have been identified. The most appropriate approach will depend upon a wide range of local factors, including available skills and resources, the urgency of the problems or opportunities, and the nature of existing planning and development frameworks. The less comprehensive approaches may be the only realistic option in some situations, but should be seen as a starting point for, and stimulus to, more comprehensive ICM. These approaches should contribute to more systematic planning and improved management of individual aquaculture operations, as well as to the coastal aquaculture sector as a whole.

Key words: Aquaculture Development, Planning, Coastal Management, Sustainable Development

CONTENTS

EXECUTIVE SUMMARY

Background and rationale

1. Aquaculture production is growing at more than 10% per year, compared with 3% for terrestrial livestock and 1.5 % for capture fisheries. This growth is expected to continue. Asian aquaculture farmers continue to contribute about 90% of the world's aquaculture production, and more than 80% of total aquaculture yield is being produced in low-income food-deficit countries (LIFDCs).

2. Coastal aquaculture is dominated by the production of aquatic plants (seaweeds) and molluscs. However, a wide range of diverse coastal aquaculture systems has been developed in Asia, Europe, and the Americas, operating at different intensities and scales of production.

3. Aquaculture has great potential for the production of food, alleviation of poverty and generation of wealth for people living in coastal areas, many of whom are among the poorest in the world. The rapid growth of aquaculture in recent years has been consistent across sub-sectors, from low-input systems generating low value products of importance for subsistence and direct food security, to medium and high value products for national and international markets, which are important for improved living standards and foreign currency earning. The great diversity of the sector encompasses very small scale to very large-scale enterprise, implying that aquaculture can contribute significantly to a wide range of development needs.

4. However, significant problems can be associated with coastal aquaculture development. These include unsuccessful development, where the potential for development is not realised, especially among the poorer sectors of society; the vulnerability of aquaculture to poor water quality and aquatic pollution, caused by industrial, domestic, agricultural and aquacultural (i.e. its own) wastes; and over-rapid development, where the undoubted successes of the sector have been tarnished by environmental and resource use issues, social problems, disease, and in some cases, marketing problems.

5. Although some of the social and environmental problems may be addressed at the individual farm level, most are *cumulative* – insignificant when an individual farm is considered, but potentially highly significant in relation to the whole sector. They are also *additive* – in the sense that they may add to the many other development pressures in the coastal zone.

6. These cumulative and additive problems can only be addressed through better planning and management of the sector - by government, in collaboration with producer associations or industry organisations. A precondition for better and more effective planning is also better organisation and representation of the sector.

7. Crucial elements in a more planned approach include:

   - improvements in siting, design, technology, and management at the farm level;
   - better location and spatial distribution of the sector as a whole;
   - better water supply for the sector as a whole;
   - better fish health management including disease and stock control at individual farm and sector levels;
   - improved communication and information exchange;
   - improved access to markets and trade opportunities;
   - more equitable distribution of the benefits derived from coastal aquaculture development.

8. In practice many of these are unlikely to be achieved without effective integration with planning and management of other sectors. The framework normally proposed to achieve this is integrated coastal management (ICM).

Review of experience

9. Some investors have responded to the problems associated with coastal aquaculture through more rigorous project appraisal. Governments have responded mainly with specific regulations relating to farm operation (such as effluent limits, design standards, best management practices,

and codes of conduct). In some cases they have responded with more rigorous requirements for social and environmental impact assessment.

10. These farm level measures have often been ineffective. Promotion of environmental assessment in particular has failed to address the problem of over-rapid and unplanned development of aquaculture in some countries. There are two reasons for this. Firstly, as noted above, the impacts associated with aquaculture are often insignificant when a farm is considered in isolation. Secondly, in the absence of any broadly agreed environmental quality standards, assessments of the significance of impacts have been highly subjective and inconsistent.

11. A range of more comprehensive approaches to coastal resources management have been proposed as frameworks for addressing the wider issues of sustainable coastal resource use, the minimisation of conflict, and the optimal allocation of resources including in particular land and water. These range from sector related environmental planning and management initiatives (enhanced sector planning) to more ambitious integrated coastal management (ICM) programmes.

12. There have been two main types of enhanced sectoral initiative for coastal aquaculture. The first has used geographic information systems (GIS) and remote sensing as the basis for defining suitable locations or zones for aquaculture. The second has focused on estimates of environmental capacity in order to define appropriate scale and location for sustainable aquaculture development. Both offer a useful practical focus for more integrated planning initiatives. Unfortunately, these initiatives have often failed to translate the findings into practical incentives and constraints to promote more sustainable development. This failure points to the need for broader and more integrated planning frameworks.

13. There are many examples of more integrated coastal zone management (CZM) or integrated coastal management (ICM) initiatives, some of which have encompassed aquaculture. The objectives of such initiatives typically include: the optimal allocation of resources to competing activities or functions; the resolution or minimisation of conflict; the minimisation of environmental impact; and the conservation of natural resources. Given the problems listed above, it is clear that they have great relevance to aquaculture.

14. Unfortunately the performance of regional or national level ICM initiatives has been disappointing in practice, particularly in relation to aquaculture. This is related to the complexity of the process, the difficulties associated with significant institutional and legal changes, and the time and cost involved. For example, the problems associated with shrimp farm development have arisen mainly when it has developed rapidly and uncontrollably in developing countries. Some major ICM initiatives have failed to respond with the rapidity required.

15. In these circumstances, more locally focused initiatives (e.g. relating to an estuary or lagoon system) may offer the most practical starting point, and are likely to lead to the identification of specific needs in terms of greater vertical integration (i.e. with higher level policy or legislation).

16. In other situations, where the nature of the resources or existing resource management systems precludes more locally based initiatives, enhanced sectoral approaches may be the most appropriate. However, the lack of effective mechanisms for implementation has often been a weakness of such approaches, and requires particular attention.

17. More comprehensive ICM may be effective as a starting point where coastal aquaculture is in the early stages of development, where institutions for resource management are flexible or un-developed, where appropriate legal and institutional frameworks are in place or can be developed rapidly, and where scientific and technical capacity is substantial.

Guiding principles

18. Despite this lack of a universal model, it is possible to present a set of widely agreed guiding principles which may be applied whatever the administrative level or scope of the planning initiative.

19. The first is the requirement for a clear planning objective. In broad terms, this would normally be *to promote or facilitate sustainable development*. Although there are many definitions and more interpretations, the most widely quoted and agreed, is: *"Development that meets the needs of the present without compromising the ability of future generations to meet their own needs"* (*Brundtland Report*; WCED, 1987). Ensuring that activities do not exceed the carrying capacity of the environment is one practical interpretation of this objective. Ensuring that the sum total of natural and economic capital is maintained or increased through time is another. Agreeing (at national or local level) on a practical interpretation of this in relation to aquaculture must be one of the first steps in any planning and management initiative.

20. Two principles were given emphasis at the Rio Summit and should be observed. ***The precautionary approach*** means that we should more carefully plan and rigorously evaluate developments that have uncertain and potentially damaging implications for the environment. The ***polluter pays principle*** is subject to a range of interpretation, from a requirement upon polluters to pay the costs of monitoring and management, through the requirement to pay the costs of clean-up, to the responsibility to pay for the cost of environmental damage as well as that of clean-up.

21. ***Integration or co-ordination*** with other sector activities or plans, with national sector plans, and with integrated coastal management plans (where these exist) is essential.

22. Wide ranging ***public involvement*** is important, meaning not only consultation and information exchange, but also direct involvement or *participation* of stakeholders in the decision making process, especially in relation to defining overall objectives and associated targets and standards. Related to this, particular attention should be paid to the promotion of ***effective representative organisation***s.

23. Thorough ***assessment of costs and benefits*** (financial, economic, social, environmental) of aquaculture in a specific area (e.g. estuarine or lagoon system) should be undertaken; as should *comparative* assessment of costs and benefits of aquaculture relative to other resource uses.

24. Some assessment of ***environmental capacity*** is desirable. The scope and accuracy of this assessment will depend critically on resources and time available.

25. ***Regulation*** is difficult, especially with respect to large numbers of small-scale developments, and offers limited incentive for improved environmental performance. It may be made more effective if responsibility for design, implementation and enforcement is located at the proper administrative level, and full use is made of self-management and self-enforcement capacity by industry and farmers' associations.

26. ***Incentives*** (financial, market, infrastructure) can be designed to stimulate innovation and improvements in environmental management, and should be used wherever possible. However, incentives may need to be underpinned or reinforced through complimentary regulation.

27. Emphasis should be on the control of ***effects,*** rather than the scale of activity. This allows for economic growth at the same time as providing an incentive for improved environmental performance.

28. More integrated planning and management is extremely complex, and the outcomes from each stage of the process are likely to be flawed or inadequate in some way. If the planning process is not to fail, it must learn and adapt. This requires an ***iterative*** approach of *action-monitor-evaluate-adapt-action-monitor-…* and so on. This applies to all forms of action associated with the planning process: research, setting objectives and targets, specific planning interventions, and designing new institutional structures and procedures.

29. Many integrated planning initiatives have foundered through lack of appropriate institutional structures or capacity for developing or implementing the plan. ***Institutions*** and capacity must be considered at all stages, but especially in relation to implementation.

Legal and institutional frameworks

30. The importance of legal, procedural and institutional frameworks designed to facilitate sustainable aquaculture development is emphasised in the FAO Code of Conduct for Responsible Fisheries. Again, there are no universally applicable models. The nature of any improvements will depend on existing laws, traditions, and institutional structures. The key point is to develop or adapt a system that allows for the comprehensive application of the principles set out above.

31. Where the introduction of new legislation is difficult, or will cause excessive delay, *guidelines* for developing new initiatives may be introduced prior to specific legislation, as a means of testing out different approaches.

32. The ideal framework would allow for vertically (national to local) and horizontally (across sectors) integrated policy-making and planning with a significant role for strategic, sector or regional (integrated) environmental assessment as an input to the planning process. Such a framework should allow for adaptation in both directions, i.e. national policy should inform local planning; local planning and public involvement should inform the development or adaptation of policy at higher levels.

The planning process

33. The planning process is broadly similar, irrespective of the degree to which it is integrated (enhanced sectoral planning or ICM), and whether it takes place at local, district, regional or national level:

    I. *Stage setting and planning* involves the identification and analysis of issues; the definition of provisional (working) goals and objectives; the selection of strategies and specific instruments to meet the objectives; and the selection or design of implementing structures.
    II. *Formalisation* involves the agreement and formal adoption of the plan or program, and securing of implementation funding.
    III. *Implementation* involves deployment of specific planning instruments and development actions, the promotion, facilitation, and if necessary enforcement of policies and regulations, and monitoring of the effects of the plan.
    IV. *Evaluation* involves analysis of progress against targets and objectives, and problems encountered

34. In practice stage I. can be further broken down into a set of operational components:

    - Identifying the means/mechanism and level of planning;
    - Initiation;
    - Gaining the trust, involvement and commitment of key stakeholders;
    - Understanding the development context (natural and human resources and economy);
    - Understanding the development options;
    - Defining goals and objectives, and identifying corresponding performance criteria, including environmental quality standards;
    - Identifying development priorities and acceptable practices;
    - Defining broad development strategies (strategic planning) to promote development priorities and practices;
    - Designing/agreeing specific planning and management instruments (incentives and constraints) to promote development priorities and practices;
    - Designing and agreeing monitoring, reporting, evaluation and response procedures;
    - Building necessary institutional capacity, and if necessary new institutions.

    A variety of tools and methods are available to help inform and facilitate each of these components.

35. Initiation must be done with great care. The “who and how” of planning is likely to have a significant impact on support for the plan and compliance with its provisions. A variety of tools may be used in this first exploratory phase, including stakeholder and institutional analysis. Public involvement and participation from the outset is crucial.

36. Understanding the development context can be extremely complex and great care should be taken to avoid data collection for its own sake. There are several examples of very detailed resource assessment for aquaculture development planning, which have fallen into this trap. The collection of information and research about human and natural resources should be undertaken in parallel with broad public involvement and issues identification, so that the research and information collection can be focussed and steadily refined. Logically, this should be done within a broader ICM, or locally integrated initiative, rather than within a sectoral planning framework.

37. The estimation of environmental capacity is of particular relevance to aquaculture, to the problem of cumulative impact, and to promoting sustainable development in general. It is therefore discussed in detail in part 2 of this report. An assessment of environmental capacity should be undertaken, even if only at the most elementary level, if promoting sustainable development is to have any practical meaning. Given its complexity however, and its relevance to other activities in the coastal zone, it is better done within a broader ICM rather than sectoral planning framework.

38. Again it is important not to be too ambitious. A very rough estimation of environmental capacity, followed by monitoring of key indicators so that the estimate can be steadily refined, may be much more rapid and cost effective than a major research initiative.

39. Describing development options is rarely done thoroughly or objectively, despite the fact that this is relatively straightforward. Financial analysis is essential, and if quantities as well as value of inputs and outputs are included in financial models or projections, important indicators of resource use efficiency and socio-economic benefit can be generated. This information, along with more qualitative descriptions of site/location requirements, markets, risk, access and equity issues, can be used to generate an analysis of comparative economic advantage and an overall “sustainability profile”. This can be done at the sector level, but the information generated will also be invaluable for broader ICM initiatives.

40. Defining goals and objectives again requires stakeholder participation. Agreement on goals and objectives (before specific development cases are addressed) can be a significant factor in conflict avoidance and resolution. It is also important to agree on specific targets and standards relating to these objectives. These may then serve as the basis for more consistent social and environmental assessment, as the rationale for specific planning interventions, and as a baseline against which progress (in terms of improved performance of the sector) can be measured. Once again, this is costly and difficult to do at the sector level.

41. Identifying development priorities and acceptable practices can be done using a range of formal and informal tools including social and environmental assessment; cost benefit analysis; and participatory/multi-criteria decision making. The success of these approaches, especially for comparing economic and environmental costs and benefits, will depend critically on the thoroughness of the issues identification; the quality of the technical-economic assessment; and the existence of agreed objectives and targets/standards. It will also depend on effective communication and exchange of information so that all those involved in the decision making process are well informed.

42. The foregoing should provide the basis for a planning and management strategy, which might include, for example:

    - zones with development and environmental objectives specifically related to aquaculture and other compatible activities;
    - environmental quality standards associated with these zones;
    - allocation of environmental capacity, in terms of waste production/emission limits, for aquaculture and other activities within these zones; and
    - production targets related to development potential, and social-economic objectives.

43. A set of planning interventions in the form of incentives and constraints (planning instruments) will be required to implement the strategy and ensure that objectives are met, standards are not breached, and environmental capacity is not exceeded. Incentives and constraints might apply to :

    - location and siting of aquaculture development;
    - waste emissions;

- the quantity or quality of inputs used (e.g. food, chemicals);
- design, technology and management practices;
- stock movement and disease management; and
- the level of activity or production.

44. The incentives and constraints may take the form of:

- rules and regulations, and associated enforcement measures;
- economic instruments (e.g. grants, subsidies, tax breaks, taxes, bonds, price intervention, product labelling);
- infrastructure provision (such as water supply, effluent treatment); and
- services (such as disease certification; marketing; training; advice; extension).

45. It is important that these are agreed with all stakeholders if compliance is to be maximised. Particular attention is paid to economic and market instruments in the report, since these are more likely to take the form of incentives rather than constraints (which are often difficult to enforce).

46. Monitoring and evaluation are of paramount importance with such a complex process. This should be straightforward if clear planning objectives have been set, and associated performance criteria (e.g. standards) agreed. However it is also important to monitor and evaluate these criteria, especially environmental standards, since the link between them and people's perception of the quality of the environment may be weak. For example, water quality standards in receiving waters are often based on national guidelines or international precedent, and rarely relate directly to local environmental quality values and objectives. It may be useful to develop "state of the environment" reporting in order to examine overall effects of development activities on the wider environment, the relevance of particular standards, and the utility of indicators.

47. Monitoring should also apply at a more immediate level to the planning and implementation process. There will be many indicators relating to the success of specific procedures or interventions, and these should be set out in the monitoring programme. In addition, it is vital to agree on the nature of the response if standards are breached, procedures fail, or targets are not met.

48. The plan must be flexible. Procedures must be established for communicating the results of monitoring and evaluation to stakeholders, and adapting and modifying the plan in the light of experience. At minimum this may involve slight adjustments to planning interventions. In the extreme it may involve developing completely new policy, laws and institutions.

49. The report presents policy guidelines for all the stages described above, describes and discusses specific tools which can be used in support of the planning process, with emphasis on those of particular relevance to coastal aquaculture development, and provides examples and case studies relating to both the planning approaches and the application of specific tools. It has not been possible to cover all areas in detail, and in this case the reader is referred to other guidelines or reviews for further information.

PART 1

GUIDELINES FOR PLANNING AND MANAGEMENT FOR SUSTAINABLE COASTAL AQUACULTURE DEVELOPMENT

Part 1 of this document contains guidelines designed to help policy makers, planners and stakeholders in the coastal zone promote sustainable aquaculture development, and facilitate its integration into broader coastal management initiatives.

The first part of the guidelines provides a background and rationale for improved planning of aquaculture development, and integration of such planning as far as possible with other sectors. The second part offers a brief review of the theory and practice of more integrated approaches to aquaculture development planning, and coastal management more generally. The third part summarises the main guiding principles that should be applied to any coastal aquaculture planning initiative, irrespective of its scope, or the administrative level at which it takes place. The fourth part deals with the need (and the obligation now resting on producer countries) for enhanced legal and institutional frameworks to promote better-planned and more sustainable coastal aquaculture development. The final part takes the reader through the various operational components of a more planned and integrated approach to promoting sustainable coastal aquaculture development, and introduces the various tools that may be used to facilitate or support these components. Brief case studies are presented throughout the text to illustrate worldwide experience in the use of different approaches and planning tools. Where appropriate the reader is referred to the more detailed discussion of supporting tools and methods in Part 2.

Our review of actual planning approaches worldwide revealed no models that were simple, effective and widely applicable. Nor did our review of the application of the various planning tools yield simple general conclusions about how and when they should be used. Their suitability and utility will depend on local circumstances and the type of aquaculture being considered. We have therefore identified as far as possible the strengths and weakness of different planning approaches, and the tools which may be used to facilitate them, so that practitioners can make a critical appraisal of these approaches, and make informed choices in relation to their own circumstances.

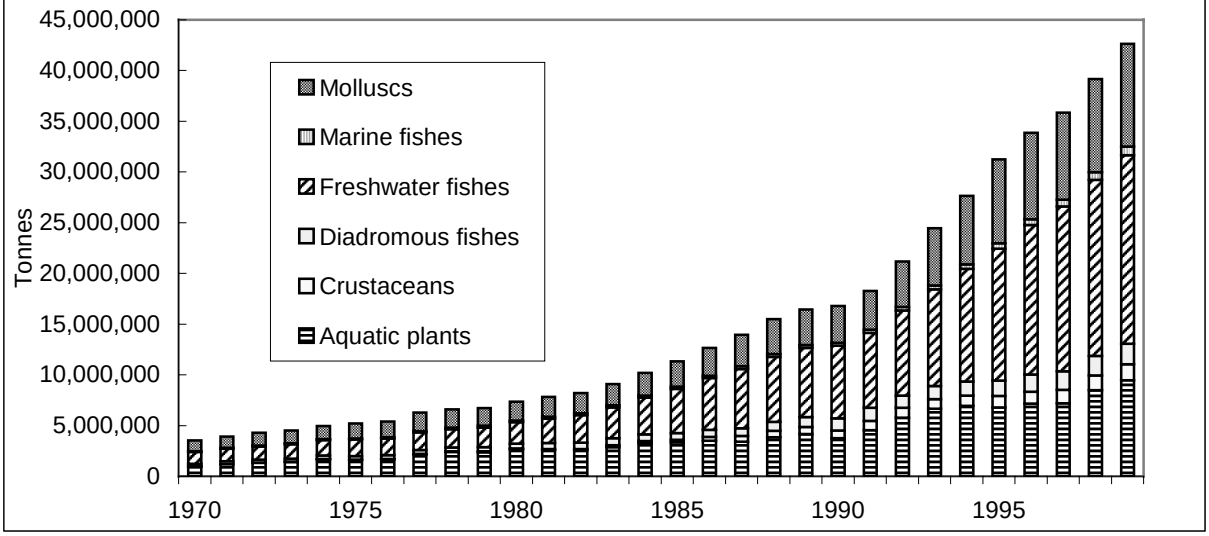
1 GUIDELINES

1.1 Background and rationale

1.1.1 The status of aquaculture development

Aquaculture is the farming of aquatic organisms, including fish, molluscs, crustaceans and aquatic plants (FAO, 2000; FAO Fisheries Department, 1997; FAO/FIRI, 1997). Aquaculture has been the world's fastest growing food production system for the past decade (Muir, 1995; Tacon, 1997).

Figure 1. Global aquaculture production trends by major species groups 1970-1999 (Source: FAO, 2001)



Aquaculture production increased from 7,4 million tonnes in 1980 and 16,8 million tonnes in 1990 to more than 42 million tonnes in 1999 (Fig. 1), valued at over US$ 53 thousand million. The sector's production is growing at an average rate of more than 10% per year, as compared with a growth of about 3% for terrestrial livestock meat production, and 1,5% for capture fisheries production. The contribution of aquaculture to world food fish landings has more than doubled since 1984. In 1997, over 30% of food fish consumed by humans, from a total average per caput food fish supply of 16.1 kg, was provided by aquaculture. Global projections for future supplies from aquaculture production include, for example, 47 million tonnes for the year 2010 (Pedini and Shehadeh, 1997).

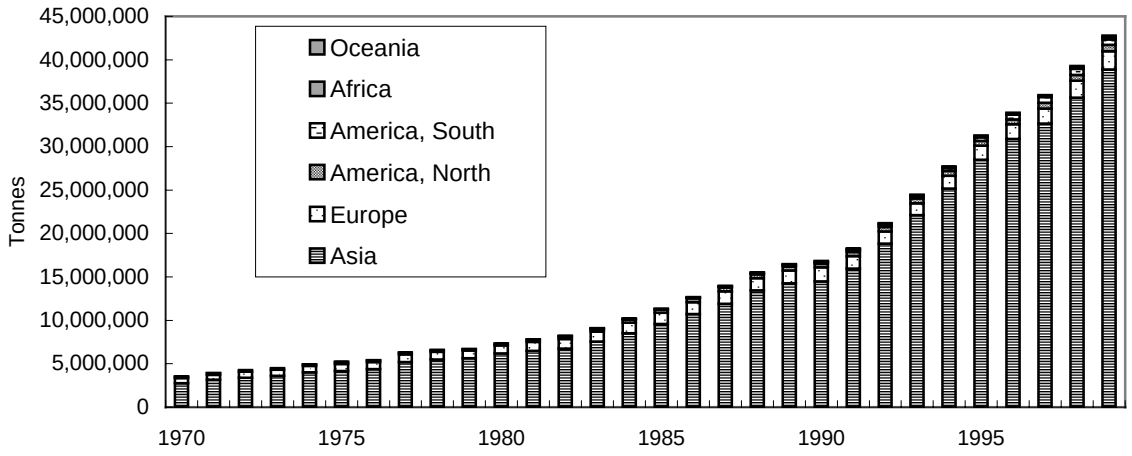
Asian aquaculture farmers continue to contribute about 90% of the world's aquaculture production (Fig. 2), and in 1999 more than 82% of total aquaculture yield was produced in low-income food-deficit countries (LIFDCs). The growth rate of the aquaculture sector in LIFDCs between 1984 and 1995 was six times faster than that for non-LIFDCs (Rana, 1997; Tacon, 1996).

The vast majority of finfish produced by aquaculture is based on extensive and semi-intensive freshwater culture systems producing predominantly Chinese and Indian carps, and contributing more than 44% of global total aquaculture production by weight in 1999. In contrast, marine and brackishwater aquaculture systems employed in coastal areas inf 1999 yielded 23,4 million tonnes, valued at US$ 30,3 thousand million, representing 55% of total volume and 56% of total value of global aquaculture production (Fig. 3).

Coastal aquaculture is dominated by production of aquatic plants (seaweed) and molluscs. For 1999, their shares of total coastal aquaculture production in terms of quantity and value are 40% and 19% (seaweed) and 43% and 30% (molluscs). The production share of crustaceans (6%) and finfish (11%)

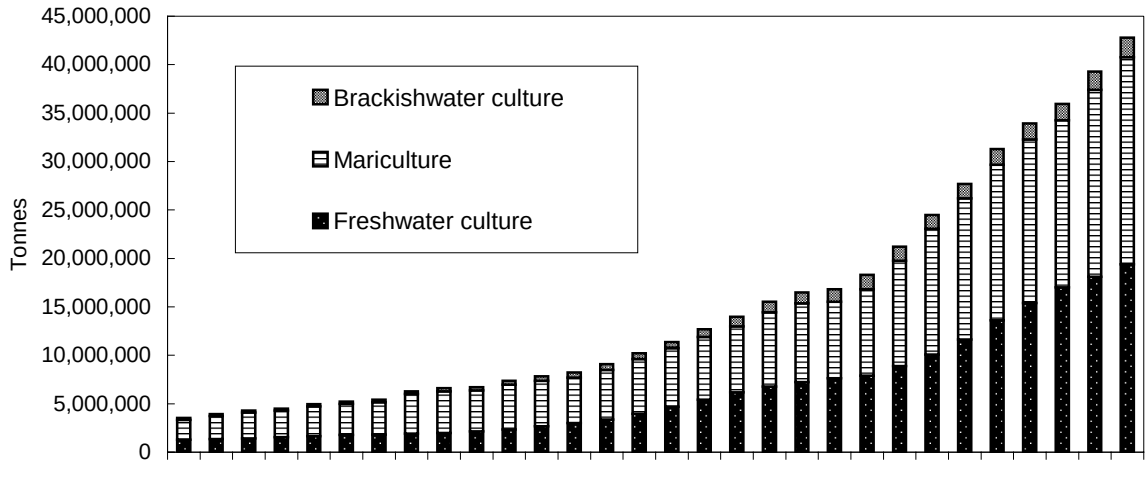
is comparatively low, but their relative contributions to the value of total coastal aquaculture production is significant, i.e. 24% (crustaceans) and 27% (finfish).

Figure 2. Global aquaculture production trends by continents 1970-1999 (Source: FAO, 2001)



A wide range of very diverse coastal aquaculture systems has been developed in Asia, Europe, and the Americas, operating with different intensities and scales of production. The potential for additional growth and future expansion of coastal aquaculture is being recognised by many government authorities, private sector (investors, aquaculturists and ancillary activities), financial institutions, such as development banks, as well as aid agencies, at national and international levels.

Figure 3. Global aquaculture production by environments, 1970-1999 (Source: FAO, 2001)



1.1.2 Sustainable Development

During the last decade there have been increasing efforts, at national and international levels, to address opportunities and needs for more sustainable aquaculture development[1]. Sustainability issues associated with coastal aquaculture developments, in particular aquaculture of salmonids and shrimp, have attracted the attention of government authorities, the private sector, environmental NGOs, the academic community, international agencies, the media and the public in general[2].

There have been many definitions of sustainable development. One of the most widely quoted and agreed, is:

> *"Development that meets the needs of the present without compromising the ability of future generations to meet their own need"* (WCED, 1987)

Rather more specifically, and in relation to agriculture and fisheries, it has been defined by FAO as follows:

> *Sustainable development is the management and conservation of the natural resource base and the orientation of technological and institutional change in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations. Such sustainable development (in the agriculture, forestry and fisheries sectors) conserves land, water, plant and animal genetic resources, is environmentally non-degrading, technically appropriate, economically viable and socially acceptable* (FAO Fisheries Department, 1997).

Other definitions have been developed by economists, which allow (in theory) for the actual measurement or quantification of sustainability. These generally require that the sum total of different resources and/or capital (natural capital; human capital; physical plant (equipment, machinery, buildings) and infrastructure; financial capital; and other forms of capital valued by particular societies) does not decrease over time (Hartwick, 1977; Solow, 1986).

The practical meaning of sustainable development will rarely be agreed in relation to particular development decisions, because:

- its component ideas may be contradictory, or interpreted in different ways by different interests;
- the values or weights assigned to its various components by different interests may differ; and
- it may conflict with short term financial viability[3]

The idea is nonetheless a powerful and constructive one, since it forces people to assess, research, and discuss development opportunities from a broad range of perspectives. It also encourages specific discussion of the trade-offs between different development and conservation objectives and their associated activities.

---

[1] ADB/NACA, 1996; Bagarinao and Flores 1995; Bailey, 1988, 1989, 1997; Bailey and Skladany, 1991; Barg, 1992; Chua, 1997; Chua *et al.*, 1989; FAO, 1995a; FAO/FIRI, 1997; FAO/NACA, 1995; GESAMP, 1991a; GESAMP, 1996a; GESAMP, 1997; ICES, 1997; Makinen, *et al.* 1991; Mires, 1995; Muir, 1996; Munday *et al.*, 1992; NACA, 1996; Barg and Phillips, 1997; Phillips and Macintosh, 1997; Pillay, 1997; Pullin, 1993; Rosenthal, 1997; Saenger, 1993; Stewart, 1997; Videau and Merceron, 1992; Wu, 1995.

[2] Bardach, 1997; Barg *et al.*, 1997; Beveridge *et al.*, 1997; Chamberlain and Rosenthal, 1995; Clay, 1997; Nambiar and Singh, 1997; Naylor *et al.*, 1998; Phillips and Barg, 1999; Phillips, 1995a; 1995b; Pillay, 1996; Reinertsen and Haaland, 1995; Rosenthal and Burbridge, 1995; Tobey *et al.*, 1998.

[3] It is for this reason that some development specialists include financial viability as part of any practical definition of sustainable development

1.1.3 The costs and benefits of coastal aquaculture development

Planning for sustainable development and improved natural resource management implies a thorough examination of different development options in terms of their financial, economic, social, and environmental costs and benefits, and the distribution of these costs and benefits through time and space, and between different groups in society. This implies some form of valuation – either qualitative or quantitative.

Despite the rapid growth of aquaculture and the growing awareness of environmental issues, few studies have been made which address these issues objectively. In many cases the debate has polarised between those who emphasise the economic benefits, and those who emphasise negative environmental impact. The debate has also tended to generalise from specific examples, although the sector is enormously diverse. For example, four major species groups are farmed in coastal areas, including seaweed, molluscs, crustaceans and finfish, with a range of significant differences within and between each of these groups.

A major purpose of this document is to help those involved in development decisions make a more rational assessment of these issues in relation to particular circumstances.

1.1.4 The need for planning and management of the aquaculture sector

Experience has shown repeatedly that without some form of intervention, short term financial perspectives will tend to dominate development decisions to the detriment of environmental and social objectives. In the case of coastal aquaculture, and indeed many activities in the coastal zone, there is a strong case for such interventions to be planned and strategic, rather than reactive and uncoordinated.

The problems associated with coastal aquaculture development may be grouped into three broad categories as follows:

- *unsuccessful development*, where the potential for development is not realised, especially among the poorer sectors of society;
- the *vulnerability of aquaculture* to poor water quality and aquatic pollution, caused by industrial, domestic, agricultural and aquacultural (i.e. its own) wastes;
- *over-rapid development*, where the undoubted successes of the sector have been tarnished by environmental and social problems, disease, and in some cases, marketing problems.

Investors have responded to these problems with more rigorous project appraisal: financial and economic analysis, and in some cases cost benefit analysis. Governments have responded with specific regulations relating to farm operation (such as effluent limits or design standards), and/or with more rigorous requirements for social and environmental impact assessment (EIA). The market itself is increasingly demanding sustainably produced goods, at least in western countries.

These responses have significant weaknesses. They arise mainly from the small scale and incremental nature of most aquaculture (and agriculture) development. While individual developments may have no significant impact on the environment or society, a large number of developments, however small, may have significant impacts on the wider social and economic environment, and on each other. Farm drainage in western countries, and shrimp farming in some regions of Asia are classic examples of this problem. Project or enterprise level approaches cannot deal with this problem (see for example Box 1.1), and the market is likely to respond only once damage is done. Furthermore, EIA and economic/financial studies tend to be undertaken by different specialists, ignoring the close links between the two, and commonly presenting contradictory conclusions.

Nor can these approaches facilitate or promote aquaculture development in those areas to which it is most suited. This is a particular problem with aquaculture, because site requirements are frequently much more demanding than those for other activities. Inadequate attention on the part of new entrants to site selection is a major cause of failure in aquaculture development, and commonly exacerbates environmental impacts.

In practice, the problems and opportunities associated with coastal aquaculture development can only be addressed or realised through:

- improvements in siting, design, technology, and management at the farm level (requiring a set of incentives and constraints to promote these changes at the sector level);
- better location and spatial distribution of the sector as a whole (implying some form of zoning);
- better water supply for the sector as a whole;
- better fish health management, including disease and stock control at individual farm and sector levels;
- improved communication and information exchange;
- improved access to markets and trade opportunities; and
- more equitable distribution of the benefits derived from coastal aquaculture development.

This implies strategic intervention by government and producer associations or industry organisations to allocate and use resources more equitably and efficiently in both time and space – in other words, more effective and integrated planning and management of the sector.

Box 1.1: EIA of a shrimp farm in Tanzania

The importance of a broader environmental management framework for effective EA

In 1994 a private company sought assistance from NORAD for the establishment of a medium-large shrimp farm near Bagamoyo, Tanzania. The farm site was set adjacent to the mangroves of the Ruvu River, the largest single expanse of mangrove in the Bagamoyo District.

NORAD commissioned an initial EIA based on the NORAD Guidelines. The overall tone of the assessment was positive, and the final paragraph of the executive summary stated:
"*We believe that if such (mitigation) procedures are followed, the proposed project might become a model for the development of sustainable shrimp culture throughout the world, and in this sense offers a unique opportunity for realising the undoubted and substantial potential benefits offered by well planned and managed farms".*However, it had already cautioned:

> *"If appropriately designed and managed, **and if considered in isolation**, this farm is unlikely to have a significant impact on the environment. However, in many other parts of the world successful farms have attracted uncontrolled smaller scale satellite developments which in places have had a serious cumulative impact on the environment and the sustainability of shrimp farming itself……. It is essential that this and future developments take place within a planning and regulatory framework which will prevent uncontrolled development and ensure on-going responsible management practices. …Without such a framework, this development may simply become a small part of a wider development problem"*

It would appear that this caution, and the evident lack of any wider environmental management framework, was taken seriously, and funding for the project was rejected.

This example demonstrates that EIA in the absence of a broader environmental management framework cannot be used as a positive planning or management tool. It will either allow or restrict development, on a relatively ad hoc basis, dependent largely on the knowledge or bias of the EIA contractor and the decision maker. It will be based on no broadly accepted decision criteria. If mitigation measures are recommended, there will be little chance of them being implemented, especially if they are associated with additional costs.

After Hambrey et al., 2000.

1.2 Aquaculture and coastal management – a brief review of theory and practice

Strategic planning has traditionally addressed the inadequacies of the enterprise level approaches highlighted in the previous Section. With some notable exceptions however (such as the Great Barrier Reef in Australia), these approaches have tended to place limited emphasis on natural resource issues, which have traditionally been addressed by sectoral agencies such as Fisheries, Agriculture and Forestry Departments.

A range of more comprehensive approaches to coastal resources management have therefore been proposed as frameworks for addressing the wider issues of sustainable coastal resource use, the minimisation of conflict, and optimal allocation of resources, including in particular land and water. These range from sector related environmental planning and management initiatives (referred to below as enhanced sectoral management or ESM), to more ambitious integrated coastal management (ICM) programmes.

The following Sections examine the various frameworks for coastal management which have been used or proposed, and discuss their strengths and weaknesses. Brief case studies are presented in boxes illustrating the application of different approaches in practice.

1.2.1 The scope of coastal management

Coastal management implies something broader than addressing the development or resource issues associated with one particular activity or sector in the coastal zone. Olsen *et al*. (1997) have proposed the following typology of coastal management:

Enhanced Sectoral Management (ESM)	Coastal Zone Management (CZM)	Integrated Coastal Management (ICM)
Focus on a single sector or topic but explicitly accounts for impacts and interdependencies with other sectors, ecosystem functions, and institutional capacity.	Multi-sectoral planning and regulation focused upon the characteristics and needs of narrow, geographically delineated, stretches of coastline.	Expands the cross sectoral feature of CZM to consideration of the closely coupled ecosystem processes within coastal watersheds and oceans

In practice there is a broad range, or continuum, of coastal management initiatives relevant to aquaculture which are more or less integrated in terms of geographical scope, horizontal (sectoral) integration and vertical (policy) integration. CZM and ICM type initiatives in particular overlap significantly in practice, and are difficult to assign to these sub-categories. For practical purposes they are therefore grouped together in the discussion below.

1.2.2 Enhanced sectoral management (ESM)

Initiatives which seek to enhance the sectoral management of aquaculture and aquaculture development are widespread in developed countries (Black, 1991; GESAMP, 1996a; ICES, 1997; Ibrekk *et al.*, 1993; Kryvi, 1995; PAP/RAC, 1996; PAP/RAC,1995; Rosenthal *et al.*, 1993; Rosenthal and Burbridge, 1995; Truscott, 1994). Interest in these approaches has been generated because of heightened awareness of sustainability issues in general, and those related specifically to aquaculture, as described above in Sections 1.1.2-4. Enhanced sectoral management tends to be conservative in nature, the initiatives usually arising within existing institutions, and based on existing responsibilities and powers.

These initiatives are diverse. They include the use of environmental impact assessment (EIA) at sector or farm level, and/or a package of tools and incentives to promote better siting or more sustainable practices (Box 1.3). In some cases assessments of environmental capacity and its relation to the quantity or location of aquaculture production have been undertaken (Box 1.2). Other initiatives focus on the identification of suitable sites or zones for aquaculture development, facilitated through the use of GIS or remote sensing. In Tasmania, a more comprehensive approach is now in place that requires the development of local marine farming development plans (Box 1.4)

Initiatives in this category have been funded by government at all levels, by development banks or aid agencies, and by private companies. However, the lead institution is generally that with traditional responsibility for fisheries and aquaculture.

Box 1.2 Enhanced sectoral management in Norway

In the early 1990s a coastal management programme for aquaculture, known as ***LENKA***, was developed in Norway.

Aims

- *To encourage the development of aquaculture while minimising conflict with other uses of coastal resources;*
- *to contribute to environmental planning in the coastal zone;*
- *to contribute to the process of siting of aquaculture facilities.*

Procedure:

1. classification of the coastal environment in terms of sensitivity to organic loading and nutrients;
2. assessment of the natural capacity of each category to tolerate organic loadings and nutrients;
3. assessment of total existing loadings/inputs;
4. estimation of the maximum acceptable additional organic loading, which is converted into an aquaculture production equivalent;
5. assessment of the physical area available for aquaculture development, arrived at by subtracting all unsuitable areas and all areas currently occupied from the total area;
6. estimation of total additional production possible without exceeding available area, or available nutrient capacity.

Despite its undoubted potential, LENKA has not become a significant planning tool for the aquaculture industry, or for coastal management in general. It has not been brought into a wider planning framework where it could be used to clarify or implement planning objectives and targets.

This failure highlights the importance of paying adequate attention to institutional issues, and ensuring that there is a mechanism for deploying effectively a suite of incentives and constraints to meet economic and environmental objectives. LENKA is a powerful tool without a framework.

Reference: Ibrekk *et al*.,1993.

Strengths

- avoids the risks of more radical approaches to institutional change (e.g. confusion over powers and responsibilities; lack of institutional capacity);
- builds on and enhances existing knowledge and skills;
- allows for relatively rapid assessment and research, followed by implementation of improved planning and management of aquaculture development - *if* appropriate institutional powers and capacity already exist.

Box 1. 3 Enhanced sectoral management in Hong Kong

In Hong Kong the rapid unregulated development of marine cage culture in the 70's led to water quality problems and conflicts with recreational uses. As a result a legislative framework for the management of the industry was introduced, and a sector environmental assessment undertaken.

The industry is now closely regulated with management overseen by a government inter-departmental working group. Legislation includes zoning, licensing and production limits. Production is being steadily phased out in areas where there is poor flushing, and environmental impacts of the industry are now considered to be acceptable.

Unfortunately the industry has suffered in recent years from fish kills and marketing problems related to "red tides" suggesting that a broader approach is required which takes account of all forms of nutrient load to the water around Hong Kong.

Reference: Wong, 1995.

Weaknesses

- sometimes "top down" and driven by technological priorities and considerations;
- the values and concerns of other stakeholders may be inadequately understood or taken into account;
- where the lead agency also has responsibility for aquaculture development, the initiative may be biased in favour of development;
- assessment, evaluation and monitoring of the effectiveness of interventions may not be objective or effective, because of a lack of external perspective;
- may ignore rather than resolve conflict;
- may end up as paper research and project style exercises, if planning and regulatory powers and institutional capacity are lacking;
- may partially duplicate the efforts of other sectoral agencies also involved in enhanced sectoral planning;
- may be more costly in the long term (because of duplication of effort), and less consistent and effective (because of duplication of policy, or formulation of contradictory policies) than more integrated approaches.

Box 1.4 Tasmania – a more institutional approach to enhanced sectoral management

The Tasmania Marine Farming Planning Act 1995 provides for the development of *Marine Farming Development Plans*. The plans consist of:

- a (sector) Environmental Impacts Statement
- a Development Proposal, including maps of the area suitable/available for marine farming;
- management controls and operational constraints affecting activities within the zones, including provision for a comprehensive environmental monitoring programme.

The plans are developed following a process of public consultation that takes account of:

- the physical suitability of the sites for aquaculture;
- the current legal situation;
- the desire to minimise impacts on other users of the coastal zone.

General management controls for the *Marine Farming Zones* are as follows:

- environmental controls relating to carrying capacity;
- environmental controls relating to monitoring (water quality, benthos, shellfish growth);
- chemicals (must comply with legal requirements);
- disposal of waste;
- disease controls;
- visual controls to reduce visual impacts;
- access controls;
- other controls, e g. controls related to other legal requirements (such as predator control, other environmental management legislation).

This approach places more emphasis on the planning framework, and less on the science of environmental capacity than the LENKA approach. It remains to be seen whether it is successful, but it has the great strength of a clear procedure for implementation, supported by specific legal provisions.

1.2.3 Coastal zone and integrated coastal management

Coastal Zone Management, Coastal Area Management, and Integrated Coastal Management have been widely proposed as more comprehensive approaches to coastal management which address the limitations and difficulties associated with sectoral and enhanced sectoral approaches, particularly in relation to aquaculture (Chua, 1997). Coastal zone management implies multi-sectoral planning and regulation, and therefore some form of co-ordinating body or authority to assess and balance the various sectoral interests. ICM also implies mechanisms for addressing trans-boundary issues (for example between land, coast and ocean).

CZM and ICM initiatives have varied enormously in terms of specific objectives, overall approach, geographical and sectoral scope, initiating or implementing institutions; and in terms of the influence they have on decision making and resource use in coastal areas. They have arisen from academic or political initiatives, aid funded projects, or directly in response to an environmental problem or development need. Nonetheless, most ICM initiatives have certain key features in common.

The *goals or objectives* usually include reference to one or more of the following:

- the optimal allocation of resources to competing activities or functions;
- the resolution or minimisation of conflict;
- the minimisation of environmental impact, and the conservation of natural resources.

In some cases ICM may also have more strictly social and political objectives, such as quality of life; the more equitable distribution of derived economic benefits; social and inter-generational equity; and poverty alleviation (Chua, 1997; Gomez and McManus in GESAMP, 1996b; Yap, 1996).

There have been many reviews and guidelines related to ICM published in recent years (Chua, 1997; Chua and Fallon-Scura, 1992; Cicin-Sain *et al.*, 1995; Clark, 1992; GEF/UNDP/IMO, 1996; GESAMP

1996b; OECD, 1993; Pernetta and Elder, 1993; UNEP, 1995; Post and Lundin, 1996; Sorensen, 1997; Scialabba, 1998; Cicin-Sain and Knecht, 1998; Lowry *et al.*, 1999). Although there is a broad consensus as to the main components of ICM, emphasis and details vary widely. Cicin-Sain *et al.* (1995) compared coastal management guidelines developed by five different international entities (IPCC, 1994; OECD, 1991; Pernetta and Elder, 1993; UNEP, 1995; World Bank, 1993). Based on their comparisons, the authors developed a "consensus set of ICM guidelines" (Table 1.1).

Table 1.1: A consensus set of integrated coastal management guidelines

Source: Cicin-Sain et al., 1995.

Purpose of ICM	The aim of ICM is to guide coastal area development in an ecologically sustainable fashion.
Principles	ICM is guided by the Rio Principles with special emphasis on the principle of intergenerational equity, the precautionary principle and the polluter pays principle. ICM is holistic and interdisciplinary in nature, especially with regard to science and policy.
Functions	ICM strengthens and harmonises sectoral management in the coastal zone. It preserves and protects the productivity and biological diversity of coastal ecosystems and maintains amenity values. ICM promotes the rational economic development and sustainable utilisation of coastal and ocean resources and facilitates conflict resolution in the coastal zone.
Spatial Integration	An ICM programme embraces all of the coastal and upland areas, the uses of which can affect the coastal waters and the resources therein, and extends seaward to include that part of the coastal ocean which can affect the land of the coastal zone. The ICM programme may also include the entire ocean area under national jurisdiction (Exclusive Economic Zone), over which national governments have stewardship responsibilities both under the Law of the Sea Convention and UNCED.
Horizontal and vertical integration	Overcoming the sectoral and intergovernmental fragmentation that exists in today's coastal management efforts is a prime goal of ICM. Institutional mechanisms for effective co-ordination among various sectors active in the coastal zone and between the various levels of government operating in the coastal zone are fundamental to the strengthening and rationalisation of the coastal management process. From the variety of available options, the co-ordination and harmonisation mechanism must be tailored to fit the unique aspects of each particular national government setting.
The use of science	Given the complexities and uncertainties that exist in the coastal zone, ICM must be built upon the best science (natural and social) available. Techniques such as risk assessment, economic valuation, vulnerability assessments, resource accounting, benefit-cost analysis and outcome-based monitoring should all be built into the ICM process, as appropriate.

ICM in practice

Integrated coastal management approaches have been widely promoted, and the approach has been widely approved (with some recent exceptions: Davos, 1998; Nichols, 1999). Indeed it is difficult to criticise the *idea* of ICM. Unfortunately implementation has been difficult, and success in practical terms mixed. Sorensen (1997) has reviewed the rather disappointing achievements of coastal management efforts in general. Very few of the many recent initiatives have been rigorously evaluated according to specified criteria; there is little evidence of success; and many examples of failure. He attributes much of this failure to a lack of genuine vertical and horizontal integration.

Aquaculture and integrated coastal management

In many ways aquaculture is a classic example of why ICM is needed:

- coastal aquaculture commonly straddles the boundary between land and sea;

- resource (land, water, and their products) ownership or rights allocation, and related administration, is often complex or ambiguous in prime aquaculture locations[4];
- aquaculture may be seriously affected by water quality and habitat degradation caused by other activities;
- aquaculture itself may affect environmental quality and the interests of other users through conversion of natural habitat, through pollution of recipient waters with nutrients, organic substances, and potentially toxic (hazardous) chemicals, and through the spread of disease;
- poorly sited or planned aquaculture may result in negative feed-back and self pollution.

Unfortunately, there are few clear examples of the successful integration of aquaculture into comprehensive ICM. It is arguable that this is because there have been very few genuine ICM initiatives, where aquaculture has been assessed alongside the full range of existing or potential activities in the coastal zone using consistent and rational assessment criteria, agreed across a range of interests and agencies. However, to do this thoroughly takes time, and this poses a dilemma in many developing country situations where aquaculture is developing very rapidly. The case of Ecuador, where population pressure, industrial development and shrimp farming have had significant negative impacts on estuarine resources throughout a period in which a long term ICM project was underway, is particularly notable. Shrimp farming has also recently developed uncontrollably in Sri Lanka (Box 1.5), with adverse environmental consequences and self-pollution, despite a strong ICM awareness, and a variety of ICM initiatives in place.

In other countries, where existing institutional and planning structures are favourable, and where the development pressures are less extreme, ICM may be both desirable and feasible. An example is the case of New Zealand (Box 1.6).

Box 1. 5 Coastal zone management in Sri Lanka

In **Sri Lanka**, the need for some form of coastal resource and environmental management was recognised as early as the mid 70's, mainly as a response to the destruction of coral for building purposes. The Coastal Environmental Management Plan (for the West Coast) was developed in 1984 with the objective of preventing the environmental degradation of coastal areas. It included setback standards; EIA's for development activities; and the prohibition of activities that would degrade designated natural areas.

Since 1987 a Coastal Resources Management Programme has resulted in a range of measures, including a Coastal Zone Management Plan. This seeks to promote sustainable yields from multiple uses of estuaries, lagoons and mangroves in the region. Under these initiatives and recent legislation, aquaculture operations must be registered, and EIA's, (assessed by a wide variety of government agencies and other interests) are normally required for farms over 4 ha in size.

Despite these provisions, shrimp farming has developed rapidly and uncontrollably, resulting in self-pollution, disease, user conflict in some areas, and significant mangrove destruction. The failure of these coastal management initiatives relates largely to the difficulties of enforcing registration, and the inability of single enterprise EIA to cope with the problems associated with small incremental, but substantial cumulative impacts. In other words, despite its name, this Coastal Zone Management Plan lacked a strategic approach to planning for aquaculture development, and depended instead on a piecemeal and bureaucratic regulatory approach, which inevitably failed.

References: Nichols, 1999; Rohitha, 1997.

Strengths

- the values and concerns of the full range of stakeholders are specifically taken into account;
- relevant institutions are encouraged to communicate, co-ordinate and co-operate;
- a broader base of information and opinion is available to decision makers;
- less technically driven than sectoral approaches;
- more "bottom up" than "top down" (if correctly implemented);
- potential development activities are assessed objectively, using a broad range of criteria, against all other possible resource uses, not just those from the same sector;
- the resolution of conflict and balancing of interests is usually a specific objective;

[4] for example, aquaculture is commonly administered by Fisheries Departments, although it may take place in the inter-tidal zone, or on land or forest areas administered by the Department of Agriculture or Forestry, or, as in the case of the UK, the Crown

- should result in consistency of policy and legislation between different levels and sectors of government.

Weaknesses

- may make inadequate use of existing institutional memory and skills: new institutions need to learn – they may repeat past mistakes or re-invent old solutions;
- since it requires institutional change, it may carry institutional risks (e.g. confusion over powers and responsibilities, and lack of institutional capacity);
- takes much time, effort and cost;
- may generate a wealth of assessment and research data with little consensus on how it should be used (as for enhanced sectoral approaches);
- may (at least in the early stages) exacerbate conflict by addressing and highlighting differing values and perspectives on resource use in the coastal zone.

Box 1.6 Integrated coastal management and aquaculture in New Zealand

New Zealand now has a relatively comprehensive framework for integrated coastal management based on the "planning cascade" (vertical integration) approach.

Under the Resource Management Act of 1991, broad policy and principles are defined in a national Coastal Policy Statement. This is interpreted and implemented on the ground through more detailed and strategic Regional Coastal Plans.

Hearing committees operate at regional level to address specific problems, and an environmental court operates at national level to deal with specific grievances arising from the implementation of legislation.

Two fundamental principles are defined in this hierarchy:

- all coastal developments require a permit unless explicitly allowed (or prohibited) in the Regional Coastal Plan; and
- the granting of permits should be related to the effects of the enterprise rather than to its scale.

The rationale for this is to encourage the adoption of improved technology to minimise environmental impact, rather than restrict the scale of development per se. It should also allow ultimately for the allocation of environmental use rights, or the allocation of a proportion of environmental capacity to particular users or user groups.

Applicants for permits must demonstrate environmental responsibility by undertaking EIA, and showing how they will minimise and mitigate environmental impact. The main problems encountered so far are:

- the difficulty of assessing environmental effects;
- the traditional tendency for officials to opt for the (easier) regulation of activity; and
- the difficulties of ensuring consistency and quality of EIA's when they are sponsored by applicants themselves, and administered by different councils with different resources and different social, environmental and political priorities.

1.2.4 Lessons learned

Constraints to integration

The reasons for the rather limited success of ICM are not difficult to find. There are usually institutional and political barriers to the key requirement for vertical and horizontal integration. There may be significant political barriers to full participation, and the resource use issues are usually complex. Control or ownership of land and water in the coastal and especially inter-tidal areas (commonly used for aquaculture) is also ambiguous or inconsistent in many countries.

The scope of comprehensive ICM (as defined in Table 1.1) can make it a long and complex exercise. Dealing with this complexity, and defining the level of detail or accuracy required for any resource appraisal or participatory process is a great, and sometimes overwhelming, challenge for ICM practitioners.

A further problem is that very detailed and comprehensive plans with specific development prescriptions may be undermined by the sheer power of financial and political/economic interests

(Yap, 1996). This may be a particular problem with those types of aquaculture, such as shrimp farming, which are the most profitable.

Local ICM

Many of the problems associated with comprehensive ICM may be overcome by developing initiatives at a local level. Although this may appear to undermine the principle of vertical integration, it should reduce complexity and make stakeholder participation more manageable and effective. The locally based schemes now evolving in Thailand (Box 1.7) to promote more sustainable shrimp farm development appear to have considerable potential in this regard, since they retain integration but at a much smaller scale, and since local planners or community leaders are well acquainted with more integrated approaches. Once underway, specific problems related to lack of vertical integration may become apparent, and pressure may be exerted from below to achieve change and/or integration at higher administrative levels. Aquaculture itself, and the potentials and problems associated with it, may thus serve as a stimulus and starting point for a developing and evolving ICM process.

Box 1.7 Management of coastal aquaculture in Thailand

In Thailand the dramatic successes and failures associated with the rapid development of the shrimp farming industry, and its vulnerability to poor water quality (arising from other resource users and the aquaculture industry itself) have led to a set of operational regulations, and a variety of coastal management efforts with emphasis on the sustainable development of aquaculture. It is as yet too early to comment on the successes or failures of these initiatives, but several features are worthy of note.

The first is the scale of the initiatives. Several projects involve the use of strategic coastal resource planning (zoning) at a local or district level. In some cases these are associated with infrastructure development (sea-water irrigation systems) which should encourage better siting, design and water management in small scale developments. There is also increasing interest in quality labelling initiatives (e.g. ISO 14000), as a means of generating a market premium, which may then be wholly or partly taxed and used for infrastructure improvements and research.

In addition to these more forward-looking projects, there is a framework for the regulation of the industry (the Fisheries Act (1947) through regulations announced by the Ministry of Agriculture and Co-operatives (1991). These regulations cover annual registration with the district fisheries office; water treatment (sedimentation) requirements for farms larger than 8ha; and effluent standards (BOD). The implementation of these regulations is however inconsistent.

Enhanced sectoral initiatives

In other situations, where local initiatives may be difficult or inadequate because of the nature of resources or existing resource management systems, enhanced sectoral initiatives may provide the most appropriate starting point for improved planning and management of aquaculture. Once underway, these initiatives are likely to be constrained by the lack of horizontal integration in specific areas, but, as with local ICM, they may serve as a stimulus to more fundamental change for greater integration as required.

Zoning and environmental capacity

The New Zealand model (Box 1.6) appears to be close to the ideal of ICM, and although there remain problems, there is as yet no reason to think it will not be successful in the long term. There are several important features in the New Zealand system, which are worthy of emphasis:

- the system is vertically integrated (“planning cascade”);
- the emphasis is on effects rather than the type or scale of activity.

The latter highlights the possibility of two significantly different approaches to integrating aquaculture in coastal management. The more conventional approach, epitomised in the provisions for the Great Barrier Reef Marine Park in Australia, relies on zoning, which is inherently an *allocation of space*. In contrast, the emphasis on effects implies an *allocation of environmental capacity* to a particular user or user group, and is likely to better meet the criteria of efficiency and adaptability. It also links more

readily to the economic approaches to implementation. Particular emphasis is therefore laid on these alternative approaches in Part 2. However, these approaches epitomise the technocratic and command and control approaches to resource management which have been criticised by some authors (Davos, 1998).

The need for incentives

It is notable that very few initiatives, either enhanced sectoral or more integrated approaches, include much in the way of *incentives* for implementation. They tend to be based on recommendations or regulations. Given the nature of coastal aquaculture as a mainly small-scale activity, the implementation of recommendations may be difficult for the farmer, and the enforcement of regulation difficult for the authorities. Much greater attention needs to be given to financial incentives for better siting and management of aquaculture.

Developed versus developing country experience

In the developed countries aquaculture development has often been singled out for restriction, partly because it is a new activity in many areas, and also because of the high priority afforded to the environment. In developing countries by contrast, there has been very little control of aquaculture. This relates partly to the lack of institutional and administrative frameworks appropriate to the implementation of coastal management, and also to the higher priorities afforded to development rather than environment.

Australia, New Zealand and the USA exhibit well developed coastal management schemes, supported by corresponding legislation, which are generally much more integrated and comprehensive in scope than those of developing countries. In contrast the coastal management process in developing countries has often been ***ad hoc***, responsive, and commonly funded as a project, rather than being implemented through existing planning and management frameworks. Coastal management initiatives must build on existing institutions, or else change them (if this is both necessary and possible). They cannot run in parallel.

1.2.5 Conclusions and recommendations

1. There is no single planning and management framework that can be applied universally to promote more sustainable coastal aquaculture development. Policy makers and planners must therefore critically appraise the options open to them, and make their own choices depending on local circumstances.
2. Despite their theoretical qualities, the more comprehensive (national; regional) forms of ICM are unlikely to offer an effective solution to the immediate needs of improved planning and management of existing or rapidly developing coastal aquaculture development. In these cases it may be more appropriate to begin with more focused local coastal management initiatives, or enhanced sectoral initiatives.
3. The more comprehensive forms of ICM should be more effective where coastal aquaculture is in the early stages of development; where institutions for resource management are flexible or undeveloped; where appropriate legal and institutional frameworks are in place or can be developed rapidly; and where scientific and technical capacity is substantial.
4. Zoning (an *allocation of space)* offers a practical focus for more integrated planning of aquaculture development. The a*llocation of environmental capacity* provides an alternative, which although sometimes difficult, should be efficient and adaptable, and links readily with economic approaches to resource management. An approach which combines the two may be particularly effective.
5. Implementation, and in particular the use of economic and financial incentives to influence the nature and location of development, and the management of operations, should be given much greater attention

1.3 Guiding principles

Notwithstanding the diversity of experience and approaches, it is possible to present a set of core principles, which should guide as far as possible the development of any aquaculture planning and management initiative, whether it be a local initiative, an enhanced sectoral initiative, or more comprehensive ICM. They may be summarised as follows:

1. *the Rio principles:* sustainable development; the precautionary approach; the polluter pays principle;
2. *integration or co-ordination:* with other sector activities or plans; with national sector plans; with ICM where such initiatives exist;
3. wide ranging *public involvement*;
4. thorough *assessment of costs and benefits* (financial, economic, social, environmental) of aquaculture in a specific area (e.g. estuarine or lagoon system) and *comparative* assessment of costs and benefits of aquaculture relative to other resource uses;
5. some assessment of *environmental capacity*;
6. use of *incentives* rather than regulation where possible;
7. emphasis on the *control of effects,* rather than the scale of activity;
8. *evaluation*, *iteration and adaptation;* and
9. *effective institutions* and representative organisations.

1.3.1 Adherence to Rio Principles

Agenda 21 generated at the Rio (Earth) Summit emphasises sustainable development, and in particular its core value or principle of inter-generational equity. It also states a commitment to the precautionary approach, and the polluter pays principle.

Inter-generational equity cannot be defined simply in practice, but needs to be incorporated as a recurrent theme in the assessments, discussions and stakeholder exchanges related to different development and resource use issues. Aquaculture, like other development activities, may change the balance and distribution of different resources or *capital.* This capital includes natural capital; human capital; physical plant (equipment, machinery, buildings) and infrastructure; financial capital; and other forms of capital valued by particular societies. These changes must be assessed to ensure that the sum total of this capital, or specific vital components, are sustained or increased in the long term, and available for future generations.

The precautionary approach implies that we should more carefully plan and rigorously evaluate developments that have uncertain implications for the environment. Under conditions of great uncertainty developments may have to be delayed or halted. This principle is controversial, since its widespread application could slow or halt much development activity. Furthermore, the most successful development has often been associated with substantial financial and environmental risk and uncertainty. This principle should therefore be applied with care, taking full account of both the magnitude and likelihood of adverse environmental impacts. This implies some form of risk assessment.

The polluter pays principle is now widely agreed, and is a central tenet of much environmental policy. It is subject to a range of interpretation, from a requirement upon polluters to pay the costs of monitoring and management, through the requirement to pay the costs of clean-up, to the responsibility to pay for the cost of environmental damage as well as that of clean-up. Applying the principle may be simple or complex, depending on the nature of the environmental effects. Environmental economic assessment, and some form of economic planning instrument, are required in order to meet this principle.

1.3.2 Integration and co-ordination

By definition integrated coastal management implies a greater level of integration than is typical of more conventional approaches. The rationale for this, especially in relation to aquaculture, has been clearly stated above.

Integration implies the involvement of a broad range of institutions in the decision making process. It implies the involvement of a wide range of stakeholders, with differing values, dealing with a wide

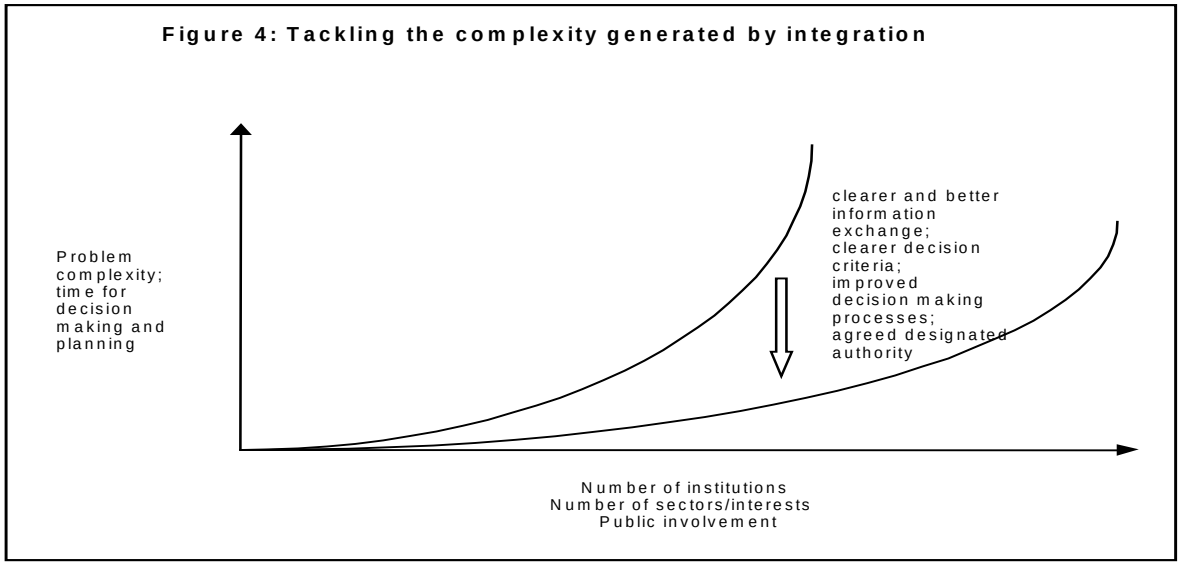
range of development issues. It implies the facilitation of a broadened perspective on the part of these stakeholders. It implies an holistic analysis and synthesis of complex technical, social, economic and ecological information. It implies a correspondence between local initiatives and regional or national level policies, and vice versa. It implies better co-ordination between different sector policies. It implies increased cross-links between institutions, and/or new institutions.

Increased integration therefore implies increased complexity. Decision-making is likely to be slower and more difficult as the degree of integration increases. Figure 4 is a schematic representation of this problem, and offers some pointers as to how this complexity can be reduced, and decision making facilitated. Key requirements are:

- high quality, well presented and effectively communicated/exchanged information;
- clear and widely agreed decision criteria;
- clear and transparent decision making processes; and (if necessary)
- a clearly designated (and widely agreed) final authority and arbiter (whether individual or committee).

In the case of less ambitious local or enhanced sectoral initiatives, these problems are reduced, but the potential for real integration more limited.

Figure 4: Tackling the complexity generated by integration



1.3.3 Public involvement

Significant public involvement is a desirable and necessary part of any planning initiative. It takes different forms, all of which are important:

- communication of information: from decision makers, planners or technical specialists to other stakeholders, and vice-versa;
- participation: shared responsibility and decision making

Comprehensive public involvement is increasingly emphasised in any assessment or planning exercise for the following reasons (adapted from UNEP, 1996):

- planning makes assessments and judgements about issues of widespread public concern: the quality of life, the value of resources, and the trade-offs between different resource uses;
- many of the assessments are subjective, and can only be agreed and/or validated through the widest possible consultation;
- local people can provide essential information about local natural resources, their status, use and value (sometimes referred to as indigenous technical knowledge);

- early exchange of views on key issues allows for the identification of information needs and improved focus of survey or research;
- public involvement may also reduce conflict through the early identification and resolution of potentially contentious issues;
- widespread consultation may generate new ideas for development alternatives, and possibilities for zoning/siting, design, and mitigation of adverse environmental effects;
- the more participatory forms of public involvement allow otherwise under-represented groups access to the decision making process;
- public involvement may contribute to, and/or reduce, the costs of monitoring and quality control;
- by engaging all stakeholders in the evaluation and decision making processes, it creates a sense of accountability, ownership and responsibility; and
- it increases transparency and accountability in decision-making, and ultimately increases confidence in decision makers.

1.3.4 Assessment of costs and benefits

The costs and benefits associated with aquaculture or other developments are rarely assessed objectively or comprehensively. If planning is to have any success in terms of optimal resource allocation to aquaculture and other activities, assessments of this kind must be thorough.

This principle implies the need for risk assessment, as well as comparative and environmental economic appraisal of the full range of alternative development (or conservation) options or strategies, including non-aquaculture developments.

1.3.5 Estimation of environmental capacity

Environmental capacity is much quoted in relation to coastal aquaculture development. Although it is often difficult to quantify accurately, the concept is useful, and serves as a framework for the discussion of issues such as environmental standards, ecological processes, and the environmental values and perceptions of different stakeholders. It is dealt with briefly below (Section 1.5.5) and in detail in Section 2.4.

1.3.6 Emphasis on incentives rather than constraints

Regulatory approaches to the planning and management of aquaculture development often have limited impact, especially where aquaculture is small scale and widely distributed. Policing is in many cases difficult, costly, and unpopular. It may be made more effective if responsibility for design, implementation and enforcement is located at the proper administrative level, and full use is made of self-management and self-enforcement capacity by industry and farmers' associations.

Incentives, on the other hand, do not suffer from the problems of evasion and non-compliance, and in some cases can be used to stimulate innovation leading to more environmentally friendly technologies.

The use of economic instruments to influence both siting and operation holds considerable promise. Although some positive incentives may be costly, it should be possible to pay for them with negative incentives (e.g. taxes on undesirable locations, activities, technologies). However, regulation may nonetheless be necessary, and a balanced approach is required.

1.3.7 Control of effects rather than scale of activity

Many forms of regulation of aquaculture (and indeed other coastal activities) are related to scale – either the area of land or water directly used by aquaculture, or the total production. For example, in line with the precautionary principle, an upper limit may be placed on aquaculture production in a bay, estuary or lagoon.

This limits the potential economic development, while providing no incentive to improve the environmental efficiency of the operation. It would not, for example, provide an incentive for the use of low pollution diets. A limit on effects (for example the concentration of nitrogen in the water at critical times of year) would provide an incentive for improved environmental efficiency through technology or management, while also allowing for increased production.

However, there are some difficulties with this approach. The relationship between cause and effect may be only partly known or understood especially where multiple uses of the resource already exist.

1.3.8 Evaluation, iteration and adaptation

Evaluation, iteration (repeated cycles of research, assessment, consultation and planning) and adaptation are required to:

- allow for a steady refinement and improved understanding of physical, ecological, social and economic parameters and processes over time;
- allow for a steady refinement and improvement of the planning instruments (incentives and constraints) used to meet the objectives of the plan.

Integration implies the need to understand a wide range of physical, ecological, economic and social processes. These cannot all be addressed in a comprehensive manner at the start of a planning initiative – it could take many years. Public involvement and expert consultation must be used in the first place to help focus research and data collection. Once the plan is implemented, the need for new research or data, or the redundancy of some research or data, should be assessed, and research and monitoring adapted accordingly.

It is also likely that some of the planning instruments themselves will fail or be inefficient in terms of meeting the objectives of the plan, and they will need to be adjusted or changed.

In general it is better to build from modest and widely agreed initiatives and adjust or expand the scope of activities as required, in the light of thorough evaluation. This also allows for much more rapid implementation of the most important elements of the plan.

1.3.9 Effective institutions and representative organizations

The importance of institutional structures, roles and capacity cannot be over-emphasised. However, it is impossible to provide simple prescriptions for appropriate institutions and procedures without reference to specific contexts. An important part of any integrated planning initiative should therefore be an institutional analysis.

Institutional change is difficult and risky, especially where many different organisations are involved. Significant structural change should therefore be approached with caution. More modest changes to procedures, both within and between existing institutions, may be the most appropriate first step. Once the initiative is underway, the need or otherwise for more institutional change can be assessed. This again reinforces the principle of evaluation and adaptation discussed above.

Effective stakeholder representative organisations should facilitate the process of public involvement. Furthermore, such organisations may take active roles in the exchange and dissemination of information, and policy development. They are particularly important for minority or highly dispersed groups whose opinions may be difficult assess in public meetings or through survey.

1.4 Legal and institutional frameworks

The importance of legal, procedural and planning frameworks designed to facilitate sustainable aquaculture development is emphasised in the FAO Code of Conduct for Responsible Fisheries (FAO, 1995; FAO Fisheries Department, 1997):

9.1.1 States should establish, maintain and develop an appropriate legal and administrative framework, which facilitates the development of responsible aquaculture.

9.1.3 States should produce and regularly update aquaculture development strategies and plans, as required, to ensure that aquaculture development is ecologically sustainable and to allow the rational use of resources shared by aquaculture and other activities.

The need for a clear and comprehensive legal framework has been explicitly recognised by all those countries that have become significant producers of farmed shrimp. At the FAO Technical Consultation on Policies for Sustainable Shrimp Culture (FAO, 1998) the following recommendation was made:

> *"Governments should have a legal framework which applies specifically to coastal aquaculture, including shrimp culture"*

and appropriate objectives for such a framework should be to:

- *"facilitate and promote the development of sustainable aquaculture practices;*
- *promote the protection of coastal resources;*
- *promote the contribution of aquaculture to food security, national and international wise."*

The approach adopted will depend on existing laws, traditions, and institutional structures. For example, an enhanced legal and institutional framework to promote planning for sustainable coastal aquaculture development could be built up around existing legislation and/or procedures for:

- sector planning;
- regional or district planning;
- watershed or coastal zone planning and management;
- environmental assessment.

The key point is to develop or adapt a system that allows for the comprehensive application of the principles set out in Section 1.3. Where the introduction of new legislation is difficult, or will cause excessive delay, *guidelines* for developing new initiatives may be introduced prior to specific legislation, as a means of testing out different approaches.

1.4.1 Ideal frameworks

The ideal is perhaps a "tiered" system, sometimes known as a "planning cascade" and exemplified in the coastal management policy and legislation of countries such as Australia and New Zealand (Box 1.6). Broad national level policies define the scope, power, and responsibilities for lower level assessment and planning initiatives relating to aquaculture, coastal, or aquatic resources. These more local initiatives (at district, coastal bay, estuarine system or watershed levels) may in turn define or feed back into higher level policy. National and local level policy and planning should evolve steadily in parallel, each informed by the other, and be progressively adapted and refined, with the overall objective of promoting or facilitating sustainable development, and/or constraining or preventing unsustainable development. Enhanced sector plans or more comprehensive ICM plans could be developed at national, regional or local level, depending on national circumstances. In general however, more locally developed initiatives will tend to be both simpler and more integrated. Such a framework would contribute significantly meeting the principles presented in Section 1.3.

1.5 The planning process

1.5.1 Main stages

The planning process is broadly similar irrespective of the administrative level at which it takes place, or the degree to which it is integrated.

A major international workshop on ICM in tropical countries, held in 1996 in Xiamen, China P.R., discussed lessons learned from successes and failures experienced with ICM efforts (GEF/UNDP/IMO, 1996). The workshop generated an overview of the processes of formulating, designing, implementing and extending ICM within the East Asian region as well as to other regions, and a set of *Good ICM Practices*. Their summary of the main stages of ICM is presented in Box 1.8.

This agrees closely with the outline presented by GESAMP (1996b). It is applicable to local and enhanced sectoral initiatives as well as to more integrated approaches. The whole process should be seen as part of a dynamic and repetitive cycle leading steadily toward more sustainable forms of coastal development in general, and coastal aquaculture development in particular.

Box 1.8: Main stages of Integrated Coastal Management

1. *Stage setting and Planning*
   - Issue identification and analysis
   - Definition of goals and objectives for this generation
   - Selection of strategies
   - Selection of implementing structures
2. *Formalisation*
   - Formal adoption of the program
   - Securing of implementation funding
3. *Implementation*
   - Development actions
   - Enforcement of policies / regulations
   - Monitoring
4. *Evaluation*
   - Analysis of progress and problems encountered
   - Redefinition of the context of coastal management

Reference: GEF/UNDP/IMO, 1996

1.5.2 Operational components

The first stage (stage setting and planning) can be broken down into a more detailed set of operational components, each of which may draw on a range of tools (Table 1.2). These components are not necessarily in chronological order. Indeed, it is highly desirable that components 1 to 5 take place in parallel, since each should serve to inform the scope and focus of the others. The tools associated with each stage may or may not be used according to local circumstances and the scope of the initiative.

The operational components, and the tools applicable to them, are described briefly below. The tools themselves, and their application to aquaculture development, are reviewed in more detail in Part 2.

It is apparent that the inclusion of all these components in any planning initiative is a formidable task. Attempts at more integrated planning for aquaculture development, and indeed ICM initiatives in general, have rarely encompassed all these elements. However, if the ideals of sustainable development are to be realised, the main operational components must be included, and facilitated where appropriate by the various tools available. The process can be made more manageable, and the research/information collection more focussed, if the principles of public involvement, evaluation, iteration and adaptation, as described in the previous Section, are applied at all stages of the process. Massive technical research and assessment exercises, however thorough, are unlikely to provide a sufficient basis for solving resource management problems, and should be used rather as an on-going input to a rolling and adaptive planning process.

The following Sections provide an introduction and outline of the main processes and procedures involved in the development of integrated approaches to coastal aquaculture development planning. Detailed descriptions and scientific review of the various tools referred to (introduced here in bold italics), and their specific application to aquaculture development, can be found in part 2.

Table 1. 2. Stage setting and planning: operational components and associated activities and tools

Main component	Sub-components	*Possible associated activities and tools*
Initiation	1. Identifying the means/mechanism and level of planning	• *Review of relevant policy and legal framework;* • *Institutional analysis;* • *Stakeholder analysis*
	2. Gaining the trust, involvement and commitment of key stakeholders	• *Communication, consultation, participation;* • *Preliminary identification of funds*
Issue identification and analysis	3. Understanding the development context: natural and human resources and economy	• *Description and mapping* • *Analysis of physical and ecological processes* • *Assessment of environmental capacity and limits to change* • *Review of sector/regional economy* • *Understanding human resources, needs and values: public involvement and social survey;*
	4. Understanding the development options	• *Technical-economic assessment* • *Sector Environmental Assessment* • *Cost-Benefit Analysis* • *Environmental economic analysis*
Definition of goals and objectives	5. Defining goals and objectives	• *Stakeholder consultation;* • *Public involvement/participation*
Selection of strategies	6. Identifying development priorities and acceptable practices	• *Economic approaches to decision making* • *Consultative and participatory approaches to decision making* • *Conflict resolution*
	7. Defining broad development strategies (strategic planning)	• *Production and environmental targets (quantity and quality);* • *Criteria for locating activities;* • *Criteria for assessing activities;* • *Definition of zones (identification and/or allocation of suitable space/locations)*
Selection of implementing structures and instruments	8. Designing/agreeing planning and management instruments (incentives and constraints)	• *Infrastructure development* • *Training, education and awareness raising* • *Economic instruments* • *Regulatory instruments* • *Codes of practice* • *Markets and labelling*
	9. Building institutions and institutional capacity	• *Defining institutional arrangements* • *Institution building* • *Procedures*
	10. Monitoring, reporting, evaluation and response procedures	• *Physical and ecological monitoring* • *Social and economic monitoring* • *Synthesis and analysis of monitoring data;* • *State of the environment reporting;* • *Public consultation and participation;* • *Performance evaluation;* • *Management capacity assessment;* • *Outcome assessment* • *Mechanisms for adjustment and adaptation*

1.5.3 Identifying the mechanism and level of planning

Any attempt to improve the planning and management of aquaculture, either from a sectoral perspective or as a component in a broader integrated management exercise, must be initiated with great care. Such initiatives are likely to be seen as threatening to some stakeholder interests. The "who" and "how" of initiation can have a major impact on long term success.

There are four key elements or pre-conditions:

- a policy or legal framework which requires, facilitates, or (at minimum) allows for improved and more integrated planning and management;
- an organisation or body which can lead or oversee the planning process, which is widely respected and trusted by the stakeholders, and which can effectively "deliver" on the guiding principles presented in Section 1.3;
- an awareness of the need for improved planning and management on the part of the stakeholders; and
- adequate funding and/or staff time to undertake the process.

Where these conditions do not already exist, they must be created before any form of improved planning or management can be initiated.

A review of relevant policy and legal framework should be undertaken to determine what is possible, and how the initiative is to be taken forward. In the case of enhanced sectoral initiatives the analysis would normally identify the most appropriate mechanisms for consultation, exchange of information, and policy integration within the existing legal/institutional framework. It would also consider how the outcomes of the initiative could be implemented.

In the case of more ambitious and integrated initiatives, it may be useful to undertake ***institutional analysis*** and a preliminary ***stakeholder analysis***[5] to help in the choice or definition of an appropriate body to co-ordinate and oversee the planning and management process. This may be some form of committee, working group, or steering group including representatives of relevant government departments and agencies, industry and user groups and community representatives. It must be able to integrate technical and socio-economic information, including the needs and aspirations of stakeholders, and co-ordinate or implement interventions to meet coastal and aquaculture management objectives. This body would normally be convened and chaired by local or regional government, depending on the scale of the planning exercise.

The main tasks and responsibilities of the co-ordinating body would be to:

- clearly delineate the responsibilities of all involved in the different stages of the planning process, especially with regard to implementation;
- facilitate, and set in place procedures, for consultation between agencies and between agencies and other stakeholders;
- set in place procedures for the exchange of relevant information between different interests;
- set in place procedures for defining and implementing planning interventions;
- set in place procedures for monitoring the effectiveness of interventions in terms of overall ICM objectives;
- set in place procedures for adapting interventions in the light of experience;

Clearly funds must be identified, preferably from a range of cross-sectoral sources to maximise ownership of the initiative. In some cases a re-allocation of staff time (again, preferably cross sectoral) may be all that is required for the initial stages. Identification and raising of further funds would also normally be a responsibility of the co-ordinating body. In principle however, once the planning and management system is set up, and in the long term, it should be largely self-financing. The ways in which this can be done are dealt with in relation to specific management interventions discussed below.

[5] For more detail see Section 2.1

1.5.4 Gaining the trust, involvement and commitment of key stakeholders

The trust and support of key stakeholders is essential from the outset. This can be gained through consultation and public involvement (Section 2.2) and is closely related to the establishment of the co-ordinating or advisory body, and the openness of its deliberations.

Trust and support is likely to be lacking if the need for improved planning and management is not widely accepted, particularly by aquaculturists themselves. A series of public meetings and/or focus group discussions related to problems and potentials in aquaculture development, with a strong emphasis on more strategic development, may help gain support for the process, and serve as a useful input to any stakeholder and institutional analysis.

1.5.5 Understanding the development context

Key issues for improved management of coastal aquaculture may be social, environmental, technical, or economic. Identifying these issues implies a thorough understanding of both the development context (natural resources and ecology; human resources and economy), and the nature of actual and potential activities or developments (technical, economic, social and environmental characteristics). This can only be done effectively using an iterative and adaptive approach:

- assimilate existing information;
- identify key issues;
- identify further information and research needs;
- collect information and undertake research;
- refine key issues;
- etc.

Public involvement

Four basic approaches/tools[6] can be used to identify key players, collect information, identify issues and possible conflicts, and encourage participation and ownership:

- ***social survey***, supplemented with public information campaigns and limited public meetings;
- ***rapid appraisal*** (relatively informal but structured interviews and discussions with a wide range of stakeholders to gain information and understanding);
- ***participatory appraisal*** (wide-ranging exchange of views and information, with direct involvement of stakeholders in the decision making process);
- ***stakeholder consultative committees***

The first approach is the most traditional, but is difficult, costly, and sometimes misleading. The second and third approaches avoid many of the problems associated with social survey, especially in relation to values and quality of life issues. Rapid appraisal is by definition rapid and relatively cheap. Participatory approaches, since they directly involve people in the planning process, should lead to a greater and wider sense of ownership and responsibility, and therefore increase compliance with planning provisions or regulations at a later stage. However, participatory approaches have their own problems, including the cost and time required, and the difficulty of involving all relevant stakeholders.

More effective participation of coastal resource users may be facilitated through the establishment of user groups or organisations to represent particular interests on consultative committees, or in higher level decision making processes. It is notable that an ICM initiative in Ecuador (Robadue, 1995; Ochoa, 1995), by setting up consultative committees of resource user representatives, actually stimulated the establishment of user organisations. It is also notable that in Thailand the establishment of shrimp farmer associations has greatly enhanced shrimp farmer representation at meetings and on committees charged with developing aquaculture development policy. Even where a significant new planning and management initiative is lacking, the establishment of consultative committees may provide a basis for enhanced planning and decision making through existing procedures (Box 1.9).

[6] for more detail see Section 2.2.1

Box 1.9 Stakeholder involvement and natural resource inventories in the UK

In the United Kingdom there is no comprehensive coastal management framework. At least 240 organisations or institutions are involved, and 80 Acts of Parliament are relevant. Salmon farming has been treated as a rather unique activity because of its relation to the seabed, which is owned by the Crown Estate. It has not featured as a significant part of any comprehensive forward planning process, although desirable and undesirable zones for aquaculture have been defined, with specific requirements in terms of consultation.

However, a variety of local coastal management initiatives have been set up in recent years, supported by the government conservation agencies or local or regional councils. They have sometimes taken the form of "fora" for discussion, debate, and exchange of information between a wide range of organisations and stakeholders with an interest in a particular coastal area or estuarine environment. These fora have served as a stimulus to the collection and organisation of natural resource data in a variety of formats, including GIS.

Description and mapping

The collection and assimilation of data relating to natural and human resources has received widespread attention, and has been facilitated through the use of ***remote sensing*** (RS) and ***geographic information systems***[7] (GIS). The latter can be used to assimilate effectively pre-existing information (for example relating to soil or water), any new information collected using the social survey techniques described above, or any more specific information collected in response to identified research needs. GIS can also be used as an accessible database for monitoring information both before and during plan implementation. The scope of GIS is usually restricted to physical parameters, but attempts have been made to extend it to financial and economic parameters.

In the case of aquaculture, this stage or component is commonly closely linked to issues of site suitability and possible ***zoning***.

It is essential that mapping, description, RS and GIS are carefully focussed, and undertaken in parallel with, and guided by, discussions relating to issues identification and the setting of goals and objectives (see below). This is an example of the iterative and adaptive process described above: RS and GIS may help in the identification and clarification of key issues; but equally, the identification and analysis of key issues (e.g. through public consultation) should serve to define the focus and scope of RS and GIS. This can then further illuminate the key issues. Without constant feedback and adaptation of this kind, RS and GIS can get out of hand, and become themselves costly ends, rather than planning tools. There must also be a clear rationale and mechanism for their use and maintenance (Box 1.10).

Box 1. 10 ODA/Dinas Perikanan North East Sumatra Prawn Project : use of GIS/RS

A project whose focus was largely on shrimp disease evolved naturally into one with a focus on coastal management, through the recognition that the problems and potentials associated with shrimp farm development could not be tackled in isolation, but required a more integrated and planned approach, based on sound information about natural resources.

The project was effective in assimilating a large amount of relevant information on natural resources, socio-economic conditions, and financial and economic profiles of alternative coastal activities. It developed a comprehensive GIS, based on maps, ground survey and remote sensing.

Unfortunately, its initiation within Dinas Perikanan (the Fisheries Department) limited its influence in terms of wider coastal management issues, and the costs and skills associated with the GIS have been difficult to maintain since project completion. It has had little long term impact on coastal aquaculture development planning.

In this case GIS/RS became an (expensive) end in itself, rather than a carefully focussed tool used in support of a broader planning and management initiative.

References: McPadden, 1993; Hambrey, 1993.

[7] Section 2.3

Understanding physical and ecological processes

The coastal environment is dynamic. A static description of resources must be supplemented with an understanding of processes, dynamics, and interactions. This is particularly important for coastal aquaculture, which is often dependent on tidal regimes and hydrography, plankton communities and water quality, and soil, water and nutrient fluxes. This relates closely to issues of ***environmental capacity*** discussed below and in detail in Section 2.4.

In many cases a descriptive synthesis of existing knowledge will be adequate in the first instance. In the longer term, and relating to critical components in the system, it may be useful to develop physical models (such as nutrient flux models), ecological models, and ultimately systems models.

The development of the more sophisticated of these models is usually difficult and time consuming, and cannot be considered as a pre-condition for either enhanced sectoral or fully integrated coastal management. Rather, the scientific research, and any associated modelling effort, must evolve and focus in parallel with, and informed by, participatory approaches to issues and problem identification. Once a plan is implemented, thorough and regular evaluation should help identify or focus specific research and modelling needs, which can then be used as a direct input to the planning and management process.

Where physical or ecological issues are complex, or modelling capacity limited, it may be more convenient and cost effective to invest in an environmental monitoring programme, with basic parameters to be recorded (related to environmental objectives discussed below), and clearly defined (and widely agreed) response procedures.

Environmental capacity

Environmental capacity is a key concept in the idea of sustainable development (see, for example, Agenda 21, 1992 UN Conference on Environment and Development; GESAMP, 1991b; IUCN/UNEP/ WWF, 1991) and must therefore be addressed in any initiative designed to promote sustainable development.

Environmental capacity (otherwise referred to as assimilative capacity) is “a property of the environment and its ability to accommodate a particular activity or rate of an activity...without unacceptable impact”. Different mechanisms of impact can be identified for a particular situation, and the capacity of the environment to absorb each of these can be estimated.

Environmental capacity measures the resilience of the natural environment in the face of impact from human activities, and must be measured against some established standard of environmental quality. Understanding and measuring environmental capacity allows for the determination of the scale of activity (using a specified technology) which can be accommodated without threat to an environmental standard.

In the case of aquaculture, environmental capacity in relation to a specified area (e.g. a bay, lagoon, estuary, fjord or loch) might be interpreted as:

- the rate at which nutrients can be added without triggering eutrophication;
- the rate of organic flux to the benthos without major disruption to natural benthic processes; or
- the rate of dissolved oxygen depletion that can be accommodated without causing mortality of the indigenous biota (GESAMP, 1996a).

If environmental capacity can be determined, this opens the door to controls on effects, rather than activity – a key principle presented in Section 1.3. Furthermore, there arises the possibility of allocating or selling a share of environmental capacity, or a share of something which affects it (e.g. total acceptable pollution loading) to a particular user or user group. This is likely to offer an incentive to producers to modify technology or management so that production may be increased without exceeding the target. This contrasts with the use of area or production limits, which are directly restrictive, and offer no such incentive.

Environmental capacity is much easier to estimate for small semi-closed marine and brackishwater systems. Methods for estimating environmental capacity are reviewed in more detail in Section 2.4.

1.5.6 Understanding the development options

A comprehensive description of the technical, economic and resource use characteristics of different technical production systems or species ***(technical-economic assessment[8])*** is a prerequisite for the rational appraisal and comparison of the sustainability of different development options. It is essential for the clarification of key issues, and as a basis for any kind of strategic planning or market intervention.

The objectives for such an assessment are:

- to identify financially viable aquaculture and alternative production systems (in the short, medium, and long term);
- to provide resource use/transformation information which can be used for accurate environmental and social assessment, and cost benefit analysis;
- to provide "sustainability" profiles of alternative development options (summaries of social, economic and environmental characteristics) which can be used to inform participatory discussions and decision making.

Ideally such assessments would include, for each type of development:

- screening for technically feasible development options;
- market assessment;
- a description of suitable location and site requirements;
- standard financial analysis, investment appraisal and sensitivity analysis;
- a profile of resource use and waste output, including temporal or seasonal variations;
- a profile of socio-economic characteristics, including potential employment generation, labour seasonality, income generation and distribution, and barriers to entry (skills, capital, natural resources requirements);
- risk analysis
- synthesis - comparative economics and technical appraisal of different options;

This kind of information is commonly generated in respect of individual projects through feasibility studies and investment appraisal, although resource use and socio-economic characteristics are rarely specifically or adequately addressed. Nor are these studies commonly applied to a whole sector, or to a range of possible development options. Information is therefore usually inadequate for comprehensive and *comparative* environmental assessment, cost benefit analysis, and other formal decision making processes or techniques.

Each development option should also be assessed in terms of how, and to what extent, it might contribute to the objectives of the planning and management initiative. This will be easier if clear criteria for measuring progress against objectives have been agreed.

Site/location requirements

The identification and selection of suitable coastal aquaculture sites is critical not only to successful aquaculture practice, but also to the overall management of the coastal ecosystem.

Assessment of location and ***site suitability***[9] is a key factor in technical, economic and environmental assessment of the aquaculture sector and individual aquaculture projects.

Site suitability, according to specified criteria, may form the basis for the control and management of aquaculture development and is discussed further under planning instruments below.

Key issues in practice

Although many different issues are likely to be identified, depending on local circumstances, resource allocation (of water, land, forest, reef etc) is a key issue that must be addressed as coastal resources become more and more scarce. This has both a technical and socio-economic dimension:

[8] Section 2.5

[9] Section 2.5.2

- what are the important resources?;
- how are they affected by aquaculture and other developments?;
- how should resources be allocated (to activities, individuals, organisations)?; and
- how should interactions and conflicts be resolved or controlled?

Resource use rights in many coastal areas are notoriously ambiguous, and clarifying rights and allocation procedures will commonly be a significant component in the planning process. Box 1.11 provides an example of what can happen in the absence of clear allocation procedures.

Rights allocation can be used not only as a tool for social development, but also as a means of regulation of aquaculture development, and should be thoroughly addressed early on in the planning process.

Box 1.11 Coastal aquaculture and resource allocation: the case of India

Shrimp farming in brackish-water ponds developed rapidly in India in the '80s, based mainly on improved extensive and semi-intensive techniques. It was very profitable. In the late '80s several large national and international corporations entered the sector with medium to large intensive operations. Access to fisheries was restricted in some areas, and there was local salination of ground and drinking water. There were also concerns about pollution.

Local fishermen began protests in the early '90s. They and environmental activists took the issue to the High Court in Tamil Nadu, and restrictions were placed on brackish-water aquaculture. The conflict then spread to other States, and culminated in a Public Interest Writ submitted to the Supreme Court of India in 1994. A final judgement was made in December 1996 based on existing coastal zone regulation which banned all non-traditional aquaculture within 500m of the high water mark, or within 1,000m of Lakes Chilka and Pulicat. Existing farms within these zones were to be demolished by March 31st 1997. An Authority was set up comprising environmental and aquaculture interests led by a judge to administer the ruling, and assess compensation for pollution impacts. Workers laid off from demolished farms were also to be paid compensation under existing labour laws.

In practice demolition has been limited, but the industry remains in a highly uncertain state. Much employment and income generation has been lost. "Traditional aquaculture", which covers the largest areas, has not however been affected.

This kind of problem is extremely difficult to address once conflict has arisen and positions polarized. Facing up to difficult resource allocation issues in the early stages of planning, before contentious individual cases arise, is essential if this kind of problem is to be avoided.

Reference: Murthy, 1997

1.5.7 Definition of goals and objectives

Draft objectives can be developed during the course of general consultations and public involvement as described above, but it will normally be desirable to conduct meetings and workshops to finalise these objectives, bringing together both policy makers and resource users. Agreeing to clear and practical objectives within a reasonable time frame will be the first major test of the strength of the institutional arrangements for improved planning, and in particular the effectiveness of the co-ordinating body.

Higher level objectives or *goals* will relate to the main component ideas of sustainable development. Examples are given in Box 1.12. More ambitious and comprehensive integrated coastal planning initiatives may also include more complex goals relating to the quality of life, inter-generational equity, and poverty alleviation (Yap, 1996; Chua 1997; Gomez and McManus in GESAMP 1996b).

More practical and specific objectives should also be developed which directly address identified issues relating to these broader goals.

The scope and wording of objectives must be agreed at a local level, but some basic principles should be observed:

- objectives should be achievable; and
- progress toward objectives should be measurable.

This implies agreement on the ***criteria*** (e.g. nutrient concentration) that will be used for measuring progress or assessing impact, and specific ***targets* or *standards*** (e.g. xmg/l) to aim for over a specified time frame. These criteria and targets should relate to social, economic and environmental objectives While some may be very simple, others may be complex; for example, criteria for measuring optimal allocation of resources would be required if the first objective in Box 1.12 were to be adopted.

Box 1.12: Goals for planning and management initiatives designed to promote more sustainable aquaculture development

- to optimise the allocation of resources (especially land, water and labour) to aquaculture and competing activities or functions;
- to maximise the economic returns from aquaculture and other coastal activities;
- to minimise the environmental impact of aquaculture and other coastal activities;
- to minimise and/or resolve conflict; and
- to promote a more equitable distribution of benefits from aquaculture and other coastal development.

Standards and targets related to the various objectives of the planning initiative are essential if there is to be rational and consistent social, economic and environmental appraisal of alternative activities and possible planning interventions. They are also essential for monitoring and performance evaluation[10].

Economic targets may relate for example to per capita GDP, disposable income, trade surplus. ***Social targets*** may relate to health, education, equity or other quality of life indicators. ***Sector targets*** will typically refer to the levels of activity in different sectors (such as aquaculture) required to meet the broader social and economic targets. ***Environmental targets*** may constrain economic and sector targets, and may be a component in social targets. They may be of two kinds: area based, or quality based. Area related environmental targets (such as natural reserves) have been widely used, and represent the commonest form of ***zoning***[11]. ***Environmental quality standards***, such as acceptable concentrations of nutrients or pesticides in receiving waters, presence or absence of indicator species, species diversity, and other indicators of environmental quality, may also serve as planning targets.

Environmental quality standards are an essential component in the application of the concept of environmental capacity, and its use to define sector targets (see Box 1.13 below). Monitoring of environmental quality against targets and standards is also an essential component in ***State of the Environment Reporting***[12]***,*** which is required, for example, from individual States in Australia, and other forms of performance evaluation. Standards and targets are also a precondition for consistent assessment of significance in environmental impact assessment.

1.5.8 Identifying development priorities and preferred options

The information collected and assimilated, relating to both the development context and the nature of existing activities or development options, should provide a sound basis for the assessment of development alternatives (activities, technologies, operational practices) against planning objectives, standards and targets, and the selection of preferred options. This assessment should identify:

- undesirable or low priority activities/developments;
- desirable or high priority activities/developments;
- design, technology and management practices likely to maximise social, economic and environmental benefits from different activities;
- mitigation measures to minimise any adverse social or environmental impacts related to otherwise desirable activities or developments;

[10] Section 2.6
[11] Section 2.11
[12] Section 2.13

There are three main techniques or approaches for presenting, analysing, comparing and prioritising the alternatives:

- Environmental assessment;
- Cost Benefit Analysis;
- Participatory decision making

Ideally, all three approaches should be used, each informing the other.

Environmental Assessment (EA)

Environmental assessment[13] is a comprehensive format for the assessment of a development or set of developments. It brings together information about the development context and development issues with the technical-economic appraisal, allowing for a comprehensive assessment of the environmental and social effects of a proposed development, or development option, in a particular location. It has become a standard planning tool, with a significant impact on development decisions, and has been used widely in coastal management. In recent years increasing emphasis has been placed on integrating social and economic considerations into the EA process.

Unfortunately EA has commonly been applied on a project basis (usually referred to as EIA), and normally only to larger projects. Although such an approach is useful, and indeed essential for large business or infrastructure, it cannot address the incremental but cumulative social and environmental problems associated with large numbers of small agricultural or aquaculture developments. It has also often been applied in the absence of clear and agreed criteria (such as environmental quality standards) against which impacts can be assessed.

To be effective as a tool for more integrated coastal management, EIA should be applied to all sectors in the form of Integrated Environmental Assessment[14]. If this is beyond the scope of the planning exercise (e.g. in the case of enhanced sectoral initiatives) EA should be applied to the whole aquaculture sector, and should be used as a tool for strategic planning rather than as a regulatory instrument. If the resource and technology assessment as described above has been done thoroughly, this process should be relatively straightforward. The likely environmental and social impacts of a range of technologies or development options in different locations can be compared, and planning interventions to minimise environmental impact devised. Sector environmental assessment has the potential to become a standard tool for strategic planning.

EA typically assigns “significance” to social and environmental impacts. The level of significance is typically used as a decision criterion. It is therefore important that significance itself is measured against some consistent and objective standard. This implies the existence of social and environmental standards or targets against which significance can be measured.

The principles and practice of EA are similar whether applied to individual projects or to a “sector” and are now well established.

Economic analysis

Economic analysis provides a formal framework for comparing the multiple functions and uses of the coastal zone. In particular, it allows for a systematic evaluation of alternative uses, which in turn can lead to the identification of options for planners and decision-makers with regard to the allocation of resources (Gittinger, 1982; Mishan, 1982; Pearce and Nash, 1981). It may also provide a framework for a rigorous assessment of the costs and benefits of interactions between activities. In its more sophisticated forms it seeks to aggregate social, environmental and financial values relating to a particular enterprise or sector into a single index of *total economic value*, allowing for a standardised comparison of development alternatives. ***Cost Benefit Analysis***[15] provides an overall framework for the comparison of development options and is widely described in the literature. ***Environmental economic techniques*** allow for the inclusion of non-market or traded goods and services.

---

[13] Section 2.7

[14] See for example the frameworks proposed by GESAMP (1991a) and Chua (1997).

[15] Section 2.8

Although there are many advantages in bringing together all the diverse values within a single overall framework, these approaches should be treated with caution. They commonly require complex and sometimes questionable sets of assumptions. They should only be used when the methodology and underlying assumptions can be clearly explained to decision-makers. This may be difficult in the case of more participatory decision making, involving many individuals and interests with radically different educational levels.

Where comprehensive CBA and environmental economics are not used, simpler economic analyses can nonetheless shed light on specific issues such as the "costs" of pollution or habitat degradation associated with particular activities. Where such figures are difficult to estimate, it may be possible to provide information on the "opportunity costs" associated with *not* developing or polluting resources. In other words simple economic analysis can provide information on the nature of the "trade-off" between competing uses of coastal resources, which is vital for economically sound and well informed decision making.

Participatory approaches

There are a variety of decision-making techniques that avoid the problems of aggregating dissimilar values and quantities noted above. These rely on meetings, discussions or interviews to determine (and in some cases aggregate) values, and examine the trade-offs between different options. For example, some options may yield higher environmental benefits, while others yield higher financial benefits. Decision makers will generally seek to balance the two, essentially trading environmental benefit for financial benefit up to a point which reflects their relative valuation of financial and environmental benefit.

There are a variety of group/participatory tools that facilitate decision making of this kind, commonly referred to as ***multi-objective decision analysis***[16]. Most are based on ranking (which is usually much easier than assigning absolute values), or paired comparisons of development options against different decision criteria. Financial or money values are used to a variable degree according to the nature of the alternatives.

These approaches rely heavily on:

- effective communication of the various characteristics or possible values and impacts (economic, social, environmental) of different development alternatives - and the trade-off between them (i.e. how much is lost or gained of different benefits as the options are changed);
- clarification of development/environmental objectives and targets, so that development alternatives can be measured (and therefore valued) against them.

The use of such approaches necessarily encourages a more integrated assessment, and allows for a wide range of stakeholders to make an input to the decision making process.

Transparency

Given the technical difficulty and cultural subjectivity of assigning values, especially in respect of social and environmental issues, the key to both approaches is *transparency*. The assumptions lying behind any aggregate figures or trade-off calculation must be clearly understood by those involved in the decision-making process.

1.5.9 Conflict identification and resolution

Conflict between different resource users may already exist in the coastal zone. Indeed, an integrated planning initiative may be a response to this conflict. Where conflict does not already exist, it may actually arise during the planning process. Public involvement and participatory decision making, environmental assessment, cost benefit analysis, and other techniques which seek to identify and compare social, economic and environmental values, may bring into the open previously hidden differences in terms of development needs, and values and aspirations between different resource users and other stakeholders. For example, public consultation in relation to shellfish farming in Sweden, and shrimp farming in India and East Africa has led to serious conflict (Ellegard, 2000; Hambrey *et al*., 2000; Murthy, 1997).

[16] Section 2.9

Clearly this kind of conflict should be avoided as far as possible, and the way in which issues are presented for public consultation should be handled with great sensitivity. One important rule is to establish broad public agreement on overall development objectives, strategy, and decision criteria, before addressing specific development cases or projects. Trying to establish decision criteria on an ad hoc basis in relation to individual projects will inevitably polarise opinion.

This reinforces the need for comprehensive stakeholder participation in the initial setting of planning objectives, which should reduce the likelihood of conflict arising during the formulation and implementation of the plan. It may be that the outcome of any conflict resolution is in fact a tightening or reformulation of the planning objectives.

Should conflict nonetheless arise, a variety of approaches are available for its resolution[17], including ***litigation, arbitration, mediation, and negotiation***. The second two are usually more desirable than the first two. Litigation and arbitration both involve the imposition of a solution, and may not address or resolve the underlying causes of conflict, which may therefore re-surface at a later date. Mediation and negotiation on the other hand seek to resolve differences through an emphasis on common objectives.

1.5.10 Defining broad management strategy

The process of public involvement, agreeing broad objectives, and evaluating alternative development (and conservation) options, should provide a comprehensive information base for defining an overall planning strategy or framework.

Sector/activity targets

A significant part of strategic planning is the setting of targets relating to particular sectors or activities. Sector targets may be set in terms of *total output* (production and/or value), or *total allocation of resources* (e.g. zoning of land or water; allocation of environmental capacity). They may be set in relation to an entire coastal area, or in relation to specific zones as defined above.

Output targets have commonly been associated with planning in centrally planned economies, but with rather little emphasis on land or resource use, environmental effects and environmental capacity. In contrast, they have generally had a minor role in integrated coastal management, where the emphasis is typically on the resource base and environmental conservation.

As discussed above, environmental capacity assessment attempts to define the relationship between sector activity levels and environmental quality, and should therefore be of particular interest in strategic conservation planning. It is an important tool for integrating aquaculture into broader coastal planning and management initiatives. An outline for the use of environmental capacity as the basis for setting different kinds of sector target is presented in Box 1.13, and is discussed in more detail in Section 2.4.

Output targets may be associated with a resource allocation target – for example a particular level of production from a specific zone.

Criteria for locating aquaculture

A key component in the integration of aquaculture in strategic planning is an understanding of the specific needs of aquaculture in terms of ***site and location***[18] requirements. These should have been defined during the technical and economic assessment phase of the planning process. These requirements may be developed into a set of criteria which can be used as the basis for a variety of planning and management interventions (such as zoning, or screening development proposals) to influence location and siting of aquaculture activities.

---

[17] Section 2.10

[18] Section 2.5.2

Appropriate siting of aquaculture and other development activities in coastal areas will:

- minimise the risks to, and maximise the returns from, coastal aquaculture;
- maximise the overall economic return from all activities in the coastal zone;
- minimise conflict between aquaculture and other resource uses; and
- minimise environmental impact.

Box 1.13: Using environmental capacity and EQS as the basis for planning interventions

The following is an example of how environmental capacity can serve planning needs:

1. Define a specific area or zone in which aquaculture and compatible activities are to be allowed or promoted;
2. Set environmental quality standards (EQS) in terms of acceptable nutrient concentrations;
3. Estimate environmental capacity (e.g. total quantity of nutrients which can be released into the area without breaching EQS);
4. Calculate acceptable nutrient loads (the environmental capacity) that will not lead to breach EQS;
5. Develop incentives or regulations to prevent aquaculture and other activities exceeding the acceptable load. These might include:

    - allocation or sale of a portion of environmental capacity;
    - cessation of issue of permits once a critical total production threshold is reached;
    - cessation of issue of permits once an environmental quality standard is reached;
    - pollution tax related to quantity of discharge

The first of these has several significant advantages. The rules are clear. There is a cost associated with pollution, and a strong incentive to develop more environmentally friendly technology, which will allow for higher levels of production and economic activity while maintaining environmental quality.

The second and third are likely to cause frustration and possible conflict when they are introduced.

The fourth will be universally unpopular, and will be difficult to fine-tune to achieve the desired EQS.

Criteria for assessing aquaculture

A variety of other criteria for assessing the social, economic and environmental impact of individual projects or proposals should be developed, based on the planning objectives. They might, for example, relate to scale, design, technology, management, or labour relations. These might be used in support of the various planning instruments described below. For example, the assessment criteria could be used as the basis for credit or grant aid, for the issuing of permits, for screening proposals for environmental assessment, or as standard criteria to be used when undertaking environmental assessment.

Zoning

Zoning (Section 2.11) implies bringing together the criteria for locating aquaculture and other activities in order to define broad zones suitable for different activities or mixes of activities. GIS is particularly well suited to facilitating this task.

Zoning may be used either as a source of information for potential developers (for example by identifying those areas most suited to a particular activity); or as a planning and regulating tool, in which different zones are identified and characterised as meeting certain objectives (see for example Box 1.14).

Zoning of land (and water) for certain types of aquaculture development may:

- help to control environmental deterioration at the farm level;
- reduce adverse social and environmental interactions;
- serve as a focus for estimates of environmental capacity (see Box 1.13)
- serve as a framework for the provision or improvement of water supply/drainage infrastructure to small scale farmers.

The strength of zoning lies in its simplicity, its clarity, and its potential in terms of streamlining procedures. For example, once a zone is established and objectives defined, then developments that meet the objectives and general conditions for the zone may need no further assessment (such as EIA). What is allowed and what is not allowed is clear, and developers can plan accordingly. Any monitoring required can be applied to the whole zone rather than individual farms.

Box 1.14 An example of zoning for aquaculture

The Republic of Korea offers an interesting example of coastal management stimulated by the need to protect an aquaculture industry threatened by land based pollution. Environmental degradation in coastal waters led to significant problems in the oyster industry beginning in the 1970s. Habitat destruction affected spat settling areas, and eutrophication led to reduced water quality, red tides, reduced production, and occasionally direct toxic and health effects on shellfish and consumers. Oysters became difficult to sell for high quality export market.

These problems have been addressed in some areas through the declaration of *Clear Zones*, and establishment of appropriate water quality standards. The Clear Zones include four "Blue Zones", associated with water quality standards designed specifically for the protection of aquaculture. The designation of these zones is integrated with controls on developments immediately adjacent to the zone, in addition to controls on development and land-use upstream within the watershed, ensuring the achievement of water quality standards required for the production of export quality oysters. Oyster producers may seek legal compensation from polluters for any related losses, and may seek compensation from government for losses related to wider environmental problems such as algal blooms or natural events. Equally, oyster producers are required to have a license and abide by siting and operational rules related to environmental capacity (in this case related to available food).

Whilst the zoning appears to have worked to a point, resulting in production and economic benefits from export quality oysters, there have been some problems to the oysters caused by red tides, arising from coastal eutrophication from non-aquaculture sources. This is an indication that - even with initially successful integration of aquaculture into coastal management - ultimate success may depend upon a much wider and more horizontally integrated coastal management process.

Reference Kim, 1995

Its weakness lies in its rigidity. No zone is perfect, land/water capability assessment may have been inadequate, boundaries are frequently arbitrary, and conditions may change. There may be small pockets of land or water of high potential for aquaculture, which were not recognised in the resource assessment process, which are not part of an aquaculture zone, and which are therefore prevented or subject to severe regulation. In some situations this could restrict access of poor people to the opportunities for aquaculture development. Furthermore, it may actually be undesirable to encourage a concentration of aquaculture in one particular area, however suitable it may be, because of the increased risk of rapid spread of disease.

1.5.11 Planning instruments: incentives and constraints

A wide range of actions may be undertaken to influence the nature, direction and location of development, so that the strategy can be implemented, and the planning objectives met. To be effective, these must be capable of serving as incentives for, or constraints to particular activities, forms of development, or the location of development. They might include (OECD, 1993):

- infrastructure development;
- training, education and awareness raising;
- economic instruments;
- regulatory instruments;
- codes of practice;
- markets and labelling; and
- improved institutional linkages

Many of these instruments work best in combination. Infrastructure, tax incentives, and regulations may all work together to achieve some particular objective. They may be associated with zoning to provide differential incentives (e.g. applied in some zones but not in others) and thus reinforce the zoning system.

Box 1.15 Infrastructure and services to promote sustainable aquaculture in Thailand

The Kung Krabaen Bay Royal Development Sudy Centre in Chantaburi province, Thailand, was founded in 1981 with the objective of increasing villager's income through the application of integrated environmental management practices. The area is surrounded by a mangrove fringe, behind which numerous small-scale shrimp farms have been established. In the high land between the bay and hill, rice fields and fruit orchards form the major component of the agro-ecosystem. The upland area is still covered with mixed forest, orchards and rubber plantations.

A significant activity of the project was to provide local poor farmers with the land and extension support to develop shrimp farming. A 1.6 ha plot was granted to each of 100 farmer households, of which 0.96 ha was for three ponds (0.32 ha each), 0.16 ha for dikes and ditches and 0.48 ha on the seaward side for houses and mangrove plantation.

Most of the farmers have been successful, with production rates generally in the range of 5-10MT/ha/yr, providing a very high net income relative to their previous agricultural activities. The incidence of disease has however increased in recent years, with declining earnings and significantly increased risk.

This has been blamed in part on poor water quality, causing stress and increased susceptibility to disease. It may also be related to the partial mixing of influent and effluent, allowing for the rapid spread of disease.

The Centre provides a variety of services to farmers, including seed, veterinary services, and technical advice. Recently, a sea-water irrigation system has been completed, comprising a water intake on the open coast (outside the bay) and pumping facility to supply a network of supply canals. It also includes provision for rationalizing effluent canals, and water treatment prior to discharge into the Bay. The objective is to provide high quality, low pathogen water to all farms within the project, thus maximizing shrimp health and minimizing disease. Water treatment, and an overall flushing of water, should also lead to improved water quality within the bay, thus reducing possible environmental impact on fish and shrimp nursery grounds in the bay.

Infrastructure and services

Infrastructure development may be used to improve the performance of aquaculture in particular locations, minimise environmental impact, and reinforce zoning by offering a comparative advantage to farmers who operate within the zone[19].

For example, new or improved water supply and wastewater treatment for aquaculture (such as that described in Box 1.15) may make a significant contribution to sustainability. They may:

- reduce problems associated with existing aquaculture developments (such as exposure to pollution from upstream industry, agriculture and domestic sources; the rapid spread of disease between farms; downstream pollution associated with aquaculture effluents);
- pre-empt such problems arising in relation to new developments; and
- influence the location of new aquaculture development, with a view to ensuring that it is located in areas where it is most likely to succeed, and where conflicts with other activities or resource users are minimised.

The provision of improved marketing and processing facilities, or the provision of infrastructure to stimulate more rapid development of private sector services, may also have a significant influence on the success and location of new aquaculture development. Access to credit (see below) may also be considered as a form of infrastructure or service.

Training, education and awareness raising

There is growing awareness of the importance of environmental issues, but this awareness is "patchy" and may be inadequate in areas experiencing very rapid development. Raising environmental awareness will reinforce the impact of specific incentives or constraints.

Research, extension services and training can be used to influence the sustainability of the sector, by offering information and advice about environment friendly technology and practice, or advising on site selection.

Economic approaches and instruments

There is increasing interest in the use of economic incentives and constraints to promote environmentally and socially friendly aquaculture siting, design and operation. Most measures of this

[19] Sections 2.11 and 2.12

kind require legislation and implementation at provincial or national government levels. Their use in relation to aquaculture (which has been limited to date) is therefore discussed in some detail in Section 2.12.2

Economic instruments include:

- access charges (e.g. to sites or space);
- pollution charges;
- tradable permits for resource use, harvesting rights, pollution/emission rights (the latter may take the form of rights to a share of environmental capacity);
- various forms of subsidy and/or credit for environment friendly location, technology or management;
- refundable deposits and bonds laid against possible environmental damage, or set aside for restoration purposes;
- process or product standards linked to labelling and marketing initiatives.

Economic instruments appear to have many strengths. They:

- can be used to directly implement the polluter/user pays principle;
- require little in the way of enforcement (they influence farmers directly through their effect on profits);
- promote innovation (since less pollution is associated with lower costs);
- are flexible and efficient;
- may not require farm specific information on operation or discharge (a major problem with many regulatory approaches);
- can be linked to environmental capacity;
- can be used to address cumulative problems; and
- can generate government revenue for environmental management.

They also have weaknesses:

- the actual effects on farmer behaviour are not very predictable;
- they may need sophisticated institutions (to define; monitor; adjust, adapt etc);
- they are not always popular with government agencies, since they imply less direct control;
- they are not always popular with industry, since (negative instruments) imply extra costs.

To date these instruments have been little used to influence the course of aquaculture development and deserve serious consideration. It is probable however that regulatory instruments will still be required to complement these approaches.

Regulatory instruments

Regulation has been commonly used in an attempt to manage the development of and impacts from aquaculture. This has succeeded in many instances, especially in developed countries, but has a rather poor record in many developing countries where the enforcement of regulation may be particularly difficult.

Regulation may include any or all of the following:

- restrictions on location. For example some zoning schemes may explicitly bar certain types of development or activity;
- prohibition of specific activities, materials or technologies (for example prohibition on the use of specific chemicals or antibiotics);
- requirements for specific activities, technology or design (for example, requirement for settling ponds in intensive shrimp culture; prescribed feed quality);
- effluent standards (e.g. acceptable N, P, BOD; TOC, chemical residues etc);
- receiving water standards (e.g. acceptable N, P, BOD; TOC, chemical residues etc);

These may be stand-alone regulations, or may be directly linked to registration, licensing or the issue of permits.

Many regulations are difficult to implement in practice, and may lead to an attitude of limited responsibility by the farmer. Their use should be limited as far as possible, but they remain an important last resort, and may serve to reinforce more positive incentives and economic instruments.

Codes of practice

Where the rationale for regulation is clear, and particularly when it relates to the interests of farmers themselves (for example where it is designed to minimise self pollution, or exchange of pathogens between farms), every effort should be made to promote self-regulation through codes of practice. These may be reinforced through peer pressure, and in some cases actually enforced by associations of farmers themselves. In Thailand for example (Box 1.16), the Surat Thani Shrimp Farmers Association has agreed to its own set of standard procedures related to water quality and disease management for a group of neighbouring farms with common water supply.

Codes of practice, including best management practice, may be used as a basis for ***certification and quality labelling***[20] .

Box 1.16: Farmer associations and self regulation

The Surat Thani Shrimp Farm Association have agreed to set regulations to minimise the impact among the members of their shrimp farm cluster area:

(i) The timing for pumping and discharge water into the canal are set daily. This practice has the benefit of maximising seawater quality and minimising the impact of discharge water.

(ii) The national regulation concerning pond sludge disposal, allows the association to prohibit any farmer from using pumps for pond sludge disposal.

(iii) In case of an occurrence of disease, especially virus disease, in culture ponds, the farmer must clean the ponds and settle suspended solids before pumping or discharging water. This practice should reduce the likelihood of a wider disease outbreak.

Markets and labelling

Farm gate price has a major impact on farmer behaviour. If this price can be linked in any consistent way to better siting and management of aquaculture operations, change will follow rapidly. Quality or “green” certification and product labelling offer significant opportunities, albeit relatively untested, in this regard.

However, the benefits from such schemes may accrue largely to the wholesaler or retailer rather than the producer, and directly linking farm gate price to environmental management will not be easy. Furthermore the process of certification is difficult and costly, and the impact on price will depend on consumer trust of the certification system. These approaches may also be easier for larger scale and well organised producers, with consequent difficulties for small scale producers.

1.5.12 Monitoring, reporting, evaluation and response/adaptation procedures

These four activities are brought together in this Section because they are intimately related and cannot be considered in isolation from each other.

Monitoring

A broad range of monitoring is required to provide information for evaluation of the overall success or otherwise of the plan, and the reasons for success or failure of individual components. The former may be relatively straightforward, but the latter implies a thorough understanding of the operation of the plan in practice, and the functioning of physical, ecological and human systems.

[20] Section 2.12.2

A monitoring program may collect information on:

- Indicators relating to specific objectives of the plan (for example, environmental quality; biodiversity; living standards; productivity; income distribution; economic activity). These are sometimes known as outcome indicators;
- Indicators relating to the efficiency or effectiveness of the planning procedures. These may relate more directly to the performance of individual components and implementing mechanisms of the plan and those associated with them (performance indicators).

If the latter are found to be wanting, it may be appropriate to initiate some form of ***management capacity assessment***[21].

The outcome indicators should be designed and serve not only to measure success in meeting objectives, but also to enhance understanding of physical, ecological and economic systems , and the causal links between development activity and environmental effects. Many gaps in knowledge and understanding in these areas will have been highlighted in the assessment phase, and long term monitoring of key variables and parameters may be required to better understand the dynamics of physical, ecological and economic systems, so that planning and management can be further improved.

More detailed discussion of ecological and other forms of monitoring in relation to aquaculture can be found in Section 2.13.

Public involvement

The general public, and other stakeholders, should be encouraged to take an active part in monitoring, and may effectively supplement more formal monitoring procedures. This will also maintain the participatory dimension of the plan, and encourage broad responsibility for meeting the objectives of the plan.

Response procedures

Monitoring of specific environmental or socio-economic indicators is of limited use if it is not linked to a pre-determined management response in the event that the monitored variables are found to lie outside their acceptable limits. There should be *a priori* agreement about the action that will be taken if, for example, environmental impacts exceed predicted levels. This action might take the form of a reduction (where monitoring indicates that environmental capacity has been exceeded) or increase (where capacity is under-utilised) in (for example) number of farms, allowable waste emissions; stocking density, or production.

Synthesis and reporting

It is equally clear that monitoring must include effective synthesis, analysis, reporting, and effective communication of monitored parameters and variables, so that agreement can be gained on any specific response, or adaptation of the plan. Reporting procedures and response mechanisms must be clearly spelt out in the plan.

State of the Environment reporting is desirable in order to synthesise, rationalise, integrate and communicate the wide range of monitoring information generated from different activities and environmental management initiatives. It is a key component of more integrated approaches. It should be developed as a format for reporting, which may also be used at higher levels of government or as a guide to research activity.

Evaluation and adaptation

As noted repeatedly, any new plan is likely to be inadequate and in some cases flawed, and clear procedures must be established for more general evaluation, including subjective assessments, coupled with specific procedures for adapting or changing the plan. This could take the form of "stakeholder committees", public meetings or other specified consultation procedures, and possibly periodic evaluations by external consultants. Once again it is clear that these committees must have access to well presented and analysed monitoring data, as well as more subjective assessments and

[21] Section 2.13

submissions. They must also have the power to modify the plan as required, on a regular (and clearly defined) basis.

1.5.13 Institutional arrangements and implementing structures

Although institutional issues will have been addressed at the outset, it will be necessary to reconsider institutional needs for effective implementation, following detailed consideration of development options and planning and management needs.

As noted above and in many other publications (e.g. Chua, 1997; FAO, 1996; Post and Lundin, 1996), institutional arrangements for implementing, monitoring and adapting a coastal management plan are rarely afforded sufficient emphasis. Actual arrangements will vary tremendously according to local and national circumstances, but there are a few simple rules:

- responsibilities for implementation must be clearly allocated to particular institutions and individuals;
- overlapping responsibilities between agencies should be minimised;
- institutions must be able, willing and allowed to implement or administer the incentives and constraints contained in the plan;
- there must be co-ordinating and integrating institutions - which may take the form of institutional procedures; or particular agencies or individuals with a co-ordinating role;
- the institutional responsibilities must be defined within, or allowed for by, a legislative framework.

It is clear that any comprehensive and integrated planning initiative will require a competent lead agency or powerful co-ordinating committee to compile the information, synthesise the various points of view, develop a strategy, design planning instruments or actions, and ensure that they are implemented. An example is presented in Box 1.17.

Box 1. 17 Xiamen demonstration project

Xiamen is a modern maritime and scenic city in Fujian Province, China. Xiamen is designated as a special economic zone, and development has been very rapid in recent years. This has resulted in severe space competition; resource use conflict; pollution; degradation of natural habitat; siltation; and erosion. The area was chosen for a demonstration project under the GEF/UNDP/IMO Regional programme for the Prevention and Management of Marine Pollution in East Asian Seas.

A steering group for integrated coastal management in Xiamen Municipality was established with the Mayor or Deputy Mayor of the municipality as chairperson. This group oversees the Office of the Steering Group which is essentially the wing of municipal government responsible for coastal management. A consultative committee for Integrated Coastal Management provides advice and scientific and technical services. Together these bodies are responsible for:

- medium and long term plans on coastal development, infrastructure development and protection;
- coastal functional zonation schemes;
- coordination and formulation of local regulations, rules and standards concerning ICM;
- organization and coordination of various concerned sectors in discharging their respective mandates and law enforcement relating to ICM;
- deciding on the major issues pertaining to coastal development, infrastructure and management;
- coastal monitoring, surveillance, information management;
- review and endorsement of coastal development projects;
- public awareness activities for ICM;
- guidance to district level government on ICM.

One of the key factors in the success of the project to date appears to have been strong Municipal Government which has, for example, enacted legislation related to functional zoning, and which is sufficiently powerful to effectively co-ordinate the (12) sectoral administrations involved in coastal management.

Source: GEF/UNDP/IMO, 1996

1.5.14 Formal adoption of the plan

A written draft plan should be produced including at least the following:

- an analysis of social, economic and resource/environment issues;
- agreed objectives with associated standards and targets;
- a broad strategy and principles to meet these objectives;
- planning actions and instruments (incentives and constraints) to guide development and practice in order to meet the targets and fulfil objectives;
- procedures for monitoring, feedback and adaptation
- an estimate of costs and revenues related to the plan for each year for the duration of the plan;
- responsibilities and commitments of key participants/players

Whatever the level of public involvement in the formulation phase, it is essential that the plan is agreed and receives broad support from all stakeholders, and especially from those likely to be most affected. A wide range of public involvement techniques may be used to finalise and agree the plan, after which it can be formally adopted.

However participatory the process, it is nonetheless likely that some elements of the plan may be unpopular with a minority. In this case the procedures for implementation – and in some cases enforcement – must be studied very carefully.

1.5.15 Implementation and adaptation

If the procedures described above have been followed, and in particular, if the planning instruments have been carefully selected and their implementation thought through, then the implementation, reporting and monitoring, adaptation and refinement, *should* flow smoothly.

However, planning and management is about modifying, co-ordinating and in some cases integrating the behaviour and actions of varied individuals, groups and organisations, and this requires great management skill. It is beyond the scope of this report to discuss organisational management or human psychology, but some key points can be made.

Finance is always likely to be a problem. Pooling of finances from several sources will not only help raise the required funds but will also involve a greater range of stakeholders. It is also essential to develop trust and commitment among the various players.

Other general rules include the need to be:

- realistic and patient;
- pragmatic and practical;
- flexible.

1.5.16 Criteria for evaluation of integrating aquaculture into coastal management

Evaluation of more integrated planning and management is vital. Planning and management is expensive, and its difficulty and complexity means that it is prone to “drift”. It is often ineffective, and it is important that poor performance is identified quickly and put right.

GESAMP in its 1996 Session recognised that:

> *“There is an urgent need for an accepted evaluation methodology for assessing the impacts of coastal management programmes so that their efficacy can be assessed and required changes identified and implemented. Indicators and methodologies are required for establishing timely baselines and appropriate monitoring and assessment programmes. When an evaluative framework is in place it will be possible to document trends, identify their likely causes and objectively estimate the relative contributions of ICM programmes to observed social and environmental change.”* (GESAMP, 1996c).

Since that time a study has been commissioned by UNDP to address these issues (Olsen *et al.*, 1997). It identifies three types of evaluation: *performance evaluation; management capacity assessment; and outcome assessment* (see Part 2). It also emphasises the potential of the pressure-state-response (PSR) framework (OECD, 1994) to *"structure the collection of data on the condition and trends in the natural environment and as a tool to assist policy makers in analysing the effects of public policies on the environment."*

There is no reason why evaluation criteria should differ when considering the management of aquaculture rather than any other coastal activity. Indeed it is essential to the philosophy of integrated coastal management that the success of the integration of aquaculture into coastal management be evaluated against the same criteria as those used for other activities.

In practice, the evaluation of any coastal planning and management initiative should be relatively straightforward, since a basic component of the planning process is the establishment of practical objectives and associated measures, standards or indicators, which can be used to measure progress against objectives.

It is worth noting that several of the approaches to the management of coastal aquaculture discussed here are particularly amenable to outcome assessment in terms of environmental quality. The assessment of environmental capacity, which has already been the subject of several studies related to aquaculture, necessarily implies a simple outcome criterion: environmental capacity, as defined during the planning process, shall not be exceeded. Equally, zoning approaches provide relatively clear benchmarks in terms of land use against which performance can be measured.

A manual for assessing progress in coastal management produced by Olsen *et al.* (1999) should be referred to for a detailed discussion and guidance.

1.6 REFERENCES

ADB/NACA, 1996. Aquaculture sustainability action plan. Regional study and Workshop on aquaculture sustainability and the environment (RETA 5534). Manila, Asian Development Bank; and Bangkok, Network of Aquaculture Centres in Asia-Pacific: 21 pp.

Bagarinao, T.U. & Flores, E.E.C. (eds), 1995. Towards sustainable aquaculture in Southeast Asia and Japan. Proceedings of the Seminar. Workshop on aquaculture development in Southeast Asia. Iloilo City, 26-28 July 1994. Iloilo City, The Philippines. SEAFDEC Aquaculture Department. 254 pp.

Bailey, C., 1988. The social consequences of tropical shrimp mariculture development. Ocean Shorel.Manage., 11:31-44

Bailey, C., 1989. Shrimp mariculture development and coastal resources management: lessons from Asia and Latin America. In Olsen, S.B. & Arriaga, L. (eds). Establishing a sustainable shrimp mariculture industry in Ecuador. Kingston, Rhode Island, University of Rhode Island, Coastal Resources Center, pp. 45-70

Bailey, C., 1997. Aquaculture and basic human needs. World Aquacult., 28(3): 28-31

Bailey, C. & Skladany, M., 1991. Aquaculture development in tropical Asia: a re-evaluation. Nat.Resour.Forum., 15(1):66-71

Bardach, J.E. (ed.)., 1997. Sustainable aquaculture. New York, John Wiley & Sons, 251 pp.

Barg, U.C., 1992. Guidelines for the promotion of environmental management of coastal aquaculture development (based on a review of selected experiences and concepts). FAO Fish.Tech.Pap., (328): 122 pp. (issued also in French and Spanish)

Barg, U. & Phillips, M.J., 1997. Environment and sustainability. FAO Fish.Circ., (886) Rev. 1:55-66

Barg, U.C., Bartley, D.M., Tacon, A.G.J., & Welcomme, R.L., 1997. Aquaculture and its environment: a case for collaboration. In Hancock, D.A. et al (eds), Developing and sustaining world fisheries resources: the state of science and management. Proceedings of the Second World Fisheries Congress. Collingwood, Victoria, Australia, CSIRO, pp. 462-70

Beveridge, M.C.M., Phillips, M.J. & Macintosh, D.J., 1997. Aquaculture and the environment: the supply of and the demand for environmental goods and services by Asian aquaculture and the implications for sustainability. Aquacult.Research, 28:797-807

Black, E.A.,1991. Coastal resource inventories: a Pacific coast strategy for aquaculture development. In De Pauw, N. & Joyce, J. (eds). Aquaculture and the environment. Spec.Publ.Eur.Aquacult.Soc., 16:444-50

Chamberlain, G. & Rosenthal, H.,1995. Aquaculture in the next century: opportunities for growth - challenges of sustainability. World Aquacult., 26(1):21-5

Chua T.-E., 1997. Sustainable aquaculture and integrated coastal management. In Bardach, J.E. (ed.), Sustainable aquaculture. New York, John Wiley and Sons, pp. 177-99

Chua, T.-E. & Fallon-Scura, L. (eds), 1992. Integrative framework and methods for coastal area management. ICLARM Conf.Proc., 37:169 pp.

Chua, T.-E., Paw, J.N., & Guarin, F.Y., 1989. The environmental impact of aquaculture and the effects of pollution on coastal aquaculture development in Southeast Asia. Mar.Pollut.Bull.,20(7):335-43

Cicin-Sain, B. & Knecht, R.W., 1998. Integrated coastal and ocean management: concepts and practices. With support from the Intergovernmental Oceanographic Commission UNESCO and the Graduate College of Marine Studies of the University of Delaware. Washington, D.C. Island Press, 517 pp

Cicin-Sain, B., Knecht, R.W. & Fisk, G.W., 1995. Growth capacity for integrated coastal management since UNCTED: an international perspective. Ocean Coast.Manage., 29(1-3):93-123

Clark, J.R., 1992. Integrated management of coastal zones. FAO Fish.Tech.Pap., (327):167 pp. (issued also in Chinese)

Clay, J.W., 1997. Toward sustainable shrimp culture. World Aquacult., 28(3): 32-37

Davos, C. A., 1998. Sustaining cooperation for coastal sustainability. J. Environ.Manage., 52:379-87

Ellegard, A., 2000. Stakeholder and conflict analysis regarding mussel culture on the western coast of Sweden. In Man and coastal areas towards a sustainable aquaculture. Final report of the European Workshop for a sustainable development of aquaculture, edited by Service Scientifique et Technologique, Ambassade de France, et al. Presence scientifique française en Suède. Stockholm, Moderna Grafiker AB, pp. 45-49

FAO,1995. Code of Conduct for Responsible Fisheries. Rome, FAO, 41 pp. (issued also in Arabic, Chinese, French and Spanish)

FAO, 1996. Integration of fisheries into coastal area management. FAO Tech.Guidel.Responsible Fisheries, (3):17 pp (issued also in French and Spanish) .

FAO, 1998. Report of the Bangkok FAO Technical Consultation on policies for sustainable shrimp culture. Bangkok, Thailand, 8-11 December 1997. Informe de la Consulta Técnica FAO/Bangkok sobre politicas por el cultivo sostenible del camarón. Bangkok, Tailandia, 8-11 de diciembre de 1997. FAO Fish.Rep./FAO Inf.Pesca, (572):31 pp.

FAO, 1999. Papers presented at the Bangkok FAO Technical Consultation on policies for sustainable shrimp culture. Bangkok, Thailand, 8-11 December 1997. Documentos presentados a la Consulta Técnica FAO Bangkok sobre politicas para el cultivo sostenible del camarón. Bangkok, Tailandia, 8-11 de diciembre de 1997. FAO Fish.Rep./FAO Inf.Pesca, (572) Suppl./Supl. 266 pp.

FAO, 2000. Aquaculture production 1998. General notes: the definition of aquaculture (p.3). FAO Yearb.Fish.Stat.Aquacult.Prod., (86/2):169 pp.

FAO, 2001. Aquaculture production: Quantities 1970-1999, and Values 1984-1999 (included in Fishstat Plus Version 2.3: universal software for fishery statistical time series). FAO Fishery Information, Date and Statistics Unit.
Ftp.fao.org/fi/stat/windows/fishplus/aquaq.zip; Ftp.fao.org/fi/stat/windows/fishplus/aquav.zip

FAO Fisheries Department, 1997. Aquaculture development. FAO Tech. Guidel.Responsible Fisheries, (5):40 pp. (issued also in French and Spanish)

FAO/FIRI (Inland Water Resources and Aquaculture Service),1997. Review of the state of world aquaculture. FAO Fish.Circ., (886) Rev.1:163 pp.

FAO/NACA, 1995. Report on a Regional Study and Workshop on the environmental assessment and management of aquaculture development (TCP/RAS/2253). Bangkok, Network of Aquaculture Centres in Asia-Pacific. NACA Environ.Aquacult.Dev.Ser., (1):492 p.

GEF/UNDP/IMO, 1996. Enhancing the success of integrated coastal management: good practices in the formulation, design and implementation of integrated coastal management initiatives. Quezon City, Philippines, GEF/UNDP/IMO Regional Programme for the Prevention and Management of Marine Pollution in the East Asian Seas and Coastal Management Center. MPP-EAS Tech.Rep., (2):32 pp.

GESAMP (IMO/FAO/UNESCO-IOC/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection), 1986. Environmental capacity: an approach to marine pollution protection. Rep.Stud.GESAMP, (30):49 pp.

GESAMP (IMO/FAO/UNESCO-IOC/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection), 1991a. Reducing environmental impacts of coastal aquaculture. Rep.Stud.GESAMP, (47):35 pp.

GESAMP (IMO/FAO/UNESCO-IOC/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection), 1991b. Global strategies for marine environmental protection. Rep.Stud.GESAMP, (45):34 pp.

GESAMP (IMO/FAO/UNESCO-IOC/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection), 1995. Biological indicators and their use in the measurement of the condition of the marine environment. Rep.Stud.GESAMP, (55):56 pp. (issued also in Russian)

GESAMP (IMO/FAO/UNESCO-IOC/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection), 1996a. Monitoring the ecological effects of coastal aquaculture wastes. Rep.Stud.GESAMP, (57):38 pp.

GESAMP (IMO/FAO/UNESCO-IOC/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection), 1996b. The contributions of science to integrated coastal management. Rep.Stud.GESAMP, (61):66 pp.

GESAMP (IMO/FAO/UNESCO-IOC/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection), 1996c. Report of the twenty-sixth session. Paris, 25-29 March 1996. Rep.Stud.GESAMP, (60):29 pp. (issued also in French, Spanish and Russian)

GESAMP (IMO/FAO/UNESCO-IOC/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection), 1997. Towards safe and effective use of chemicals in coastal aquaculture. Rep.Stud.GESAMP, (65):40 pp.

Gittinger, J.P., 1982. Economic analysis of agricultural projects. Baltimore and London, Johns Hopkins University Press, 505 pp.

Gomez, E.D. & McManus, L., 1996. Case study 4. Coastal management in Bolinao town and the Lingayen Gulf, the Philippines. Rep.Stud.GESAMP, (61):57-60

Hambrey, J.B., 1993. Comparative economics of different land-use options in the mangrove forest area of North Sumatra Province. Report prepared for NESPP/ODA and Direktorat Jenderal Perikanan, Indonesia, by Nautilus Consultants, Edinburgh, 60 pp.

Hambrey, J.B., Phillips, M.J., Chowdhury, M.A.K. & Shivappa, R.B., 2000. Guidelines for the environmental assessment of coastal aquaculture development. An environmental assessment (EA) manual to assist governmental agencies, coastal aquaculture developers, non-governmental organisations (NGOs) and community organisations. Maputo, Mozambique, Secretariat for Eastern African Coastal Area Management (SEACAM) 213 pp.

Hartwick, J.M., 1977. Intergenerational equity and investing of rents from exhaustible resources. Am.Econ.Rev., 66:972-4

Ibrekk, H.O., Kryvi, H. & Elvestad, S., 1993. Nationwide assessment of the suitability of the Norwegian coastal zone and rivers for aquaculture (LENKA). Coast.Manage., 21(1):53-73

ICES, 1997. Report of the ICES Working Group on Environmental Interactions of Mariculture. Weymouth, United Kingdom, 1-5 March 1997. Copenhagen, International Council for the Exploration of the Sea, Mariculture Committee, CM 1997/F:35 pp. plus annexes

IPCC (Intergovernmental Panel on Climate Change), 1994. Preparing to meet the coastal challenges of the twenty-first century. Conference report. World Coast Conference 1993. Noordwijk, The Netherlands, 1-5 November 1993. The Hague, National Institute for Coastal and Marine Management, Intergovernmental Panel on Climate Change (IPCC)

IUCN/UNEP/WWF, 1991. Caring for the earth: a strategy for sustainable living. Gland, Switzerland, IUCN/UNEP/WWF:228 pp.

Kryvi, H., 1995. Aquaculture in Norway: the use of areas - conflicting interests. In Reinertsen, H. & Haaland, H. (eds). Sustainable fish farming. Proceedings of the First International Symposium on sustainable fish farming. Oslo, Norway, 28-31 August 1994. Rotterdam, Balkema, pp.195-9

Lowry, K., Olsen, S. & Tobey, J., 1999. Donor evaluations of ICM initiatives: what can be learned from them? Ocean Coast.Manage., 42:767-89

Mäkinen, T. (ed.) et al., 1991. Marine aquaculture and environment. Copenhagen, Nordic Council of Ministers. Nord, (1991:22):126 pp.

McPadden, C.A., 1993. The Malacca Straits coastal environment and shrimp aquaculture in North Sumatra Province. NESPP/ODA in cooperation with Dinas Perikanan (N. Sumatra) and Directorate General of Fisheries, Indonesia. London, Department for International Development (DFID UK)

Mires, D., 1995. Aquaculture and the aquatic environment: mutual impact and preventive management. Bamidgeh, 47(3-4):163-72

Mishan, E.J., 1982. Cost-benefit analysis. London, George Allen & Unwin, 384 pp.

Muir, J.F., 1995. Aquaculture development trends: perspectives for food security. Contribution to the International Conference on the sustainable contribution of fisheries to food security, organized by the Government of Japan in collaboration with the Food and Agriculture Organization of the United Nations (FAO). Kyoto, Japan, 4-6 December 1995. Rome, FAO, KC/FI/95/TECH/4:133 pp.

Muir, J.F. 1996. A systems approach to aquaculture and environmental management. In Baird, D.J., Beveridge, M.C.M., Kelly, L.A. & Muir, J.F. (eds). Aquaculture and water resource management. Oxford UK, Blackwell Science, pp.19-49

Munday, B., Eleftheriou, A., Kentouri, M. & Divenach, P. 1992. The interactions of aquaculture and the environment: a bibliographical review. A report prepared for the Commission of European Communities. Directorate General for Fisheries. Brussels, Directorate General for Fisheries of the Commission of the European Communities, pag.var.

Murthy, H.S., 1997. Impact of the Supreme Court judgement on shrimp culture in India. INFOFISH Int., (3/97):30-4

NACA, 1996. The second five year programme of the Network of Aquaculture Centres in Asia-Pacific (NACA), 1996-2000. Theme: aquaculture sustainability. Bangkok, NACA, 27pp.

Nambiar, K.P.P. & Singh, T. (eds), 1997. Sustainable aquaculture. Proceedings of the INFOFISH-AQUATECH 96 International Conference on aquaculture. Kuala Lumpur, Malaysia, 25-27 September 1996. Kuala Lumpur, INFOFISH, 248 p.

Naylor, R. L. et al., 1998. Nature's subsidies to shrimp and salmon farming. Science (Wash.), 282(5390): 883-884

Nichols, K., 1999. Coming to terms with "integrated coastal management": problems of meaning and method in a new arena of resource regulation. Prof.Geogr., 51(3): 388-399

Ochoa, E., 1995. Manejo costera integrado en Ecuador. Guayaquil, Programa de Manejo de Recursos Costeros, 417 pp. http://crc.uri.edu.eccover.html

OECD, 1991. Report on CZM: integrated policies and draft recommendations of the Council on Integrated Coastal Zone Management. Paris, Organization for Economic Cooperation and Development.

OECD, 1993. Coastal zone management: integrated policies. Paris, Organization for Economic Cooperation and Development, 126 pp.

OECD, 1994. Environmental Indicators. OECD core set. Paris, OECD, 157 pp.

Olsen, S.B., Lowry, K. & Tobey, J., 1999. A manual for assessing progress in coastal management. Coast.Manage.Rep.Coast.Resour.Cent.Univ.R.I., (2211):56 pp.

Olsen, S.B. et al., 1997. Survey of current purposes and methods for evaluating coastal management projects and programs funded by international donors. Coast.Manage.Rep.Coast.Resour.Cent.Univ.R.I., (2200):28 pp.

PAP/RAC, 1995. Report of the Workshop on the selection and protection of sites suitable for aquaculture. Iraklion, Greece, 1-4 November 1995. Split, Croatia, Priority Actions Programme/Regional Activity Center (Mediterranean Action Plan-UNEP), PAP-10/EAM/W.2/1: 23 pp.

PAP/RAC, 1996. Approaches for zoning of coastal areas with reference to Mediterranean aquaculture. Split, Croatia, Priority Actions Programme/Regional Activity Center (Mediterranean Action Plan -UNEP). PAP-10/EAM/GL.1:35 pp.

Pearce, D.W. & Nash, C.A., 1981. The social appraisal of projects: a text in cost-benefit analysis. London, Macmillan, 225 p.

Pedini, M. & Shehadeh, Z.H., 1997. Global outlook. FAO Fish.Circ., (886) Rev.1: 30-37

Pernetta, J.C. & Elder, D.L., 1993. Cross-sectoral integrated coastal area planning (CICAP): guidelines and principles for coastal area development. A marine conservation and development report. Gland, Switzerland, IUCN in collaboration with World Wide Fund for Nature, 63 pp.

Phillips, M.J., 1995a. Aquaculture and the environment - striking a balance. In Nambiar, K.P.P. & Singh, T. (eds). Aquaculture towards the twentyfirst century. Proceedings of the INFOFISH-AQUATECH '94 International Conference on aquaculture. Colombo, Sri Lanka, 29-31 August 1994. Organized by INFOFISH and the Sri Lanka Export Development Board. Kuala Lumpur, INFOFISH, pp.26-55

Phillips, M.J., 1995b. Shrimp culture and the environment. In Bagarinao, T.U. & Flores, E.E.C. (eds). Towards sustainable aquaculture in Southeast Asia and Japan. Iloilo, The Philippines, SEAFDEC Aquaculture Department, pp.37-62

Phillips, M.J. & Barg, U., 1999. Experiences and opportunities in shrimp farming. In Svennevig, N., Reinertsen, H. & New, M. (eds). Sustainable aquaculture - food for the future. Proceedings of the Second International Symposium on sustainable aquaculture. Oslo, Norway, 2-5 November 1997. Rotterdam, Balkema, pp.43-72

Phillips, M.J. & Macintosh, D.J., 1997. Aquaculture and the environment: challenges and opportunities. In Nambiar, K.P.P. & Singh, T. (eds). Sustainable aquaculture. Proceedings of the INFOFISH-AQUATECH '96 International Conference on aquaculture. Kuala Lumpur, Malaysia, 25-27 September 1996. Kuala Lumpur, INFOFISH, pp.159-170

Pillay, T.V.R., 1996. The challenges of sustainable aquaculture. World Aquacult., 27(2):7-9

Pillay, T.V.R., 1997. Economic and social dimensions of aquaculture management. Aquacult.Econ.Manage., 1(1):3-11

Post, J.C. & Lundin C.G. (eds), 1996. Guidelines for integrated coastal zone management. World Bank Environ.Sustain.Dev.Stud.Monogr.Ser., (9):16 pp.

Pullin, R.S.V., 1993. An overview of environmental issues in developing country aquaculture. In Pullin, R.S.V., Rosenthal, H. & Maclean, J.L. (eds). Environment and aquaculture in developing countries. ICLARM Conf.Proc., (31):1-19

Rana, K.J., 1997. Status of global production and production trends. FAO Fish.Circ., (886) Rev. 1:3-16

Reinertsen, H. & Haaland, H. (eds.), 1995. Sustainable fish farming. Proceedings of the First International Symposium on sustainable fish farming, Oslo, Norway, 28-31 August 1994. Rotterdam, Balkema, 307pp.

Robadue, D. (ed.), 1995. Eight years in Ecuador: the road to integrated coastal management. Coast.Resour.Cent.Tech.Rep.Univ.R.I., (2088):319 pp. http://crc.uri.edu.eccover.html

Rohitha, W.R., 1997. Strengthening the institutional framework to promote coastal aquaculture in North Western Province, Sri Lanka. Masters thesis, Bangkok, Thailand, Asian Institute of Technology, 105 pp.

Rosenthal, H., 1997. Environmental issues and the interaction of aquaculture with other competing resource users. Aquacult.Assoc.Can.Spec.Publ., (2):1-13

Rosenthal, H. & Burbridge, P., 1995. Report of the ICES Workshop on principles and practical measures for the interaction of mariculture and fisheries on coastal area planning and management. Kiel, Germany, 19-22 July 1995. ICES Working Group on Environmental Interactions of Mariculture. Copenhagen, International Council for the Exploration of the Sea Mariculture Committee/FS:31 pp.

Rosenthal, H., Hilge, V. & Kamstra, A. (eds)., 1993. Workshop on fish farm effluents and their control in EC countries. Hamburg, Germany, 23-25 November 1992. Kiel, Germany, Institute of Marine Science, 205 pp.

Saenger, P., 1993. Some environmental aspects of aquaculture planning and operation. In Al-Thobaiti, S. et al. (eds). Proceedings of the First International Symposium on aquaculture technology and Investment opportunities. Riyadh, Kingdom of Saudi Arabia. Riyadh, Ministry of Agriculture and Water, pp. 590-600

Scialabba, N. (ed.), 1998. Integrated coastal area management and agriculture, forestry and fisheries. FAO Guidelines. Rome, FAO, Environment and Natural Resources Service, 256 pp.

Solow, R.M., 1986. On the inter-generational allocation of natural resources. Scand.J.Econ., 88:141-149

Sorensen, J., 1997. National and international efforts at integrated coastal management: definitions, achievements and lessons. Coast.Manage., 25(1):3-41

Stewart, J.E., 1997. Environmental impacts of aquaculture. World Aquacult., 28:47-52

Tacon, A.G.J., 1996. Trends in aquaculture production with particular reference to low-income food-deficit countries, 1984-1993. FAO Aquacult.Newsl. , (11): 6-9

Tacon, A.G.J., 1997. Contribution to food fish supplies. FAO Fish.Circ., (886) Rev.1: 17-21.

Tobey, J., Clay, J. & Vergne, P., 1998. A difficult balance: the economic, environmental and social impacts of shrimp farming in Latin America. Coast.Resour.Cent.Coast.Manage Rep.Univ.R.I., (2002)

Truscott, S.J., 1994. Capability studies for finfish and shellfish aquaculture as a prerequisite to coastal planning. In Wells, P.G. & Ricketts, P.J. (eds). Coastal zone Canada '94: cooperation in the coastal zone. Coastal Zone Canada Association Conference Proceedings. Dartmouth, Bedford Institute of Oceanography, Vol.1:1611-29

UNEP, 1995. Guidelines for integrated management of coastal and marine areas with special reference to the Mediterranean basin. UNEP Reg.Seas Rep.Stud., (161): 80 pp.

UNEP, 1996. Environmental impact assessment training resource manual. Prepared for the United Nations Environment Programme by the Environment Protection Agency, Canberra, Australia under the guidance and technical support of the UNEP International Working Group on EIA. Preliminary version June 1996. Nairobi, UNEP and Canberra, Australian Environment Protection Agency. 699 pp. (loose-leaved binder)

Videau, C. & Merceron, M., 1992. Impact de la pisciculture marine intensive sur l'environnement: revue bibliographique. Brest, France, IFREMER, 105 pp.

Wong, P.S. 1995. Hong Kong. In Report on a Regional Study and Workshop on the environmental assessment and management of aquaculture development (TCP/RAS/2253). Bangkok, Network of Aquaculture Centres in Asia-Pacific. NACA Environ.Aquacult.Dev.Ser., (1):113-139

World Bank, 1993. The Noordwijk guidelines for integrated coastal zone management. Paper presented at the World Coast Conference, 1-5 November 1993. Noordwijk, The Netherlands. Washington, DC, World Bank, Environmental Department, 21 pp. (mimeo)

World Commission on Environment and Development (WCED), 1987. Our common future. Oxford UK, Oxford University Press, 383 pp. (issued also in French and Spanish)

Wu, R., 1995. The environmental impact of marine fish culture: towards a sustainable future. Mar.Pollut.Bull., 31:159-66

Yap, H.T., 1996. Attempts at integrated coastal management in a developing country. Mar.Poll.Bull., 32(8/9):588-91

PART 2

TOOLS AND METHODS

Part 2 of this report is designed primarily for scientists and technical specialists who may draw on these methods in the course of their professional lives. It should also serve as a reference and resource for others with an interest in, or a need to understand the strengths, weaknesses and application of different approaches and techniques. **Part 1** should be read as background material, since it describes the context and rationale for the use of these tools.

It is beyond the scope of this report to review in detail all the individual tools and methods of relevance to more integrated coastal planning and management of aquaculture. Nor is this necessary: there already exist excellent reviews and guidelines that focus on particular tools and methodologies.

We therefore summarize the more generally applicable tools, comment on specific issues related to aquaculture, and refer the reader to more comprehensive reviews or guidelines where possible. The working group discussed some tools of particular relevance to aquaculture in more detail, and in this case the review is more thorough, and the main findings and recommendations of the group are presented. For example, particular emphasis is laid on zoning and environmental capacity, since these highlight particular problems and opportunities for integrating aquaculture into wider coastal management initiatives.

The structure of this Section is based loosely on the components presented in Table 1.2 and the overview of procedures presented in Section 1.5.