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

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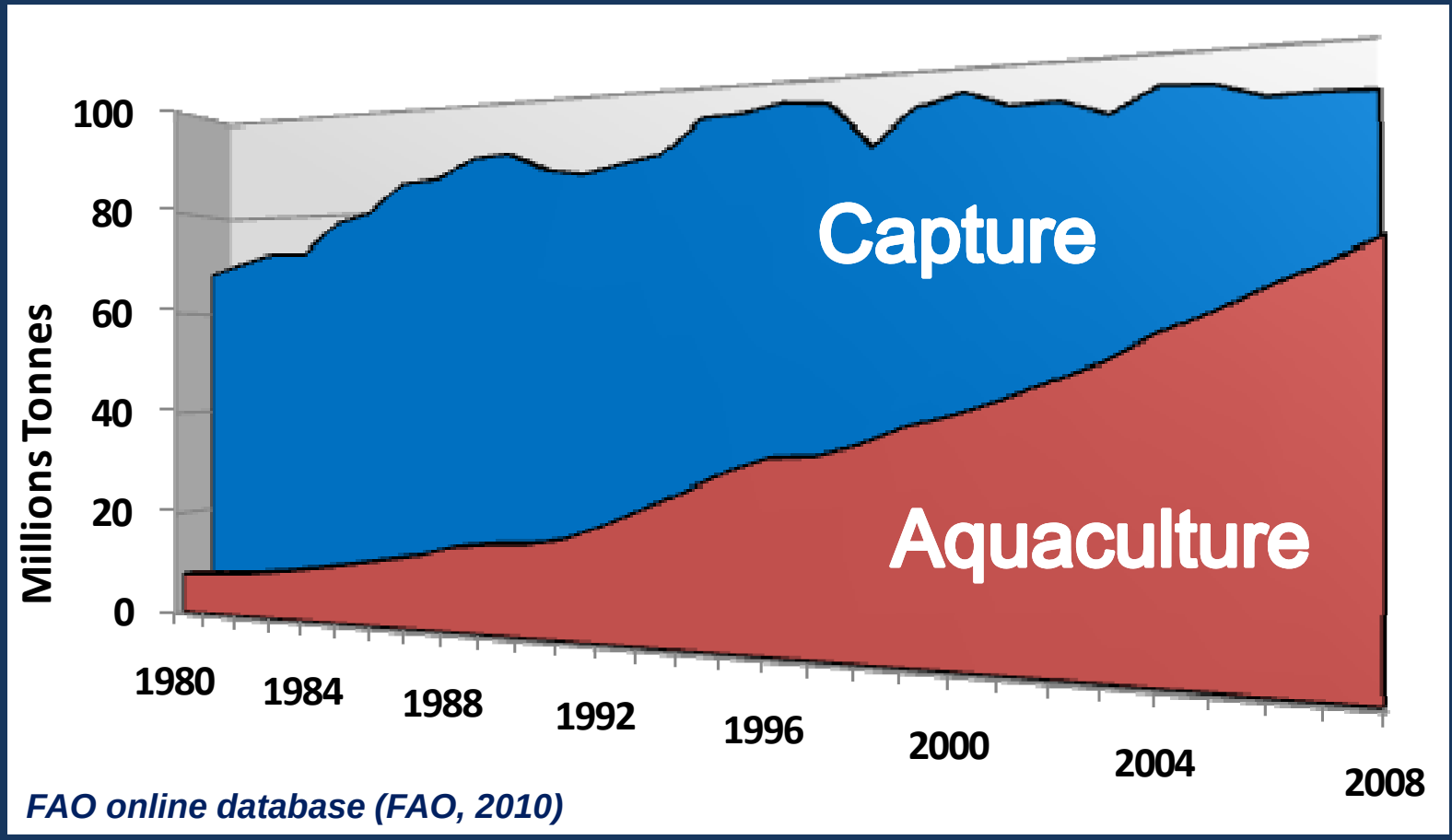
- Spatial data to support sustainable aquaculture
- GIS/RS in aquaculture development
- Case study of GIS/RS in aquaculture
- Summary

Overview of sustainable aquaculture

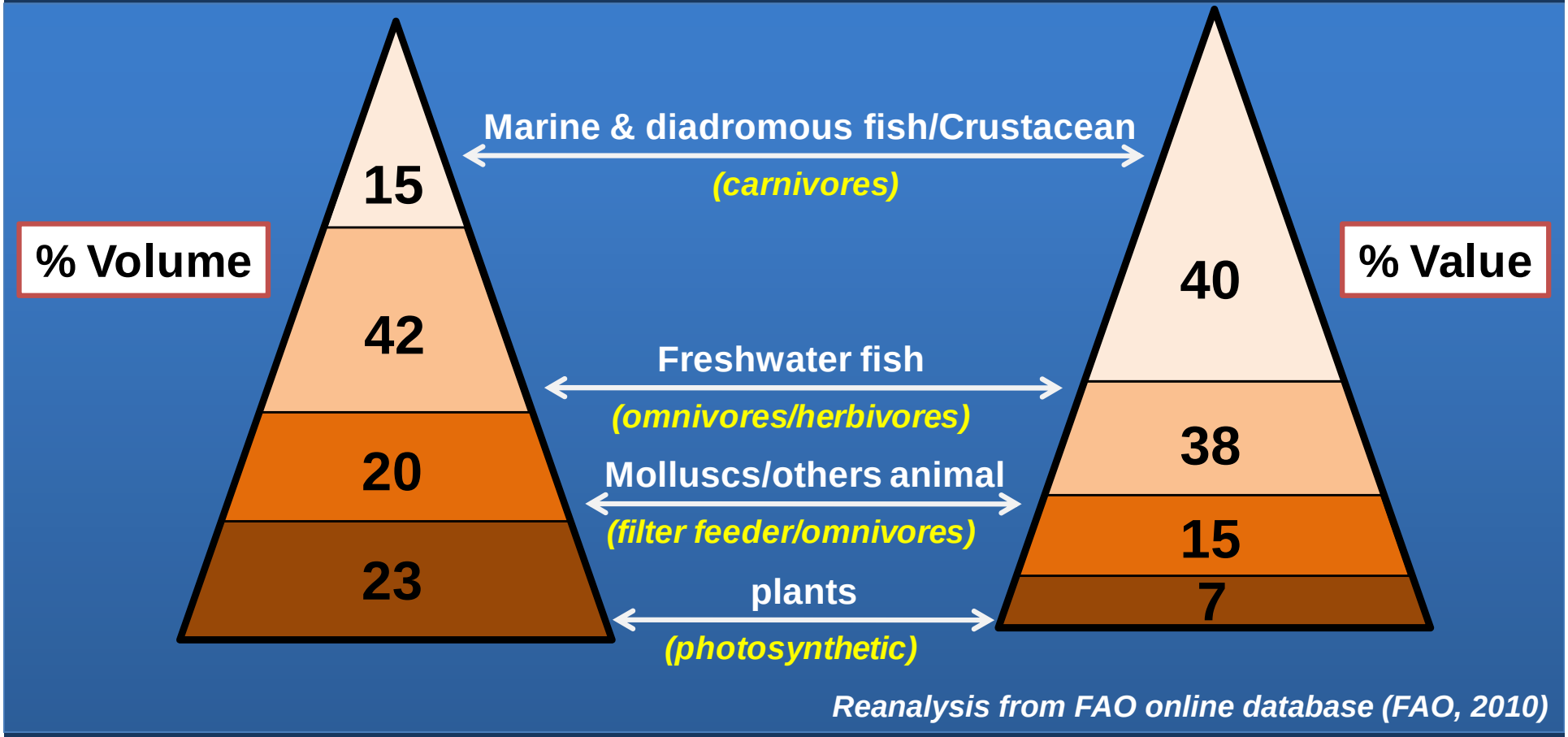
- Aquaculture the fastest growing food producing sector
- Global aquaculture increased significantly, reaching ≅ 68 million tons in 2008.



FAO online database (FAO, 2010)

Overview of sustainable aquaculture

- World aquaculture production in 2008

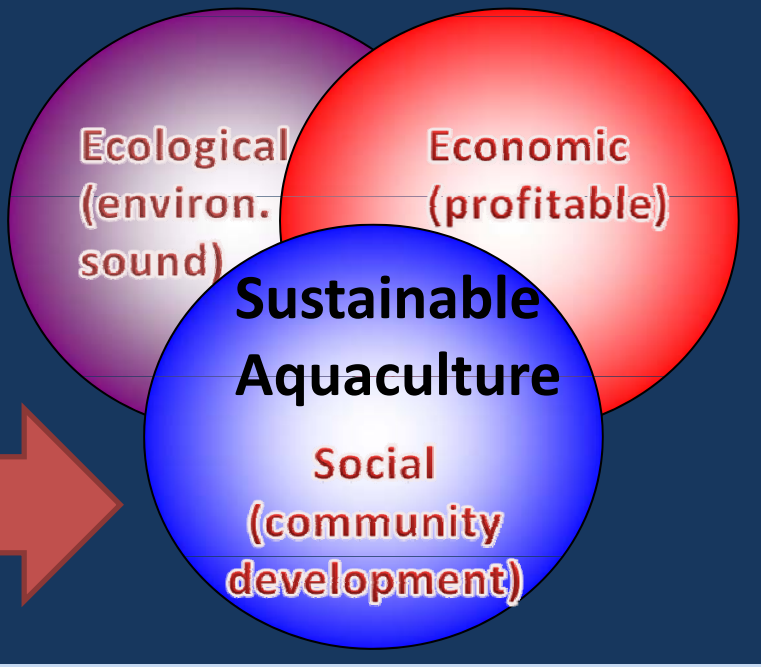


- Aquaculture has great potential for alleviation of poverty and generation of wealth for the people living in the rural and coastal areas.

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

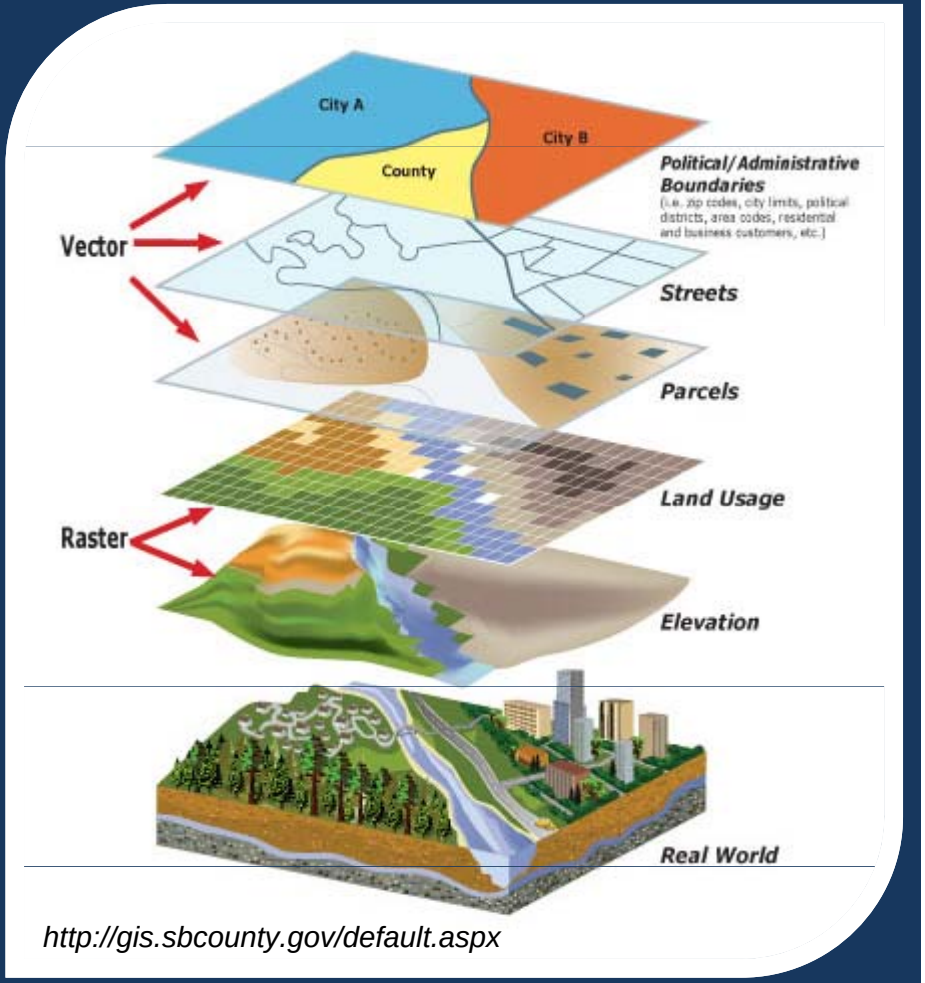
- Primary data
- Secondary data (e.g., hardcopy map, internet sources etc)
- Proxy data, refer to information derived from another data sources (e.g., Water temperature-air temperature)
- Satellite data, in digital form (e.g., MODIS, ALOS-AVNIR)

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 evaluation model (DEM), satellite data



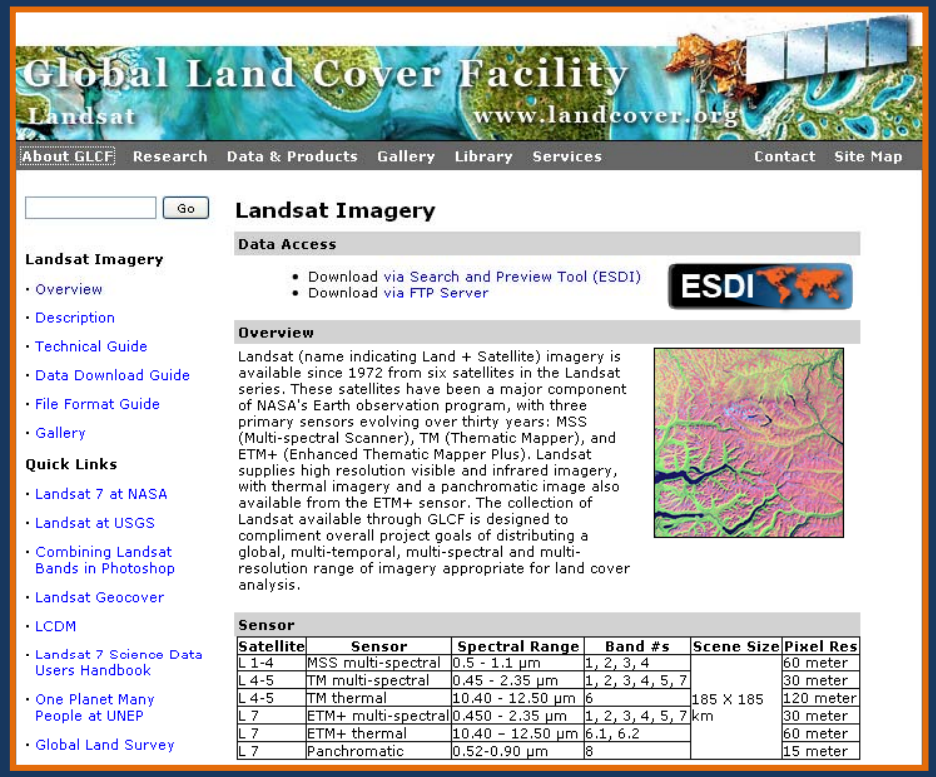
http://gis.sbcounty.gov/default.aspx

Spatial data to support sustainable aquaculture

Fish cage culture in Indonesia

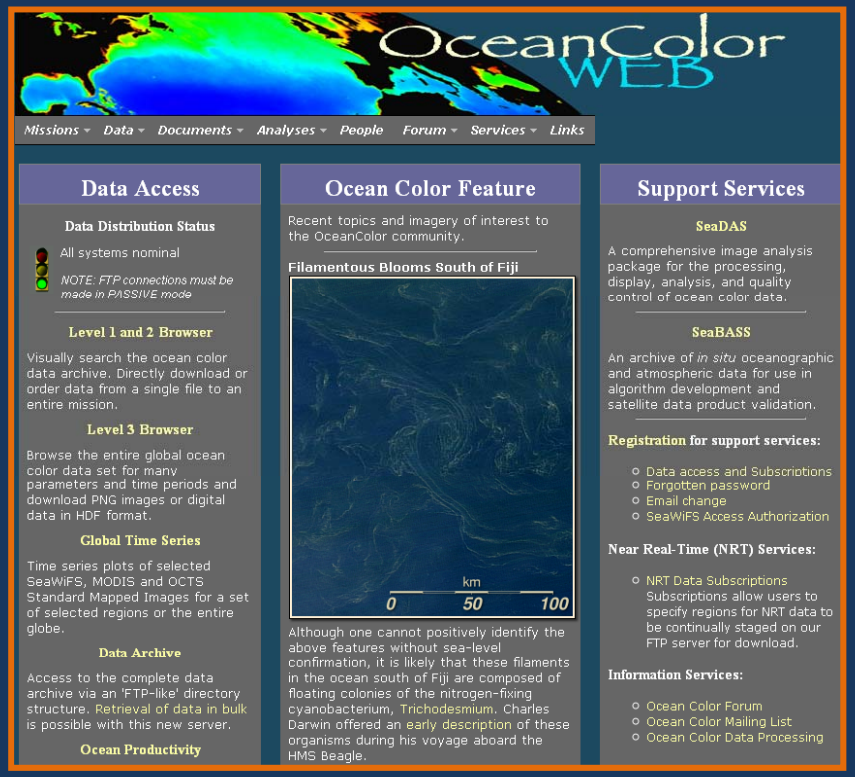
Spatial data to support sustainable aquaculture

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



- **Water quality assessment**
- **Land use /cover data**

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



Coastal/marine environment

- **Chlorophyll-*a***
- **SST**
- **nLw - Suspended solid**
- **Light**

GIS/RS in aquaculture development

Spatial data use for aquaculture development, the issues:

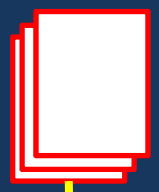
- Development of aquaculture: Identification of suitable site
- Aquaculture practice and management: aquaculture inventory & monitoring.
- Multi-sectoral development that includes aquaculture: integration issues.

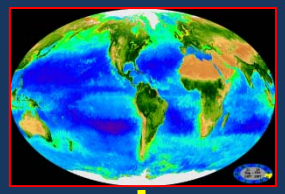
- Greatly improve understanding of the interaction between aquaculture, other sectors and the ecosystem.
- Assist decision maker for making better planning and management.

GIS/RS in aquaculture development

Spatial modeling

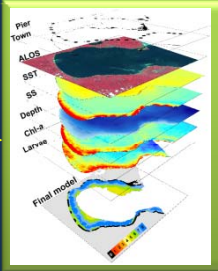
Tabular *Graphic; Map* *Digital data* *Satellite RS*





INPUT

Users requirement



GIS: Data management; manipulation and analytic operation

PROCESS

Report

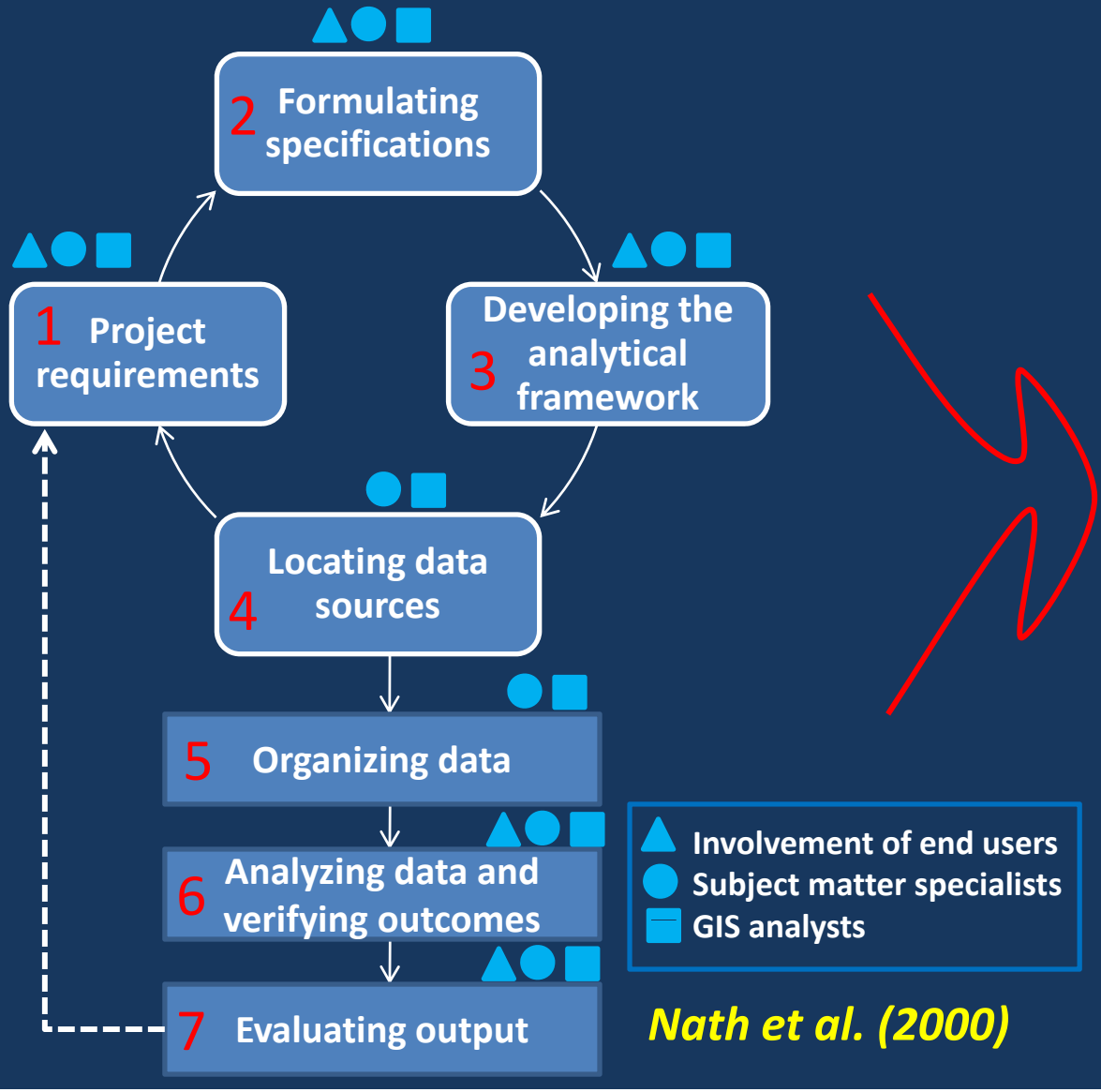
Thematic Map

Statistic

OUTPUT

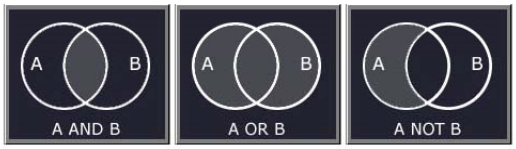
GIS/RS in aquaculture de

Schematic GIS analysis

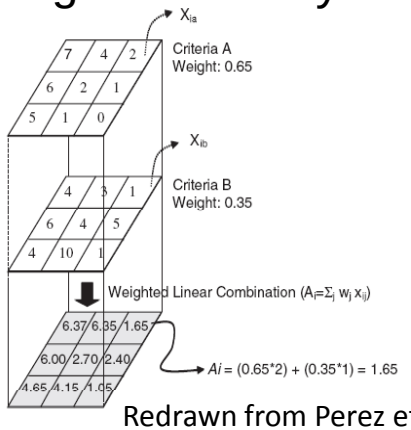


Nath et al. (2000)

- Simple Overlay

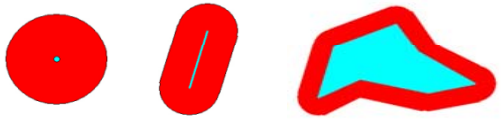


- Weighted overlay

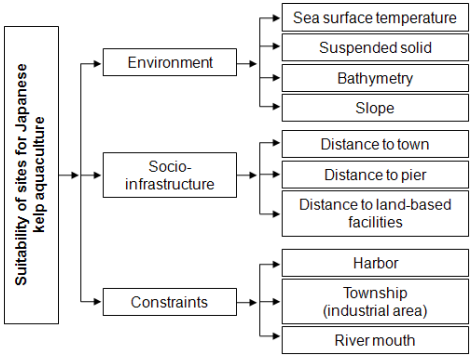


Redrawn from Perez et al., 2005

- Neighborhood analysis



- Hierarchical models



Case study of GIS/RS in aquaculture

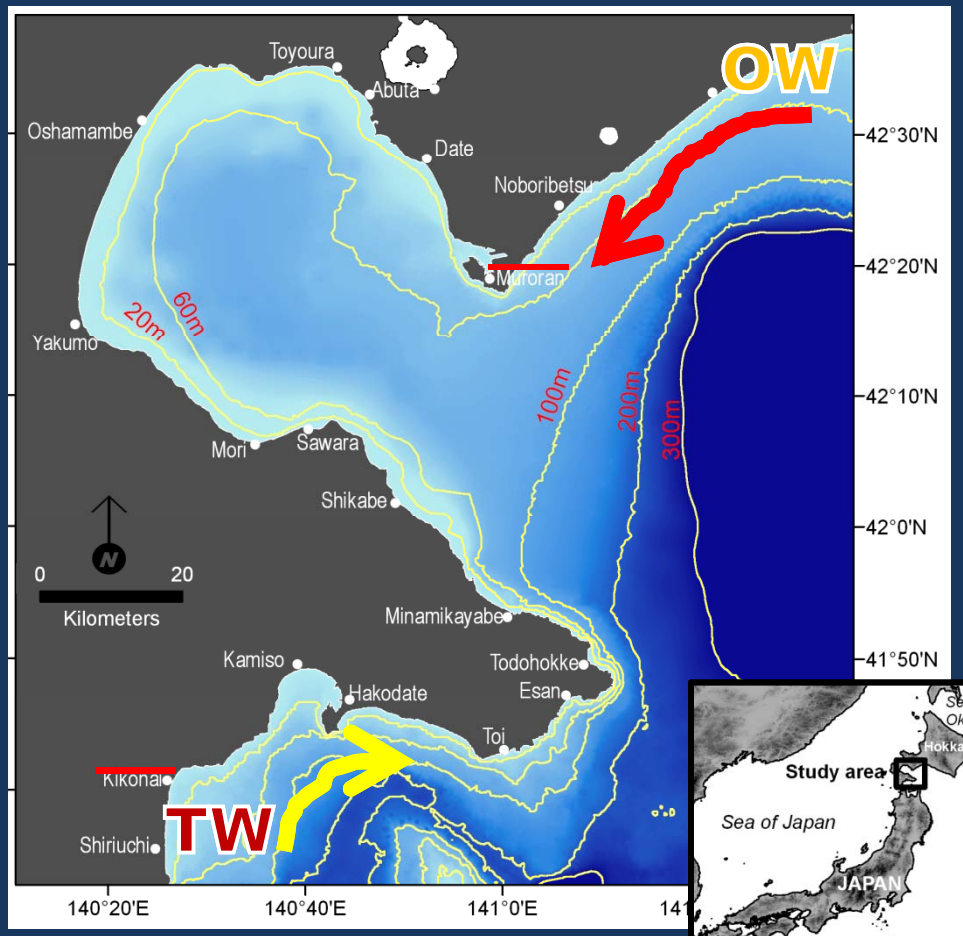
Aquaculture site selection for *Laminaria japonica*

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

Objective:

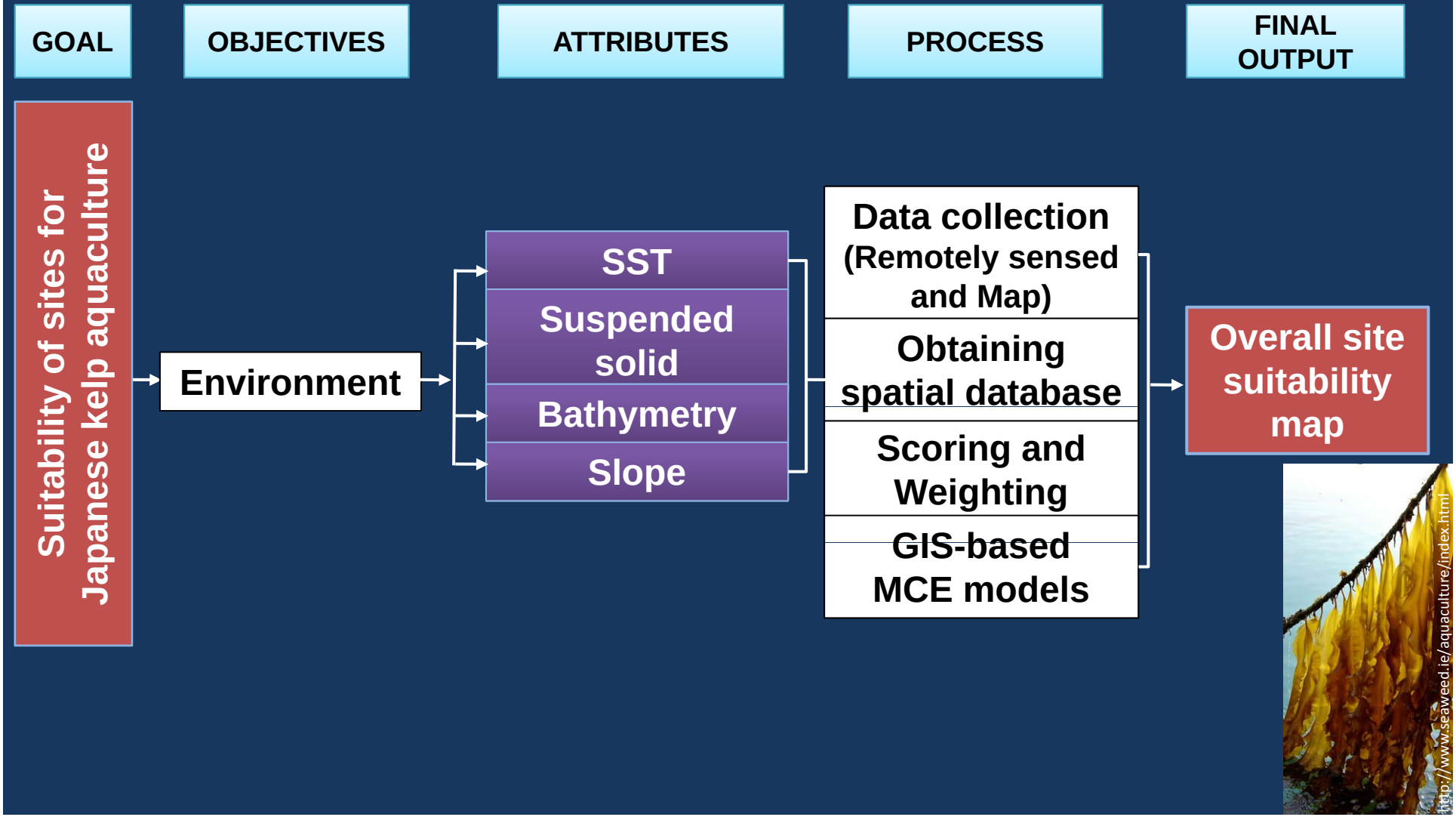
To identify suitable sites for hanging culture of Japanese kelp aquaculture development in southern Hokkaido, Japan, using GIS-based MCE models

http://www.seaweed.ie/aquaculture/kelp_china.html



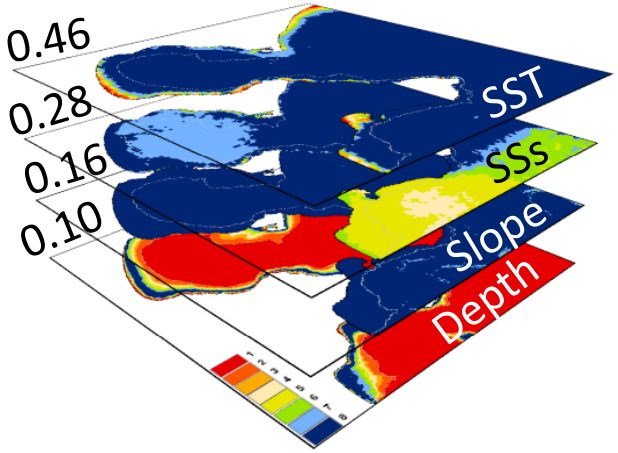
Case study of GIS/RS in aquaculture

GIS-based models construction

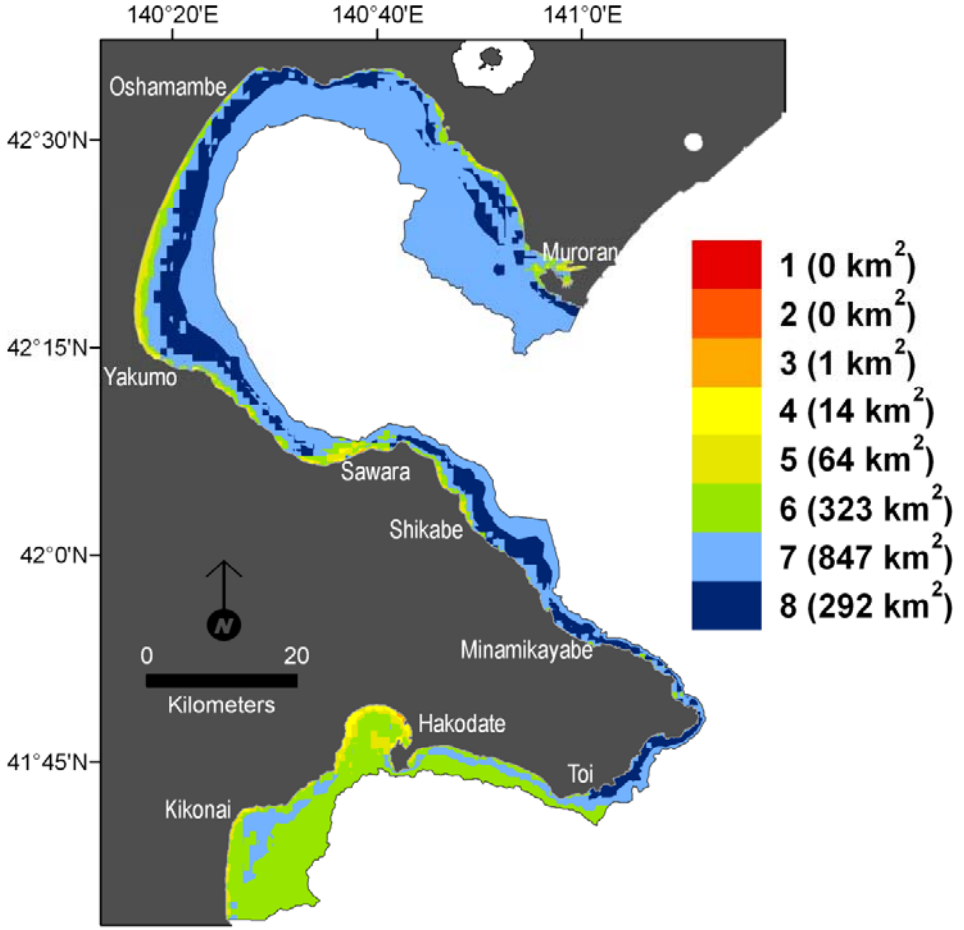


Case study of GIS/RS in aquaculture

Final model



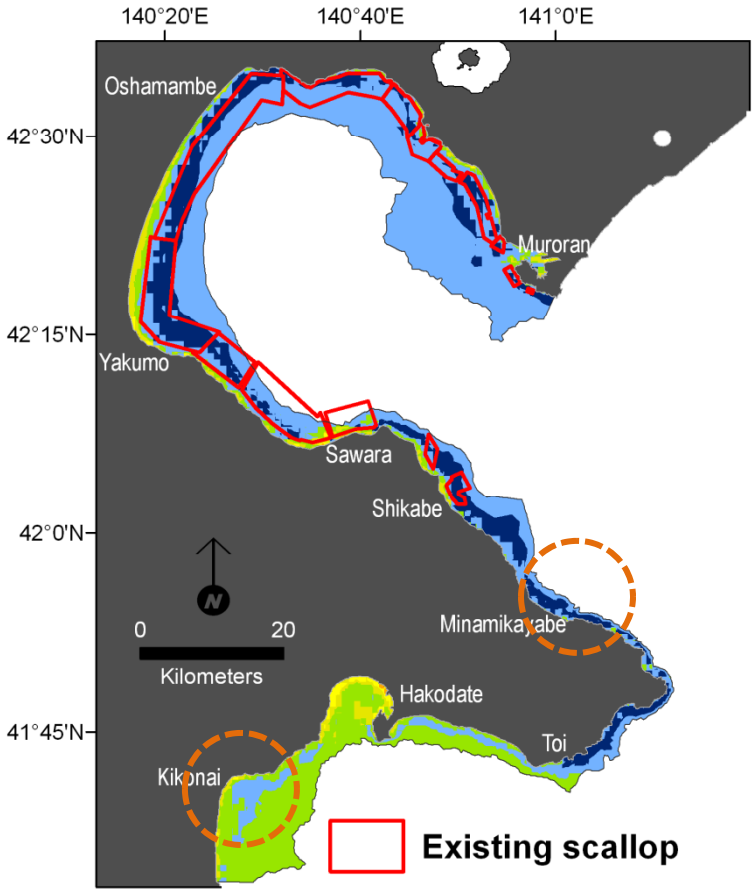
Weighted overlay

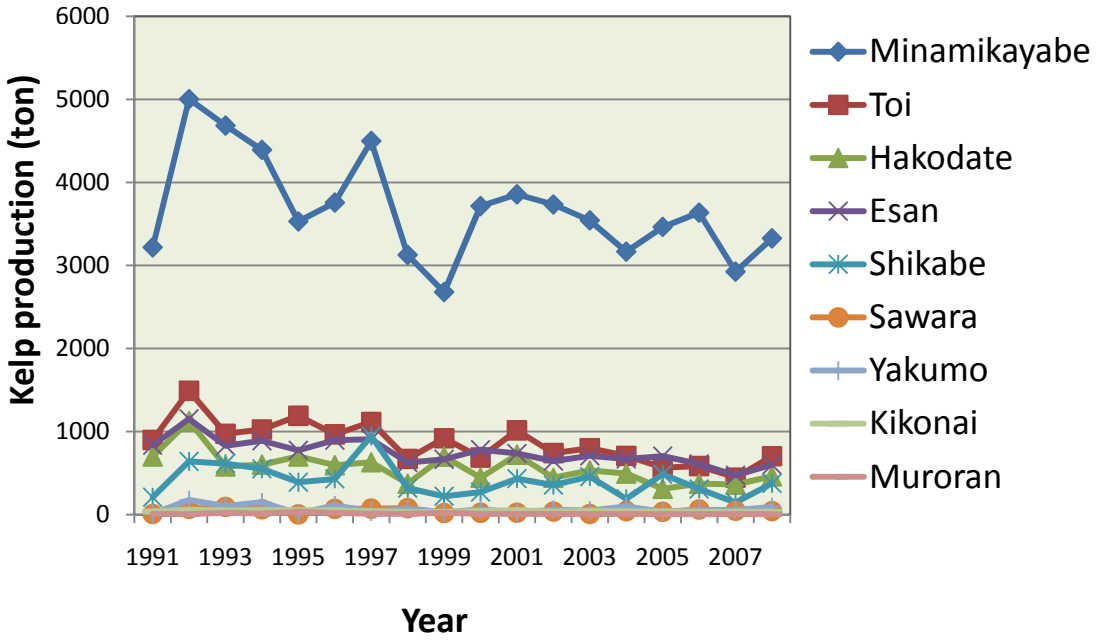


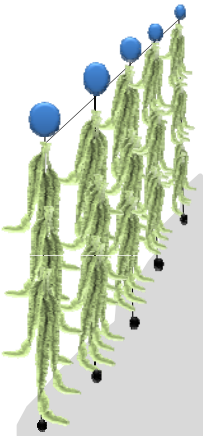
Scores and proportional area (%)							
1	2	3	4	5	6	7	8
0	0	0.1	0.9	4	21	55	19

Less ← Suitability levels → Most

Partial model validation



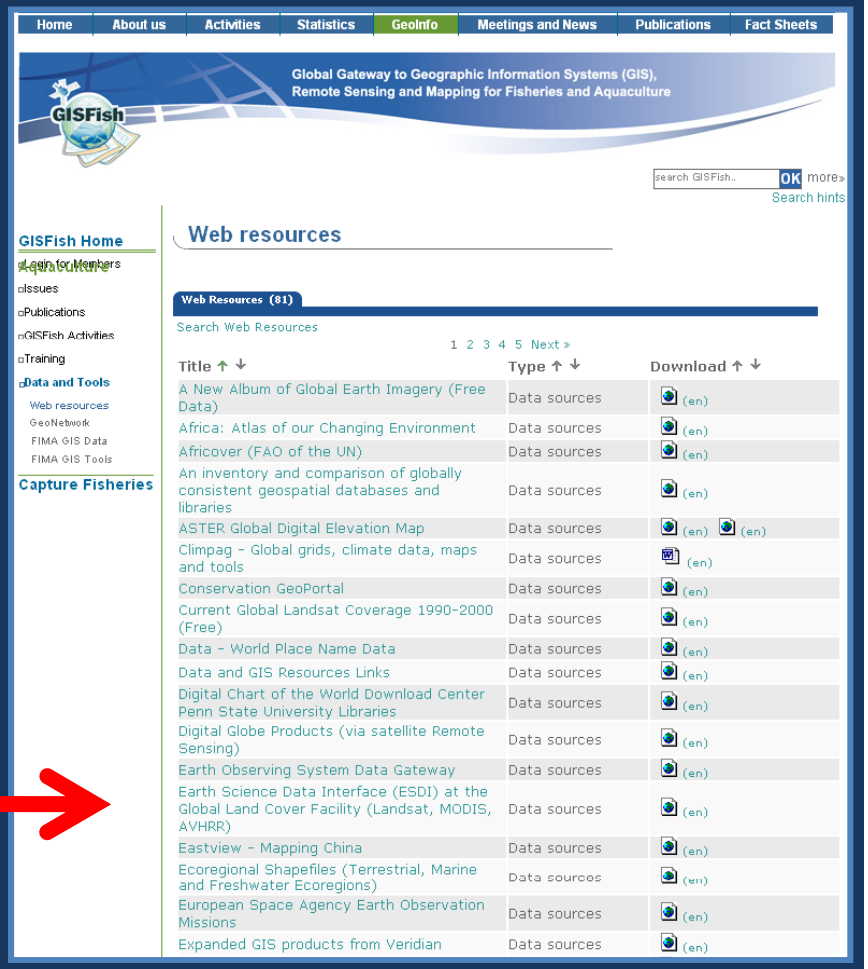




Reference

GISFish

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



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.

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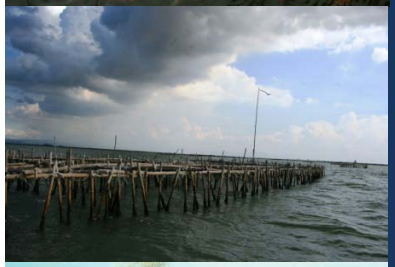

Thank you

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