

Developing an Online Map for the Accra Metropolis using MapServer

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Abstract

With the increased use of broadband Internet facilities and high speed computers, the range of desktop GIS applications being migrated to the Internet is growing by the day. This study presents the development of an online mapping application for the Accra Metropolitan Assembly (A.M.A.) using MapServer, an Internet GIS technology.

MapServer is an open source development environment used for creating mapping applications to display dynamic spatial maps over the Internet as well as generating geographic image maps. MapServer is fast, flexible and runs on all major operating systems.

The process of developing the Accra online map, its advantages and drawbacks of the MapServer application are discussed. The application displays interactive online map for the A.M.A. area drawn from shapefiles. GIS functions such as measure, query and navigation tools including pan, zoom etc, have been programmed. This application can serve as an online resource for disseminating public information for the Accra Metropolitan Assembly. Furthermore, as more digital spatial data on mining concessions, geology, water resources, protected areas etc., becomes available, this online GIS could be re-structured and used by the relevant Government Agencies to disseminate information on the web so as to attract more foreign investment in the area of mining and related industries.

Keywords: Accra Metropolitan Assembly (A.M.A.), MapServer, Internet GIS, Web server, Online Map.

1.0 Introduction

Until the early 1990s, maps were mainly served on paper and digital media (Peterson, 2003). This limited the distribution and usage of spatial data. However as Internet use became wide spread, serving maps on the Internet became a new and fastest way to share and distribute maps. The challenge to serve maps on the Internet had to do with making it possible to perform various functions associated with desktop based mapping. This has been partly solved by the development of a number of Internet based GIS softwares. There are two types of Internet based GIS softwares on the geospatial market; commercial-off-the-shelf (C.O.T.S) and open source map servers. The major difference between the two is that users of commercial map servers have to purchase the map server software whereas users of open source map server can simply download the map server software over the Internet.

With the advent of Internet mapping and GIS, many countries have taken advantage to make geographic information more accessible to their citizens. This ensures transparency and good governance.

In the UK for instance, the National Mapping Agency, Ordnance Survey, serves maps of Britain online (Anon, 2010a). Also, the USA Census Bureau serves census maps online where anyone can download Census information (Anon, 2010b). There are also many instances where local authorities have used online mapping and GIS to support community participatory decision-making when citing social amenities (Malczewski, 1999).

The benefits of serving maps online are numerous, however in developing countries like Ghana, spatial information and maps meant for the citizenry ends up on desktops without getting to the larger public. This is mainly due to high cost of commercial Internet GIS software applications available.

The aim of this study therefore was to demonstrate the applicability of using a total open source solution of online mapping to make urban information in the Accra Metropolis available to users. The open source solution used in this study range from database, web server, map server to the scripting language.

2.0 Structure of the MapServer Application

A basic MapServer application consists of;

- a) **Map File:** This is a configuration file presented in an ASCII format with a dot map (.map) extension in order for it to be recognized by the MapServer application. It defines the

area of the map, the map layers including the data source and location, as well as projections and symbology.

b) **Geographic Data:** MapServer natively supports two raster formats namely; GeoTIFF and EPPL7 (Kropla, 2005), but the mapserver is capable of handling both raster and vector data formats. Examples of vector data include PostGIS and ArcSDE geometries, Arc/Info coverages and Census TIGER files.

c) **HTTP Server/Web Server:** This is a program that serves web content such as HyperText Markup Language (HTML) pages to a web browser over the World Wide Web using the HyperText Transfer Protocol (HTTP). This can be an Apache or Microsoft Internet Information Server (IIS).

d) **MapServer Common Gateway Interface (CGI):** This is an executable file located in the script directory of the HTTP Server whose function is to receive request and return image data.

e) **Template Files:** This consists of HTML pages which serve as the interface between the User and the MapServer. MapServer can operate in two different ways; that is CGI and MapScript.

- **CGI:** A MapServer CGI application consists of HTML pages. It is easy to setup and produces fast and straightforward results such as rendering maps, displaying attribute data and performing basic spatial queries.

- **MapScript:** The MapServer API is accessible from popular scripting and development environment such as PHP, Perl, Python, Ruby, Java and dot Net (.Net). In addition to the capabilities of a CGI application, the MapScript applications also allows for flexible, dynamic, rich and powerful mapping applications.

3.0 Study Area and Data

The study area covers the Accra Metropolitan Assembly (A.M.A.) which is one of the assemblies in the Greater Accra Region. The A.M.A. covers an area of 200 km² and is the most populous of the 170 district assemblies in Ghana. The A.M.A. is made up of eleven sub-metros namely; Ablekuma Central, Ablekuma North, Ablekuma South, Ashiedu Keteke,

Ayawaso Central, Ayawaso East, Ayawaso West-Wuogon, La, Okaikoi North, Okaikoi South, and Osu Klottey. The A.M.A. lies within the Savannah zone and experiences two rainy seasons annually. The first begins in May and ends in mid-July. The second season begins in mid-August and ends in October. The average annual rainfall is about 730 mm, which falls primarily during the two rainy seasons (Anon, 2008). There is very little variation in temperature throughout the year. The mean monthly temperature ranges from 24.7 °C in August (the coolest) to 28 °C in March (the hottest) with an annual average of 26.8 °C (Anon, 2008).

Data for this study is a structured map made up of the following Shapefiles; A.M.A. boundary, A.M.A. suburbs, roads, hospitals, fire stations, buildings and petrol filling stations (Figure 1).

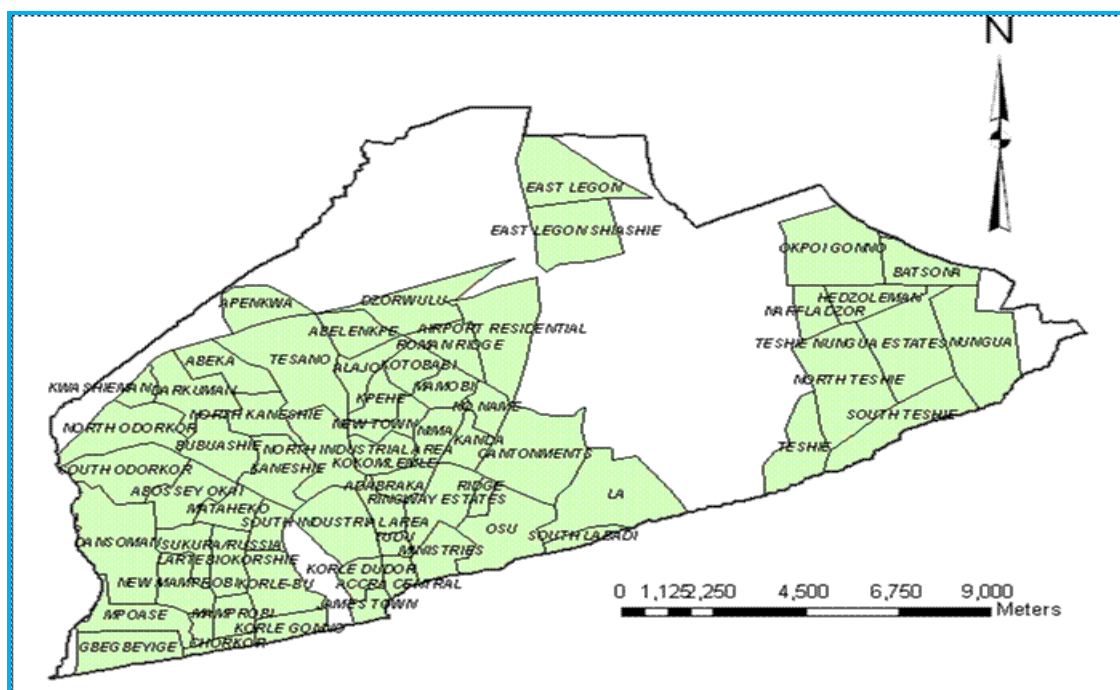


Figure 1: The Accra Metropolis

4.0 Methodology

The general approach for the implementation of the Accra Online Map comprises:

- examination and validation of existing data,

- setup of a data server for storage, processing and analysis of spatial data together with relational data,
- implementation of the user interface to enable online access to application via Internet and
- creation of a map file to define the area of the map, scale bar, symbology and map layers.

The Accra Online Map was designed using a three-tier architecture as shown in Figure 2. These are the presentation/client tier, business logic/application tier and the data tier.

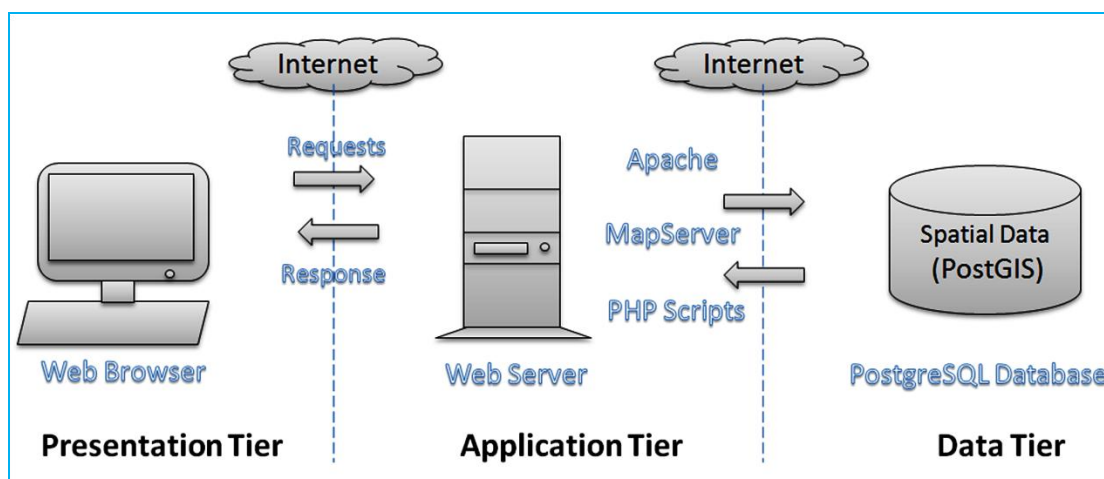


Figure 2: Accra Online Map's System Architecture

The presentation tier is located on the client machine and represents the Web browser. It is responsible for displaying the application's user interface. It communicates with the application tier by requesting data through input from the user and sends back responses in a form of an HTML page or map. The application tier is located on the application server machine and it is built on the open source MapServer, Apache Server and PHP. The data tier is located on the data server machine and consists of a PostgreSQL object-oriented relational database with PostGIS support, which makes PostgreSQL database capable of storing and manipulating spatial data. The spatial data is stored or loaded into the PostgreSQL database through the help of a data loader (shp2pgsql) which converts ESRI shape files into SQL (Figure 3).

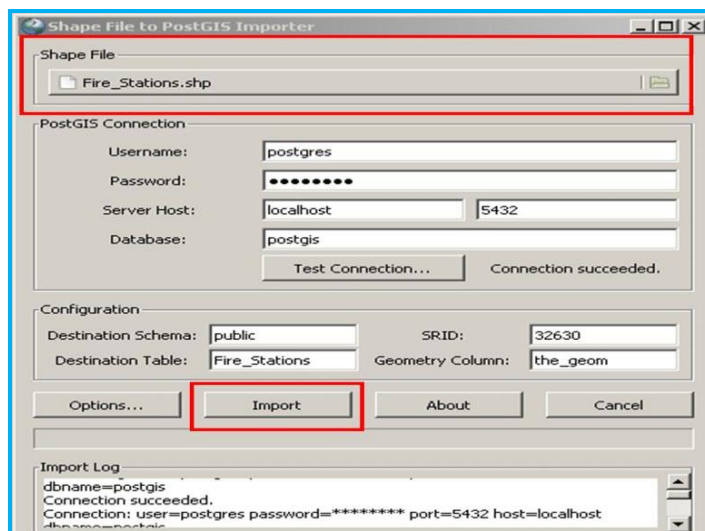


Figure 3: ESRI Shapefile Loader Graphical User Interface

The Accra Online application was developed using MapServer for Windows (MS4W), a set-up installer MapServer on Microsoft Windows platform. The basic MS4W package installs a pre-configured web server environment that includes the following components (Anon, 2010c):

- Apache HTTP Server version 2.2.10
- PHP version 5.2.6
- MapServer CGI 5.2.1
- MapScript 5.2.1 (CSharp, Java, PHP, Python)
- Includes support for Oracle 11g, and SDE data
- MrSID support built-in
- GDAL/OGR 1.5.1 and Utilities
- MapServer Utilities
- PROJ Utilities
- Shapelib Utilities
- Shp2tile Utility
- Shpdiff Utility
- AVCE00 Utilities
- OGR/PHP Extension 1.0.0
- OWTChart 1.2.0

In addition to the basic MS4W package, two MS4W application packages were utilized for the Accra Online Map. These are;

- P.mapper (MapServer PHP/MapScript Framework) and
- PhpPgAdmin tool for PostgreSQL

The p.mapper framework is based on PHP/MapScript and it is intended to offer several functionalities such as query functions (identify, select and search) as well as measurement functions (distance and area) (Burger, 2010). The PhpPgAdmin tool for PostgreSQL is also a web-based open source tool, which is used by the administrator to remotely access the PostgreSQL database (Anon, 2003). Figure 4 illustrates the PhpPgAdmin tool for PostgreSQL graphical user interface.

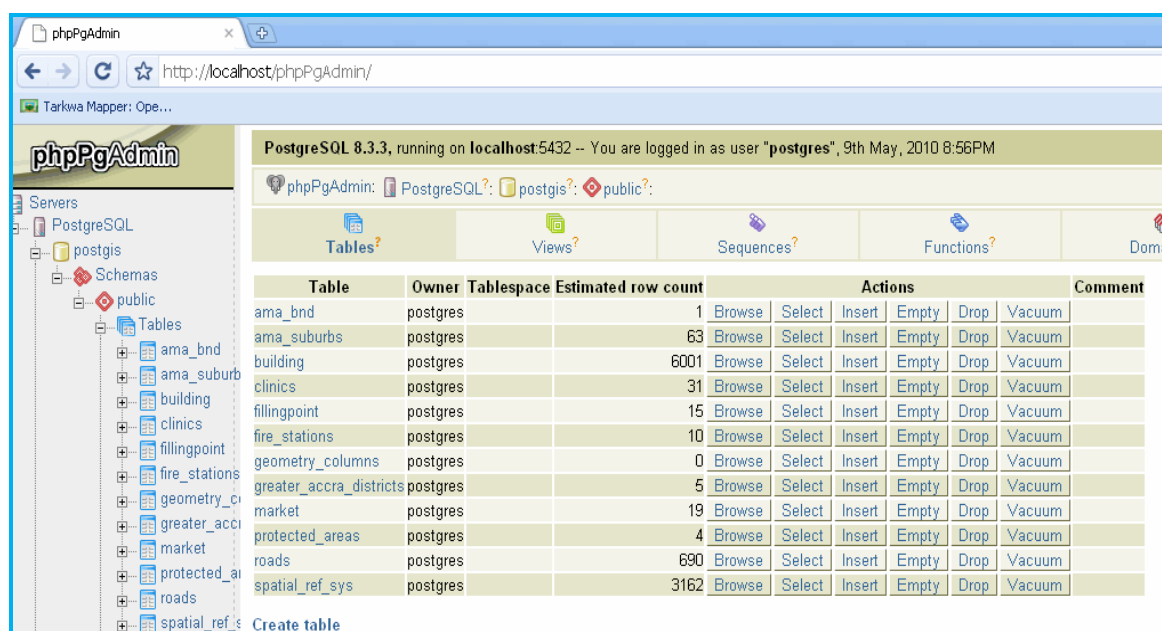


Figure 4: PhpPgAdmin tool for PostgreSQL Graphical User Interface

5.0 Results and Discussions

The result of this paper presents an online MapServer application dubbed 'Accra Online Map' that is used to access and share spatial data for the Accra metropolis. Spatial information such as roads, hospitals, fire stations, buildings and petrol filling stations are displayed on map layers. This online map can be used by Government Agencies in

disseminating public information to citizens home and abroad. Information such as land parcels and their allodial owners, land title registry zones, areas liable to different flooding magnitudes etc., can be served online for the public so as to enhance transparent governance. Figure 5 shows the graphical user interface of the Accra Online Map. Businesses in the metropolis can also post their office location by using the Point of Interest functionality (Figure 6). However, these added locations will be validated by the administrator before it is permanently stored.

The application also determines real-time co-ordinates of locations in UTM mode. It also makes it possible to calculate distances between features of interest and also compute the areas of features. An example of the distance functionality is displayed in Figure 7. Another capability of the application is to search for place marks (for example a market) using the auto-suggest function. Figure 8 shows a step-by-step process used as an example in searching for the Achimota market. Other navigational tools like pan, zoom and identify are used to interact and query the map.

Other available spatial information including mining concessions, geology, water resources, protected areas etc., can be served online. The relevant Government Agencies such as the Minerals Commission can therefore use these online resources to effectively advertise their products to the international community so as to attract more foreign investment in the area of mining and related industries.

The MapServer (web-base GIS) application has a number of advantages over the Desktop GIS applications. These include a reduction in software costs, a superior environment for DBMS integration as well as reducing the need for software installation, support and maintenance (Greenwood, 2002). Also, desktop GIS programs are generally weak at presenting complex attribute data such as one-to-many relationships and are also limited in terms of DBMS to which it can connect. Desktop GIS are also accessible at only one site. However, MapServer provides strong web based tools for presenting attribute data from any DBMS (Greenwood, 2002). MapServer is also free open source software with a flexible programming environment and has a good speed.

Though MapServer does not have a graphic user interface and an integrated geocoder, an application built with MapServer can be used to successfully execute many of the important online GIS functions.

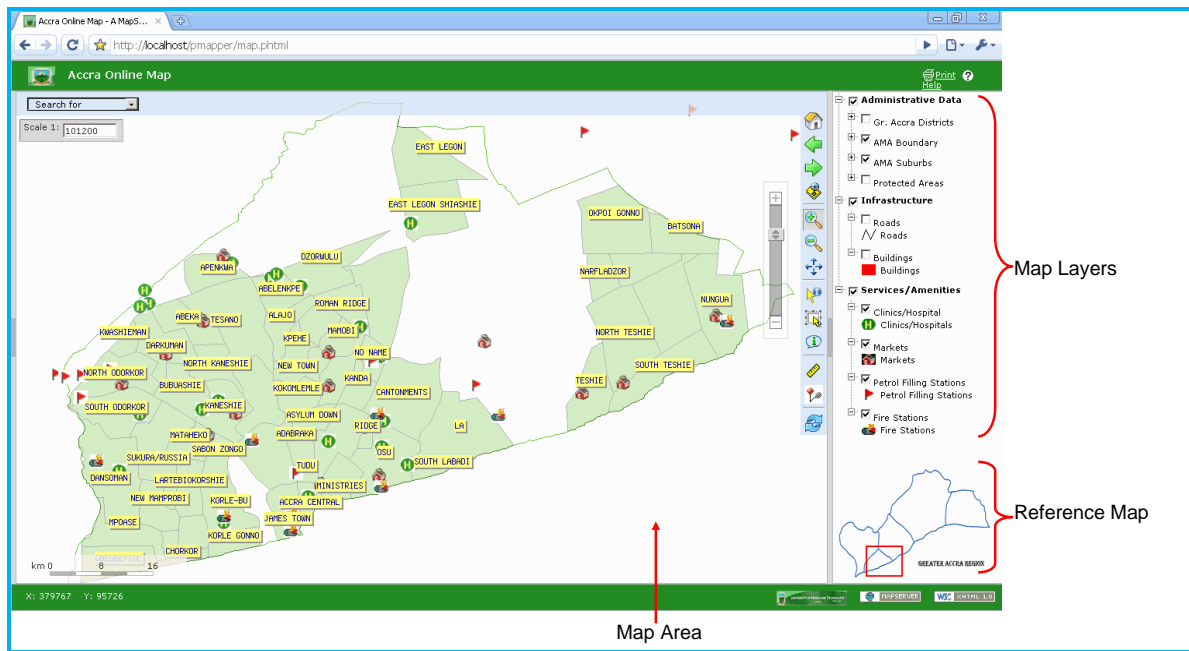


Figure 5: Graphical User Interface of the Accra Online Map



Figure 6: Point of Interest Functionality

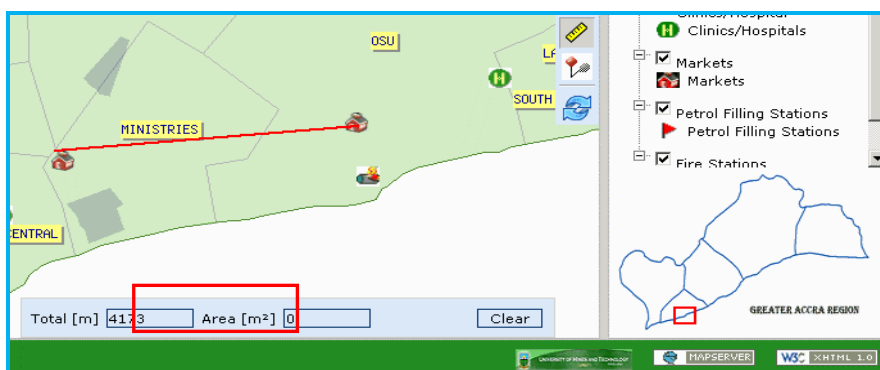


Figure 7: Distance Measure Functionality

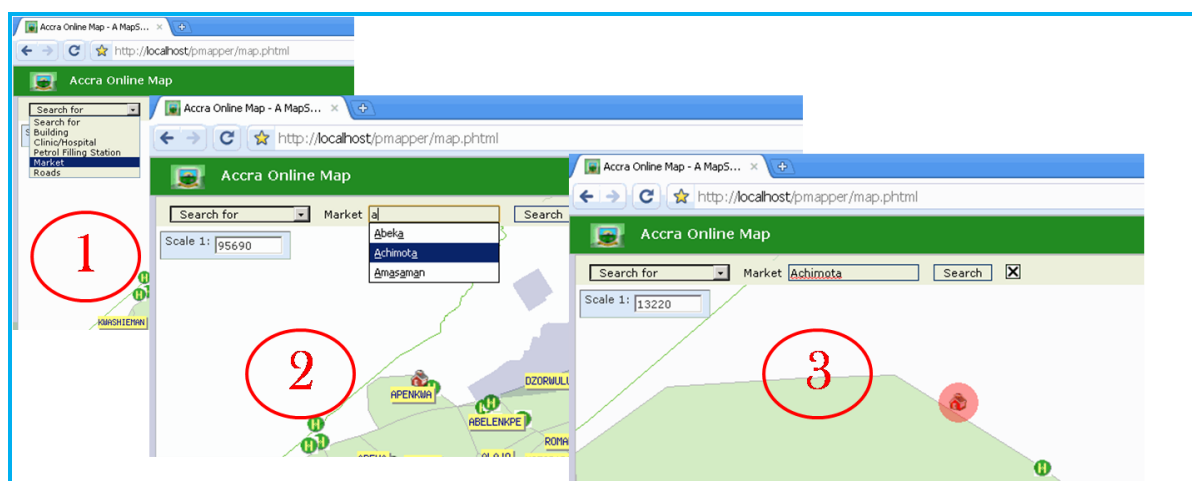


Figure 8: Search Tool using Auto-suggest

6.0 Conclusions

In conclusion this application provides;

- A visual gateway to geospatial data and query database associated with the map.
- It also allows users to turn layers on and off, pan, zoom, and click a variety of buttons to interact with the features.
- The features are drawn from spatial data sets consisting of shapefiles, from which layers are generated.
- The application can be installed and used on almost any web server.
- This application will serve as an online detailed destination gazetteer for the Accra Metropolitan Assembly.

7.0 References

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