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ここから広がる未来への一歩
Sustainability Weeks

2010



Public Lecture: Theory and Practice of Fisheries Sustainability Science
Hakodate: November 9, 2010

Sustainable aquaculture from space: application of geographic information system and satellite remote sensing

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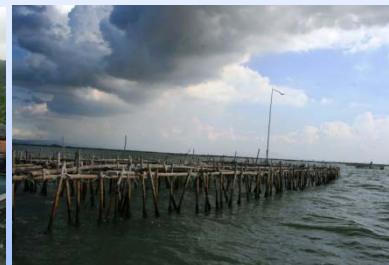
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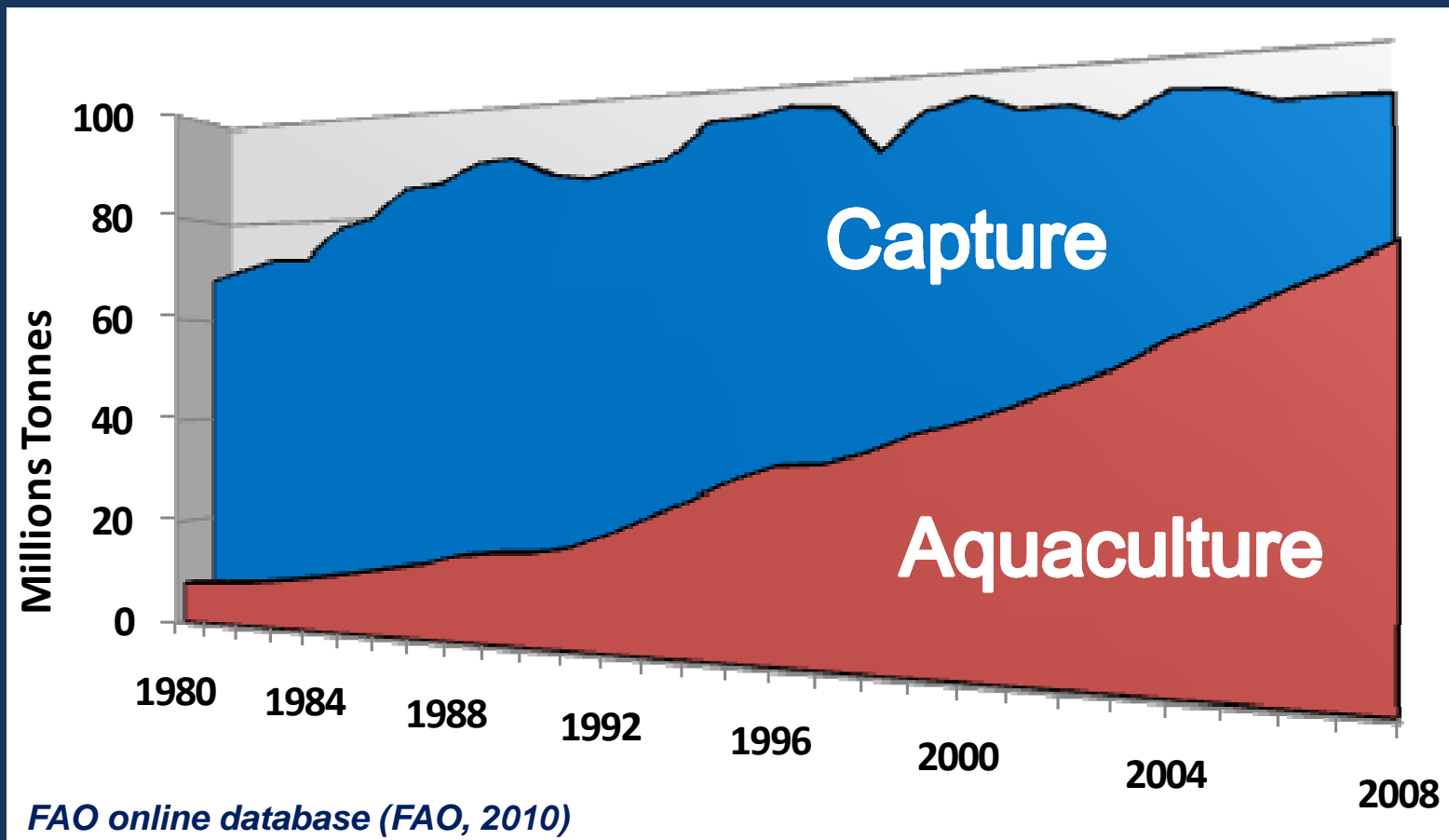
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- ❑ Spatial data to support sustainable aquaculture
- ❑ GIS/RS in aquaculture development
- ❑ Case study of GIS/RS in aquaculture
- ❑ Summary



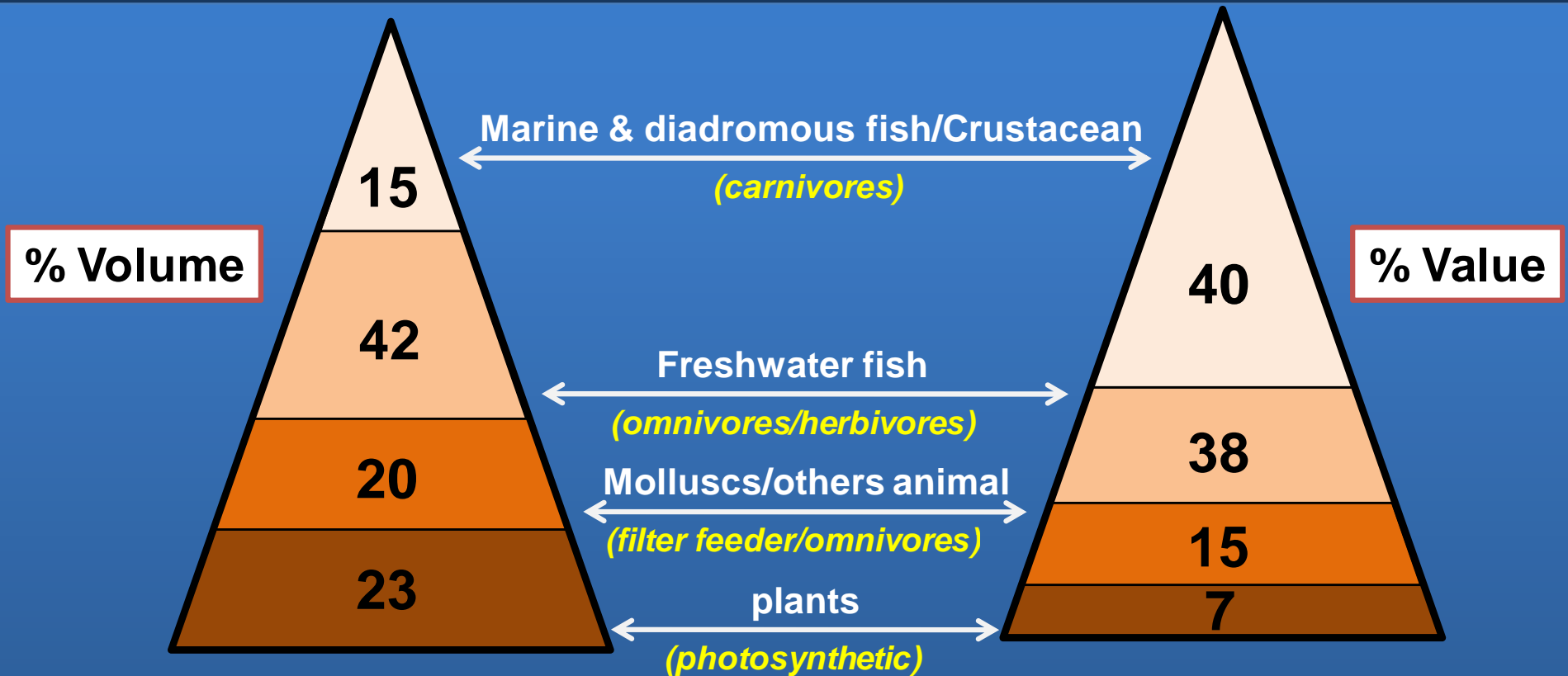
Overview of sustainable aquaculture

- Aquaculture the fastest growing food producing sector
- Global aquaculture increased significantly, reaching \cong 68 million tons in 2008.



Overview of sustainable aquaculture

■ World aquaculture production in 2008



Reanalysis from FAO online database (FAO, 2010)

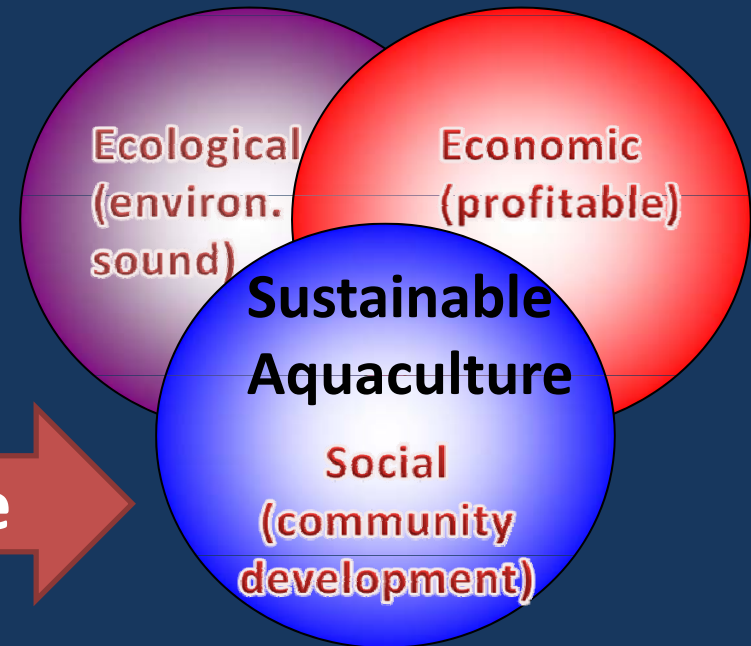
- Aquaculture has great potential for alleviation of poverty and generation of wealth for the people living in the rural and coastal areas.

Overview of sustainable aquaculture

Problems on aquaculture development

- Limited suitable sites
- Negative impact on the environment
- Multi-use conflicts
- Impact of climate change on aquaculture development

Need much effort for sustainable



To ensure long-term sustainability, FAO guideline:

- Code of conduct for responsible fisheries (FAO, 1995)
- Ecosystem approach to aquaculture (Soto *et al.*, 2008) and
- Aquaculture planning: policy formulation and implementation for sustainable development (Brugère *et al.*, 2010).

Spatial data to support sustainable aquaculture

Aquaculture ecosystem

1. Fresh water
2. Brackish water
3. Marine aquaculture

Spatial scale related with aquaculture - EAA

Farm scale (small scale)

The watershed /aquaculture zone
(geographic region)

Wider regional (global scale)



Spatial data requirement

- Primary data
- Secondary data (e.g., hardcopy map, internet sources etc)
- Proxy data, refer to information derived from another data sources (e.g., Water temperature-air temperature)
- Satellite data, in digital form (e.g., MODIS, ALOS-AVNIR)

Spatial data to support sustainable aquaculture

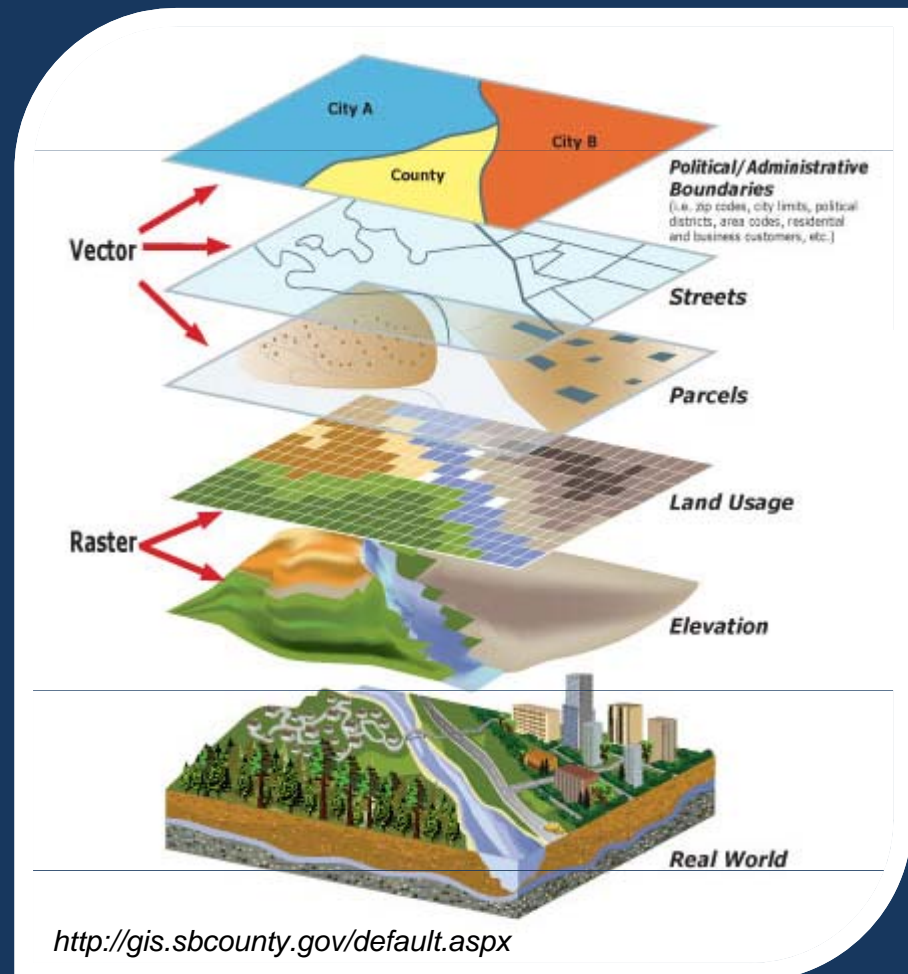
Common spatial data use in aquaculture analysis, either for farm level; geographic region or global scales

1. Vector

- Point: sampling data (sea temperature, chl_a, turbidity etc);
- Line: street, river, contour;
- Polygon: settlement, lake

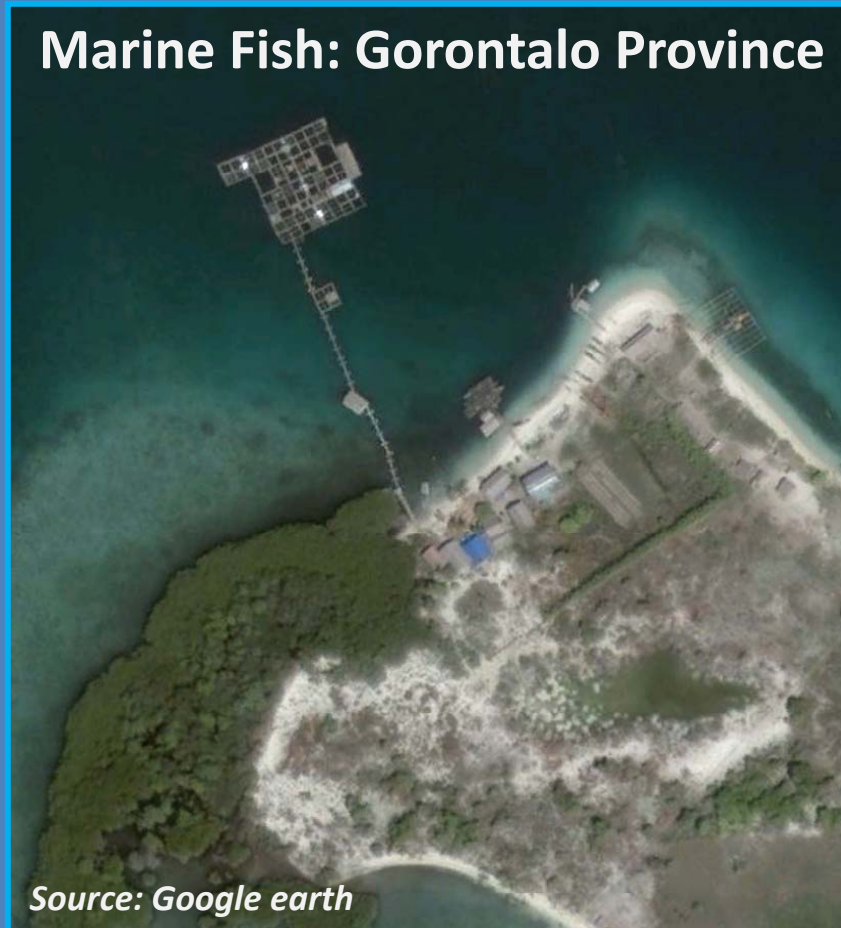
2. Raster

- Pixels: digital elevation model (DEM), satellite data



Fish cage culture in Indonesia

Marine Fish: Gorontalo Province



Source: Google earth

Freshwater Fish: Cirata Reservoir



Source: Google earth

Spatial data to support sustainable aquaculture

<http://glcf.umiacs.umd.edu/data/landsat/>

Global Land Cover Facility
Landsat
www.landcover.org

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Search:

Landsat Imagery

Data Access

- Download via Search and Preview Tool (ESDI)
- Download via FTP Server

Overview

Landsat (name indicating Land + Satellite) imagery is available since 1972 from six satellites in the Landsat series. These satellites have been a major component of NASA's Earth observation program, with three primary sensors evolving over thirty years: MSS (Multi-spectral Scanner), TM (Thematic Mapper), and ETM+ (Enhanced Thematic Mapper Plus). Landsat supplies high resolution visible and infrared imagery, with thermal imagery and a panchromatic image also available from the ETM+ sensor. The collection of Landsat available through GLCF is designed to compliment overall project goals of distributing a global, multi-temporal, multi-spectral and multi-resolution range of imagery appropriate for land cover analysis.

Sensor					
Satellite	Sensor	Spectral Range	Band #s	Scene Size	Pixel Res
L1-4	MSS multi-spectral	0.5 - 1.1 μ m	1, 2, 3, 4	185 X 185 km	60 meter
L4-5	TM multi-spectral	0.45 - 2.35 μ m	1, 2, 3, 4, 5, 7		30 meter
L4-5	TM thermal	10.40 - 12.50 μ m	6		120 meter
L7	ETM+ multi-spectral	0.450 - 2.35 μ m	1, 2, 3, 4, 5, 7		30 meter
L7	ETM+ thermal	10.40 - 12.50 μ m	6, 1, 6, 2		60 meter
L7	Panchromatic	0.52-0.90 μ m	8		15 meter



- Water quality assessment
- Land use /cover data

<http://oceancolor.gsfc.nasa.gov/>

OceanColor WEB

Missions | Data | Documents | Analyses | People | Forum | Services | Links

Data Access

Data Distribution Status

All systems nominal

NOTE: FTP connections must be made in *PASSIVE* mode

Level 1 and 2 Browser

Visually search the ocean color data archive. Directly download or order data from a single file to an entire mission.

Level 3 Browser

Browse the entire global ocean color data set for many parameters and time periods and download PNG images or digital data in HDF format.

Global Time Series

Time series plots of selected SeaWiFS, MODIS and OCTS Standard Mapped Images for a set of selected regions or the entire globe.

Data Archive

Access to the complete data archive via an 'FTP-like' directory structure. Retrieval of data in bulk is possible with this new server.

Ocean Productivity

Ocean Color Feature

Recent topics and imagery of interest to the OceanColor community.

Filamentous Blooms South of Fiji

Although one cannot positively identify the above features without sea-level confirmation, it is likely that these filaments in the ocean south of Fiji are composed of floating colonies of the nitrogen-fixing cyanobacterium, *Trichodesmium*. Charles Darwin offered an early description of these organisms during his voyage aboard the HMS Beagle.

Support Services

SeaDAS

A comprehensive image analysis package for the processing, display, analysis, and quality control of ocean color data.

SeaBASS

An archive of *in situ* oceanographic and atmospheric data for use in algorithm development and satellite data product validation.

Registration for support services:

- Data access and Subscriptions
- Forgotten password
- Email change
- SeaWiFS Access Authorization

Near Real-Time (NRT) Services:

- NRT Data Subscriptions

Subscriptions allow users to specify regions for NRT data to be continually staged on our FTP server for download.

Information Services:

- Ocean Color Forum
- Ocean Color Mailing List
- Ocean Color Data Processing



- Coastal/marine environment
 - Chlorophyll-*a*
 - SST
 - nLw - Suspended solid
 - Light

GIS/RS in aquaculture development

Spatial data use for aquaculture development, the issues:

- Development of aquaculture: **Identification of suitable site**
- Aquaculture practice and management: **aquaculture inventory & monitoring.**
- Multi-sectoral development that includes aquaculture: **integration issues.**

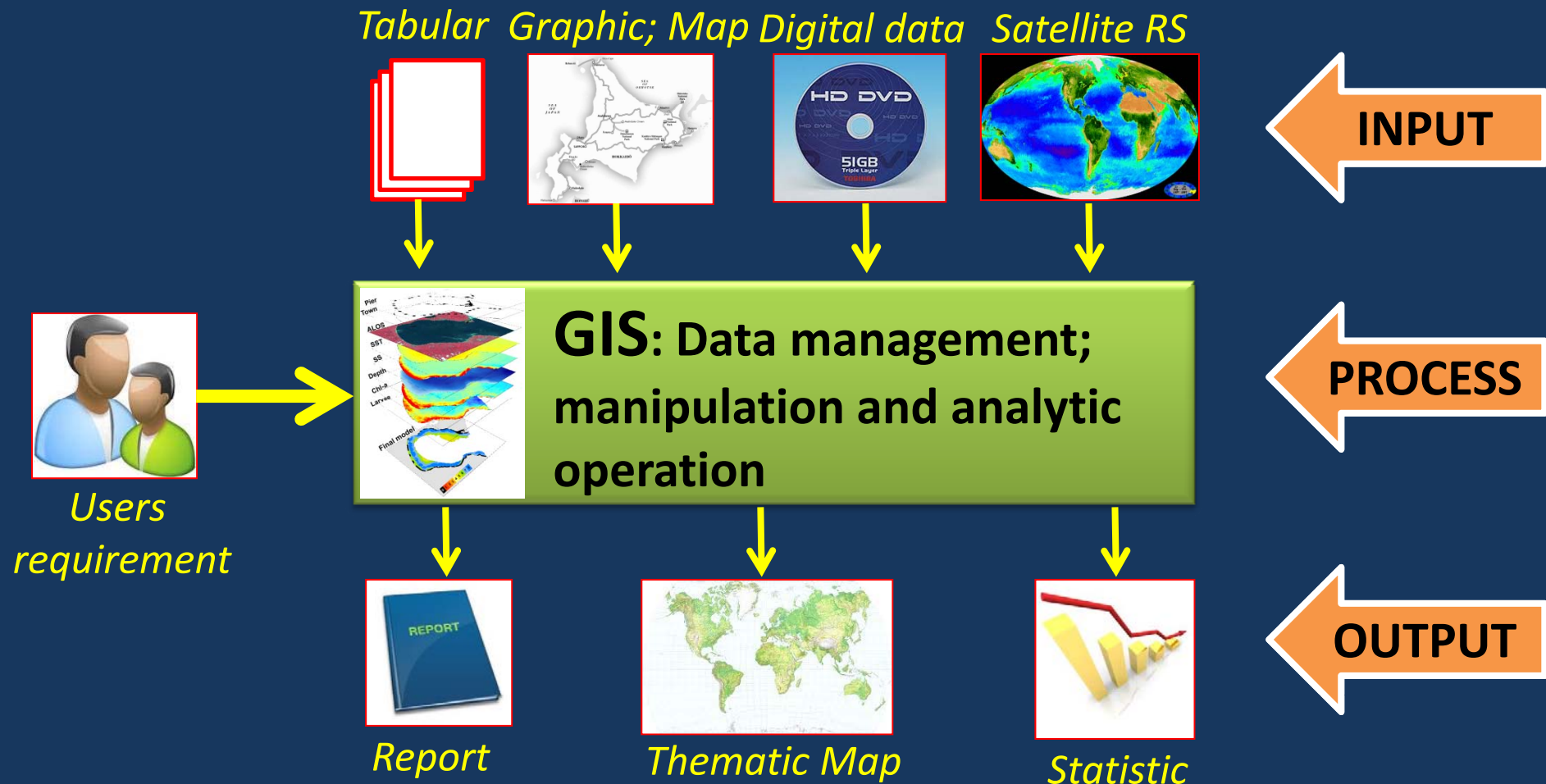


GIS and RS Solution

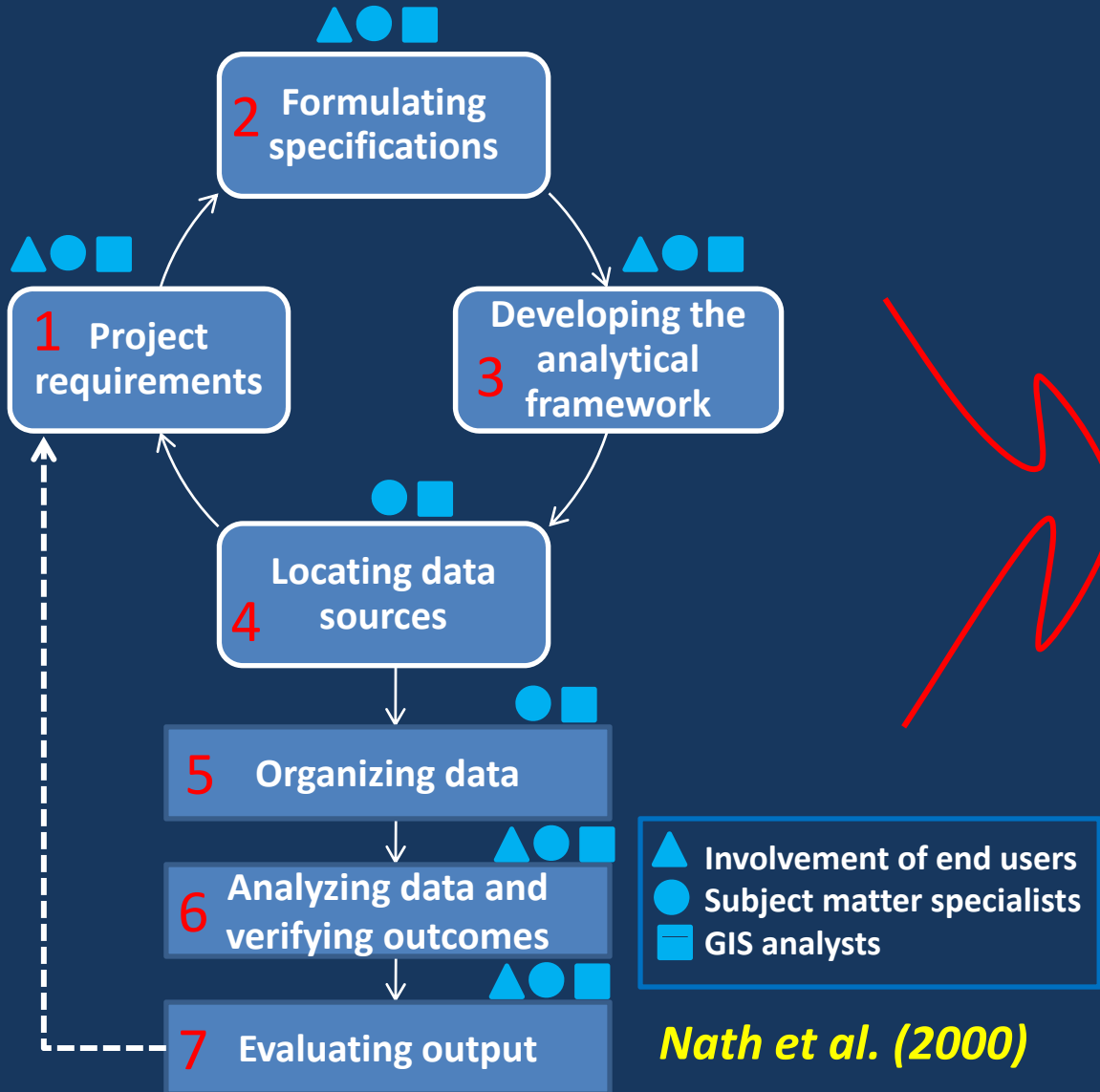
- ❑ Greatly improve understanding of the interaction between aquaculture, other sectors and the ecosystem.
- ❑ Assist decision maker for making better planning and management.

GIS/RS in aquaculture development

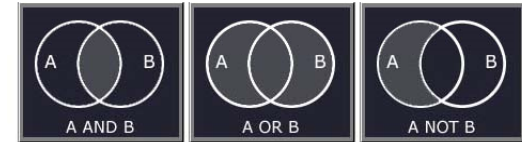
Spatial modeling



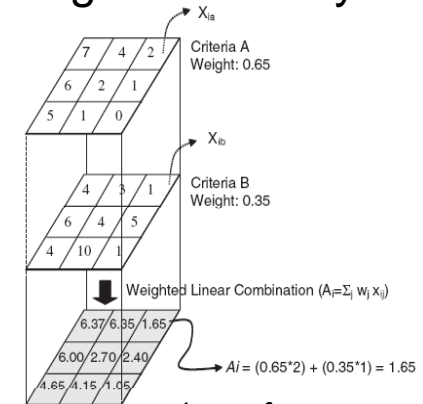
Schematic GIS analysis



Simple Overlay



Weighted overlay

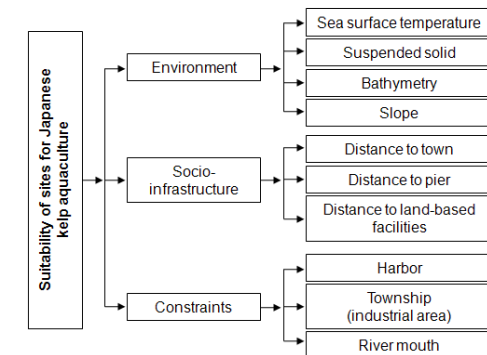


Redrawn from Perez et al., 2005

Neighborhood analysis



Hierarchical models



Case study of GIS/RS in aquaculture

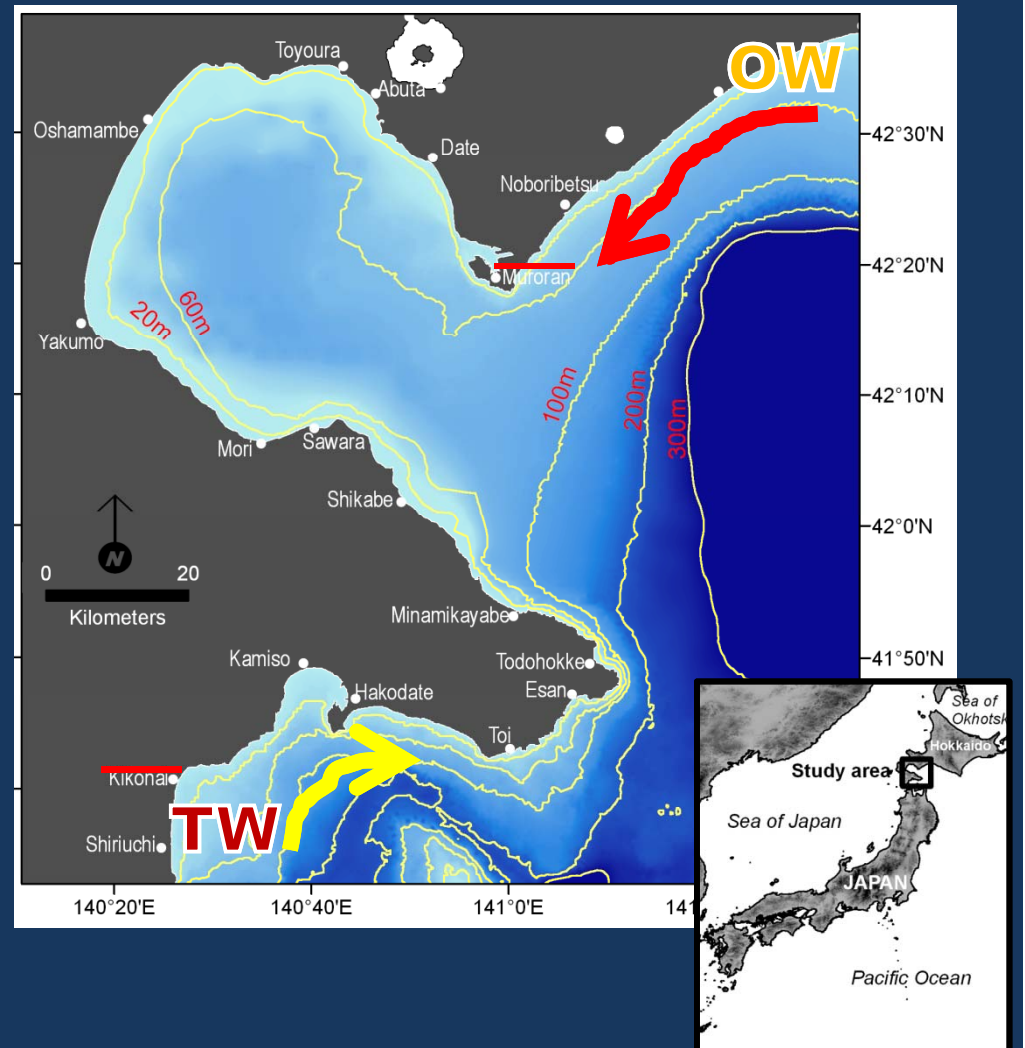


Aquaculture site selection for *Laminaria japonica*

(Radiarta *et al.*, in press (doi:10.1093/icesjms/fsq163))

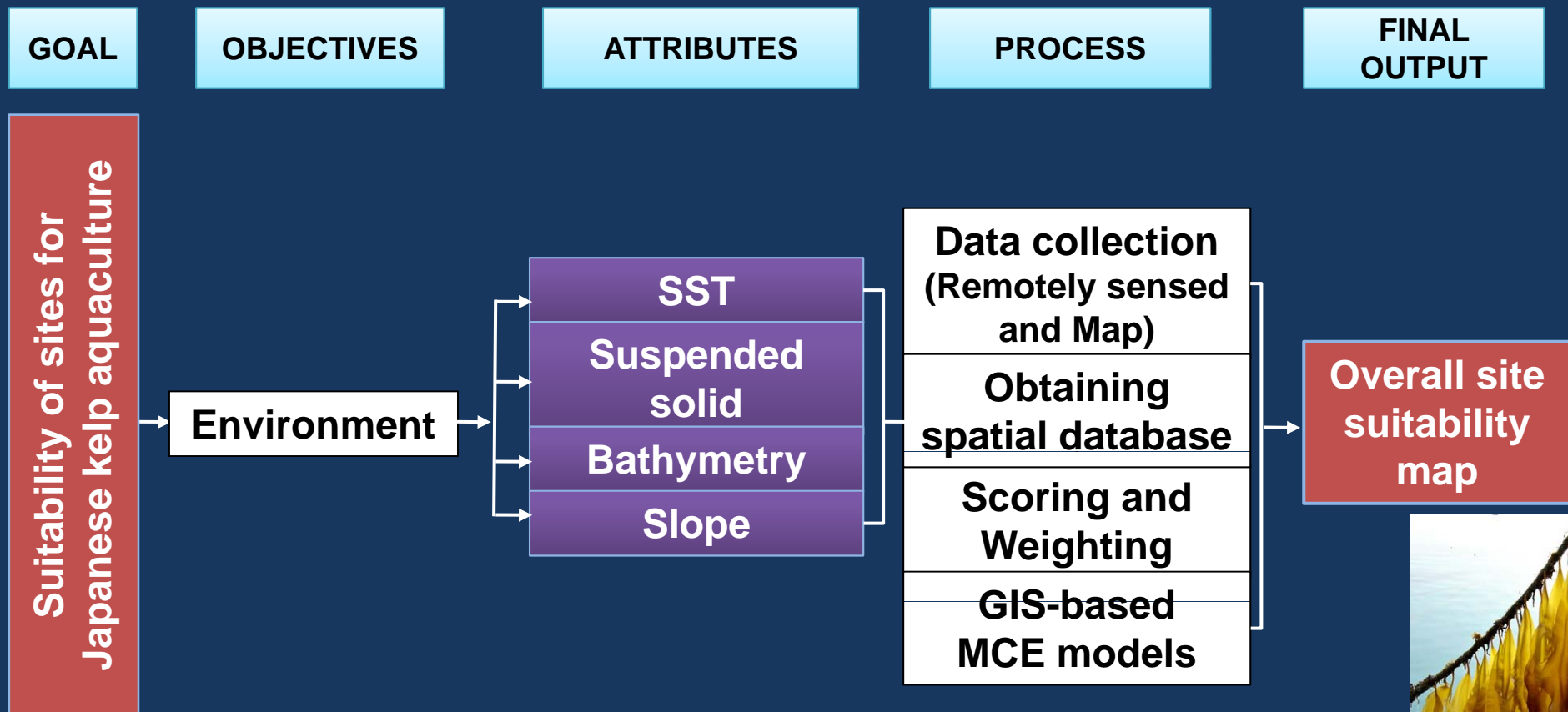
Objective:

To identify suitable sites for hanging culture of Japanese kelp aquaculture development in southern Hokkaido, Japan, using GIS-based MCE models



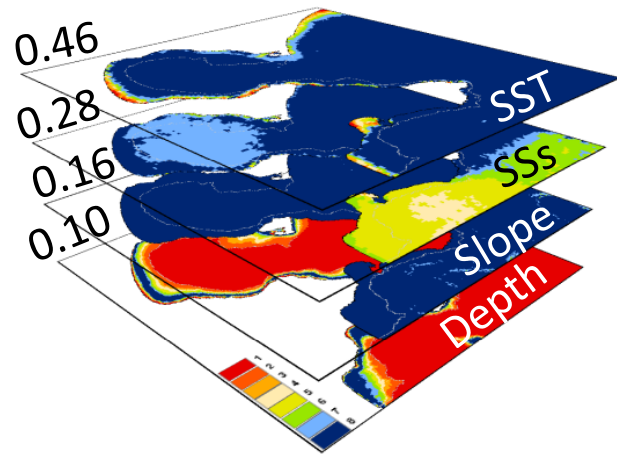
Case study of GIS/RS in aquaculture

GIS-based models construction

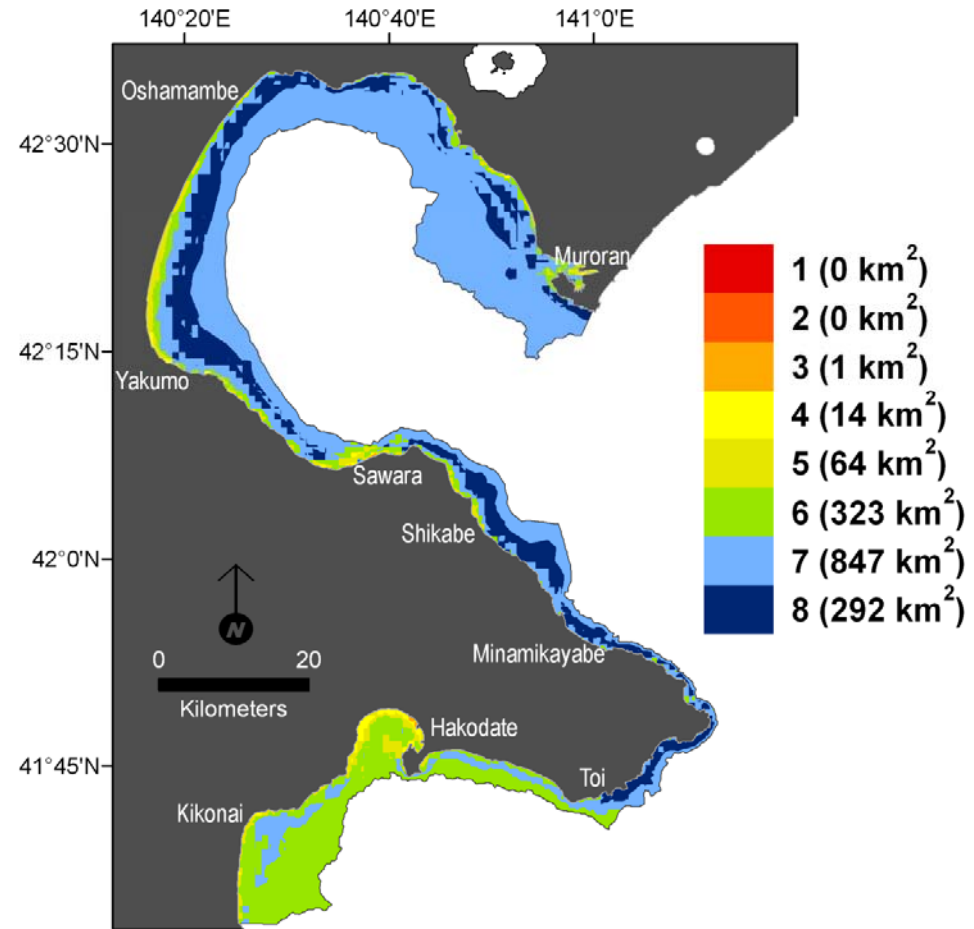


Case study of GIS/RS in aquaculture

Final model



Weighted overlay



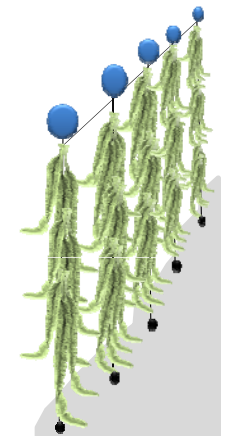
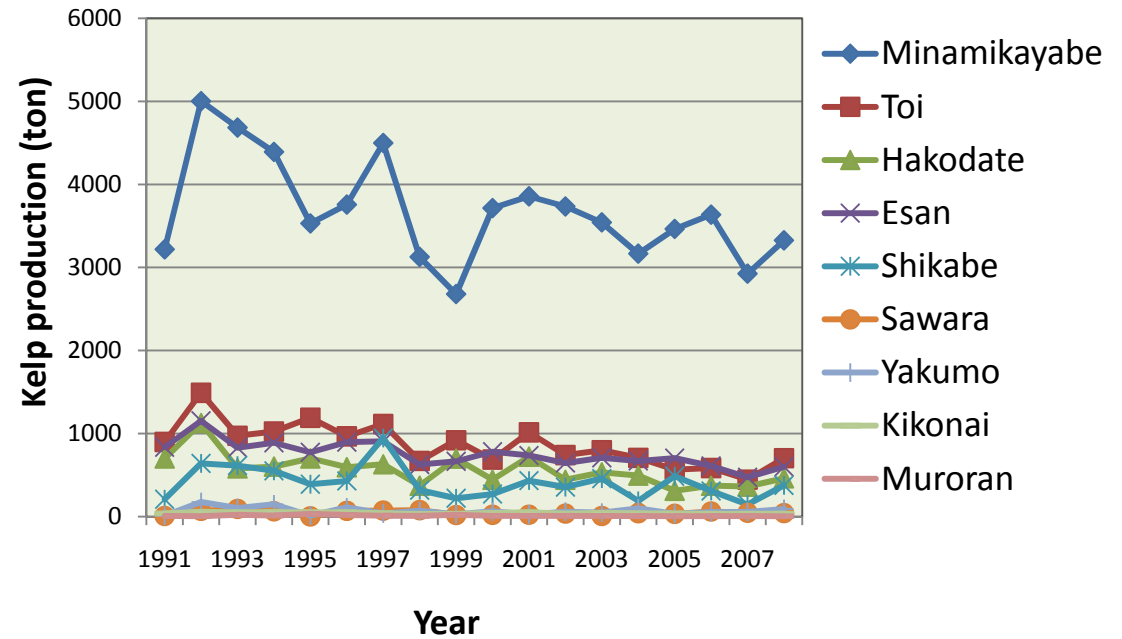
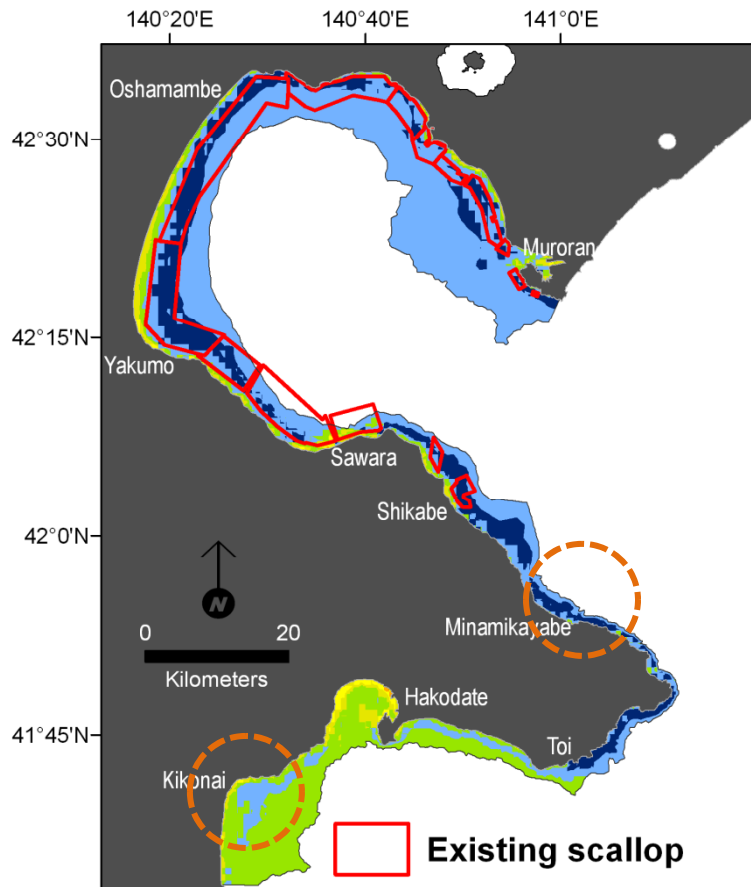
Scores and proportional area (%)

1	2	3	4	5	6	7	8
0	0	0.1	0.9	4	21	55	19

Less ← Suitability levels → Most

Case study of GIS/RS in aquaculture

Partial model validation



Reference

GISFish

<http://www.fao.org/fishery/gisfish/index.jsp>

FAO Home > Fisheries & Aquaculture > GISFish >

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Global Gateway to Geographic Information Systems (GIS), Remote Sensing and Mapping for Fisheries and Aquaculture

Welcome to GISFish!

The Fisheries and Aquaculture Management Division at FAO is actively promoting the use of spatial analytical tools and geo-referenced information for the analysis of Fisheries and Aquaculture data and in the development of Fisheries and Aquaculture management.

GISFish is a "one stop" site from which to obtain the global experience on **Geographic Information Systems (GIS), Remote Sensing** and **Mapping** as applied to Fisheries and Aquaculture.

GISFish sets out the issues in Fisheries and Aquaculture, and demonstrates the benefits of using GIS, remote sensing and mapping to resolve them. The global experience provided by GISFish is captured in **Issues, Publications, Activities, Training, Data and Tools, Contacts, Discussions, News and events.**

GISFish is broadly divided into two domains, **GISFish Aquaculture** and **GISFish Capture Fisheries** with a wide range of material and information that is shared between the two domains to address the role of GIS to support the **Ecosystem Approach to Fisheries (EAF)** and the **Ecosystem Approach to Aquaculture (EAF)**.

Contribute to and participate in the growing GISFish community by becoming an active **Member of GISFish** today.

Recently added content

Aquaculture

- Sistema de identificación de instalaciones de acuicultura
- Spatial Analysis and Remote sensing for the Sustainable Development of off-the-coast and offshore aquaculture from a global perspective

Capture Fisheries

- Habitat suitability modelling of economically important fish species with commercial fisheries data
- Using fishers' local knowledge to aid management at regional scales: Spatial distribution of small-scale fisheries in the northern Gulf of California, Mexico

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Newsletter

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December 2009
May 2009
December 2008
April 2008
November 2007

Events

October 29, 2010: 8th International Conference of the African...

August 26, 2011: Fifth International Symposium on GIS/Spatial Analyses...

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Web resources

Web Resources (81)

Search Web Resources

Title ↑ ↓	Type ↑ ↓	Download ↑ ↓
A New Album of Global Earth Imagery (Free Data)	Data sources	(en)
Africa: Atlas of our Changing Environment	Data sources	(en)
Africover (FAO of the UN)	Data sources	(en)
An inventory and comparison of globally consistent geospatial databases and libraries	Data sources	(en)
ASTER Global Digital Elevation Map	Data sources	(en) (en)
Climpag - Global grids, climate data, maps and tools	Data sources	(en)
Conservation GeoPortal	Data sources	(en)
Current Global Landsat Coverage 1990-2000 (Free)	Data sources	(en)
Data - World Place Name Data	Data sources	(en)
Data and GIS Resources Links	Data sources	(en)
Digital Chart of the World Download Center Penn State University Libraries	Data sources	(en)
Digital Globe Products (via satellite Remote Sensing)	Data sources	(en)
Earth Observing System Data Gateway	Data sources	(en)
Earth Science Data Interface (ESDI) at the Global Land Cover Facility (Landsat, MODIS, AVHRR)	Data sources	(en)
Eastview - Mapping China	Data sources	(en)
Ecoregional Shapefiles (Terrestrial, Marine and Freshwater Ecoregions)	Data sources	(en)
European Space Agency Earth Observation Missions	Data sources	(en)
Expanded GIS products from Veridian	Data sources	(en)



Summary

- Recent development of aquaculture need to concern on its negative impact on the environment toward sustainable aquaculture.
- Development IT and availability spatial data, those could be enhance the spatial analyses in order to provide and update final information outcome.
- Within the development of GIS and RS can further enhance the development of generic framework that can be used by aquaculture planner and policy maker to integrated aquaculture based activities in a sustainable way.

Public Lecture: Theory and Practice of Fisheries Sustainability Science
Hakodate: November 9, 2010



Thank you

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