CYBERCARTOGRAPHY AND THE ENVIRONMENT: THE CHAPALA ATLAS

Martha Lucía Alviar
Fernando López
Carmen Reyes
Centro de Investigación en Geografía y Geomática
Ing. J.L. Tamayo (CentroGeo)
Adolfo Prieto 1638
Colonia del Valle,
México D.F.
mlalviar@centrogeo.org.mx
ferlopez@centrogeo.org.mx
creyes@centrogeo.org.mx

Fraser Taylor
Carleton University
1125 Colonel By Drive
Ottawa, ON K1S 5B6 Canada
fraser_taylor@carleton.ca

ABSTRACT

This paper presents the results of an application of the concept of cybercartography for the purpose of supporting the design of an information and analytical product to help environmental public policy-making on Lake Chapala. The methodological approach used to undertake this exercise encompasses well-known practices such as user requirement analysis, mapping and database modeling, as well as others less reported in the cartographic literature, which include team building, qualitative research, and strategic design to incorporate maps into organizational processes.

INTRODUCTION

Multimedia cartography has embraced concepts and practices already in use by the communication, entertainment, and computing science communities. Media elements complement each other and are presented as partners in information delivery. Interface devices assume the dual roles of functional and decorative components. According to Ken Francis, “Sound and image are vehicles for information delivery as well as acting to ground the work within its cultural foundation.”[1]

There are, however, other fundamental elements of spatial data modeling that should be considered in contemporary mapping. Taking as a point of departure the

[1] Francis, Ken. “Wula Na Lnuwe´kati: A Digital Multimedia Atlas”, Germany, 1999, p. 147. in Multimedia Cartography (Cartwright, Peterson and Gartner, Eds.) Springer. New York

concept of cybercartography[2], a mapping solution to an environmental problem was designed and developed. In this new approach, multimedia is incorporated into the map language as well as other elements of spatial data modeling such as: the interaction of the user with specific products, the establishment of multidisciplinary groups to build cybermaps, multidimensional views, as well as the impact that the spatial message given through the cybermaps has on society (organizations, public policy-makers, etc.).

The integration of multimedia with digital cartography will help the user understand and interpret in different ways the information given. Therefore, "the work will not be created as an encapsulated moment: it will achieve a life of its own."[3]

The Chapala Atlas meets the requirements of the Direct Watershed Commission (an NGO) to have a tool to support planning and public policy in the region. The Atlas was conceived following the landscape ecology model and a regional planning scheme. The six chapters include historical data, contextual information, an ecological breakdown by, environmental data, natural resource scenarios, and environmental management issues.

CASE STUDY

The Lerma-Chapala Basin is economically and demographically important to Mexico. The basin occupies an area of 52,000 km^2, originating east of the city of Toluca and ending at a dam in the vicinity of Poncitlán, a small town located 20 km downstream from Lake Chapala along the Santiago River. From its headwaters to its outlet in Lake Chapala, the Lerma River travels more than 500 km through one of the most important agricultural and industrial regions in Mexico (SRH 1972).

Lake Chapala, the largest freshwater lake in Mexico and the third largest lake in Latin America, has a nominal water surface elevation of 1,524 mamsl (meters above mean sea level). The Lerma River-Lake Chapala-Santiago River Basin is located roughly between 19° and 23° North latitude and between 99° and 105° West longitude. Lake Chapala is 77 km long from east to west and has a mean north-south width of 15 km. The mean depth of the lake based on the 1974-1997 period is about 4.80 m.

The total drainage area of the Lerma-Chapala-Santiago system is about 130,000 km^2, and is located in the west central part of Mexico, partially in the States of México, Querétaro, Guanajuato, Michoacán, Jalisco, Aguascalientes, Zacatecas, Durango, and Nayarit (SRH 1972).

[2] As defined by Taylor (1997)
[3] Idea adapted from Ken Francis, "Wula Na Lnuwe´kati: A Digital Multimedia Atlas", 1999, p. 148.

The lake is the main water supply for Guadalajara, the second most important city in the country with a population of some 4.5 million inhabitants. Unfortunately, large quantities of domestic, agricultural, and industrial sewage from the entire Lerma-Chapala Basin still flow untreated into the lake. Besides, both the local population and tourism are increasing, bringing a high quantity of pollution into the lake water.

There are more than 30 communities established around the lake. Most of them are made up of farms, who work the land, fish, and raise animals. These towns maintain their cultural heritage, which promotes respect for and full awareness of the great significance the lake has in their everyday lives.

Anthropogenic water demand surpasses the surface supply and ground water recharge rate. This has resulted in a hydrologic imbalance in the basin that is jeopardizing both the ecological and economic viability of the lake, if not its very survival. This situation has affected the water level of the lake, affecting the water supply for Guadalajara.

The changing flow patterns of the Lerma River have resulted in a hydrologic imbalance in the basin that is also jeopardizing the ecological and economic viability of the lake. The situation is aggravated by the lake's chemical and biological degradation, and the erosion processes in the hills surrounding it due to high deforestation and changes in land uses.

DESIGN AND PRODUCTION PROCESS

Compiling of geospatial information regarding environmental issues in Lake Chapala, provide us with insights as to the importance of representing this space with a holistic approach. So the representative model must be as close as possible to the environmental reality of the basin, with the help of maps, videos, graphic images and photos, texts and music.

To achieve a holistic spatial representation, the Cybernetic Atlas of Chapala was designed and created by means of a methodological process that included three different stages: conceptual framework definition, product design, and product development.

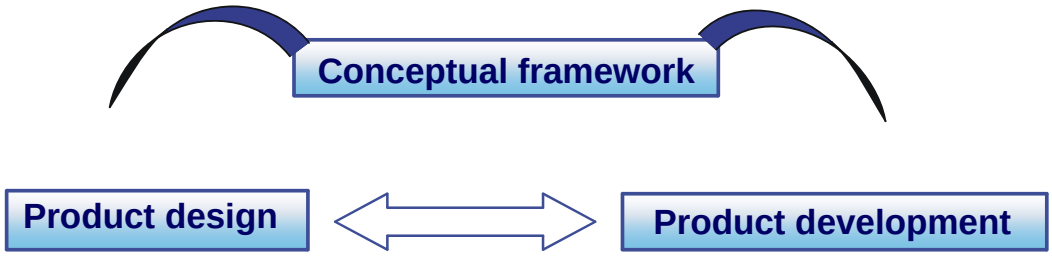

Figure 1 Stages of the methodological process of development.

The solution in Geomatics was designed considering a conceptual framework that integrates existing basic information on natural resources, sociocultural conditions, and economic and environmental issues for the purpose of attaining an integral approach to the environmental problems.

To accomplish this, diverse spatial communication elements were used so that the executive level of government and other officials in charge of natural resource management, who are also decision-makers, would be able to comprehend the whole product and its results. Thus, users can handle the product easily and gain an awareness of the environmental problems affecting this area; it will also be possible to produce new information to support decisions regarding natural resource planning and management for the basin.

The conceptual design of the atlas shows the cultural, organizational, and political context in which Lake Chapala Basin´s natural resource management takes place. It also allows us to evaluate and gain greater knowledge of the environmental problems and their causes and effects based on a holistic approach to landscape ecology and regional planning scheme.

This stage includes a requirements analysis in which the users´ information needs are considered. This includes the type of organization characterizing institutions devoted to planning Lake Chapala's natural resources and management as well as cultural issues and the environmental perception of local communities.

The conceptual geographic model was also designed to help shape the structure and content development of the cybernetic atlas.

In order to design the Cybernetic Atlas of Chapala, the methodology developed by Dr. Reyes[4] was applied. This methodology covers three conceptual levels: the design, which explicitly considers the organizational, cultural, and political contexts; the information system, and the technological solution.

[4] Dr. Carmen Reyes in a World Bank internal report "A qualitative approach for the design and implementation of community-based geographic information systems," 1998.

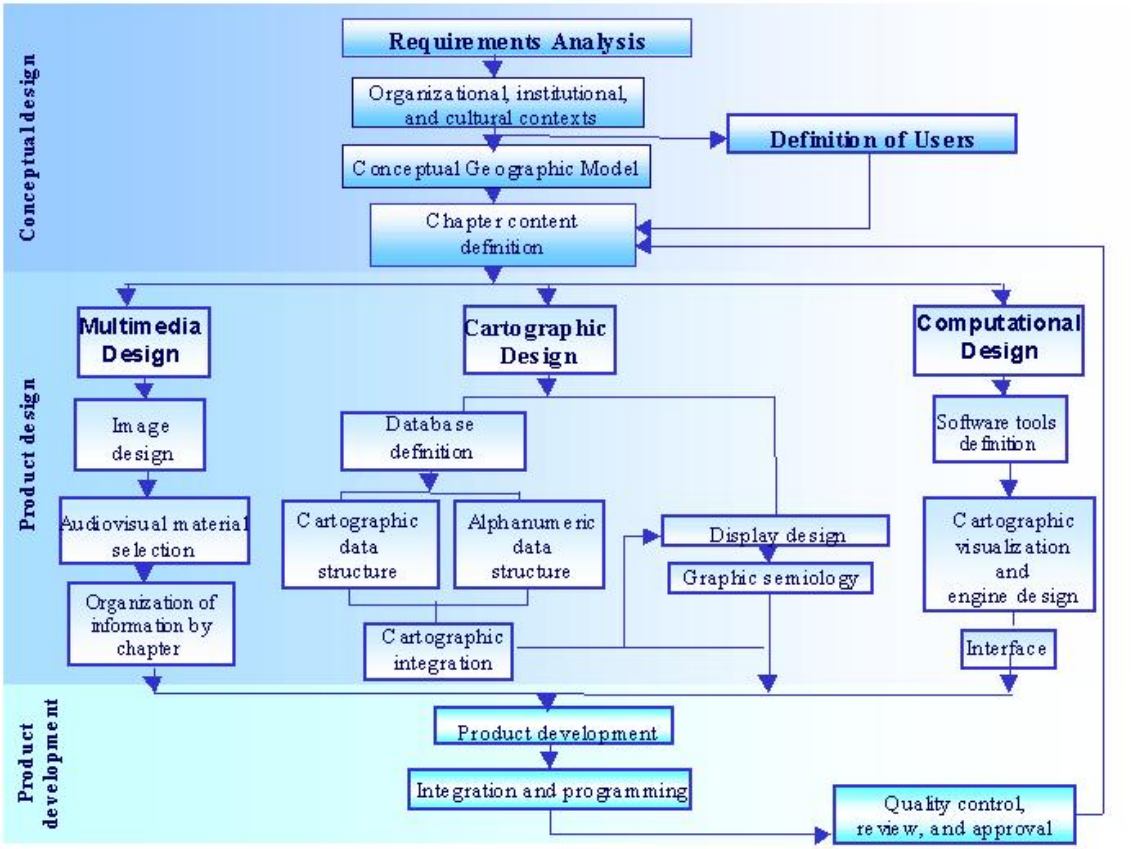

Figure 2 Methodological design of the Cybernetic Atlas of Chapala development and production.

During the first stage, the table of contents was divided into six chapters based on the conceptual design: history, spatial dynamics, the lake and its surroundings, environmental concerns, the horizon and beyond, and environmental management.

During product design, one of the most important stages is the definition of the multimedia design. Here, the image to be projected is chosen depending on the user and the specific topics; videos, graphic images and photos, and texts are also defined, according to the message to be delivered.

Furthermore, all the necessary elements were established in the technological solution so that the computational design could be developed in accordance with the software tools and appropriate programming for the user interface.
At present there is a wide variety of commercial systems allowing for statistical and cartographic data consultation. However, these systems are sometimes hard to consult, so qualified personnel are needed. Due to the operational complexity of

this software, it is difficult for the decision-makers[5] to take advantage of the benefits of statistical and cartographic data consultation systems.

Another basic aspect of this stage is cartographic design definition, in which the cartographic layers are determined in accordance with the particular chapter´s topic and the necessary alphanumeric databases to characterize each of the cartographic units represented. The design of cartographic tools must permit the user to obtain all possible knowledge about a specific topic.

The Cybernetic Atlas of Chapala is a tool that allows for increased consultation potential, comparison, management, and analysis of cartographic data and statistics, in order to guide and improve decision-making and planning processes.

PROPOSED TECHNOLOGICAL SOLUTION

The tools used for developing the Cybernetic Atlas of Chapala were: Visual Basic programming, ESRI´s MapObjects, and HTML files. Thanks to the combined use of these tools, it was possible to create a system with real-map manipulation (with a geographic reference), as well as new maps and multimedia addition. For this atlas, programs in Visual Basic were developed; in their window display, images were inserted and other sensitive objects were superimposed to create different menus, facilitating navigation through the atlas. These menus are linked to other menus and maps, as well as to text, video, and audio displays through an Internet explorer window especially developed for the Chapala Atlas.

A new option is given in the programming, by which it is possible to link additional information such as videos, texts, and images to the component units and to the maps´ cartographic attributes (points, lines, and polygons); a *link* column is created in the table record; this column stores the HTML file location containing the information to be displayed. In this case, a special procedure was developed in order to select the attribute and then identify the record and field for obtaining a HTML file location, transfer it to the Internet explorer, and display it.

Based on the MapObjects libraries, a cartographic user interface for mapping was developed to display the maps in the same way as in the commercial systems. This system has a group of reduced functions that permit map displays with different formats such as *shapes, images, dxf,* etc*.* It also includes procedures for zooming in and zooming out of an area, full and layer extent, panning, digitizing maps, and saving and recovering all the modifications made to the cartography presented.

Atlas users can modify and add new maps, digitize areas and points over existing maps, and add to these digitized new maps information in HTML files. They can

[5] We are referring to decision-makers such as: company or institution managers, researchers, governmental officials, etcetera.

also superimpose layers of different topics in order to effect a visual analysis. The figure shown below is an example of the cartographic display:

RESULTS

Applications at the local level for environmental and sustainable decision-making require methodological approaches that allow for the design of solutions that fully respond to the specific needs of the communities. There are similarities in the contextual issues found in organizational and community environments. Therefore, the approach described above could be generalized or replicated in a local community, in the design and development of the Chapala Atlas, to support the community in its efforts to solve environmental and social problems.

In Mexico, natural resource management has been one-dimensional. The environmental information for the Chapala Atlas was compiled according to a holistic approach and a well-defined conceptual model, which has allowed the local community and federal government to attain a comprehensive vision of the region's environmental problems and potential solutions. Moreover, it has been widely used as a means for obtaining consensus and agreement among the stakeholders.

The atlas has proven to be a very powerful communication tool that helped establish a consensus among all the different people related to the Lake Chapala Basin when their everyday activities were shown in the atlas, reinforcing their awareness of the effects that their actions have on the environmental and ecological processes of the Lake Chapala.

A process-oriented and integral approach to the design, development, and management of spatial information has been a key element in the success of the entire project.

The information contained in the atlas was acquired from various sources, including federal and state governments, universities, research institutes, and NGOs. The atlas has been distributed on a compact disk, at no charge, to all the different users.

REFERENCES

Cartwright, W. and M. Peterson and Gartner, G. (1999). Multimedia Cartography. Springer-Verlag.

Francis, K. (1999) "Wula Na Lnuwe'kati: A Digital Multimedia Atlas" in Cartwright, W., Peterson, M. and Gartner, G. Op.Cit.

Reyes, C. (1998). "A Qualitative approach for the design and implementation of community-based geographic information systems," World Bank, internal report.

Reyes, C. (2000). “Informe final de la Gerente de Proyecto Piloto en Cartografía Digital y Sistemas de Información Geográfica”, Pan-American Institute of Geography and History, internal report.

SRH, 1972. “Estudio limnológico del Lago de Chapala. Primera etapa”. In Contrato No. SP-72-C-6. Dirección General de Usos del Agua y Prevención de la Contaminación. Centro de Investigación y Entrenamiento, Instituto de Ingeniería, UNAM.

Taylor, D.R.F. (1997). “Maps and mapping in the information era.” Keynote address to the 18th ICA Cartographic Conference, June, 23 1997, Stockholm, pp. 1-10.

Taylor, D.R.F., Liu Yue, and Chu Shiqiang (1996). “Design and production of the Electronic National Economic Atlas of China (ENEAC),” in Barend Kobben, Ferjan Ormeling and Timothy Trainor (eds.), *Proceedings of the Seminars on Electronic Atlases II* held on July 31-August 2, 1996 and at the 28th International Geographical Union Conference, The Hague, August 8, 1996. Enscede, The Netherlands: ICA, 1997, pp. 7-10.