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Research Article

RURAL LAND INFORMATION SYSTEM

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ABSTRACT
Web based GIS are being used for disseminating a land related information and providing ready to use analytical tools online. This study will demonstrate the development of web-based rural land information system prototype that embraces the connectivity of the web, to deliver geo-spatial information from a centralized database and to assist land development and management process. Further analyzing the requirements brings a system design including the systems behavior using use case diagram, the system interaction using sequence diagram and logical design of the system database using a class diagram. By using open source software and open web standards a proof of concept system is implemented and tested. The use of Web based Rural Land Information System supported and implemented using the open standards and open source tools is very promising and offers a great potential for disseminating land related information.

Keywords: *Cadaster, Land Information System (LIS), Open Source, Web GIS, Mekelle*

INTRODUCTION
Land Information System has become a key for those involved with development and administration of rural land in Tigray and Ethiopia at large. A Land Information System is a tool for legal, administrative and economic decision-making and an aid for planning and development. It consists of a database containing spatially referenced land-related data for a defined area, on the other hand of procedures and techniques for the systematic collection, updating, processing and distribution (UN/ECE, 1996). As stated by International Federation of Surveyors (IFS), the base of land information system is a uniform spatial referencing system for the data, which also facilitates the linking of data within the system with other land related data. Land information such as cadaster, information from land registers has traditionally been gathered from isolated systems of surveying, title registration and tax assessment. The systems have existed as isolatedand to a certain extent independent systems. As a result gathering complete and up to date parcel information is often time consuming and difficult.

A Geographic Information System (GIS) has been widely used in solving a variety of problem in gathering, storing, retrieving, analyzing, manipulating and visualizing data. Together with the use of the World Wide Web (WWW), GIS could be further developed to allow many more people to have access to GIS functionality and to enhance community participation in planning. According to Alesheikh *et al.,* (2002) GIS software has enabled users to view spatial data in its proper format. As a result, the interpretation of spatial data has become easy and increasingly simple to understand. Unluckily, everyone does not have access to GIS, nor would be able to devote their time necessary to use it efficiently. Therefore web GIS becomes a cheap and easy way of disseminating geospatial data and processing tools. Many organizations are interested to distribute maps and processing tools without time and location restriction to users. Recent internet development has allowed various forms of text and images to be easily gathered, using the World Wide Web. This has contributed to the growth and construction of digital libraries and as a direct result, society are now demanding greater forms of data, especially relating to the land parcel, such as cadastral maps and title information, land use type, soil type to be viewed and retrieved just as easily as textual or static images. The rapid growth of the internet provides highly customizable, accessible, and interactive sources of public information and is changing the ways that people capture and manipulate spatial information. Internet allows all levels of society to access geospatial informationand delivers a media for processing geo-related information with no location restrictions.

Moreover, disseminating spatial information on the internet improves the decision-making processes. Nowadays the internet has become an integral part of GIS especially in information dissemination and geo-data processing. There is also a need for a web GIS system to allow timely information on land use such as land ownership natural resource perspectives, existing infrastructures, topography, soil type and metrological data. This study will demonstrate the development of web-based rural land information system prototype that embraces the connectivity of the web, to deliver geo-spatial information from a centralized database and to assist land development and management process.

MATERIALS AND METHODS

Methodology

For this study, TabiaNegasharea was chosen from the Eastern Zone KilteAwlaelo Wereda, Regional state of Tigray, Ethiopia to show the prototype Rural Land Information System based on Web GIS. TabiaNegashis the smallest administration boundary and it is mainly characterized by having mountainous topography like most part of the Tigray region. It is foundin13°.87833N, 39°.59778and 50 kilometers to the North East of the Tigray Regional Capital City, Mekelle (Figure 1).

The reason for choosing the study area is that Negash only have aerial ortho-photos with a resolution of 0.30cm specifically intended for cadastral mapping and ready for digitization and also have both the spatial data and attribute data in digital format. Mainly the land parcels have been digitized.

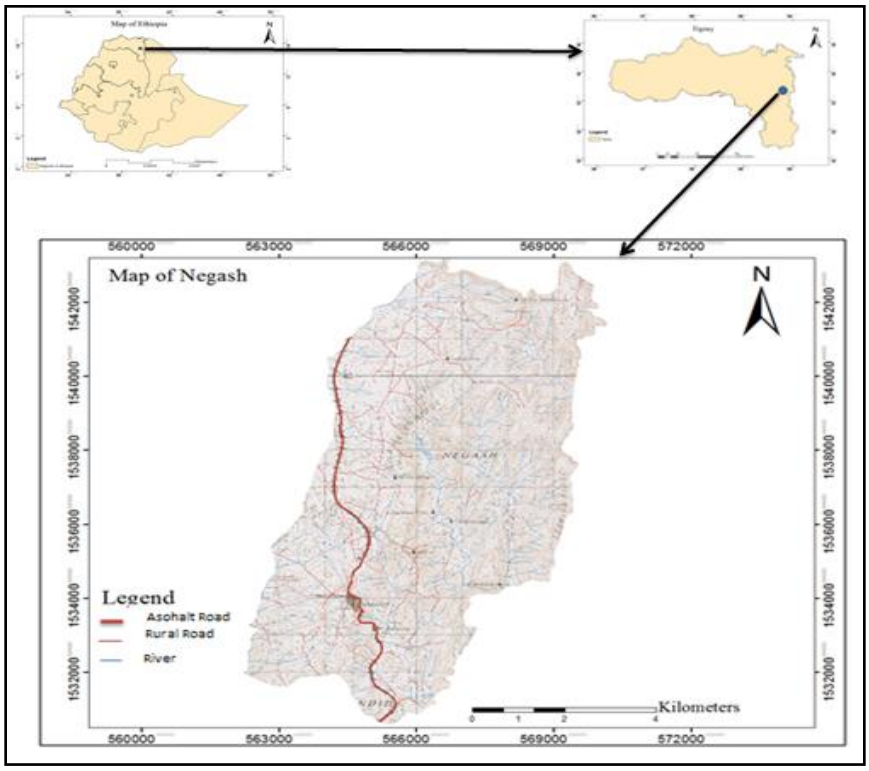

Figure 1: Location Map of the Study Area (CSA, 2007)

Desk Research

Desk research method is established on the literature review of the LIS, web GIS and the architecture of web GIS. The technical definition of desk research is "collecting and analyzing from already available and known to work technology and information", it is also known as a secondary research (www.businessdictionary.com/definition). The method is adopted mainly to find the issues related to web based LIS, its importance, components of web based LIS, challenges of LIS, web GIS for land management, three-tier architecture for web GIS and its significance.

Research Article

Case Study, Methodology

Case study in cadastral system is defined by Williamson and Fourie (1998) as an investigation of the cadastral system of a particular jurisdiction, both at a mostly descriptive level and at a more focused level, where specific problems have been identified. Case study methodology is the most frequently used technique in the field of cadastral system research (Silva and Stubkjaer, 2002). This method offers a better understanding of the existing cadastral systems including its setbacks, and an ability to adapt improvements to the problems on hand in comparison with global practices. This methodology is chosen for this study because its ability allowing understanding of the existing cadastral systems drawbacks prior to the construction of models or the development of solutions for the existing problems. Besides to the case study methodology, questionnaire, interviews, desk research and observation of daily work are also used. The output of the data analysis from this method does not provide the statistical values and results rather it gives an exhaustive analysis of existing system and users requirements.

Data Collection Techniques

The primary data collection was based on the questionnaire and interviews on user requirement for rural land information dissemination to personnel who involve in rural land management and to investors who seek rural land for agricultural investment respectively. Secondary data collection was carried out from different written documents such as proclamations, rules, regulations and other scientific publications (Figure 2). Most of these materials were downloaded from the internet.

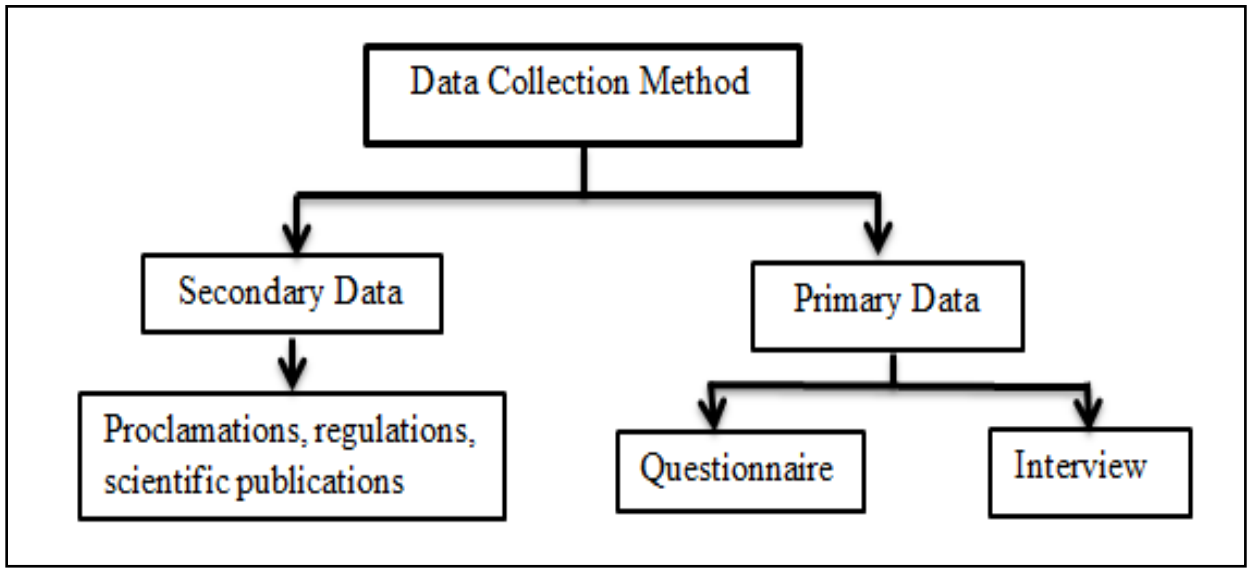

Figure 2: Data Collection Methodology

Web GIS Development Approach

There are a number of design and development models for system development process. To mention some of the waterfall model, the iterative model, the object oriented model, the spiral model and so on. These models depict the process comprising a series of planned activities to develop a system.

Iterative Model

The iterative approach as defined by Larman (2002) is software development process organized into a series of short, fixed-length (for example, four weeks) mini-projects called iterations; the outcome of each is a tested, integrated and executable system. All iteration includes its own requirements analysis, design, and implementation and testing activities (Figure 3). The iterative model is chosen for this study since it is difficult to incorporate the entire user requirement at the beginning of the system development and this approach of system development gives the developer a chance to incorporate additional requirement and functionalities later. In such situation the development process is executed in small incremental or iterations with a reduced functionalities (Morales, 2004).

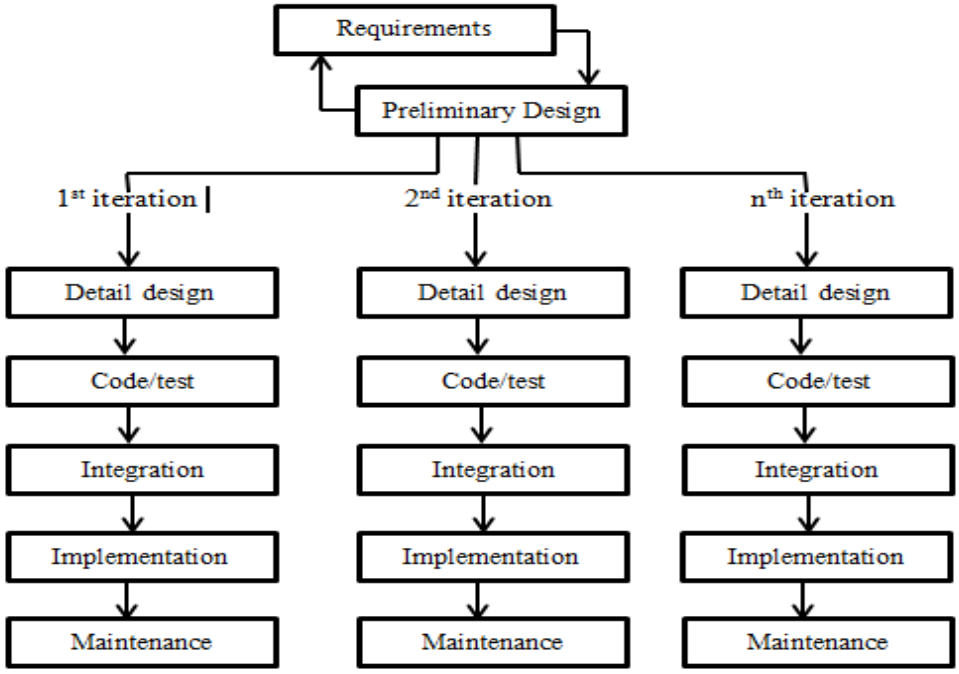

Figure 3: Iterative Development Model (Morales, 2004)

Study Set – Up

In order to carry out this study the following methodology is proposed. These are literature review, requirement gathering, analysis, system design, system implementation, prototyping, system test and finally reporting the overall work.

The Requirement Gathering and Analysis

Selecting proper approaches for creation of web based land information system need detailed survey of literature. Various concepts and technologies in the domain of Geospatial Information Technology (GIT) and Information Technology (IT) have been offered which allow developing Land Information Systems required abilities. To enable the web GIS system to efficiently run with strong flexibility and scalability, the three tier architecture approach was used in the system design and implementation steps. This step is performed through literature review, interviewing potential users and personnel who work in the land management. This step produced two critical pieces of information which are a list of functions that is important for end users (user requirement) and List of available and required geographic data.The information gained in the requirement analysis is used directly into the system design and system implementation and prototyping steps in the web GIS development process.

Data Collection

Based on the desk research a questionnaire of seventeen questions categorized in to five classes is completed by the IT and GIS department of the Environmental Protection Land Use and Administration Agency (EPLUAA) and an interview is held with the clients of the agency. The result of the analysis of the data collected allow to identify the spatial data necessary for web GIS such as boundary map, farm land, residential land rivers, roads, communal land maps, soil map and the system functionalities.

System Design

Designing the system based on the three-tier Architecture for Rural Land Information System has the following parts. These are Geo-data Modeling: Designing the geo data for Rural Land Information System using Unified Modeling Language (UML), Data Base Design & Development: The database is designed for the Rural Land Information System and populated with data using the PostgreSQL/PostGIS for data storage and management and finally web GIS Design: According to the users' requirement analysis and business process of the Rural Land Information System's web interface layout is designed,

and main analytical tools that are used determined at this step. These analytical tools might include zoom in/out, pan, spatial query and identify.

System Implementation and Prototyping

Using the initial requirement analysis, the collected data, the database designed and the necessary software acquired for the Rural Land Information System based on Web GIS is developed based on the three-tier architecture approach. The initial user interface and the application are programed using HTML, map script, php, CSS. In order to produces map and other service information the University of Minnesota (UMN) Map server was used the Web Map Service (WMS) service. In the final step the overall report is prepared about the methodology used, system design, implementation, and the system development process.

Software Requirement

In order to realize the proposed system, it required the use of eight software components. These are enterprise architect version 7.5, ArcMap 10.2, mapserver 6.2, Apache 2.2, posgreSQL/postGIS, PHP, notepad^{++}. Among these software enterprise architect and ArcMap are the only proprietary software used and the rest are free and open source software systems employed in this study (Table 1).

Enterprise architect is a comprehensive UML analysis and design tool used in designing the rural LIS based on web GIS system behavior such as the use case diagram and the structure of the system database using the class diagram. ArcMap is mainly used in preparing the spatial data by digitizing the parcels from the orthophotos of the study area.

The other categories of software used are the free and open source software. These are mapserver, posgreSQL/postGIS, apache and php mainly resides in the server side of the system. Notepad^{++} is used as script editor.

Table 1: Software Used

Free and Open Source Software	**Description**
Map Server	Used to Generate Maps.
P.Mapper	Mapping Application, to Provide APIs.
Apache	Used to Serve the Web Page by Invoking the Map Server.
PostgreSQL/PostGIS	Used as the DBMS with a Spatial Database Extension.
PHP	It is a Server Side Scripting Responsible for the Communication of Server Side Components.
Notepad++	Used as Script Editor.
Proprietary Software	
ArcMap 10.2	Used in Digitizing, Defining Projection and to View Data
Enterprise Architect	Used in Designing the Structure and Behavior of the System.

Implementation of the Prototype

This section starts by discussing the spatial data preparation, database development process, technology for prototype implementation and finally deals with the usability evaluation and system test.

Data Preparation

All the cadastral data for Negash were acquired from the regional state of Tigray Environmental Protection Land Use and Administration Agency. Before using this data directly in populating database and using it in the mapserver, the data was checked for its projection, whether it has appropriate fieldsto classify and create seven land use type cadastral maps. All this operations were processed using ArcGIS 10.2 software (Figure 4).

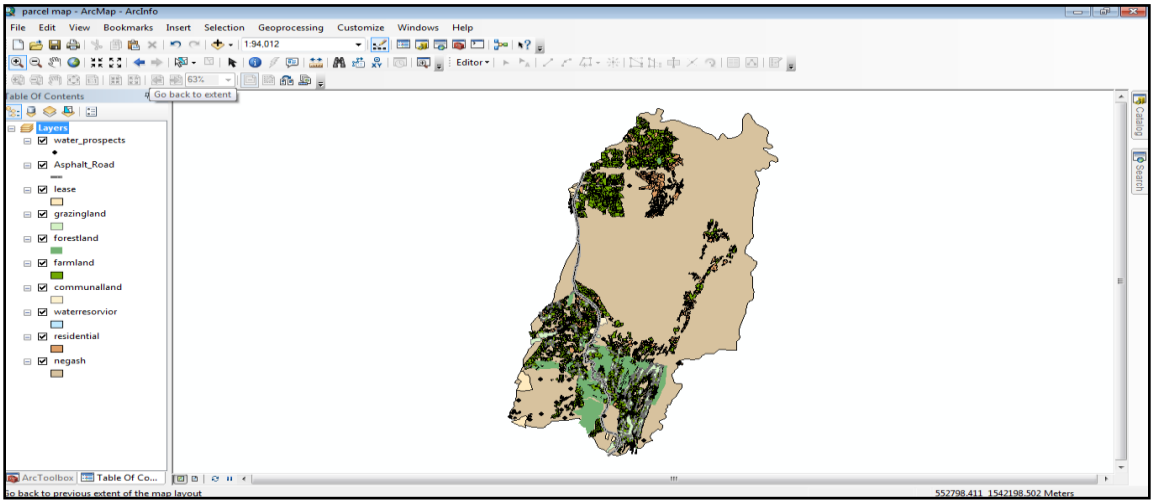

Figure 4: Cadastral Data Used for Developing the Web Based System

Some of the shape files and attribute data are synthetic data, these includes the shape files such as the land for lease, water prospects, and the attribute data soil type are all synthetic data.

Database Development

The data base for the Rural Land Information System based on web GIS was developed using the object relational database principles. The database was developed using a Database Management System (DBMS) which has the capacity to store and manipulate geographic data. The choice of our database system was the postgreSQL/PostGIS which has a spatial extension to support geographic data which is also open source and freely available.

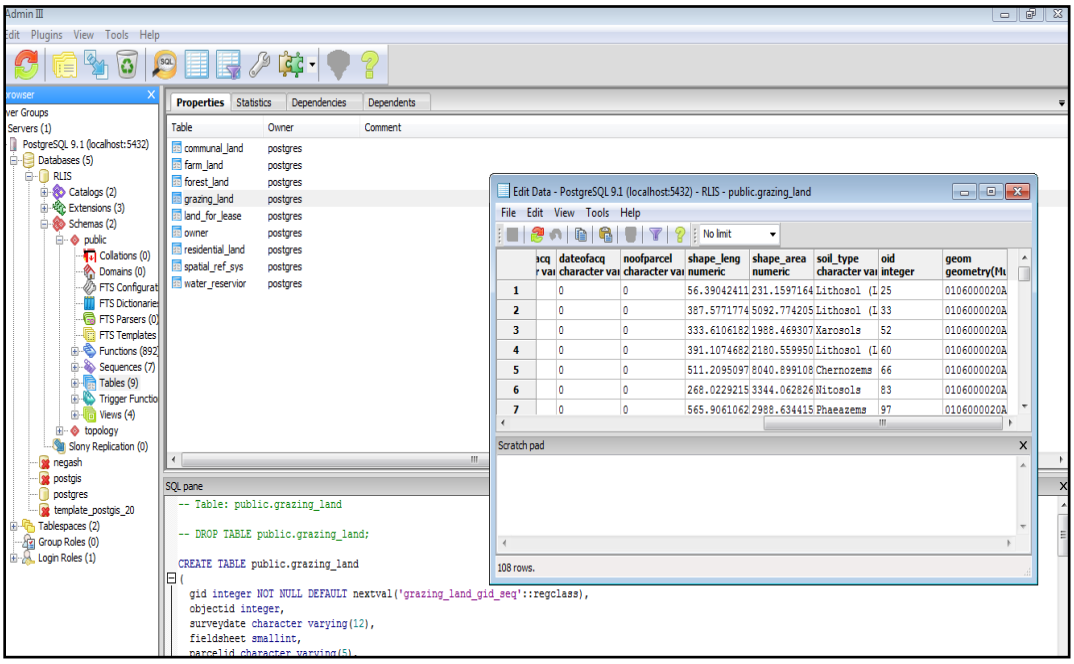

Figure 5: Database for the Rural Land Information System

The Rural Land Information System database created by the above procedure is tested for its workability using SQL queries by the SQL editor in Postgre SQL and Open Jump for visualization and selection query (Figure 5).

Technology for Prototype Implementation

The implementation of a Rural Land Information System based on Web GIS requires a three-tier system architecture which is a web browser as a presentation layer, application layer, and the database (data layer). One of the tools for developing a web based GIS is the mapserver. It offers functionalities for processing different vector and raster data formats and produces a geo-referenced image maps from the parameters provided.

Configuring p.mapper

As explained above the p.mapper is a built in application for map server as a mapping engine and works with all map server supported data formats. The main purpose of the p.mapper is creating an interactive user interface. The first step to integrate the p.mapper with MS4W is to unzip the p.mapper application in the web accessible default directory of apache that is apache/htdocs. Figure 6 shows the application directory structure. Configuration (Config) contains config_default.xml and subdirectory default, which is the default location for custom.js, js_config.php and the mapfile. The prepared shape files (Data) which are used by the map file are put in this folder. Plugins folder contains additional functionalityfor p.mapper and allow a more modulate design of the application. This directory contains other additional functionalities and tools of the p.mapper that can be called from the Config_default.xml and easily integrated with the web GIS system.The template directorycontains cascading style sheets. This directory contains the cascading style sheets for the legend of the web GIS, the layout, the query result, and the default style of the web GIS. And, the Index.phtml file is the home page of the application and it will be accessed by a user.

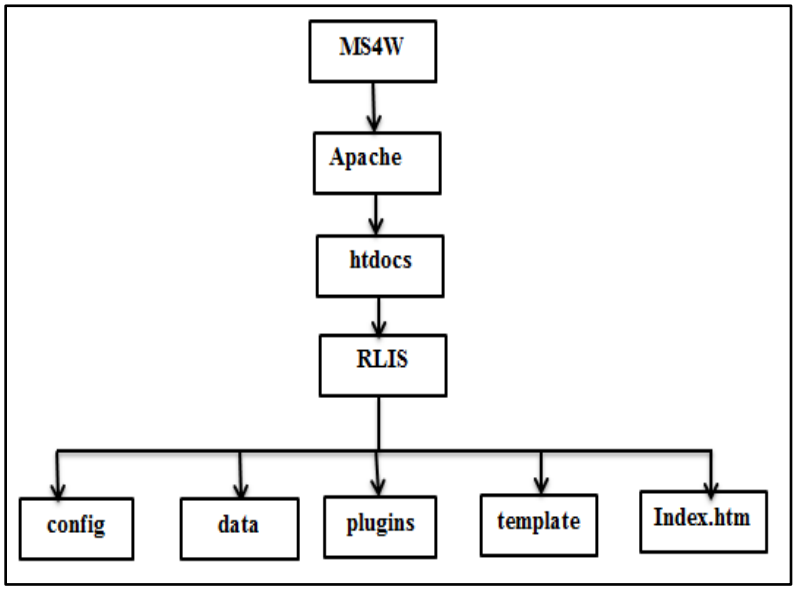

Figure 6: Application Directory Structure

Implementation

After setting up and installing the above mentioned software, the prototype implementation has followed. The functionalities of the proposed system were implemented in to a prototype in conformance with the users' requirements. Therefore, the system development begun by preparing a map file, the template html file, and the setting the built in initialization file. The map file is the basic configuration file for data access and styling for map server. The file is an ASCII text file and is made up of different objects such as the layer object, class, symbol and so on. Each object has a variety of parameters. The template file provides the client web interface of the system with the overall style of the web GIS including the legend style, the tools, the color of the query result (hi lighted a feature) and the layout of the map. The index.html file provides the user with links for choosing among the layers and loads the image produced

by the map server. The other important file is the p.mapper application configuration fileConfig_default.xml. This file provides the web GIS system with the interactive tools such as the zoom in/out, full extent, pan, querying select, measure tools. The segment of code listed below from the Config_default.xml was used to add the plugins for enhancing the functionalities of the web based GIS system

```
<config>
<pm_config_location>default</pm_config_location>
<pm_javascript_location>javascript</pm_javascript_location>
<pm_print_configfile>common/print.xml</pm_print_configfile>
<pm_search_configfile>inline</pm_search_configfile>
</config>
```

Preparing and configuring the above files allowed us to run the proposed web based GIS system. Application running was done by using the common web browsers such as Google chrome, Internet Explorerand Mozilla Firefox. Tested by running a URL http://localhost/rlis/map_default.html using the above web browsers will lead us to the developed rural land information system based on web GIS prototype system. Figure 6 shows the developed Web GIS for Rural Land Information System of the study area. The layer produced by the mapserver as an image in PNG format for displaying in the p.mapper application is presented in the main map frame. The developed web GIS was an interactive web GIS system every click on it results the web and application server to send parameters to the map server and reloading of map takes place.

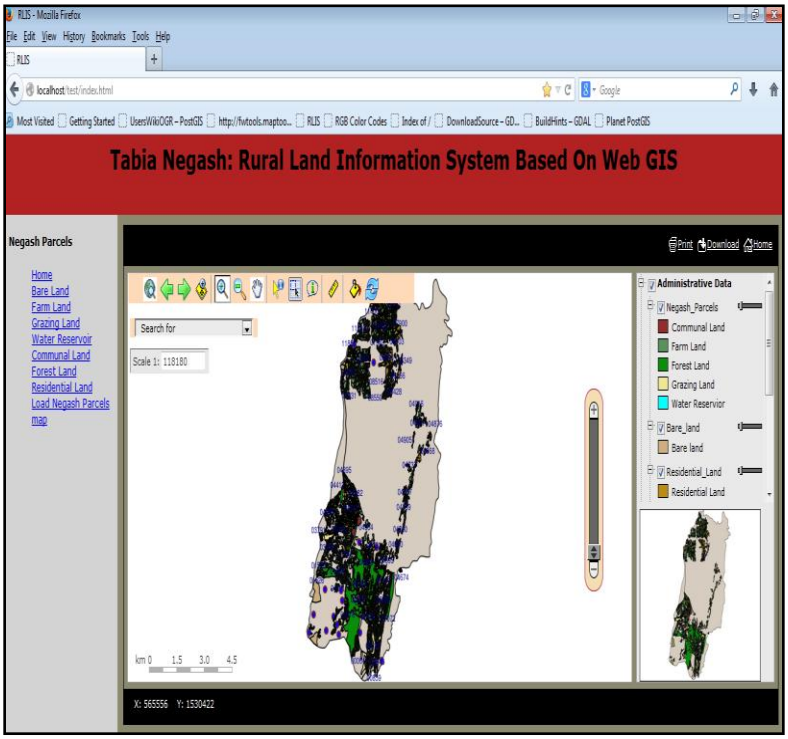

Figure 7: Web GIS for Rural Land Information System of the Study Area

The developed web based GIS system as shown in Figure 7 is rich in analytical tools, it include Zoom to Full Extent, Zoom to Selected, Zoom In, Zoom Out, Pan, Identify, Select, Measure, Search and Print. These tools make the system a user friendly since it provides users with simple processing tools and most of the time produces result on the click action. An average web user could use these tools for identify a geographic feature, measure distance, search a parcel by its dataset and so on without having to write any syntax.

Searching

The other system functionality implemented in the prototyping is the search for a a certain layer from the map (Figure 8). In our case we only implemented the searching prototype for searching the current land use (CurrentLU) from the negash_parcel layer, residential land using its parcel id, bare land using the area of the parcel. The searching query that are implmented in this prototype are the following and the developed prototype are has the ability to answer this searching queries. These are, What are the current land use trype of Negash and what is the fertility of a certain parcel?What is the area of a certain bare land and its details? and Where is a residentail parcel with a certain parcel id (parcelid =050) found and what are the details of that residential parcel?

The the following segment of code shows the implementation of the searching functionality of the first searching query.

```
<searchitem name="Negash_Parcels" description="Current Land Use">
<layer type="shape" name="Negash_Parcels">
<field type="s" name="CurrentLU" description="Current Land Use" wildcard="2">
<definition type="options" connectiontype="ms" sort="asc" firstoption="*">
<mslayer encoding="ISO-8859-1" keyfield="CurrentLU" showfield="CurrentLU"/>
</definition>
</field>
<field type="s" name="fertility" description="Fertility of a parcel" wildcard="0">
<definition type="operator">
<option name="=" value="="/>
</definition>
</field>
</layer>
</searchitem>
```

The above segment of searching code produces an output if it is provided with the right parametrs. The searching is done from the shape file negash_parcel and the input parameter for the searching should be a data set from the column called CurentLU and fertility. It generates a result when the inserted parameter is among the CurrentLU field such as residential land, farmland, grazing land, forestland, bareland, water reservior. And for the second input among the data set fertility should be less fertile (rekik), moderatly fertile (makelay) and fertile (regud). Figure 8 shows the searching result for the CurrentLU with an input of the field farmland (Taharasi), generate the list of all parcel with the current land use type of farmland (taharasi) of negash and with a fertility of parcel equals to less fertile.

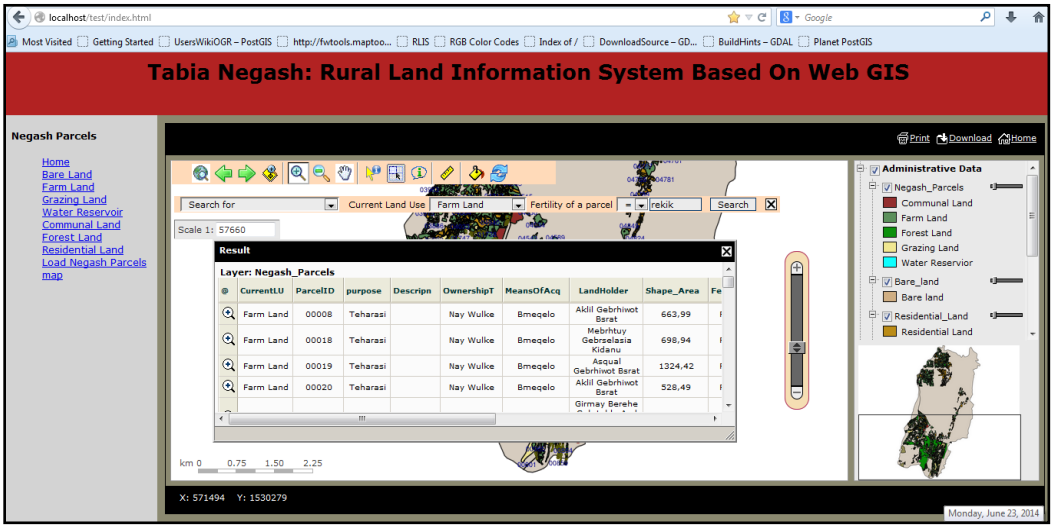

Figure 8: Searching Result for Farmland Land Use Type and Fertility of the Parcel in Negash

For the second searching query the question is what is the area of a certain bare land (Figure 9) and its details?The the following segment of code shows the implementation of the searching functionality of the second searching query. What is the area of a certain bare land and its details?

```
<searchitem name="Bare_land" description="Area of bare land parcels">
<layer type="shape" name="Bare_land">
<field type="n" name="Shape_Area" description="Area of parcel">
<definition type="operator">
<option name="&gt;" value="&gt;"/>
<option name="=" value="="/>
<option name="&lt;" value="&lt;"/>
</definition>
</field>
</layer>
</searchitem>
```

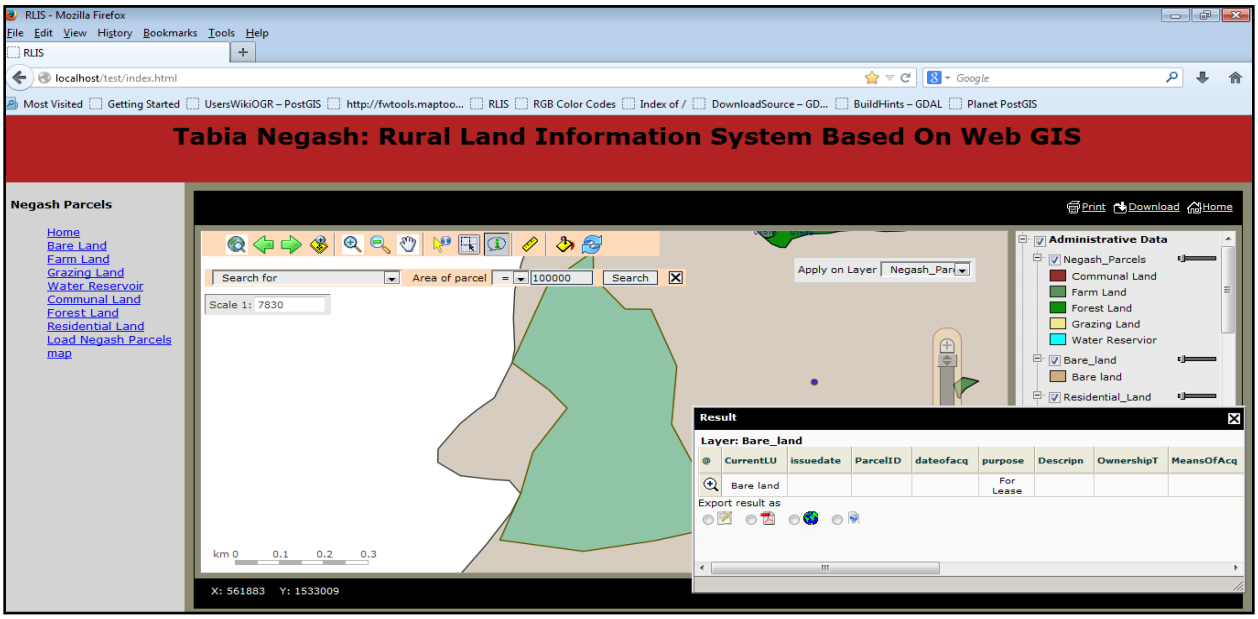

Figure 9: Searching Result of an Area ofBare Land and Its Details

For the third searching query the question is where is a residential parcel (Figure 10) with a certain parcel id (parcelid =050) found and what are the details of that residential parcel?That is the area of a certain bare land and its details?The the following segment of code shows the implementation of the searching functionality of the third searching query.

```
<searchitem name="Residential_Land" description="Parcel ID of Residential House">
<layer type="shape" name="Residential_Land">
<field type="n" name="ParcelID" description="Parcel ID of ResidentialHouse" wildcard="0">
<definition type="operator">
<option name="&gt;" value="&gt;"/>
<option name="=" value="="/>
<option name="&lt;" value="&lt;"/>
</definition>
</field>
</layer>
</searchitem>
```

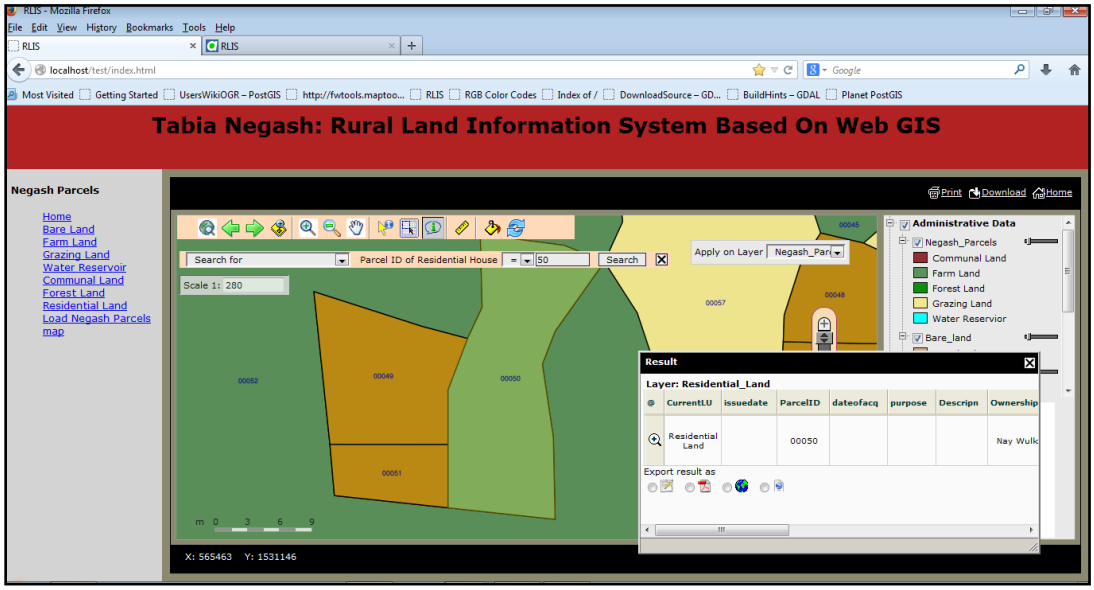

Figure 10: Searching Result for a Residential Land with a Parcelid = 50

Selection Query

Another functionality implemented in the during the prototyping is the selection query (Figure 11). The selection query is the action of clicking on a map to ask for information about the map features in that location or "Querying a Map". It is implemented and configured using the segment of code listed below from the config_default.xml file. The result of the selection query work when a mouse click on a certain parcel on the map it retrieves the data set related to that geographic feature and presented it in a table form. When a user selects a certain geographic feature in the web GIS system using the select tool from the developed rural land information system based on web GIS it zooms in the selected geographic feature for a closer look by the user and displays the result containing the details of the selected geographic feture. The selected feature can be differentiated with a hilighted color and the selected parcel information can be downloded in CSV, PDF or shapefile format

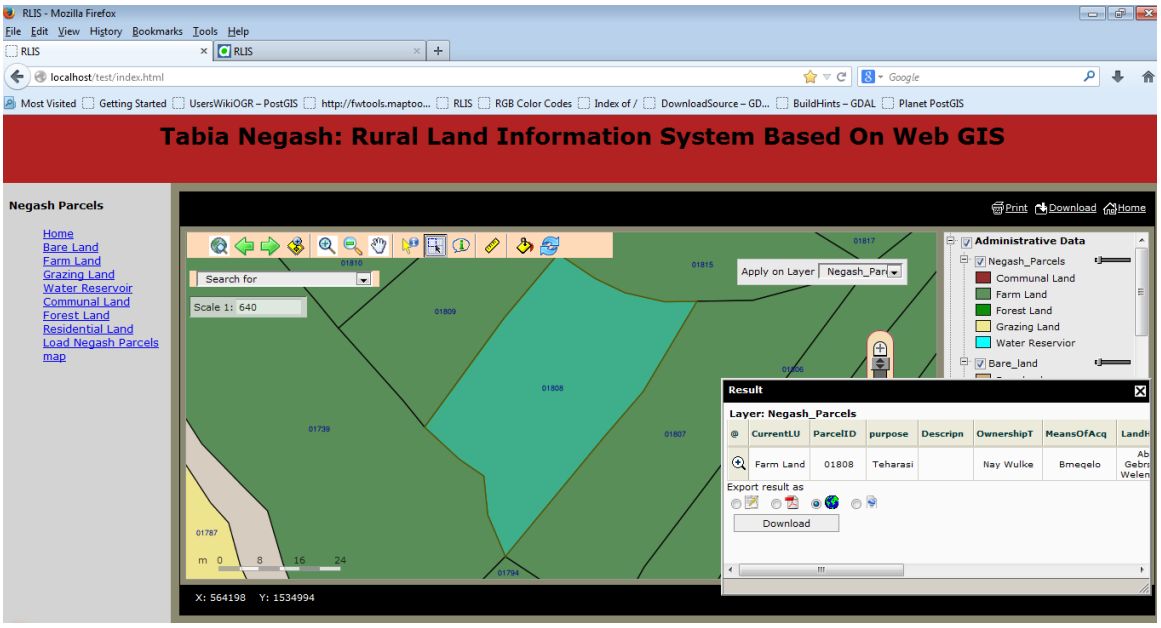

Figure 11: Selection Query Result

Usability Evaluation

It is obvious that the Rural Land Information System based on GIS developed is a usable and valid but rather it needs an exhaustive system and usability test. The system mainly focused on end users who have no or average knowledge of GIS. For this reason the system should be user friendly, in terms of workability of the system have to be usable and easy to use by the potential end users. According to the ISO/IEC 9126 quality model and quality characteristics the usability test used to check whether an application is easy to use or not by end users. In other words it answers the question 'is the software easy to use?' The main problem in undertaking the usability test in real situation, done by real users was difficult. Therefore the usability test was conducted by representative of users. There were a total of ten representative potential end users of the system who participate in the testing and evaluation process of the system. The test and evaluation was carried out on a standalone lap top.

Test Procedure

The test environment and equipment is set which is a standalone laptop computer followed by undergoing the testing. And finally the collected data were processed and a report is generated. Prior to the testing a task list of thirteen activities is given to the participating users. These are:

1. Display the land use map of NegashTabia from the home page link.
2. Zoom in to a certain parcel of the given cadastral map.
3. Go to the full extent of the map.
4. IS the layer containing the parcels of Negash turned on? If not turn it on.
5. What is the scale of the map in the current view?
6. Set the map scale to 1:40,000
7. Pan the map to the southern part of the map.
8. Chooser or select a single parcel on the map and find out the details of that parcel.
9. Select one parcel and measure the distance from asphalt road in the map.
10. Search for a bare land which has a fertile soil.
11. Search for a residential land with a parcel id equals to 117.
12. Zoom out to display the whole region of the map
13. Go back to previous scale and display extent.

RESULTS AND DISCUSSION

Results

The following Table 2 and graphs (Figure 12) are the summary of the results of the questionnaire completed by the potential users who participate in the usability test after undergone the thirteen tasks listed above on the TabiaNegash: Rural Land Information System based on Web GIS.

Presentation of the Web GIS Application

Table 2: Questionnaire Result for the Presentation of the Web GIS Application

Presentation of Web GIS	Layout	Ease of Use	Over All Rating
Excellent	2	3	2
V.Good	7	7	8
Good	1	0	0
Average	0	0	0
Poor	0	0	0

Among the ten users participated on the evaluation of the web GIS application most of them; more than 70 % reply that the layout, ease of use and overall rating are in very good status.

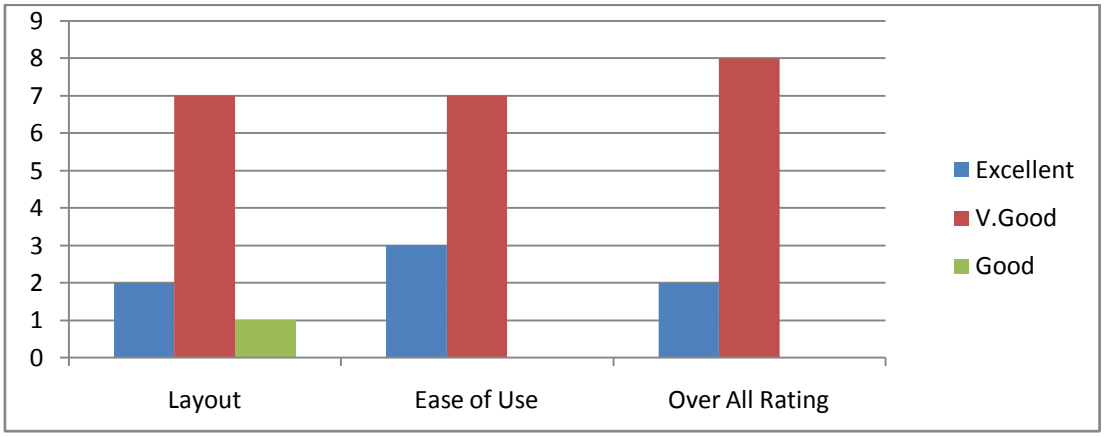

Figure 12: Graph of the Result for Presentation of the Web GIS

Analytical Tools

On evaluating the analytical tools provided by the Rural Land Information System based on web GIS resulted that 80 % of the respondents reply that the tools are easy to use. And 70% believe that the purpose and use of the tools are clear (Figure 13). Beside this all the participants of the evaluation test believe that the navigation tools are very easy to use.

Table 3: Questionnaire Result for the Analytical tools of the Web GIS application

Use of Analytical tool of web GIS	Ease of Use	Clarity of Tools	Ease of Navigation of Tools
Excellent	8	7	10
Very Good	2	2	0
Good	0	1	0
Average	0	0	0
Poor	0	0	0

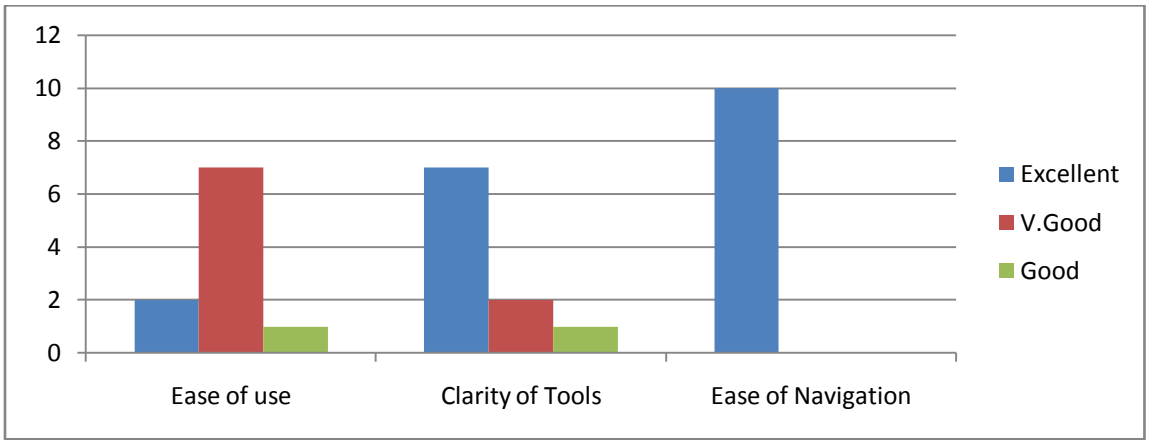

Figure 13: Result for Evaluating the Analytical Tools on the Web GIS

The difficulty level of the searching mechanism was tested and the result was 70 % of the potential users participate in the evaluation test of usability answer that the searching tool is easy to use and 10 % say that it is very easy and the rest believe that the searching tool is an average in easiness (Figure 14).

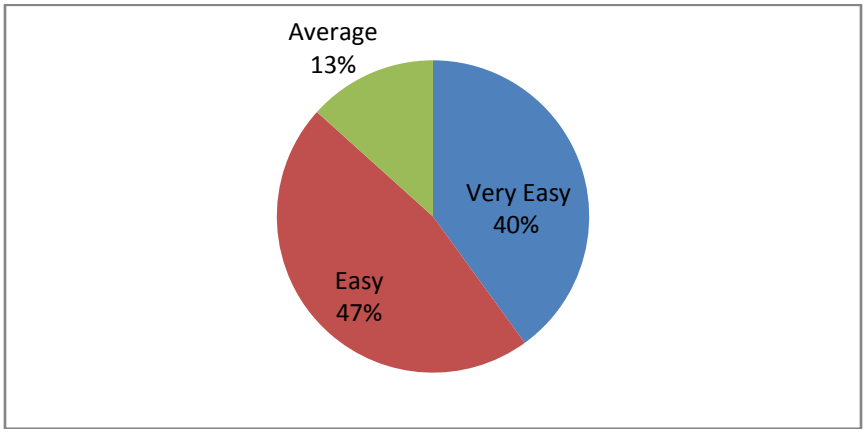

Figure 14: Test Result of Searching Tool

Among the users participate in the usability test 60% found that the searching tool is the most important tool of all the tools provided by the rural land information system based on web GIS. 20% indicate that the select tool is important and 20 % of the respondents reply that the measuring and identify tools are important in fulfilling their task (Figure 15).

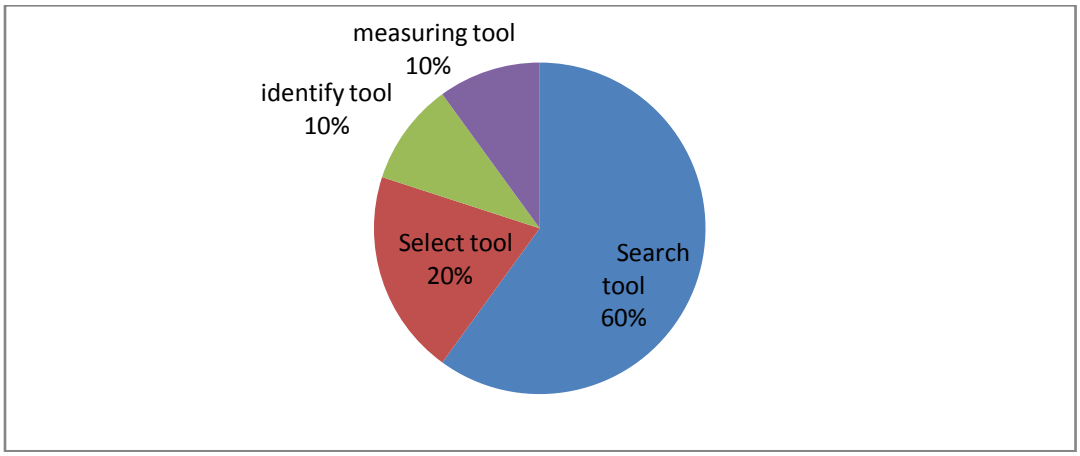

Figure 15: Test Result for Importance of Tools

Content

Among the users participate in the evaluation test of the Rural land Information System based on Web GIS for NegashTabia, most of the respondents about 70 % replied that the content of the system provides them with the information they intend to get from the application and 10 % said that the content of the system is good and the rest indicate that it is excellent (Figure 16).

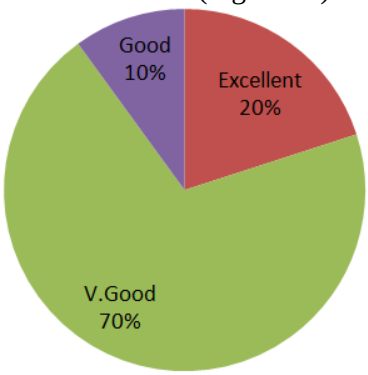

Figure 16: Test Result for Content of the Web GIS

System Test

In order to assure the web GIS works exactly to meet the expectations of information delivery and performance expectations, the developed rural land information system based on web GIS application was subjected to some testing procedures. Adopted from Kamachi *et al.,* (2013) the Rural Land Information System based on web GIS was tested with the following test check list. These are 1.Validation (Validate the HTML, Validate the CSS and Check for broken links, 2.Flexibility (Trying varying window size) and 3.Browser independent (Trying different browsers such as Internet Explorer, Mozilla Firefox, and Google Chrome and Switching plug in off in browser).

Discussion

The general objective of this research was to design and develop a Rural Land Information System based on Web GIS that allow decision makers and land developers to have spatial and non-spatial information enriched with analytical tools ready for decision support. Even though, there are different methods exist to disseminate and collect Rural Land Information in Tigray such as field trip and visiting different agencies and governmental organizations for data. This research proposed to use a web based GIS for collecting and dissemination of rural land related information. This method will allow land developers and managers an integrated (one-stop) information service. The information includes soil type, land use type, land use plan, land development prospects and so on.

In order to achieve the main task of developing a Rural Land Information System, the general objective of the research further divided into three specific objectives and in turn three research questions were drawn from the specific objectives. The three research questions are answered in the course of the research study in order to fulfill the general objective. The methodologies adopted to address the research questions are discussed below.

What is the Land Related Information Required in Rural Land Information System based on Web GIS according to users' Requirement? In order to address this question the researcher used the data collection methodology. Taking the literature review as a basis a questionnaire with seventeen questions categorized into five classes and an interview question guide was designed. The questionnaire was completed by the EPLUAA GIS experts and the interview was held with investors who were clients of EPLUAA at the time of the research study specifically the month of March. This method allowed the researcher to gather the users' requirement and the land related information required.

How to Design and Implement the General Framework for Rural Land Information System based on Web GIS?Having identifying the users' requirements, the researcher discussed the potential modeling and designing approach such as the object oriented approach. To design the system behavior, and the system structure, the researcher used the Unified Modeling Language (UML). The unified modeling process was chosen because of its interactivity and it ability to clearly depict the use case scenario.

Finally, how to develop prototype system of Rural Land Information System based on Web GIS with Online Interactive Analytical Tools that can be Useful to Organize and Present Rural Land Information to the Target User? In order to address this question, first a web GIS development approach was chosen. The main advantage considered for using this approach was because it delivers a working system in with a limited functionality at early stage which will gradually developed in to a fully functional system. This was mainly helpful for correcting bugs at early stage and this method allow adding of additional functionality in the design and implementation in the later iterations to come as slots of functions.

The third and the final task to address the above research question were the prototype implementation of the rural land information system based on web GIS. The prototype implementation begins by installing an open source mapserver packaged as MS4W 3.0.6 and p.mapper application software. The directories and all the subdirectories of the mapserver and the p.mapper were configured in a way to allow the running of the application. In the course of developing the prototype first the map file was coded and followed by configuration of the Config_default.xml file in the p.mapper to suite the prototyping of the proposed system.

The rural land information system based on web GIS is developed in accordance to the users' requirement. All the functionalities in the users requirement are implemented in the developed prototype

such as the navigate a map, search, query, measure, find x,y coordinate, print, identify are implemented. Most of the implemented requirements are generated from the one actor called client. The users requirement from the other actor namely GIS expert use case scenario are not implemented. The requirement from this actor includes registration of parcel and updating of database. The reason for not including these requirements in the developed prototype is shortage of time to implement these needs.

Conclusion and Recommendations

Conclusion

This research is about the development of a Rural Land Information System based on Web GIS. The study investigates the current practice in disseminating Rural Land Information and looked for an enhanced methodological approach in designing and implementing a system to address the current problem related in rural land information handling and management. This has been accomplishing through adopting three main methodologies feeding one to the other. These were: Desk research was used to bring existing scientific practices, local regulations and proclamations to the local research context. Case study approach has been used in order to concentrate on specific and existing real problems and practices on the ground as well as the system development approach to design and develop a working prototype system using the outcome of the above two methods as an input. Therefor the following points can be concluded from this study.

The development of web based rural land information system can serve as a means to disseminate an integrated information regarding land from different sources. This includes soil data, ownership type, current land use, planned land use and so on and this could significantly reduce the high cost to gather information regarding rural land from different sources and rom field visits. The system could also ease over-the-counter bureaucracy in gathering land related information.

Investors and managers are always tried to look for integrated information about a certain parcel regarding its soil type, current land use, distance from main roads, dispute type and ownership type. Developing a Web based GIS for Rural Information System using free and open source software with the least cost of development can be used to develop an integrated Rural Land Information System based on Web GIS. This present a chance to local governments to store, maintain and disseminate integrated data from different sources.The web base rural land information system provides users with the visualization of information and ready to use analytical tools. This helps decision makers and land developers in making sound decision making.

Recommendations

Even though in this study the researchers have tried to answer the research questions adequately, there are still issues which need further improvements and research. The following recommendations could contribute in improving the design and implementation to enhance the functionalities of the system.

Designing the system**,** in this regard the use case and the sequence diagram can be further extended to include for the client to handle an application for a land ownership certificate online. In this condition, further investigation and research could be done on how to extend the use case scenario and the database design to come with the system design for handling this scenario as well as the process of certifying clients need to be included.

Implementation,the researchersaimedat implementing a parcel registration and updating the spatial data base. In this respect the researchers have designed the use case and the sequence diagram for this scenario. However, we could not manage to implement this scenario due to the shortage of time. It would be interesting to implement all the designed scenarios.

REFERENCES

Adnan M, Singleton AD and Longley PA (2010). Developing Efficient Web-based GIS Applications. Department of Geography and Centre for Advanced Spatial Analysis University College London, Gower Street, London, WC1E 6BT.

Alesheikh AA, Helali H and Behroz HA (2002). Web GIS: technologies and its applications. *In Symposium on Geospatial Theory, Processing and Applications*.

Bertolotto M, Carswell JD, McGeown L and McMahon J (2010). Web-based spatial information management systems. Digital media centre, dublin institute of technology, Ireland.
Chen SC, Gulati S, Hamid S, Huang X, Luo L and Morisseau-Leroy Zhang C (2003). A three-tier system architecture design and development for hurricane occurrence simulation. *Proceedings ITRE2003, International Conference on Information Technology: Research and Education* (IEEE) 113-117.
Esri White Paper (2007). *Geospatial Service-Oriented Architecture (SOA)* (ESRI press).
Federal (2005). Negaritgazeta of the federal democratic republic of Ethiopia. 11thYear No. 44 Addis Ababa-15th July, 2005, Federal Democratic Republic of Ethiopia Rural Land Administration and Land Use Proclamation, Proclamation No. 456/2005.
Ibraheem AT (2012). Development of Large-Scale Land Information System (LIS) by Using Geographic Information System (GIS) and Field Surveying. *Engineering*, Published Online February 2012 (http://www.SciRP.org/journal/eng) **4**(2).
Jiulin N and Pinde Fu (2010). *Web GIS: its Application and Concept,* second edition (Esri press) ISBN: 9781589482456.
Kropla B (2005). *Beginning Map Server: Open Source GIS Development* (A press).
Luaces MR, Brisaboa NR, Paramá JR and Viqueira JR (2005). A generic framework for GIS applications. *In Web and Wireless Geographical Information Systems* (Springer Berlin Heidelberg) 94-109.
Mao L (2005). Web-based Information System for Land Management. A thesis Submitted to the faculty of graduate studies in partial fulfillment of the requirements for the degree of Master of Science master.
Mitiku Haile, Wray Witten, Kinfe Abraha, Sintayo Fissha, Adane Kebede, Getahun Kassa and Getachew Reda (2005). Research Report 2: Land Registration in Tigray, Northern Ethiopia. Mekelle University.
OMG (2005). Introduction to OMG's Unified Modeling Language. Accessed on Apr. 01, 2014, http://www.OMG.org/getting started/what_is_uml.htm.
OMG (2010). Unified Modeling Language. Accessed on Apr. 01, 2014, http://www.uml.org/.
Open GIS Consortium Inc. (2002). Web Map Service Implementation Specification 1.1.1. Open GIS project document: OGC 01-068r3.
Pascual M, Alves E, Roig H, Almeida TD, França GSD and Holanda M (2012). Architecture for Geographic Information Systems on the Web-WebGIS. *In GEO Processing 2012, the Fourth International Conference on Advanced Geographic Information Systems, Applications, and Services* 209-214.
Silva MA and Stubkjær E (2002). A Review of Methodologies Used in Research on Cadastral Development. *Computers, Environment and Urban Systems* **26**(5) 403-423.
The Map Server Team (2011). Map server open source web mapping. Map Server Documentation Release 6.0.1.
Theseira M (2002). Using Internet GIS technology for sharing health and health related data for the West Midlands Region. *Health & Place* **8**(1) 37-46.
Tuladhar AM (2004). *Parcel-based Geo-information System: Concepts and Guidelines*. ITC, Enschede.
UN (2005). Land Administration in the UNECE Region, Geneva, United Nations.
USAID (2004). Ethiopia Land Policy and Administration Assessment. Final Report with Appendices May 2004. USAID/Ethiopia.
Xiaolin Lu (2005). An Investigation on Service-Oriented Architecture for Constructing Distributed Web GIS Application. *Proceedings of the 2005 IEEE International Conference on Services Computing.*
Zahir A and Shakir M (2012). Implementing GIS-based Cadastral and Land Information System in Pakistan. *Journal of Settlements and Spatial Planning* **3**(1) 43-49.