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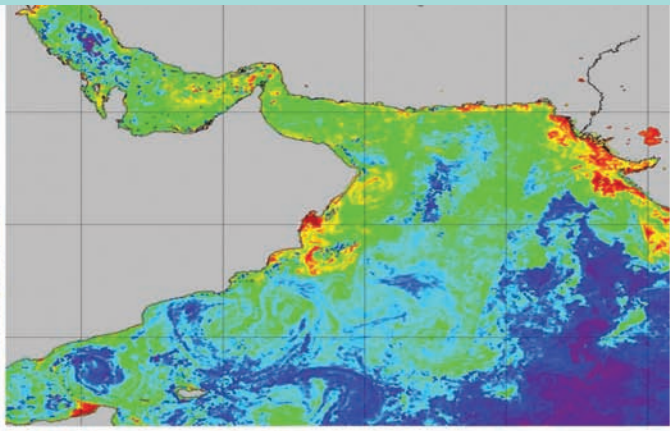
Advances in geographic information systems and remote sensing for fisheries and aquaculture

Summary version



Cover photos:
Clockwise from top left: Double-rigged shrimp trawler with cod end of one net about to be opened (courtesy of Robert K. Brigham, NOAA's Fisheries Collection); Chlorophyll concentrations in the Gulf of Oman region (courtesy of ACRI-ST InfoceanDesk environment monitoring service from EU FP7 and ESA MyOcean GlobColour Products, ESA ENVISAT MERIS data, NASA MODIS and SeaWiFS data); Uur River in Mongolia (courtesy of Zeb Hogan); Gilthead seabream cages, Lavagna, Ligurian Sea, Italy (courtesy of Aqua sarl and Francesco Cardia).

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Edited by
Geoffery J. Meaden
FAO consultant
Canterbury
United Kingdom of Great
Britain and Northern Ireland

and

José Aguilar-Manjarrez
Aquaculture Officer
Aquaculture Branch
FAO Fisheries and Aquaculture Department
Rome, Italy

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Preparation of this document

A challenge to geographic information systems (GIS) and remote sensing work on fisheries or aquaculture concerns geographic cognition and spatial awareness. There is a lack of appreciation that many or perhaps most of the problems concerning fisheries and/or aquaculture may be rooted in spatial differentiation, thus fisheries managers and others may often not appreciate the importance of the geographic perspective. It is because of this lack of appreciation that there is the need to train people in the use of GIS and remote sensing. The recent emergence of "marine spatial planning" is an exact reaction to this lack of realization about the importance of spatial issues. As a consequence, this technical paper was prepared to provide policy-makers and senior managers, who have to deal with their national fisheries and aquaculture sectors, with an overview of GIS and remote sensing tools to help them lead to more sustainable fisheries and aquaculture. This document will also be of relevance to aquaculture operators, industry organizations, non-governmental organizations and other groups interested in understanding GIS and remote sensing and their influences on master plans, industry regulation and the management of aquatic resources.

The FAO Fisheries and Aquaculture Resources Use and Conservation Division has been active in promoting the use of GIS and remote sensing in fisheries and aquaculture for many years. Promotional activities have been carried out by means of technical publications, training courses and workshops as well as the FAO GISFish Web site also created for this purpose.

The need for technical papers for understanding and applying GIS and remote sensing in fisheries and aquaculture was recognized in the 1990s; in fact, the Food and Agriculture Organization of the United Nations (FAO) commissioned and published the first technical papers on the subject: *Geographical information systems and remote sensing in inland fisheries and aquaculture* (Meaden and Kapetsky, 1991) and *Geographical information systems: applications to marine fisheries* (Meaden and Do Chi, 1996). The present technical paper aims to update these papers.

Abstract

Marine fisheries around the world remain seriously threatened from fishing overcapacity plus a range of environmental problems. As a result, the rising demand for fish products is largely being supported from increased aquaculture output. Changes in the sourcing of fish will continue to cause significant spatially variable effects on the marine and other aquatic environments, effects that are best managed through the application of geographic information systems (GIS) and remote sensing methods. Furthermore, changes need to take into account wider approaches to addressing aquatic problems, i.e. via marine spatial planning and/or ecosystem approaches to both fisheries and to aquaculture. This publication is an essential guide to understanding the role of spatial analysis in the sustainable development and management of fisheries and aquaculture. The publication is an easy-to-understand publication that emphasizes the fundamental skills and processes associated with geographic information systems (GIS) and remote sensing. The first chapter initially puts the array of spatially related problems into perspective and discusses the earlier applications of GIS and remote sensing. Chapters, 2, 3 and 4 outline what are considered to be the basics on which GIS can function, i.e. hardware and software; spatial data; and how GIS systems themselves are best implemented. Chapter 5 looks at preparing the data for GIS use and Chapter 6 explores what remote sensing consists of and the main purposes for its use. Chapter 7 discusses the functional tools and techniques offered by typical GIS software packages. Chapters 8, 9 and 10 examine respectively, the current issues and status, including extensive case studies, of the application of GIS and remote sensing to aquaculture, to inland fisheries and to marine fisheries. The final two chapters examine the emerging thematic issues that will be faced by fisheries and aquaculture in the near future, and then provides useful clues as to how challenges in accomplishing GIS work might best be overcome. The paper concludes with a series of recommendations underlining the paramount need to recognize that it is mainly through the application of a spatial perspective and approach that problems in fisheries and aquaculture will be better addressed. This technical paper is an update of previous FAO publications.

This publication is organized in two parts to inform readers who may be at varying levels of familiarity with GIS and remote sensing. One part is a summary and is addressed to administrators and managers, while the other is the full document and is intended for professionals in technical fields and for university students and teachers. The latter part is available on a CD–ROM accompanying the printed part of this publication.

Meaden, G.J. & Aguilar-Manjarrez, J., eds. 2013. *Advances in geographic information systems and remote sensing for fisheries and aquaculture.* Summary version. FAO Fisheries and Aquaculture Technical Paper No. 552. Rome, FAO. 98 pp. Includes a CD–ROM containing the full document (425 pp.).

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Abbreviations and acronyms

ASFA	Aquatic Sciences and Fisheries Abstracts (FAO)
AUV	autonomous underwater vehicles
CHARM	Channel Habitat Atlas for Resource Management
COAs	conservation opportunity areas
DEM	digital elevation model
DMBS	database management systems
EAA	ecosystems approach to aquaculture
EAF	ecosystems approach to fisheries
EMR	electromagnetic radiation
ERS	Earth Resources Satellite (from ESA)
ESRI	Environmental Systems Research Institute
FAO	Food and Agriculture Organization of the United Nations
FOSS	free or open source software
GIS	geographic information system
GISFish	Global gateway to geographic information systems, remote sensing and mapping for fisheries and aquaculture
GPS	global positioning systems
IFREMER	Institut Français de Recherche pour l'Exploitation de la Mer
ISO	International Organization for Standardization
IT	information technology
LAN	local area network
LiDAR	light detection and ranging
MERIS	Medium Resolution Imaging Spectrometer
MODIS	Moderate Resolution Imaging Spectroradiometer
MPA	marine protected area
NASO	National Aquaculture Sector Overview
PDA	personal digital assistant
SAR	synthetic aperture radar
SMOS	Soil Moisture and Ocean Salinity
SPEAR	Sustainable options for People, catchment and Aquatic Resources
SPOT	Système Pour l'Observation de la Terre
TIN	triangulated irregular network
TOREDAS	Traceable and Operational Resource and Environment Data Acquisition System
UNESCO	United Nations Educational, Scientific and Cultural Organization
USB	Universal Serial Bus
UTM	Universal Transverse Mercator
WAN	wide area network

Foreword

Global ecosystems are under enormous pressure. The pressure comes mainly from the increasing human population, which is attempting to extract resources at an accelerating rate from a planet that is finite. The pressure on fishery resources is manifested in a variety of ways, including: (i) reduced access to, and availability of, land and water (especially freshwater); (ii) overfishing of commercial fish stocks; (iii) degradation of fish habitats; (iv) pollution and deoxygenation of waters; (v) increasing competition for the use of the aquatic space; and (vi) changes in atmospheric processes, such as climate change and its consequences.

The FAO Fisheries and Aquaculture Department is charged with the important responsibility of tackling these issues. Its principle "mission" is to "promote policies and strategies aimed at sustainable and responsible development of fisheries and aquaculture in inland and marine waters." More specifically, within the Fisheries and Aquaculture Resources Use and Conservation Division (FIR), the Aquaculture Branch (FIRA) is responsible for "programmes and activities related to development and management of marine, coastal and inland aquaculture, with regards to technical, socio-economic and environmental aspects, and conservation of aquatic ecosystems, including biodiversity", and the Marine and Inland Fisheries Branch (FIRF) is "responsible for all programmes and activities related to management and conservation of fishery resources, including mainstreaming biodiversity and ecosystem concerns in fisheries management through an ecosystem approach to fisheries". Readers of this technical paper will see that its subject matter goes right to the heart of both of these remits.

In order to directly address the serious aquatic issues described above, how is it best possible for FAO to meet its responsibilities? Although each of the issues has to be dealt with in an individual way, a detailed look at the full range of issues reveals that spatial problems are an important commonality.

The use of spatial planning tools such as Geographic information systems (GIS) and remote sensing for fisheries and aquaculture can greatly help in the identification, analysis and possible allocation of specific geographical areas to be used for fisheries and aquaculture, particularly in those countries that have limited natural resources that are in high demand by competing users. Spatial tools can also simplify the process of zoning and site selection for aquaculture and can match other demands on the marine space. These tools, therefore, become important considerations in bridging the future supply and demand gaps in fishery products. And now that planning, management and research in the marine and other aquatic spaces is dominated by "ecosystem approach" considerations, and with the need to better consider other users of marine

space through "marine spatial planning", it is certain that GIS will prove to be an indispensable tool. GIS and remote sensing technologies are invaluable technologies to support sustainable aquaculture expansion and intensification as well as sustainable fisheries.

Árni M. Mathiesen
Assistant Director-General
FAO Fisheries and Aquaculture Department