Geographic Information Systems - GIS, a view from the water resource

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ABSTRACT

This research paper presents an overview of the state of the art Geographic Information Systems - GIS, which has been defined and characterized important aspects about these systems and their contribution to the analysis of water bodies from various use and development, which allows the achievement of the Platform for water Resources Network of the Colombian Caribbean

Keywords: Water Resources, Water, Geographic Information Systems, Bodies of Water

1. INTRODUCTION

Water resources are immersed in the vast majority of ecosystems in which a variety of human activities is based, the which can be classified by seven types of use: agriculture, domestic, public, industry and services, power generation, water transportation, recreation [1]. These resources can be found on the planet in different states such as groundwater, snow, ice, lakes, wetlands, rivers, seas, etc., forming bodies of both saltwater and freshwater, artificial and natural [2]. According to the classification of uses, water resources such as rivers or marshes are directly related to agriculture, industrial processes and human consumption [3].

These water bodies have characteristics of both chemical and biological order, because these can affect the coexistence of the human race in neighboring [4] areas. Also, to maintain control and monitoring of the impact of these water bodies on the populations around them and use it for various uses is necessary to have reliable, timely and accurate information about the quantity and quality of water in them, thus supporting decision making an ecosystem balance between body water and population [5], [6].

Similarly, the need arose to conduct performance analysis of these water bodies, consolidating a number of studies related to hydrodynamics. [6], [7], [8]. These contribute valuable information about the incompressibility of a fluid, viscosity, energy, inertia of motion, speed [9].

According to the above, there are several ways to perform analysis of these water bodies, from traditional crafts and more to the most modern and technologically advanced. Traditional forms seen as core business making in situ measurements. However, given the rapid technological advances various strategies to optimize time and resources in achieving data accuracy, reliability and validity [10] are set.

SIG, which include both the processing and storage of spatial data volumes, with accurate information regarding the geographical location, in turn, have to allow metadata - In response to this, the GIS is used store information from the data, however, this type of data in themselves contain a number of behavior patterns that allow the achievement of new information that creates value [11], [12].

The spatial databases, has its origin in different conceptual and technological developments type, which are directly related to geographic information according to the spatial dimension. This spatial information is directly related to the mapping for the effective achievement of objectives based on the analysis and management of spatial data, which are represented by maps and symbols [11], [10]. Similarly, the evolution of information technologies and communications - ICT enabled achievement Information Systems Geo-referenced - SIGs, which have been established as a highly useful tool for managing this type of data in particular enabling the visualization, querying, editing and analyzing spatial data. The information stored by the SIGs, is available concerning the geometric location of the object that is stored in a spatial database [12] data layers, [13], [14].

Currently, there are databases with spatial type, which are constantly growing with relevant and useful data. It is for this reason that makes it necessary for interpretation and discovery of information about these [10], in addition to the schema definition search aimed at identifying both objects and emerging relationships with significant values, which defines a high level of complexity [15], [16]. Providing response to these requirements arise SDM spatial databases, which provide for automatic analysis, using algorithms aimed at finding relationships between objects not apparent and with a high potential for this kind of objects [17] [18]. The definition of a SDM aims for the set implicit knowledge that can reveal the deduction of categories and patterns either associatively or various types of spatial relationships [15], [19].

Consistent with the need for the implementation of spatial databases [20] that support the achievement of the project objectives, it is necessary to conduct the study and characterization of the Information Systems GIS geographic markets to help the process of technology selection and how lessons learned as a knowledge base for the construction of the platform of Water Resources department of the Atlantic.

2. CONCEPT OF GEOGRAPHIC INFORMATION SYSTEMS

The Geographic Information System - GIS can be defined as a population or set of data, tools, or methods whose purpose is demarcated on coordinated action and logical process of collection, storage, analysis, transformation and presentation of geographic information type for specific purposes. The emergence of GIS stems from the definition of a technology that could provide answers to queries related thematic geographic information. It is also defined GIS as an integrated spatial information system for analysis and decision making that contribute to national and international development Local, Regional,.

Considering the above aspects, states that the main goal of such applications is to have databases associated mapping information for the purpose of responding to problems of spatial and territorial type, achieving jointly manage both mapping and alphanumeric data type. Hardware and Software: GIS DEFINITIONS Other relevant aspects such as the hardware associated with the different solutions achieving global integration of the solution are considered. The National Center for Geographic Information and Analysis - NCGIA (USA), provides one of the most complete definitions GIS conceptualize as a system of hardware, software and procedures designed to facilitate the collection, management, manipulation, analysis, modeling and data output spatially referenced, to solve complex problems planning and management [21].

Differentiation of definition GIS lies mainly in the approach in which the applications reside. Among these are:

1. Focus Database, the main contribution of this approach is to have digital support for the historical information of spatial data to be included in implicit spatial components, supported by servers, companies and agencies responsible for the daily management of this information.

2. Mapping Approach, the purpose of the mapping approach is the design of tools to streamline the various production tasks both users and agencies to generate cartographic data type.

3. Approach to Joint Analysis and Geographic Information Management, this approach establishes ity that different actors such as research centers and universities, can make use of the information contained in the GIS for simulation and analysis of future trends.

3. HISTORY OF GEOGRAPHIC INFORMATION SYSTEMS

The evolution of GIS lets show the progress of different aspects inherent in this technology and in turn allows an overview of them. The early stages of development have shown GIS have also enabled a constant evolution of both hardware and software support, which also potentiates the development of other areas of knowledge.

Currently, different aspects can be defined in terms highlight both facts and characters that have defined a milestone in the evolution of this technology, but has not been able to establish the phases or periods temporarily. Through the chart below shows the development of GIS is established.

	1950	1960	1970	1980	1990
Technologies	first computer	CAD, GIS -assisted cartography (raster structure) tables plotters digitacion	CAD, GIS - assisted cartography (vectorial structure)	CAD, GIS -assisted cartography	CAD, GIS - assisted cartography(integracion raster vectorial)
User	army	American and British universities	National geographic institute	Spanish universities, Cartographic Institute of	Automatic municipal administrations
Applications	military	Research and education, urban planning, management and analysis of natural resources		Research and Development	global applications

Figure 1: Evolution of Geographic Information Systems [22]

However, the beginnings of GIS are attributed to the time of the first computers and 50s, in keeping with the history these beginnings must be placed in advance, the history of civilizations has its origins in the analysis of behavior of the stars, just as the ancients defined on a map the behavior of the Earth's information, therefore can be defined as the following outline history of GIS:

1. Origins to 1950: During this period you can set the analog mapping whose purpose was the distribution of land, with the aim of generating taxes and collections to the community. Subsequently, they were defined by mapping the location of natural resources, which strengthens the thematic mapping.

2. (1950-1975): The fact that marks the entrance to this stage is the incursion of information with regard to spatial analysis and cartographic production type. The main features of this period are as follows:

- Appearance of the first computers.
- Development of GIS applications and individual initiative.
- Participation of the army as the main user of GIS.

Computer software to support the development of GIS, are in response to the need to use the theme Cartographic the nationality of territorial-type analyzes, this information was handled manually.

In order to solve the issues raised above, it was not until 1988 that Roger Tomlinson developed the first GIS, called CGIS (Canadian Geographic Information System). Roger, a worker from a surveying firm of the time was given the task of making an inventory of Canada's land in forestry.

To achieve the CGIS were referred to various theoretical and practical basis of new technologies for GIS, which enables this system is still in effect. Among them you can find: The Structure of Spatial Information Techniques Cartographic Overlay, Data Collection Systems, vectorization of scanned images. Currently the CGIS has stored in its database just over 10,000 maps which are included various topics, and is recognized as one of the most important GIS, due to the large surface area which gathers information.

In parallel, the MIT (Massachusetts Institute of Technology) conducts research related to the application of computer techniques whose main objective is the achievement of drawings such as foundation to CAD (Computer Aided Drafting). It is precisely the incursion of technology that sets forth the origins of computer mapping. By the late 70s, the automatic mapping is added databases to support the storage of cartographic information.

Likewise in 1968, it created the SYMAP (Synagraphic Mapping) by LGSSA (Laboratory for Computer Graphics and Spacial Analysis. In this application, which is used to explore the issue of modeling and simulation of urban planning.

4. (1975-1980): the epicenter of the development of this second step is the development of GIS, defining a system for spatial information grids complemented with vector structure, which allows vector systems emerge. For this particular case of geographic data types are located on maps using coordinates.

The start of vector programs have a greater similarity with the programs aided design computer SIG them. Thus it becomes essential defining the topological data for subsequently performing spatial relationships between the different type spatial entities.
From these investigations the POLYVRT system, which was designed and developed by Harvard University, in which a specific data model is defined and thus improve information display appears.

5. (1980-1990): the inclusion of marketable GIS according to the specific needs of the industry actively promotes commercialization.

The massive proliferation of information produced by the GIS, for commercial purposes, is attractive to US universities for the unification of the graphical data with alphanumeric. There is an expectation of achieving programs that make use of cartographic production in order to perform predictive analysis.

6. Update: Currently the developments of GIS, have as foundation the use by users of these systems, a large number of applications. Key features of this phase are:

• Standardization of GIS, due to competition in the market.
• Diversification of the fields of applications, due to increased user.

4. MAKING INFORMATION PLATFORM USING GIS

Currently, regarding the use of GIS, the central theme of Water Resources there are different information platforms that have been developed in different settings that allow delve into the central theme of the development of the research project of this study. Which are listed below:

a. The semi-distributed hydrological modeling system PREVAH (Precipitation Runoff evapotranspiration HRU Model) implements a conceptual process-oriented approach has been developed especially to suit conditions in mountainous environments with their highly variable environmental and climatic conditions.

The real core model PREVAH introduces the various tools that have been developed for obtaining a comprehensive, user-friendly modeling system used: DataWizard for importing and managing hydrometeorological data, WINMET for pre-processing meteorological data , GRIDMATH to carry out elementary raster data operations, FAOSOIL for processing global information of the FAO Soil Map of WINHRU for pre-processing spatial data and aggregating hydrological response units (HRU) for WINPREVAH model performance, hYDROGRAPH to display data to display VIEWOPTIM hydrograph and the calibration procedure.

The PREVAH components, support modeling task pre-processing the data through the current model calibration and validation for visualization and interpretation of the results (post-processing). A brief description of the current applications demonstrates the flexibility PREVAH modeling system with examples ranging from water balance modeling over flood estimation and flood forecasting to drought analysis in Switzerland, Austria, China, Russia and Sweden. [23].

b. Decision Support Systems for Water Resource: In water systems that often experience severe droughts, generic simulation models can provide useful information for the development of mitigation measures for drought information. It emphasizes the application of simulation models of generic to a temporary user-water system multi-reservoir and multi-use in southern Italy, where frequent droughts in the last two decades have necessitated the use of constraints supply and untenable. In particular, AQUATOOL (Polytechnic University of Valencia), ModSim (Colorado State University), RIBASIM (Deltares) wargi-SIM (University of Cagliari) and WEAP models (Stockholm Environment Institute) are considered in a preliminary analysis, which considers simple series and parallel schemes and evaluates the possibility of alternative operating plans and policies in the complex water system.

Each model has its own characteristics and uses different methods to define and release the resources of the reservoirs and the allocation to the demand centers. The comparison of the proposed models and their application does not identify in detail all the features of each model, but provides an overview of how these generic simulation models implement and evaluate the various performance standards. [24].

c. Space System multi-scale land use: planning sustainable land use strategies involving land use. In this work, a spatially and temporally explicit multi-scale system explains, demonstrates and reveals the biophysical indicators that affect land use options of the different stakeholders. It consists of three different environmental assessment tools designed to work with the data provided by traditional ground surveys and organized in a system of information on land resources. A qualitative ranking process of land suitability is adapted to translate large-scale biophysical data provided by a reconnaissance soil survey in five suitability classes.

Locally, the productivity of the soil units identified during the semi-detailed soil survey are estimated using an estimator of crop productivity in three hierarchical levels, simulation of potential, the production potential of land and water limitation . On the smallest spatial and temporal resolution, the approach of daily water balance is linked to a model of crop growth, using climatic daily data recorded at different weather stations and the description, physical and chemical analysis perles soil.

The decision support system is applied and validated using the information system of land resources in Rwanda. The system was able to reveal the biophysical properties affecting regionalization of crops at national and local level. The yield gap between the potential, the potential for limited production of water and earth, the options identified to optimize productivity, such as irrigation or fertilization.

The model of crop growth illustrates the delicate balance between planting date, length of the growing season and the length of the rainy season, limiting the options for intensification. [25].

d. Integrated System of Integrated Environmental Modeling: The software prototype for integrated environmental modeling system enables interoperability between the Consortium of Universities for the Advancement of Hydrologic Science, Inc. (CUAHSI) Hydrologic Information System (HIS) and interface open modeling (OpenMI). The main motivation for making these two interoperable systems is that the CUAHSI HIS has a primary focus on hydrological data management and visualization while the OpenMI has a primary focus on integrated environmental modeling. By combining the two systems into one software application, you can create an environment of integrated environmental modeling that scientists and engineers can use to understand and manage environmental systems. The use of standards to achieve the necessary steps to find, collect, integrate and analyze hydrological data enables broad community participation groups, and establishing the rules and the key protocols that must be followed to the general system. The main contribution of this paper, therefore, is an investigation of two standards of the community and explore ways to provide interoperability between them. HydroModeler is a software application of our work and provides a modeling environment OpenMI compliant embedded within the CUAHSI HIS system software HydroDesktop. [26].

e. Geographic information systems for agricultural water management: A key to environmental management is to understand the impact and interaction of people with natural resources as a means to improve human welfare and environmental sustainability as a result of future generations. In terms of water management in one of the ongoing challenges is to evaluate the impact of interventions in agriculture, and in particular the different irrigation strategies have on livelihoods and water resources in the landscape.

While global and national policy will provide the overall vision of the desired outcomes for environmental management, agricultural development and water use strategies often face local challenges to integrating these policies into reality on the ground, with different stakeholders.

The concept that government agencies, advocacy organizations, and private citizens must work together to find mutually acceptable solutions to environmental problems and water resources is increasing in importance. Participation participatory techniques related to spatial geographic information systems (GIS participatory commonly called (PGIS)) offers a solution to facilitate such dialogues with stakeholders in an efficient and consultative manner.

In the context of water management in technical agriculture PGIS multiscale have recently been tested as part of the 'Agriculture Solutions Water Management "to investigate the use and the current dependence of the water by small farmers with connection point in Tanzania. the approach piloted PGIS developed scenarios that describe the effects on livelihoods and water resources in the basin in the introduction of various management technologies.
These relatively fast multi-scale PGIS methods to assess current and potential future water management technologies for agriculture in terms of its biophysical and socioeconomic impacts to the watershed scale. The article analyzes the development of the methodology in the context of improving decision-making for water management. [27].

f. Object oriented data model in an information system for water catchment management: object-oriented technologies, which are playing an increasingly important role in all levels of software application for water resource management and modeling role, except management levels where the relational data logic remains the undisputed choice of information system developers despite the mismatch of object-relational impedance. The application presents the experience on two different technologies for the development of data management layer object-oriented information systems for the management of water resources:

• The Java solution to obtain transparent persistence, Java technology object (JDO) data.

5. PLATFORM FOR NETWORK INFORMATION WATER RESOURCES OF THE COLOMBIAN CARIBBEAN

Environmental phenomena caused by climate change are affecting much of the Colombian population, which makes it important for society to have Integrated Risk Management Systems, as the very nature of these, such as floods, rains, floods , landslides and others, it is clear that there are aspects that can become measured and taken as indicators to make projections about the risks that may arise in certain regions.

Moreover, global policies aimed at improving the utilization of Water Resources, and international organizations such as the United Nations through its UN-WATER, the Program for International Scientific Cooperation in Hydrology and Water Resources Programme of UNESCO and Institute for Water Education (UNESCO Institute for Water Education IHE) among others, develop studies, research, support and monitoring programs worldwide to ensure the sustainability of Water Resources. Colombia as part of the nations of these organizations have representation on the World Water Improvement Program (World Water Assessment Programme WWAP) through Amazon Cooperation Treaty Organization (ACTO, which makes part of Colombia along with 7 more countries) IDEAM and the Ministry of Environment.

It should be noted that within this whole international scene UNESCO through two of its programs, the International Hydrological Programme (IHP) which has as its theme the strengthening governance in the management of Water Resources for the sustainability of ecosystems and World water Improvement Program (WWAP) highlights the fact that data on almost all topics related to water issues is usually nonexistent, unreliable, incomplete or inconsistent. Only when the data were collected and analyzed is when you can properly understand many of the issues related to water resources (hydrological, socio-economic, financial, institutional and political alike), to be taken into account in managing this for decision-making at the state level. Thus UNESCO itself implements programs such FRIEND Flow Regimes from International Experimental and Network Data, which aims to help establish regional networks for the analysis of hydrological data in order to develop a better understanding of the variability and hydrological similitude in space and time, through the mutual exchange of data, knowledge and techniques at the regional level.

UN Water also relates in his Report on Policies for Water Quality 2011, addresses on the Data Monitoring as:
● The strengthening regional and national capacity to collect, manage and analyze information about water quality.
● The need to find and publish research that deals with statistical time series needed to establish baselines, trends and seasonality

There computing platforms such as World-wide Hydrogeological Mapping and Assessment Programme (WHYMAP), which is responsible for collecting, sorting and visualizing hydrogeological information globally to transmit data related to groundwater in a manner appropriate to the global debate on water and emphasize the presence of groundwater resources.

Thus arose the design and implement a platform that allows information kept informed scientific, academic and government community, the conditions of the water bodies in the region, as well as indicators of flood risk and the use of the water and environmental resources of the Caribbean.

To achieve these objectives need to be made:
. To characterize the information from the socio-economic, environmental, water and biodiversity cores.
● Design the data structure to allow proper storage of information from the network core.
● Develop the components of the information platform.
● Implement a network architecture that supports the information platform.
● Training in the use of the information platform.
● Design a system for capturing and storing data from a pilot monitoring system applied to a specific core.

At first, an overall analysis of the problem using as basic books and articles published in recent years related to the prompt was made. An assessment of existing information platforms and in the Caribbean region of Colombia is then made; then arrive at the particular case which is our problem to solve, such as the design platform that maintains information reported to the scientific, academic and government community, the conditions of the water bodies in the region, as well as indicators of flood risk and the use of water and environmental resources of the Caribbean.

Development were therefore referred to the following phases:

1. Data collection and review of the state of the art topics related to the project: In the first stage all the information necessary to have adequate knowledge of the subject to be developed will be collected. This information was obtained from the literature review is done through specialized articles and books on the subject as well as the information in the district and local entities that have an interest in the subject.

2. Documentation of the characteristics of information: We analyze and classify information from the socio-economic, environmental, water and biodiversity, information gathered in the previous phase nuclei. At the end of a document with the appropriate characterization is generated.

3. Design the data model for storing information concerning the settlements of the project: the data model to enable proper storage of information from socio-economic, environmental, water and biodiversity cores will be designed.

4. Select the database engine supports the computing infrastructure: the database engine supports the entire software infrastructure will be defined, for this is taken as a basis the estimated volume of information and data model built on the previous phase.

5. Selection of development framework: At this stage the software architecture is defined and the respective development framework is selected.

6. Development of platform components of information: You will develop and implement all components that are part of the platform of information proposed in the project based on the information collected from the cores that form the megaproject of Water Resources.

7. Implementation of the network architecture to support information platform: will select and implement network infrastructure that will support the information platform. For this the state of the existing network infrastructure will be reviewed and will make decisions about acquiring or updating network equipment; then they will install and configure the equipment according to the network architecture defined for commissioning, and further shall define and implement security policies required for the entire IT infrastructure.

8. Training in the use of the platform of information: At this stage platform socialization and training in their use to a set of end-users of the same will be done.

9. Designing a system for capturing and storing data from a pilot monitoring system applied to a specific nucleus: a system for capturing and storing data from a pilot monitoring system applied to a specific core is designed.

10. Phase of tests designed computing platform: Once you have completed the development of the platform will be used to set all components of this project from the results of a pilot test.

11. Project Documentation: Each of the results obtained in the different phases of the project will be fully documented at the end as being information holder.

8. CONCLUSIONS

The system provides support for decision-making for flood control and drainage management and simulation and prediction of the aquatic environment. Similarly, the analysis of the supply and demand of water resources, greatly improving the level of management and decision making of water resources, and become a reliable guarantee for economic growth and development is contemplated social

9. REFERENCES

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