PORTABLE GEOGRAPHIC INFORMATION SYSTEM OF "RED TIDE" (GISRETI) AS AN AID IN THE ANALYSIS OF DATA AND DECISION-MAKING.

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Abstract
Due to the dynamics of marine ecosystems and continued expansion of Geographic Information Systems (GIS) in new areas of aquaculture and oceanography, it is necessary to have tools for the analysis and decision-making that involves the life and health of population. However, GIS is difficult to implement because visualization and manipulation tools of information are not easily available. Researchers and authorities do not have the appropriate software, either by their higher costs or expertise for using them, which hinder the compilation and dissemination of cartographic information. In this scenario, the generation of a "Portable Geographic Information System" was created to face the necessities of the "Program of Management and Monitoring of Red Tides in the Regions of Los Lagos, Aysén and Magallanes" period 2007-2008 (Programa de Manejo y Monitoreo de las Mareas Rojas en las Regiones de Los Lagos, Aysén y Magallanes, período 2007-2008). This program is implemented with the support of the Subsecretaría de Pesca (SUBPESCA) since 2007, and extends from Cochamó, in the Region of Los Lagos, to Caleta Eugenia, in the Region of Magallanes, having a total of 151 stations distributed in representative areas of each region.

The large extension of the area and the type of sampling generate large amount of information that must be readily recorded, organized and available to be used in different scenarios, and oriented to users who are not familiarized with the use of GIS.

The implementation of GIS with the software TimeMap®, developed by the Archaeological Computing Laboratory of The University of Sydney, Australia, was used to accomplish with these requirements. Initially, the base cartography was defined for the representation of the information and then relevant topics were identified for subsequent research and/or decision-making. In this manner, the graphical presentation was customize for displaying the information (layout) and the different GIS tools of TimeMap®, which were programmed in XML (Extensible Markup Language). Cartographic and thematic information, which consist on different layers of

information, were managed with ArcMap using the “shape” format that is fully compatible with TimeMap®, allowing to each spatial datum holds attributes. A webpage was created to support and display the GIS. This page works from a CD-ROM, performing all the queries directly from it. By the volume of the generated information and the type of interrelated information, it was necessary that the deployment of information be intuitive, with links between GIS and Report and a help file for its use.

Thus it was possible to create the “Portable Geographic Information System of Red Tide” (GISRETI), which needs no previous knowledge in GIS or specific software in order to visualize and analyze the information, and can be displayed on any computer with minimum requirements. This type of low-cost tools opens the way for new developments in cartographic products, where an incorrect planning and identification of the needs and requirements of the GIS users, could lead to a wrong implementation, with the consequent loss of working hours and investment.

Introduction

The dynamics of marine ecosystems and the continued expansion of the Geographic Information Systems (GIS) in new areas of expertise in aquaculture and oceanography, leads to the implementation of new tools for space-time analysis of oceanographic phenomena. Each day these areas generate greater amount of information which can be used to make decisions that directly affect to communities that depend on the marine resources.

Harmful Algal Blooms (HABs) are natural phenomena produced by the multiplication of microscopic algae (phytoplankton). Normally these blooms are also known as “Red Tide” due to the color acquired by the seawater. Red tide causes disturbances to marine life and the economy of the affected areas. Depending on the toxicity of the phytoplankton microorganisms, the HAB can have severe repercussions for human health by eating transvector shellfish, i.e. contaminated with the toxin (Avaria, S., Cáceres, M., Muñoz, P., Palma, S., Vera, P., et al., 1999).

In general, harmful microalgae are classified as toxins- or high biomass- producing microorganisms. The first includes species associated with harmful toxins known as paralytic shellfish poison (PSP), diarrheic shellfish poison (DSP) and amnesic shellfish poison (ASP), among others, which affect part or all of the territorial sea of the southern Austral macro zone between Canal de Chacao and Canal Beagle (Guzmán, L., Vidal, G., Vivanco, X., Palma, M., Espinoza, C., et al., 2007).

Faced with the economic and social damage generated by the harmful algal blooms, the Instituto de Fomento Pesquero (IFOP) developed the "Program of Management and Monitoring of Red Tides in the Regions of Los Lagos, Aysén and Magallanes" period 2007-2008 (Programa de Manejo y Monitoreo de las Mareas Rojas en las Regiones de Los Lagos, Aysén y Magallanes, período 2007-2008). This program is implemented

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The specific objectives of this program is to "Develop an integrated information flow system between agencies responsible for the generation of information, and those responsible for decision making, both for domestic consumption purposes and for export markets" and "Develop and/or provide a geographic information system with the database generated".

The monitoring program generates large volumes of information, which should be available for the authorities who are not familiar with GIS. It must also present the particularity of being transportable, self-supported and run with minimum hardware requirements. With all that in mind, it was developed a "Portable Geographic Information System of Red Tide" (GISRETI).

Objectives

- Develop a Geographic Information System that meets the requirements of the Program of Management and Monitoring of Red Tides in the Region of Los Lagos, Aysén and Magallanes.
- Deliver a product that store all the generated information in the Monitoring Program of the Red Tides to be used in different scenarios.
- Generate a Geographic Information System that require no specific software.
- Guide the use of this system as intuitive as possible, for users not familiar with GIS.

Methodology

- **Identification of necessities and requirements of final users.**

The identification of users along with their needs and requirements, as proposed by Tomlinson (2007, p. 12), is in relation to the following questions:

- How do the authorities make decisions?
- What do they need to know to perform their tasks?
- What are the information products appropriated for these tasks?

Previously to the generation of this GIS, the analysis and decision-making by the authorities and researchers were done with paper-based information in tables, graphs and some static maps, which could not show different types of information in an instructive, comprehensive and/or particular way. Faced with these questions and problems, GIS should exhibit information showing the space-time evolution and development of variables of importance, and the impact on the potential development of a red tide phenomenon.

- Definition of the software for the GIS development .
After an investigation of free available software on the web, it was decided to generate the GIS with TimeMap ®, because it meets standards and support various types of graphic files (ESRI shapefiles MapInfo MIFID, GML), databases (CSV, TXT and DBF) and image files (JPG, GIF, Zoomify and JPEG2000). In addition, it is a standalone application, i.e. works independently in any computer on a standard web browser (Jonson, I., Evans, D. 2005).

This software was developed by the Archaeological Computing Laboratory, The University of Sydney, Australia, which is based on Java, for the generation of interactive maps, space-time maps, which are supported in Web pages either as independent products on a CD-ROM or through the Web (Jonson, I., Osmakov, A., Evans, D., Murtagh, T. y Moore, R. 2006).

- Definition of the cartographic and thematic basis to represent.
For the representation of the information, in first instance, the cartographic and geodetic parameters of the base and thematic cartography are clearly defined. For the base cartography were defined 8 layers of information; "Sampling stations (150 points of sampling),"Populated Centers (minor towns and coves), "Urban zones" (major cities and towns), "Roads" (main ground transportation), "Hydrography", " Lakes", "Glaciers" and "Region". Then, the themes of importance were identified: Relative Abundance (semi-quantitative estimation for the toxic and potentially toxic species), Densities (quantitative estimation for the toxic and potentially toxic species), Toxins (detection and quantification of paralytic shellfish poison and diarrheic shellfish poison), Meteorology (temperature, cloudiness, air pressure, wind direction and wind speed) and Oceanography (condition of water in terms of temperature, salinity, sigma-t, chlorophyll and transparency).

Sub-groups were defined in order to represent the data for each subject area of thematic information. For Relative Abundance and Density, the information was classified by species of microalgae; toxins were classified by type of poison (PSP and DSP); and Meteorology and Oceanography were classified by variables measured in-situ in each cruising. "Shapefiles" were created in ArcMap with their respective databases. Every item of information was subdivided by periods of sampling (cruising) generating new "shapefiles".

For base and thematic cartography, the information was represented in a geographic coordinate system, in WGS-84 datum. Although TimeMap® supports shapefile consisting of the three basic types (.dbf, .shx and .shp), i.e. no rectified (no “georeferenced”) layers, georeferencing files (.sbn, .sbx and .prj) were entered into the GIS as cartographic support in the metadata.

- Construction of GIS.

The definition of the GIS structure was the first topic for its implementation. Two folders were generated containing information related to the CD AutoRun, and other with 4 subfolders in which appears the base cartographic information (contains shapefiles of base cartography and sampling stations), thematic cartography (contains shapefiles of thematic information), reports (contains PDF files of the report, tables and appendage of the Program of Management and Monitoring of Red Tides) and structures of GIS application (contains all the architecture and algorithms for the deployment of GIS).

Then, TimeMap® was customized, programming in XML (Extensible Markup Language) the "layout" for the deployment of the information, eliminating tools that would not be used (which are in the default software) and generating help files for the final user. Subsequently in the software TMWin of TimeMap®, thematic areas to represent were defined. Finally the information was loaded: the base cartography, which has different layers of information, the sampling stations and the thematic information (Figure 1).

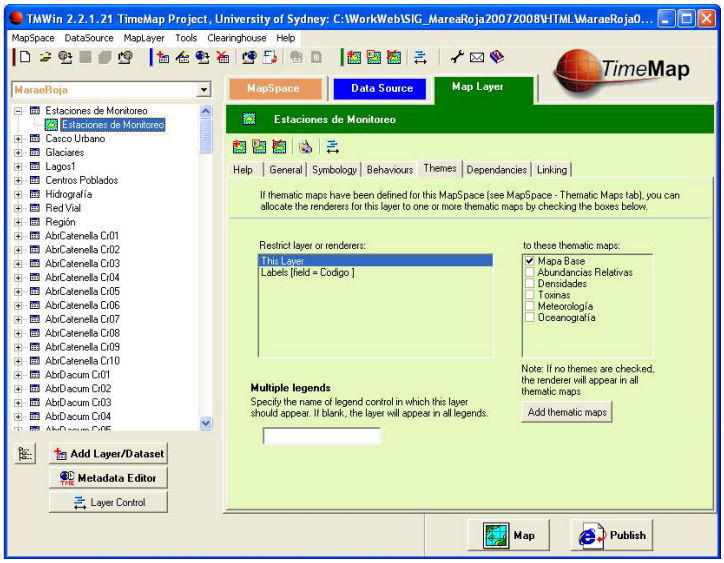

Figure 1. View of the software TMWin with information and thematic definition.

All the information recorded through this software was structured, symbolized and represented by algorithms in a TimeMap® file (.TMS). This file is decoded by Java to graphically represent the information in the layout (Figure 2).

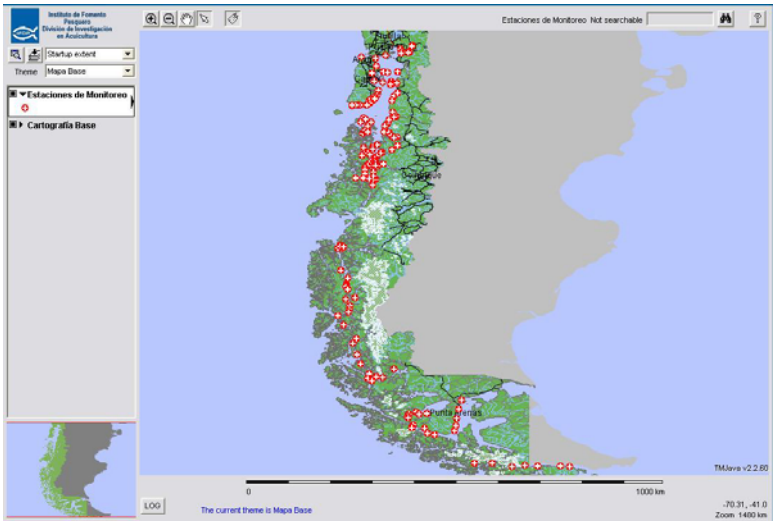

Figure 2. View of GIS in TimeMap.

A web page was generated in HTML (Hypertext Markup Language) for the display of the GIS. This web page runs directly from the CD-ROM and additional web functions can be incorporated (Figure 3).

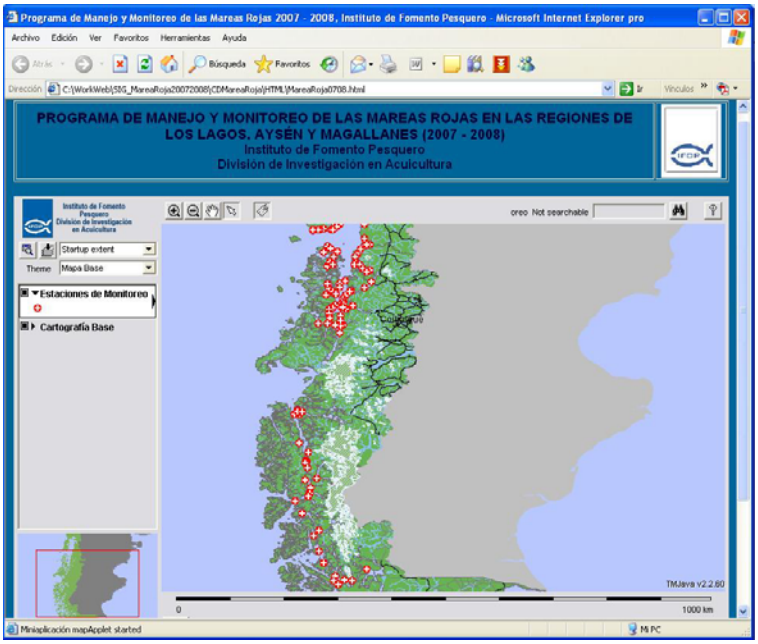

Figure 3.View of the Web page with the GIS.

Finally the CD-ROM AutoRun was generated, which displays a menu when the CD is put into the computer. GIS and Report buttons (links) show all the information

concerning the "Program of Management and Monitoring of Red Tides in the Regions of Los Lagos, Aysén and Magallanes" (Figure 4).

Figure 4. View of start autorum.

Result

With this work was possible to bring the Portable Geographic Information System of Red Tide (GISRETI) to a broad spectrum of users, as diverse as marine biologists, fish farmers, biochemists, veterinarians and decision-making authorities, that without the knowledge in GIS could easily and quickly reach the information for its analysis.

Conclusion

The final product delivered in this work fulfills the objectives of the Program of Management and Monitoring of Red Tides in the regions of Los Lagos, Aysén and Magallanes, with regard of being part of an integrated system of flow of information and, together, consisting on a Portable Geographic Information System of Red Tide (GISRETI).

The user can consult geospatial information depending on the topic of interest, analyze trends and time-series of variables recorded at each sampling point, as well as tabular information in the report, graphs and tables.

By its structure, the generated product, can store either tabular or graphical information through queries directly on the GISRETI. Among their key features are its portability, because all the GIS structure and information are stored on a CD displaying the information directly from it, as well as its interoperability, for being built with common-use- programming languages, allowing the displaying of information for querying and/or analysis in various scenarios.

The GISRETI does not work as a project file that sorts the data for its deployment, hence does not depend on specific and expensive software, which hold restrictive licenses for a single computer. GISRETI may be used on any computer, because the information, the project file and the applications for the deployment run as a whole from a specific location (CD-ROM), where the user only needs a PC, Acrobat Reader (free) and a Java engine, which comes by default on all computers.

The Portable GISRETI is quite intuitive, with a simple menu and with a help file to guide its use. It has become a partical working tool that allows the visualization and analysis of the information at any time.

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