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The potential of spatial planning tools to support the ecosystem approach to aquaculture

FAO/Rome Expert Workshop
19–21 November 2008
Rome, Italy

Cover illustration by Emanuela D'Antoni.
This illustration aims to convey the main ecosystem approach to aquaculture (EAA) spatial scales (i.e. the farm, the aquaculture waterbody/watershed or aquaculture zone and the global market) and the power of Geographic Information Systems to spatially represent, integrate and analyze the natural and human environments at any scale. Shrimp aquaculture ponds in Mexico were used here as an example to highlight the need to address environmental and socio-economic issues within higher strategic planning and management frameworks as part of an EAA.

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The potential of spatial planning tools to support the ecosytem approach to aquaculture

FAO/Rome Expert Workshop
19–21 November 2008
Rome, Italy

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Preparation of this document

This publication is the proceedings of the Food and Agriculture Organization of the United Nations Expert Workshop *The potential of spatial planning tools to support the ecosystem approach to aquaculture* convened in Rome, Italy 19–21 November 2008. Fourteen internationally recognized experts representing different regions of the world and providing a wide range of expertise in the areas of aquaculture, natural resources management and environment, Geographic Information Systems, remote sensing, mapping, as well as social, economic, and legal aspects contributed to discussions on a review paper entitled *Status and potential of spatial planning tools, decision-making and modelling in implementing the ecosystem approach to aquaculture.*

The workshop was organized by the Aquaculture Service of the FAO Fisheries and Aquaculture Department. We would like to thank our many colleagues who kindly provided their papers, articles and technical reports for review. Special thanks go to Geoff Meaden and Lindsay Ross for their valuable edits and comments. The authors also thank, in alphabetical order: Cécile Brugère, Fabio Carocci, João Gomes Ferreira, Donna Hunter, Suan Pheng Kam, Alessandro Lovatelli, Philip Conrad Scott, Diego Valderrama, Luiz Vianna and Patrick White for their suggestions and additions. Also, we would like to thank Jeff Jenness for organizing the Global Lakes and Wetlands Database (GLWD) included in the present review. We acknowledge Tina Farmer and Françoise Schatto-Terribile for their assistance in quality control and FAO style. Emanuela D'Antoni prepared the cover and José Aguilar-Manjarrez and Doris Soto assisted in its design. The document layout specialist was Koen Ivens.

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Abstract

Attention is presently turning to the processes, methods and tools that allow practical implementation of the ecosystem approach to aquaculture (EAA).This will require the use of various tools and methodologies, including environmental impact assessments and risk analysis. Ecosystem-based management involves a transition from traditional sector-by-sector planning and decision-making to the more holistic approach of integrated natural resource management at different scales and for ecosystems that cross administrative boundaries. An essential element for the implementation of the EAA will be the use of spatial planning tools including Geographic Information Systems, remote sensing and mapping for data management, analysis, modelling and decision-making.
These proceedings focus on the status and process of implementing these tools which, in turn, necessitate the development of capacity building, training and promotion of spatial planning among decision-makers and technical staff. The document is organized in two parts. The first, the workshop report, deals with the background of the EAA effort and the genesis of the workshop. Most importantly, it captures the salient contributions of participants from their formal presentations and general discussions. The main conclusions of a review of the status and potential of spatial planning tools, decision-making and modelling in implementing the EAA are also included. The review itself, along with an abstract, forms the second part.

Aguilar-Manjarrez, J.; Kapetsky, J.M.; Soto, D.
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Contents

Genesis of the workshop

BACKGROUND

Building an ecosystem approach to aquaculture

Aquaculture growth worldwide involves the expansion of cultivated areas, a higher density of aquaculture installations and farmed individuals and more efficient use of feed resources produced outside of the immediate culture area. Such evolution of the sector could have negative impacts on the environment and on sections of the society if unregulated and badly managed. In 2006, the Aquaculture Service (FIRA) of the FAO Fisheries and Aquaculture Department initiated an effort to look into the development and application of the ecosystem approach to aquaculture.

An initial expert workshop co-organized with the Universitat de les Illes Balears (Palma de Mallorca, Spain) in May 2007 on "Building an ecosystem approach to aquaculture" agreed that: "*An ecosystem approach for aquaculture (EAA) is a strategy for the integration of the activity within the wider ecosystem in such a way that it promotes sustainable development, equity, and resilience of interlinked social and ecological systems*". Such a strategy should be guided by three main principles to ensure the contribution of aquaculture to sustainable development: (1) aquaculture should be developed in the context of ecosystem functions and services with no degradation of these beyond their resilience capacity; (2) aquaculture should improve human wellbeing and equity for all relevant stakeholders; and (3) aquaculture should be developed in the context of (and integrated to) other relevant sectors. At least three relevant geographical scales/levels for the application of EAA were identified and discussed: the farm; the waterbody and its watershed/aquaculture zone; and the global, market-trade scale.

The main output of the Mallorca workshop is the published proceedings; Soto, Aguilar-Manjarrez and Hishamunda (2008). Guidelines for EAA implementation are being developed as a follow-up to an Expert Workshop on "Guidelines for the implementation of an ecosystem approach to aquaculture (EAA)" that took place in FAO headquarters, Rome, Italy from 24–26 November 2008. The final general guidelines will be published in the FAO Technical Guidelines for Responsible Fisheries Series in 2010.

The present publication is the proceedings of the FAO Expert Workshop *The potential of spatial planning tools to support the ecosystem approach to aquaculture* convened in Rome, Italy 19–21 November 2008.

Attention is presently turning to the processes, methods and tools that allow practical implementation of the EAA. Such implementation will require the use of various tools and methodologies. Some relevant tools include environmental impact assessments, and risk analysis.

An essential element for the implementation of the EAA will be the use of spatial planning tools including Geographic Information Systems (GIS), remote sensing and mapping for data management, analysis, modelling and decision-making.

OBJECTIVES

The focus of discussion of the present workshop was a review on the *Status and potential of spatial planning tools to support the ecosystem approach to aquaculture* drafted by the Aquaculture Service (FIRA) of the Fisheries and Aquaculture Department, specifically by James McDaid Kapetsky, José Aguilar-Manjarrez, and Doris Soto.

Specific objectives of the EAA review and workshop were to:

1. Determine the status and potential of spatial planning tools, including decision-making and modelling, to support the ecosystem approach to aquaculture (EAA).
2. Identify gaps and recommend future activities to ensure that the potential of spatial planning tools is fully utilized in support of the EAA.

The workshop agenda is provided in Annex 1.

PARTICIPATION

The workshop was attended by fourteen internationally-recognized experts consisting of FAO staff and consultants representing different regions of the world and providing a wide range of expertise in the areas of aquaculture, natural resources management and environment, Geographic Information Systems, remote sensing and mapping. The socio-economic and legal sectors were also represented. The list of participants is provided in Annex 2.

Workshop overview and findings

OVERVIEW

The workshop consisted of plenary presentations and brainstorming discussions focused on spatial planning tools in the context of a wide a variety of aquaculture applications as well as others related to aquaculture, including natural resources, environmental management, economic and social realms as well as law and policy (see Annex 1).

The FAO Secretariat introduced the workshop by presenting an overview of an initial EAA framework and the Review mentioned below on the S*tatus and potential of spatial planning to support the EAA*. Additional presentations illustrating a wide range of GIS applications addressing different issues, environments, culture species, culture systems, scales, and regions were made by the participants. Thereafter, the participants jointly created a group presentation by selecting key material from the various presentations. The executive summary of the EAA review was also discussed and improved by participants. The group presentation and the executive summary were then presented to the FAO Fisheries and Aquaculture Department as a seminar for final discussions.
The expert's discussions and recommendations have been integrated into a review entitled: *Status and potential of spatial planning tools, decision-making and modelling in implementing the ecosystem approach to aquaculture*. It is expected that the recommendations from the workshop will be used to develop ideas for: (a) the creation of a manual for decision-makers to illustrate the use of spatial panning tools to support EAA implementation; and (b) development of FIRA's activities on spatial planning tools in support of the EAA that will include technical assistance and training.

CONTRIBUTED PRESENTATIONS AND DISCUSSIONS

The presentations from participants offered a broad spectrum of issues and case study examples which were extremely useful in shaping ideas on the role of GIS to support the implementation of the EAA.

Ms D. Soto presented an overview of sustainability approaches in aquaculture and background information on the proposed EAA initiative and framework. She described the concepts, guiding principles and scales approaches for an EAA; she then summarized the results achieved so far on EAA and the potential next steps for EAA implementation.

Messrs J.M. Kapetsky and J. Aguilar-Manjarrez presented a wide ranging review covering the Status and potential of spatial planning tools to support the ecosystem approach to aquaculture. The main topics included data availability; environmental impacts of aquaculture; issues, geographic distribution and scales of applications; indicators of capacity and decision-making and modelling. They concluded that spatial tools are essential for the EAA to enable better understanding of the ecosystem, to generate scenarios illustrating the consequences of different management decisions on natural resources and economy and to facilitate multistakeholder participation in the planning processes. A priority objective is to spatially integrate socio-economics with ecosystems in recognizing that people are key components in the EAA.

Mr P. White (FAO consultant) presented "Development of programmatic EIAs and monitoring programs for clusters of small scale cage farmers in the Philippines – a case study" illustrated a methodology for the estimation of safe aquaculture carrying capacity, optimal site selection, and zoning of aquaculture parks for sustainable aquaculture development for small scale farmers (www.fao.org/fishery/gisfish/id/4840). From a

practical viewpoint, even with the availability of carrying capacity models, administrators and regulators must have the interest and political will to use the model outputs for zoning aquaculture. An important facet of the EAA is to forge a link between ecosystem management and aquaculture planning.

Mr L. Ross showcased the current work on GIS at the Institute of Aquaculture in Stirling, United Kingdom of Great Britain and Northern Ireland relating to the EAA development. Their programme has taken two directions: the strategic evaluation of large regions for aquaculture exploitation and development, and the use of GIS in detailed facility location and management within a site. GIS-based environmental impact modelling has also been developed, with special emphasis on coastal zone management. Currently, the group is focusing on environmental and socio-economic interactions of aquaculture, the relationship with biodiversity, and impacts of climate change. They adopt a holistic view of aquatic resource management and aquatic production and are working to integrate a range of GIS decision-making tools for multi-site assessment and management, including 2-D and hydrological models; and exploration of dynamic 3 dimensional plus time (4D) modelling tools (www.aqua.stir.ac.uk/GISAP/gis-group).

The use of spatial tools to globally assess the water resources of ecosystems for uses broader than aquaculture was presented by Mr J. Hoogeveen of the Water Development and Management Unit of the FAO Natural Resources and Environment Department (FAO-NRLW). The assessment is aimed to support integrated water use management of the main users: industry, agriculture, and domestic consumption, and works at a continental level. GIS is used in a modelling context as a check on reported water use statistics at the country level. Discussions emphasized the need to consider water quality as well as quantity, the applicability of water resources models to aquaculture and including aquaculture planning in more general water use planning.

A very practical need for spatial tools to assist in marine aquaculture development planning in the RECOFI region (www.fao.org/fishery/rfb/recofi/en) was presented by Mr Alessandro Lovatelli (FAO-FIRA). There is an increasing demand for products from aquaculture and fisheries in the region. A solution is to expand marine aquaculture, but there is resistance from other users of ocean space. Consequently, there is a need for marine aquaculture zoning and site selection with due consideration to other uses of the ecosystem. Building capacities to use spatial tools for marine aquaculture development and management in the region is required with the impetus coming from investors in marine aquaculture development. Finances are available.

The Fishery Information Technology Center (FITC) at the Department of Fisheries Thailand (DoF) is responsible for developing and maintaining computer networking, GIS, management information systems, and fisheries data collection and statistics reports. Work on GIS at the FITC is divided by culture environments: coastal, marine and freshwater. Projects presented by Mr P. Suvanachai mainly include the use of satellite imagery to inventory and monitor aquaculture and fisheries structures. Inventories derived from their spatial analysis are available via the Internet for public and/or internal use (http://gis.fisheries.go.th/WWW/index.jsp). DoF Thailand is committed to secure/sustain the use of GIS for fisheries and aquaculture at all administrative levels. The FITC, well-equipped with skilled manpower and data, could provide strong support to EAA related projects. The main impediments are the lack of appreciation of the benefits of spatial tools at the executive level, development of specialized GIS applications within sections of the DoF rather than as a centralized service, and lack of data standardization and harmonization.

A complementary review to the EAA on "Geographic information systems to support the ecosystem approach to fisheries" by Carocci *et al*. (2009) was presented by Mr Fabio Carocci (FAO-FIRF). The EAF review illustrates the use of GIS for a wide range of EAF-related projects, first via a range of example applications to address key issues in

fisheries management and then via a number of detailed case studies that illustrate the degree to which GIS is currently being used for EAF implementation. Overall, it was noted by participants that many parts of the review will be very useful not only for the EAF, but also for their relevance to the EAA. Noteworthy characteristics of the use of spatial tools to achieve the EAF are that issues and objectives guide implementation, and because capacities vary, the work is carried out through developing partnerships with FAO. Defining spatio-temporal boundaries is essential, and mapping and modelling of different scenarios is a key contribution to EAF implementation.

MAJOR FINDINGS AND CONCLUSIONS FROM PRESENTATIONS

Current status of GIS, remote sensing and mapping applications in aquaculture.

Expanding spatial awareness and realizing the analytical potential of GIS are key to making better informed decisions. Essentially, GIS takes data from different formats, sources and disciplines to make complex information about a location comprehensible, so that informed decisions could be made.

The presentations clearly illustrated that the rapid evolution of remote sensing and GIS based modelling and mapping have radically transformed our ability to detect, map, and model environmental and socio-economic related changes. GIS is now being used in several countries to regularly and systematically monitor aquaculture development. Remote sensing-based mapping of aquaculture is an FAO/FIRA activity. Data sharing within and across disciplines is crucial to the success of GIS advancements, but only a small proportion of potentially useful information is actually shared. Despite advances, there is still a need for facilitated data sharing agreements.

Relevance of GIS applications to EAA guiding principles in relation to scales and boundaries.

Current and past GIS applications relate well to the guiding principles of the EAA in that they deal with ecosystems and environments at all scales in the context of aquaculture development and management. GIS can support a decision-making process (including policy-making, planning and management) and can help evaluate how it influences the driving forces of development (such as population growth, climate change etc.). GIS can be used to monitor the results (human impacts) of development, and its impacts on the physical, social, and economic environment (environmental change). GIS is an excellent data visualization medium with an important role to play in stimulating discussion amongst stakeholders and GIS can be integrated into many aspects of governing and policy-making by using rules arising from management.

An essential step in implementing the EAA is the ability to work across administrative and ecosystem boundaries. Administrative boundaries seldom parallel ecosystem boundaries and legal boundaries frequently dictate quite different land uses. GIS has the ability to discern both kinds of boundaries and to intersect and integrate the data and analysis belonging to both realms.

Capacities to implement GIS.

Decision-makers, faced with data and output from GIS and other geospatial tools, often lack a basic understanding of these technologies, including both their limitations, strengths and the kinds of questions that can be addressed by them which would allow for operational use and informed decisions. The same range of understanding is required to decide on the level of adoption of GIS.

Synergies between the EAA and EAF and with other sectors.

Issues in aquaculture and fisheries can be quite different, but they have many kinds of data needs that are common to both. Similarly, data and technical innovations applied for other purposes such as coastal area management and water resources assessments

also can be useful for aquaculture. For the sake of economy as well as to promote cooperation, opportunities to realize synergies need to be pursued at all levels.

Suggested plans of action for FAO for the use of spatial planning tools to support EAA.
Thailand could serve as an immediate follow-on "pilot project" and model for the operational use of GIS for EAA because the DoF is committed to sustain the use of GIS for fisheries and aquaculture at all administrative levels, and the FITC at the DoF is well equipped with skilled manpower and data.

Additional findings and conclusions derived from the presentations are included in the conclusions to the review listed below.

CONCLUSIONS TO THE REVIEW ON STATUS AND POTENTIAL OF SPATIAL PLANNING TOOLS, DECISION-MAKING AND MODELLING IN IMPLEMENTING THE ECOSYSTEM APPROACH TO AQUACULTURE

The key findings are summarized and general agreements are listed below.

Background to the ecosystem approach to aquaculture.
The implementation of the EAA will require the use of various tools, methodologies, and guidelines that are very specific. These include adequate guidelines for aquaculture site selection, for integrated aquaculture, for aquaculture-based fisheries, etc. An essential element for the implementation of the EAA will be spatial planning tools for analysis, decision-making, modelling, and data management.

There are a number of key issues in the ecosystem approach planning and implementation cycle that require explicit consideration of spatial information about ecosystem components and properties. Furthermore, because of the interrelationships of inputs, resource use and outputs at the different scales, spatial data visualized within a GIS environment can help improve understanding of the interactions between aquaculture, other sectors and the ecosystem in question and allow for more spatially resolved analyses and integrated planning and management.

Spatially defined global ecosystems, their issues and relevance to the ecosystem approach to aquaculture.
An evaluation of the readiness of spatial planning tools to support the EAA is based on the perceptions that major ecoregions and ecosystems have to be spatially defined and their main issues known. Fundamental to knowing where, in what ways and for whom the EAA will be spatially supported requires knowledge of where the problems are, their magnitude and the administrative responsibilities for their mitigation.

Spatially defined global ecosystems are useful to the EAA by raising the awareness of aquaculture planners and practitioners to issues that must be taken into account for the further development of aquaculture and for the mitigation of the potential impacts of aquaculture on the environment. Many spatially defined ecosystems can be used for aquaculture planning. Issues associated with ecoregions and ecosystems need to be associated with the main issues in aquaculture in the same areas. Although many kinds of ecosystems are already defined, a considerable expenditure of time to evaluate the methods used and the actual relevance and quality of the data will be required in order to use them effectively for GIS in support of the EAA.

Spatial data to support the ecosystem approach to aquaculture.
In many cases ecosystem boundaries may not be already defined so spatial data will be required to do so, or to enhance existing ecosystem data with data specific to the needs of aquaculture. There are vast quantities of spatial data freely available that could be important for use in spatial analyses in support of the EAA. One of the early

and essential steps of implementing spatial analyses in support of the EAA at national levels will be to inventory and evaluate relevant spatial data at all resolutions.

The geography of aquaculture in relation to environments and potential impacts.

Globally comprehensive and comparative estimates of the potential impact of aquaculture on coastal (marine and brackishwater) and freshwater environments at the country level were developed. Likewise, an index-based approach was used to make comprehensive and comparative estimates of the environmental impacts on aquaculture at the same level. Estimates from each of these approaches are useful as a starting point to gauge where GIS in support of the EAA could be most usefully deployed.These results call attention to the need for improved ways to comprehensively and comparatively assess aquaculture's potential impact on the environment and the environment's impact on aquaculture. Spatially comprehensive inventories of aquaculture and its attributes are an essential requirement for implementing the EAA at national and sub-national levels.

Current status of GIS, remote sensing and mapping applications in aquaculture from an ecosystem viewpoint.

GIS has been implemented in a very broad variety of ecosystems and scales as well as in a wide range of culture systems. Spatial analysis experience in terms of addressing issues in the development of aquaculture and in aquaculture practice and management is good overall. Specific gaps in experience (i.e. know-how) are in economics and socioeconomics as well as in multisectoral planning for aquaculture. GIS is completely scaleable and can include ecosystem, administrative, and social, boundaries. The power of GIS is the capability to spatially integrate and analyze the natural and human as components of ecosystems. The most appropriate "scale" for the EAA and for GIS in support of the EAA is defined by the boundaries of the problem expressed both in ecosystem, economic, social and administrative terms. It is noteworthy that these kinds of spatial boundary differences are easily reconciled by spatial analyses.

Decision-making and modelling approaches for aquaculture development.

GIS can support decision-making and modelling within and among all boundaries associated with aquaculture development and management. There are many immediately available decision-making tools that could be used in support of the EAA within GIS and many aquaculture models (e.g. carrying capacity) can be run inside GIS, or be spatially related to aquaculture by GIS (see Figure 7.3a-d in Chapter 7).The latest methods and applications for GIS-based decision support can be taken from other sectors and adapted for use in the EAA.

Remote sensing in support of the EAA.

Remote sensing already provides historical and real-time information of demonstrated use to aquaculture and the potential for increased use is great. Data and software will become more widely available, user friendly, and accessible to managers rather than just to specialist remote-sensing scientists. Also, archived remote sensing data can be used to analyze change spatially and temporally. Therefore, it would be of utmost value if remote sensing data could be made more readily available to non specialists for the EAA.

Case studies of GIS, remote sensing and mapping applications in aquaculture in relation to EAA implementation.

Case studies that span all of the EAA principles and scales were selected and summarized in tabular format. These clearly demonstrate that spatial analyses

can be easily designed to meet a variety of EAA needs with respect to scales and principles.

Capacities of GIS to implement ecosystem approach to aquaculture. The success of spatial tools in support of the EAA depends on interest, finances and capacities. With regard to the latter, there is a need to identify, qualify and quantify spatial analysis capacities at the country level in order to match training and technical support to the capacity to absorb them. Capacities appear to vary widely. For example, there are many countries for which there were no identifiable aquaculture GIS applications. Some of these countries are the most intensive users of the environment for aquaculture. GIS and spatial analytical techniques should be designed and delivered to match the requirements and levels of capacities of the users. This has to be done at the national level because such information is difficult to come by remotely.

The Internet is the most rapid and efficient pipeline for wide ranging technical assistance, for the exchange of data and to communicate in support of the EAA.

Advancing the use of spatial planning tools to support the EAA. Future activities in support of the EAA can be viewed as several major but related initiatives: (1) development of in-house innovative applications of spatial planning tools that can serve as core training materials that, in turn, can be deployed to EAA hotspots as needed, (2) capacity building that goes forward at all levels from global to sub-national, and (3) promotion at decision-making and technical levels.

In order to ensure that planning for the use of spatial tools and analyses in support of the EAA is well founded, more specific and more detailed preparatory work will have to follow this review including:

- Incorporating GIS-based social and economic analyses in aquaculture
- A further exploration and documentation of GIS-based decision support and risk analysis and catalogues of their respective tool boxes
- Innovative ways to identify needs and capacities at the national and sub-national levels
- Increasing capacities for training in spatial analyses (e.g. via the Internet).

In order to build capacity, there is a need to reach many small, globally dispersed audiences, Therefore, a broad strategy is required that takes advantage of common interests and synergies in the EAA principles and objectives that are shared by other organizations, some of whom could become potential partners.

The EAA is holistic and therefore promotion of spatial awareness has to be at the ecosystem level as well as all administrative levels and a broad audience has to be addressed that includes not only aquaculture administrators and the aquaculture industry, but also educators; and high-level decision-makers and NGOs.

The locations of aquaculture producers, processors, transporters and marketers are fundamental for defining aquacultures potential impacts on ecosystems and within administrative boundaries. Expansion and/or acceleration of the mapping component of the National Aquaculture Sector Overviews (www.fao.org/fishery/naso/search/en) could contribute greatly to the implementation of the EAA.

Expansion of the capabilities of FAO's GISFish Global Gateway to Geographic Information Systems (GIS), Remote Sensing and Mapping for Fisheries and Aquaculture (www.fao.org/fishery/gisfish) could provide an avenue for promotion of the EAA and for pipelining technical information and tools based on a Web infrastructure that already attracts users worldwide.

Investment in GIS should be made with a clear understanding of what should be accomplished with such capabilities, and the decision support needs of the stakeholders that GIS can fulfil. In many cases, GIS capabilities are primarily used as tools for

generating and displaying maps. However, the current state of spatial methods and technology, on the other hand, clearly indicates that GIS capabilities go far beyond data management and visualization alone.

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Workshop recommendations and the potential role of FAO

RECOMMENDATIONS

Participants concurred that there are many benefits that GIS can bring to EAA management processes, from simple mapping to sophisticated modelling. Presentations at the workshop as well as the review (Kapetsky, Aguilar-Manjarrez and Soto, 2010) demonstrated that GIS has the potential to support EAA, Therefore, the principal task is to determine the ways that spatial tools can be best implemented to support the EAA.

The workshop recommended that FAO should continue to promote the use of GIS and associated spatial tools to facilitate the implementation of EAA. However, an enabling environment is crucial to adopt the use of spatial tools to support the EAA. There is a need to gauge capacities (human resources, infrastructure, finances) at national and/or regional level to implement spatial tools in support of the EAA so that capacity building initiatives can be matched to capabilities.

Participants agreed that practical steps for the use of spatial tools are needed. Implementation of spatial tools in support of the EAA at national levels can come only through an awareness of benefits and a knowledge of their techniques. Thus, as a practical first step, development of a manual was recommended to illustrate the use of GIS to support EAA using a few case studies from different regions, environments, species and culture systems.

THE POTENTIAL ROLE OF FAO

FAO should continue efforts to define the role of spatial planning tools to support the EAA. The main follow-up activities to this workshop include the completion of one review paper on the "Status and potential of spatial planning tools, decision-making and modelling in implementing the ecosystem approach to aquaculture" and the meeting report being presented in these proceedings.

To better define the role of spatial planning tools for both the EAA and EAF, and as an immediate follow-up to these proceedings FAO should focus in developing projects for the practical implementation of the ecosystem approach to fisheries and aquaculture. Case studies of national implementation for the EA, or national opportunities for application of the ecosystem approach should be identified; e.g. finding sites for aquaculture has been and will be a challenge; therefore, as an initial first step, a case study focused on the use of spatial tools for zoning aquaculture in an EAA context would be particularly useful as a model that could be followed and improved elsewhere. Furthermore, zoning would also simplify and streamline the process of farm site selection.

In parallel to the above, from a more technical viewpoint, FAO should organize a much larger workshop to better define the use of spatial planning tools for both the EAA and EAF with about 25-30 international experts including top scientists in aquaculture, fisheries, production systems, ecosystem based management, economics and sociology, law and policy. The EAA and EAF FAO reviews would serve as discussion documents for this larger FIRA-FIRF workshop.

The results of the practical case studies for EAA implementation and/or the outputs of a larger workshop in the form of management options, strategies, technical guidelines and recommendations would be essential inputs to FAO member countries in their implementation of the EAA/EAF.

Annex 1 – Agenda

STATUS AND POTENTIAL OF GEOGRAPHIC INFORMATION SYSTEMS IN IMPLEMENTING THE ECOSYSTEM APPROACH TO AQUACULTURE

WEDNESDAY, 19 November morning – Opening of workshop and background
15:00-17:00

Agenda item	Presenter
Opening the meeting. Presentation of participants Adoption of the agenda	D. Soto and J. Aguilar-Manjarrez
Presentation of the EAA principles and general EAA guidance and advice	D. Soto and P. White
Coffee break	
A presentation on the review on the "Status and potential of geographic information systems, remote sensing and mapping to support implementation of EAA"	J. Kapetsky and J. Aguilar-Manjarrez

THURSDAY, 20 November – Role of spatial planning tools for EAA implementation
9:00-17:00

Wrap-up of previous day discussion	J. Kapetsky
Presentation on "A case study on the development of programmatic environmental impact assessment and monitoring programs for clusters of small scale cage farmers in the Philippines"	P. White
Coffee break	
Presentation on GIS applications at the Institute of Aquaculture in Stirling	L. Ross
Use of spatial tools to globally assess the water resources of ecosystems	J. Hoogeveen
Need for spatial tools to plan for marine aquaculture development in the RECOFI region (Arab Gulf)	A. Lovatelli
Presentation on the use of GIS at the Department of Fisheries Thailand	P. Suvanachai
Lunch break	
Working group discussion to wrap-up key findings	P. White

FRIDAY, 21 November – Synergies between EAA/EAF and wrap-up
9:00-17:00

Presentation on Review on "Geographic Information Systems to support ecosystem approach to fisheries".	F. Carocci
Discussion – Synergies and strategies for cooperation and collaboration between EAA and EAF reviews.	J. Kapetsky
Coffee break	
Working group discussion – List recommendations discussed and agreed in the previous days.	J. Aguilar-Manjarrez
Lunch break	
Working group discussion – Agreement on major findings from the review on the "Status and potential of geographic information systems, remote sensing and mapping to support implementation of EAA"	J. Kapetsky
Coffee break	
Departmental seminar – Conclusions and recommendations: the way forward	J. Aguilar-Manjarrez and J. Kapetsky
Adjourn	

Annex 2 – List of participants

FRANCE
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