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Developing a Geoportal for County SDI: Case Study of Nairobi County

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Abstract: ***The purpose of this study was to assess the existing spatial data type holdings within geospatial organizations in Nairobi County and determine their current spatial data sharing patterns. The main objective was to develop a geoportal to enhance spatial data sharing and effective management in Nairobi County. Our methodology entailed configuration of the database followed by server and web setup. A combination of tools were used which included Apache Tomcat, PostgreSQL as the database, Esri Geoportal Server, Apache Directory Server and Jxplorer for establishing the LDAP connection to the database. Fifty organizations from Nairobi County that handle geospatial data were interviewed via the online survey to find out the data sharing practices between organizations. The results rate the data sharing practices in the county to be poor. The final results comprise of a working geoportal application, with data download and other repository tabs together with the interactive web map embedded to the map viewer. The main conclusion is that geospatial organizations within Nairobi County own various types of spatial data based on their day to day activities. The main recommendation is that the same model used at the county can be scaled and replicated at the national level.***

Keywords: spatial data, geoportal, online survey, County

1. Introduction

Appropriate management and sharing of geospatial data is important in the development of a nation as it reduces duplication of spatial data collection efforts and increases the rate of decision making. This needs collaboration across geospatial organizations both private and public that produce different datasets in order to solve the spatial data sharing problem. Accessing these data in local organizational files is a great challenge as there is no established platform that would enhance sharing of data. Collaboration between organizations that use geospatial data is impossible without an operating Spatial Data Infrastructure where agencies are allowed to share and access data. With the recent developments in web GIS and portal technologies an effective solution can be achieved.

The major objective of this research was to develop an online geoportal for Nairobi County in order to enhance geospatial data sharing across departments for effective management. The development of the geoportal would ensure that the metadata uploaded is certified, facilitate adoption of metadata standards, enhance publishing and downloading of datasets. This would enhance the SDI operations from the county level which can be replicated at the national level. Such a framework would also promote collaborations within key ministries in the county and provide a platform for sharing spatial data sets in the governance of the county resources.

Recent studies have investigated various ways for managing geospatial information. [1] Developed a land cataloguing process that allowed the registration of land information on the geoportal using metadata. This model allowed the uploading of the metadata only while the sensitive data remained securely housed within the local servers. [2] Established that one of the main problems with sharing data was that the existing spatial datasets and amenities did not have logical documentation. He used the geoportal extension to create metadata in order to organize the information into a manageable content. Using the geoportal extension, an online metadata editor that made it easy to publish geographic resources in relation to the national profile was created. This opened a way for allocation and reuse of resources across the community boundaries within the country. [3] Used the SAFE software Spatial Direct product and OGC standards specifications to create metadata services. By integrating the former with google search appliance consumers would create content-based queries and made catalogue searches 10 times faster which improved data sharing within the government. Other models [4], used an already existing digital government to pave way for the development of a geoportal through the use of GIS. The portal developed had two sections thus a members' plus partners section and non-members' section that was open for the public. The results show that this geoportal offered tools to locate, view and manipulate datasets together with other capabilities for ordering spatial information. [5] Combined a bottom-up approach by engaging the GIS specialists and the community service in digital mapping exercise with a top-down approach by engaging the management in decision making to develop the Danish geoportal. This strategy was used together with the existing e-Government to ensure that all the collected spatial data was centrally hosted in a platform where it could be discovered, used and shared with all agencies concerned. The newly developed portal enhanced spatial data management. [5] Used web and server GIS technologies in the development of the Danish portal.

There is very limited on-going research regarding geoportal that support extensive services such as web mapping and

geocoding at ago. Most geoportal support the search, discovery, uploading & downloading plus viewing services but lack the web mapping aspect. The purpose of this study was to fill this gap by developing a geoportal with a wide range of services including web mapping and geocoding.

2. Study Area

The study focuses on Nairobi County which is situated at 1°17′S 36°49′E in South-Central Kenya, 140 Kilometers (87 miles) south of the Equator. It is bordered by Kiambu to the north, Machakos to the east, Kajiado to the south and Nakuru to the west, Figure 1. [6]The study area is surrounded by 113 km² (70 mi²) of plains, cliffs and forest that makes up the city's Nairobi National Park which is indicated in the map below. It is the most populous city in East Africa, with a current estimated population of about 3.5 million. According to [6], this makes it the 14th largest city in Africa. Being Kenya's capital and the arrival point for many visitors, it is well served by international airlines, and a regional road network linking it to other major East African urban centers. [6]Nairobi is the most developed city in East Africa and therefore serves as the engine for Kenya's economy.

Being centrally located, it links the major towns within Kenya and also East Africa at large, making it a major attraction to investors and planners.

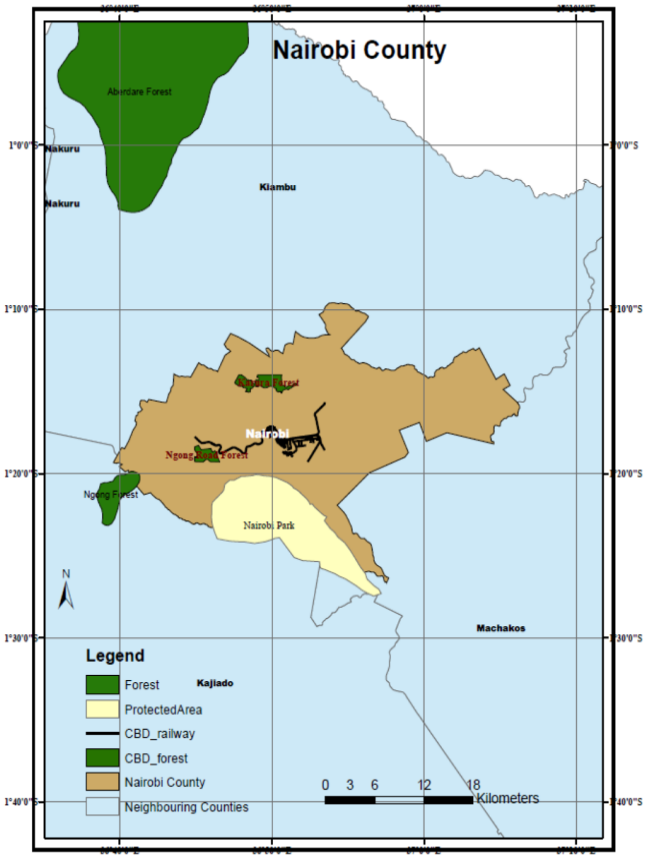


Figure 1: Map of the study area

3. Methodology

The methodology took the approach in figure 2 below in the development of the geoportal.

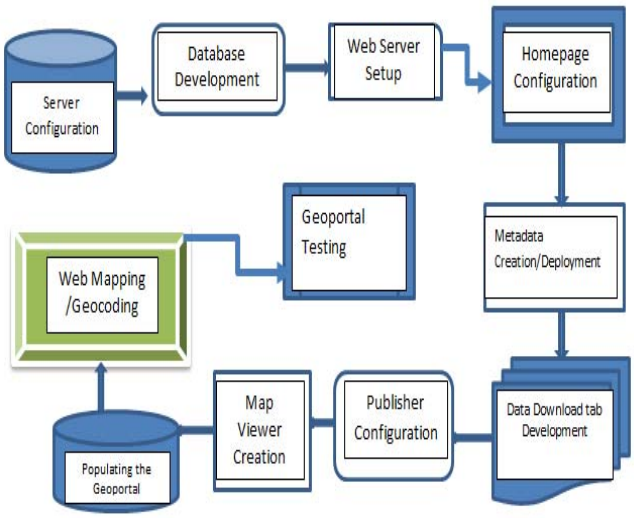


Figure 2: Flow Chart of application development

3.1 Configuration of the server and Database Development

This was done through establishing a Light-weight Directory Access Protocol (LDAP) connection that gives access and control of the clients who will be using the geoportal. For this study, three major client rights were created; the administrator, publisher and the user. The database development was done by configuring the PostgreSQL database connection by updating the computer's environmental variables. By running the scripts from the command prompt window it was possible to set up the database permissions and create the schemas. Lastly the scripts user permissions were generated that would help create the geoportal schema. This in turn enabled the creation of the table structures, Figure 2.

3.2 Configuration of the homepage

The home page was created through writing a homepage code that supports the various aspects that determine the look and feel of the home page. The login tab was created that supports infinite logins based on the number of accounts that have been created. The registration tab was created that would help link users to the registration page during creation of accounts. Relevant graphics and other social media links were configured and uploaded, Figure 2.

3.3 Metadata creation/deployment

The Dublin Core standards was adopted in creating a metadata form in the source code. This was accomplished through use of a template code that was in .xml format. Elements chosen for this study were then entered in the code. These include items such as identification information, the point of contact, browse graphic, theme keywords, spatial reference information and metadata reference information

for future contact. Then metadata XML's xpaths for these elements was identified and added. Then the metadata editor interface for this profile was designed and elements grouped in the order in which they should appear. At this stage the obligation rules for the supported metadata elements were set allowing the user to identify mandatory requirements for the resource to be published in the geoportal. So if a publisher attempts to publish metadata that does not contain information for a mandatory value, the document will fail validation and will not be published, Figure 2.

3.4 Data download tab development

The data download tab capability was enabled by configuring the geoportal to enable data download from a custom map document using the ArcGIS 10.1 Extract Data and Email Task. This was done through configuring a geoprocessing service in ArcMap which was achieved by first creating a map to be published to the cloud that would later be accessed from the geoportal. The Extract Data and Email Task (Server) tool was used to create Data Extraction geoprocessing service. The tool was copied into a custom toolbox, then the model was edited and reconfigured as necessary by opening and editing before publishing as a service. After this a blank ArcMap document was opened and the downloadable layers were added. Then the new tool box was added to the Arctool box and named data download. Finally the geoportal was configured to use the new data download service created, Figure 2.

3.5 Configuration of the publisher and Map Viewer Creation

The configuration of the publisher was done through writing a publisher configuration code in Notepad++. The publish client was then added to the Arc Catalogue interface in ArcMap. Then the tool was customized in the commands tab to point to the geoportal. The map viewer was developed by creating a URL link to the map viewer. This link was created by inputting a Hyper Text Transmission Protocol (HTTP). The path for the map viewer application was added followed by the service type in ArcGIS Server services and the URL to the map service. The link was created in such a way that it supports the 'Add to Map' functionality for a search result on the search page enabling users to add their search results to the map. The geoportal link was then configured to launch the map viewer by modifying it accordingly using the newly created URL for the map viewer, Figure 2.

3.6 Populating the Geoportal

The PostgreSQL database was prepared by changing the database scripts in the directory to point to the geoportal. A schema was created and populated with tables that would help the geoportal work correctly. This was enabled by writing the commands and then querying the database to confirm that the tables were created, Figure 2.

3.7 Web mapping/ geocoding configuration

An address locator was created in ArcGIS Desktop and the Manager configured to publish the locator as a geocode service. With a client application that uses the geocode service the 'Find Address task' was added to the Web mapping application to help users locate an address.

The web mapping application was created using the ArcGIS Viewer for Flex plugin. First the layers to be displayed on the web map were created in ArcMap and then shared as a map package. The map package was then published to the server hosting the web mapping services. The Flex for Viewer was then configured by changing the source code to point to this web map. Various tabs were added to make the map more interactive for instance the data extract tab, a legend for the various layers. A chart widget, directions widget, pop ups and the locator for locating addresses. Various links to other freely available applications like Google Earth, JavaScript and ArcGIS.com map viewer were also added to enable users view the web map in other applications. The web map was cached to help increase the loading speed. After all the necessary details had been added, the geoportal was configured to point to this web map application by copying its URL and pasting it in the gpt.xml code, Figure 2.

The study used a combination of tools which include Apache Tomcat as the web server, PostgreSQL as the database, Esri Geoportal Server, Apache Directory Server and Jxplorer for establishing the LDAP connection to the database. In order to determine the spatial data type holdings, a questionnaire was developed and deployed via email to a sample of 50 geospatial organizations within Nairobi County. In choosing the sample organizations, purposive sampling was used as the research targeted organizations that use spatial data in their day to day activities. This method was used as it was cheaper in terms of cost, accurate in data analysis and saved on time. Data analysis was done using online analysis tools provided by the survey tools.

4. Results and Discussion

4.1 Spatial Data Holdings Survey

The results for spatial data type holdings show that organizations own data on various sectors in the economy. These include but not limited to data on buildings, land parcels, utilities e.g. sewer, transportation e.g. road networks and natural resources. Land parcel is the dataset owned by most organizations as it attracts the largest percentage of 35.71% as evident in the pie chart in figure 3. The spatial data is in various formats but the most common format observed is the shapefile. The survey shows that majority of organizations collect this data directly from the field other than borrowing as most of the borrowed data from other sources is mostly not compatible with the local data. This is evident in table 1 below where 78.25% collect spatial data directly from the field.

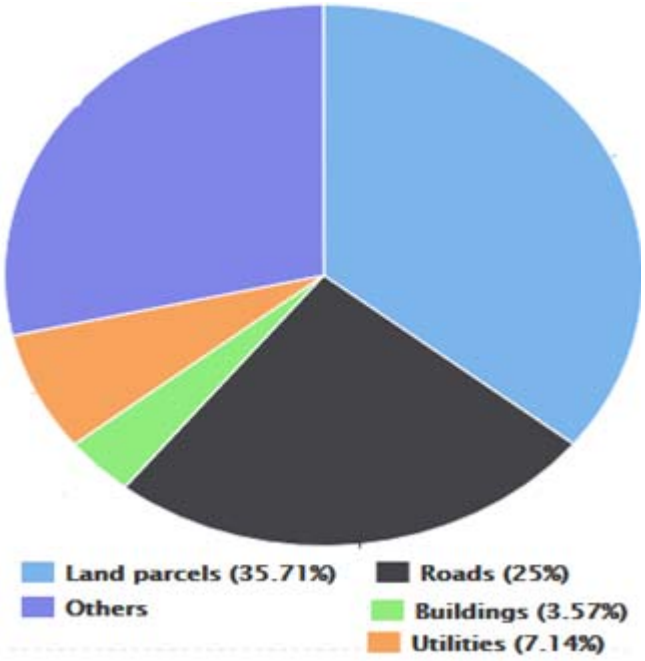


Figure 3: Pie chart of results on spatial data type holdings

Table 1: Results on current source of spatial data for various organizations

Question	Series 1
Collect directly from the field	78.26%
Borrow from other organizations	17.39%
Buy from data vendor organizations	4.35%

Results for the spatial data sharing patterns between organizations rate this as poor. This is evident in the pie chart in figure 4 where 60.71% confirmed so. This is because most organizations have data lying within their local organizations' file and not in a sharable format. The survey shows that this data is seldomly shared and is difficult to acquire when one is in need as the majority at 56.52% said so. This is evident in table 2 below.

Table 2: Results on data sharing level between organizations

Question	Series 1
Data is frequently shared according to the need.	39.13%
Data is not shared at all	0%
Data owners are generous and easily share their data when requested.	4.35%
Data is seldomly shared and is a struggle to acquire when needed.	56.52%

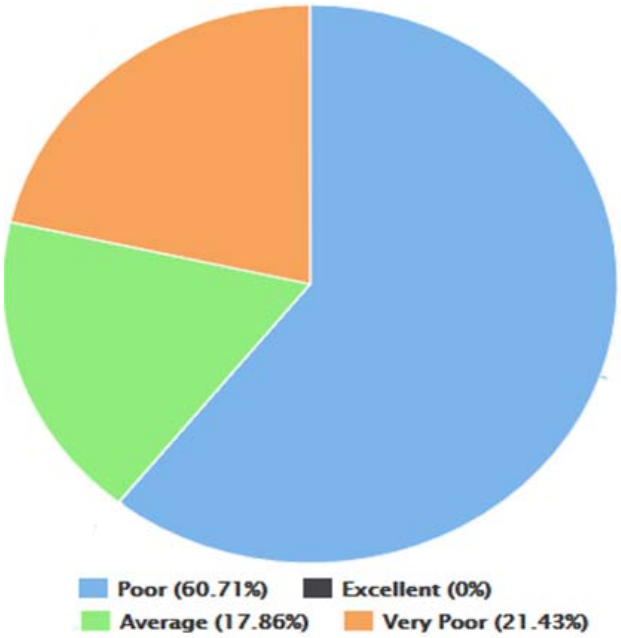


Figure 4: Pie chart of results on data sharing practice between organizations

4.2 Nairobi County Geoportal

The major objective of the research was to develop a geoportal for Nairobi County that will enable effective data management.
Results show that the geoportal development was successful as the directory and web servers were successfully configured. The database was successfully developed and enabled to point to the geoportal. Twenty nine data sets were uploaded to the geoportal and can be downloaded as zip files in the desired format. The web map is up and running and users can interact with it, they can measure distance, locate addresses, download data, create charts as evident on this link.
http://41.215.35.53:8080/geoportal/Flexviewer/index.html

All the elements are working fine as the geoportal tests were successful as shown in the screenshots below. The tests were achieved by opening a web browser after saving all the file codes and going to http://41.215.35.53:8080/geoportal/ to access the geoportal home page. All the elements were tested as shown in the screenshots below and results show they are working well.

Figure 5: Screenshot of results for homepage

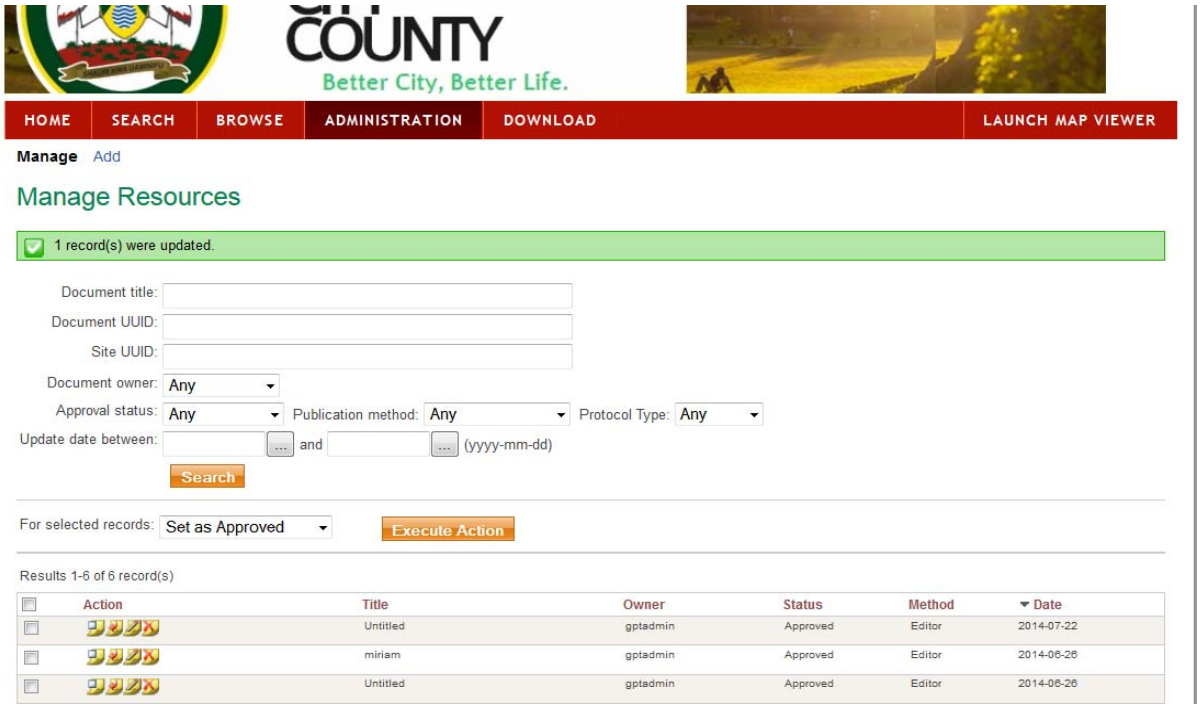
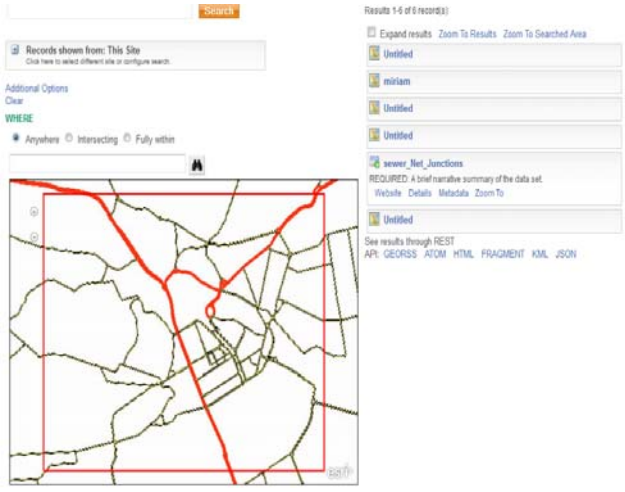


Figure 6: Screenshot of results for management of resources



The record was clicked to display its options. The metadata link was clicked which opened and displayed in a new browser as shown below. This proved that the metadata is up and running and is working well.

Figure 7: Screenshot of results for search/browse tabs

Figure 8: Screenshot of results for metadata download

The data download tab was also tested by clicking on it to download data. Some of the uploaded data was downloaded and it did download a zipped file. This is evident in the screenshot below.

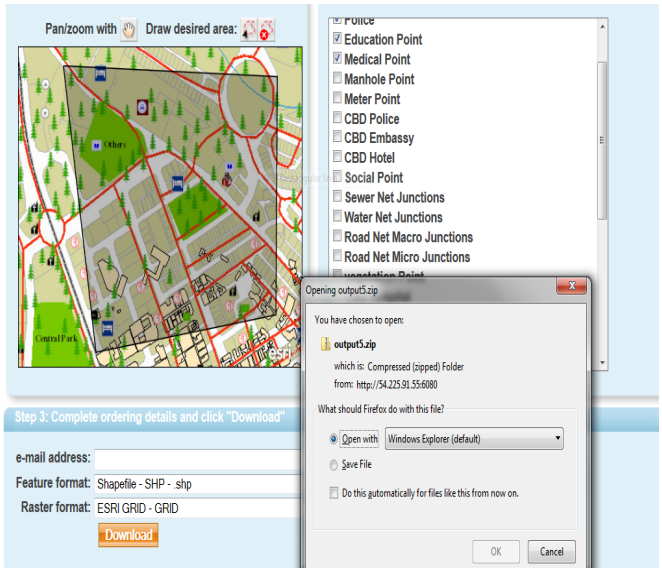


Figure 9: Screenshot of data download results

So the above data download tab shows that it was configured well and is working fine. Users can download data for their area of interest. The web mapping application was also successfully embedded in the geoportal plus the address locator that would enable the geocoding aspect as seen in the screenshots below. These are up and running and can be accessed at http://41.215.35.53:8080/geoportal/Flexviewer/index.html

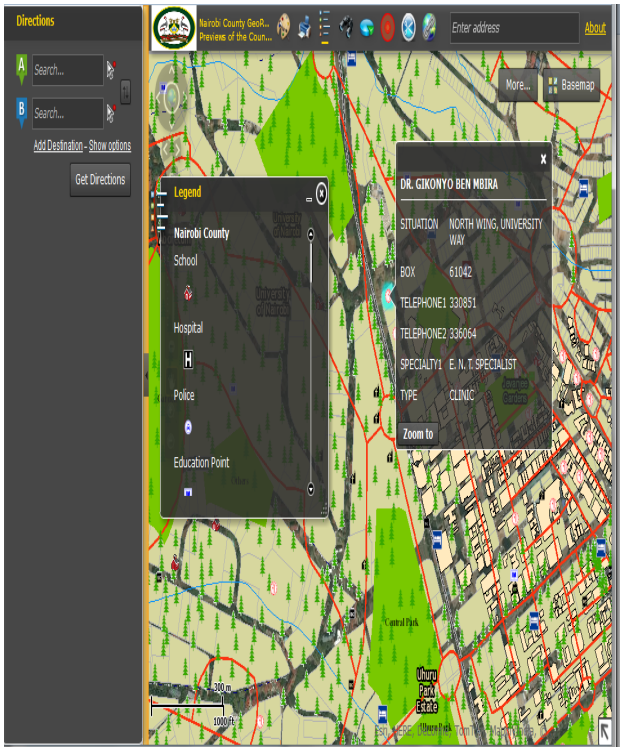


Figure 10: Screenshot of results for web mapping

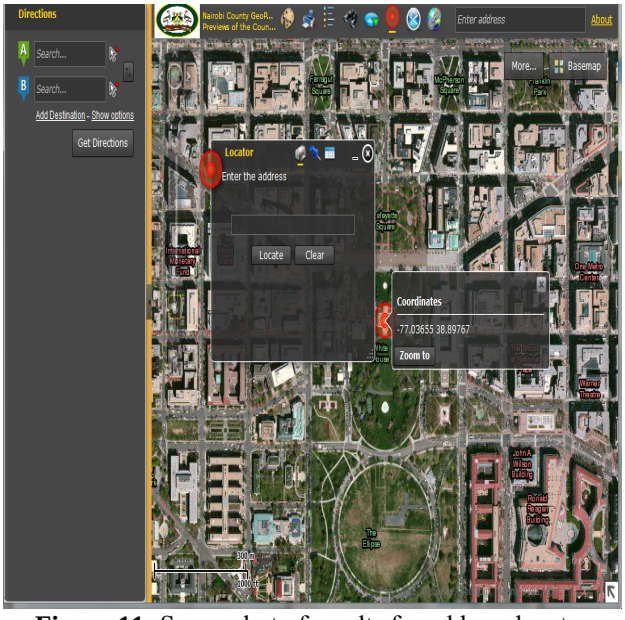


Figure 11: Screenshot of results for address locator

5. Conclusions

Our results show that geospatial organizations within Nairobi County own various types of spatial data based on their day to day activities. These include but not limited to buildings, land parcels, utilities e.g. sewer, transportation e.g. road networks and natural resources.

According to the results data owned is in separate repositories and is difficult to share. A geoportal with web mapping and geocoding capabilities was successfully developed to enable easy search, discovery of data hence solve the data sharing problem. The testing results show that these capabilities are working fine. The online geoportal offers a viable solution to the interoperability and data sharing problem among various departments and organizations within Nairobi County. The implementation of the geoportal can lead to enhanced and effective decision making since geospatial organizations would be able to access data from the portal.

6. Recommendations

More research is required to improve the geoportal analysis and geoprocessing capabilities especially the web mapping analytical capabilities e.g. shortest route analysis.

This study focused on development of a geoportal to address the problem of data sharing at the county level. However, the same model can be scaled and replicated at the national level under the broad framework of a Kenya National Spatial Data Infrastructure (KNSDI).

The future scope of this study should further entail the development of a geoportal with a web map that has the analysis tools and displays the analysis results on the web map interface for users to see and interact with.

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