WebGIS to Managing Natural Resource: Case of Flooded Pasture in Lake Débo and Walado Débo

Kone Forokoro & Zhong Xie

Faculty of Information Engineering, China University of Geosciences, Wuhan China

388 Lumo Road, Wuhan, P.R. China Postcode: 430074

Tel: (0086)13720126275 E-mail: forocone@yahoo.fr, xiezhong@gmail.com

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Abstract

Lake Débo and Walado Débo, one of the major Sahelian wetlands is located in Inner Delta (Mali). Given the environmental and community interest in this wetland, there is urgent need to share spatial data on natural resources. Most of the covered information is published in (internal) reports with a limited distribution. With the advent of GIS and Internet technologies, the conventional intricacies to get solutions in time and position have been improved. The combination of Web technologies and the power of GIS software enable natural resource managers to analyze GIS data that resides across the Internet. This paper is based on the design and architecture of a Web-based GIS to managing flooded pastures. MapGIS IGS (MapGIS Internet Server) is used to provide a user-friendly GIS front-end for natural resource managers and public users to perform routine GIS functions on geographic data that are distributed across the Internet. Internet based geographical data services involve management spatial data. Geographic Information System (GIS) is an indispensable tool for analyzing and managing spatial data.

Keywords: WebGIS, Lake Débo and Walado Débo, Natural resource, MapGIS IGS

1. Introduction

The Lake Débo and Walado Débo is located in Inner Delta of Niger River in Mali between 15°15'N and 004°15'W. It is part of one of the major Sahelian wetlands and is composed of an extensive flood plain area containing seasonally inundated lakes (Lac Débo and Walado Débo), and water network. It serves as habitats for paleo-arctic and afro tropical birds and the endangered West African manatee (*Trichechus senegalensis*). For centuries, local people managed this site successfully, whereby different user groups (cattle herders and fishermen) alternated responsibilities between the wet and dry seasons. Traditional management collapsed after political changes in the 1960s, followed by catastrophic droughts in the 1970s and 1980s, when most flooded forests and pasture were destroyed. With the return of the floods in the 1990s, people recognized and often regretted their loss, and community based restoration efforts started, with help from UICN (International Union for Conservation of Nature), Wetlands International and other partners. To support these initiatives, there is urgent need to share spatial data on natural resources of Débo and Walado Débo. The scientific community has elaborately described the vegetation (pasture) in the Inner Delta including Lac Débo and Walado Débo: Boudet (1972), Cipéa /Odem(1983), Marie (2000, 2002)… Especially in June and November 2004, through the FAST(Faculté des Sciences et Techniques Université de Bamako) we have collected an important data on the flood pastures of Lake Débo and Walado Débo. Most of the covered information is published in (internal) reports with a limited distribution. Sharing of geographic information is vital because the more it is shared and used, the greater the society's ability to evaluate and address the wide range of pressing environmental, social and economic issues. The ability of GIS to analyze and visualize spatial data in the form of maps made it an essential tool for natural resource management systems. Recent advances in information technology, including hardware, software and networks, provide potential solutions to the problems of data accessibility. The main objective of this paper is to develop a WebGIS holding the potential to make distributed geographic information available to a very large public. Internet users have access to GIS applications from their browsers without purchasing proprietary GIS software and do not need extensive training.

Natural resource-based GIS may be used as: (1) an inventory tool , (2) to better manage the marketing of the resource, (3) to protect the resource from improper development and (4) to model the complex interactions between phenomena so that forecasts can be used in decision-making.

Existing commercial GIS packages, MapGIS IGS (**www.mapgis.com.cn**), is used to create maps, perform queries, and provide spatial analysis and overlay functions. The rest of this paper is organized as follow. Section two describes the component of the proposed WEBGIS system. Section three provides the implementation results and shows the interfaces of web. Finally the conclusion of the paper is described in the last section.

2. Methods and Materials

2.1 Input data

The input data is our own data collected on the Lake Débo and Walado Débo through the FAST (Faculté des Sciences et Techniques Université de Bamako) in June and November 2004. Data structured in MapInfo file as shows the table 1 is converted to MapGIS files before using.

In inundated pasture the estimating stocking rates is most often assessed on the soil basis of the forage production of the pasture: the edible forage production or just the biomass, measured at the end of the active period. The rate of stocking of pasture represents the amount of grazing stock that the pasture can support without deterioration. This rate of stocking depends in part on the quantity of forage produced and also on the quality of the forage available to the livestock to enable it to produce economically satisfactory results. The daily consumption of a head of cattle is usually estimated at 2.5 kg of dry matter (DM) per 100 kg of live weight. Providing that forage production is calculated in dry matter and not in “green" forage, the rate of stocking can be estimated in the number of days of feed per hectare for 100 kg of live weight.

$$\frac{DM/_{Hectare\ of\ forage}}{25} = x days\ of\ feed\ for\ 100g\ of\ 2.5\ livestock$$

Since the average weight of adult cattle in the tropical zones varies from 200 to 400 kg, a tropical livestock unit may be defined as an animal with an average weight of 250 kg. This is the UBT (Unite Bovine Tropicale), equivalent to the LSU (Livestock Standard Unit) in English-speaking countries.

Its daily consumption would normally be 6.25 kg of DM, The UBT was evaluated in consideration of the following parameters: (1) 50% of dry matter harvested per hectare, quantity considered as adjusted by the rejects of perennial species during the Adry season. Hiémaux & Diarra (1883) evaluate the production during the dry season to 300 -500kg/ha; with nitrogen rates average 10 g / kg dry matter (Traoré, 1978); (2) Rate of digestibility of dry matter above 50% and nitrogen rates above 7.5 g per kg of dry matter. The (apparent) dry matter digestibility (DMD) or the organic matter digestibility (OMD) of a feed material is the proportion of its dry matter or of its organic matter which disappears in the digestive tract.

2.2 System Architecture

The architecture of the system developed is made up of four major components and follows architecture similar to other web-based system such as that described by (Bapna and Gangopadhyay, 2005). An overview of the architecture can be seen in figure 1. The architecture consists of four tiers; MApGIS data server, GIS Web server, GIS Web service integration, and client

2.2.1 Client: It uses the common web browser to access to the WebGIS site and submit the operation request to the IMS service layer.

2.2.2 IMS service**:** It supports two kinds of GIS service, grid map service and vector map service.

GIS platform**:** It provides storage service and various core function interfaces of WebGIS.

2.2.3 Data layer**:** It can manage the geography spatial data and provide various data supports.

2.3 Site development strategy

Creating a Web site with MapGIS IGS can be achieved in three ways: (1) the simplest method is to using rapid development configuration and no programming is required. (2) Control type development uses the dynamic components made in the form of development control to build a site by direct drag and drop (figure2). (3) Programming development for advanced programmers.

The second solution was used to build the proposed project. MapGIS IGS Web Control provides the necessary features for Natural resource-based GIS: (1) Basic functions including basic display, magnifying glass and measurement. (2) Service functions including layer control, map query, map editors, spatial analysis and statistical analysis.

3. Results

3.1 System functions

Figures 3 and 4 respectively show the map before and after publishing. Systems functions provide a user-friendly GIS front-end for natural resource managers and public users to perform routine GIS functions on geographic data that are distributed across the Internet. An example of statistical analyze shown in figure 5 allows the analysis of environmental conditions related to vegetation types - especially the water level - to restore the areas that are potentially flood. By the same way statistical analyze of Samples (25) provides a comparison of the quality and capacity of different pastures in the area study. User can add his own data using service map editor to update the existing data.

3.2 System utilities

The proposed system is a promising tool which brings new approaches to access, share and disseminate geographic information: (1) it is useful for resource inventory. Cataloging and inventorying resources and environmental features is an essential step in the planning process. Tools that allow this enable decision makers and planners to address current issues and plan for future scenarios. (2) It can help fulfill requirements or meet regulations. Tools that help citizens and government accomplish their central roles, make informed decisions, or otherwise support government functions with regard to natural resource management and environmental protection. (3) It is useful for developing or implementing natural resource programs or plans. (4) It connects natural resources and comprehensive planning. Tools that allow natural resource issues can be integrated within the context of various plan elements. Comprehensive planning defines a process and framework for considering how disparate issues fit together.

3.3 The limits of this tool

Our system has well its limits. It w built with data collected in June and November 2004. However, production and quality of flooded pastures depend on its management and the intensity of the inundation. Data collected in 2004 cannot be used to estimating pasture lands of another year. To solve this problem the system must be updated yearly.

4. Conclusion

The prototype system described in this presentation affords easy and rapid collection and dissemination of spatial information. Since system has been developed using MapGIS IGS, it is easily adapted in a distributed database environment. The system provides the basic components for generation and delivery of spatial information at very affordable costs and would be greatly beneficial to small organizations (population that might neither have the neither financial resources nor range of expertise needed to implement proprietary solutions. The system can provide a platform for developing Spatial Data Infrastructures (SDI) through collective participation and could also serve as a means for standardizing data collection. Such efforts will help coordinate better strategies for environmental assessments, hazard mitigation and resource evaluation in the future. The ongoing work will be focused at adapting to global standards for data access and portrayal services and tighter integration between the GIS and geospatial database management component. Web-based GIS system allows multi-scientific collaborators to easily access to the last updated data and to monitor and validate easily their works. This application presents a lot of advantages compared to a traditional paper bulletin. Tables, graphics and maps are built online based on end-user criteria (Web queries). All the data are continuously updated and can be consulted anywhere and anytime

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Table 1. Input data

Data directory	Characteristic of Data and storage system
Data on vegetation	Vector data representing (polygon) types of vegetation group
Data on samples	Vector data representing (point) locations of 25 samples. (S1,S2,S3,..S25) Access as database management system. X/Y –coordinates , water depth, dry matter /ha, UBT, … are stored in regular columns
Data on Water networks	Vectors data representing (polygon and line) lakes, ponds and river channels
Data on flooded pasture	Vector data representing pasture types according to their management style
Data on Village	Vector data representing (points) villages on the site.

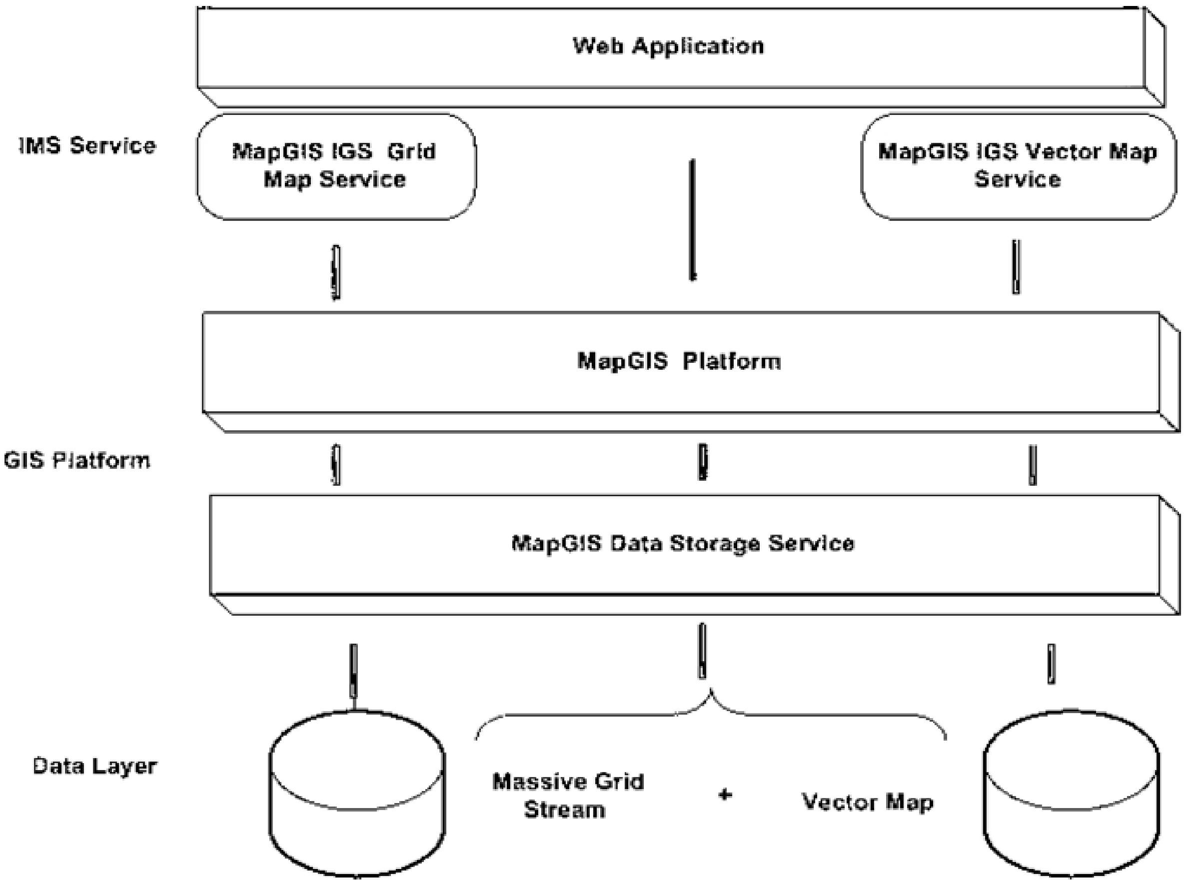

Figure 1. Architecture of MapGIS IGS

Figure 2. Contents of the dynamic libraries

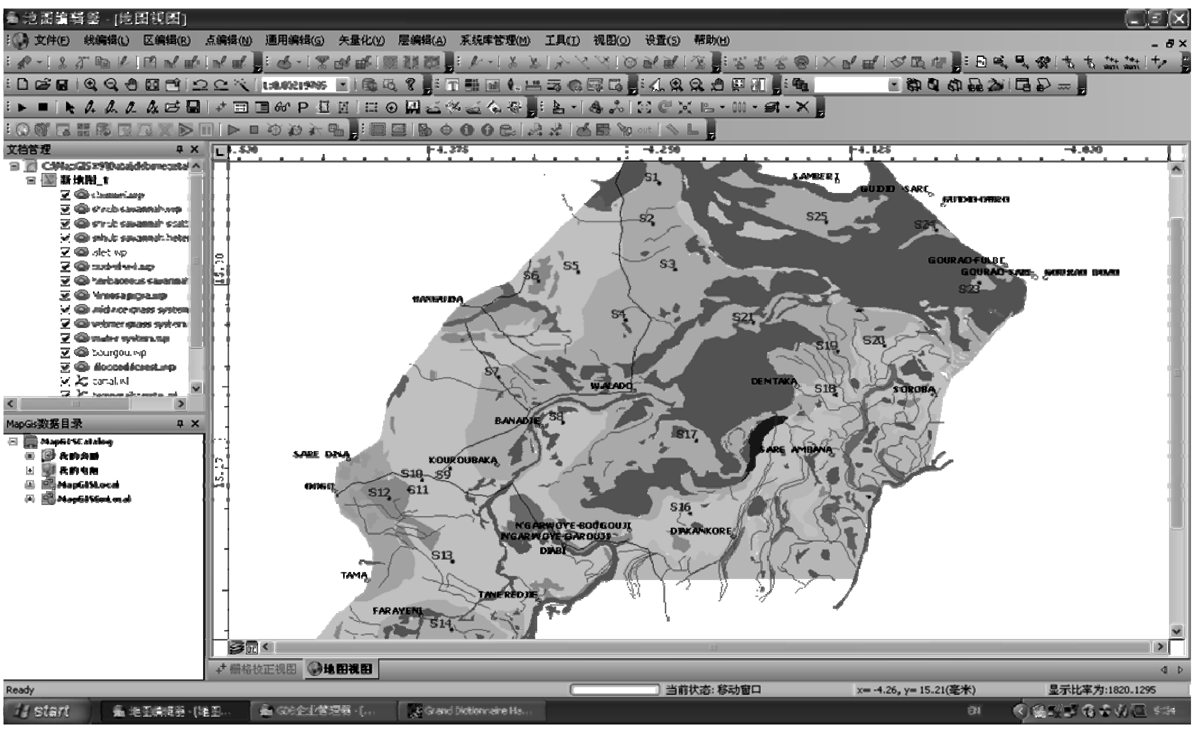

Figure 3. Map before publishing

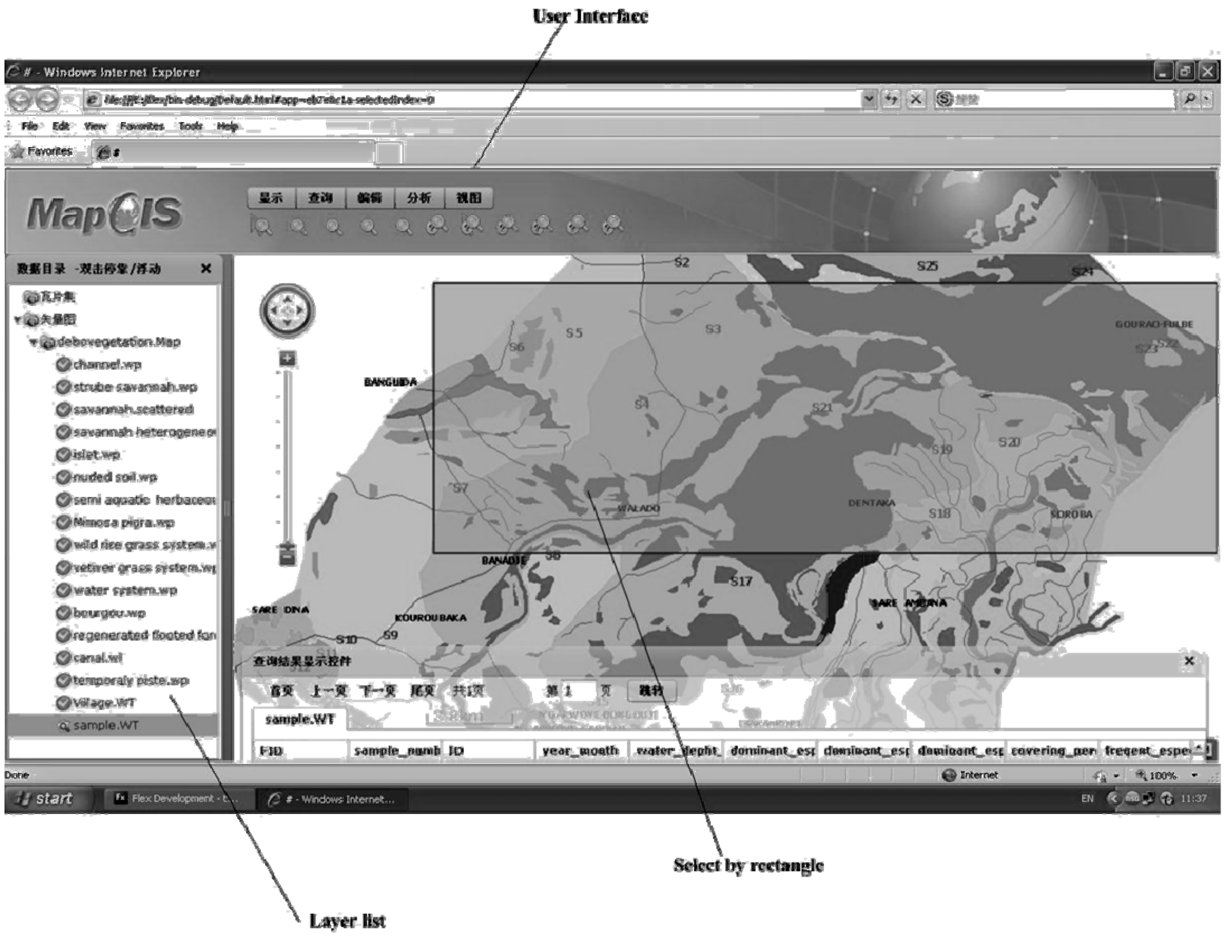

Figure 4. Map after publishing

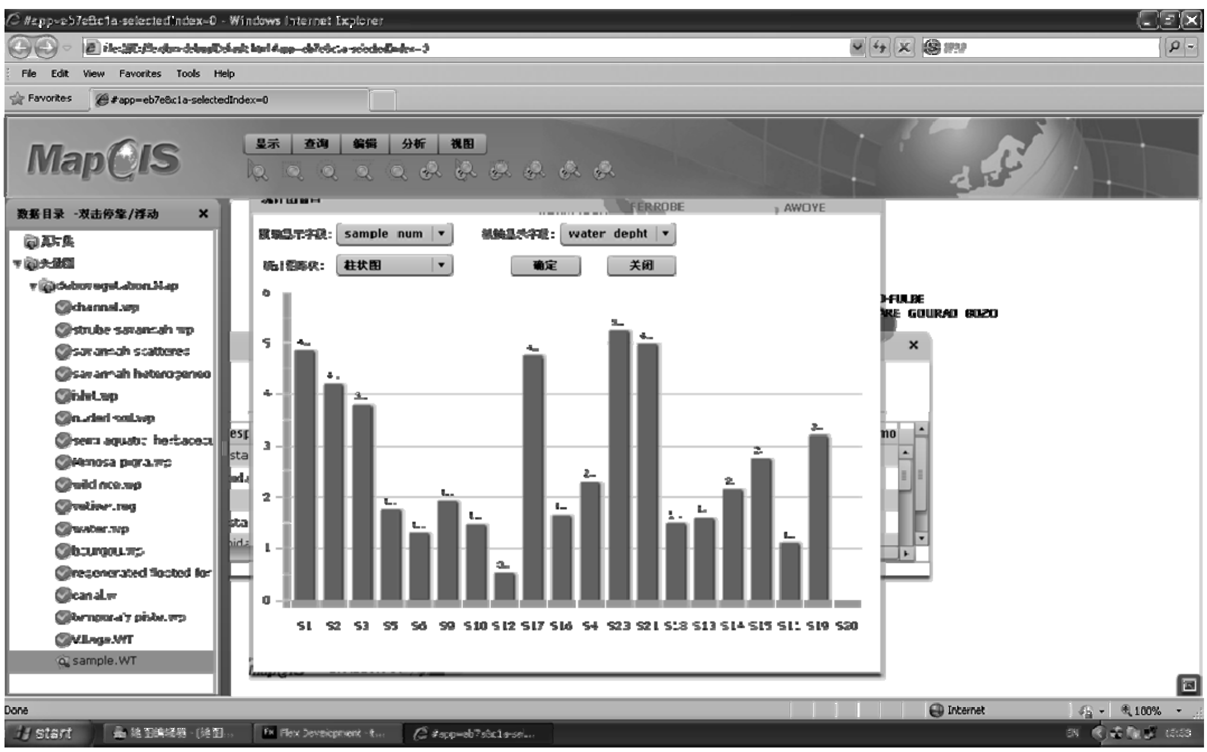

Figure 5. Statistical analysis