

GIS DATABASE FOR SUSTAINABLE AQUACULTURE IN MEKONG DELTA

Nguyen Tac An and Tong Phuoc Hoang Son

Institute of Oceanography – Nha Trang - Vietnam

Address : 01 Cauda Street – Vinhnguyen – Nha Trang – Vietnam

Email : haiduong@dng.vnn.vn ; gishaiduong@dng.vnn.vn

ABSTRACT

In framework of GAMBAS (Global Assessment of Mekong Brackish water Aquaculture of Shrimp) project: Environmental sustainability of brackish aqua culture in the Mekong delta (The cooperation France – Vietnam Project in 3 years 2000 – 2003), one of its importance missions is the establishment of a GIS – Database for sustainable aquaculture in Mekong Delta with 2 key studies: Camau and Travinh. This GIS – Database manages digital maps (GIS maps) on the environmental conditions of water, bottom sediment and also of soil over the difference investigated periods. The land – use maps from measurements and remote sensing data also exist in the Database, as well as the storage of socio – economical data and maps. Another Module of Database is Metadata. It contains the references related to topics such as: marine aquaculture, mangrove forest, the ecological characteristics of acid sulfate soil, socio – economical problems and also land – use,... The main information relevance to references such as the title, author, abstract, year of publication, storage organization and so on... are stored in Metadata. There are also some other studied information such as curriculum vitae, the study organization and their contribution in Project in Metadata. The third Module of Database is investigated Data (raw data). We can edit, update and manage raw data in each station or all region from different tools that exist in Database. The final module of Database stores full text of annual reports, final report, newsletter, booklet, brochure,... They are study products of Project in 3 year 2000 – 2003. A tool for sustainable aquaculture management and planning which is built based on full database also exists in this module.

This GIS – Database is a powerful tool combination for managers, scientists and also farmers in brackish water aquaculture and environmental protection in Mekong Delta.

1. INTRODUCTION

Aquaculture is the strategic orientation in marine economy of Vietnam, but now it is facing great challenges such as rapid reduction in natural resources, in biodiversity, environment quality...

The rapid increase in culture area and lack of detailed researches are the main obstacles to the local land use and development planning and directly affect farmers' culture activities and investments. Research results (Fuchs J., Nguyen Tac An, 1999) /1/ show, now there is very little surface left, which has enough ecological conditions to expand for shrimp culture, so we can only increase output by checking and adjusting the culture management, proper designing of culture structures, using high quality seeds, selecting suitable food and suitable culture methods (intensive, semi-intensive or extensive culture...). Monitoring the pond water and pond bottom. In addition, reducing seed density, providing knowledge of culture

techniques and environmental ecology, proper management modes for farm and resources are all important, prolonged effective methods.

To manage the sustainable development of aquaculture, we have to solve a number of issues such as:

- What can we do to maintain the culture output stable in the present ecological conditions?
- With the present ecological conditions, where and to what extent can we intensify aquaculture?
- Propose and give guidelines to effective management and culture development options for the farmers in each specific region, based on the integrated standpoint embracing economic, social, scientific, technical and environmentally ecological aspects. However, these proposals may have to face some chronic difficulties in the coastal communities such as: lack of capital, lack of understanding, knowledge, skills, as well as training courses, detailed guidelines...

To support the process of decision-making concerning sustainable management and development of aquaculture in the coastal waters, we have to apply modern tools based on the research results, data collection and processing, establishing environment resource profile. The main issues are:

- Assessment of the ecological conditions of waters and soil in the main aquaculture locations.
- Analyze the suitability and compatibility between the natural conditions and the farming techniques and farm structures, based on the integrated economic, social and environmentally ecological standpoint.

This process can be done through following steps:

- Step 1: Review environmental and ecological characteristics, determine the typical environmental indicators represent each ecological zones
- Step 2: Review the ecological characteristics, culture techniques and link these with environmental zones, based on available materials; integrated analyses on environment, soil ecology, culture techniques; and associated culture economic survey data. Development policy and social aspects should also be investigated and assessed.
- Step 3: Establish database and design management software, based on technological achievements on GIS, computer, algorithm and modeling. Transfer and train on different levels the usage of research results directly to the stakeholders .

In this paper we only deal with the establishment of GIS database for sustainable shrimp culture and development in Mekong delta. This is one of the most important results of the Vietnam – France cooperative project (Project GAMBAS) /2/.

2. GIS DATABASE FOR SUSTAINABLE ENVIRONMENT MANAGEMENT OF COASTAL AQUACULTURE

In the former sections we have mentioned the natural characteristics, environmental ecology and soil ecology (1st approaching step), analyzed the economic characteristics and culture techniques (2nd approaching step). These steps have been formed based on the

plentiful data captured in surveys and have been carefully analyzed and processed. However, these results will only have practical meaning when they have really reached the local stakeholders (at different levels, of course). To do this, a database managing spatial and attribute data need to be built, based on the GIS technology, at the same time transferring and training the usage of these results directly to the stakeholders (scientists, managers and also local farmers) at different levels.

GAMBAS database has been built based on objective-oriented program. It is the close combination between database building on MS ASSESS and GIS program on Map Basic and Visual Basic. This database includes 4 main components: 1) Investigated Data; 2) GIS maps; 3) MetaData; 4) Reports and Guidelines (figure 1).



Figure 1: The main interface of GIS Database for sustainable aquaculture in Mekong Delta. It shows sub-components that exist in Database

2.1 GIS map

GIS maps contain digital maps created from investigated data and remote sensing images. These information layers are geometric correction and convert to the standard projection (UTM, Datum WGS84, Zone 48). These maps are presented separately or together on the same interface of GIS and remote sensing layers. Remote sensing images are also shown on this interface (figure 2).

2.2 MetaData

This sub-component includes general information from related documents on the aquaculture, environmental ecology and also laws, strategies, regulars on the environmental protection, appropriated utility of coastal resource in Mekong delta. This metadata show following main information (figure 3):

- Data type (paper maps, documents, reports, personal information...)
- Data size (number of pages, Kbytes, original map scale)

- Author
- Year published
- Affiliations and places of storage
- Data title
- Data content

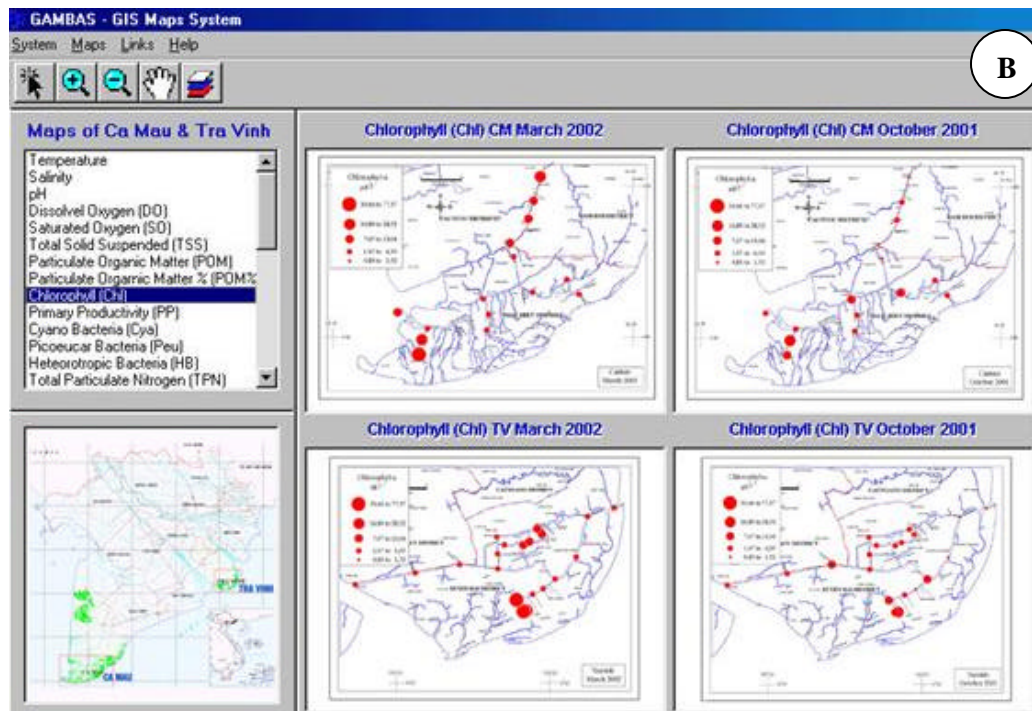
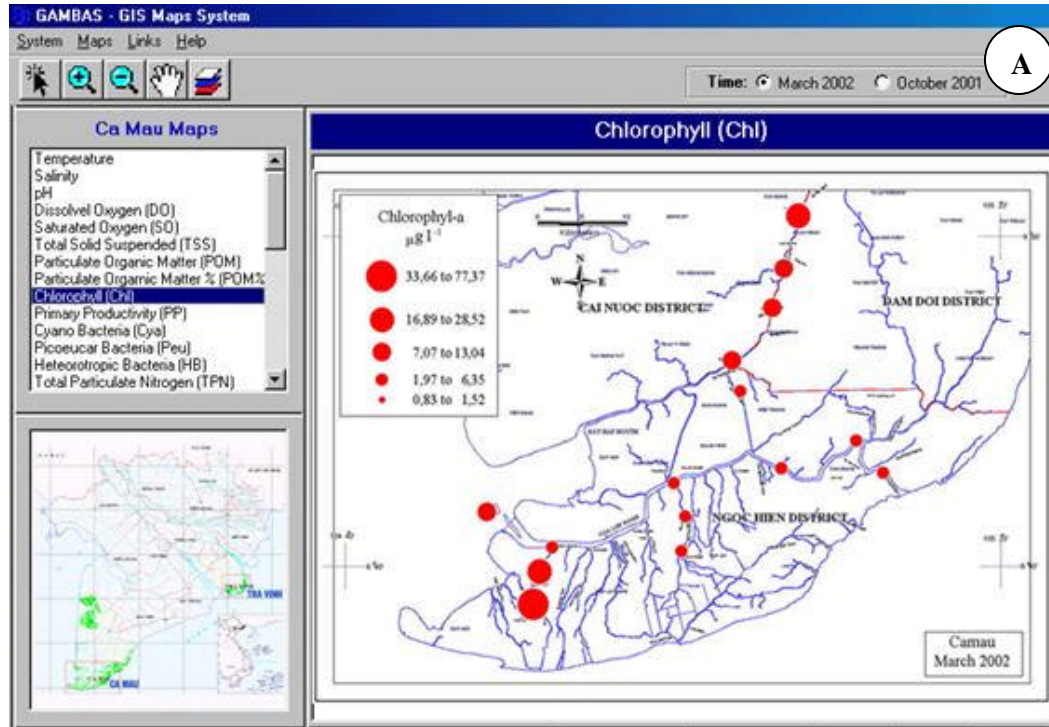


Figure 2: The interface show GIS maps in separated maps (A) or combined maps (B)

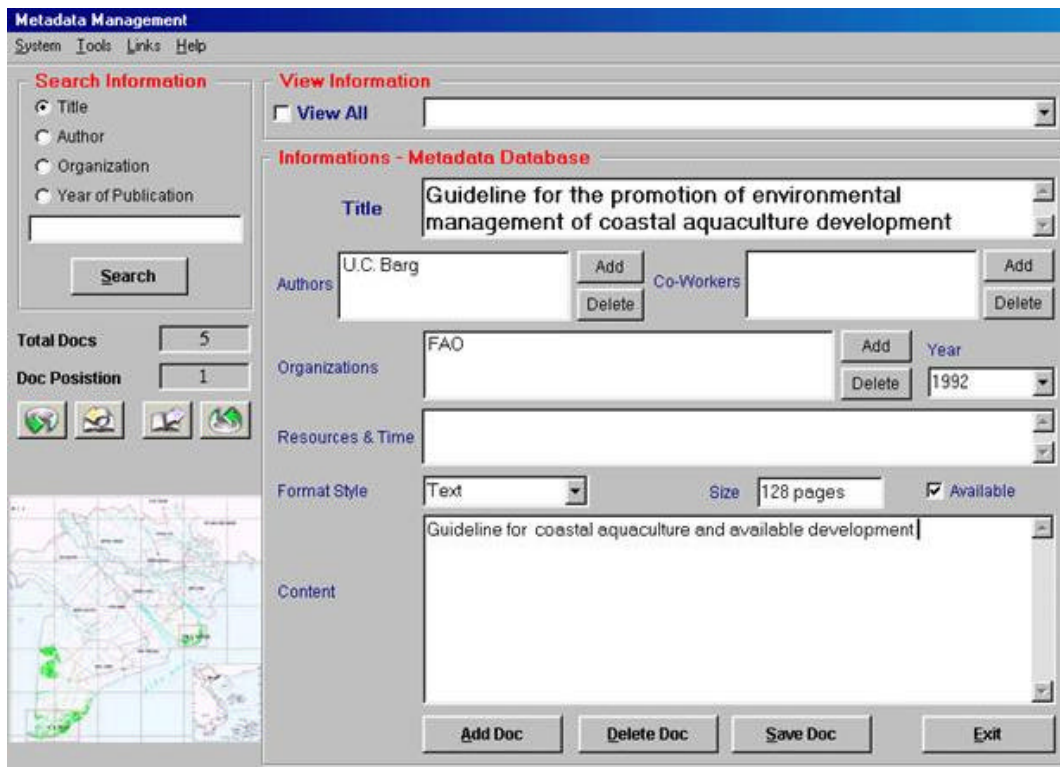


Figure 3: The interface of MetaData sub-component

2.3 Investigated Data

This database archives/stores raw data collected from project surveys and data analyzed in the laboratory. These data can be divided into 3 main data groups: a) environmental-ecological data; b) land ecological data; c) social-economic data (figure 4).

2.3.1 Environmental-ecological data

This data group was collected during both rainy and dry seasons, included:

- Data on the physical properties of water such as: salinity, temperature, total solid suspended matter (TSS), dissolved oxygen, respiration oxygen, pH, Eh....
- Data on environmental ecology such as: primary productivity (gross, net, respiration), BOD, COD, Chlorophyll-a, Pheophytin...
- Hydro chemical data: main nutrients ($\text{NH}_3\text{-N}$, $\text{NO}_3\text{-N}$, $\text{NO}_2\text{-N}$, $\text{PO}_4\text{-P}$, $\text{SiO}_3\text{-Si}$...), dissolved and undissolved organic matters (DON, DIN, POM, TPN, POC...)
- Microorganism quantity in water (Vibrio, Cyano, Pico, Heterotropic, SRB...), Organic matter, nutrients and microorganisms in sediment (organic matter content, C, N, P, Vibrio, SRB...)

2.3.2 Data on soil ecology

This data group includes grain size, pH, carbon, nitrogen, C/N contents in different locations around the collected point (in the culture pond, near culture pond, in the mangrove

forest, on land, near the river bank...) and on different soil layers (surface, middle layer (0,5m), bottom layer (1m)).

2.3.3 Social-economic data

This data group contains materials collected from questionnaires from shrimp farmers. For each shrimp farm there are 5 random questionnaires in the area around in both rainy and dry seasons. The detailed information of farmers is shown in the general and detailed questionnaires (which can be seen in subject reports on economy and culture techniques). Here we only list the main characteristics such as:

- Name, age and personal information of the farmer and his family
- Farmer's knowledge, abilities and experiences
- Capital capacity, labor source...
- Culture area
- Culture model (intensive, semi-intensive, improved extensive, extensive, mixed shrimp-forest model, mixed shrimp-rice model...)
- Culture techniques (pond structure, management of pond, water, diseases, seed, food...)
- Economic and technical efficiencies
- Remaining difficulties and real needs of farmers ...

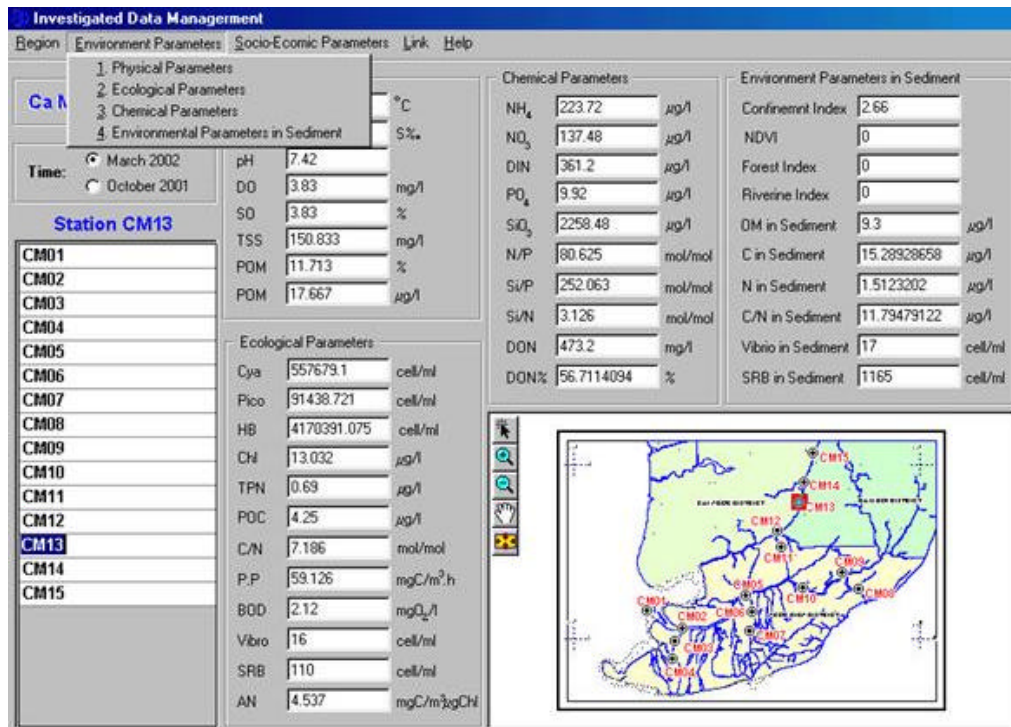


Figure 4: The Interface of Investigated Data Sub-Component

2.4 Reports and Guidelines

Reports and Guidelines are the last section in the GAMBAS database. They store reports of all specific subjects, annual reports, summarized reports, scientific information, training materials. All these materials are stored in normal formats of Microsoft Office such as Word, Excel, Power Point and also in Adobe Acrobat. There is also personal information (scientific vitae) of each member, scientific activities of organization members of the project in this section (figure 5).

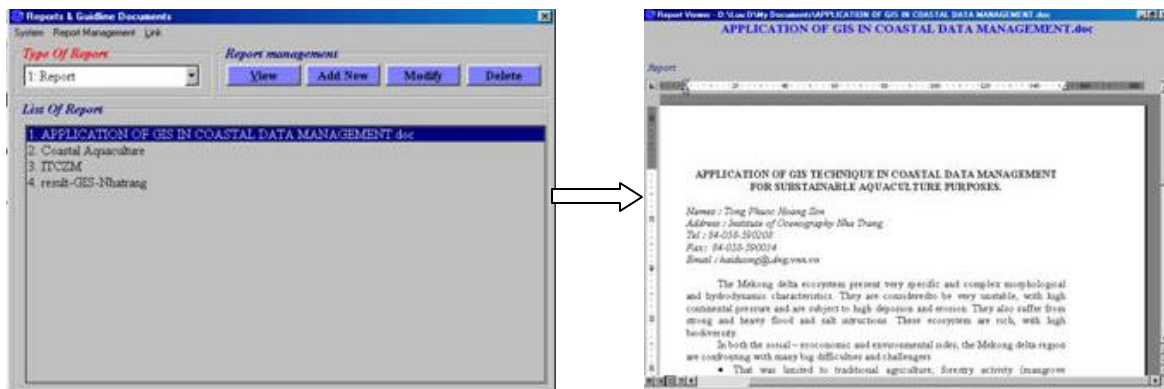


Figure 5: The interface of reports and guidelines

There is an important part in the GAMBAS database, which has extremely great practical significance. This is the guidelines and support tools for the managers, decision makers, planners for sustainable shrimp culture in Mekong delta.

Figure 6 shows the interface of support tool for managers, decision makers for sustainable aquaculture planning in Mekong Delta. This tool also helps farmers in shrimp culture by giving different options of culture techniques for an effective and sustainable culture. This tool has been built using statistical technique (V Test) that based on plenty database of GAMBAS project as mentioned above.

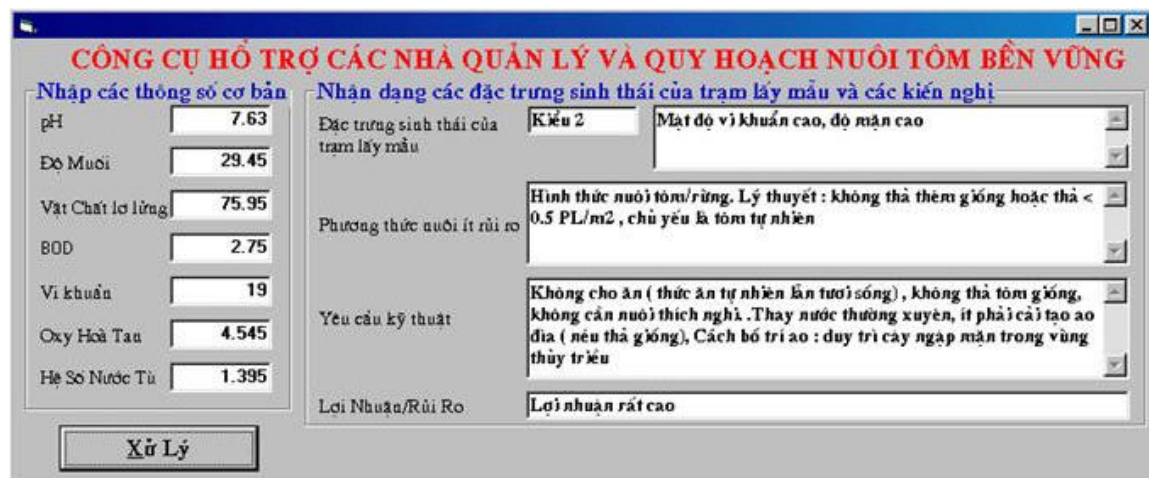


Figure 6: The support tool for managers, decision maker in planning for sustainable aquaculture in Mekong Delta (using for Vietnamese persons)

3. CONCLUSION

By using GIS techniques in Database-GIS management for sustainable aquaculture in Mekong Delta, we have obtained some results as following:

- Establishment of a GIS-Database for sustainable aquaculture with geometry high accuracy and contain plenty information in Mekong Delta
- GIS Map and Metadata have been managed by a special tool that has been built based on objective-oriented program. It is the close combination between database building on MS ASSESS and GIS program on Map Basic and Visual Basic.
- This tool includes 4 sub-components : 1) GIS maps; 2) MetaData; 3) Investigated Data and 4) Reports and Guidelines and contains many fundamental functions such as view, update , modify, query, zoom, draw, print,...
- Using effectively GIS technique in the establishment of maps for functional zoning and territorial planning for sustainable aquaculture in Mekong Delta.

The above mention results open a new approach method in analysis and environmental interaction assess, planning and coastal zone management in Mekong delta. The application of GIS Database combines with algorithm in spatial analysis, statistical methods and multiple criteria analysis will allow to make appropriate Decision Support Systems (DSS) and create advantage conditions for zoning, planning and sustainable development for marine aquaculture in Mekong Delta.

4. REFERENCES

- Fush.J., Martine.J.T., N.T.An, 1999. *Impact of tropical shrimp aquaculture on the environment in Asia and the Pacific*. EC Fisheries Cooperation, Vol. 12 No.4, 5p.
- Populus. J., Martine.J.L, Raux.P, Auda.Y, 2004. *Environmental sustainability of brackish water Aquaculture in the Mekong Delta Vietnam – GAMBAS*. Final report of EU contract VNM/B7-6200 – 85 p.