Prepared for the Secretariat for Eastern Africa Coastal Area Management (SEACAM)

Composite Guidelines for the Environmental Assessment of Coastal Aquaculture Development

Volume 1: Guidelines

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Document Guide

Purpose

The overall objective of these guidelines, and the associated training initiative, is to improve the environmental assessment capacity for mariculture developments in a variety of stakeholder groups in Eastern Africa. The guidelines and associated technical appendices provide detailed practical and technical information to reduce and mitigate the environmental and social impacts of mariculture developments along the eastern African coast. The emphasis in the guidelines is on those forms of activity likely to pose the greatest threat.

The guidelines should serve as a “hands-on” technical manual that will assist, for example:

- government regulatory agencies to assess and recommend modifications to coastal aquaculture developments;
- policy makers and planners to improve the procedures for the environmental assessment and management of individual coastal aquaculture projects, and the coastal aquaculture sector as a whole;
- coastal aquaculture developers to recognize negative impacts from proposed developments and provide them with practical and cost effective measures to reduce the impacts, and
- NGO’s and community organizations to better assess the social and environmental impacts of coastal aquaculture developments, and the efficacy of government EIA activity in this sector.

While the regional focus of this document is Eastern Africa, it draws heavily on experience from other parts of the world, and in particular SE Asia, where coastal aquaculture is far more developed, and where environmental issues related to aquaculture have already become significant. The document will therefore be relevant and useful to people from throughout the world with an interest in more sustainable coastal aquaculture development.

Scope

These guidelines go beyond previous environmental assessment (EA) compilations in one important respect. They strongly emphasize the need for sector EA (ideally as part of regional integrated EA) for aquaculture wherever it is likely to become a significant industry. This is necessary in order to address the problems associated with individually small scale but cumulative impacts, and the unacceptable costs of applying environmental assessment to large numbers of small aquaculture development proposals. These guidelines present specific and detailed advice on how to undertake these broader assessments.

Major sources

These *composite* guidelines draw on a wide range of existing resources. In particular, much of the more general structure and content is based closely on the *UNEP EIA Training Resource Manual*, (UNEP 1996) and the accompanying book EIA: Issues, Trends and Practice (Bisset 1996). These provide a thorough review of the “state of the EIA art”, and represent broad international consensus on the nature of the EIA process, and best current and proposed future practice. This document in turn draws significantly on the findings of the International *Study of the Effectiveness of Environmental Assessment* (Sadler 1996). Other key sources were the *World Bank Environmental Assessment Source Book*, and OECD’s (1992) *Good Practices for Environmental Impact Assessment of Development Projects*. A wide range of other texts and guidelines were reviewed and contributed to the detail of these guidelines.

The literature on the application of EIA to aquaculture is more limited. The ADB (1987) *Environmental Guidelines For Selected Agricultural and Natural Resources Development Projects*, the UNEP (1990) *Environmental Guidelines for Fish Farming*, the NORAD (1992) *Guidelines for initial environmental assessment of aquaculture*, and a more recent study by Vel (1996) on preparing an environmental impact assessment statement for aquaculture in India, served as useful starting points for adapting the more general EA guidelines to the specific needs of aquaculture.

The more detailed assessment and analytical tools related specifically to aquaculture are drawn from a wide range of literature on the resource characteristics of aquaculture and its interaction with the environment. Of particular relevance are *Guidelines for the promotion of environmental management of coastal aquaculture development* (Barg 1992), and the various documents produced by GESAMP in recent years, including the current working papers and draft reports from GESAMP Working Group 31 on the Environmental Impacts of Aquaculture.

The document draws heavily on a range of guidelines and codes of practice for sustainable aquaculture which have been published in recent years, stimulated in part by the rapid development of shrimp farming These include the FAO (1995) *Code of Conduct for Responsible Fisheries*, and the associated *Technical Guidelines for responsible fisheries: aquaculture development* (FAO 1997; the draft World Bank report on *Shrimp Farming and the Environment* (Hempel and Winther 1997); the FAO *Technical Consultation on Policies for Sustainable Shrimp Culture* (FAO 1998); the *Global Aquaculture Alliance Codes of Practice for Responsible Aquaculture*; and *Guidelines for the sustainable development of aquaculture in Belize* (Huntington and Dixon, 1997).

Material relating specifically to Aquaculture in Eastern Africa is more limited. The *Programme SEACAM de Formation en Evaluation Environmentale – Activite: Mariculture* (Maharavo, 1999) is an important resource for the region, especially in relation to shrimp culture. Documents relating to the *EIA for an environmentally responsible prawn farming project in the Rufiji Delta, Tanzania* (Ndimbo et al 1997), and those relating to an EIA of a shrimp farm near Bagamoyo (AIT 1995) were important sources, as were recent documents from the Tanzania Coastal Management Partnership, especially the *Mariculture Issues Profile (TCMP 1998*). A recent report on *Estuarine Mariculture in South Africa* produced for the South African Network for Coastal and Oceanic Research, and the Foundation for Research and Development (Cowley et al 1998) provides important information on the context for coastal aquaculture development in South Africa.

Terminology

There is some variation in the literature in the use of terms. In particular some authors and organizations use the term environmental assessment (EA) while others use environmental impact assessment (EIA) for essentially similar activities. In this document we have used *EA* as a generic term for all forms of assessment. *EIA* is used specifically for project or farm level assessment. *Sector EA* is used to refer to environmental assessment of the effects of a particular sector (such as fisheries or aquaculture) or sector development plan, rather than to the effects of a specific project. *Integrated* or *regional EA* is the process of determining the regional cumulative environmental and socio-economic implications of multi-sectoral developments within a defined geographical area, over a defined period of time. *Strategic EA* is the process of identifying and addressing environmental consequences (and associated social and economic effects) of existing, new, or revised policies, plans and procedures. A full set of definitions and acronyms is presented in the Glossary.

Document structure

The structure of the guidelines (main document) is similar to that used by UNEP (1996) and many other standard guidelines on EA. Each section opens with a summary of content. Text boxes are used throughout the document to highlight specific lessons and experience, or to summarize key issues or techniques. References, plus a comprehensive bibliography, are annexed to the main document.

The Appendices contain several case studies; summaries of legal and institutional frameworks for aquaculture development in various countries; the bulk of technical material relating to the assessment and mitigation of the environmental effects of aquaculture; and the full text of the FAO Code of Conduct, and the Global Aquaculture Alliance Code of Practice.

Using these guidelines

Most policy makers or officials with some interest or responsibility relating to coastal development and environment will wish to use the overall summary (based on the individual section summaries) and refer to the main document only where necessary for clarification or further understanding. Those commissioning EA studies relating to aquaculture, or undertaking screening or initial environmental examinations, should read the bulk of the main guidelines. EA practitioners and technical specialists or academics are likely to make significant use of the technical material in the appendices.

About SEACAM

In August 1997, the Secretariat for Eastern African Coastal Area Management SEACAM) was launched in Maputo, Mozambique. The Reference Group of country representatives from the ten Eastern African countries officially opened the Secretariat in October 1997. The Secretariat springs from the desire of the Eastern African countries to accelerate implementation of integrated coastal zone management (ICZM) in the region as put forth in the Arusha Resolution (1993) and Seychelles Statement (1996) on ICZM.

The Secretariat is a truly regional organization, which works with ten countries: Comoros, Eritrea, Kenya, Madagascar, Mauritius, Mozambique, Réunion (Fr.), Seychelles, South Africa, and Tanzania. SEACAM is designed to assist the many different stakeholders in the region striving to improve the management of coastal resources, including: Governments, local and international NGOs, donors, academics, communities and the private sector.

The Secretariat is hosted by the Ministry for Coordination of Environmental Affairs of Mozambique (MICOA). The Swedish International Development Cooperation Agency (Sida/SAREC) is the major international supporter of SEACAM.

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Introduction and overview

1. Aquaculture is one of the most dynamic sectors in the world economy, with an annual growth rate exceeding 10%. Although growth has been slower and more erratic in Africa, there is great potential, and parts of the continent have a comparative advantage in terms of climate and resources. It is therefore probable that aquaculture, and especially coastal aquaculture, will grow significantly in future years.

2. Although aquaculture compares well with many other development activities in terms of environmental impact, the over-rapid, unplanned, and unregulated development of the sector in some parts of the world (notably South and Southeast Asia and South America) has led to locally serious cumulative environmental impacts. Careful and strategic use of environmental assessment in its various forms should help prevent these problems occurring. Africa is fortunate in that it can draw on the experience and lessons from other parts of the world, where too often the undoubted benefits of coastal aquaculture development have been tainted by negative social and environmental impacts. It can also draw on the wealth of experience from around the world in the application of different environmental assessment methods and tools, and the use of a wide range of mitigation measures that can greatly reduce the potential environmental impacts of aquaculture.

3. Many African countries have already committed themselves in principle to the use of EA for development activities in the coastal zone. It is important that EA does not become a routine bureaucratic exercise, but rather is developed as a tool to facilitate and promote more sustainable aquaculture development. In order to minimize duplication and cost, and ensure consistency in assessment, sector level EA should be used to define the requirements and standards for farm or project level EIA, and as a means to address the cumulative problems associated with large numbers of small scale aquaculture developments.

Values and principles

4. In 1993 by the Canadian Environmental Assessment Agency and the International Association of Impact Assessment launched an “International Study of the Effectiveness of Environmental Assessment” (ISEEA). It identified a series of core values, guiding principles, and operating principles. These are reproduced in full in section 2 of the guidelines.

5. EA can too easily become a cumbersome, routine, and ineffective set of bureaucratic procedures. It has often been lifted out of one context and applied inappropriately in another. By keeping these principles in mind, rather than focusing narrowly on specific procedures, the application of existing EA will be more flexible and cost-effective. These principles should also form a sound basis for the development of new or modified procedures applicable to particular sectors or development contexts.

Legal, policy and institutional context

6. EA cannot be effective as an isolated tool. If it is to be used to promote sustainable development and improve environmental management, and if the ISEEA principles are to be implemented, it must feed into a broader policy, planning, and regulatory framework. The lack of an adequate framework has been a significant constraint to the application of EA in many developing countries.

Developing and implementing environmental assessment systems

7. Section 4 of the guidelines discusses how environmental assessment systems and procedures can be initiated or improved in practice, specifically in relation to aquaculture. This will vary enormously from country to country, but some general principles and lessons learned from other countries are presented.

8. Particular emphasis is placed on the potential of (aquaculture) sector EA as an effective starting point for introducing or improving EA procedures, and ultimately as a building block for integrated coastal management.

9. The existence or setting of environmental quality standards is a precondition for effective EA, and an essential component of integrated coastal management. This can also serve as a practical starting point for improved procedures.

Overview of the environmental assessment process

10. Section 5 of the guidelines presents general guidance on the overall structure and process of EA, and the nature of the outputs, as it applies to aquaculture and other development types. It is strongly recommended that aquaculture sector EA be undertaken for the whole country, and preferably also in respect of important coastal systems. This should provide the basis for more efficient and effective project EIA if and when required. There is limited experience worldwide of sector EA to date.

11. The basic EIA process as applied to projects is now widely agreed. However, there are a variety of issues relating to best practice that are still the subject of intense debate. Although widely agreed as an essential part of the process, the scope and timing of public involvement is highly variable. The extent to which economic techniques can and should be used in EA also remains contentious.

Public involvement

12. It is widely accepted that EA should be open, transparent and democratic. Public involvement is seen as an essential component of EA by all major international organizations and development agencies.

13. The effective use of public involvement should shift the EA process from one of administration, regulation and document generation, to one which promotes more democratic decision making on issues affecting the quality of life, and which minimizes potential conflict, or resolves existing conflict.

14. Public involvement can be difficult, and requires great skill and sensitivity. Significant social conflict has been generated by coastal aquaculture development in Asian, and more recently African countries, and in some cases public involvement has actually increased conflict. Conflict is likely to be minimized if public involvement is used mainly as an input to sector EA so that objectives, general principles and guidelines can be agreed without reference to specific and potentially contentious individual projects. Once these are in place, the ground rules are known, and the likelihood of conflict arising over individual projects is lessened.

15. If, nonetheless conflict arises, a variety of conflict resolution techniques may be used to minimize the damage.

Screening

16. Screening is the process used to decide whether or not a policy, plan, programme or project requires environmental assessment, and if so, at what level. Screening depends either on a subjective decision by an administrator, or (more usually) checking of a proposal against a set of standard criteria. These criteria may range from very general (such as “projects likely to cause potentially significant impacts”), to very specific (such as scale, location, type of activity, technology, relation to other resource users).

17. These criteria should be an output from sector environmental assessment. Where there is a strong environmental management framework, criteria can be made clearer and more explicit, and there will be less need for individual project EIA.

18. If there is uncertainty about a project in relation to the criteria, an initial environmental examination (IEE) or initial environmental assessment (IEA) may be required, and this may be subject to review by some form of advisory committee before decision is made about the need or otherwise for full EA.

19. Whatever criteria are used, it is important that they, and the screening procedures in general, should be widely known and understood, so that proponents can design to meet environmental standards, or locate in suitable areas, thereby minimizing costs to all parties, while maximizing environmental management benefits.

Scoping

20. Scoping is a process to identify and evaluate community and scientific concerns about a proposed policy, development plan, project or action, so that they can be addressed systematically in the EA. The output from scoping usually includes detailed terms of reference for further work.

21. Whereas in the past this was seen as a largely technical matter, it is increasingly seen as an important opportunity for public involvement in the decision making process. The use of improved techniques for the communication and exchange of information and opinion is therefore a vital part of scoping.

Assessing

22. Assessment is the core of EA, and involves identifying and defining more clearly the impacts that are to be investigated in detail, and analyzing these impacts in terms of their major characteristics and significance.

23. Assessing usually involves a range of techniques, from baseline data collection to modeling, and in some cases decision analysis.

24. Although many of the techniques are widely agreed, there is debate about the way in which different kinds of information (relating to social, environmental and economic impacts; or to impacts through time or space) can be presented or aggregated to provide an overall indication of impact significance or sustainability.

Mitigation and impact management

25. Since EA should be used more as a tool for improved environmental design and management, rather than as an administrative and regulatory procedure, the identification of

mitigation measures becomes paramount. There is enormous scope for mitigating the environmental effects of coastal aquaculture. This can be done at several different levels through:

- improved planning and regulation;
- improved infrastructure;
- improved siting (closely related to planning and regulation);
- improved design;
- higher quality inputs;
- improved input and waste management; and
- improved husbandry and water quality management.

26. These measures can be encouraged or enforced through a suite of incentives, constraints and regulations, which are themselves a form of mitigation at sector level. The whole package, or parts of it, may in turn be linked to quality or environmental management certification and/or product quality labeling initiatives.

27. Details of possible mitigation measures for coastal aquaculture can be found in the guidelines and appendices.

28. Public involvement and conflict resolution processes may contribute significantly to identifying and developing desirable or necessary mitigation measures.

Reviewing and decision making

29. Review of an EA report, and the process that generated it, is important to maintain standards and ensure neutrality, especially in respect of project EIA. It may also be used to provide a broader perspective on the issues raised, or a more specific perspective related to particular interest groups. In general terms it provides the additional information which decision makers may require in order to assess whether a proposal is acceptable (project EIA) or an environmental management plan for the sector desirable and feasible (sector EA).

30. The review process for project EIA should be clear and consistent, using standard criteria, for the sake of the proponent, the public, and the decision-makers. This is likely to result in improved quality EAs.

31. Decision making itself will depend heavily on the report and the review process. It is essential therefore that both are clear and transparent. Decision making itself is not a single action, but a series of incremental actions, and the final outcome will depend heavily on many of the early decisions and choices. The nature of these early decisions must be clearly stated in the EA report.

Monitoring

32. Effective monitoring and follow up actions are essential if EA is to become an effective tool for environmental management and the promotion of sustainable development. Without follow up, EA becomes a costly and bureaucratic exercise with little long-term impact.

33. Monitoring is required not only to ensure than mitigation and environmental management plans are implemented, but also to see whether they work, and whether the analysis of impacts was accurate. As noted in the section on assessment, impact analysis is extremely difficult and is unlikely to be accurate in the first instance. Only through monitoring, adaptation and evolution will effective environmental management strategies be developed.

Introduction and Overview

Aquaculture is one of the most dynamic sectors in the world economy, with an annual growth rate exceeding 10%. Although growth has been slower and more erratic in Africa, there is great potential, and parts of the continent have a comparative advantage in terms of climate and resources. It is therefore likely that aquaculture, and especially coastal aquaculture, will grow significantly in future years.

Although the environmental impacts from aquaculture are relatively limited compared with many other development activities, the over-rapid, unplanned, and unregulated development of the sector in some parts of the world (notably S and SE Asia and S America) has led to locally serious cumulative environmental impacts. Careful and strategic use of environmental assessment in its various forms should help prevent these problems occurring in Africa. In this sense Africa is fortunate in that it can draw on the experience and lessons from other parts of the world, where too often the undoubted benefits of coastal aquaculture development have been tainted by negative social and environmental impacts. It can also draw on the wealth of experience from around the world in the application of different environmental assessment methods and tools.

Many African countries have already committed themselves in principle to the use of EA for development activities in the coastal zone. It is important that EA does not become a routine bureaucratic exercise, but rather is developed as a tool to facilitate and promote more sustainable aquaculture development. In order to minimize duplication and cost, and ensure consistency in assessment, sector level EA should be used to define the requirements and standards for farm or project level EIA, and as a means to address the cumulative problems associated with large numbers of small scale aquaculture developments.

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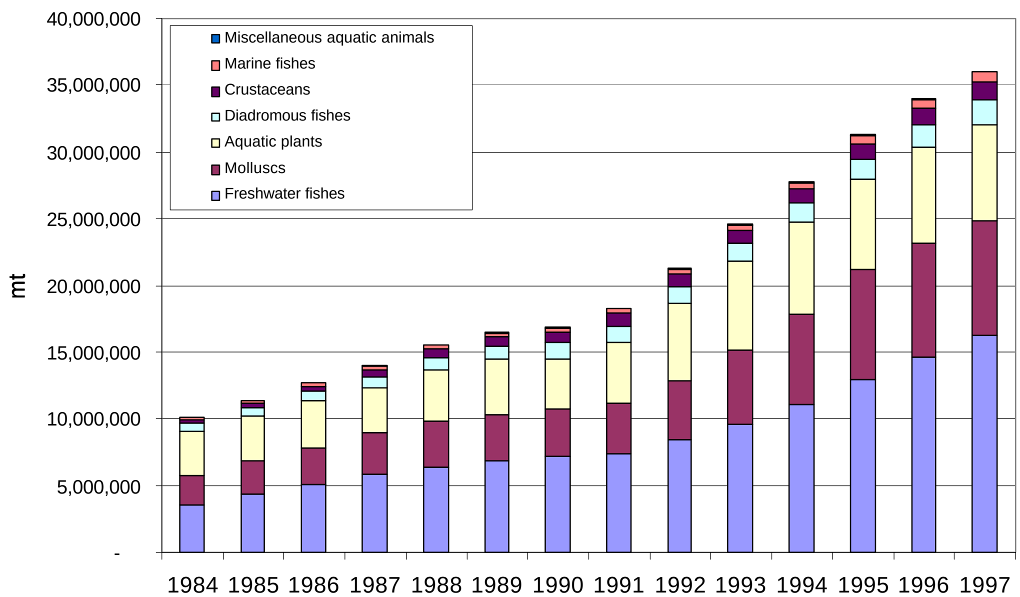
1 Introduction and Overview

1.1 Global perspective on coastal aquaculture

World Aquaculture production almost trebled in terms of production, and increased 3.5 fold in terms of value between 1984-1995. This corresponds to an average annual growth rate in production of 10% and in value of 12%, making aquaculture one of the most dynamic sectors in the world economy. There was significant expansion in all major categories.

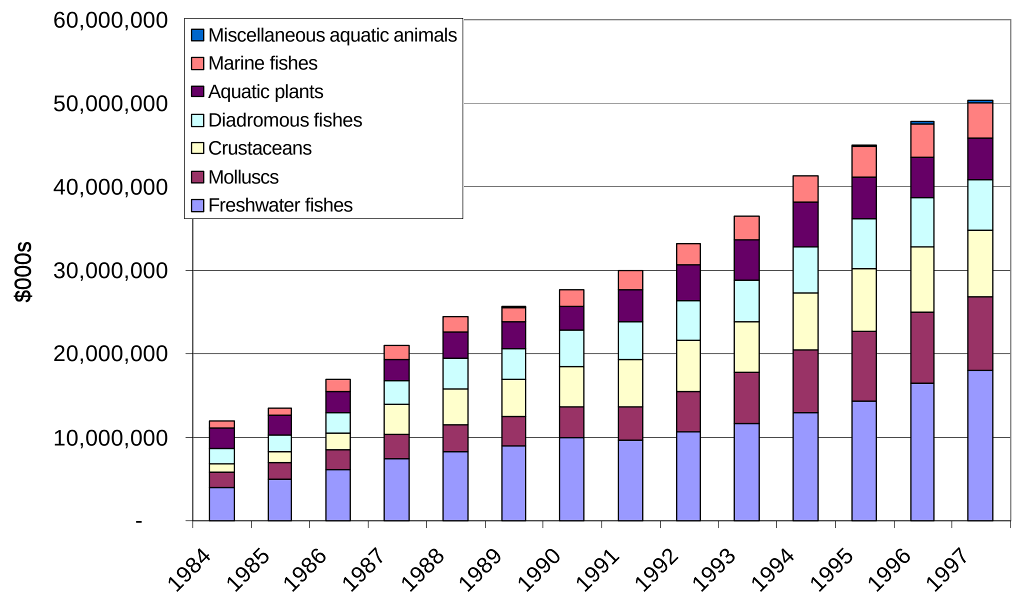
Figure 1.1
World Aquaculture Production Trends by Major Group (FAO)



Although representing a relatively small part of total fisheries production, farmed crustacean production (mainly shrimp) has increased very rapidly, and now represents a significant proportion of total production, and a higher proportion of total value. A large part of this increase has come from marine shrimp production in Asia. Between 1983 and 1988 the average annual growth rate of marine shrimp farming in Asia was 41%, and by 1990 reached 5% of volume of cultured organisms (including fresh-water) in the region. The proportion in terms of value was very much higher. World production is now close to 700,000MT.

Figure 1.2

Value of world aquaculture production



The success of shrimp farming is related mainly to:

- well established distribution and marketing systems in some countries (originally related to capture fisheries);
- high market value (US$5-10/kg farm gate price);
- short crop cycle (only 3-5 months for grow-out);
- the abundance of wild seed in some countries;
- the relative ease with which they can be spawned from wild broodstock;
- the ease of transportation of larvae;
- high tolerance of salinity variation and pond water quality during grow-out (especially *Penaeus monodon*); and
- adaptability to artificial diets.

Production of shrimp in Asia is now constrained by disease, shortage of wild broodstock, and in some cases the increasing scarcity of suitable sites. It is often associated with environmental degradation, and its impact on mangrove habitat has been of particular concern. While mangrove destruction and other environmental issues related to coastal aquaculture development is not yet a major concern in Africa, some problems have been identified in Cote d’Ivoire, the Gambia, Guinea Bissau, Madagascar, Mozambique and Senegal (King,1993).

Despite the disease problems in many countries, well sited and managed shrimp culture remains extremely profitable, even on a small scale. Market demand (which is truly international) remains strong, providing a major incentive for entry of new countries/regions into marine shrimp production.

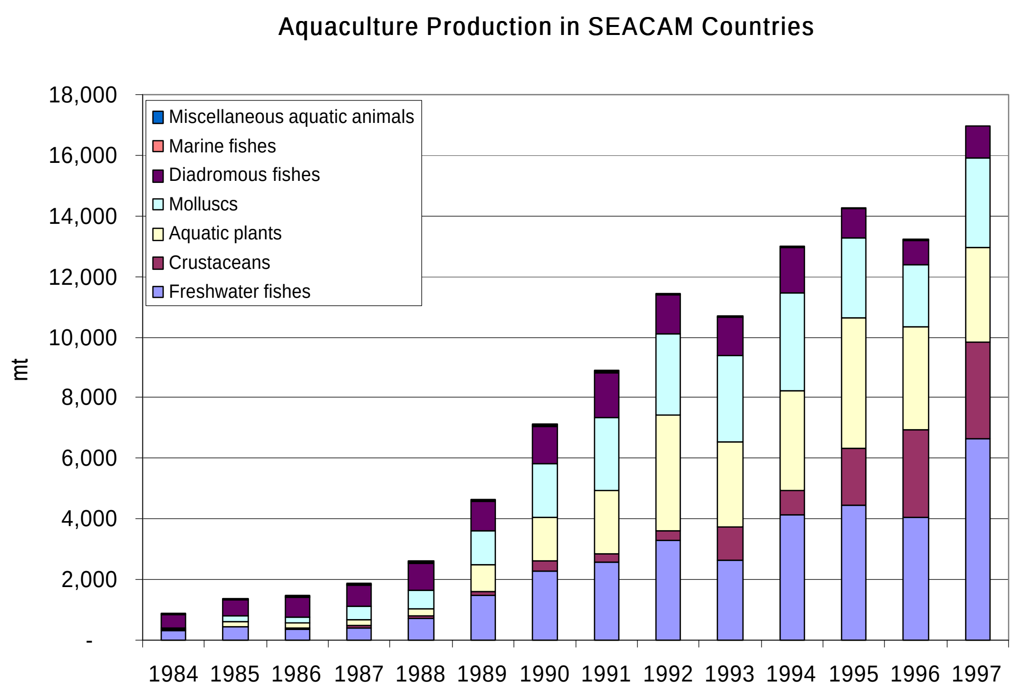
The culture of diadromous species (such as milkfish, salmon and seabass) has also increased very rapidly, and now amounts to more than 50% of production from capture fisheries. The culture of marine finfish on the other hand still contributes very little to total finfish production (capture and culture), although there is significant production of some high value species in Asian countries.

1.2 Coastal aquaculture in Eastern Africa

The growth of aquaculture production in Africa has been significantly less than in other parts of the world, and with some exceptions, production has been limited and erratic. Figure 1.3 provides an overview of trends in total aquaculture production in Eastern Africa, and figure 1.4 illustrates trends for some of the more significant coastal aquaculture activities in recent years. The most significant components at present are: Giant tiger prawn (*Penaeus monodon)* production in Madagascar, seaweed (*Euchema*) culture in Tanzania, and Mussel (*Mytilus galloprovincialis*) culture in South Africa

Culture of the seaweed *Euchema* began in Tanzania in the '80's, stimulated by support from both government and private sector. However growth has slowed in recent years related in part to market constraints. The culture of the mussel (*Mytilus galloprovincialis*) in S. Africa began in the mid '80s, and has shown erratic growth since. The greatest contribution to the value of aquaculture production in the region is from Tiger prawn (*Penaeus monodon*) production in Madagascar, where there has been significant investment in the planning and development of the industry in recent years. While the potential for shrimp culture has been recognized in several other countries, with significant proposals for shrimp farm development in Tanzania for example, development has been limited and erratic.

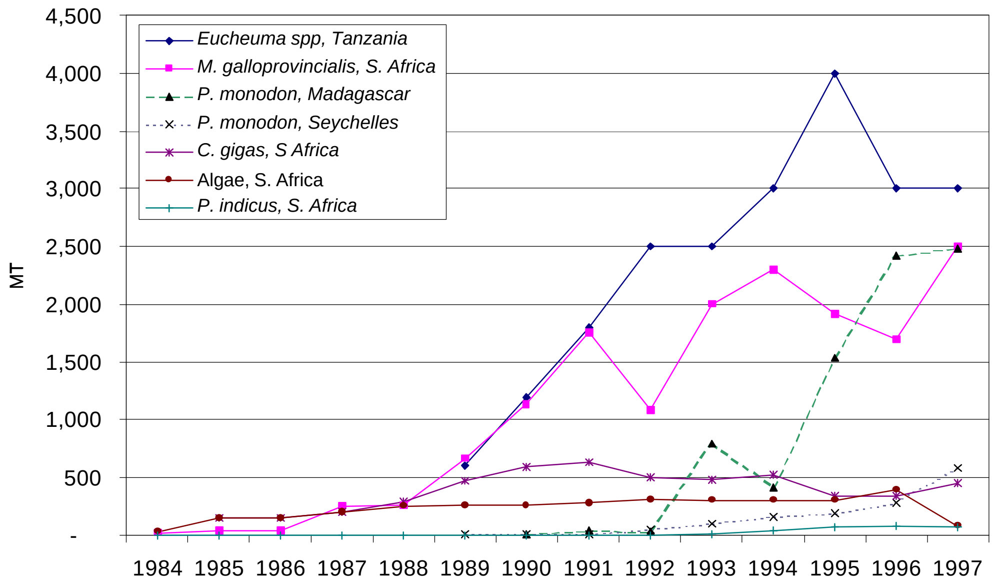
Figure 1.3



Data FAO

Figure 1.4

Significant mariculture activity in SEACAM countries



Data FAO

There has also been limited production of several other marine organisms including abalone, green turtle, *Chelonia mydas*, Carpet shell (*Tapes*), and *Mactra spp*. Giant freshwater prawn (*Macrobrachium rosenbergii),* although not strictly a coastal species, is similar in many ways to brackish-water prawn culture, and is a significant industry in Mauritius and Reunion.

Pedini (1998) has summarized the reasons for the erratic and limited development of aquaculture in Africa:

- poor macro-environment for development;
- limited financial resources;
- differences in expectations between host countries and donor organizations;
- “project dependent” development;
- the novelty and low priority accorded to aquaculture;
- frequent drought and water shortage;
- lack of cohesive aquaculture development plans;
- inconsistency between aquaculture development strategies and local needs and circumstances; and
- excessively “top down” approaches to aquaculture development.

It is probable also that the lack of market and distribution infrastructure is a major factor.

Despite the recession in the world economy, demand for high quality seafood products is likely to remain high, and continuing rapid growth of aquaculture may be anticipated. Given the disease problems now endemic to coastal aquaculture industry in Asia, and the increasing scarcity of high quality sites in those countries, Africa offers significant potential for future expansion. Effective development policies must therefore be put in place if the mistakes made in aquaculture development in other countries are to be avoided.

1.3 What is environmental assessment (EA)?

Environmental (Impact) Assessment (EA or EIA) is:

> *"the systematic, reproducible and interdisciplinary identification, prediction and evaluation, mitigation and management of impacts from a proposed development and its reasonable alternatives." UNEP (1996)*

The ***purpose*** of EA is to ensure that development proposals, activities, plans and programs are environmentally sound and sustainable. EA is a structured approach for obtaining and evaluating environmental information prior to its use in decision making in the development process. This information consists of predictions of how the environment is expected to change if certain alternative actions or policies are implemented, and advice on how best to manage environmental changes if one alternative is implemented. It may refer to individual physical actions, development projects, programmes, plans or policies. (modified from Bisset, 1996).

Increasingly, EA is considered as a ***management tool*** rather than as an administrative or regulatory process. In particular it may be used to:

- modify and improve the content or design of a policy, plan or proposal;
- ensure that resources are used efficiently;
- enhance the social aspects related to a proposal;
- identify measures for monitoring and managing impacts; and
- facilitate informed decision making, especially in relation to sustainability criteria.

1.4 History and evolution of EA

Environmental impact assessment procedures first evolved from the application of the US National Environmental Protection Act (NEPA) 1970. It spread rapidly to other countries in the late '70s and early '80s, and is now widely used and internationally recognized. There is a growing consensus on the main elements and procedures involved, but there remains considerable uncertainty about when and how it should be used.

In its original form the emphasis was on physical, chemical and ecological impacts of individual projects. In the late 70's and early 80's however, the scope expanded in many countries to include social and health impacts, and more comprehensive analysis of risk. Public involvement in the process was also increasingly emphasized. In terms of outputs and reporting, emphasis was placed on impact management.

By the mid to late 80's the importance of addressing cumulative effects was recognized, and ***Cumulative Environmental Assessment (CEA)*** became an important component in effective project level EIA. This is of particular relevance to agriculture and aquaculture projects where the impacts of an individual farm may be insignificant, but those associated with many small developments may be highly significant. The need to integrate the EA process with policy, planning and regulatory frameworks also began to be recognized. Monitoring, audit and other follow up procedures – or impact management planning – also became important elements in best practice EIA.

Unfortunately, there has been a continuing – and in many countries increasing - trend of resource degradation and loss of biodiversity. Despite international commitments, many kinds of development having significant impacts on the environment have either not been subject to EA, or their impacts (especially those of an incremental or cumulative nature) have not been easy to mitigate through existing EIA procedures.

Awareness of this continuing loss, and the need to address environmental issues at a broader development planning and policy level was a major stimulus to the development of the idea of ***sustainable development***, defined most succinctly in its original expression:

> *"Development that meets the needs of today's generation without compromising those of future generations"*
> (World Commission on Environment and Development 1987)

Partly in response to this, a "second generation" of EA procedures has developed which may be used to promote sustainable development. They include ***Integrated*** or ***Regional EA; Sector EA; Programmatic EA;*** and ***Strategic EA (SEA)*** which refers to EA of higher level policies. Together with project EIA and Cumulative EA these represent a comprehensive package of tools that can be applied at all levels – and hopefully in a coordinated way – from international trade agreements down to individual projects.

The main principles relating to best practice application of all these approaches may be summarized as follows:

- fully integrate physical, social, economic and environmental analyses within the EA process;
- integrate EA into the development policy and planning process at all levels (project, program, plan, policy, budget/fiscal measures, structural adjustment measures, trade agreements) as a tool for decision making and the promotion of sustainable development;
- introduce EA at the earliest possible

Box 1.1 The relevance of regional and sector EA to aquaculture

Like agriculture, most individual aquaculture projects are relatively small scale and have little significant impact on the environment. A large number of such developments can however have significant effects.

Traditional "project" EIA is inadequate to address these "cumulative" or "incremental" issues. They can be addressed in part through the use of cumulative environmental assessment (CEA) as part of project EIA. However, a useful practical response in the case of an individual project assessment is unlikely: it is administratively and legally difficult to limit one development on the basis that there may be others.

Furthermore, high quality EIA applied individually to a large number of small aquaculture developments is likely to be unacceptably costly. Sector EA, or regional EA incorporating the aquaculture sector, should be undertaken to adequately address these issues, if possible within a broader framework of integrated coastal management (ICM), or national policy level Strategic EA.

stage in policy, plan or project development, so that it can be used as a design tool rather than as a restriction;
- promote positive impacts as well as mitigate negative impacts;
- use EA as a framework for conflict resolution;
- encompass trans-boundary effects;
- effectively link EA to monitoring and environmental management.

Goodland (1995) noted the new opportunities presented by EA when applied to sector studies and project appraisal. In the past the "least economic cost" criteria was commonly used to rank projects. If EA can be effectively integrated into such studies, projects may be ranked according to least economic, social, and environmental cost, providing a basis for the selection of the most sustainable development options.

To date the practical implementation of these more advanced approaches has been limited, especially in developing countries, but the concept is receiving widespread support from Governments, NGOs, Agencies and Development Banks.

1.5 Relevance and importance for aquaculture development

Aquaculture is one of the fastest growing sectors of the world economy. It is one of the few activities offering real hope of significant poverty alleviation or elimination in the coastal zone, where land-less people are commonly marginalized, and where land quality is often poor and unsuitable for agriculture. However, the success and potential of aquaculture has often been tarnished by social and environmental problems including:

- direct and indirect resource and biodiversity degradation;
- resource use conflict;
- social disruption, including increases in inequity;
- catastrophic or chronic disease problems; and
- direct and indirect health impacts, particularly in relation to indiscriminate use of chemicals and antibiotics.

Strategic and project level EA, undertaken as key components of more integrated approaches to development planning and project appraisal, provide a feasible and practical framework for addressing these issues, and promoting sustainable aquaculture. They may also serve as a keystone in the further development of integrated coastal management (ICM).

1.6 International commitments to EA

The role and importance of EA was formally recognized at the United Nations Conference on Environment and Development held in Rio in 1992. Rio Principle 17 states:

> *"Environmental impact assessment, as a national instrument, shall be undertaken for proposed activities likely to have a significant adverse impact on the environment and are subject to a decision of a competent national authority".*

The commitment of African countries to this principle was reaffirmed in the communiqué issued by African Ministers and representatives at Durban, South Africa, June 24-25th 1995. They committed themselves to:

> *"formalize the use of EA within a legislative framework for development planning and decision making at the project, programme and policy levels"*

The need to take account of environmental impact specifically in relation to aquaculture development is recognized in Article 6.19 of the FAO Code of Conduct for Responsible Fisheries:

> *"States should consider aquaculture, including culture based fisheries, as a means to promote diversification of income and diet. In so doing, States should ensure that resources are used responsibly and adverse impacts on the environment, and on local communities are minimized."*

and Article 9.1.5 states:

> *"States should establish effective procedures specific to aquaculture to undertake appropriate environmental assessment and monitoring with the aim of minimizing adverse ecological changes and related economic and social consequences resulting from water extraction, land use, discharge of effluents, use of drugs and chemicals, and other aquaculture activities".*

Regarding shrimp aquaculture, at the FAO Bangkok Technical Consultation on Policies for Sustainable Shrimp Culture (FAO 1998) Government representatives from major shrimp farming countries[1] agreed that:

> *"Achievement of sustainable shrimp culture is dependent on effective government policy and regulatory actions as well as the cooperation of industry in utilizing sound technology in its planning, development and operations"*

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

> *"Considering the significance of appropriate national development planning for the sustainability of aquaculture, it was recommended that when States undertake strategic planning for national development, they should place aquaculture, including shrimp culture, within such plans".*

The UN Convention on Climate Change and Biological Diversity (1992) places further obligations on member countries in respect of EIA.

The World Bank, Asian Development Bank and International Development Aid agencies have all introduced and promoted EA as an important tool in development planning, feasibility studies, and project appraisal in recent years, and the World Bank in particular is promoting the more integrated and strategic approaches discussed above.

[1] Bangladesh, China, Ecuador, India, Indonesia, Malaysia, Mexico, Philippines, Sri Lanka, Thailand, USA, Vietnam

1.7 Costs and benefits

The costs and benefits of the application of EA to aquaculture have not been rigorously assessed, and evidence is limited, especially in Africa. However, the current problems associated with coastal aquaculture in developing countries which already implement some form of EA for aquaculture, suggest that it has not always been cost effective. The continuing emphasis on project level EIA, rather than sector or strategic EA, has almost certainly contributed to this failure.

Costs[2]

The World Bank notes that the cost of preparing an EA rarely exceeds one per cent of the project costs and even this relatively low cost can be reduced further if local personnel are used to do most of the work. For instance, an investigation of water resource projects in Thailand found that the costs of EIAs there ranged from 0.01 per cent to 0.11 per cent of the total project costs.

The costs of EA, if applied to large numbers of individual fish farms, may however represent a significant cost to a small producer and to the sector as a whole. This is one reason why a size “threshold” is set for EIA requirements for aquaculture in some countries in Asia (e.g. Malaysia, Indonesia). Unfortunately this allows the majority of aquaculture development to “escape” the EA system, and has resulted in widespread uncontrolled development in some Asian and S American countries. The solution to this problem is not to reduce the size threshold, but rather to apply sector EA, which allows the cost to be spread over a large number of developments, while at the same time addressing the cumulative and incremental problems noted above.

Although proponents sometimes complain that EIA causes delays in projects, these are often caused by poor administration of the process rather than by the process itself. These occur when:

- the EIA is commenced too late in the project cycle;
- the terms of reference are poorly drafted;.
- the EIA is not managed to a schedule;
- the EIA report is inadequate and needs to be upgraded; and
- there is a lack of technical data.

Adherence to the guidelines presented here should reduce the risks of these problems arising.

Furthermore, if there is a shift to sector EA, the need for individual project EIA should be reduced, since acceptable locations, type and scale of aquaculture activities would already have been defined.

There is no standard timeframe for the EA process. Most projects merely require screening and might take only an hour or two's work. An initial environmental examination (IEE) might take a day or more. For a medium sized aquaculture project the whole EIA process may take a few weeks to a few months, whereas for a large farm or

[2] This section is summarized from the UNEP EA training resource manual, with some additions relating to the specific case of aquaculture

sector plan the EA process could take significantly longer. Regional or strategic EA may be on-going, routinely undertaken for example as part of regular (e.g. 5 year) planning.

The costs and time involved in EA decrease once experience is gained with the process and the availability of baseline data is increased.

Benefits
The potential benefits from EA increase when the process commences early in the policy development or project design process.

In general the benefits of EA include:

1. Improved policies, programs, plans or regulations for promoting environmentally sustainable aquaculture. These can be developed or adapted in the light of sector EA to optimize the location of aquaculture activities in terms of productivity, minimizing self pollution, minimizing conflict between farms or with other resource users, and minimizing resource and biodiversity degradation. They may promote restrained and sustainable aquaculture development, avoiding the social, economic and environmental disruptions caused by boom and crash production cycles at individual farm or sector level.

2. More environmentally sustainable design or better siting of a farm or farms. Carrying out an EA entails an analysis of possible alternatives in the design and siting of projects. This results in an overall improvement in the general state of the environment and location of projects or activities. A well designed project can also minimize the risk of project-induced disease and the associated costs of treatment or compensation.

3. Savings in capital and operating costs. Costs can escalate if environmental problems have not been considered at the beginning and require correction later. This may involve adopting expensive mitigation measures, or reducing the size or output of the project. The chances of expensive late changes can be minimized by carrying out EA at the earliest stages of the project cycle. The costs to the aquaculture industry of poor planning, siting, design and management (resulting in self pollution and disease) are well known, and amount to billions of dollars worldwide.

4. Reduced time and costs of approvals of development applications. If all environmental concerns have been taken into account before submission for project approval, then it is unlikely that delays will occur. Again, this particularly the case if sector EA has been undertaken.

5. Increased project acceptance by the public. This is achieved by public involvement throughout the process. Many of the social problems, which have arisen in relation to some of the larger shrimp farming projects in S and Central America and Asia, might have been avoided with adequate and carefully planned public involvement.

1.8 EA practice and experience in Eastern Africa

There are rather few objective studies of the application and value of EA procedures in Africa. An exception is the study by IIED (Mwalyoshi and Hughes 1998) of the application of EA in Tanzania. This concludes that EA has had little impact on decision making in Tanzania. The following limitations were identified:

- usually started late in project development;
- under-resourced;
- limited stakeholder involvement;
- output, rather than process orientated;
- limited input to design or location issues;
- limited identification, costing and integration of environmental management into project design;
- poor definition of compliance responsibilities;
- EIA seen as an impediment to development; and
- limited monitoring or audit.

Although EA procedures are allowed for in the legislation of most African countries, experience of their application to aquaculture is limited. This reflects the generally undeveloped status of aquaculture, and the small scale of most individual developments. However EIA procedures have been applied to two shrimp farm projects in Tanzania in recent years. The first was an Initial EA, undertaken for a potential sponsor (NORAD) relating to a medium scale (160ha) shrimp farm on the Ruvu river near Bagamoyo. The second related to a large shrimp farm in the Rufiji Delta, also in Tanzania. The latter was a comprehensive project EIA. It was specifically highlighted in the Mwalyoshi and Hughes study, as a case of an EIA that led to intense public debate – a clear example of "public involvement".

These examples are instructive since the process and outcome was very different in the two cases. In the first case, funding had been sought from NORAD for a moderate scale shrimp farm development sited on the landward fringe of the mangrove of the Ruvu river estuary. NORAD required an initial EA using their own guidelines (NORAD 1992), which was undertaken by foreign consultants (AIT, Thailand). Though few serious impacts were identified in relation to the project itself, the IEA report pointed out the dangers of associated cumulative development, and the lack of an appropriate coastal planning framework to address these issues. NORAD did not support the project, and it has not materialized. In the second case a much more comprehensive EIA was undertaken, including public meetings, which led to both local and international debate. The project was finally approved amid considerable controversy. These examples are used to illustrate particular aspects of aquaculture EA at various points in the guidelines, and form the basis for a more detailed case study (Appendix 1).

Madagascar is the only country in the SEACAM region which has undertaken a sector EA focussing in particular on shrimp culture, which has led to a set of clear guidelines and procedures for the assessment and development of the industry. The framework and approach used in Madagascar is presented and discussed in Appendix 2.

1.9 International experience of the application of EA to aquaculture

EA procedures relating to aquaculture are extremely varied throughout the world, and even vary significantly between states in federally organized countries. The main approaches may be summarized as follows:

- EIA not required for aquaculture projects (e.g. Thailand);
- full EIA not legally required, but specific forms of information and consultation required with environmental agencies or other interests prior to aquaculture development approval (marine cage culture in Scotland);
- aquaculture projects “screened” to determine need for EIA (e.g. Tanzania);
- initial environmental examination (IEE) required as input to screening (e.g. Sri Lanka, Indonesia, Philippines);
- EIA required for aquaculture above a certain scale (e.g. Malaysia 50ha; India 40ha);
- EIA required for aquaculture in “environmentally sensitive areas” (e.g. Indonesia, UK);
- EIA required for farms above a certain scale and located in environmentally sensitive areas (e.g. Sri Lanka, 5ha; Malaysia, 50ha (mangrove));
- EIA normally required for all coastal aquaculture (e.g. Australia; USA; many European countries);
- EA undertaken for aquaculture sector leading to the establishment of a planning and regulatory framework for individual farms (e.g. Hong Kong, Tasmania, Norway).

In practice most countries operate a mix of these approaches. Some examples are provided in Appendix 2.

In developing countries, these different approaches have met with only limited success in terms of promoting sustainable aquaculture development. For example, both Sri Lanka and Indonesia, which have reasonably comprehensive sector specific legislation including well defined EIA procedures, have experienced serious local environmental degradation and industry crashes related to disease (see Case Study 2). Current procedures would appear to be inadequate to meet the challenge of the rapid and unplanned development of a highly profitable industry such as shrimp farming. The biggest problem probably relates to the nature of most aquaculture development. Fish farms are usually far too small to be subject to individual project environmental assessment. In the absence of broader sector EA, aquaculture development commonly escapes the "EIA net". Furthermore, even when high quality EIA is undertaken for larger enterprises, follow through, in terms of environmental management, monitoring, and ensuring compliance is usually limited. Some developed countries operate comprehensive monitoring and follow up to ensure compliance, or in some cases to assess suitability and effectiveness of any discharge or management conditions set (e.g. Australia).

Overall, procedures appear to have worked rather better in developed countries, but this may be related to larger scale operations, and lower overall pressure for development.

Values and Principles

Summary

In 1993 the Canadian Environmental Assessment Agency and the International Association of Impact Assessment launched an “International Study of the Effectiveness of Environmental Assessment” (Sadler 1996). It identified a series of core values, guiding principles, and operating principles. These are reproduced in full in this section.

EA can too easily become a cumbersome, routine, and ineffective set of bureaucratic procedures. It has often been lifted out of one context and applied inappropriately in another. By keeping the following principles in mind, rather than focusing narrowly on specific procedures, the application of existing EA will be more flexible and cost-effective. These principles should also form a sound basis for the development of new or modified procedures applicable to particular sectors or development contexts.

At the end of this section some important general conditions and requirements for effective EA are summarized.

Contents

2 Values and Principles

2.1 Core values

1. *sustainability* - the EIA process will result in environmental safeguards;
2. *integrity* - the EIA process will conform to agreed standards;
3. *utility* - the EIA process will provide balanced, credible information for decision-making.

2.2 Guiding principles

1. *participation* - appropriate and timely access to the process for all interested parties;
2. *transparency* - all assessment decisions, and their basis, should be open and accessible;
3. *certainty* - the process and timing of assessment should be agreed in advance and followed by all participants;
4. *accountability* - decision-makers are responsible to all parties for their actions and decisions under the assessment process;
5. *credibility* - assessments are undertaken with professionalism and objectivity;
6. *cost-effectiveness* - the assessment process and its outcomes will ensure environmental protection at the least cost to society;
7. *flexibility* - the assessment process should be able to adapt to deal efficiently and effectively with any proposal or decision-making situation;
8. *practicality* - the information and outputs provided by the assessment process are readily usable in decision-making and planning.

2.3 Operating principles

EIA should be applied:

1. to all development project activities likely to cause potentially significant adverse impacts, or add to actual or potentially foreseeable cumulative effects;
2. as a primary instrument for environmental management to ensure that impacts of development are minimized, avoided or rehabilitated;
3. so that the scope of review is consistent with the nature of the project or activity and commensurate with the likely issues and impacts;
4. on the basis of well defined roles, rules and responsibilities for key actors.

EIA should be undertaken:

5. throughout the project cycle, beginning as early as possible in the concept design phase;

6. with clear reference to the requirements for project authorization and follow-up, including impact management;
7. consistent with the application of 'best practicable' science and mitigation technology;
8. in accordance with established procedures and project-specific terms of reference, including agreed timelines;
9. to provide meaningful public consultation with communities, groups and parties directly affected by, or with an interest in, the project and/or its environmental impacts.

EIA should address, wherever necessary or appropriate:

10. all related and relevant factors, including social and health risks and impacts;
11. cumulative and long-term, large-scale effects;
12. design, locational and technological alternatives to the proposal being assessed;
13. sustainability considerations including resource productivity, assimilative capacity and biological diversity.

EIA should result in:

14. accurate and appropriate information as to the nature, likely magnitude and significance of potential effects, risks and consequences of a proposed undertaking and alternatives to it;
15. the preparation of an impact statement or report that presents this information in a clear, understandable and relevant form for decision-making, including reference to qualifications, confidence limits in the predictions made;
16. ongoing problem solving and conflict resolution to the extent possible during the application of the process.

EIA should provide the basis for:

17. environmentally sound decision-making in which terms and conditions are clearly specified and enforced;
18. the design, planning and construction of acceptable development projects that meet environmental standards and resource management objectives;
19. an appropriate follow-up process with requirements for monitoring, management, audit and evaluation that are based on the significance of potential effects, the uncertainty associated with prediction and mitigation, and the opportunity for making future improvements in project design or process application.

(Sadler 1996)

2.4 Key requirements

Although the application of these values and principles should be flexible according to sector or local conditions, several key requirements have been identified for effective EA systems (Bisset 1996):

- a legal base with accompanying regulations and guidelines;
- stakeholder involvement;
- high level political commitment;

- technical capacity;
- formal review of EA reports;
- mechanisms to encourage accountability of decision makers;
- a clearly defined role for an environmental agency.

2.5 Comment

The values and principles set out above were discussed in detail at the training course held in Dar Es Salaam in June 1999. The participants agreed with all the values and principles. However, it was felt that “neutrality” or “impartiality” should be included as a core value or guiding principle.

This has implications for the way in which EIA is commissioned. The cost of EIA is traditionally born by the developer, and it is therefore the developer who typically commissions the EIA. This may compromise the principle of neutrality. Countries should therefore examine ways in which EIA can be commissioned by an independent agency, while still ensuring that the full cost is born by the developer.

The participants also noted the difficulty of reconciling some of the principles. Participation, transparency, and credibility all cost a great deal of money, and may be difficult to reconcile with minimal or acceptable cost to society. Possible ways to get around these problems are discussed in the next two sections.

Legal, Policy and Institutional Context

EA cannot be effective as an isolated tool. If it is to be used to promote sustainable development and improve environmental management, and if the principles described in the previous section are to be implemented, it must feed into a broader policy, planning, and regulatory framework.

The lack of an adequate framework has been a significant constraint to the application of EA in many developing countries.

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3 Legal, Policy and Institutional Framework

3.1 The need for a framework

Project or farm level EIA of aquaculture, in the absence of a broader legal, policy, planning or institutional framework, is unlikely to result in sustainability for the sector as a whole, nor will it address many of the principles listed in section 2. This has been a significant weakness in the application of EIA for aquaculture in many countries.

- A **legal framework** is required to allocate specific responsibility and accountability, as well as provide a broad policy framework for the development of more specific policies and plans relating to particular regions or sectors;
- A **planning framework** is required to take account of locational, cumulative, and strategic development issues; and to define development objectives, economic and environmental standards and targets, and decision criteria;
- A **regulatory framework** is required to prescribe and enforce specific operating or environmental standards;
- **An institutional framework** is required to develop policies and plans, to ensure compliance with regulations, and to monitor, review and adapt policies, plans and regulations in the light of experience.

Without such a context the findings of any EA will have little meaning, decision criteria will be inconsistent, and mechanisms for ensuring compliance with any recommendations will be lacking. In particular, there will be no mechanism for addressing cumulative and incremental environmental issues, which are a basic characteristic of agriculture and aquaculture developments.

For example, cumulative EA may be undertaken in respect of a particular project, and may identify impacts which are insignificant when considered in isolation, but which may cause problems when “added” to other existing or possible future developments in the area. However, since these are not directly attributable to the development being considered, mitigation is hard to prescribe, and an appropriate regulatory response is unclear. It is hard to refuse authorization to a project on the basis that, if there were many more such projects, there could be environmental problems. If on the other hand, authorization is refused, this may limit development, rather than promote sustainable development. Box 3.1 provides a specific example of this dilemma, and the lack of a satisfactory solution in the absence of a broader planning or policy framework.

This problem should be solved in part through the application of Sector or Regional EA. The mitigation measures prescribed for the sector or region should encompass an adequate response to cumulative or incremental impacts. This might include zoning for different activities, and/or an overall ceiling on the number of developments, the total production from an area, or the total acceptable nutrient load. In all these cases some form of consistent overall framework is required.

Box 3.1: 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 shrimp farm on a 600 ha site on the south side of the Ruvu river, about 5km from the sea, near Bagamoyo, Tanzania. Initially 160 ha of ponds were to be developed, with an estimated production of around 500mt per year. 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 which was undertaken by AIT, Thailand (AIT 1995), using the NORAD (1992) Guidelines. The EIA report discussed and summarized all the major impact issues, and proposed a comprehensive set of mitigation measures, covering design, technology and management. 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 realizing 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.

3.2 International recognition of the need for a legal framework for EA of aquaculture

The importance of legal, procedural and planning frameworks designed to facilitate sustainable aquaculture development is emphasized in the FAO Code of Conduct for Responsible Fisheries:

> *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 recognized by all those countries that have become significant producers of farmed shrimp. At the FAO Technical Consultation on Policies for Sustainable Shrimp Culture 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."*

A variety of recommendations are presented in the FAO technical consultation report for the content of an appropriate legal framework, including provisions for EA, and a further technical consultation on the issue is planned.

3.3 Frameworks in practice

There will be a range of possible approaches depending on existing laws, traditions, and institutional structures. For example, the legal and institutional framework could be built up around:

- specific EA legislation;
- sector planning;
- regional or district planning;
- watershed or coastal zone planning and management.

The key point is to develop or adapt a system that allows for the comprehensive application of the principles set out in section 2. It may also be worth introducing *guidelines* prior to specific legislation as a means of testing out different approaches.

3.3.1 Ideal frameworks

The ideal is perhaps a "tiered" system (sometimes known as a "planning cascade") incorporating an appropriate form of EA at each level. An idealized framework applicable to aquaculture and other coastal activities is presented in Figure 3.1. Several "real world" examples are described in more detail in Appendix 2.

The framework presented in Figure 3.1 assumes a vertically and horizontally integrated planning and assessment framework. Broad national level policies define the scope, power, and responsibilities for lower level planning and assessment initiatives relating to aquaculture, coastal, or aquatic resources. These more local initiatives (perhaps 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, and be progressively adapted and refined, with the overall objective of promoting or facilitating sustainable development, and/or constraining or preventing unsustainable development. Broad frameworks of this kind would go a long way toward meeting the principles presented in section 2.

3.3.2 Sector Environmental Assessment

In practice the level of vertical and horizontal integration required in these "ideal" systems may be difficult or impossible to achieve in many development contexts. Sector EA, associated with sector plans for a particular administrative unit (such as a district) or aquatic resource system (such as a bay or estuary), may be a more realistic objective, and more effective in the short term. This is of particular importance when addressing the sometimes rapid development of aquaculture. The process of sector or regional EA should define environmental standards, possible zones (suitable areas for aquaculture development), and criteria for the assessment of individual projects. A sector EA for the mariculture industry in Hong Kong provides an example of such an approach (Box 3.2). To a large degree such approaches should remove the necessity for project EIA on all but a few exceptional projects. Ideally sector EA would then "nest" within, and form the building blocks or stimulus for broader integrated coastal management initiatives.

Sector EA for aquaculture is probably essential if the values and principles presented in the previous section are to be applied in practice in a cost effective way.

3.4 Environmental agency

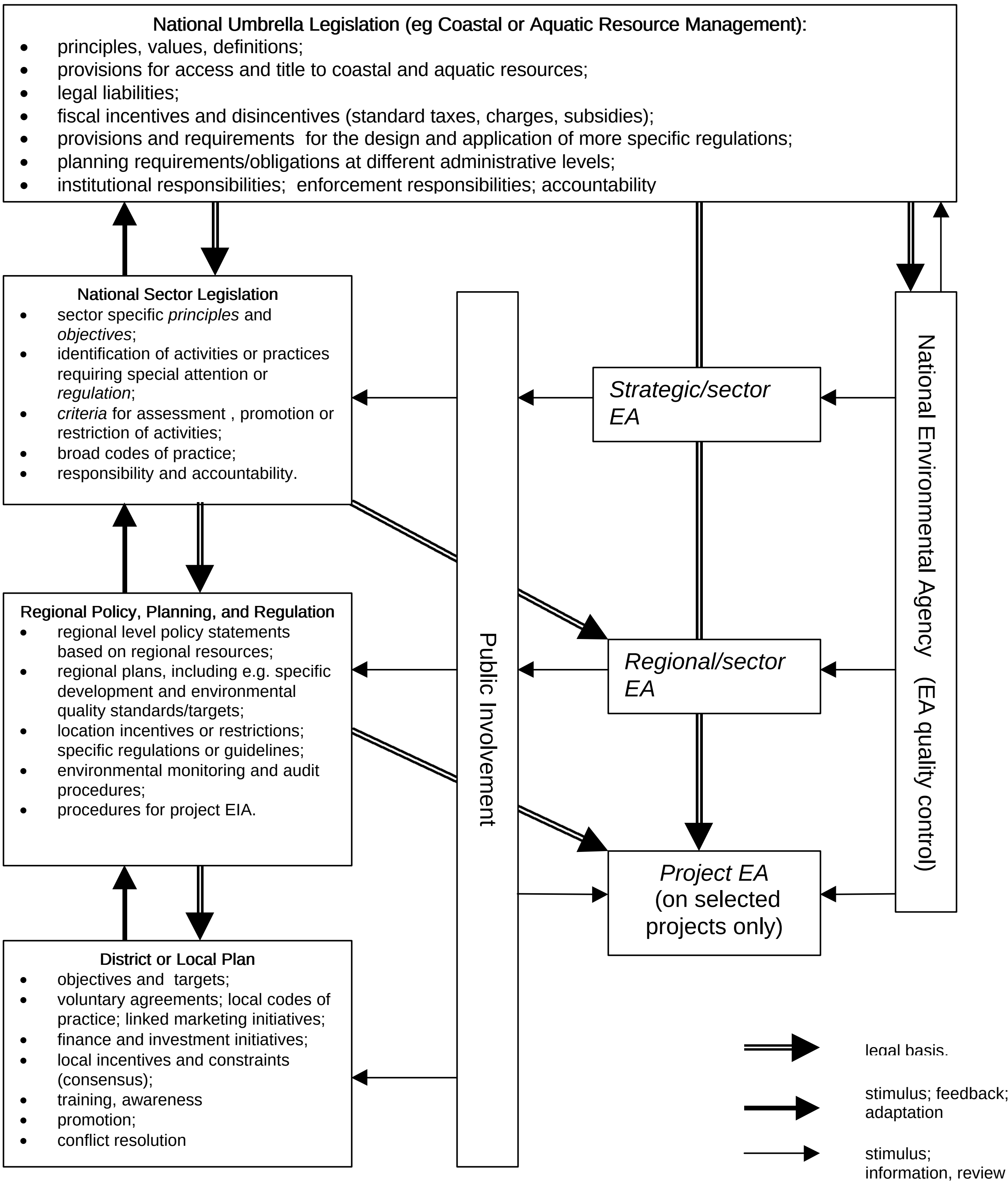
Several analysts suggest that the existence of an ***environmental agency*** may be an important component in any framework for the application of effective EA. The role of such an agency might include the following:

- approval of TOR;
- implementation of stakeholder involvement, including formal public hearings on draft/final EIA reports;
- review of EIA quality;
- making a recommendation, or issuing an environmental approval/decision document (though this perhaps role for another agency – eg local government);
- control over environmental management audit procedures;
- development of standards and guidelines.

(modified after Bisset 1996)

An environmental agency can play a key role in ensuring the neutrality and quality of any EA.

Figure 3.1 Model legal and institutional framework for effective EA of aquaculture



Box 3.2. Sector EA of aquaculture: the case of Hong Kong

The rearing of high value marine finfish (grouper, seabream etc) in net cages was a growth industry in Hong Kong from 1970 to1990. The government designated 28 mariculture zones under a Marine Fish Culture Ordinance in 1982, and in 1990 there were 1,770 licensed operators, and the industry supported directly and indirectly about 6,000 people. The production of fish in 1989 was 3,020MT with sales of around US$24m.

As marine cage farming developed in Hong Kong, impacts from people and animals residing on rafts, litter and debris affecting coastal areas, and the release of nutrients and organic matter from fish cages became of increasing concern. In response the Environment Protection Department of the Government of Hong Kong undertook a sector environmental assessment (EA) of the marine cage farming industry in 1990.

The EA quantified pollutant loads from the marine cages and made recommendations on the future environmental management of the industry. Particular attention was given to impacts of solid organic wastes on benthic communities, effects of release of soluble nitrogen on phytoplankton production, eutrophication and visual impacts. The study concluded that impacts of marine cage farming were fairly localized and that "there is a place for cage fish farming in the overall utilization of Hong Kong's coastal waters". It concluded that the concerns raised were mainly a result of:

(a) designation of some mariculture zones which were unsuitable because of their limited environmental capacity;
(b) lack of compliance by farmers with certain components of the Marine Fish Culture Ordinance (particularly those relating to visual impacts); and
(c) inefficient fish husbandry leading to pollution from feed wastage and dead fish.

The EA recommended further stepping of enforcement of the Marine Fish Culture Ordinance to reduce visual impacts, and introduction of improved fish feed management practices to reduce wastage. It further suggested relocation of marine cage farmers from certain aquaculture zones (with limited environmental capacity) to more open water sites.

The Hong Kong government subsequently initiated a programme to replace the widely used minced 'trash fish', which has a high pollutant load, with a low polluting moist diet, which by 1997 was being used by an increasing number of farmers. There has also been experimental work on 'offshore' cages which can be located in more open waters with high environmental capacity.

However, implementation of the recommended management strategies were not successful in protecting the cage culture from the phytplankton blooms which caused serious losses to the marine cage industry in early 1998. These blooms were probably caused by a wide range of factors (rather than aquaculture itself), and this highlights the need to incorporate the environmental management of aquaculture within broader coastal environmental management initiatives.

Developing and Implementing Environmental Assessment Systems

This section discusses how environmental assessment systems and procedures can be initiated or improved, specifically in relation to aquaculture. This will vary enormously from country to country, but some general principles and lessons learned from other countries are presented.

Particular emphasis is placed on the potential of aquaculture sector EA as an effective starting point for introducing or improving EA procedures, and ultimately as a building block for integrated coastal management.

The existence or setting of environmental quality standards is a precondition for effective EA, and an essential component of integrated coastal management. This can also serve as a practical starting point for improved procedures.

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4 Developing and Implementing Environmental Assessment Systems

The introduction of efficient and effective environmental assessment for aquaculture will vary tremendously between countries depending on existing policies, laws, institutions, procedures, and attitudes to environmental issues. There is no simple formula. There are however some general principles that may be applied, useful approaches to developing procedures, and several examples to draw on.

4.1 Building on existing procedures

The introduction of any new set of procedures is often disruptive, may involve extra work, may compromise existing power relations, and may be resisted by (or conversely taken over by) vested interests. While completely new institutions or responsibilities may be necessary in the long term, especially if integrated coastal management is the ultimate objective, it is usually wise to begin with what is available and possible within the existing order.

In most countries, some provision for environmental assessment of aquaculture already exists. In the case of South Africa (Box 4.1) national policy and legislation specifically provides for EIA for “commercial scale operations”. However, this particular framework appears to allow for considerable flexibility of interpretation, as well as significant discretion on the part of “the minister”. In this case, the various stakeholders should be able to influence the way these provisions are implemented to a significant degree.

> Box 4.1: The statutory basis for EIA in South Africa
> (after Cowley et al 1998)
>
> *Marine Fisheries Policy*:
> - Development of mariculture operations will be encouraged within the limits of relevant appropriate environmental regulations;
> - Mariculture research and the development of expertise will be a national effort, and will be promoted by the State as well as by the private sector;
> - The introduction of foreign species will be controlled and care will be taken over possible environmental effects, particularly with respect to any resulting impacts on indigenous stocks;
> - A full environmental, economic and social impact study will be carried out prior to the establishment of any commercial scale operations;
> - The problems of the effect of pollution, or from, mariculture will be addressed.
>
> *Marine Living Resources Bill*
> - No person shall engage in mariculture unless a right to engage in such activity has been granted to such person;
> - An application to engage in mariculture shall be submitted to the Minister in the manner that the minister may determine;
> - The minister may require an environmental impact assessment report to be submitted by the applicant;
> - The right to engage in mariculture may be granted for the period that the minister may determine

The question is, should it be improved, and if so, how? Some suggestions as to how to improve existing systems are presented in the following sections.

4.2 Minimizing bureaucracy, duplication and cost of EA

If EIA is to be done thoroughly, and if the principles and values outlined in section 2 are to be applied, then EIA will be a long, complex, and difficult process. It must cover social as well as environmental issues; it should be integrated with engineering design, feasibility studies, and investment appraisal; it should involve extensive public consultation and participation; it will require monitoring and in some cases enforcement. In practice, if this is applied to individual initiatives or projects, it may cripple both the bureaucracy and the development process. It may loose credibility.

There are three possible solutions to this problem:

1. a scale criterion, so that only larger projects are subject to full EIA, or which provides for different levels of assessment according to scale or type (this is relatively common approach and is a simple form of screening, described in more detail in section 7);
2. more sophisticated screening processes, usually associated with location and operational guidelines, so that only those projects likely to have a significant impact are subject to full EIA (this process is also described in detail in section 7);
3. an aquaculture sector plan, which defines clearly where coastal aquaculture development, of particular types is acceptable, at what scale or density, and under what conditions (including, *in some cases*, a requirement for full project EIA).

The first of these is a blunt instrument, which takes no account of the likely cumulative impacts of aquaculture development, including numerous small-scale developments, which have caused significant environmental damage in many parts of the world. Furthermore, it may lead to significant duplication of effort, since each new project which meets the scale criterion will require its own full scale independent EIA, and many of the issues addressed will be similar in each case. This approach is therefore likely to be costly, potentially contentious, and ineffective in the absence of a broader planning and management framework.

The second of approach is likely to be inconsistent and ad hoc, unless based on clear guidelines or criteria. Defining such criteria implies some form of sector environmental assessment.

The third approach, if its objective were to promote sustainable aquaculture development, would require a sector environmental assessment as a key component in its development.

The second two approaches have many advantages including:

- minimal duplication of effort: the major issues which are likely to arise in relation to more specific projects are dealt with once (initially) and clear broadly agreed procedures for addressing these issues, coupled with necessary decision criteria are developed;
- public involvement and participation can be thorough, across a broad range of issues, and strategic approaches to development agreed;

- developers will have a much better idea of what is possible, and what decision criteria or conditions will be applied;
- sector EA would also identify institutional and regulatory needs for the environmental management of the industry as a whole;
- the process of aquaculture sector EA, if undertaken properly, would in itself be a major step toward, and building block for, more comprehensive integrated coastal management.

It is instructive to consider the current situation in Tanzania in this regard (box 4.2, Appendix 1 and Appendix 2). The Tanzania Coastal Management Partnership identified several shortcomings in the existing procedures for EIA. In particular, the document notes that:

> *"Local communities play an important role in regulating mariculture development because site allocations should be decided at local level. In practice, most decisions on investment projects are made outside of the local community, which often leads to conflicts. On the other hand, consultation at the local level is time consuming, and approval by district and regional authorities can be frustrating due to contradictory and overlapping policies, regulations and legislation".*

The document also points out the lack of transparency relating to land rights. In order to address many of these difficulties the Investment Promotion Centre is delegated responsibility for facilitating and coordinating decision-making – a "one stop shop". Unfortunately, while such an approach should facilitate investment, it is unpredictable and ad hoc, lacks transparency, and does not meet the principle of local participation in decision making.

Thorough sector EA should help resolve these problems by reducing duplication of effort while at the same time promoting maximum public involvement.

4.3 Sector EA as a starting point

In many countries of Africa environmental procedures are either not in place, or their application is unsatisfactory in one form or another. Change may be required in policy, legislation, institutions and procedures.

Aquaculture sector environmental assessment can be an important first step toward improving procedures. This can be undertaken by a project, by the sectoral agency (e.g. the Department of Fisheries) by a government agency or department responsible for environment, or by local government. Of these the least desirable is usually a project, since this is by definition short term, and likely to lie outside mainstream government procedures and activities. Some form of project may nonetheless support a government initiative (see financing below).

The sector EA should follow the basic procedures and structure set out in sections 5-12. The output of a sector EA would be a range of proposals for mitigating the potential environmental impacts of the sector, and might range from zoning proposals to regulations and financial incentives. It would also present proposals for approval procedures, including guidelines for screening and the application of project EIA. It could also serve as the basis for the development of an aquaculture development plan (see

GESAMP 1999), and would represent a major contribution to any integrated coastal management initiative. The process of assessing the impacts and defining the mitigation measures would inevitably require significant liaison between different government and stakeholder interests and would serve to initiate a broader move toward more integrated management.

There are many advantages of using this approach as a starting point for regional environmental assessment and full blown integrated coastal management. It is:

- more modest and manageable in scope than regional EA or ICM;
- it has a clear sectoral focus and responsibility, while still promoting the ideal of integration;
- it should provide thorough technical and scientific foundation for improved policy and planning, while at the same time introducing the more participatory approaches required in dealing with social and environmental issues;
- it requires little immediate change (most sectoral agencies or local government will have a remit to undertake such studies) , but the process is likely to lead to a demand for some change, and a wider recognition of the need for more integrated coastal management;
- the outputs are clear and practical.

> **Box 4.2: Sector EA as the starting point for policy development:**
> ***the Case of Tanzania***
>
> The following *needs* in terms of policy development were identified in the Tanzania Mariculture Issue Profile produced by the Tanzania Coastal Management Partnership (1998):
>
> "The various sectoral policies relating to mariculture must be harmonized and integrated into a single statement. There are gaps in the various sectoral policies and regulations where concerns related to mariculture are not addressed. New policies and regulations are needed to cover these areas. Priority areas are:
>
> - permitting procedures;
> - procedures governing access to land and water tenure;
> - water use regulations;
> - water quality control and standards;
> - monitoring guidelines and procedures;
> - licenses addressing operational issues that affect environmental quality;
> - strict enforcement of existing laws and regulations;
> - provision of oversight for the permitting process
>
> A thorough coastal aquaculture sector environmental assessment should provide much of the basic technical underpinning for the development of most of these policies and procedures, and if done well should start the process of public involvement and participation, and integration of government activity in the aquaculture sector. Ideally, these processes would continue, and the policies/regulations would be refined, through a broader process of integrated coastal management.

Sector EA as a starting point for more integrated environmental management of coastal aquaculture has been used in Hong Kong (box 3.2), Norway, and Tasmania (see Appendix 2). We are not aware of its application in any tropical developing countries other than Belize.

4.4 The need for agreed environmental quality standards

Agreed environmental quality standards are a precondition for effective environmental assessment and integrated coastal management. This is because the *significance* of any impact (a key issue addressed in EIA) cannot be assessed without some environmental standard to measure the impact against.

Ideally environmental quality standards should be developed *and agreed* prior to any form of EA or integrated coastal management. However, they are often lacking, or have been developed by environmental agencies or departments independently, or based on those from other countries. There is rarely any critical independent or public review of these standards. Since environmental quality is relatively subjective, and of great concern to the population at large, and since these standards are likely to vary according to local natural and social conditions, this technocratic approach is inappropriate. While science and scientists should play a major role in providing the technical information required, the setting of standards should be a far more accountable process, with more input from a broad range of institutions and the general public.

Any integrated coastal management or planning initiative should include the development of such standards as a key task early in the process. If ICM is not underway, or if existing environmental quality standards are lacking or inadequate, the issue must be raised at the outset of any EA process, and provisional standards, against which the assessment is made, stated clearly. This will require significant liaison between government departments or agencies, and ideally also significant public involvement. This may serve as a first step in consensus building, since the setting of such standards will be of interest to – and in the interests of - most institutions and stakeholders. Furthermore, agreeing on environmental quality standards and objectives at the outset is likely to reduce conflict at later stages, providing clear and agreed criteria for decision making.

4.5 Learning from experience: monitoring and adaptation

Environmental assessment is extremely complex, and new procedures are likely to be imperfect in many respects. Any change in policy and procedure should be carefully monitored and assessed. Whenever recommendations for change or adaptations are made, there should also be presented a mechanism for:

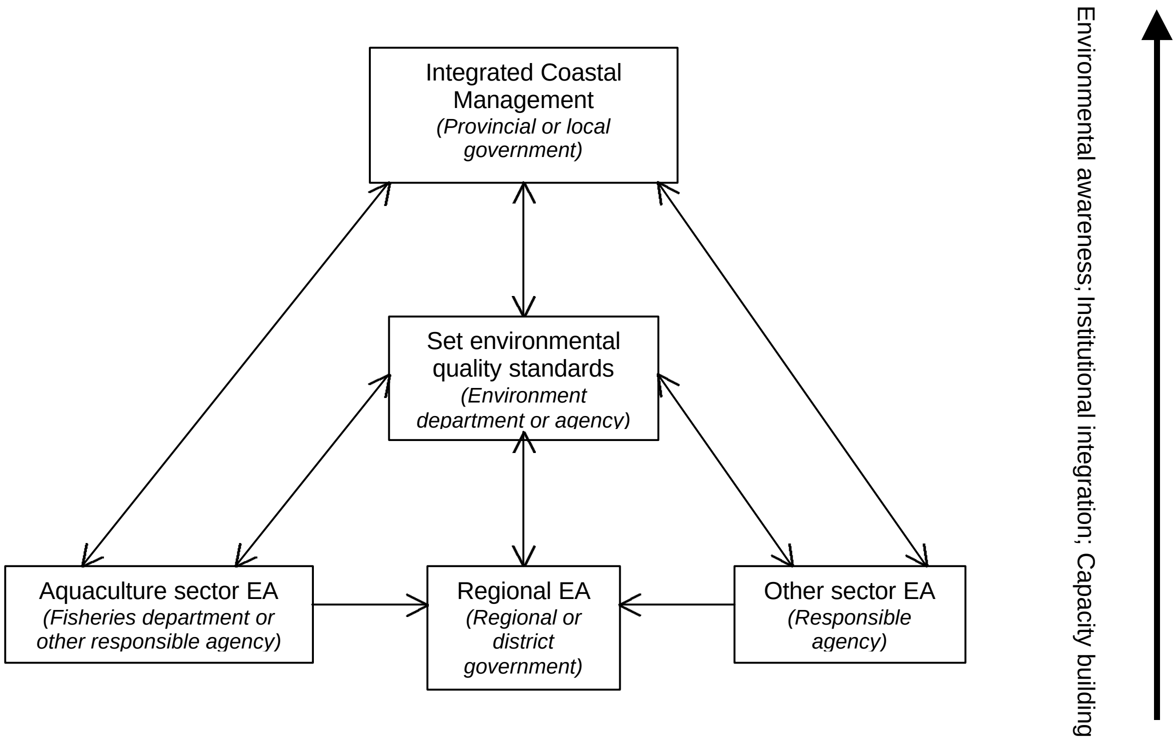
- monitoring their effects;
- assessing their success or otherwise (against defined objectives or standards); and
- adapting the policy or procedures in line with experience.

4.6 Overview of the relation between different environmental management initiatives

Figure 4.1 shows the dynamic relationships between the setting of standards, sector EA project EIA, regional EA and integrated coastal management (ICM). These initiatives should all be seen as mutually reinforcing, and government should have a clear strategy for implementing and integrating them. While ICM (including the setting of environmental quality standards) should ideally be the overall integrating framework, sector EA or regional EA can serve as a more simple and practical starting point.

Figure 4.1: Relationships between different initiatives for environmental management of coastal aquaculture

(brackets/italics indicate most likely lead agency)



4.7 Costs and financing

Thorough environmental assessment (sector or project) is costly. The use of sector EA should reduce the need for project EIA and therefore reduce overall costs. However, the costs of project EIA have traditionally been borne by the developer, whereas government normally undertakes sector EA.

The marginal (additional) costs associated with sector EA will vary greatly according to existing institutional structures and capacity. It will also depend on the need or otherwise for technical research, modeling, GIS and so forth. In practice much can be done on the basis of existing information, and the main task will be improved liaison and coordination between government agencies and NGOs in order to assimilate this information. In the process additional information or research needs will be identified, and prioritized, and additional sources of finance may then be sought.

In any case, the process of sector EA should be seen as a major contribution to institutional capacity building, and should be a priority of any government committed to the principles of sustainable development.

Overview of the Environmental Assessment Process

This section presents general guidance on the overall structure and process of EA, and the nature of the outputs, as it applies to aquaculture and other development types. Detailed guidance relating to each of the more complex and important stages is presented in sections 6-12. Specific examples of EA procedures and regulations as they are currently applied to aquaculture in various countries are presented in Appendix 2.

It is strongly recommended that aquaculture sector EA be undertaken for the whole country and preferably also in respect of important coastal systems. This should provide the basis for more efficient and effective project EIA if and when required. There is limited experience worldwide of sector EA to date.

The basic EIA process as applied to projects is now widely agreed. However, there are a variety of issues relating to best practice which are still the subject of intense debate. Although widely agreed as an essential part of the process, the scope and timing of public involvement is highly variable. The extent to which economic techniques can and should be used in EA also remains contentious.

Contents

5 Overview of the Environmental Assessment Process

The following presents an overview of the main stages and overall process of EA. Details relating to the various components of environmental assessment, and supporting tools, are presented in sections 6-12.

The sector environmental assessment process is essentially similar to that for the better known project EIA, except that instead of being applied to a specific project, it is applied to the sector as a whole, within some defined area (such as an estuary, bay, lagoon system, watershed system). It addresses similar issues using broadly similar tools. However there are significant differences of approach and emphasis in several components, and they are treated separately below.

5.1 Sector EA

5.1.1 Purpose

The purpose of (aquaculture) sector environmental assessment may be summarized as:

- to assist *the sectoral agency responsible for aquaculture, and/or the environmental agency responsible for coastal environmental management* to develop practical policy and strategy for the development and environmental management of coastal aquaculture development;
- to assist these agencies, and/or others concerned with environmental planning and management, to develop an environmental management plan for the sector;
- to provide the necessary technical information relating to the aquaculture sector as an input to broader integrated coastal management;
- to facilitate *public* understanding of the nature of coastal aquaculture development, the options available, and their technical, socio-economic and environmental characteristics and effects;
- to facilitate and promote informed *public involvement in* policy and planning related to the aquaculture sector;
- to define procedures for screening for project EIA, and guidelines and standards for undertaking project EIA.

5.1.2 Process

The sector EA process will require a high level of integration and liaison between the responsible or initiating agency (usually the fisheries department or environmental agency), and other departments, agencies and stakeholders. It will probably be necessary to establish some form of joint committee or steering group (covering all relevant institutions and stakeholder representatives) to oversee the work and facilitate exchange of information, perspectives and ideas. The assessment may relate to the country as a whole, some administrative region or district, or some natural system such as an estuary, lagoon, delta or bay,

The process can be summarized as follows:

1. Scoping: the identification of key impacts from different forms of (actual or potential) coastal aquaculture development which require further investigation, and prepare the terms of reference for the study.

2. Assessing: the identification, analysis, and evaluation of the significance of impacts from different forms of coastal aquaculture development. This will require a broad and comprehensive understanding of the natural and human environment, and a thorough understanding of the technical characteristics of a range of coastal aquaculture development options, all of which will need to be assessed;

3. Mitigation: identifying and developing measures to prevent, reduce or compensate for impacts from the sector, and to make good environmental damage. Examples are given in Box 5.1.

4. Reporting: presenting the results of the impact assessment in a format useful for, and accessible to planners, decision makers and stakeholders.

5. Reviewing : Assessing the adequacy of the EA report, taking account of the views of all relevant government departments/agencies and stakeholders, and assessing the acceptability of the proposals in terms of existing plans, policies and standards. This process is likely to lead to debate over resource allocation issues, and may therefore be a significant stimulus to broader integrated coastal management initiatives.

6. Decision-making: The objective of this component is to decide whether the proposed environmental management plan (suite of mitigation measures + proposals for implementation) for the sector is desirable and acceptable to all relevant stakeholders, and which parts can be implemented, when and by whom. The "decision maker" (which may be an individual, committee, hearing, local government assembly etc) will depend on local circumstances. The result of the

Box 5.1: Types of mitigation which may be considered in sector EA

- site selection criteria for different forms of aquaculture to minimize environmental impacts;
- suitable zones or locations for aquaculture development based on these and other criteria;
- requirements, guidelines and procedures for the approval of mariculture projects and the application of EIA at project level, including criteria for the assessment of individual projects;
- agreed environmental quality standards to be used in assessment and monitoring of the impacts of individual farms and the sector as a whole;
- codes of conduct and practice for the design, construction, and operation of different forms of aquaculture;
- guidelines or protocols relating to the control of disease spread, movements of stock and introduction of exotic species;
- regulations related to design, construction, and operation of different forms of aquaculture;
- possible ceilings on production or waste output from different forms of coastal aquaculture related to environmental capacity;
- economic, financial and market incentives to minimize environmental impact;
- services which could reduce environmental impacts (such as disease identification, monitoring, control; disease and/or quality certification; information, training and extension)
- infrastructure which could reduce impacts (such as water supply and treatment; markets);
- legal and institutional requirements and capacity building for the effective implementation of all forms of mitigation;
- an overall environmental management plan for the sector incorporating all the proposed mitigation measures, including implementing/monitoring procedures

decision making process may be a request to modify or improve the report and the environmental management plan. It may be that while there is agreement on the plan, there are major institutional or legislative constraints to its implementation, in which case the report may be used as a tool and rationale for institutional change.

7. Monitoring and managing: This involves implementing mitigation measures; monitoring the overall effects of the sector on the environment, and the efficacy of specific mitigation measures; and responding by adapting and improving the mitigation measures as appropriate.

8. Public involvement: The importance of public involvement in the EA process is now widely recognized. Sector EA provides an opportunity to involve the public in defining overall policy and strategy, and may pre-empt serious conflict related to individual aquaculture proposals. Public involvement ranges from relatively formal exchange of information and ideas about the effects of coastal aquaculture, to more participatory approaches to policy development and decision making. Public involvement will vary greatly in nature and scope according to local culture and tradition, but would typically encompass actual and potential stakeholders with an interest in all forms of actual and potential coastal aquaculture, from all parts of the region under study.

5.1.3 Outputs

The main tangible output from sector EA is a report. This must be accessible and comprehensible to all parties, and must clearly state the major issues, and options for the environmental management of the sector, in a non-technical way.

A sector EA report should include:

- an executive or non-technical summary (which may be used as a public involvement document);
- a rationale for the assessment (for example drawing on current problems or opportunities; the need for guidelines etc);
- description of the scope of the exercise. For example as a basis for improved regulation; for the development of guidelines or codes; as a basis for broader policy and plan development; as a basis for incorporating coastal aquaculture development into a broader integrated coastal management process;
- discussion of the environmental quality standards (either existing, or where these are lacking, proposed) against which the assessments of impact significance have been measured (under the sector EA) and should be measured (in project level EIA);
- description and comparative evaluation of coastal aquaculture systems, technology and management practices in the region, both actual and likely, in the short and medium term;
- discussion of the relationship between possible land/water use for coastal aquaculture and existing land/water-use policies;
- description of the conditions (biophysical, socio-economic etc) and locations in which coastal aquaculture development might take place;
- discussion of environmental capacity, in relation to environmental quality standards, for these locations;

- evaluation of the impacts of each kind of coastal aquaculture, with clear information on the criteria used to assign significance. Also, descriptions of the characteristics of each impact, the predictive methods and analytical techniques used, discussion of the uncertainties involved in interpreting the results, and descriptions of gaps in the baseline data or other data used in the EA work and included in the EA report;
- comparative evaluation of alternatives, covering significant adverse and beneficial impact, mitigation possibilities for different technical options (see for example Box 5.1) and monitoring;
- identification of environmentally preferred options, if possible using a set of sustainability criteria;
- an environmental management plan for the sector as a whole, based on identified mitigation (possibly including complete exclusion of some development options), including draft procedures for implementation and regulation;
- a monitoring plan and proposed training; and
- appendices: all technical information and description of approaches/methods used to provide conclusions in the EA report which are not suitable for the main text.

5.2 Project EIA

5.2.1 Purpose

The purpose of project EIA is to assist:

- *the proponent* to design and implement a proposal in a way that eliminates or minimizes the negative effect on the biophysical and socio-economic environments and maximizes the benefits to all parties in the most cost effective manner;
- the *public* to understand the proposal and its impacts on the community and environment, and to make an informed input into the decision making process; and
- the *responsible authority* to decide whether a proposal should be approved, and the terms and conditions that should be applied.

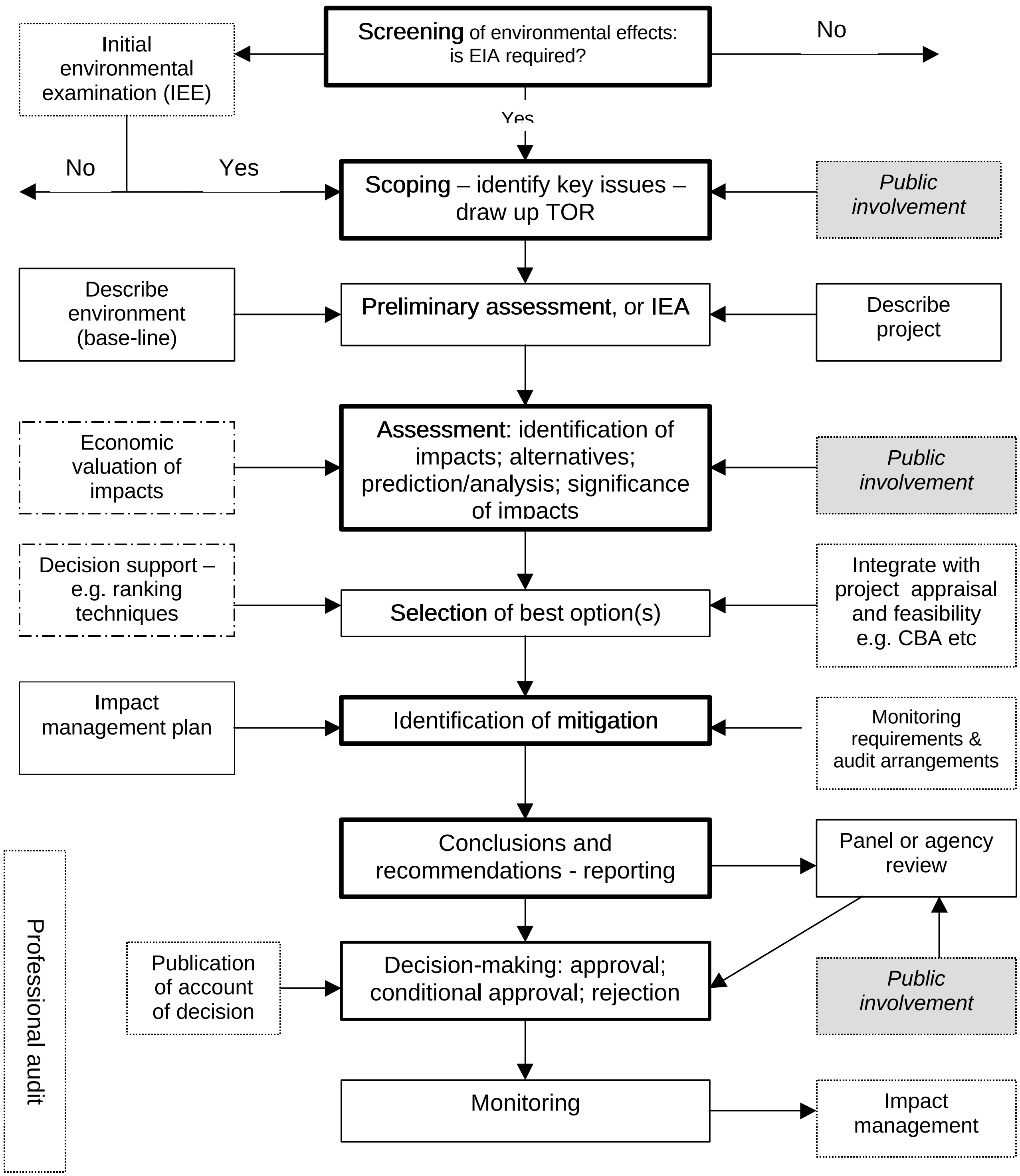
(adapted from UNEP 1996)

5.2.2 Process

The process for undertaking EIA is presented in Figure. 5.1. This shows both the basic framework, which is widely applied and accepted, and more recent additions or extensions to the basic methodology which are not applied universally, but which may be considered to represent best practice. The details and emphasis will also vary according to the particular requirements of a country, proponent, bank or donor. A summary comparison of the procedures recommended in different guidelines is presented in Appendix 3.

In practice it would be unreasonable and impractical to apply the more comprehensive “best practices” to individual small-scale aquaculture developments. This reinforces the need for sector EA, so that full project EIA is then only required for large scale or

Figure 5.1 Summary of the EIA Process



A bold box indicates that this step is common to almost all guidelines or procedures.
A thin line indicates that such a step is commonly recommended.
A dotted box indicates that such an activity is sometimes recommended, and is increasingly considered to represent best practice
A dot-dash box indicates recommended by some analysts but not widely accepted as representing best practice.

otherwise exceptional farms. "Best practice" options, such as integrating the environmental assessment with economic assessment; feasibility studies; economic valuation of impacts; and comprehensive public involvement are all much better done on a "once off" basis at sector level, except for very large individual projects.

The guidelines which follow are framed around the basic core components, which may be summarized (modified from UNEP 1996) as:

1. Screening: An initial assessment to decide whether a project requires further investigation in an EIA. This may require a short report or submission in the form of an *initial environmental examination* (IEE).

2. Scoping: To identify the key impacts requiring further investigation, and prepare the terms of reference for the study. This is an important first opportunity for public involvement. In some cases this leads into an *Initial Environmental Assessment* (IEA) which is a limited form of assessment, sometimes used to determine the need or otherwise for a full EIA and the scope of the exercise.

3. Assessing: The identification, analysis, and evaluation of the significance of impacts. In some cases this stage may be extended to include *economic valuation* of impacts, and/or various *ranking techniques* with a view to providing information for *selection* of best options from an environmental perspective.

4. Mitigation: Identifying and developing measures to prevent, reduce or compensate for impacts, and to make good environmental damage (examples in box 5.2).

Box 5.2: Types of mitigation for project EIA

- alternative location and siting;
- alternative/improved technology or design;
- limitations on scale or waste production/output;
- construction guidelines (e.g. guidelines for habitat restoration);
- guidelines for food or other input quality and quantity;
- guidelines for feed or other input use and management;
- guidelines/protocols for disease prevention and management;
- selection of suitable species and seed;
- management of influent and effluent water quality;
- an overall "environmental management plan" for the project incorporating all proposed measures, including appropriate incentives and constraints, implementing and monitoring procedures.

5. Reporting: Presenting the results of the impact assessment in a useful and accessible format.

6. Reviewing: Assessing the adequacy of the EIA report, taking account of the points of view of stakeholders, and assessing the acceptability of the proposal in terms of existing plans, policies and standards.

7. Decision-making: To decide whether the proposal can proceed and under what conditions. The decision-maker has the option to request that the project be redesigned (or aspects of the project redesigned) so that the environmental effects are minimized.

8. Monitoring and managing: This involves implementing mitigation measures, monitoring impacts for compliance, checking that they are as predicted, and where necessary taking action to ameliorate problems.

9. **Public involvement**: The importance of public involvement in the EA process is now widely recognized. In practice this involvement ranges from making information about a project, policy or plan more widely available through formal consultation, to more participatory approaches to project design and decision making. Public involvement will vary greatly in nature and scope according to local culture and tradition. The scope of the public involvement requirement will be much less if effective sector EA, with significant public involvement, has already been undertaken.

5.2.3 Outputs

The main tangible output from the EIA process is the ***report***. The quality of the report will reflect the quality of the process, and the process itself may bring benefits in terms of environmental awareness, capacity building, and liaison and integration between institutions and stakeholders.

In order to contribute effectively to the purpose of the assessment as stated above, EIA reports should:

- be proactive, aimed at assisting the proponent achieve good environmental design;
- be accessible and comprehensible to all parties; and
- state the issues clearly in a non-technical way.

The broad structure and content of an EIA report will usually be specified in the legislation or guidelines of the country or donor. These will usually be made more specific in accordance with the terms of reference established during the scoping process of the EA.

A project EIA report typically addresses the items listed below. It should include:

- an executive or non-technical summary (which may be used as a public involvement document);
- a description of the aims of the proposal;
- a description of the proposal and alternatives (in terms of siting; design; technology; management);
- discussion of the relationship between the proposal and current land/water-use or other relevant policies for the area likely to be affected ;
- description of the expected conditions (biophysical, socio-economic etc) at the time of probable implementation, including potential impacts from other activities;
- discussion of the environmental capacity and environmental quality standards for the area likely to be affected;
- evaluation of the impacts of each alternative with clear information on the criteria used to assign significance. Also, descriptions of the characteristics of each impact, the predictive methods and analytical techniques used, discussion of the uncertainties involved in interpreting the results and descriptions of gaps in the baseline data or other data used in the EIA work and included in the EIA report;
- assessment of possible cumulative impacts associated with other developments (including aquaculture) likely to take place in the same area;

- comparative evaluation of alternatives covering significant adverse and beneficial impact, mitigation and monitoring;
- identification of the environmentally preferred option, if possible using a set of sustainability criteria;
- detailed proposals for mitigation;
- impact management plan, monitoring plan and proposed training; and
- Appendices: all technical information and description of approaches/methods used to provide conclusions in the EIA report which are not suitable for the main text.

5.3 Integrating EA with economic appraisal and the project cycle

Harou, Kjorven and Dixon (1995) have noted the need to integrate EA information into the economic appraisal of projects from the earliest stages through to project implementation and completion. It is particularly important that EIA begins during the project preparation and design phase, so that appropriate mitigation can be "built into" the project from the outset, thus improving the quality of mitigation, and reducing the chances of the project being rejected, and much investment lost. The integration of EIA into the project cycle is presented in figure 5.2.

In practice this must be done with great care so as to avoid compromising the neutrality of the assessment. It is instructive to consider the case of the African Fishing Company in Tanzania in this regard (Box 6.5 and Appendix 1). Environmental considerations were built into the second phase of project design, to the extent that the proponent felt sufficiently confident to place the following sub-title on the EIA report: *"an environmentally responsible prawn farming project in the Rufiji Delta, Tanzania".* Unfortunately this pre-judged the outcome of the assessment and any review, and undermined the neutrality and credibility of the EIA document as a whole.

The financial and economic appraisal of the project should also be extended where possible to take full account of environmental costs and benefits. This can be done formally – by extending the cost benefit analysis to include environmental impacts – or informally, by comparing economic cost benefit ratios with environmental impacts or benefits.

There is ongoing debate as to the desirability of converting environmental and social values into standard financial units and aggregating with economic values into a single index. The advantages are clear – decision making is easier, since it is based on a single index, and environmental concerns are automatically factored into the most common project decision-making criterion. The disadvantages are that there are usually widely divergent views on the value or otherwise of environmental goods and services, and this divergence is not usually represented in the aggregate index. Although there are ways of dealing with this, they can be costly, complex and sometimes unreliable. Perhaps more seriously many of these approaches lack transparency – one of the fundamental principles of EA – since they are not accessible to non-specialists and the general public.

5.4 Roles and responsibilities

5.4.1 Sector EA

The sectoral agency responsible for the development and/or regulation of coastal aquaculture may be best placed to undertake or commission a sector EA, or at least contribute the bulk of the technical input. Alternatively the assessment could be carried out or commissioned by local government, or by an environmental agency, but with significant technical input from the sectoral agency and/or technical consultants.

Sector EA will require much liaison and exchange between different departments and agencies. This may be difficult in the absence of a clear policy direction or remit given by central government. In such circumstances, any agency or department wishing to undertake or commission sector EA should seek such a remit, or clear approval, from a higher level of government, along with a commitment to promote the exercise, and encourage liaison and free exchange of information and ideas between agencies and departments. It should also seek to establish a process by which the findings of the EA can be used in policy development and coastal environmental management.

A coordinating or steering committee with membership from a range of relevant interests will probably be desirable to oversee the process and ensure maximum cooperation and collaboration between different interests.

The sector EA itself should clearly identify roles and responsibilities for implementation of any proposals for mitigating the environmental impacts and promoting more sustainable coastal aquaculture development.

5.4.2 Project EIA

The proponent of the project should normally be responsible for the costs and effective implementation of the EA process. This would normally involve contracting independent consultants or government agencies to undertake parts of the work. In the case of project EIA some countries operate guidelines restricting the relationship between proponent and EA contractors.

An agency or government department will need to review the EA documents and process to ensure quality control and compliance with legislation and/or guidelines. They may seek technical assistance to do this.

A second government department or local government office would normally make the final decision.

5.4.3 The EA team

The assessment team should have clear roles and responsibilities but regular interaction. In the case of sector EA the team should work closely with economists and sociologists to consider a range of development strategies or plans, and mitigation options to maximize the benefits of the sector while minimizing environmental impacts. In an ideal project EIA the team (or individual) would work with the proponent, and the design and project appraisal teams, so that a variety of project options could be assessed in parallel on the basis of feasibility, cost, and environmental impact .

5.5 Terms of reference (TOR)

Whoever undertakes EA, be it related the sector or to an individual project, clear and agreed TOR will be required. Detailed TOR should be an output of the scoping exercise, and this is described in more detail in section 8.5.

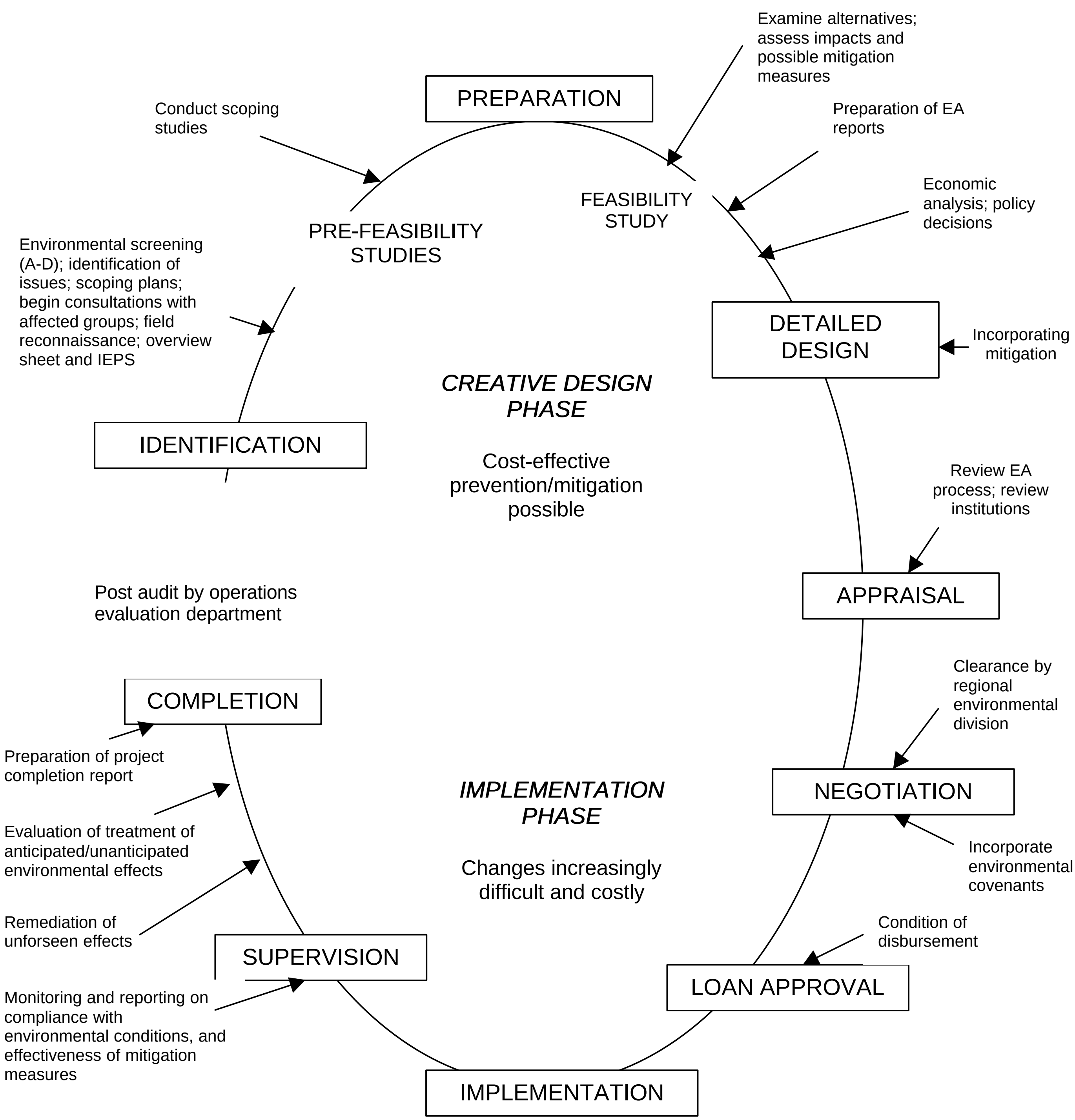
In the case of sector EA, broad participation of all relevant agencies and stakeholders in the scoping process and development of TOR is particularly important. The TOR may provide for a sectoral agency to make assessments related to the activities and responsibilities of other departments or agencies, and this may be contentious. It is important to meet this challenge head-on, and to gain the broadest possible agreement on, and support for, the TOR and the whole process.

5.6 Timing

Strategic or sector EA should be undertaken *before* aquaculture development becomes significant. It is extremely difficult to change the rules for a sector mid way through a development boom, and it may already be too late to reverse environmental degradation except at great cost.

Environmental assessment of individual aquaculture projects should be initiated as early as possible in the planning or project cycle, so that it can be an effective management tool, influencing for example site selection and design to minimize impacts, and reduce the risks of conflict or abandonment at a later date.

Figure 5.2: Environmental assessment and the project cycle
(after Harou et al 1995)



Public Involvement

It is widely accepted that EA should be open, transparent and democratic (Bisset 1996). Public involvement is seen as an essential component of EA by all major international organizations and development agencies.

The effective use of public involvement should shift the EA process from one of administration, regulation and document generation, to one which promotes more democratic decision making on issues affecting the quality of life, and which minimizes potential conflict, or resolves existing conflict.

Public involvement can be difficult, and requires great skill and sensitivity. There has been significant social conflict generated by coastal aquaculture development in Asian, and more recently African, countries, and in some cases public involvement has actually increased conflict. Conflict is likely to be minimized if public involvement is used mainly as an input to sector EA so that objectives, general principles and guidelines can be agreed without reference to specific and potentially contentious individual projects. Once these are in place, the ground rules are known, and the likelihood of conflict arising over individual projects is lessened.

If, nonetheless conflict arises, a variety of conflict resolution techniques may be used to minimize the damage.

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6 Public Involvement

6.1 The rationale for public Involvement

Public involvement is an essential tool in EA for the following reasons:

- environmental assessment makes judgements about the quality of life, the value of resources and development, and the trade-offs between them. Many of these assessments are subjective and can only be validated through the widest possible consultation;
- it can help evaluate the need for and define the scope of the assessment;
- it can provide essential information about local natural resources, their status, use and value (sometimes referred to as indigenous technical knowledge);
- it can help identify and assess benefits and impacts (especially secondary or higher order effects);
- it can generate new ideas for alternatives, siting, design, and mitigation;
- it may allow otherwise underrepresented groups access to the decision making process;
- it can reduce conflict through the early identification and resolution of contentious issues;
- It can provide valuable feedback on the report or hearings;
- local people and other stakeholders may serve an important role in quality control and monitoring of project implementation and impact;
- it creates a sense of accountability, ownership and responsibility;
- it increases confidence in the reviewers and decision makers;
- it increases transparency and accountability in decision-making.

Box 6.1 Objectives of public involvement

- exchange of information;
- identification of problems;
- generation of ideas;
- determination of values;
- evaluation of alternatives;
- feedback on decisions or analyses;
- conflict avoidance, resolution and consensus building.

Lack of consultation and public participation in the processes of shrimp farming in some countries (for example India, Indonesia, and some South American countries) has led to serious conflict and in some cases abandonment or prohibition of shrimp farming (Box 6.2). It is possible (though by no means certain) that this could have been avoided through greater public involvement in planning or project design, especially if this was of a participatory nature. Public involvement, though sometimes difficult, may reduce the likelihood of controversy at a later date.

Unfortunately, public involvement in the EA process is limited to the review stage in many countries. Public involvement should begin at the earliest possible stage if the potential benefits noted above are to be realized in full.

6.2 Public involvement in practice

Although public involvement is necessary, it is also difficult, expensive, and can easily inflame conflict (see boxes 6.2, 6.3, and 6.5). In some cases it has led to a “stalemate” situation of “development or no development” rather than contributed to more sustainable development. It is important to undertake it with great care, with adequate knowledge of local conditions, and at the right level.

Box 6.2 Social conflict and shrimp farm development: 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 Tamil Nadu, and near Lake Chilka 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 Orissa and Andhra Pradesh 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.

Although there is little doubt that there were problems with shrimp culture in some areas, the response has been extreme and unsatisfactory. While it has undoubtedly prevented some undesirable aquaculture development, it has not promoted sustainable development.

There are three lessons to be learned. Firstly, if environmental concerns had been taken into account more effectively in relation to the larger industrial developments, the conflicts may not have arisen. Secondly, conflict escalated rapidly, with an extreme polarization of positions. Effective use of conflict resolution techniques may have led to a more satisfactory overall solution. Thirdly, the extreme impact of the Supreme Court Ruling was based on existing coastal legislation which did not take full and proper account of the nature and role of aquaculture.

More effective public involvement, including where appropriate the use of conflict resolution techniques, would probably have resulted in a better planned, and more sustainable development of the shrimp farming industry in India. These approaches could have been applied within the framework of sector EA relating to the majority of semi-intensive developments in each State or District, and full EA for large intensive industrial operations.

Any new project is likely to upset some stakeholders, especially if there have been problems with similar developments elsewhere. Local meetings may inflame these feelings and lead to rapid polarization. Although conflict resolution techniques may reduce these problems, it is better to avoid such polarization if possible.

Public involvement should be carried out primarily at the sector level, although it may also be appropriate at the project level for large scale projects. There are several reasons for this:

- public involvement for a large number of small aquaculture projects would be impractical and costly;
- project EIA should be paid for by the proponent. It is naïve to expect a neutral appraisal, synthesis or interpretation of public opinion from the proponent;
- confidentiality may be important to the proponent in project EIA, constraining the scope or detail of public involvement;
- in the absence of any agreed overall strategy, public involvement in decision making related to individual small scale projects is likely to be ad hoc, inconsistent, and based on emotional rather than rational appraisal;
- in the absence of agreed objectives and strategy, conflict is likely to be inflamed, and rational assessment will become more difficult.

If comprehensive public involvement takes place as part of a sector assessment exercise, then objectives, targets, general principles and guidelines can be agreed without reference to specific and potentially contentious individual projects. Once these are in place, the ground rules are known, and the likelihood of conflict arising over individual projects is lessened. This is a classic technique used in conflict resolution as described below in section 6.6.

Notwithstanding this, there may arise individual projects that do require public involvement. Criteria for such projects (e.g. scale, location) and procedures for the public involvement exercise should be an output of the sector EA process. These should set out clearly the ways in which the exercise will be undertaken, and how neutrality is to be ensured.

The difficulty of public involvement should not be under-estimated. However, these difficulties can be minimized through a more strategic approach, and where necessary the use of conflict resolution techniques. The risks of avoiding public involvement and not facing up to possible problems as early as possible are high. Some of the large shrimp aquaculture operations which were plundered by local people in Indonesia early 1998 probably regret they did not involve the public more fully during project design and implementation.

Box 6.3: Public involvement in mussel culture in Sweden

When mussel farming first developed in Sweden, there was conflict between mussel farmers and local residents over the use of near shore areas. These areas were already heavily used for recreation, and there were fears related to physical disruption, aesthetic intrusion, and pollution.

The Environmental Protection Act of the time required that any new farm be discussed at public information meetings. These meetings "turned into regular catalysts of conflicts, and in some cases stirred emotions and stigmatized entrepreneurs to the extent that they had to abandon the project in spite of final approval by the authorities". Largely as a result, the legal requirement for such meetings was later dropped.

There is now renewed interest in mussel cultivation, and in order to avoid these problems in future "the political and social intentions of local communities and authorities need to be clearly formulated. This would pre-empt the disastrous social and personal effects" caused previously. *(source: Ellegard 1999)*

6.3 Constraints to public involvement

Public involvement is likely to be more costly in rural areas and in developing countries. It will be more costly where communities are less well organized and represented, where communications are poor, where language is diverse, and where levels of illiteracy are high. Behavioral norms and traditions in some countries may inhibit or preclude involvement of some potentially affected groups.

Many individual project proponents wish to minimize public involvement. They may consider it costly and time consuming. They may be reluctant to start it before the project is well defined. They may be concerned that it will be taken over by unrepresentative interest groups, or misrepresented in the media, and liable to increase, rather than decrease conflict. They may doubt the capacity of the public to fully understand the issues. All of these concerns should have been addressed to some extent if public involvement has already taken place at the sector level.

6.4 Who are the stakeholders?

The widest possible range of stakeholders should be consulted or actively involved. They might include:

- representatives of the aquaculture industry (sector EA);
- the proponent and other project beneficiaries (project EIA);
- the people, individuals or groups in the communities which may be affected;
- the administering agency;
- specialist government agencies;
- NGOs and technical specialists;
- others, such as donors, the private sector, academics etc.

It is sometimes very difficult to define exactly who is likely to be affected by a development, especially with respect to indirect impacts, and consultation should therefore be as wide as possible in the early stages.

When direct local public participation is difficult, NGOs are sometimes used as “proxy” local representatives. Although this can be useful and efficient, it should be done with great care, as they may not always accurately reflect local opinion or knowledge.

Box 6.4: Techniques for public involvement

Note: many of the following are suitable for aquaculture sector EA, but only very large individual aquaculture projects, and/or those sited in very sensitive areas would justify the more comprehensive and costly techniques.

- Media (television, radio, pamphlets, presentations, exhibitions);
- Open houses and field offices (manned information displays, access, opinion exchange);
- Participatory appraisal;
- Workshops;
- Public meetings; public hearings;
- Small representative or specialist meetings;
- Employment of community interest advocates;
- Individual interviews and two way consultations;
- Questionnaires;
- Advisory panels, working groups, task forces;
- Interim consultative reporting;
- Demonstration projects.

6.5 Techniques for communicating and information exchange

Public involvement can be undertaken at different levels. ***Informing*** may involve a largely one way flow of information about a policy or project. ***Consulting*** involves a two-way interaction and exchange of information and opinion between the EIA team, or proponent and the public. ***Participation*** implies a greater role for the public in setting the agenda, analyzing information, and reaching decisions on the basis of consensus.

There is a range of specific techniques available which are more or less effective at these different levels (Box 6.4). These tools have particular strengths and weaknesses in terms of their contribution to the specific outputs or objectives of public involvement (summarized in Box 6.1).

An appropriate package will depend on the nature and scale of the project, and local social and cultural circumstances.

It should be remembered that many stakeholders with a significant interest in the outcome of a decision or development process might nonetheless have limited time for, interest in, access to, or aptitude for active participation. It is therefore important to raise general awareness of the process using rough and broader access techniques in the early stages (such as television, radio and papers), in order to identify important areas requiring the use of more specific and targeted techniques.

UNEP(1996) presents the following principles for making public involvement more effective:

- sufficient relevant information must be provided in a form that is easily understood by non-experts;
- sufficient time must be allowed for stakeholders to read, discuss and consider the information and its implications;
- sufficient time must be allowed to enable stakeholders to present their views;
- the selection of venues and the timing of events should encourage maximum attendance and a free exchange of views by all stakeholders (including those that may feel less confident about expressing their views); and
- responses should be provided to issues/problems raised or comments made by stakeholders. This enables confidence in the public involvement and EIA process to be maintained.

6.6 Conflict minimization and resolution

EA of aquaculture may be applied in a situation in which conflict already exists. This may have arisen in relation to previous aquaculture developments, or may be related to public perception of aquaculture as environmentally damaging. This is increasingly the case for shrimp farming.

On the other hand, comprehensive participation in an EA process may actually generate conflict by highlighting potential future problems or differences between the various stakeholders. This should not be used as an argument against public involvement,

Box 6.5 Public involvement in aquaculture EA: the case of the African Fishing Company, Tanzania

Following a proposal in mid 1995 for a large prawn farming project to be sited in the Rufiji Delta, the District Commissioner requested that the proposer (African Fishing Company) collaborate with a consultant to write an initial environmental impact statement. The EIS was produced and submitted to relevant ministries for review in May 1996. Before an official answer was received the environmental community in Dar es Salaam pressured the government to have a public debate on the proposal. AFC also increased the scope of their consultation to a range of government agencies, ministries and academic institutions. The National Environment Management Council then convened a forum of interested parties which was attended by more than 70 participants, mostly from government, regional authorities, aid assisted projects or programs, NGOs and journalists, embassies, and commercial companies. AFC and various technical experts described the project, and a range of academics made comments.

The forum cleared up a good deal of misunderstanding about the project that had already grown up, and it was agreed that a comprehensive EIA was required. The forum offered some guidance on content. A large team was appointed, including aquaculture specialists, fisheries specialists, ecologists and sociologists.

The first contact with the villagers was by the fishery specialists. They observed that the villagers had many serious concerns, and some significant misconceptions as to the nature of the project. As a result they "advised that a high ranking governmental delegation be sent to the area to inform the people of the pro's and cons of the project, and *the benefits that such a project would bring to them" .* The suggestion was immediately implemented. Other teams also visited the villages and found that the inhabitants did not have accurate facts. As a result a critical report was produced by the sociologist team reflecting the (possibly erroneous) fears of the villagers. As a result a more technical team, a fisheries specialist, a sociologist, and a representative of AFC was sent to the villages to explain the nature of the project and the socio-economic benefits it would bring. After the visit " a good number of villages now accepted the project and were eager to see it implemented immediately".

A final survey was then made by a new team in order to assess "whether or not the people are now aware of the project, and have accepted or rejected it, especially after the several visits to the area by senior government officials and experts. The survey identified the nature of local economic activities, as well as a range of local concerns about health, education and transportation, and explored ways in which the project might contribute to their alleviation. They also reviewed both the positive and negative views of the project. Concerns included mangrove cutting, impacts on fisheries, impacts on local markets, pollution and chemicals, fears that they would be prevented from fishing. A larger number of positive impacts were identified related to transportation, marketing employment. Overall about 82% of interviewees and members of focus groups accepted that the project would beneficial, while only 18% opposed it. A series of suggestions were also reported for more local participation in the development of the project.

Subsequently, this project became the subject of "intense debate" over the appropriateness of a major aquaculture development proposal (Myalyosi and Hughes 1998). This debate became the subject of international comment on email discussion groups related to sustainable aquaculture and mangrove conservation. The EIA itself was criticised (Hughes 1996) as being seriously biased.

There is little doubt that the EIA does not read as an impartial assessment. It is also clear from the notes above that the public involvement exercise was promotional in nature. It was this that so angered many environmentalists. This is unfortunate because in some ways the EA process was exemplary. The proposer set out from the beginning to design an environmentally responsible farm using a respected consultant with international experience in mitigating the environmental impacts of shrimp farming. The analysis of impacts appears to have been thorough. But unfortunately, since the mitigation was "built in" to the project design, the proponent used the EA process as an opportunity to advocate, rather than impartially assess the project. However good the design, and however thorough the analysis, the EIA necessarily lost credibility. It should be added in their defense however, that this tendency to advocacy rather than assessment, was in part a reaction to the adversarial approach of environmental pressure groups to any kind of shrimp farming.

The company itself, and the project designers, could have engaged the local people at an earlier stage to explain, discuss, and adapt project design, as well as take account of local concerns (*information, consultation* and *participation)*. The EIA should then have been undertaken by a more independent team – although still working closely with the designer and proponent -–to produce a more credible EA. Had conflict still arisen, some of the resolution techniques described below might have been used to gain a broader consensus.

although (as noted previously) it does suggest that a more strategic approach is required. Either way, the sooner these issues are addressed and resolved the better. A good recent example of this was the EIA of a shrimp farm in Tanzania (Box 6.5) which led to a heated local and international debate. Clearly, if such conflicts arise, there should be efforts to resolve them, and this may be a significant role for the EA team.

The process needs to be culturally sensitive:

> *The objective is to define traditional mechanisms for making agreements, for negotiations, and for managing conflict in affected communities. Understanding and working within cultural expectations and practices may enhance consultation and participation processes, especially in projects where there are multiple and competing stakeholders or where disputes or conflict are evident. (The World Bank, 1995)*

UNEP (1996) presents the following principles for minimizing conflict:

- involving all those likely to be affected, or have a stake in the matter;
- communicating the objectives of the proposal, and how it is planned to achieve them;
- actively listening to the concerns of affected people, and the interests which lie behind those concerns;
- treating people honestly and fairly, establishing trust through a consistency of behaviour;
- being empathetic, putting yourself in the shoes of the other party, and looking at the area of dispute from their perspective;
- being flexible in the way alternatives are considered, and amending the proposal wherever possible to better suit the interests of other parties;
- where others' interests cannot be accommodated, mitigating impacts to the greatest extent possible, and looking for ways to compensate for detriment;
- establishing and maintaining open two-way channels of communication throughout the planning phase, and beyond into implementation; and
- acknowledging the concerns and suggestions of others, and providing feed-back on the way these matters have been followed up and evaluated.

Even allowing for the comprehensive application of these principles, conflict may arise. The coastal zone is notorious for ambiguities relating to resource access and control in most countries. Any new form of resource allocation, acquisition, appropriation, degradation, or control, is likely to result in conflict. Addressing some of the existing ambiguities related to resource use may also undermine existing power relations between different groups. A large aquaculture enterprise in Malaysia went through a long public consultation exercise, but was still plagued with conflict and disagreement, long after initial agreements were made (Al-Sahtout 1997).

A summary of the different approaches to conflict resolution, and their advantages and disadvantages is presented in table 6.1. They include litigation (court rulings) and a range of less formal techniques collectively referred to as "alternative dispute resolution" (ADR) techniques (Scialabba 1998). These consist of direct negotiations between interest groups or their representatives, with or without some form of intermediary (conciliator, mediator or arbitrator), and usually based on agreed roles, ground rules, and objectives.

The table clearly presents the few advantages of litigation compared with the many advantages associated with ADR techniques. Litigation will in almost all cases result in one party "losing"; the root cause of the conflict may not be addressed; and the problem may not be solved in the long term. Examples of the use of litigation relating to aquaculture include the Supreme Court Judgement in India (Box 6.2) and the current ban on brackish-water aquaculture activities in some rice growing areas of Thailand. Both of these have resulted in significant disruption of an established industry. Clearly litigation and arbitration should be used only as a last resort, and the need for their application should as far as possible be pre-empted by active promotion of ADR techniques. The EA process, at sector and individual project level, can and should effectively facilitate these processes.

Conflict resolution techniques usually involve one or more of the following:

- clear identification of interests;
- joint fact finding;
- informed dialogues;
- joint/creative problem solving and identification of alternatives;
- identifying opportunities for mutual gain;
- clear identification of implementation procedures for agreed solutions.

There are four simple but essential pre-conditions for success (adapted from Bisset 1996):

- an impartial mediator (where one is used);
- equal status and access to information and support services;
- the option of withdrawal at any time;
- no forced agreement

There is no guarantee that consensus will be reached, and litigation may ultimately be required. However, the process can be especially effective when conflict is related to value differences (not moral right and wrong) and where problems are discrete and well defined. This is often the case in the coastal zone.

6.7 Designing a public involvement programme

The scope and cost of public involvement will need to be related to the complexity and uncertainty associated with the issues raised by the policy, plan or project.

TOR for the EA should include an outline for the public participation process, or a requirement that a public involvement programme be designed by those executing the EA as their first task. TOR may include a requirement for a sociologist with local knowledge to be a member of the EA team.

The public involvement programme should cover the scope, timing, techniques, and resources required. The programme should include at least the following:

- procedures for identifying stakeholders;
- procedures for informing the public about the objectives of the proposal and/or the EA at an early stage;
- provisions for updating the public and providing feedback on progress with the study;

- provisions for giving the public opportunities to share their knowledge, values and concerns; and
- methods of integrating with traditional decision making processes.

Ideally these provisions should provide for public involvement during all the major stages of the sector EA and project EIA process, including screening; scoping; assessment; mitigation; review; implementation and monitoring

Table 6.1: Comparative table of conflict resolution techniques
(from Scialabba 1998)

	Litigation	Arbitration	Mediation	Negotiation
Result sought	Court judgment	Arbitration award	Mutually acceptable agreement	Mutually acceptable agreement
Voluntary/ involuntary	Involuntary	Voluntary	Voluntary	Voluntary
Binding/ non-binding	Binding (Subject to appeal)	Binding (subject to review on limited grounds)	Agreement enforceable as contract	Agreement enforceable as contract
Private/public	Public	Private (unless judicial review sought)	Private	Private
Participants	Judge and parties	Arbitrator and parties	Mediator and parties	Parties only
Third-party involvement	Judge, not selected by parties and usually with no specialized subject expertise, makes decision based on law	Arbitrator, selected by parties and often with specialized subject expertise, makes decision	Mediator, selected by parties, facilitates negotiation process	Parties communicate directly
First steps	One party initiates court proceedings	Parties agree on arbitration and appoint arbitrator	Parties agree on mediation and appoint mediator	Parties agree to negotiate
Approach/ methodology	Formal Structured by predetermined rules Adversarial	Less formal Procedural rules and substantive law may be set by parties Less adversarial	Flexible Usually informal and unstructured Non-adversarial	Flexible Usually informal and unstructured Non-adversarial
Advantages	Application of legal rules may help to address power imbalances	Quicker and cheaper than litigation Parties can tailor procedure to suit their needs Parties can choose subject matter experts as arbitrators	Quicker and cheaper Enables creative solutions to be found Can resolve conflicts over policy issues and/or where clear legal rights/obligations are lacking Parties retain control over process and outcome Parties work together to find win-win solutions Substantive issues of importance to parties can be addressed Decisions can be tailored to needs of parties Parties can directly contribute expert understanding and expertise Agreement more likely to be implemented and future problems solved in non-adversarial way Mediation, in particular, can restore communication between alienated parties and break deadlock	
Disadvantages	Slow and expensive Reinforces conflict between parties; may result in further litigation Decision restricted within narrow legal parameters Parties relinquish control over process and decision Inappropriate for disputes involving wider policy issues	Parties relinquish control over final decision Success depends on competence of arbitrators No appeal against decision (usually)	Power imbalances may be enhanced Agreement may not be reached Failure to implement agreement may necessitate enforcement through courts	

Screening

Screening is the process used to decide whether or not a policy, plan, programme or project requires environmental assessment, and if so, at what level. Screening depends either on a subjective decision by an administrator, or (more usually) checking of a proposal against a set of standard criteria. These criteria may range from very general (such as "projects likely to cause potentially significant impacts"), to very specific (such as scale, location, type of activity, technology, relation to other resource users etc).

These criteria should be an output from sector environmental assessment. Where there is a strong environmental management framework, criteria can be made clearer and more explicit, and there will be less need for individual project EIA.

If there is uncertainty about a project in relation to the criteria, an initial environmental examination (IEE) or initial environmental assessment (IEA) may be required, and this may be subject to review by some form of advisory committee before decision is made about the need or otherwise for full EA.

Whatever criteria are used, it is important that they, and the screening procedures in general, should be widely known and understood, so that proponents can design to meet environmental standards, or locate in suitable areas, thereby minimizing costs to all parties while maximizing environmental management benefits.

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7 Screening

7.1 Objective

To determine whether or not a policy, plan, programme or project requires full scale EA, and if not, at what level, if any, an assessment should be made.

7.2 Criteria for the sector

Operating principle No 1, as presented by the international study of the effectiveness of environmental assessment states that EA:

> *"should be applied to all development project activities likely to cause potentially significant adverse impacts, or add to actual or potentially foreseeable cumulative effects". (Sadler 1996)*

According to this criterion, most intensive aquaculture, and extensive aquaculture developments that involve habitat conversion, however individually small, require some form of EA.

The Ramsar Convention on Wetlands of International Importance advocates EA for projects likely to negatively impact wetlands. Most coastal aquaculture currently takes place within salt marsh, mangrove, lagoon, and estuarine systems.

According to UNEP (1996) full scale EA is typically required for proposals which involve:

- exploitation of natural resources;
- infrastructure;
- industrial activities;
- extractive industries;
- waste management and disposal; and
- substantial changes in farming or fishing practices.

Most policy, planning or programme initiatives related to coastal aquaculture satisfy the first and last of these criteria, and there is a strong case for sector EA of such initiatives, preferably within a broader integrated coastal management initiative. This case is further strengthened since coastal aquaculture is typically developed in physically and ecologically valuable and sensitive areas including salt marsh, mangrove, lagoons, estuaries, and coral reefs. These are also areas where resource rights and ownership are often ambiguous, and where conflicts of interest between different resource users are common.

On the basis of these requirements and observations, clear and simple criteria for screening coastal aquaculture developments, and defining the level of EA, if any, which may be appropriate, are presented in Box 7.1.

In practice, most countries have not made significant use of sector EA for aquaculture, and therefore rely on screening procedures applied to most individual projects. These may classify aquaculture proposals into different groups requiring more or less rigorous EA. Figure 7.1 shows a simplified example from Belize (Huntington and Dixon 1997).

7.3 Criteria for assessing individual coastal aquaculture projects

If a sector or regional EA has been undertaken during the development of a sector plan, integrated coastal management plan, or district plan, then as part of the mitigation process, rational decision criteria for authorizing or restricting individual aquaculture development, or requiring IEE, or full EIA, should have been established. These criteria may be based on size; location; spatial relationship with other resources, farms or activities; technology; or management practices, and are likely to be closely related to the mitigation measures presented in section 10.

In the absence of strategic or sector EA, there is a strong argument for IEE of any aquaculture development that, through size or location, is likely to have a significant effect on any of the following:

- **natural habitat and biodiversity**: estuary, salt marsh, mangrove, lagoon and coral reef
- **other aquaculture operations**: in particular their water supply (in terms of pollution or disease);
- **other resource users**: for example the quality and quantity of water available for agriculture or household use;

Note that in assessing significance, the cumulative effects of existing and likely future developments should be considered. On this basis, most coastal aquaculture operations, however small, would meet the criteria for IEE. This would represent a high cost and administrative burden, especially for developing countries, and further strengthens the argument for sector EA of coastal aquaculture. If done well, this broader assessment would remove the need for EIA of most aquaculture projects.

Box 7.1 When and how should EA be applied to coastal aquaculture?

All coastal aquaculture development should be subject to sector or regional EA, preferably as part of the development of an environmentally sustainable sector plan, or an integrated coastal management plan (ICM).

Sector EA should form the basis for developing screening criteria to determine which, if any, individual aquaculture projects should be subject to EIA, and the form that this assessment should take.

These criteria might, for example, relate to:
- location relative to sensitive natural habitat;
- location relative to other resource users;
- location relative to land/water use zones;
- size;
- design;
- technology;
- species;
- management practices.

7.4 Screening procedures and methods

Screening procedures should be developed as an output of sector EA. Decision criteria should be made explicit in legislation, regulations or guidelines, and they should be sufficiently clear to ensure that different analysts will arrive at similar conclusions. The clear and consistent use of screening procedures is the first vital step in encouraging sustainable proposals, and reducing the cost of unnecessary EAs.

Screening may include either or both of the following:

- project lists with/without thresholds;
- initial environmental examination.

7.4.1 Project lists and standard criteria

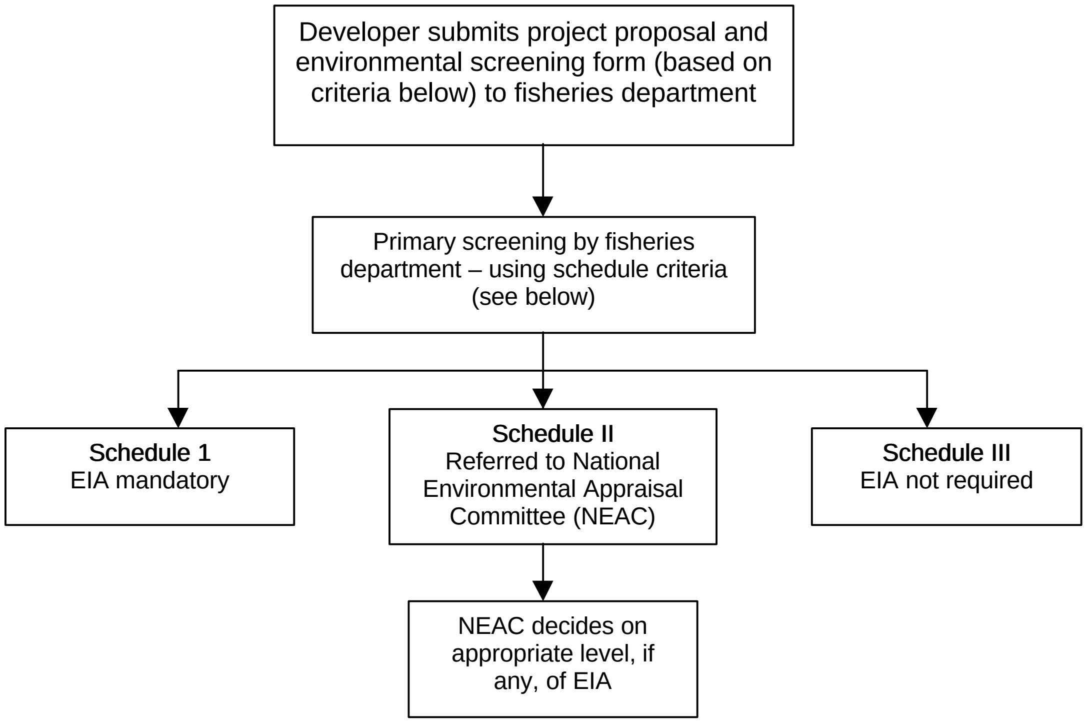
Certain types of proposal, as listed in regulations or guidelines, will be either included (inclusion list) or excluded (exclusion list). Specific threshold values, technology, or location may characterize the types. For example the following may be subject to either IEE, IEA, or full EIA:

- farms located outside aquaculture development zones;
- brackish-water pond aquaculture projects of > Xha ;
- cage farms with projected production > Xmt;
- farms located in or within Xm of sensitive natural habitat, such as mangrove or coral reef;
- farms located within X m of existing farms;
- brackish-water ponds located within < Xm of agriculture or bore-holes for domestic water supply;
- cages located in navigated waterways.

The actual threshold figures (represented above by X) should be based on local conditions, and developed as part of a sector or regional EA. Guidance on how to develop some of these figures is provided in sections 9 and 10. Criteria of this kind are simple, and once agreed (preferably drawing on significant public consultation), the process is virtually cost-free, the outcome is predictable, and both proponents and the general public can readily understand them. They may be used to define the need for EIA, or IEE, or the need to adhere to certain environmental management practices (as is done for example in Thailand). They can be adapted over time in the light of experience. In many ways they represent the best approach to screening aquaculture developments. However, they offer only limited response to the incremental and cumulative impacts commonly associated with aquaculture development, unless they are set within the context of a broader aquaculture or integrated coastal management plan.

For example, some countries have introduced standard size criteria for EA of aquaculture. In Sri Lanka for example, EA is required for aquaculture operations of more than 5 ha located in environmentally sensitive areas. However, farms close to this size usually do not (individually) have a significant impact, and are rarely turned down on the basis of an EA. Nor can compliance specified in any approval document be effectively monitored for a large number of individual farms. In Malaysia the size criterion is 40 ha, effectively excluding all small to medium scale aquaculture development. The value of the exercise is therefore questionable in both cases (see Case Study 2: EA of Aquaculture in Sri

Figure 7.1: Proposed screening of aquaculture projects in Belize (simplified)



Criteria for schedule classification

Schedule I (full EIA automatic)	Schedule II (secondary screening by NEAC)
• New mariculture ponds > 40ha; • New mariculture ponds abstracting > 45,460m^3 of seawater/day; • Finfish production in the intertidal or sub-littoral zones; • Any aquaculture project planning to use non-endemic species; • Any culture of seaweeds exceeding a total seabed area of 4 ha	• New mariculture ponds < 40.5ha; • New mariculture ponds abstracting < 45,460m^3 of seawater/day; • Any culture of seaweeds less than a total seabed area of 4 ha
Schedule III	
• Extensive (non nutritive input) culture of seaweeds or bivalves with an area not exceeding 2ha; • Aquaculture projects designed solely for subsistence use	

Adapted and simplified from Huntington and Dixon (1997)

Lanka) since it cannot effectively address the cumulative problems of highly concentrated but small-scale aquaculture development.

Location in relation to natural resources
Coastal aquaculture developments are commonly located in, or close to, estuarine, salt flat, mangrove, lagoon, or coral reef resources. These are valuable natural resources providing a wide variety of physical and ecological functions and services. They are also vulnerable to physical conversion and pollution. Farms located in such areas, or in particular land-use categories of such areas, might be automatically included in such lists (as is the case for example in Indonesia), unless specifically allowed for within an integrated coastal management plan, sector plan or district plan which has been subject to thorough strategic EA. This is the case for example in Indonesia.

Location in relation to other aquaculture developments
Coastal aquaculture is sometimes a victim of self (sector) pollution and spread of disease. It is arguable that any significant aquaculture development which is likely to share water supply or effluent channels with other farms should be subject to IEE, unless specifically allowed for within an integrated coastal management plan, sector plan or district plan which has been subject to thorough strategic EA.

Location in relation to other resource users
Brackish-water pond culture may affect the salinity of surface or ground-water, and may therefore affect drinking water supplies (as has happened for example in some parts of India) or agricultural activities (as has happened recently in Thailand). Any significant aquaculture development sited close to such uses should be subject to EA, unless specifically allowed for within an integrated coastal management plan, sector plan or district plan which has been subject to thorough strategic EA. Brackish-water pond culture may also restrict access and passage between villages and the coast, and may disrupt fishing activities. Again, if this is possible or likely, EA should be undertaken.

7.4.2 Initial Environmental Examination (Evaluation) IEE

Where there is uncertainty as to whether a full EA is required, an initial environmental examination can be undertaken. As noted above, this is probably the most appropriate response to any coastal aquaculture development project that is not specifically allowed for within a previously assessed ICM or sector planning framework. IEE’s are normally based on existing or readily available information. Although similar in content and structure to full EA’s, they address issues in much less detail, involve only limited quantification of impacts, and require less in the way of public involvement. As with full EIA’s, they may be used to improve design and management of proposed projects, whether or not full EIA is recommended. They can be applied at policy, programme or project level. Summary content of an IEE is presented in Box 7.2.

Several aid agencies use a form of IEE in respect of development programmes. An example is the UNDP Environmental Overview (UNDP 1992). Sri Lanka requires an IEE for all (official) aquaculture proposals (see case studies, Appendix 1)

Box 7.2 Typical procedure for an initial environmental examination (IEE)

- describe the proposal and examine alternatives that might improve the environmental outcomes;
- describe the environment and its vulnerability to development impacts;
- identify and address the concerns of the local community;
- identify and assess the potential environmental effects;
- assess the degree of uncertainty associated with possible impacts;
- identify ways to mitigate adverse effects and enhance potential benefits;
- define appropriate environmental objectives for the programme or project; and
- contain environmental monitoring and management plans.

7.4.3 Initial Environmental Assessment (IEA)

Some countries require an assessment for certain kinds of project, which lies between an IEE and a full scale EA. This may be referred to as Initial Environmental Assessment (IEA). A detailed checklist for what should be addressed in an IEA specifically for aquaculture projects is presented in Appendix 4. It draws extensively on the NORAD (1992) guidelines for initial environmental assessment of aquaculture. Detailed discussion of most of the impacts or mitigation measures listed in the checklist is provided in Section 9 (assessment) and Section 10 (mitigation). For an IEE these issues should be addressed in less detail than for a full EA, based on review of existing documents, and direct consultation with the widest possible range of stakeholders including local communities.

7.5 Clarity of procedure

Procedures for screening should be spelt out clearly in regulations or guidelines, so that proponents are aware of their obligations, and therefore design more environmentally sound proposals.

Scoping

Scoping is a process to identify and evaluate community and scientific concerns about a proposed policy, programme, project or action, so that they can be addressed systematically in the EA. The output from scoping usually includes detailed terms of reference for further work.

Whereas in the past this was seen as a largely technical matter, it is increasingly seen as a major opportunity for public involvement in the decision making process. Techniques for the communication and exchange of information and opinion (section 6) are therefore a vital part of scoping.

Contents

8 Scoping

8.1 *Objectives*

The objectives of scoping are:

- to identify community and scientific concerns about a proposed policy, programme, project or action;
- to evaluate these concerns to determine the key issues for the purpose of the environmental assessment (and to eliminate those issues which are not significant); and
- to organize and communicate these to assist in the analysis of issues and the ultimate making of decisions.

Scoping can apply equally to project, sector, regional or strategic EA. However, one of the outputs of a comprehensive sector EA should be a definition of the scope appropriate to individual project EIAs (see section 5), which might vary according to the type and scale of aquaculture development in different locations. In this way sector EA can be used to make project EIA more efficient or effective, or remove the need for it altogether.

As with other stages in the EA process, scoping can contribute to heightened awareness of the issues, and lead to improved policy, better development programming, or improved siting and design with respect to specific project proposals.

8.2 *Issues to be addressed*

The scoping exercise seeks to define - and reach agreement among the major stakeholders and technical specialists on - the overall scope of the assessment, in terms of:

- the range of zoning, siting, and technical alternatives to be assessed (see Box 8.1);
- the possible impacts which should be addressed;
- the criteria or standards to be used for assessing significance;
- the methodologies to be used, including the mechanisms, extent and role of public involvement;
- the information available and required;
- the spatial boundaries of the study;
- the time period over which impacts should be considered (for example should it address issues related to abandonment or

Box 8.1: Alternatives to be explored during scoping

- *location alternatives* (e.g. the location and boundaries of an aquaculture development zone; the location of associated infrastructure or services such as canals, processing or feed mills (sector EA); the location of a particular farm (project EIA));
- *activity alternatives* (e.g. different aquaculture species or technologies);
- *input alternatives* (e.g. feed, fertilizer, chemicals).
- *demand alternatives* (e.g. using energy, food, or other resources more efficiently);
- *process or management alternatives* (e.g. water treatment or re-use; feed management; disease management); and
- *scheduling alternatives* (where a number of measures might play a part in an overall programme, but the order in which they are scheduled will contribute to the overall effectiveness of the end result);

Aadapted from UNEP (1996)

after use?).
- the kinds of mitigation which should be explored.

By gaining consensus on the scope of the study, much irrelevant data collection and analysis can be avoided, and time and effort saved. It is also an opportunity to inform stakeholders about the policy, programme or project, the EA, and its objectives, and to obtain some preliminary knowledge of the local area, including in particular local concerns and values. It is clear (in retrospect) that one of the weaknesses of the Rufiji EIA (Box 6.5) was a late and rather limited public involvement in scoping.

TOR for the EA are normally the main output from the scoping exercise, supplemented in some cases with a more detailed consultant brief.

8.3 Process

Typical steps or stages in the scoping process are presented in Box 8.2. These should be considered as indicative only, and should be tailored to the type of EA, and local circumstances.

Scoping is a process of interaction between the interested public, government agencies, technical specialists and proponents. Public and expert consultation and participation (see section 6), coupled with a preliminary analysis of existing documentation, are key tools for scoping.

Draft TOR may serve a useful function in the consultation process. The final TOR should be detailed, but flexible, to be adapted if required and agreed.

Scoping offers an important opportunity for an initial appraisal of alternatives in terms of zoning, siting, design and management, and appropriate modifications to the plan or proposal (Box 8.1).

Particular attention should be paid to secondary and higher order impacts, and the extent to which these should be covered in the assessment.

In addition to the specific scoping stage, scoping should be undertaken as an on-going part of all subsequent stages, so that the focus and boundaries of the effort can be defined and agreed.

Box 8.2 Typical steps in scoping
(Ridgeway et al 1996)

1. Prepare an outline of the scope, with headings such as:
   - objectives and description of the proposal
   - the context and setting of the proposal
   - constraints
   - alternatives
   - issues
   - public involvement (in scope), and
   - timetable
2. Further develop the outline of the scope through discussion with the proponent, the EIA authority, and other key stakeholders and government agencies, assembling available information, and identifying information gaps.
3. Make the outline and supporting information available to those whose views are to be obtained.
4. Identify the issues of concern.
5. Evaluate the concerns from both a technical and subjective perspective, seeking to assign priority to the more important issues.
6. Amend the outline to incorporate the agreed suggestions.
7. Develop a strategy for addressing and resolving each key issue, including information requirements and terms of reference for further studies.
8. Provide feedback on the way comments have been incorporated.

8.4 Responsibility and administration

Depending upon the EA system, responsibility for scoping may lie with the proponent, or with the EA authority, or with an expert group set up for the purpose. Some authority will be designated with responsibility for ensuring that the completed EA meets the agreed scope or TOR.

8.5 Terms of reference (TOR) and consultant brief

The main output from scoping is normally, TOR and in some cases a more detailed consultant brief presenting the findings, and defining the scope for the EA study.

In practice, the purpose of EA as presented in sections 5.1.1(sector EA) or 5.2.1(project EIA) coupled with the outputs described in sections 5.1.3 and 5.2.3 respectively, should provide the broad basis or outline for the TOR. These should then be refined, and made more specific and relevant on the basis of the scoping exercise. Detail relating to specific methodologies or approaches, if required, may be based on an appraisal of relevant techniques described in sections 9 and 10. A broad outline for TOR for project EIA is presented in box 8.3.

In some cases relatively detailed requirements in terms of public involvement may be laid down. The Terms of Reference can also contain various matters relating to project management, such as:

- the proposed study schedule;
- the budget allowed for the study;
- the expected outputs (interim and final reports, format of the environmental impact statement, number of copies); and
- the basis on which variations to the brief will be negotiated.

Box 8.3: Broad outline for TOR of a project EIA

- background to the proposal;
- the context (summary of the proposal, objectives of the EA, cooperation amongst jurisdictions, legal/policy basis and institutional capacity for EA);
- alternatives (to, and within, the plan, program or project);
- relevant institutions and public involvement;
- required information and data (project description, description of environment, quality of information);
- analysis of impacts (positive, negative: natural resources, human resources, relocation and compensation, cumulative impacts, trans-boundary impacts, impact significance);
- mitigation and monitoring (impact management plan, environmental monitoring plan); and
- conclusions and recommendations (project decision, technical matters, non-technical summary).

(adapted from OECD 1994)

Assessing

Assessment is the core of EA, and involves identifying and defining more clearly the impacts that are to be investigated in detail, and analyzing these impacts in terms of their major characteristics and significance.

Assessing usually involves a range of techniques from baseline data collection to modeling, and in some cases decision analysis.

Although many of the techniques are widely agreed, there is debate about the way in which different kinds of information (relating to social, environmental and economic impacts; or to impacts through time or space) can be presented or aggregated to provide an overall indication of impact significance or sustainability.

Contents

9 Assessing

This is the core of EA and may require significant resources.

9.1 Objectives

- identifying and defining more specifically the impacts that are to be investigated in detail;
- analyzing impacts: the collection of baseline data; the important characteristics of impacts and the range of different analytical techniques; and
- determining impact significance or acceptability.

(UNEP 1996)

9.2 Impact identification

This stage involves confirming the existence or relevance of impacts identified during the screening and scoping stages, and going beyond this to identify additional impacts which may be direct, indirect or cumulative. It involves gaining a better understanding of the nature of these impacts and their causes.

The range of impacts considered in EA has broadened substantially in recent years to include social, health, economic and other issues. OECD/DAC (1994) defined environment for the purposes of EA to include:

- effects on human health, well-being, environmental media, ecosystems and agriculture;
- effects on climate and the atmosphere;
- use of natural resources (regenerative and mineral);
- utilization and disposal of residues and wastes; and
- resettlement, archaeological sites, landscape, monuments and social consequences as well as upstream, downstream and trans-boundary effects.

Box 9.1 Examples of positive and negative higher order Impacts

Positive. Coastal aquaculture commonly results in the release of nutrients and organic matter to coastal waters. While this may cause some local problems if the loading is high or concentrated, there is also evidence (for example from S Thailand) that it has resulted in increased production of bivalve molluscs in some places, and boosted the local fishery.

Negative. The development of coastal aquaculture commonly involves the sale, allocation (by government), or appropriation of coastal resources, which may previously have been common access or subject to community control. Those previously dependent on such resources may be forced to over-exploit adjacent resources, or develop new resources, with complex and in some cases damaging impact on the natural resource base.

It is particularly important, and difficult (except with hindsight) to identify higher order impacts and confirm the links or relationships with particular activities (Box 9.1). There are often complex social-environment interactions and many ecological feedback loops. Possible links may be promoted and publicized by particular interest groups. It is essential that the EA team identifies all possible impacts of this kind objectively, and is not excessively influenced by particular groups or interests.

This implies the need for a structured and systematic approach to impact identification and improved understanding of their causes. These approaches also usually help in the presentation of information in the report. They are described in the following section.

9.2.1 Tools for impact identification

The most common methods or tools for impact identification are:

- professional and technical experience
- checklists
- matrices
- networks
- overlays and geographic information systems (GIS)
- expert systems

(UNEP 1996)

These may be used together or alone. Most can also be used to help analyze and assign significance to different impacts. The particular mix will depend on local circumstances, resources, team experience, and the nature of public involvement. It may be useful to "pilot" a particular technique to see whether it is useful in meeting the objectives of the EA. The advantages and disadvantages of the different techniques are presented in table 9.1

Table 9.1: Advantages and disadvantages of different impact identification methods

Tool	Advantages	Disadvantages
checklists	• simple • good for site selection and priority setting	• do not distinguish direct and indirect impacts • do not link action and impact • incorporation of values can be controversial
matrices	• link action to impact • good for displaying results	• difficult to distinguish direct and indirect impacts • may "double count" impacts
networks	• link action to impact; • checking for 2nd order impacts; • handles direct and indirect impacts	• can become very complex
overlays	• simple • good display • good for siting issues	• address only direct impacts • do not address impact duration or probability
GIS	• good for impact identification and analysis; • good for "what if"	• heavy reliance on knowledge and data; • complex and expensive

(after UNEP 1996)

Professional and technical experience

Although impacts are likely to be different in different places, a great deal of international experience has now been built up on the social and environmental impacts of many different forms of aquaculture. This is summarized in table 9.3 below, and in more detail in Appendix 5.

However, these cannot in any way substitute for the breadth of understanding, and ability to interpret and focus on key issues, which is the hallmark of a skilled and experienced professional with broad experience of the sector in a variety of natural environments and socio-economic contexts.

Checklists

Checklists are the basic tool for environmental assessment, and can be steadily developed and refined on the basis of both local and international experience. A checklist for IEA of aquaculture is provided in Appendix 4.

Checklists however have some limitations, and in particular, they are not effective for the identification of locally unique higher order impacts, or the relationships between impacts, or the relationships between impacts and project/plan activities.

Matrices

Matrices are used to identify the interaction between project activities and environmental features or characteristics. They are also of great value as a framework for discussions and exercises in workshops, and in presentations. Each cell can be used to describe the interaction in terms of its nature, severity, and significance. The cells may contain comments, or summaries presented in terms of numbers, symbols, shades or colours. Impacts may also be related to possible mitigation measures. A specific example of a simple matrix is presented in Table 9.2. This was designed to identify and explore a range of possible impacts within a systematic framework, and to serve as the basis for discussion and further research.

Networks

Networks are used to illustrate the complex links between aquaculture developments and environmental features or characteristics. They are particularly useful for identifying, presenting, and discussing higher order impacts and interactions.

A simple network illustrating some of the interactions between a hypothetical shrimp aquaculture development and the environment is presented in Figure 9.1. More detailed information based on local conditions should be presented in such networks, such as the probability of a link or impact, and the scale or quantification of the impact. Very detailed networks can be produced, but they are time consuming and can be difficult to interpret.

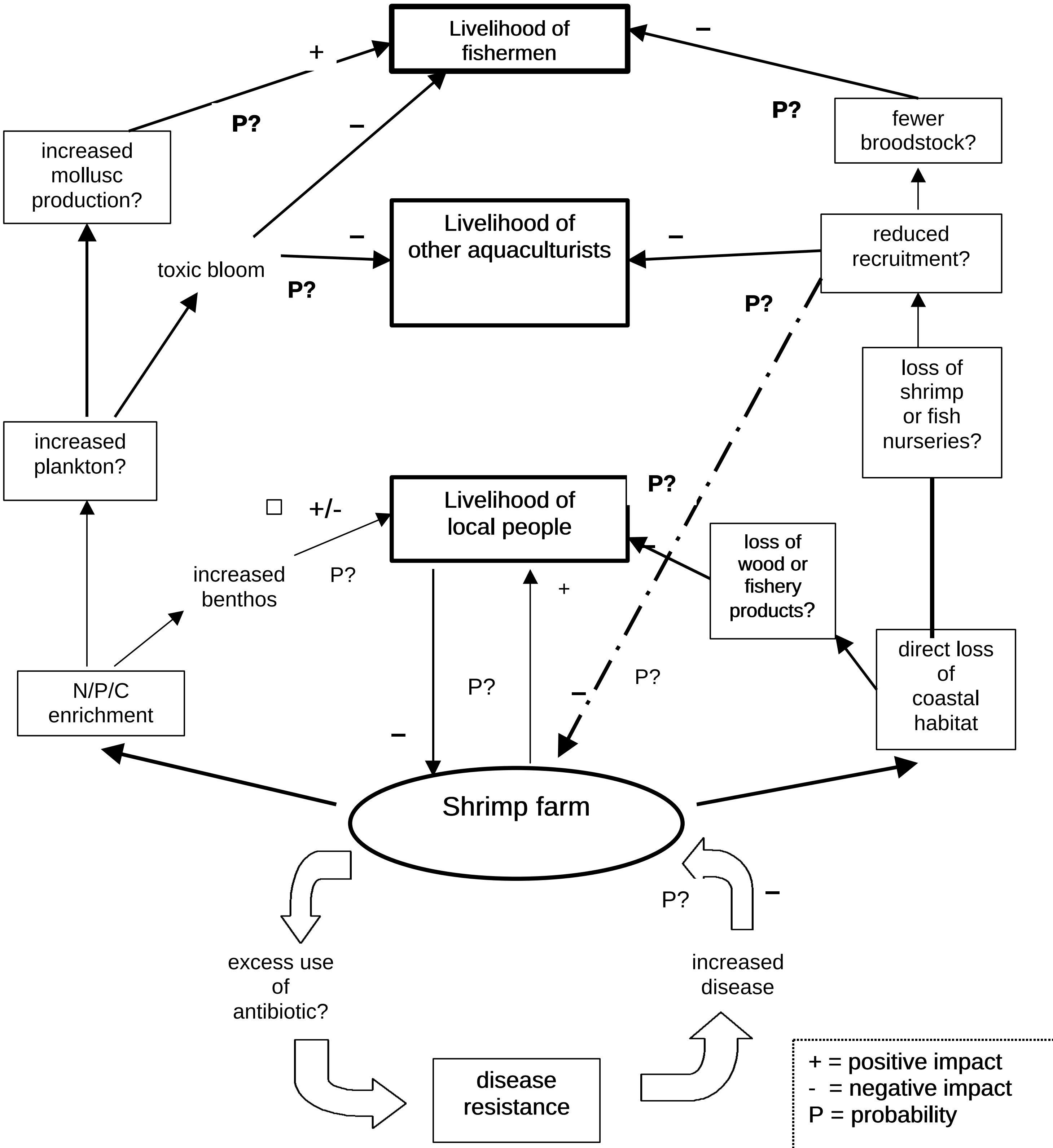
Overlays and Geographic Information Systems (GIS)

Overlay of different maps presenting different kinds of environmental data (e.g. land quality, land use, salinity regimes, population, existing activities, proposed activities etc) on a transparent background, is a simple and powerful tool for the analysis and presentation of data relating to environmental impacts and their interactions. It is suited to all kinds of assessment but especially to sector or regional EA.

Table 9.2: Example of matrix used as a summary of potential impacts of a proposed shrimp farm development in Tanzania
(adapted from AIT 1995)

	Natural function and conservation value	Commercial function/uses		Possible physical impact from proposed farm	Possible biological impact	Possible economic impact	Affected groups or communities
		actual	*potential*				
Ecosystem							
mangrove	coastal protection, sediment trap, nursery medium-high conservation value; migrant birds etc	poles, fuel, charcoal, bait, manufactures; shellfish, fishery nursery,	tourism; conversion to rice/arable; conversion to salt production; new organic chemical products (eg drugs, dyes etc)	locally increased water flow; increased salinity in dry season; increased nutrient; reduced oxygen; increased organic sediment; increased inorganic sediment (construction phase); pH change?	mangrove species change?; other species change? increased productivity; positive or negative effects on nursery areas?	increased commercial yield of mangrove products? Improved coastal protection? probably insignificant	artisanal fishermen; offshore shrimp fishermen; mangrove wood collectors (charcoal, poles, manufactures, firewood); villagers (subsistence products); charcoal manufacturers
river system	hippo, crocodile etc...	FW fishery		increased salinity in dry season; increased nutrient; increased organic sediment (if no settling); piscicides?	possible increased productivity; possible shift in species composition; accidental fish kills?	probably insignificant	river fishermen, tourist operators
estuarine system		fisheries: milkfish; mud-crab; shellfish		little	little	probably insignificant	coastal fishermen
seagrass	nursery for coral reef and offshore species	nursery for coral reef and offshore species		possible slight impact of sediments in absence of settling	possible loss of fisheries	probably insignificant	coastal and offshore fishermen
coral reef (to the South of estuary)		tourism	more tourism	Possible suspended solids in absence of settling, but N flowing currents imply low risk	Fouling and loss of corals	probably insignificant	reef fishermen; tourist operators; collectors
floodplain grassland and scrub		rice salt	variety of arable arable etc	local loss (up to 160 ha)		probably insignificant	
wider environment				antibiotics; nutrients	antibiotic resistance? red tides?	?	?

Figure 9.1: Example of a network presentation of the environmental effects of aquaculture:
Some possible interactions between shrimp farming and the environment



The computerized version, known as GIS, is in essence a spatially referenced database, and adds flexibility of presentation, massive data storage capacity, and a range of analytical tools.

GIS is a powerful and increasingly accessible tool for environmental assessment and planning. It is particularly appropriate for sector or regional EA since spatial and locational considerations play a key part in these assessments. Furthermore, since they, and the planning processes with which they are associated, are regular exercises, the initial costs of setting up GIS (an in particular inputting data) can be spread over a range of planning and assessment exercises through time and space.

Some “warnings” are however appropriate. GIS and remote sensing are attractive and seductive technologies, and sometimes become a costly “end in themselves” rather than being developed, refined and focused for assessment and decision making purposes.

There are several examples of the application of GIS to regional or programme level planning for aquaculture development (see bibliography), and at least one related to environmental assessment of shrimp farming at the regional/sector level (McPadden 1993, Hambrey 1993).

9.3 Impacts associated with coastal aquaculture

Clearly the actual impacts will vary according to location and development context, but a good deal of experience has now been built up relating to aquaculture impacts throughout the world, and these (both positive and negative) are summarized in Table 9.3. This information is presented in more detail in Appendix 5, where the following matrices can be found:

- matrix for impact identification and mitigation: hatchery;
- matrix for impact identification and mitigation: brackish-water pond aquaculture;
- matrix for impact identification and mitigation: coastal cage or pen culture;
- matrix for impact identification and mitigation: seaweed and mollusc culture

This information is based on a wide range of publications and author experience relating to the environmental impacts on aquaculture, and represents accumulated experience over many years from many parts of the world.

9.3.1 Impacts on biodiversity, ecosystem functioning and natural resources

These are generally easy to identify, but much more difficult to analyze (see below). Thus habitat loss or water quality change is easy to describe, but very hard to analyze objectively in terms of impact on economic activity and/or long term significance. The matrix presented in table 9.2 provides a graphic illustration of how difficult it is to translate physical effects into biological and ultimately economic impacts.

Although biodiversity may be quantified at various levels (for example in terms of number of species in a particular area, or in terms of genetic diversity within species), it is hard or impossible to assess what the impact of local habitat conversion, or a slight change in water quality, will be on this quantity.

The main biodiversity and natural resource impacts associated with coastal aquaculture are summarized in Table 9.3.

9.3.2 Social impacts

Ultimately all environmental impacts are social in so far as they only have significance when set against cultural values and the quality of life. Some of those, which may be associated with aquaculture, are given in Table 9.3.

Social impacts or effects are “alterations in the way people live, work, play, relate to each other and organize to meet their needs, as well as changes in the values, beliefs and norms that characterize their 'group' and guide their individual and collective actions (UNEP 1996).

Social impacts may be categorized as follows:

- demographic impacts such as changes in population numbers, population characteristics (such as sex ratio, age structure, in-and-out migration rates and resultant demand for social services, hospital beds, school places, housing etc);
- cultural resource impacts including changes in archaeological, historical and cultural artifacts and structures and environmental features with religious or ritual significance; and
- socio-cultural impacts including changes in social structures, social organizations, social relationships and accompanying cultural and value systems (language, dress, religious beliefs and rituals).

Information on most of these impacts is collected through the public involvement programme. It is recommended that social scientists, preferably with considerable local knowledge, lead any public involvement programme and analyse the information generated related to social impacts. However, they should work closely with biophysical scientists or economists working on the team.

Table 9.3: Positive and negative Impacts sometimes associated with coastal aquaculture

negative impact	causes
• on and off site damage to natural resources; - associated social conflict	• direct conversion of semi-natural habitat, or land used for other purposes; • indirect impacts: - organic or chemical pollution; - introduction of salt water -over-exploitation of capture fishery resources for fish-meal or trash fish supply;
• on and off site damage to sites of cultural or aesthetic value	• as above
• over exploitation of wild seed or broodstock	• poor fisheries management; • lack of hatchery production
• loss of biodiversity and wetland habitat	• direct conversion; • changes to hydrology; • organic and chemical pollution; • displacement of resource users, resulting in increased human pressure elsewhere
• water pollution	• poor nutrient (food or fertilizer) conversion; • poor water and sediment management
• changes to hydrology or salinity	• water extraction, use and management
• solid waste production and disposal	• poor food conversion; • poor pond water management; • poor pond sediment management; • poor waste disposal
• social inequity	• land/resource appropriation for aquaculture development; • rapid increase in income for successful farmers; • increased cost of land or resources related to profitable aquaculture
• demographic impacts	• use of significant outside labour or technical expertise
• aesthetic impacts	• direct conversion; • extraction activities; • structures
• impact on worker health	• pesticides, disinfectants, antibiotics; • water borne disease
• disease spread	• poor husbandry and stressed stock; • mixed influent and effluent water; • exchange of water between farms; • diseased seed; diseased broodstock; • stock movements
• genetic pollution	• introduction of new species; • introduction of new races; • introduction of associated organisms including disease
• noise and disturbance during construction	• pond, cage or building construction
• secondary impacts at materials extraction sites	• removal of (eg dyke) materials from borrow pits
• secondary impacts on product quality	• chemical and antibiotic residues in product
positive impact	**cause**
• increased natural productivity in coastal waters and wetlands, including mangrove	• nutrients and organic matter released at moderate concentrations to the coastal environment from semi-intensive and intensive shrimp and fin-fish culture
• reduced plankton and nutrient loadings in coastal waters	• filter feeding of farmed molluscs and planktivorous fish; • nutrient uptake by seaweed culture
• reduced extractive/exploitative pressure on semi-natural habitat	• provision of alternative employment and income generation
• increased individual and communal income	• high profitability of some forms of aquaculture; • increased spending in local economy
• employment generation	• aquaculture often supports a relatively high rate of employment per unit land
• training and education	• directly related to specific enterprises; • secondary effect from increased income
• stock enhancement	• hatchery production of over-exploited or endangered species
• increased bio-diversity	• greater structural habitat diversity related to pond and canal construction

9.3.3 Health impacts

Health impacts can be extremely disruptive and costly and should be assessed as early as possible in the EA exercise. There have been few health impacts formally reported for aquaculture, but some activities may be associated with health risks (Box 9.2), and should be explored in more detail. As for other kinds of impact, they may be direct or indirect. With respect to residual chemicals in aquaculture products, a recent paper by WHO (1998) concludes that overall the risks to food safety from disease treatment chemicals in aquaculture are negligible, provided good aquaculture management practices (such as withdrawal times, treatment using recommended doses, approved chemicals) are observed. A list of chemicals which are commonly used in intensive aquaculture, and their known effects and levels of risk, are presented in Appendix 9

Box 9.2: Examples of possible health impacts associated with coastal aquaculture

Direct:

- Use of dangerous chemicals and antibiotics (eg chloramphenicol) in hatcheries;
- Antibiotic residues in marketed aquaculture products

Indirect:

- Development of antibiotic resistance in shrimp, and possibly human, pathogens;
- Increased incidence of toxic phytoplankton blooms and associated fish and shellfish poisoning;
- Reduced access of poor people to coastal fish and shellfish resources, and consequent reduced intake of high quality protein.

9.3.4 Economic and fiscal impacts

Any significant policy, programme or project is likely (indeed is intended) to affect employment, business activity, and levels of regional or individual income, and these may in turn cause social impacts.

Fiscal impacts are the changes in costs and revenues of different government sectors resulting for example from demographic changes and associated changes in tax revenue and demand for infrastructure and services.

Some of these effects can be analyzed and predicted using standard economic techniques such as input-output models. Increasingly, as EA is integrated with sector analysis, policy development, integrated coastal management, local planning, and project appraisal, these economic analyses will be a normal part of the

Box 9.3: Factors affecting economic and fiscal impacts

Factors affecting economic impacts

- duration of construction and operational periods;
- workforce requirements for each period and phase of construction including numbers to be employed during the peak phase for construction works;
- skill requirements (local availability);
- earning;
- raw material and other input purchases;
- capital investment;
- outputs; and
- the characteristics of the local economy.

Factors affecting fiscal impacts

- size of investment and workforce requirements;
- capacity of existing service delivery and infrastructure systems;
- local/regional tax or other revenue raising processes; and
- likely demographic changes arising from project requirements (these need to be estimated during the assessment of social impacts).

(from UNEP 1996)

overall analysis.

9.4 Impact analysis

9.4.1 Overview

Impact analysis can become very complex and time consuming. It is therefore important that the methods used in impact analysis, and the detail of the analysis, should be in proportion to the scope of the assessment and the relative importance of the impact.

Assessments should be quantitative where possible. Simple description is the only realistic and "transparent" approach for some impacts, but these descriptions must be as focused and precise as possible.

In order to assess impacts there must be a *baseline* or *standard* to measure against. Describing baseline conditions can easily get out of hand. Baseline description should therefore always relate to *significant* impacts, and must be developed in parallel with impact analysis. It may be desirable to restrict the length of the baseline description. It may also be necessary to predict a "future (at time of implementation) baseline", taking into account trends, and other developments.

There are typically three closely related stages in impact analysis:

1. characterization;
2. quantification and prediction; and
3. assigning significance.

9.4.2 Impact characteristics

Impacts vary in:

- nature (positive, negative, direct, indirect, cumulative, synergistic with others);
- magnitude;
- extent/location (area/volume covered, distribution);
- timing (during construction, operation, decommissioning, immediate, delayed, rate of change);
- duration (short term, long term, intermittent, continuous);
- reversibility/irreversibility;
- likelihood (risk, uncertainty or confidence in the prediction); and
- significance (local, regional, global).

(UNEP 1996)

They can be described or ranked in terms of these various attributes.

Nature

It is self evident that impacts can be *positive or negative*, and both should be considered in an EA (examples are presented in box 9.1).

Direct impacts are those that occur at the same time as some activity, for example habitat conversion, or increase in nutrients or organic matter in receiving water.

Indirect or higher order impacts are less obvious and may occur at a different time or place from the activity that causes them. An example is the positive or negative impacts of nutrient discharges on a fishery or shell-fishery.

Cumulative impacts are those that are insignificant when considered in isolation but which may accumulate through both time and space. For example, occasional use of antibiotics on one small fish farm may have negligible impact, but if done by a large number of small farms, or if done regularly over a long period of time, pathogen resistance may develop, and the overall impact may be serious. Many of the small impacts associated with coastal aquaculture are cumulative in nature.

Magnitude

The size of an impact is obviously important, and should be measured where possible. It is a relatively straightforward matter to calculate the magnitude of some of the causes of impacts from coastal aquaculture. It is more difficult to estimate the magnitude of any direct physical or ecological impacts, and it is usually very difficult to quantify indirect physical, ecological and social impacts. For example the nutrient (N, P, organic matter) loading from an intensive brackish-water pond can be calculated relatively simply (Box 9.4 and Appendix 6). The effects of this loading on nutrient levels in the soil or waterways is more difficult to assess in most “real world” situations (Appendix 7). And the impacts of these nutrients on ecology, fishery production, and the livelihoods of other resource users are usually extremely difficult to assess quantitatively or qualitatively.

In some cases, although it may be relatively straightforward to make detailed and accurate calculations on direct effects, the inability to translate these into impacts of relevance to the stakeholders, or to relate them in any way to the concepts of sustainability, may make such calculations largely worthless.

Extent and location

An indication of the location, distribution, and size of the areas to be affected should be given for each impact.

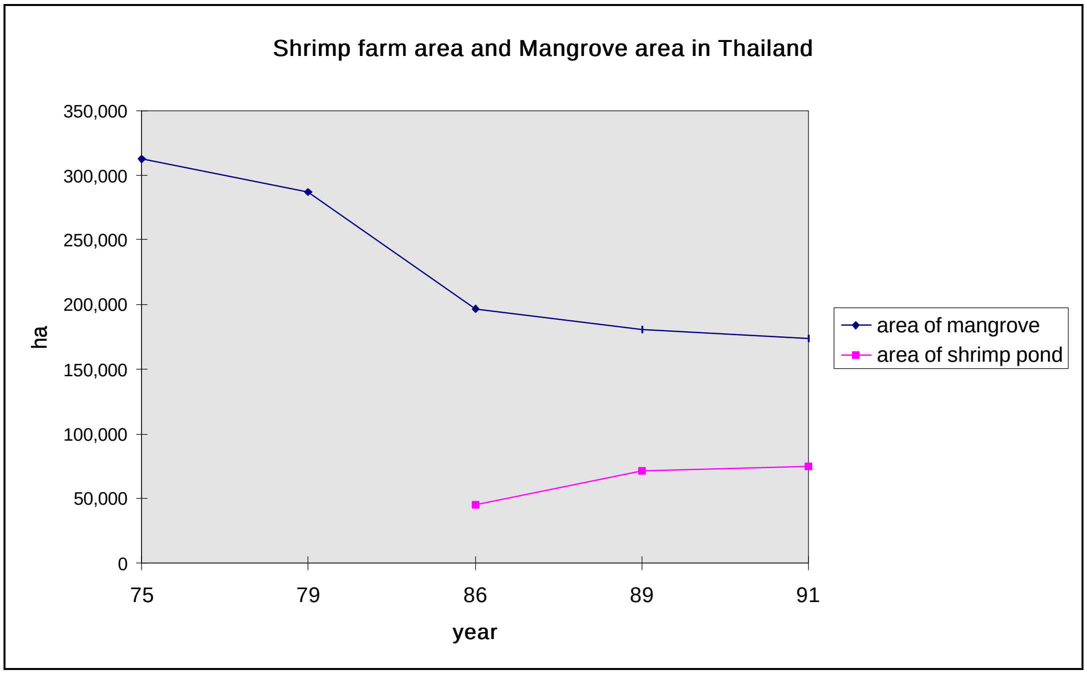
Assessing the extent of direct habitat conversion for aquaculture development appears at first sight to be a relatively straightforward matter. However, two important factors should be taken into account. Firstly, the effects are likely to be cumulative. If one farm is successful, others are likely to follow, and however small they may be the cumulative effect may be substantial.

Secondly, as with all impacts, it is necessary to compare the predicted impacts against a baseline, which may be moving. Figure 9.2 shows the loss of mangrove habitat in Thailand over a period of years when shrimp farming was developing rapidly. In practice shrimp farming was one of many activities leading to the destruction of mangrove (others were over-exploitation for charcoal and firewood, conversion for salt farming and agriculture, and rapid urban and industrial development. This has two important implications:

- correlation does not mean there is a causal link;

- taken alone the impact of shrimp farming may have been acceptable, but together with other factors it was (in retrospect) unacceptable, and conversion for aquaculture is now illegal.

Figure 9.2 Mangrove destruction and shrimp farm development in Thailand



Assessing the direct and indirect effects of nutrient loadings from intensive aquaculture has been referred to in the previous section, and methods for calculating the location and extent of the effects are also considered in Appendices 6-8. The importance of allowing for a probable upward baseline trend in nutrients in coastal waters should also be stressed.

Timing

Impacts will take place during site preparation, construction, operation, and in some cases post-operation. Furthermore, some of the effects will be immediate, while others will be delayed, in some cases for many years.

Duration

Impacts may be short term, long term, or intermittent. For example the immediate impacts of site preparation are likely to be short term, while the accumulation of organic matter in the immediate environment, or the release of antibiotics to the wider environment may have long term effects. Introduction of new species could have indefinite effects.

Reversibility

Some impacts may be relatively temporary, and the environment may revert to its previous state relatively easily and quickly. The release of phosphorus and nitrogen is likely to cause effects which are rapidly reversible. The build up of organic matter is also likely to be reversible, but over a longer period. The loss of mangrove or coral reef is also reversible, but it may be many years before the habitat regains its former biodiversity. Reversible impacts are generally amenable to restoration, in other words, specific actions may speed up the process or reversion.

Likelihood (risk) and uncertainty

It is important to distinguish between risk and uncertainty. If an impact may or may not happen there is a risk associated with it. If the probability of this impact is known, then the risk is quantifiable. If the probability of the impact is unknown, then we are dealing with uncertainty, which is far more difficult to quantify.

For example, the probability of achieving a particular food conversion rate on an intensive farm could be estimated from industry surveys, and the probability of associated nutrient loading then calculated. Disease, and the use of antibiotics are much less easy to predict, and is therefore associated with considerable uncertainty. The impacts associated with introducing new species or varieties of fish are likely to be extremely uncertain.

The level of uncertainty also tends to be much higher with secondary or higher order impacts.

Some effects are low risk but potentially high impact. Some species introductions may fall into this category.

9.4.3 Quantification and prediction

The impacts can be predicted using a variety of methods including:

- professional judgement;
- quantitative mathematical models;
- experiments, physical models; and
- case studies

It should be noted that quantification is often extremely difficult. For example, quantifying the impact on biodiversity can be almost impossible, except at the crudest level of habitat area.

Professional judgement

All forms of analysis involve some degree of professional judgement. However, this should be used as far as possible with systematic tools. The role of professional judgement becomes more important with indirect and especially social effects. Professional judgement may have a significant effect on the outcome of the assessment.

Professional judgement should be restricted as far as possible to very experienced and respected practitioners with detailed knowledge of the issues, local conditions, and type of policy or project.

Quantitative mathematical models

Mathematical models can be readily developed to describe or simulate some aspect of reality. The calculation in box 9.4 is an example of a very simple model for predicting the nutrient discharges from aquaculture. More complex hydrological models for predicting nutrient concentrations in receiving waters are presented in Appendix 7. Sophisticated computer based hydrological models are available commercially. Increasingly, these physical models can be linked to biological, economic and sometimes social models.

Whenever using mathematical models, of whatever complexity, the basic nature of the model must be clearly described, and all significant assumptions (especially those associated with a high degree of uncertainty) must be clearly stated.

Models have the enormous advantage that they can be used repeatedly to address "what if" type questions, based on varying parameters and input values. Furthermore, the analysis is by definition repeatable and comparable.

Box 9.4 Simple quantitative model: output of phosphorus and nitrogen from an intensive brackish-water pond

Total projected production	P
Food conversion ratio	FCR
Total food required	= P*FCR
Nitrogen content of feed	= Nf
Total nitrogen to pond	=Nf*(P*FCR)
Nitrogen content of fish or shrimp	=Ns
Nitrogen harvested in crop	=Ns*P
Nitrogen retained in pond sediment	=R
Nitrogen in farm effluent =(Nf*(P*FCR))-(Ns*P)-R	

For a dry pellet formulated feed, and reasonable food conversion, these calculations will typically yield figures of around 60-120kg nitrogen and 15-30kg phosphorus waste per tonne production.

Typical measured values, and a full sample calculation is presented in Appendix 6

Surveys of similar enterprises

There have been many surveys of the environmental impacts of aquaculture in recent years. In particular a good deal of information has been collected on the release of nutrients to the environment from intensive coastal aquaculture. This work is summarized in Appendix 6, and may be used for rough assessments of nutrient loading. These figures, especially those related to nutrient *concentrations*, should be used with care. Actual loading will vary enormously according to feed quality, feed management, water and sediment management, and general husbandry practices, and should be modified according to the nature of the proposal. These variations form the basis of many of the mitigation measures presented in section 10.

Sensitivity analysis

Large changes in the magnitude of some impacts may result in relatively insignificant environmental changes, while small changes in others may result in major environmental effects. This can be analyzed or presented by comparing the percentage change in a direct impact (e.g. nutrient loading) with the likely percentage change in the environmental effect. An example of calculating the percentage change in concentration of a nutrient in a receiving water following a doubling of nutrient loading from a farm is given in Appendix 7.

Experiments and physical models

Experiments and physical models are rarely used to assess impacts related to aquaculture. However there have, for example, been some experiments on the reversibility of mangrove destruction. Mangrove has been replanted in old shrimp ponds with considerable success (see section 10, mitigation). Physical models might also be used to model the impact of effluent from the whole aquaculture sector in a particular estuary or bay. Such procedures are well developed in relation to major industrial projects. However, physical modeling in relation to specific aquaculture developments is probably unnecessary and excessively costly.

Case studies
Case studies of policy or project impacts on the environment, or environmental assessments relating to similar policies or projects in similar environments elsewhere provide important clues as to the kinds of impacts which may be expected, and the ways in which they can be mitigated.

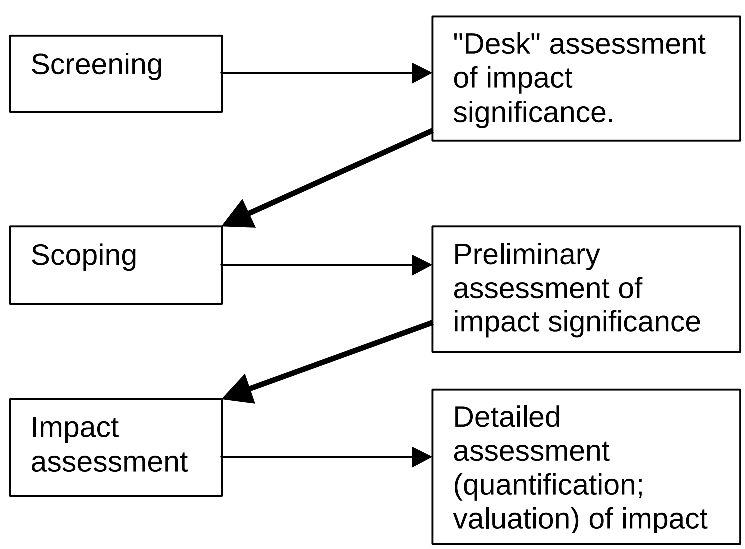
A set of case studies relating to coastal aquaculture developments in developing countries are presented in Appendix 1.

9.4.4 Significance

Once impacts have been identified and analyzed, their significance must be assessed. Significance only has real meaning if it can be agreed, and this implies a statement of values, which may be translated into specific criteria for use in decision making. An impact may be measured against some accepted standard or criteria (such as maximum nitrogen concentration in a waterway, or total allowable reduction in area of mangrove). It may also be measured against a more fundamental concept such as environmental capacity or sustainability.

The process
Significance assessment should be an ***iterative*** process (Figure 9.3). A preliminary assessment of significance is made at an early stage (screening and scoping) in order to define priorities for more detailed analysis; a preliminary analysis may then run counter to the original assessment of significance and further analysis may be downgraded or increased as appropriate. In this way the detail of the analysis should reflect the evolving assessment of significance.

Figure 9.3 Assessment of significance - an iterative process



In order to assess significance, the characteristics – which will as far as possible have been quantified – are compared with, or multiplied by their value. In the most straightforward cases the value can be expressed in financial or economic terms and can be multiplied by the effect. For example an impact may result in a decrease or increase in fisheries yield, and the value of the fishery may be relatively easy to determine. Unfortunately the significance of most impacts is much more difficult to assess, since they are commonly difficult to quantify, and the valuation may be highly subjective, and vary between different stakeholders. This is why public involvement has an important role to play in the assignment of significance to different impacts.

Box 9.5 Example of water quality standards which can be used as significance criteria

Tolerance limits for aquaculture wastewaters discharged into inland surface or marine coastal water in Sri Lanka (*source NACA*

Parameter	Values (not to exceed)	
	Inland Surface	Marine Coastal
BOD_5 (5 days at 20°C) mg/l	30	50
COD (mg/l)	250	250
PH	6.0 - 8.5	6.0 - 8.5
Suspended solids (mg/l)	50	100
Temperature (°C)	30	35 at point of discharge
Oil and grease (mg/l)	10	20
Total Nitrogen (mg/l)	2.0	2.0
Phosphate (mg/l)	2.0	2.0
Phenolic compounds (mg/l)	1.0	5.0
Cyanides (mg/l)	0.2	0.2
Sulphides (mg/l)	2.0	5.0
Fluroides (mg/l)	1.0	1.0
Total residual chlorine (mg/l)	1.0	1.0
Arsenic (mg/l)	0.2	0.2
Cadmium (mg/l)	0.1	2.0
Chromium (mg/l)	0.1	1.0
Copper (mg/l)	3.0	3.0
Lead (mg/l)	0.1	1.0
Mercury (mg/l)	0.0005	0.01
Nickel (mg/l)	3.0	5.0
Selenium (mg/l)	0.05	0.05
Zinc (mg/l)	5.0	5.0
Pesticides	Absent	Absent
Radioactive materials		
Alpha emitters (μc/ml)	10^{-7}	10^{-8}
Beta emitters (μc/ml)	10^{-6}	10^{-7}

Standards

One way round this problem of subjectivity is to compare impacts with existing or proposed "standards", such as water quality standards (an example is presented in Box 9.5). Pre-defined environmental quality standards for a range of parameters in particular areas or zones would allow for the significance of impacts to be measured against standards. However this puts the problem one step back. Agreement on what such standards should be, and what they represent is commonly fraught with difficulty. Standards for water quality, either in the effluent itself, or in the receiving water (appropriately defined) are common, and can be simply applied, but they may bear little relation to environmental quality in terms of ecosystem diversity and function.

Another approach is to take the current ecological state, and its associated nutrient concentrations as the standard, but the zone in which such a standard is to be applied must also be defined. Either way, public involvement in defining standards, or in assessing significance on an ad hoc basis is essential, if there is to be any confidence in the EA. One solution to this problem is to use sector EA as the public forum and technical basis for setting such standards.

Environmental capacity

In order to fully understand how a direct impact (e.g. nutrient load) may relate to an environmental standard (e.g. a nutrient concentration in receiving waters) it is desirable to understand the assimilative capacity of the environment - for example, how rapidly the nutrients are diluted; how much is absorbed by sediments; how much is taken up by mangrove or plankton etc). This may ultimately be used to assess how much aquaculture can be supported by a particular system (e.g. a lagoon or estuary) before the environmental standard is exceeded - i.e. to assess environmental capacity. Details of how this may be done for some of the impacts related to coastal aquaculture are presented in Appendix 8.

Sustainable development criteria

The concept of sustainable development is simple and important, but translating it into specific standards or criteria is difficult and often subjective. Although many specific sustainability criteria have been proposed (see Appendix 10) there is no single universally agreed set.

Some general criteria are presented in box 9.6. It is probably more appropriate to develop detailed and locally appropriate criteria starting from these more general ones, than to use more detailed criteria promoted by specific interests. The most difficult, most political, and least widely agreed of these criteria, are those relating to social and equity issues.

An example of the assessment of intensive shrimp farming against these criteria is provided in Appendix 10. One particular aspect of this assessment is worth mentioning here as an example. Most intensive aquaculture of fin-fish or shrimp currently relies on trash fish or fish meal as a significant component of feed input. There are two sustainability issues associated with this. The sustainability of input supply is questionable given the poor state of the management of high seas fisheries. The efficiency of resource use is also questionable (conversion of fish to fish) although much depends on the measure of efficiency used. The ways in which these issues such as this can be addressed are dealt with in section 10 (mitigation).

> **Box 9.6 Broad sustainability criteria**
>
> *In assessing the sustainability of any enterprise or technology, consideration should be given to at least the following*:
>
> - the sustainability (or continuity) of supply, and quality of inputs;
> - the social, environmental and economic costs of providing the inputs (e.g. depletion of resources elsewhere);
> - the long term continuity (or sustainability) of production;
> - financial viability;
> - social impact and equity;
> - environmental impact;
> - the efficiency of conversion of resources into useful product.

Significance and decision making

Assessment of significance should not be confused with decision making. Significance information should be presented as clearly as possible so that decision makers can make an informed decision. It is not appropriate for the EA team to take on the role of decision making[3].

[3] Note that this is one of the arguments against economic valuation of "none-market" effects. In the extreme case the economist weights all values in order to reach an "optimal solution". In effect the economist becomes decision maker.

9.5 Summary and presentation

In order to make the findings accessible to the general public and decision makers, a variety of presentations and summaries are possible.

Table 9.4 provides a summary of impacts and their characteristics, associated with semi-intensive or intensive brackish-water culture of shrimp.

Table 9. 4 Hypothetical example of impact characteristic summary table

	Impact from shrimp farm		
characteristic	*nitrogen content of receiving water*	*increased exploitation of adjacent mangrove reserve by local people*	*release of foreign genetic material*
nature	direct	indirect	direct
magnitude	increase by 0.1mg/l in wet season; 0.4mg/l in dry	Extraction of additional 50m3 of firewood	estimated average 500 escapes per year
extent/location	within 1 km of farm effluent	reserve mangrove forest	national and possibly continental ecosystem
timing	continuous during operation	within six months of site preparation	within 3 years of first operation
duration	until operation ceases	until alternative resources or employment found	indefinite
reversibility	high	medium	low
probability	certain	medium	low-medium
uncertainty	low	medium	high
Overall significance	***low***	***medium***	***high***

9.6 Towards consistency in assessment

It should be clear from this section that the quantification and valuation of impacts - i.e. *assessment of significance* - is difficult, both technically and philosophically. As a result individual project EAs are likely to be inconsistent and difficult to interpret. In other words, they may provide a rather poor basis for decision making.

One way round this is to establish much clearer ground rules for individual project assessment. The wider application of regional or sector EA to assess impacts of different activities more generally, and to define appropriate environmental standards, possibly relating to different zones, should form the basis for this. An outline of the process is presented in Figure 9.4

Figure 9.4: A hierarchical approach to developing assessment criteria

Regional Environmental Assessment:

- Identify major environmental issues and sensitive/valuable ecosystems.
- Define environmental standards relating to possible impacts in specific zones.
- Define assimilative capacity relating to particular impacts in particular zones (e.g. N loading).

↓

Sector (aquaculture) Environmental Assessment

- Assess environmental impacts of different forms of aquaculture against standards and zones;
- Define acceptable limits in terms of nutrient loadings, or other potentially adverse effects, taking account of other sectors;
- define possible restrictions on location;
- define rights, incentives, constraints, regulations;
- define criteria for project EIA requirements

↓

Project Environmental Assessment:

screening: assess need for project EA against standard regulations;
assess impact significance against defined environmental quality standards

Mitigation and Impact Management

As EA is used more as a tool for improved environmental design and management, rather than as an administrative and regulatory procedure, the identification of mitigation measures becomes central to EA. There is enormous scope for mitigating the environmental effects of coastal aquaculture. This can be done at several different levels through:

- improved planning and regulation;
- improved infrastructure;
- improved siting (closely related to planning and regulation);
- improved design;
- higher quality inputs;
- improved input and waste management; and
- improved husbandry and water quality management;

These measures can be encouraged or enforced through a suite of incentives, constraints and regulations, which are themselves a form of mitigation at sector level. The whole package, or parts of it may in turn be linked to quality or environmental management certification and/or quality labeling initiatives

Public involvement and conflict resolution processes may contribute significantly to identifying and developing desirable or necessary mitigation measures.

Contents

10 Mitigation and Impact Management

10.1 Overview of mitigation needs for coastal aquaculture

The mitigation measures that can used to address the impacts associated with specific coastal aquaculture activities are presented in the matrices in Appendix 5. The main categories of impact and their corresponding mitigation measures are summarized in Table 10.1. This table may be further adapted and developed according to particular aquaculture systems and local circumstances. Public involvement and conflict resolution techniques have been discussed in detail in section 6. They may apply equally to regional, sector, or project EA. They are essential tools for the development of locally appropriate mitigation strategies and specific measures.

Table 10.1: Summary of reported impacts from coastal aquaculture and mitigation

Impact	Causes	Mitigation
On and off site damage to resources and social conflict	Direct conversion; organic or chemical pollution; release of salt; introduction of salt water	siting, scale, conflict resolution
Social inequity	Land/resource appropriation for aquaculture development; rapid increase in income for successful farmers	taxes, regulations, controls, conflict resolution
Loss of biodiversity and wetland habitat	Direct conversion; changes to hydrology; organic and chemical pollution; displacement resulting in increased human pressure	siting, scale, management, compensation
Aesthetic impacts	Direct conversion; extraction activities; structures	siting, design, scale
Water pollution	Poor nutrient conversion; poor water and sediment management	siting, design, management, input quality and intensity
Changes to hydrology or salinity	Water extraction, use and management	siting, design, management
Solid waste	Poor food conversion; poor pond water management; poor pond sediment management; poor waste disposal	High quality feeds; good feed management; efficient species; better pond water management; better sediment management; better sediment treatment and/or disposal; better design
Disease spread	Poor husbandry and stressed stock; mixed influent and effluent water; exchange of water between farms; diseased seed; diseased broodstock; stock movements	Disease free stock; disease resistant stock; disease monitoring; control of stock movement; better husbandry; better disease treatment and management; high water quality supply; high quality effluent; disinfection procedures; separation of water supply (influent-effluent, and between farms); general siting, design, and management.
Impact on worker health	Pesticides, disinfectants, antibiotics, water borne disease	Protocols for improved chemical use and management practices
Over exploitation of wild seed or broodstock	Lack of hatcheries; over-rapid development	Development of hatchery technology; restraint on development
Genetic pollution	Introduction of new species; introduction of new races; introduction of associated organisms including disease	Restriction on movement of exotic species
Noise and disturbance during construction	Pond, cage or building construction	Restrictions and guidelines
Secondary impacts at materials extraction sites	Removal of (eg dyke) materials from borrow pits	Restrictions and guidelines
Secondary impacts on product quality	Chemical and antibiotic residues in product	Restrictions on use of chemicals and antibiotics; testing procedures; quality standards and labeling;

Below are presented the main ways in which mitigation can be effectively implemented.

10.2 Mitigation at the sector or strategic level

Table 10.1 suggests that most mitigation opportunities are either beyond the scope of an individual project to implement, or are related to management practices, so that monitoring, and some form of on-going incentive or regulation will be required if they are to be implemented. In other words, a broader planning and management framework is essential for the long-term sustainability of aquaculture development.

Siting in particular is difficult to change once an aquaculture development project is proposed, since it will be initiated largely on the basis of the availability of a site. Sector environmental assessment of aquaculture should identify opportunities for mitigation of the impacts of the aquaculture sector as a whole, within a particular area (for example a bay, estuary or watershed). These mitigation measures may be promoted through a wide range of instruments as described below. If possible, they should be brought together within the framework of an aquaculture development plan, ideally as part of an Integrated Coastal Management Plan.

10.2.1 Zoning

Zoning is one of the few available approaches for *avoiding* or *pre-empting* issues of resource use conflict. The alternative, where resource use conflict may be an issue, is conflict resolution, which has been dealt with in section 6. In practice the two are related, since zoning may be a solution or mitigation measure proposed through the conflict resolution process. Furthermore, public involvement should play a key role in the definition of zones, and agreeing the rules or procedures that should apply to such zones.

Zoning can be undertaken most effectively as part of a broader integrated coastal planning and management initiative, since rational allocation of land or water to specific activities requires a thorough assessment of the strengths and weaknesses of alternative uses. Zoning may be used to define exclusive zones for particular activities, priority zones, or mixed zones. The approach, if any, should depend on local circumstances.

If a zone is allocated to

Box 10.1 Example of environmental quality standards for sensitive habitats

(Based on the recent 'Draft Planning Guidelines - Protecting the Values of Coastal Ecosystems' prepared for the Queensland Department of Environment)

SEAGRASS: No increase in mean seasonal levels of suspended solids; light levels at 2m depth should not normally fall below 10% of surface incident light; total Kjeldahl N not to exceed 140 µg/L; mean total N not to exceed 500 µg/L.

CORALS: Deviation from mean ambient nitrogen concentrations should not exceed 5%; deviation from mean ambient phosphorus concentrations should not exceed 5%; no increase in mean ambient levels of suspended solids; changes in salinity levels from seasonal ambient state not to exceed 5 ppt.

MANGROVES: No change from ambient tidal inundation frequency; changes in salinity levels from seasonal ambient state not to exceed 5 ppt.

SANDFLATS: No change in mean seasonal sand transport to exceed 10%; changes in salinity levels from seasonal ambient not to exceed 5 ppt; mean levels of organic carbon not to increase above ambient levels by more than 5%.}

aquaculture and/or other activities, the issues of biodiversity conservation, pollution and water quality can be addressed systematically. Firstly, environmental quality standards for the zone should be set. An example of such standards relating to major coastal ecosystem types is presented in Box 10.1. This addresses one of the main problems discussed in section 9, the need for consistent criteria against which impacts can be judged.

10.2.2 Management of environmental capacity

Once a zone has been defined, it may be possible to assess the environmental capacity of the area, in terms of total nutrient loading (phosphorus, nitrogen, carbon, suspended solids) which can be assimilated or dispersed without exceeding environmental quality standards. Environmental capacity is likely to vary greatly according to local ecological and hydrological conditions. Methods for its estimation are presented in Appendix 8.

If environmental capacity can be estimated or approximated, three main approaches may be used to prevent it from being exceeded:

1. The ideal is to sell or allocate a portion of environmental capacity to individual enterprises (aquaculture and other resource users, including agriculture). This approach is being explored in New Zealand at the present time.

2. A variation on this approach, currently in use in Finland, is to define the total acceptable food input (which may be calculated on the basis of typical nutrient conversion on farms, coupled with estimates of environmental capacity for the nutrient), and then to allocate a portion of this to licensees.

3. A less desirable approach is to define total acceptable aquaculture production, on the basis of environmental capacity and the pollution rates from aquaculture (Appendix 6) and other activities, and to halt the issue of permits once this production is reached.

The first approach should encourage improved environmentally friendly technology without specifically restricting production. The second encourages the use of higher quality feeds and improved feed management. The last offers no incentive for better management, and also restricts production.

Box 10.2: Mitigation of nutrient enrichment through zoning

The ideal process

1. Define environmental quality standard for zone (eg acceptable N concentration);
2. Estimate assimilative/dispersive capacity of zone;
3. Estimate acceptable nutrient load on the zone (environmental capacity);
4. Estimate rate of nutrient production from aquaculture and alternative uses;
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 the advantage that the rules are clear from the outset, and it provides an incentive to minimize pollution while placing no restriction on production.

In practice the accurate assessment of environmental capacity is difficult and expensive. An alternative approach is to use rough estimates initially, and then to monitor and adapt estimates in the light of experience. In line with the precautionary approach, these rough estimates should be conservative.

If environmental capacity cannot be estimated, then there are again two options:

1. environmental quality can be monitored against agreed standards, and restrictions or limits placed on development once they are reached; or

2. a flat rate tax for a zone may be applied to any pollution discharge – either measured, or estimated on the basis of the type of aquaculture, design and management.

There are several significant disadvantages with the first approach:

- aquaculture operations will anticipate restrictions on their activities at some uncertain time in the future. This may discourage desirable development;
- aquaculture operations will not be able to plan ahead in terms of production;
- by the time the restrictions are in place, the scale of activity may already be too high. It will be difficult to reduce the activity or output levels of existing farms;
- the incentive for more environmentally friendly aquaculture technology is weak - the standards may be exceeded because of the activities of other farmer.

The second approach, while serving as a disincentive to pollution, will represent a significant financial burden to some operators.

Given these disadvantages, every effort should be made to estimate environmental capacity, even if only very roughly and provisionally, and use this as the basis for interventions. Monitoring should allow for the estimate to be steadily refined over time.

Box 10.3: Tasmania - an example of zoning and its relation to legal frameworks

The Marine Farming Planning Act 1995 was passed in 1995 and provides for the development of *Marine Farming Development Plans*. The Plans identify areas of water that may be suitable for marine farming (mainly cage culture of salmon, and oyster culture) , while also considering the other users of the coastal zone. 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 comprehensive environmental monitoring programme.

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

- the physical suitability of the sites for aquaculture
- the current legal situation
- the desire to minimize 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).

10.2.3 Codes of conduct and practice

Codes of practice amount to generalized and agreed forms of mitigation for the impacts of a sector, sub-sector, or individual farm. They may also serve as standards against which aquaculture siting, design or operation may be assessed.

There is increasing interest in codes of practice on the part of international organizations, governments, and the industry itself. Indeed, there is growing awareness that environmentally sensitive shrimp aquaculture may make good business sense. This is particularly so when considering the perceptions of some importing markets. This provides an incentive for both the shrimp industry (and supporting governments) to further promote adoption of environmentally and socially responsible farming practices through appropriate standards or codes of conduct. The benefits possible through the development *and adoption* of codes of practice in aquaculture are summarized in Box 10.4.

Examples range from general to specific and include *the FAO Code of Conduct for Responsible Fisheries,* and the associated *Technical Guidelines* which relate specifically to aquaculture; the *Global Aquaculture Alliance* (a newly formed international industry association) Codes of Practice; and a variety of more specific codes developed for particular countries, species or systems, such as the *Code of Practice for Australian Prawn Farmers* (Donovan 1997), the guidelines produced in relation to coastal aquaculture in Belize (Huntingdon and Dixon 1997) and recommended standards and practices for shrimp culture in Madagascar (Maharavo 1999). The World Bank is also in the process of developing guidelines for planning shrimp farming, and recommended practices. FAO has facilitated agreement among many countries on a range of desirable policies for sustainable shrimp culture (FAO 1998). A comprehensive synthesis of all these codes is presented in appendix 11 along with a complete reproduction of the FAO Code of Conduct, and the GAA Codes of Practice. It is recommended that any new guidelines should be based on, or comply with, these widely agreed codes.

Box 10.4 Benefits associated with the adoption of codes of practice

- enhanced public image and demonstrated industry responsibility;
- greater common understanding and agreement on measures required for sustainable aquaculture;
- clarification of roles and responsibilities;
- a framework and vehicle for awareness raising, information exchange, and training within and outwith the sector;
- a framework for the development of market led incentives (such as labeling and product certification) for improved management and sustainability;
- a "pilot run" for more formal financial incentives or regulations;
- a building block in the development of integrated coastal management; and
- a strengthened and informed negotiating position for the sector

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(adapted and developed from Barg 1996)

There is much similarity and overlap between these and other codes and guidelines, although there are understandable differences in emphasis and detail relating to the interests of the organizations*.* All are designed to promote the development of sustainable aquaculture. Because of the importance of the shrimp farming sector, and the environmental issues which have been associated with its development, the GAA and Australian codes and guidelines, and the various World Bank initiatives are directed mainly at this sub-sector.

The practical application of different approaches to codes, guidelines standards *etc*, however, must be very carefully assessed. There may be some important lessons to be learnt from forestry for example, where after several years and much effort, there are still differing views on standards and certification programmes for ‘sustainable’ forestry. The development and implementation of appropriate standards and codes, therefore, will take time.

Box 10.5 Proposed limits for effluent water quality for shrimp farms in Madagascar

pH	<9
Dissolved oxygen	>3mg/l
BOD	<20mg/l
Suspended solids	<10mg/l
Total phosphorus	<0.2mg/l
Ammonia N	<0.5mg/l
Nitrite	<0.05mg/l
Nitrate	<0.1mg/l

Source Maharavao 1999

Particular attention should be given to the difficulty of implementing schemes where there are large numbers of small-scale farmers involved in shrimp farming, as is the case for many parts of Asia. Two approaches may serve to overcome this problem. One is to relate or link codes of practice to aquaculture zones as defined above. Operation in a zone might be conditional on adherence to certain codes of practice. The other is to promote farmer's associations or similar groupings which can help develop, and agree to implement, area specific codes.

Without full farmer participation and willingness, compliance is likely to be a major problem, unless financial benefits (short, medium or long term) can be related to adoption of such codes. Links to marketing and environmental quality labeling schemes are one obvious way to make this link, but this can be difficult and costly in practice, especially for the smaller, less well organized, and more isolated farmers. Related to this, there is the need to ensure that the move towards adoption of codes (which may have a short term economic cost) does not adversely affect the poor small-scale farmers. Assistance from donors may be required to "kick start" this process, and this is also highlighted in the FAO Code of Conduct for responsible Fisheries.

Overall, codes of conduct have considerable potential, and may be promoted on a variety of fronts. Perhaps the most promising avenue is through linking them to other initiatives, such as coastal management plans, or conditions required for EA or license approval. Once again the requirement for a more comprehensive planning and administrative structure for aquaculture development is highlighted.

Box 10.6: Protocols for quarantine

These are difficult to formulate because many variables affect the risk of introducing disease, including:

- age;
- species;
- source;
- history;
- known disease status;
- reliability of health certification;
- known diseases of candidate species;
- disease status of exporting region/country; and
- facilities and capabilities of importing or exporting authorities

(after Humphries, 1995).

10.2.4 Disease exchange and stock movement protocols

Many social and economic benefits have accrued from the importation of aquatic animal species for aquaculture. However, requests for importation of fish, shrimp ad other species for an aquaculture project need to be given special attention in environmental assessments. The main concerns are introduction of diseases (which may impact aquaculture and wild fisheries) and impacts of introduced species on indigenous biodiversity resulting from escapes of aquaculture species.

There is very little information available on the status of aquatic animal diseases in Africa, but it has to be presumed that many of the serious diseases which have affected aquaculture elsewhere are not yet present. The risk of introducing new diseases can be minimized by following an appropriate quarantine strategy. Guidelines are being developed relating to these issues (FAO/NACA 1998) and should be followed.

A semi-quantitative scoring system relating to some of these risks has been developed for the Pacific islands by Humphries (1995) and is given in Table 10.2.

Guidelines on procedures for assessing the risk of ecological impacts, including those on biodiversity, are given in the ICES/EIFAC Code of Practice on the Introduction and Transfer of Marine Organisms

Table 10.2: Semi-quantitative scoring system for assessment of quarantine stringency for imports of aquatic animals in pacific island nations
(from Humphries, 1995).

		Risk category *Lower*	(Score) *Higher*
Age at transfer	Egg Larvae or juveniles Adult	+ (1) + (1)	 + (100)
Source	Farm or hatchery Wild caught	+ (1)	 + (100)
Geographic origin	Within natural range Outside natural range	+ (1)	 + (100)
Country or regional disease status	Free of specified diseases Status uncertain Specified diseases present	+ (1)	 + (100) + (100)
Disease in candidate species	Major disease not described Recognised host to major diseases	+ (1)	 + (100)
Interpretation	*Score* • <105 • 200-400 • >400	*Quarantine strategy* • Minimum quarantine; • Higher stringency; • Prolonged quarantine and testing of parent stock with transfer of progeny	

10.2.5Regulation

Government regulations are often required for maintaining environmental quality, reducing negative environmental impacts, allocating natural resources between competing users and integration of aquaculture into coastal area management.

Mariculture is a relative newcomer among the many traditional uses of natural resources, and has commonly been regulated under an amalgam of fisheries, water resources, agricultural and industrial legislation. Land and water use in particular is commonly affected by a wide range of existing legislation that may not be appropriate for aquaculture. The need for a more rational legal and regulatory framework which takes specific account of aquaculture has already been discussed in section 3, and is now widely recognized and agreed (FAO 1997,1998). It is necessary not least to protect aquaculture development itself. Recent problems in India which have placed severe restrictions on coastal aquaculture within a certain distance of the coastline arose partly because the coastal zone regulation did not include specific mention of aquaculture (see box 6.2.

Box 10.7. Regulations applied to intensive shrimp farming in Thailand

1. Shrimp farmers must register with the local district office of the Department of Fisheries.
2. Shrimp farms over 8 ha must have a waste water treatment (sedimentation) pond equal to 10% of farm area
3. Saltwater must not be discharged into public freshwater resources or agricultural areas .
4. Sludge and pond bottom sediment must be confined and not pumped into public areas or canals .
5. BOD of discharge water must be less than 10 mg/l.

Note that 2, 3 and 4 are examples of best management practice or BMP

Rubino and Wilson (1993) and Howarth (1995) define the key issues to be considered in aquaculture regulation as:

- land use (e.g. pond construction, impacts on wetlands);
- use of water column and bottom in coastal and offshore waters;
- water use and water discharge;
- protection of wild species;
- non-indigenous species;
- aquatic animal health; and
- use of drugs and chemicals.

Public health issues, quality control and trade laws may also be relevant.

Examples of regulations applicable to coastal aquaculture in Thailand are presented in Box 10.7. In practice an enormous range of regulations are possible, which might include for example:

- “no go” areas for aquaculture development;
- minimum distance between farms;
- requirement for water treatment such as settling;

- effluent water quality standards or discharge consents in terms of nitrogen, phosphorus, BOD etc;
- regulations related to chemical use and disposal;
- handling of diseased stock and notification of disease;
- movement of stock; quarantine; disease certification

Licensing and registration
Enforcement of regulation will always be difficult, especially where there are a large number of small farms. A legal requirement to register farms, possibly associated with the issue of a license or permit, is a precondition for any effective regulation. If a license fee is levied, this may pay for the costs of regulation enforcement.

10.2.6 Economic and financial incentives

Most business enterprises respond more rapidly and willingly to financial incentives rather than rules and regulations. In countries with a reasonably well-developed and regulated trading system, taxes and tax breaks can be applied with relative ease to encourage particular kinds of behaviour. These approaches were specifically allowed for under Principle 16 of the Rio (UNCED) Declaration, which requires that the costs of environmental damage be internalized, and that the polluter pays.

Financial incentives or restraints may include the following:

- Charges related to the issue of operating permits (user fees);
- Charges related to the rate of production;
- Charges related to the rate of pollution (pollution taxes);
- Tradable or non-tradable permits (e.g. a permit to discharge a certain amount of waste, or use a certain quantity of a resource, or to use a certain amount or proportion of environmental capacity);
- Deposit refund systems (a deposit or bond is deposited as a guarantee against environmental degradation, or to pay for restoration should this be required);
- Environmental trust funds (similar to deposit refund systems, but allowing for critical spills, accidents etc during normal operation);
- Subsidies for certain (environmentally friendly) technologies, or a tax or surcharge on less desirable technology;
- Legal liability for certain kinds of environmental damage

There are also more subtle ways of influencing the financial pressures operating

Box 10.8 Infrastructure as a tool for environmental mitigation
Seawater irrigation

Many of the environmental and disease problems prevalent in brackish-water shrimp culture are related to poor water supply, mixing of influent and effluent, and exchange of water between adjacent farms. There are now several schemes in Thailand which involve the provision by government of well designed canal systems, including in some cases waste water treatment, to ensure that shrimp farmers receive high quality water, low in pathogens, and that influent and effluent streams for a whole group of small farmers are kept safely apart.

Shrimp farming is quite capable of generating sufficient profit to pay for such investments, so that the investment cost burden can be passed on to the farmers over a period of years.

on aquaculture operators. For example the provision of infrastructure (roads, canals, water treatment facilities, markets, processing facilities; laboratory/disease services; extension services; electricity supplies etc) may all make certain areas or zones more attractive to aquaculturists, while at the same time reducing environmental impact (Box 10.8). Such approaches may contribute significantly to the success of zoning systems described above.

10.2.7 Market incentives

European and American markets are increasingly demanding products which have been produced organically or in an environmentally sustainable way. This translates into a price premium for such goods. Finding ways to certify or label products grown sustainably, market them at a premium, and ensure that some of the increased margin goes to the producer, represents a significant opportunity in terms of providing a financial incentive for particular forms of aquaculture. There is significant experience relating to such schemes for sustainable forestry, and more recently for sustainable fisheries, but these approaches are not easy to implement in developing countries, especially in more isolated regions or countries.

However, it may be possible to bring together the ideas of farmer associations, aquaculture zones, codes of practice, and infrastructure provision as mutually reinforcing elements in support of the development of product labeling and marketing schemes.

10.2.8 Institutional issues

Institutional capacity to support sustainability in aquaculture development is a critical consideration. Key issues include research, extension, monitoring and having sufficient trained and qualified people to implement supporting strategies. The importance of strengthening institutional capacity within developing countries to deal with the complex issues related to aquaculture development and integrated coastal resource management is now widely recognized
.
Thus, application of any guidelines or codes designed to enhance sustainability in coastal aquaculture must also give consideration to ways to support human resource development within both government and non-government sectors to extend such guidelines to farmers. This may require increased education and training initiatives, communication and dissemination of appropriate information.

10.3 Mitigation of impacts from Individual farms

Implementing relatively simple mitigating measures related to individual farm (or group of farms) siting, design, and management can lead to large decreases in nutrient loading on the environment, the use of chemicals, the incidence of disease, and the possibility of salination.

10.3.1 Location and siting

Conversion or pollution of sensitive habitat, salination of agricultural lands, access problems, exchange of disease, and poor pond soil and water conditions, may all be avoided by careful site selection. Unfortunately, siting of farms is usually based on land availability rather than technical criteria. Mangrove land, for example, whilst widely recognized as a poor site for intensive shrimp pond development, was easily accessible for mariculture ponds because of lack of clear property rights, and further encouraged by government incentives which previously classified mangroves as 'waste' land. Government must now take a role in encouraging or facilitating aquaculture in areas best suited to the industry and least likely to compromise environmental or other resource user interests.

For sea-based farms, siting is also important to reduce impacts on coastal environmental integrity. Problems of overstocking of mollusc culture beds are recognized in the Republic of Korea where regulations have been developed to restrict the areas covered by mollusc culture. These measures (Table 10.3) are designed to reduce environmental impacts and contribute to the environmental sustainability of mollusc farming.

Table 10.3 : Methods for reducing environmental problems on oyster farms in the Republic of Korea

(from: Republic of Korea country report in FAO/NACA, 1995).

Management strategy	Potential benefit to environmental sustainability
Dredge beds below and around oyster long-lines once every three years	Oxidation of sediments and maintenance of sediment quality. Ensures waste 'emissions' remain with assimilative capacity of sea-bed.
Distance of more than 100m between sites	Adequate water circulation and to ensure supply of food to oysters.
Oyster beds (licensed area) must be within 1ha - 20ha in size	Ensures oyster beds to not interfere with other coastal resource users and that farms do not exceed local 'carrying capacity'
Culture area must not exceed 3-10% of then total licensed area and no more than one 100m long-line per 50 m^2	Adequate food supply and ensures that farms do not exceed 'carrying capacity' of local environment.

For marine cage culture, off-shore cages, and new technologies developed in European countries are attracting increasing interest in SE Asia. They may allow for siting well

Box 10.9 Examples of possible mitigation through siting

Ponds

- Whenever possible, farms should be sited well away from each other to minimize the risk of disease spread;
- where this is not possible water supply and disposal should be designed so as to minimize water exchange between different farms;
- brackish and marine farms should not be sited in freshwater areas unless specific measures are taken to protect soils, groundwater and the interests of other resource users;
- avoid permeable soils, or use liners;
- farm location should not interfere with access;
- potential acid sulphate soils should be avoided

Cages and rafts

- farms should not disrupt access or navigation;
- farms should be sited in areas where there is good water exchange;
- rotation of culture sites, or siting in deeper water offshore may be used to reduce local impacts on sediments;
- environmentally sensitive habitat such as coral reef should be avoided

away from other interests, with minimal risk to water quality and sensitive habitat. Offshore cages, however, are large and expensive and, while appropriate for salmonids and yellowtail, are untested for tropical marine species, many of which are sold live and in relatively small numbers.

Rotation of culture sites can be used to reduce impacts of cages or rafts on the sediments. This must be considered carefully in terms of environmental objectives. In some cases a minor impact over a large area may be appropriate, while in others a more severe impact in a more restricted area may meet environmental objectives. This highlights the difficulty of prescribing specific mitigation measures in the absence of a broader environmental policy or plan including environmental quality standards or objectives, ideally for specific zones or locations.

10.3.2 Construction and design

Adoption of appropriate practices in the construction and design of farms can do much to mitigate environmental problems. Salt-water intrusion, for example, caused by seepage from ponds, can be controlled by careful compaction during dyke construction, and by siting farms on clay soils. The use of pond liners can also eliminate soil erosion, facilitate collection of waste materials, and may allow longer-term use of sub-optimal soils with low agricultural value. However, water quality may be more difficult to manage in lined ponds. The incorporation of water treatment ponds (as in the case of Thailand, where larger farms are now required by law to incorporate a settlement pond in farm designs) can significantly reduce effluent load. Buffer zones between farms and surrounding land can also be used to minimise impacts on surrounding ecosystems, protect nursery grounds for aquatic life, and protect traditional activities. Mangrove buffer zones provide protection from storms, maintain traditional fisheries and may even improve water quality.

Box 10.10 Examples of possible mitigation through design and construction

Ponds

- Ensure dykes are well compacted;
- Allocate at least 25% of pond area for water and sediment treatment in the case of intensive production (10-15% for reservoir settling of routine discharge; 5-10% for settling effluent at pond drainage and harvest; 5% for drying/oxidation of pond sediments)
- Leave a buffer (i.e. unused semi-natural) zone around the farm. The width will depend on the nature and intensity of the farm, local soil and water conditions, and the nature and sensitivity of the surrounding environment;
- In mangrove areas a mangrove belt to seaward of the farm comprizing at least 1ha of mangrove per tonne annual production of intensive farm may serve to assimilate most if not all nutrients released, as well as serve the function of a natural settling basin;
- Ensure supply canal is not contaminated significantly with effluents from other ponds or other activities
- Ensure discharge canal does not contaminate water supply to other farms or other resource users

Note. *The above figures are for very rough guidance only. Engineering design should include comprehensive discussion and calculation related to these issues.*

10.3.3 Operation and management

Figure 10.1 shows the fate of nutrients in a coastal aquaculture pond, and the management interventions that can affect the total nutrient loading, or its partition between stock, water, sediment and effluent. Simple adjustments to management practice can significantly reduce effluent quantity and total nutrient loading.

Feed quality

Improved feed quality in semi-intensive and intensive pond and cage culture can have a significant impact on fish farm effluent quality, and may also reduce costs. For example reducing phosphorus content can be done relatively easily, and can be effectively regulated, as has been done in some European countries. Better formulated feeds will result in better food conversion and less waste. Both phosphorus and protein have been significantly reduced in salmonid diets without compromising growth, and this could probably be done for tropical marine fin-fish and shrimp, reducing nitrogen losses.

High handling and water stability (either whole rather than minced or chopped trash fish; or water stable pellets) will reduce pollution. Moist and chopped or minced fresh diets are more polluting and wasteful of resources, and may be associated with pathogens. Recent trends in intensive shrimp farms in Asia are towards reduced use of such diets.

Feed management

Simple improvements in feeding management in semi-intensive and intensive pond and cage systems can significantly reduce nutrient loading, improve water quality and reduce costs. Carefully controlled feeding and use of feeding trays can reduce feed losses and reduce pond environmental conditions in shrimp culture. Surveys have shown that Food Conversion Ratio is less on small family operated farms than on larger-scale shrimp farms.

Disease prevention and management

Disease prevention and management requires a suite of measures from national level to farm operation. The following might be important elements in such a strategy:

- effective procedures, protocols, and regulations relating to the movement of seed and broodstock;
- high technical capacity to check for disease;
- improved understanding of disease epidemiology;
- high quality, low pathogen water supply;
- high quality, low pathogen seed supply;
- high quality, pathogen free feed supply;
- more rapid diagnosis and

Box 10.11 Examples of possible mitigation through operation and management at farm level

Feed and feeding

- Use low phosphorus diets;
- Use carefully formulated feeds which maximize nitrogen conversion efficiency and minimize protein requirement ;
- Use water stable diets;
- If using trash fish use only that which is known to give efficient food conversion;
- Avoid chopping or mincing trash fish;
- Use feeding trays in ponds to gauge feeding activity and general health;
- Feed according to the preferences of species in terms of quantity, quality, timing and frequency

Disease and therapeutants

- Maintain high water quality at all times. Actual critical parameters are species dependent;
- Conduct regular health checks on stock;
- Do not discharge disease contaminated water to a shared or common canal.
- Break the production cycle periodically (fallow) to prevent pathogen build up;
- Use seed or broodstock which is health certified;
- Use antibiotics only for serious bacterial disease, and only when it is identified early enough to have a chance of success;
- Do not use antibiotics such as chloramphenicol which are important for disease treatment in humans;
- Do not use Azinphos (Gusathion) and organotin compounds;
- Minimize use of organophosphates;

treatment of disease;
- optimal grow-out conditions and quality husbandry to minimize stress;
- increased species and system diversity;
- cautious intensification;

The detailed implications of such a strategy will depend on species, aquaculture system and local conditions, but will require coordinated efforts at various decision making levels, and should be initiated before any disease problems arise. If such a strategy is successful it should greatly reduce the use of chemicals, and reduce negative feedback to and between farmers.

Attention to water supply and the possibility of introducing infrastructure (as described in Box 10.8) may be a significant part of such a strategy.

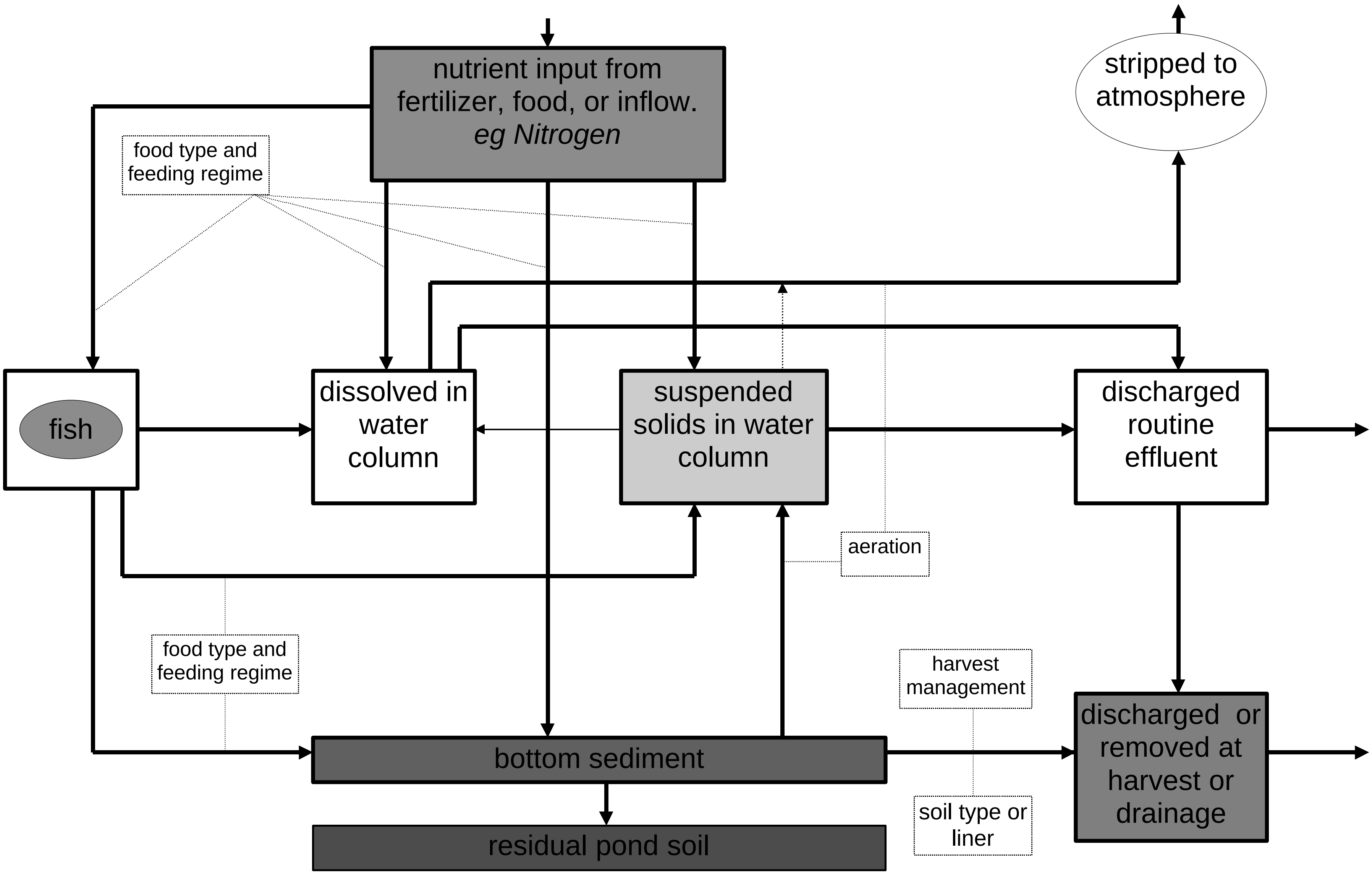
The development of captive broodstock for major farmed shrimp species followed by genetic improvements should result in farmers having better quality seed free of and/or resistant to specific pathogens. Pathogen free/low pathogen/high health seed production is also showing promise.

As a matter of policy the use of antibiotics of particular importance for human health should not be allowed.

Selection of suitable species and seed

Shrimp and marine fish culture in some countries rely heavily on collection of fry and juveniles from the wild, leading to concerns about social and environmental impacts of seed collection. The increasing trend towards use of hatchery reared shrimp provides a basis for reducing the reliance (and potential impact) on wild stock. Seed production is now also possible for a range of marine finfish species and governments should take all measures to encourage and facilitate the development of commercial hatcheries. The use of indigenous species would be preferable to introduced species, and genetic improvements may provide better stocks. Care needs to be taken not to impact wild stocks with such practices, but protocols now being developed may help in this regard (e.g. FAO, 1997).

Fig 10.1 Pathways for nutrients and suspended solids in fish ponds



Note: bold lines show the alternative pathways for nutrients and suspended solids through the pond system. Dotted lines indicate where the proportion of nutrients or solids following a particular path will vary with feeding, aeration, and harvesting regimes.

Effluent water management

Environmental sustainability requires that the surrounding environment can assimilate wastes from aquaculture systems, and also supply nutrients and organic matter to extensive mariculture farms.

For sea-based aquaculture, where waste materials are discharged directly into the surrounding environment, appropriate siting and feed management as described above are the main forms of mitigation.

In land-based ponds (and tanks), there are various options for control of effluent discharge. Recent research has shown that reducing water exchange in intensive shrimp ponds can dramatically reduce effluent loads. Many shrimp ponds in Thailand now operate with zero water exchange for a significant proportion of the production cycle, and completely closed systems are possible and operating. Although this practice developed mainly to avoid the introduction of pathogens in the intake water, it has the effect of reducing the nutrient load on the external environment. In effect intensively aerated shrimp ponds operate in part as their own oxidation ponds, with significant in-pond waste removal. However there will be greater accumulation of organic wastes in the pond sediment of these near closed systems, and care must be taken to not to flush these into the environment in a concentrated slug at the time of, or shortly after harvest. These sediments may be left in situ, and oxidized through drying and in some cases tilling; physically removed, and spread elsewhere for oxidation, or used for alternative purposes such as soil conditioner; or flushed into settling ponds for subsequent removal.

Box 10.12 Settling of organic wastes

Settling is a simple and effective way of increasing the quality of effluents from coastal aquaculture ponds or tanks. The removal of suspended solids results in significant removal of organic matter (and associated BOD) as well as nitrogen and phosphorus.

The settling characteristics of aquaculture effluents are generally rather poor, being made up of finely divided and hydrated organic matter (food and fecal material). However there is considerable variation related to:

- the nature of aeration in the ponds or tanks;
- the hydrodynamics of the ponds or holding tanks;
- the feeding rate and type;
- salinity;
- the age of the fish (which affects the size and quality of both feed and fecal wastes).

Settling requirements can be greatly reduced through well designed holding ponds/tanks and good feed management. In the case of pond culture, settling is most important and cost-effective with water discharged towards the end of a production cycle, or at the time of harvesting.

Settling is typically done in a simple pond, whose efficiency may be enhanced by using influent and effluent buffer zone to minimize turbulence and water velocity. It may be done in a large reservoir or lagoon, in which case biological degradation of sediment may also take place. In more intensive systems, tanks with tubes or plates to increase settling area may be used. These may be conical or wedge shaped to allow simple sludge removal.

For settling to take place, it can be shown mathematically that, irrespective of depth:

Area required = water flow/settling velocity

The water flow per unit area of settling pond is known as the *overflow rate* and is the critical design parameter for a settling pond. Settling velocity for particular effluents can be measured relatively easily in experimental water columns. For most pond aquaculture effluents, about 50% of the solids will settle in less than 1 hour in still water. The residual is usually made up mostly of plankton and is difficult to settle but has limited environmental impact.

Overflow rates for settling tanks or ponds for aquaculture should be in the range of 10-30 lpm/m^2 or 15-45 m^3/m^2/day

Simple settling (Box 10.11) is effective in removing a significant proportion of the solids effluent from brackish-water ponds. Settlement ponds are increasingly being used to treat effluent from intensive shrimp ponds. In Thailand, large farms are required by legislation to allocated 10% of pond area to settlement ponds.

It should be emphasized that effluents from coastal aquaculture are normally of relatively high water quality, and commonly exceed the quality of secondary treated domestic and industrial wastes. It is only toward the end of the production cycle when stocking rates and feeding rates are at their highest, and particularly at the time of harvest when pond sludge may be re-suspended, that problems may occur. This means that rather little effort is required in practice to significantly reduce the overall loading on the environment. For example, settling may only be required in respect of water pumped from ponds at the end of the production cycle, so greatly reducing the area of settling ponds required.

If necessary, further reductions can be made using bio-filters, artificial or natural wetlands. Mangrove is effective at removing significant quantities of solids, nitrogen and phosphorus from aquaculture effluents (see appendix 8). The use of intensive aquaculture effluent as a source of nutrients and organic material for extensive or semi-intensive aquaculture, including oysters and plankton feeding fish is a further option.

Management strategies for effluent should be carefully balanced against discharge targets. Nutrient and organic matter concentrations in effluent are highest during shrimp harvesting and subsequent cleaning of ponds, when effluent quality can be very poor due to disturbance and release of material previously bound to the sediment. For example, the use of suction pumps or high pressure hoses to clean pond bottoms, as practiced in Chantaburi province in Thailand and also reported for Taiwan, produces a very high pollutant load. The practice of allowing pond sediment to dry before removing the sediment by mechanical means, as is common in Southern Thailand, is more environmentally sound. The need to find environmentally sound ways to manage bottom sediments is most important in intensive systems with high stocking and feeding rates. Because of environmental concerns, some countries have already placed restrictions on indiscriminate discharge of shrimp farm sediments (FAO/NACA, 1995).

Reviewing and Decision Making

Review of an EA report, and the process which generated it, is important to maintain standards and ensure neutrality, especially in respect of project EIA. It may also be used to provide a broader perspective on the issues raised, or a more specific perspective related to particular interest groups. In general terms it provides the additional information which decision makers may require in order to assess whether a proposal is acceptable (project EIA) or an environmental management plan for the sector desirable and feasible (sector EA).

The review process for project EIA should be clear and consistent, using standard criteria, for the sake of the proponent, the public, and the decision-makers. This is likely to result in improved quality EAs.

Decision making itself will depend heavily on the report and the review process. It is essential therefore that both are clear and transparent. Decision making itself is not a single action, but a series of incremental actions, and the final outcome will depend heavily on many of the early decisions and choices. The nature of these early decisions must be clearly stated in the report.

Contents

11 Reviewing and decision making

11.1 Reviewing

The following is a brief outline of the review process for both sector and project EIA.

11.1.1 Objectives

The objectives of the review process are broadly similar for sector and project EA:

- to determine whether the information is correct, and scientifically and technically sound;
- to determine whether the information has been presented so that it can be understood by both the decision-makers and the public;
- to determine whether the EA report is an adequate assessment of environmental effects, and of sufficient relevance and quality for decision-making;
- to determine whether additional information or prescriptions are required;
- to collect and collate the range of stakeholder opinion about the acceptability of the proposal or proposals and the quality of the EA process;
- to ensure that the EIA report and process complies with the Terms of Reference;
- to determine whether the proposal complies with existing plans, policies, standards and codes of practice; and
- to ensure that the EA process was conducted appropriately, and the points of view of all parties involved have been taken into account.

11.1.2 Sector EA

The review process should allow for a broad and critical appraisal of the quality of the assessment, and the desirability and feasibility of the proposals for environmental management of the coastal aquaculture sector.

Where the EA has been undertaken or commissioned by a single organization, the review process should be coordinated by a different organization. This would normally be a non-sectoral department or agency, such as an environmental agency/department, a planning agency/department, or local government.

Where the process has been overseen by an inter-agency steering committee, this same committee may coordinate the review.

All relevant stakeholders (government and non-government) should be involved in this process. This reinforces the need for a clearly written and presented report. Public presentation of the report may be required, as may summary reports or resource materials related to specific issues. The techniques discussed in the section on public involvement (section 6) are again relevant here.

If the report is broadly supported, the review should serve as the starting point for a series of discussions or workshops on how to implement the proposals. If the report is not acceptable, it should serve to develop broadly agreed recommendations for improving the report or undertaking further work.

11.1.3 Project EIA

The review process for project EIA is a more formal and routine process. It should generate the additional information that decision-makers will require in order to decide whether the proposal and its effects are acceptable.

The EIA review process should be clear and consistent, using *standard criteria*, for the sake of the proponent, the public, and the decision-makers. This is likely to result in improved quality EAs. The application and utility of criteria should be reviewed so that they can be steadily improved.

It is recommended that a short review report is published, so that decision makers and the general public have a thorough understanding of the status of the EIA report and the nature of any further deliberations.

Box 11.1 Best practice review process

- set the scale/depth of the review;
- select reviewer(s);
- use input from public involvement;
- identify review criteria;
- carry out the review;
- determine the remedial options;
- publish the review report.

The steps recommended for best practice approach to reviewing an EA are presented in Box 11.1.

Who should review?

Review of project EIA reports may be undertaken by government, independent authorities, independent accredited experts, or review panels. Members of such review panels should not be stakeholders in the proposal. Review can also be carried out by proponents during the preparation of the EA report, as part of a quality assurance process. In this way proponents can ensure that their work is of an appropriate standard before it is subject to external review.

Review through ***stakeholder input*** can be undertaken using the draft EA report, or its summary, as a resource document at public meetings, briefings or as a basis for media reports. It is important that the results are effectively recorded, collated and summarized for decision-makers. Examples of presentation techniques have been dealt with in section 9 (assessment). They include GIS, matrices, networks, ranked and sorted tables, graphs and transects etc.

Box 11.2 Example of possible review criteria

- Have the terms of reference been met?
- Is the basis or standard against which significance is measured clearly stated?
- Is the information presented sufficient and necessary to support the assessment of significance?
- Is the information presented sufficient and necessary to support the recommendations for mitigation and environmental management?
- Has public involvement been adequate, constructively used, and fairly reported?

Timing

It is preferable for the review to be held before the final EA report is submitted to decision makers, so that it can be used as a monitoring and project management tool to ensure that progress is satisfactory, and that the terms of reference are being complied with. When there are issues requiring further research or where the report is inadequate, reviewing may be an iterative process, with the report being returned to the proponent for amendment to remedy inadequacies identified.

11.2 Decision-making

The purpose of EA is to provide information and analysis to decision-makers so that:

- full account is taken of environmental issues;
- environmentally damaging developments are prevented;
- developments which are allowed are well managed to minimize any possible negative impact and maximize benefits; and
- the sector as a whole develops in a sustainable manner.

In order to provide this information in a usable form, a range of subsidiary decisions are made by different individuals or groups during the EA process (Box 11.3). EA may be considered as a process of review, negotiation and incremental decision-making. Many of the decisions are value-laden, and constrained by expectations, political culture or existing higher-level policy decisions.

Many of the smaller decisions and choices made during the preparation of an EA report will affect the final outcome, and should be taken and recorded with great care.

11.2.1 The decision makers

The people making decisions on a proposal subject to project EIA, or those capable of promoting or implementing the recommendations of a sector EA, will frequently be elected central, state or local government politicians. They are expected to use the information provided by EA, along with information obtained from other sources, to inform them of the environmental consequences of their decision-making. Apart from the summary, they will seldom have time to read the EA report and other EA documentation. They will depend upon their officials and technical specialists for a summary evaluation of the earlier stages of the EA process, and the detailed technical content of the report.

Box 11.3 Important decisions made during the EA process

- screening: whether an EA is required, and what kind;
- scoping: which impacts are significant and require specific attention; the drawing up of TOR;
- commissioning: e.g. who will undertake a sector EA;
- the choice of public involvement process;
- the choice of assessment methods and analytical techniques;
- the assessment of impact significance;
- the composition and powers of any review team or body;
- final approval, conditional approval, or rejection of a specific project;
- adoption or otherwise of recommendations of sector EA..

11.2.2 The nature of decision making: trade-offs

The decision making process involves a large number of trade-offs (Box 11.4). In practice these trade-offs can be very complex. It is important that the EA report analyses and presents them as clearly and simply as possible. Furthermore, these trade-offs should be made explicit in the justification and reporting of any decisions related to the EA.

Making a trade-off between, for example, an economic benefit and an environmental loss implies assigning relative values or priorities (see Box 11.5). If these values and priorities are not made explicit, decision making is unlikely to be consistent. A variety of quantitative techniques have therefore been developed which allow the *assessor* to analyze or summarize the differences and trade-offs between options, with a view to facilitating more rational and consistent decision making. These techniques can provide simple summaries of complex information, and are therefore attractive to some decision-makers. Necessarily however, all these approaches require value judgements to be made, usually (though not always) by the assessor rather than the decision maker, in the form of weighting, ranking and aggregation of variables. If they are described and justified in detail, then the method is no longer an effective summary. If they are not, then the decision making process lacks transparency, and therefore fails to meet one of the guiding principles of EA.

> **Box 11.4: Trade-offs in EA decision making**
>
> - between simplification and the complexity of reality;
> - between the urgency of the decision and the need for further information;
> - between facts and values;
> - between forecasts and evaluation;
> - between certainty and uncertainty; and
> - between ecological, equity and economic considerations.
>
> (adapted from Wood 1995)

There is increasing interest in techniques (e.g. multi-objective decision analysis) which clarify, rather than quantify and aggregate the trade-offs that need to be addressed.

> **Box 11.5. Trade-offs between different kinds of *value* in coastal aquaculture development**
>
> Coastal aquaculture development (like most development) may bring significant short and medium term economic benefits, but also some loss of natural habitat.
>
> More extensive production systems may involve the conversion of larger areas for the same net economic benefit, but may also be more accessible to poor local communities.
>
> The information in the EA report must make the nature of these trade-offs clear, and where possible provide quantification (e.g. how much of one “value” is lost per unit gain of another)

11.2.3 The neutrality of EA

EA should have a significant impact on decision making, although it is rarely the sole basis. An important and controversial question is whether EIA should be neutral in its presentation of information and options, or whether it should promote or advocate environmentally optimal solutions. The predominant view is that EA should be a rational assessment, and a clear and accessible presentation, of different options and their environmental consequences. It should not specifically advocate environmental interests.

11.2.4 Outcomes

There can be a number of different outcomes from project level decision-making. These include:

- the proposal can be approved;
- the proposal can be approved with conditions;
- the proposal can be approved subject to on-going investigations;
- further investigations of particular issues can be requested before the EA report is reconsidered;
- a supplementary document or new EA report can be requested if there are any significant problems with the original investigation or EA report; and
- the proposal, as formulated, may be rejected.

Decisions related to sector EA may result in a variety of individual or planned interventions.

11.2.5 Decision making in sector EA

A sector environmental assessment is not usually subject to any kind of "final" decision; rather it serves to inform a wide range of decisions, initiatives or interventions designed to mitigate the impacts of the sector. These may be specific technical or political decisions (such as setting discharge consents; banning aquaculture in certain areas), the promotion of guidelines or codes of practice, or broad frameworks for decision making, such as a local plans, sector plans or integrated coastal management plans.

As with project EA there will be substantial uncertainty associated with many of the assessments and predictions, and provision should be made to monitor and adapt or modify decisions in the light of experience.

11.2.6 Accountability and transparency in decision making

A number of checks and balances are built into EA processes that help ensure accountability and transparency.

In the case of project EA, approvals for the proposal are made by a body other than the proponent, and the reasons for the decision and any conditions attached to it are made public, in some cases in the form of an official decision report. In some jurisdictions this goes as far as including an explanation of how the EA report and review influenced the decision. There may also be provision for public right of appeal against any decision. This can increase public confidence in the process, although it may raise costs and add to delays.

Any plans developed on the basis of sector EA are normally subject to substantial peer review and public

Box 11.6: An example of decision reporting

Some jurisdictions require a formal report of a decision. For example, the US Record of Decision must contain:

- a statement explaining the decision;
- an explanation of alternatives considered and those which are environmentally preferable;
- the social, economic and environmental factors considered by the agency in making its decision;
- an explanation of the mitigation measures adopted and, if practicable mitigation methods were not adopted, an explanation of why not; and
- a summary of the monitoring and enforcement programme which must be adopted to ensure that any mitigation measures are implemented (Regulations, Section 1505.2).

This record is on some occasions published in the Federal Register.

(from UNEP 1996)

involvement.

11.2.7 Participation in decision making

As has been noted frequently in these guidelines, public participation in the EA process is of great importance. Although direct public involvement in detailed post-EA decision making is likely to be limited, effective input at the review stage should provide the basis for significant influence on the final outcomes.

Monitoring

Effective monitoring and follow up actions are essential if EA is to become an effective tool for environmental management and the promotion of sustainable development. Without follow up, EA becomes a costly and bureaucratic exercise with little long-term impact.

Monitoring is required not only to ensure than mitigation and environmental management plans are implemented, but also to see whether they work, and whether the analysis of impacts was accurate. As noted in the section on assessment, impact analysis is extremely difficult and is unlikely to be accurate in the first instance. Only through monitoring, adaptation and evolution will effective environmental management strategies be developed.

Contents

12 Monitoring

Effective monitoring and follow up actions are essential if EA is to become an effective tool for environmental management and the promotion of sustainable development. Without follow up, EA becomes a costly and bureaucratic exercise with little long term impact. The application of EA to aquaculture in developing or newly industrialized countries in Asia is an excellent example of this (see Appendix 1: Sri Lanka case study). However, without effective management and clear procedures for using information generated, monitoring itself may become a costly and pointless exercise.

Monitoring should not be undertaken in isolation from other activities. The way in which cost-effective monitoring is defined by, and in turn defines, other environmental management activities is presented in Box 12.1.

A detailed design for a monitoring programme should form a part of the EA report. Monitoring applies equally to sector and project level EA.

12.1 Objectives of monitoring

Environmental assessment monitoring is the planned, systematic and repeated collection of environmental data to meet specific objectives and environmental needs.

The objectives of monitoring are broadly similar for project and sector EA::

- to document the baseline conditions at the start of the EA;
- to assess performance and ensure that conditions of approval are adhered to (project EA);
- to ensure that the anticipated impacts (from the project or sector) are maintained within the levels predicted;
- to ensure that mitigation measures are effectively applied;
- to verify the accuracy of past predictions of impacts and the effectiveness of mitigation measures, in order to transfer this experience to future activities of the same type;
- to identify trends in impacts;
- to identify, measure, and manage unanticipated impacts;
- to provide information for periodic review and alteration of environmental management plans, or sector plans;
- to optimize environmental protection through good practice at all stages of the project or planning process; and
- to provide feedback on how the EA process is working.

Box 12.1: Relation between monitoring and other activities

Monitoring will be more cost effective if undertaken within a broader context of supporting activities:

- Define environmental quality standards (strategic or sector EA, and/or higher level environmental planning);
- Assess sector or project impacts;
- Design sector or project mitigation and environmental management plan;
- Design sector or project monitoring programme;
- Environmental audit and review of sector or project;
- Improved management and targeting of monitoring;
- Enterprise environmental management certification and product labeling?

(adapted from UNEP 1996)

12.2 Legal and policy frameworks

The importance of a broader policy, institutional and legislative framework in which EA can be effectively undertaken has already been emphasized. This is particularly the case in respect of monitoring and follow up. Ideally sector EA should be used in the design of sector-specific planning and regulation. This should include provision for a suite of measures to encourage, facilitate, or require compliance with mitigation measures proposed for the sector as a whole, and compliance with specific project EA conditions. Monitoring is largely pointless if there is no way for the findings to be used for improved environmental management.

12.3 Scope

Monitoring of the impact of coastal aquaculture can be done at different levels:

- individual farm;
- group of farms;
- estuary, bay, lagoon, or wetland which may be affected by aquaculture activities.

In general the level of monitoring will be related to the level of EA: at the farm level for a project EA; and at the estuary, lagoon or bay level for sector EA. Groups of farms involved in quality management schemes may monitor at the farm group level.

Monitoring is costly, and the capacity to undertake it effectively may be limited. In poorer countries, priority should therefore be given to higher level (estuary, lagoon or bay) monitoring (with the cost spread over many activities). If quality standards are threatened, individual operations should then be investigated.

Monitoring should be focused on the impacts that are either significant, uncertain, or not well understood (requiring further analysis). The collection of information needs to be regularly reviewed to ensure that sufficient data is collected, while at the same time minimizing redundancy. In other words the information must be both necessary and sufficient for the task.

Box 12.2 Possible roles for stakeholders.

- responsible authorities make decisions on, and inspect or check implementation of, the terms of the conditions;
- proponents or their agents are responsible for implementing the projects by monitoring the actual effects, implementing remedial measures, and verifying the accuracy of predictions;
- environmental protection agencies as regulatory authorities check compliance with regulations, and verify the effectiveness of mitigation measures; and
- the public can be formally or informally involved in monitoring activities and may highlight inadequacies in monitoring programmes. They may also have practical suggestions to help solve problems as they arise.

From UNEP 1996

The information may relate to physical/chemical, biological/ecological, socio-economic and health impacts, according to the findings of the EA.

12.4 Responsibilities and procedures

Monitoring is easy to agree on, but rarely implemented well. Before any plan or project is approved, *responsibilities need to be defined and allocated:*

- who will do the monitoring;
- who will pay;
- how the information will be collected, stored, analyzed and communicated;
- how the results will be used;
- how any required action will be implemented.

The main stages and procedures for developing and implementing an environmental monitoring programme are presented in Box 12.3.

Box 12.3 Main stages in the development of an environmental effects monitoring programme (sector or project EA)

- Determine environmental quality standards and associated indicators (strategic or sector EA, or other higher level environmental policy initiatives; public involvement);
- Identify those which may be affected, and in what ways, by the aquaculture sector or specific developments (impact prediction and analysis);
- Define an environmental management plan to mitigate these impacts;
- Define the objectives and scope of monitoring in relation to quality standards, and the objectives of the environmental management plan;
- Identify sites or critical habitats where standards are most likely to be breached, or which are most sensitive to changes in the defined indicators and parameters; define the boundaries and select maps and plans, and sites for observation, measurement and sampling;
- Design a program of repeated measurements over a specified period of time, taking into account seasonal variation, to monitor key indicators and parameters at these critical sites (see Box 12.4);
- make decisions on the level of accuracy required in the data;
- Ensure compatibility and minimal overlap with previous or existing data collection programmes;
- Agree on procedures and responsibilities for analysis, reporting, and mitigating action, including possible emergency responses, should standards be approached or breached;
- If feasible actions within existing regulatory and planning structures are likely to be ineffective, call for review of planning and regulatory framework;
- Implement monitoring program;
- Review quality and value of information collected, and efficacy of follow up actions, on a regular basis.

12.5 Environmental monitoring activities

A number of different monitoring activities can be identified:

- **Baseline monitoring** refers to the measurement of environmental parameters during a pre-project period for the purpose of determining the nature and ranges of natural variation and to establish, where appropriate, the nature of change;
- **Effects monitoring** involves the measurement of environmental parameters during sector development or project implementation so as to detect changes in these parameters which can be attributed to the sector or project;
- **Compliance monitoring** takes the form of periodic sampling and/or continuous measurement of environmental parameters, levels of waste discharge or process emissions to ensure that specific regulatory requirements are observed and standards met.

Surveillance and inspection may form a part of compliance monitoring but need not necessarily involve measurement of a repetitive activity.

Closely related to monitoring, though not based on repeated measurements, is Environmental audit, which is a one-off or regular assessment of environmental performance of an enterprise, and compliance with codes, standards and regulations.

If any form of natural resource management plan, or integrated coastal management plan, is in place or under development, regular *State of the Environment Reporting* may be particularly suitable, since it will address all sectors, interactions between sectors, and incremental or cumulative change. It is particularly important as a follow up to sector EA, and any plans that may be developed on the basis of such assessments. The further development of State of the Environment reporting should be a major priority, and is called for under Section 17.8 of Agenda 21 ("..it is necessary to …conduct regular environmental assessment of the state of the environment of coastal and marine areas".

Specific monitoring activities related to aquaculture and other sectors may form the basis for more accurate and comprehensive state of the environment reports.

In addition to these specific approaches to monitoring, it should be noted that many countries monitor water quality in rivers, estuaries and coastal waters on a routine basis. This may be further developed or adapted to meet the needs of sector EA and sector planning, or monitoring in the vicinity of major projects or aquaculture production areas. However this kind of monitoring must be clearly linked to any standards set as part of the EA process, and there must be clear procedures for action where standards are breached.

Box 12.4: Effective data collection and management

Environmental monitoring programmes should have:

- a realistic sampling programme (temporal and spatial)
- sampling methods relevant to source (point source, aerial, 3D)
- collection of quality data
- compatibility of new data with other relevant data
- cost-effective data collection
- quality control in measurement and analysis
- innovations (e.g. in tracing contaminants and automated stations)
- appropriate databases
- multi-disciplinary data interpretation to provide useful information
- reporting for internal management and external checks
- allowance for, and response to, input from third parties
- presentation in the public arena (external assessment)

UNEP 1996

12.6 Environmental effects monitoring

This may range from simple observation of key parameters and reporting by locally affected people (which can very useful and cost effective) to comprehensive soil and water quality sampling programmes linked to higher level state of the environment reporting.

The main stages in developing an environmental effects monitoring programme for aquaculture are presented in box 12.3. Specific advice relating to sampling and data collection is provided in Box 12.4.

Typical indicators of environmental quality associated with aquaculture include BOD, suspended solids, total nitrogen, total phosphorus, total organic carbon, and possibly antibiotic and other chemical residues (see Appendix 9 for a range of chemicals used in aquaculture, some of which might form a component of a monitoring programme). In some cases they may include secondary indicators or indicator organisms such as plankton abundance and type, benthos composition, and presence or absence of certain indicator organisms, such as benthic worms and fungi.

The monitoring programme should follow directly from the impact assessment and analysis. For example, current meters may have been used to assess the distribution and concentration of nutrients or chemicals released from marine cage culture (Appendices 7 and 8). The results of this assessment should form the basis for an appropriate monitoring sampling frame.

Of particular importance is the way in which monitoring data is managed, organized and presented. A variety of techniques can be used including maps, photographic records, databases, standard tabulations/reports and graphs. Maps of the scale 1:5000 are normally sufficient for data presentation and a scale of 1:10 000 is adequate for catchment maps and general site maps. If there is a higher level natural resource integrated coastal management plan, the incorporation of the data into a GIS database may be possible and desirable.

Monitoring programmes should provide time series data which can be analyzed from time series graphs. This can be done by:

- visual qualitative assessment of the graphs;
- testing statistical significance of variations;
- determining rates and directions of change; and
- noting the approach to, or exceeding of, critical levels (eg water quality guideline levels).

12.7 Environmental audit

Audit is a term taken from financial accounting which implies verification of practice and certification of data. In terms of environmental management, the objectives of audit include:

- the organization and interpretation of the environmental monitoring data to establish a record of change associated with the implementation of a project or the operation of an organization;
- the process of verification that all or selected parameters measured by an environmental monitoring programme are in compliance with regulatory requirements, internal policies and standards, and established environmental quality performance limits;
- the comparison of project impact predictions with actual impacts for the purpose of assessing the accuracy of predictions;
- the assessment of the effectiveness of the environmental management systems, practices and procedures; and the determination of the degree and scope of any necessary remedial or control measures in case of non-compliance or in the event that the organization's environmental objectives are not achieved.

An EIA audit can provide an evaluation of compliance with the conditions of approval along with an assessment of the effectiveness of a particular EA at predicting impact type and characteristics. Feedback from this type of audit can be used to improve the effectiveness and efficiency of other EAs in the future.

Environmental impact assessment auditing is a management tool that:

- determines the actual impacts and outcomes of projects or decisions that have been subjected to an EIA;
- assesses whether the conditions established by statutory bodies for mitigating the environmental impacts of developments have been implemented and enforced, and whether they ensured that the environment was protected;
- identifies the nature and accuracy of impact predictions, and evaluates the role of impact prediction in the management of environmental impacts of developments;
- evaluates the effectiveness of the EIA process in order to identify areas that could usefully be revised or refocused; and
- examines the effectiveness of an individual EIA in an attempt to identify ways of improving the utility and efficiency of future assessments.

They can include the completion of checklists and questionnaires, as well as following written guidelines and using rating systems. The table of contents of an Impact Management Plan can be used as a checklist for an audit. An EIA audit can be difficult in the absence of an effective environmental monitoring programme.

Auditing can also result in:

- an improved image for the product as environmentally sound;
- reduction in public opposition to operations; and
- avoidance of penalties which could result from non-compliance with stricter environmental controls.

EA audits are not always straightforward. Quite often impact predictions have not been made in a form which can be audited, and the design of the project may have changed between the EA and implementation. Many of the impacts associated with coastal aquaculture are gradual and cumulative, and may be difficult to identify without many years data. Others are low risk, but long term and potentially serious, such as escapes and genetic pollution, which are not apparent until they are serious.

12.8 Social and economic monitoring

Social and economic monitoring in relation to a single project is unlikely to be cost effective unless the project is very large. This should be determined in the assessment. However, it will normally be a an important part of monitoring the implementation of any sector plan and appropriate indicators and a monitoring programme would normally be defined in sector EA. However, many socio-economic indicators are routinely collected by local and national government and may be simply adapted for monitoring purposes.

12.9 Feedback and adaptation

Environmental audit can be used to review and adapt/improve environmental monitoring, as can routine analysis of monitoring data. Public involvement and comment on predicted or new impacts can be used to adapt and refine both the monitoring programme and environmental management plan.

12.10 Environmental performance assessment

An impact management plan coupled with an appropriate monitoring programme, and possibly environmental audit, may form the basis for comprehensive environmental performance assessment, and possibly associated certification and/or product labeling. Although this may be an ambitious target for aquaculture enterprises in developing countries, some forms of coastal aquaculture (notably shrimp farming and marine fin-fish), are supported by high value international markets with significant quality and environmental awareness. An annual cycle of reporting and review is usually necessary to meet regulatory requirements or quality standards.

Examples of existing standards include environmental management systems ISO 14000 series and BS 7750, and quality assurance ISO 9000 series. These or other standards may be linked to labeling initiatives resulting in a price premium. If this premium can be passed down to the producer, there will be a strong incentive for compliance and willingness to accept inspections. This approach has the enormous advantage that the market may ultimately bear the bulk of the cost. As an example, there is now great interest in Thailand in developing such standards, and linking them to a variety of environmental management initiatives related to coastal aquaculture, including infrastructure (high quality water supply and waste water treatment) and codes of practice.

Bibliography

This bibliography is divided into two parts:

- a list of documents specifically referred to in the text of the guidelines.
- a comprehensive bibliography, broken down into major subject sections, intended as a resource for further reading and research.

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14 Glossary

Assessing. Identifying and defining clearly environmental and social impacts, and analysing these impacts in terms of their major characteristics and significance.

Cumulative impact. An impact which may be small or insignificant in relation to an individual enterprise, but which, when added to impacts from other existing or future activities, may become significant.

Cumulative Effects Assessment (CEA) and Cumulative Impact Assessment (CIA) Refers to the assessment of the impacts on the environment which results from incremental impact of an action when added to other past, present or reasonably foreseeable actions regardless of what agency or person undertakes such actions. Cumulative impact can result from individually minor but collectively significant actions taking place over a period of time.

An *Environmental Impact Statement (EIS)* is an assessment of the changes in environmental resources or values resulting from a proposed project. It has been largely superceded by the term environmental assessment report, which implies, in addition to the above, a more comprehensive coverage of issues including mitigation, impact monitoring and management.

(Environmental) Health Impact Assessment ((E)HIA) is used to identify, predict and appraise those environmental factors which might affect human health. Factors can include geology, vegetation, demography, economics, pollutants as well as the availability of health services.

An *Initial Environment Evaluation or Examination (IEE)* is a report containing a brief, preliminary evaluation of the types of impacts that would result from an action. It is often the product of a screening process to assess whether or not proposals should undergo full scale EA.

Initial Environmental Impact Assessment (IEA). This lies between an IEE and a full scale environmental assessment. It is usually a thorough report based on secondary sources and rapid appraisal of the main stakeholders/technical experts. It may take from a few days to several weeks.

Integrated Environmental Impact Assessment (IEIA). See regional environmental assessment.

Mitigation. Reducing the severity of environmental or social impacts through improved planning, infrastructure, regulation, design, technology, or management practices.

Significance. Assigning significance to an impact implies measurement against some standard, which may reflect values relating to environmental quality or socio-economic wellbeing.

Regional Environmental Assessment (REA) is the process of determining the regional cumulative environmental and social implications of multi-sectoral developments within a defined geographical area over a defined period. They are usually called for when a relatively pristine area is likely to be subjected to relatively intense development pressure for the first time. If part of a broader process including economic analysis this may be referred to as *Integrated Environmental Impact Assessment (IEIA)*

Social Impact Assessment is that component of EA concerned with changes in the structure and functioning of social orderings, such as changes in social relationships; community (population, structure, stability etc); people's quality and way of life; language; ritual political/economic processes; attitudes/values. It may also include health impacts (UNEP 1996)

Scoping. Scoping is a process to identify and evaluate community and scientific concerns about a proposed policy, programme, project or action, so that they can be addressed systematically in the EA. The output from scoping usually includes detailed terms of reference for further work

Screening. A preliminary examination of a plan or project to determine whether more detailed environmental assessment is required.

Strategic Environmental Assessment (Strategic EA) is the process of identifying and addressing environmental consequences (and associated social and economic effects) of existing, new, or revised policies, plans and procedures. These may be at any level from International agreements to district level policy or plans.

Sector Environmental Assessment (Sector EA) refers to environmental assessment of the effects of a particular sector (such as fisheries or aquaculture) or sector development plan, rather than to the effects of a specific project. Like Strategic EA, Sector EA has the great advantage that it can address cumulative or incremental impacts which may be insignificant for an individual activity or operation, but which may be of great significance for the sector as a whole. It is particularly suited to agriculture and aquaculture developments, since individual farms tend to be small, while the impacts of the sector can be substantial.