Interoperable and Distributed Processing in GIS to Sustain the Development of Local Authorities in Mali

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Authors’ contributions

This work was carried out in collaboration among all authors. Author KF designed the study, performed the computations, wrote the protocol and wrote the first draft of the manuscript. Author MM managed the literature search. Author MSM supervised the project. All authors read and approved the final manuscript.

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ABSTRACT

Since 1992, implement decentralization reform in Mali has made it possible to empower populations in their own development planning. Resources distribution to local authorities requires detailed information of the constraints and the assets linked to their development. Data collected on rural area are often poorly defined, redundant or incomplete and inefficiencies for sharing due to a lack of applied standard tools. The information is too descriptive and it is difficult to extract useful one for decision making process. There is inadequate information upon which to base resource allocation decisions. The purpose of this paper is to define data that can be collected on rural municipalities or localities and handled by GIS to make information available for decision-makers, planners and beneficiaries. The data used from Malian poverty survey performed in 2001-2002 focused on the satisfaction of basic household needs. This concept is based on meeting those who lack access to basic living needs, which generally include clean water, sanitation, nutrition, primary health services, and basic education. The method used the platform of "MapGIS IGS, IIS6, Windows Server 2003, ASP.NET and MS SQL Server 2000" to develop an application GIS Web Service. Data are integrated and published as services by the platform. The product output have been tested successfully on the intranet of Wuhan Zondy Cyber in the term of interoperability and

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The dramatic progress of communications and telecommunications technology, the paradigm of linking GIS and decision making is shifting into distributed computing technology with independently provided, specialized, interoperable geo data and services. GIS projects usually take several months to set in place [13,14]. The GIS Server is a solution to this problem. The public wants to consume a product right away; he prefers to access it remotely, by importing the data that interest him or by working directly online [15,16]. To interact with such systems and the problems mentioned above, the broad aim of this study is focused on approaches of distributed computing technology based on web services as well as the role of interoperability in information process. This project initiative is to promote Municipality GIS in developing Country and to contributing to the standardization and interoperability of GIS data and functions in Mali. It is designed for local authorities, NGOs, searchers and whom interested by rural development and fight against poverty in Mali. It is a tool that should be able to play a large part to sustain the decentralization process and the development of rural spatial infrastructure in Mali. This study learnt from the experiences and knowledge of previous efforts of GIS municipalities solutions through the world and some local cases: ARP's Cartography of Republic of Mali CD-ROM*and SIGMA Database, a Information System for Water Resources Management in Mali.

1. INTRODUCTION

Development interventions in the rural municipalities are effective and sustainable only if there is sufficient data available to decision-makers, planners and beneficiaries and ability to use them. In Mali however, all these conditions do not yet exist. Specifically, spatial information in Mali is sparse, difficult to access and manage [1-3]. The data collected on rural area are not well coordinated resulting in redundant maintenance of datasets, duplication of applications, and inefficiencies for the sharing due to a lack of applied standard tools. The diagnostics have demonstrated that the department responsible of national statistical data has no adequate tools to handle and share the necessary information. The information is too descriptive and it is difficult to extract useful one for decision-making [4-6]. There is inadequate information upon which to base resource allocation decisions. However in Mali, there is a large quantity of spatial data collected on rural localities by different institutes of the government, organizations and private sectors. To better understand how these data can be process by GIS to help rural municipalities' development, research is needed on new approaches to make available GIS data and services [7,8]. Together producers, users of GIS data in Mali will lead to a consensus in order to find a tool to share the basic spatial information. Through the world, most municipalities have been using GIS for many years provide us with a way of capturing geographic information in digital form, and manipulating, sharing, and displaying it in myriad ways. GIS has a long history of successfully adapting to new technologies, applications, customer types, and business models [9-11,12]. From mainframe to the desktop and, more recently, to the Internet, the mobile device and cloud computing, each round of technical innovation has resulted in improvements for GIS. Today, GIS is still evolving in response to infrastructure changes. Due to the popular recent use of the Internet and the dramatic progress of communications and

Keywords: Local authority; web service; distributed GIS; poverty line; map GIS IGS.

2. MATERIALS AND METHODS

Data used by the methodology from different sources. The map Data of administrative localities, road and Water network, Villages were provided IGM ( “Institut Géographique du Mali”). The project especially uses census data and data collected on rural area (water, health, education…) that the government has entrusted the management to the local communities. The data mainly provided by the SNS “Système National de la Statistique”: INStat,CPS (Planning and Statistic Unity) of the corresponding department, are the basic information needed to
design, implement and evaluate the socio-economic development policies in rural localities. The same data are used to set the poverty range of village or commune.

The poverty range or line is a measure of a certain amount of material well-being possessions or money, a government or a society believes it is necessary for a person to have a minimum level of subsistence or standard. In developing country as Mali, the basic needs in education, health, sanitation and water is a priority and can be more easily satisfied by the public and local services than to increasing personal incomes, especially since individuals do not always use their extra income to satisfy more needed cause. This poverty range is evaluated from an index of targeting or poverty score (Is) that recognizes the existence in the locality the based need infrastructure: education, sanitation, health, clean water, cereal bank and rural savings bank. This score is 20 if all of these services are available. The methodology is therefore based on an indicator (Is) called “poverty score” that takes account of population size and distance from a selected number of socio-economic infrastructures. The score, which ranges from zero to 20, is a sum of partial scores attributed to each infrastructure. The “Is” of a village is the sum of partial scores. The “Is” of a commune is the average of the scores of its villages. The poverty range is “Is” = 10. Based on this poverty line, two factors are using to set the degree of poverty in Mali: 1) the incidence of poverty in a locality or country is the proportion of people living below the poverty range, 2) the depth of poverty is the poverty index percentage of the poverty range. For example, a locality which has six as poverty range, the poverty depth would be (10-6) / 10 or 40%. The census data has been processed by Ms SQL Server 2000. In addition to the information cited below, methodology took into account the access to mass media: radio, television, mobile phones.

The approaches, used to build GIS data and functions, are based on web Service (SOAP and REST), Open GIS Consortium specifications (WMS and WFS) and a DBMS solution. The method has used the platform of "Map GIS IGS.

Fig.1. Data imput and MapGIS IGS – SOA & REST protocols
IIS6, Windows Server 2003, ASP.NET and MS SQL Server 2000" to develop an application GIS Web Service. Data are integrated to the platform and published as services. MapGIS IGS is under the license of Map GIS (www.mapgis.com.cn). MapGIS IGS meets the standards and ISO of Information Technology, Web and GIS to support multiple approaches to interoperability. The developers can use MapGIS IGS to create reactive and user friendly applications that take the best part of the common Web technologies such as AJAX, SOAP, REST, JavaScript, Adobe Flex... The SOAP is based on asmx and REST (HTTP, GET/POST. Data on villages were integrated into MapGISDatabase by using OLE DB connection.

3. RESULTS AND DISCUSSION

The following samples “get WMS" and “WMFS service" request have been implemented from the REST encoding. Web Map Service provide interfaces which allow client to access maps as illustrated by the Figs. 3-5.

Get Map:

http://kone/MapgisOGCWebService/rest/kone/WMSServer?VERSION=1.3.0&REQUEST=getmap &LAYERS=Commune.WP&STYLES=&CRS=&BBOX=12.24131,11.898007,8.133862,15.700753 &WIDTH=700&HEIGHT=800&FORMAT=image/gif&TRANSPARENT=true&BGCOLOR=&EXCEPTIONS=&TIME=&ELEVATION=

Get Feature:

http://kone/MapgisOGCWebService/rest/kone/WFSServer?Version=1.1.0&Service=WFS&Request=GetFeature&TypeName=Commune.WP&OutputFormat=&Filter=<?xml version="1.0" encoding="utf8"?><WFS_GSQLxmlns="http://www.opengis.net/wfs"xmlns:gml="http://www.opengis.net/gml"><FeatureName>communewp</FeatureName><Filter><PropertyIsMoreThan><PropertyName>IDD</PropertyName><Literal>111</Literal></PropertyIsMoreThan></Filter></WFS_GSQL>&PropertyName=

Transaction WFSs: This specification allows transforming a WFS server into transactional server. It is then possible to add, modify and delete objects in geographic databases searched by the WFS server Fig. 5

http://kone/MapgisOGCWebService/rest/kone/WFSServerVersion=1.1.0&Service=WFS&Request=Transaction&TypeName=region.WP&OPERATION=delete&Feature=5.
The tool achieved, have been tested successfully on the intranet of Wuhan Zondy Cyber in the term of interoperability and extraction of the information needed.

Fig. 3. Get map request output –communes of kayes province (region)

Fig. 4. Getfeature request output
Fig. 5. Transaction request output: feature (region of Mopti)

Fig. 6. Architecture of rural municipality’s solution

4. CONCLUSION

The web services model of the GIS systems described provides to the user, the services and data they need, without having to install, learn, or pay for any unused functionalities. The use of such service holds many advantages for municipalities in terms of required qualification of users, cost of software, efficiency of workflows and decision-making.

In order to benefit from the use of GIS in Mali a standardization of geographic information management is a necessity. The extension of this standardization in all ECOWAS countries would be a great advantage regarding the
sharing of geographic information between countries.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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