



**ADDIS ABABA UNIVERSITY  
SCHOOL OF GRADUATE STUDIES  
MASTER'S PROJECT REPORT**

**Internet-GIS:**

**An application to Real Estate and Housing management  
in the City Government of Addis Ababa (CGAA)**

**BY**

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partial fulfillment of the requirements for the Degree of Master of Science in  
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## **Abstract**

GIS has become an indispensable tool for effective planning, communication, and training in the various stages for Real estate and housing management systems. The prime concern during any housing management system is the availability of the spatial information, and the dissemination of this information to all concerned bodies. Internet-GIS can play a key role in this aspect by providing cost-effective information at various stages for users of Real estate and Housing management system.

In this work the available models and important tools for the development of Internet-GIS applications are investigated and the appropriate ones are used. Moreover, observation and questionnaire are used to determine requirements of the proposed system.

To demonstrate this a system named as HISAA (Housing Information System of Addis Ababa) is developed. HISAA is an Internet-GIS application developed using an open source software, map server with a PHP scripting language. Users of HISAA can display mapfile on their browser from the central server and can Zoom-in, zoom-out and apply query to get certain house information.

## **Key words**

**GIS:** Geographic information system that enables to store, manipulate analyze and display spatial and non-spatial data.

**Spatial data:** Any information referencing location and other geographic features

**Internet-GIS:** It is the integration of GIS and Internet technology that helps to overcome information and data accessing problems without burdening end users with any GIS software

# **CHAPTER ONE**

## **1. Introduction**

### **1.1. Overview**

The Internet and Web are tremendously changing every aspect of our lives. Communication with business partners, commerce transactions, buying and selling goods and services, sharing and exchanging ideas and information, learning, software development, business and leisure activities and many others are possible by the use of Internet and web technology. The most Popularly Known Internet and Web based information systems include E-business, E-commerce, E-learning, E-medicine, etc.

Internet and Web technologies are applicable in every day human and business activities. The fundamental characteristics of these technologies include efficient data access, delivery over the Web, heterogeneity, and interoperability. The primary focus of Internet or Web use is for mass distribution and presentation of public information and distribution of software services over a network.[10].

The wave of Internet and Web technology has also reached to the Geographic Information Systems (GIS) research and development sector. Geographic Information system (GIS) is an emerging technology encompassing many disciplines namely geography, cartography, Geometry, remote sensing, surveying, GPS technology, statistics and other disciplines concerned with handling and analyzing spatially referenced data. GIS is mainly comprised of data handling tools for storage, retrieval, management and analysis of spatial data as well as solving complex geographical problems [4].

GIS can also be used for the generation of new information by the user-defined combination of several existing information. Because of the various distinguishing features of GIS, it is considered as an indispensable tool for conducting spatial searches and overlays and association of the spatial data with the non-spatial attribute data to eventually generate useful information.

The integration of GIS and Internet technologies is allowing GIS developers to provide access to geo-information and processing without burdening end users with complicated and expensive software and dedicated hardware.

Internet-GIS is a Geographic Information System (GIS) distributed across a computer network that integrate, disseminate, and communicate geographic information visually on the World Wide Web [1]. Internet-GIS technology provides dissemination, sharing, displaying and processing of spatial information over the Internet. Internet based geographical data services mainly involve sharing and management of spatial and non-spatial data. With Internet access and a web browser, larger and larger amounts of information can be made available quickly and conveniently to users.

Internet geographic information system, which can directly run on the Internet, is developed to transmit the geographic information data on the Internet and for real-time analysis, to distribute processing and calculating approach on spatial information data. [7] Internet-GIS provides a much more dynamic tool than a static map display. It enables the user to access Geo-referenced data and deliver interactive query capabilities such as:

- Searching for specific site locations
- Displaying and viewing multiple data sets
- Conducting queries for specialized analysis
- Retrieving specialized data services

Internet-GIS has a lot of importance in urban information management. One of these is, it can be used as a tool in real estate and housing management. So, there are a lot of GIS applications that could be of benefit for a housing management.

Housing Agency of Addis Ababa City Government is responsible in the development of housing policies and optimized usage of governmentally owned residential houses. Housing Agency cooperates with governmental offices, private investors and NGOs working in the alleviation of the public house problem.

For better management and coordination the Housing Agency has decentralized the responsibilities. The agency has branch offices at the Kifle-Ketema and Kebele level, which are responsible to public and Kebele house management. These branch offices select a site plan and decide on the areas that need to be considered for activities such as re-locating people and construction of Condominium houses. To decide on the areas that needs to be replaced by the new houses and to allow people to stay close to their old homes query-able spatial data is important.

Even then there is no GIS applications used at the main office as well as on the Kifle-Ketema offices. They use AutoCAD software as a visualizing application to see the area where new houses are going to be built. Which makes their activities difficult, as AutoCAD don't support spatial query.

## **1. 2. Statement of the problem**

The Kifle-Ketemas and the main office of the Housing Agency of CGAA use AutoCAD for the management of housing and residential areas. The office of Housing Agency of CGAA does not use GIS system for its applications. The fact that AutoCAD is not query able, and that the agency does not use GIS, has created a serious problem on the recently introduced decentralization management and the centralized control of the Housing of the city. A successful decentralization needs network access to a centrally manage datasets so that at the different Kifle-Ketemas viewing maps and querying certain information will be possible from the map server.

In this work we propose a system that will enable the Housing Agency of CGAA to execute its responsibilities more efficiently.

## **1.3. Objective of the project**

### **General objective**

Internet-GIS is a new technology that is used to display and analyze spatial data on the Internet. It combines the advantages of both Internet and GIS. It offers the public a new means to access spatial information without owning expensive GIS software.

The main objective of the project is to design and develop an Internet-GIS to the Housing Agency of CGAA so that branch offices at the Kifle-Ketmas can get an online access to the Addis Ababa house map.

### **Specific Objectives**

The specific objectives of this project are to:

- Explore the existing Internet-GIS tools and technologies
- Investigate the current situation in Housing management at the Housing Agency of the CGAA and identify the problems
- Design a model for Internet-GIS solution for the Housing Agency of CGAA.
- Develop a prototype to demonstrate the recommended tools and models.

### **1.4. Significance of the project**

Internet-GIS helps to maintain, manage, plan and analyze geographically referenced data on public utilities (water supply, sewerage, electricity) and development planning (town planning, roads and building, estate and land acquisition)[5].

Real Estate and Housing management is one part of urban management information system. This project can serve as a ground reference and initiative to develop Internet-GIS in other governmental and non-governmental offices. It also enables stakeholders of the Addis Ababa Hosing Agency to have spatial data access and make effective decisions. The following are some of the domain of applications that can benefit from the project result.

- For Real Estate and Housing management: An integrated Housing management at the different Kifle-Ketemas of the city with minimum cost can be possible to facilitate planning and decision-making.
- Data source for other urban managements systems: The information from this project can for example be used by Land Administration Authority for land use, ownership and planning.
- Can also be used by municipalities of other cities in the country.

## **CHAPTER TWO**

### **2. Internet-GIS Applications**

Internet is a vast collection of different networks that uses some common protocol and provides certain common services [8]. It is a super network made up of regional, national and international telecommunication networks that links computers found in educational institutions, government departments, and military establishments as well as commercial and non-commercial organizations all over the world [10].

The Internet is a client/server-based system where the client sends a request for service and the server processes the request and returns information to the client. The Internet, unlike other Client/Server based networked applications, is constrained by the network size, speed and administration [8].

Internet can be used for delivering digital files in multiple forms including text, picture, sound and animation, for exchanging files between computers, for a log-on procedure in accessing programs on remote computers as though they were local, for a mailing system to exchange messages among Internet users and for discussion groups which contribute information to communities of users in a particular area of interest.

Internet also enables to access and transmit data (including GIS data) and makes the user to use the data in their local machine with stand-alone GIS software installed. This is useful in the sense that it can facilitate users to obtain data more efficiently [6].

The tremendous growth of Internet use has resulted in an increased demand for the delivery of geographic data, maps, and applications over the Internet. The integration of GIS and Internet technologies is named as Internet-GIS, which allows for easy access to information and data without using any specific GIS software.

Internet-GIS focuses on the Internet technology and utilizes a distributed architecture framework, symbolizes and invisible revolution of GIS - from closed, centralized GIS to open, distributed GIS Services. Internet-GIS has been widely accepted in governmental agencies and educational institutions and among Geo-Spatial data producers and users, GIS vendors, and GIS professionals. GIS products can easily be distributed to every desktop in an organization through the Web server and to the general public through World Wide Web communications [11].

The organization can centralize the maintenance of GIS data and decentralize the GIS applications. Using the Internet, GIS data can easily be updated, and users can gain access to the applications and information they need for specific tasks.

Internet-GIS opens many new possibilities such as geographically communicating with other people in presenting ideas and integrating information or making the right decision in figuring out which is the nearest house to certain road.

Furthermore, interactive maps often let the user query the data in order to derive more useful information such as what are the spatial features of a parcel or block in comparison to traditional maps that are static and also for displaying multiple data sets. The question of data sharing gets more important at the same time as digital data resources are growing with the expansion of the World Wide Web.

The applications of Internet-GIS according to [4] are growing rapidly due to the services the user acquires. Some of these are:

- Displaying static maps, which users can pan or zoom.
- Provide data that are kept secure at the server side.
- Provide maps and data across the network or Internet
- Creating user defined maps online.

Due to increased productivity, improved customer satisfaction and reduced cost, Internet-GIS is gaining more popularity in the GIS users' choice [3]. In general Internet-GIS can distribute GIS data and geo-processing tools to a broader range of potential users that conventional GIS implementation may never reach.

## **2.1. Internet-GIS Architecture**

The basic approach for deploying Internet-GIS application depends on the user requirements that have to concern with which Internet-GIS packages are suitable to accomplish their objectives [1].

Developments of Internet-GIS are changing as fast as Internet and Web technologies. Because one depends on the other. Internet applications can be built with a variety of object-oriented languages, such as Visual Basic, Visual C++, JAVA and DELPHI. On the client side of Internet-GIS more and more people will access geographic information directly by means of programs like Internet Explorer. According to [9] there are basically two types of architectures for developing Internet-based GIS applications: client-side, and server-side.

### **2.1.1. Server-side strategy**

In a server-side Internet-GIS application, a Web browser is used to generate server requests and display the results on client-side browser. An Internet-GIS server usually combines a standard Web (HTTP) server, GIS application server, and the GIS databases and functionalities that reside completely on the server.

As it is shown in figure.2.1.users interact with the client machine and type the address they are looking for (the request), which is transferred to the Web server. The Web server passes the request to the GIS application server, which runs an address matching routine, generates a map graphic, convert the graphic to Web format, wraps the image in HTML and sends it back to the Web server, which then returns the response to the client as a standard Web page.

Map data transmitted to a Web client are in standard HTML formats that can be accessible through any Web browser, creating significant positive implications for performance, reliability and size of user base.

Because of the entire complex and proprietary software, as well as the GIS databases resides on a server, it is easier for simplified application development in Server-side

applications for deployment and maintenance of data. But server-side solutions are primarily associated with poor performance and limited user interface and interaction.

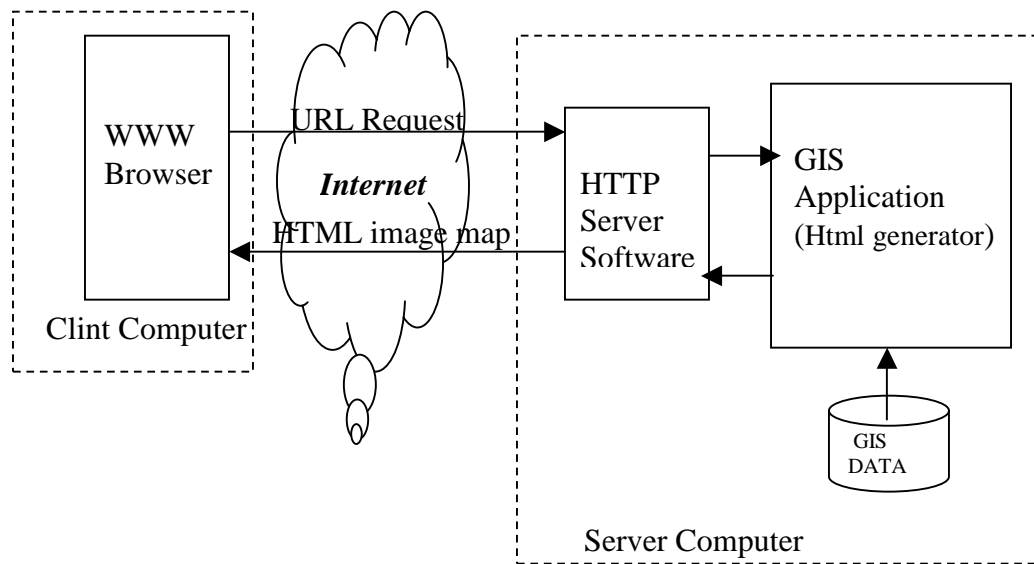


Fig.2.1. Server side Internet-GIS application [9]

### 2.1.2. Client-side strategy

Client-side Internet-GIS applications can provide full GIS analysis and management support to specific users within business, government or public sectors. In a client-side Internet-GIS application, users are required to install a complete client application. In such systems, either a substantial amount of GIS functionality is moved to the client, or only the user interface is enhanced slightly to enable specific user interaction. In either case client-side application require software of some kind (other than browser) to be transferred to the user. In client-side Internet-GIS, the client system should be enhanced to support GIS operations. That is, to implement client-side solutions, software must be transferred to the client [9]. Client-side solutions can be implemented with all the features and capabilities allowed by a modern graphical user interface.

Multipoint feature selection, and selecting an area by dragging a window and a modal cursor operations controlled by clicking on menu icons are capabilities available in client-side products that aren't available in server-side implementations.

Core GIS operations like editing, buffering, overlay analysis and route tracing are examples of operations that are enhanced by exploiting vector data structures on the client side without re-transmitting a request to the server. In the client-side Internet-GIS applications, the client and the server process different tasks. This division of the tasks allows the system to speed up the data transfer between server and clients. [9]

As it is shown in figure.2.2, in client-side Internet-GIS, the main tasks will be processed in the server, which is basically delivering files. The server receives request from the client and starts to communicate to the database and retrieves attributes of the map stored in the database. The GIS application server has also direct access to the map file. The map file could be SHP, DXF, etc and used to create map files like lines, point, area and labels. The server provides the client with raw data map and HTML image.

The primary advantages of client-side solutions are the abilities to enhance user interfaces, improve performance and implement solutions using vector data. It has significant advantage on the performance. This is because window display changes can happen without re-transmitting a request to the server.

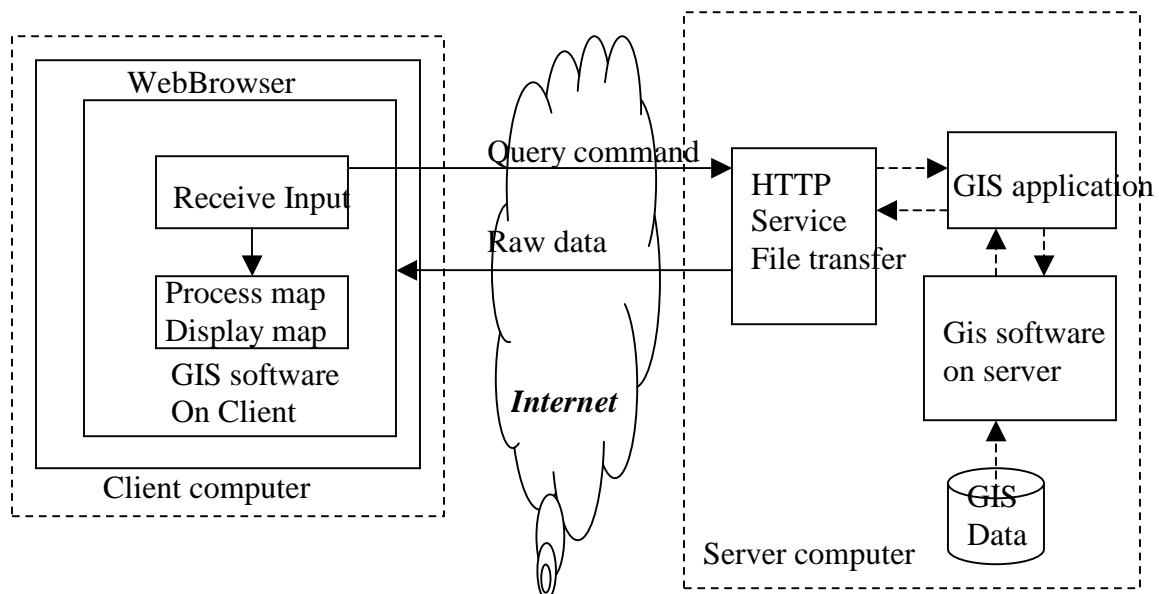


Fig.2.2. Client side Internet GIS application [9]

The disadvantages associated with client-side solutions are related to distributing software and data. Distributing software is problematic. Some potential users will be lost due to platform incompatibilities, some users will undoubtedly have difficulties loading software, and providing technical support is time consuming and expensive.

To overcome the limitations a hybrid solution can be used [12]. In the hybrid Internet based Geographic information systems i.e. client /server systems, the server holds data possibly in relational database management system and desktop clients use standard browser software to view those data

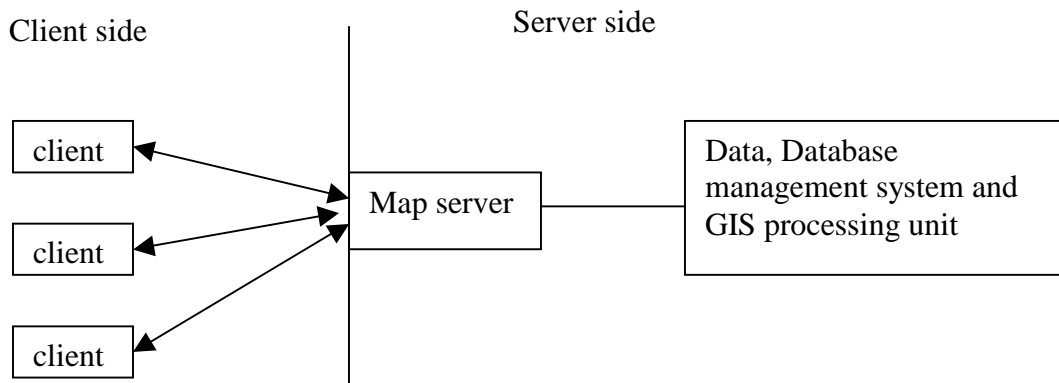


Fig.2.3. Hybrid or Client/Server Internet GIS application [12].

As it is shown in figure2.3.above the client browser program sends a URL request to the server and the server processes the map and finally a file is transmitted from the server to the client. The server side usually consists of many technologies that are working together such as databases and GIS processing unit.

The Internet map server typically provides functions to allow zooming or panning around map images. The client requests a map image from a server and the Internet map server creates a map based on the request from the client as a graphics file GIF, PNG or JPEG [4]. A map server performs GIS operations and sends the results of the operation to the client browser, which will be displayed as images or text or a combination of both. The server and client communicate using a protocol like HTTP [2].

## 2.2. Experience of others using Internet-GIS Applications for municipality applications

### 2.2.1. GIS for land use and housing in a district of Hochiminh city of Vietnam

Hochiminh city (HCMC) is the biggest city in Vietnam. It has over 6 million residents, over 1 million immigrants and 1 million visitors. HCMC consists of 23 districts including 17 urban and 6 suburban districts as shown in figure 2.4.

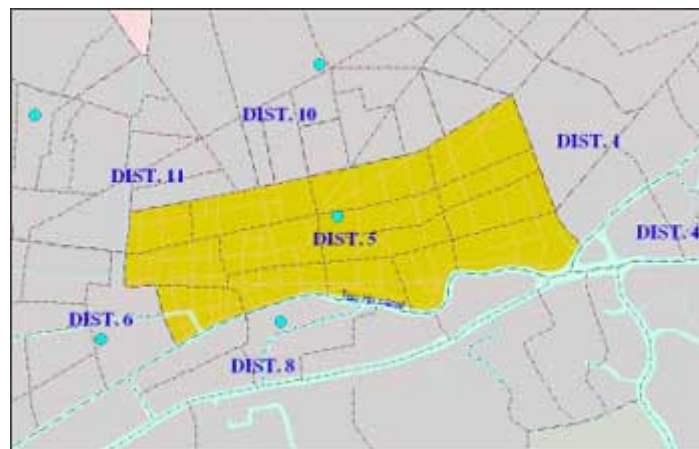


Fig.2.4. Suburban districts of HCMC [13]

District 5, which is shown above in figure 2.4, has a lot of schools, hospitals, and entertainment places. It is 4.14 square kilometers, 4 kilometers long and 1 kilometer wide. It is surrounded by district 1 on the east side, district 6 on the west side, district 10 and 11 on the north side, and district 8 on the south side. The Tau Hu canal passing district 5 and separating it with district 8 makes it more beautiful.

The district 5 governmental agencies encounter a lot of difficulty in activities of the urban management. The processing, analytical and data storage capabilities of computers have given public agencies that have invested in such systems a great tool for accomplishing their duties. The ability of GIS to store, manage and manipulate large amounts of spatial data provides urban managers with a powerful tool. [13]

This paper focuses on how GIS has been applied to establish, maintain, and analyze urban and land-use information to support the functions of local government in district 5, Hochiminh City (HCMC), Vietnam.

The objective was:

- To design and implement GIS database for land use and Housing management for district 5
- Implementing in a centralized manner to keep it with an existing official management

### **GIS model for district 5 of HCMC**

In order to be linked with an existing official management, the system should be a centralized one. This centralized system needs one server computer that stores all of GIS data in one geo-database while other client computers connect to the server to exchange data through a backbone network as shown below in figure 2.5.

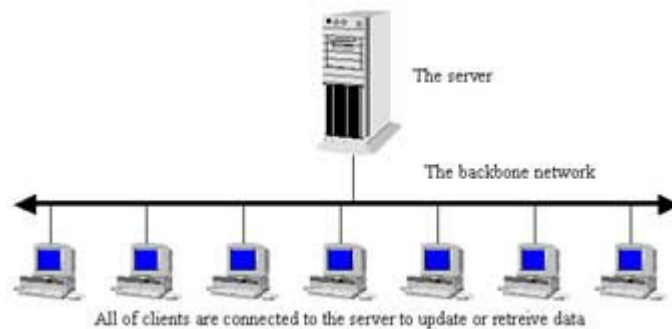


Fig.2.5. Internet-GIS network of the district [13]

Hardware and Software Requirements of the system are:

- Pentium II workstation (Client Side Browser)
- Web Server
- Database Server
- Mapping Server
- Network (Intranet/ Internet)

The applications that the users can acquire from the system include:

- Both the district's staffs and the citizens can use it.
- It supports users to identify, query, and count up data.
- Users can retrieve data from database rather than update data.
- Data to be retrieved can be spatial or attribute data.
- Results produced by these tools are reported on maps or on forms.
- The toolbox is a good tool for people to retrieve land-use and housing information in a short time

### **2.2.2. Web-GIS based urban planning and information system for municipal corporations**

Urban Planning and Information System is an Internet -GIS based application system, which have been used for automating the day-to-day operations of Nashik Municipal Corporation (NMC).

Nashik or Nasik is a city, and also a district and division, in India's Maharashtra state. Nashik is in the northwest of Maharashtra, 200 km from Mumbai (Bombay) as well as Pune. The city, located in the Western Ghats, has become a center of attraction because of its beautiful surroundings and cool and pleasant climate. Nashik has a personality of its own due to its mythological, historical, social and cultural importance. The city, vibrant and active on the industrial, political, social and cultural fronts, has influenced the lives of many a great personalities. The Godavari River flows through the city from its source to the northwest of the city.

The city is home to an important thermal power plant (Eklahare) and a National Treasury Printing Press (India Security Press in Nashik Road). There are 3 'Industrial Estates' in the metropolitan Nashik area and outskirts (Satpur, Ambad and Sinnar)[5]. Among various companies that have operations in these industrial estates are Mahindra, MICO (Bosch), VIP, Crompton Greaves, Glaxo, etc.

Nashik is also famous for its grapes, and ongoing efforts are underway to promote the growth of an export-oriented wine industry in the district.

As it is noted in [5] the paper shows the use of GIS and Internet technology for Municipal Corporation of India, which has been illustrated with a typical case study where the urban planning and information system is implemented for use.

There are two indigenously developed Web-GIS solutions namely PUPIS (Public Utility Planning and Information System), which is useful for utility functionalities like water supply, sewerage operation and electricity network and DPIS (Development Planning and Information System), which is useful for town planning and related departmental activities [5]. The functioning of all the 11 departments of this corporation has been integrated into a single system using the above two solutions.

The system addresses holistic approaches to solve bunch of Municipal issues based on a client - server architecture. All the three basic modules under this system, Data Entry, Reporting, GIS - based Query, can be accessed from the remote client machines located in corporations' ward offices using a browser. The only perquisites being that the terminal nodes (Ward Offices) are connected to the server (Head Office) via Internet or Intranet. Data Entry screens are used for entering data related to the various entities related to functional requirements of all the departments.

Reports (maintenance) are generated periodically for each department using the report generation facility provided within the system. These reports provide department-wise consolidated information regarding a particular entity for a given period. GIS based query is the most important module of this system since the visualization of data and maps are the main criteria for planning and decision-making.

All in all the system helps to maintain, manage, plan and analyze geographically referenced data on public utilities (water supply, sewerage, electricity) and development planning (town planning, roads and building, estate and land acquisition, accounts, fire, health and sanitation, property taxation, encroachment, garden).

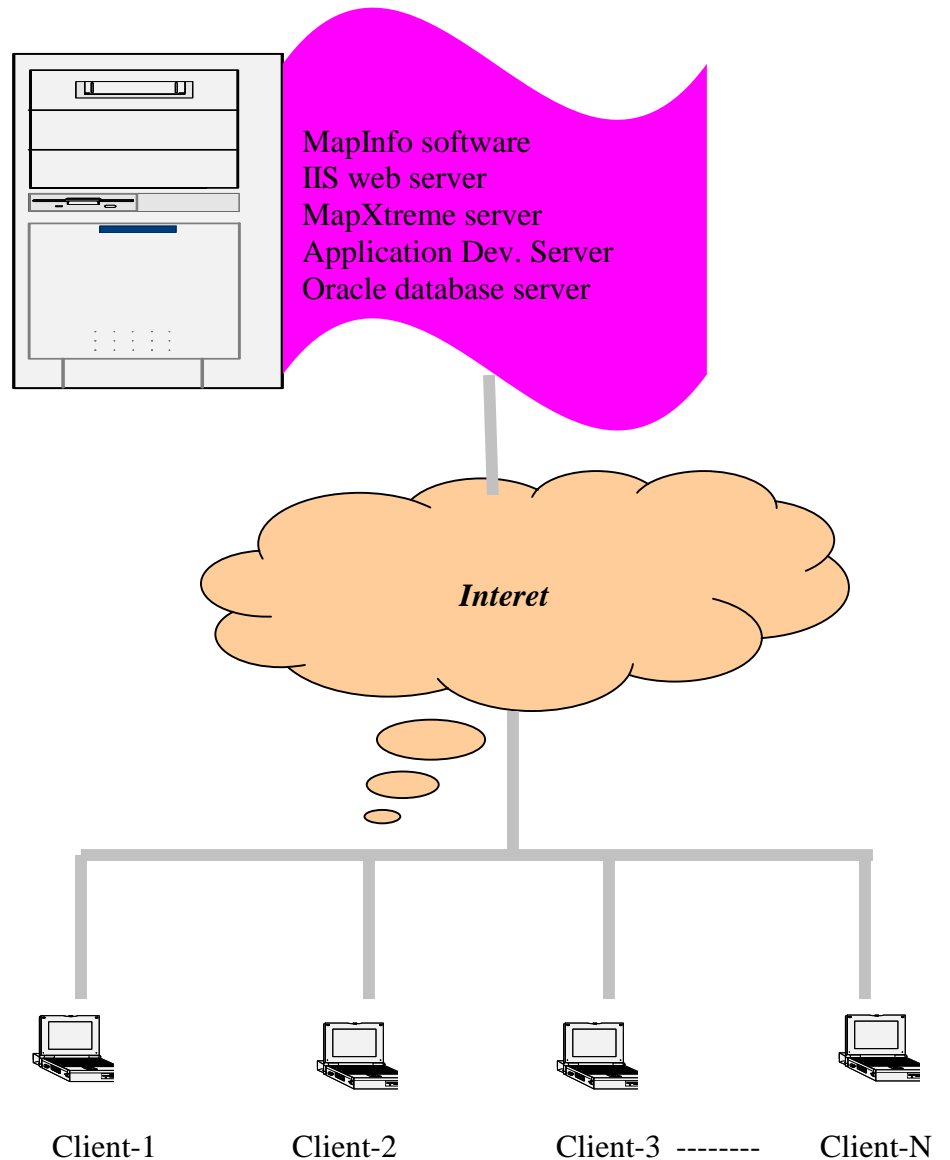


Fig.2 .6. Urban planning and information system networking [5]

As it is shown above in figure.2.6, the system amalgamates MapInfo's, MapXtreme server, Oracle8i database server and Microsoft Internet technologies like Active Server Pages (ASP) and Component Object Model (COM). This system shows the spatial and attributes data of map layers.

The map features are stored in the MapXtreme server as layers or geo-sets. These layers are used with the database attributes for visual display of information that is required for urban planning and information system. The system requires Microsoft Internet Information Server (IIS 4.0) Web server to host the system and available to the users via web browser.

Hardware and Software Requirements of the system as it is noted in [5] are:

- NT Server, 512 MB RAM, 40 GB HDD
- Pentium II workstation (Client Side Browser)
- IIS Web Server
- Database Server
- Application Server
- Mapping Server
- Network (Intranet/ Internet)

The functional and technical benefits as it is noted in [5] are:

- Interdepartmental information sharing and communication
- Better planning of public utilities services and Town Planning
- View and presentation of municipal information
- Geographic database (GDB) creation and maintenance
- Perform spatial queries, spatial modeling and analysis like where are all suitable sites to build new schools, buildings, shopping malls etc.
- Tools to query, analyze, and map data to support decision making process
- Planning & Management of Utility and Town Planning Database
- Ease in Maintenance and better monitoring of municipal resources
- On-line Decision-Making

## **CHAPTER THREE**

### **3. Problem Identification**

#### **3.1. Overview**

In Addis Ababa there are a lot of governmental and non-governmental offices that give services to the people in different areas. One of the governmental organizations that provides and manages houses in the city is the Housing Agency.

The Addis Ababa Housing Agency is institutionalized to organize and manage governmentally and privately owned houses. The Agency also facilitates and coordinates organizations that build houses for public use in the city [15].

Housing agency of the City Government of Addis Ababa (CGAA) keeps data of houses to administer, manage houses of the city, which will help for better use for study and policy development.

This data according to [15] includes:

- Year of construction
- Addresses (House No, block No, Site name, Kifle-ketema, kebele etc.)
- Agreement document
- The material by which the house is made of
- Number of rooms
- Income of the Resident
- Plot land area of the House
- Total expense for the construction

In addition to this, the Agency has activities to properly manage the Housing data and provide information to the users when needed. In order to specify the requirements of the Agency on how it is providing spatial and non-spatial housing data to other offices, an interview, a questionnaire and close observations are conducted on the Agency employees, three selected Kifle-ketema workers and also on customers of the agency.

The interview as well as the observation made helps to get information on how the housing agency is doing its activities, how it keeps records, how the agency communicate with other offices, the technology used for data management and communication and problems occurred.

### **3.2. Analysis of the Responses**

From the responses of the respondents and also from the observation made, the Housing Agency exchange information with the Kifle-Ketemas, the NGO's who are developing houses to the public and with House development progress office. The technology used for the exchange of information includes telephone, data CDs and floppy. These technologies didn't support them for:

- Quick decision making
- Better resource utilization
- Better communication
- Coordinated performance

Hence the different Kifle-Ketemas of the city didn't get the necessary information on time and it is common to perform the same activity repeatedly.

According to the response obtained, there should be better communication system that helps all stakeholders of the Agency to communicate efficiently and perform their activities in coordinated way.

The interview and the observation are made on those who are working in related areas on land and house development offices of ARADA Kifle-Ketema, LEDETA Kifle-Ketema and ADDIS KETEMA Kifle-Ketema.

According to the response of the respondents the duties of the Kifle\_Ketemas in relation to housing management activities include:

- Control and inspect house development in the Kifle-Ketemas
- Putting the orders of the housing agency in to practice
- Site selection and site plan preparation
- Discuss about the selection Site with the Agency

The selected Kifle-Ketemas doesn't use computerized system to their activities. The Kifle-Ketemas share information with the Housing Agency to perform activities that include:

- Supervision of sites in which houses are being developed
- Regarding orders from housing Agency to lower levels
- For Experience sharing with other Kifle-Ketemas
- For Site plan approval by Land administration office

But due to the communication technology they use there are some problems observed.

These include:

- Unable to perform their activity according to the plan designed
- Difficulty to get quick information from other offices of the city
- Performing the same activity repeatedly
- Transport problem for inspection and supervision of sites

### **3.3. Recommendations**

From the result of the analysis there is a need for an automated, more organized and integrated housing information system that include spatial and non- spatial data. I therefore recommend an Internet-GIS system to the Housing Agency of the CGAA. To realize this recommended system the needs of the housing agency in general include:

#### **Database system**

A database management system that will represent detail information on houses i.e., residents of the house, type of house, structure of the house, location, economic condition of the residents, etc The information should include spatial and non-spatial data.

#### **Networked systems**

Currently the Agency doesn't have networked system. To communicate with other office posts, CDs and telephone are used. These communication technologies will not enable for reliable exchange of data and quick decision-making. A networked system will allow the Agency to easily communicate and share information internally and externally with other offices. It also enable users to access spatial data without installing GIS software.

#### **Use of better GIS software**

Currently the Housing Agency of the CGAA uses AutoCAD to visualize housing map of the city. The AutoCAD used is helpful only to provide visualization application. But there is a need even more than visualization like querying, updating etc. The use of better GIS software enable workers with better GIS service and also for spatial analysis.

## **CHAPTER FOUR**

### **4. System Analysis**

#### **4.1. The Housing Agency of the CGAA**

The Addis Ababa City government is organized in a decentralized form in various governmental offices. The administration is organized in to different functionally authorized agencies and 10 kifle-Ketemas (city blocks). Housing Agency is one of the agencies institutionalized to facilitate the working of the administration. The different agencies of the administration will work together for the effectiveness of the whole system in general. The working flow of the agency is given in figure 4.1 below [15]. As can be seen from the figure the Housing Agency, for construction permit, works in close collaboration with the Land Administration. This shows that in addition to the communication between the different offices with in the Agency, there is a communication requirement with the Land Administration Authority. The design of the new system should consider this fact.



The Housing Agency of CGAA manages governmental renting as well as privately owned houses in the city. The agency is not organized with respect to human power and so has problems in proper management and coordination of activities. The agency uses AutoCAD software for the visualization of the housing dataset. This software does not support for spatial analysis. Moreover, when a new site is surveyed for construction the site plan will be drawn on the same location of the master plan and is saved in a separate file. The master plan is AutoCAD based which is known as Nortech. The Nortech is used as a base map and identifies parcel and some other feature of the city. The parcel is based on blocks, zones, kebele and hose numbers.

Currently the Agency decentralizes its responsibilities to Kifle-Ketema level. In each of the Kifle-Ketemas, there are branch offices that manage and coordinate governmentally and privately owned houses. The kifle-Ketemas are also responsible for site selection for the construction of public houses. These Kifle-Ketemas use the Nortech data, which is on CD, as a base map for their activities.

## **4.2. Requirement Analysis**

The housing agency of CGAA has responsibilities for efficient service provision in the city. The following are the weaknesses of the agency on its current practice regarding housing information management [15].

**The agency works closely with Land administration, Land development Agency, and Kifle-Ketemas, etc. Even if they need to work in harmony for better performance the current system is not capable for reducing and avoiding redundant works in the different offices. This results for the wastage of human resource and utilization of inconsistent information.**

The house information is paper based and also the non-spatial data of the clients, i.e. renters is not integrated with the spatial data.

**The Database found in Land Administration is not used by the Housing Agency. This database is designed with visual foxpro and has full information of houses in the city like size, material used for development, owner, location etc. The Land Administration provides information about the clients to the Agency after the data is imported to data sheet.**

**The current system couldn't help to locate a house in the city given Kifle-Ketema, kebele and house number though it is very important in bigger cities like Addis Ababa.**

**The Agency, even if it is decentralized its activities to Kifle-Ketema level, it is highly difficult to share housing map. This is because there is no integrated information system in use and also no local area network that links the Agency with other Agencies and branch offices. So a client need to use a separate housing data stored in digital CDs and possibly there will be inconsistency of information usage.**

Although the requirements of the Agency as it is listed above are too much, this project will try to propose a solution to the communication problems of the agency with Kifle-Ketema branch offices. This is by using Internet-GIS application. With this regard the use case diagram that depicts requirements identified are shown in figure 4 .2.

### 4.2.1. Use case diagram

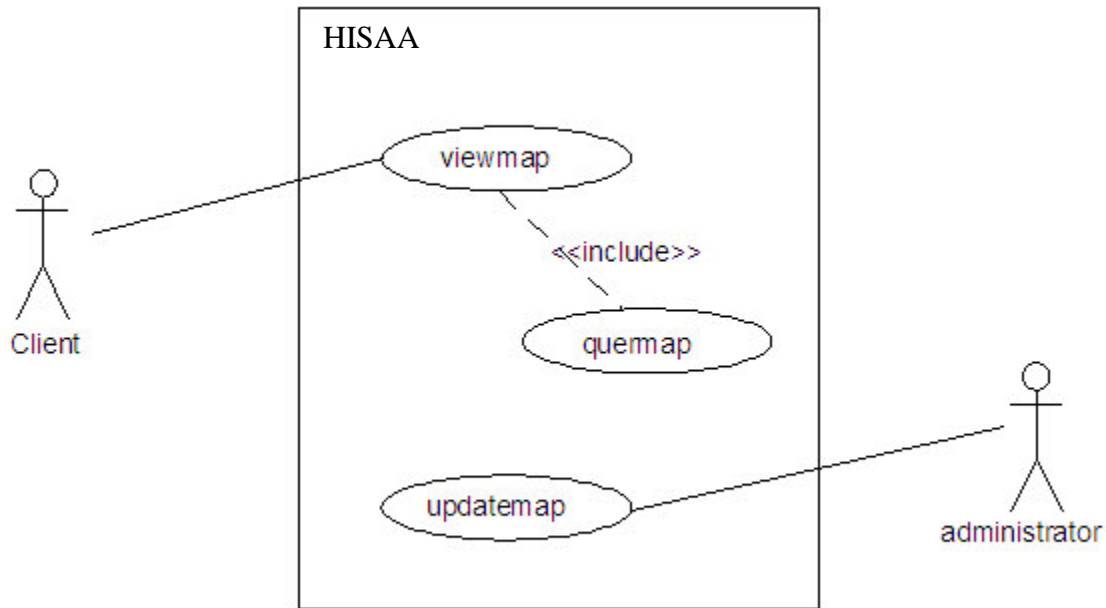


Fig.4 .2. usecase model for the proposed system.

#### 4.2.1.1. Usecase Descriptions

Viewmap usecase.

Use case name	Viewmap
Participating Actors	Client initiates the “viewmap” functionality by typing the URL on their browser.
Entry condition	<ol style="list-style-type: none"> <li>1. Client types the URL on the browser to view house map</li> <li>2. HISAA displays login form</li> <li>3. The client types the username and password and submits.</li> <li>4. HISAA authenticates and displays the house map that contains information like house No, Kifle-Ketema, Kebele of the house etc.</li> <li>5. The client zooms or pans the house map.</li> </ol>
Flow of events	
Exit condition	<ol style="list-style-type: none"> <li>6. Client closes /logs out from the system.</li> </ol>

Table 4.1. Viewmap Usecase description

### Updatemap usecase

Usecase name	Updatemap
Participating Actors	Administrator initiates the “Updatemap” functionality by typing the URL on their browser.
Entry condition	1. Administrator types the URL on the browser to view house map
Flow of events	2. HISAA displays login form 3. The Administrator types the username and password and submits. 4. HISAA authenticates and displays the administrator website. 5. The administrator makes changes on the house map, like modifying block size, house No change., Kifle-Ketema change etc.
Exit condition	6. The administrator commits changes and logs out.
Special condition	7. The system should enforce session expiry after 30 minutes..

Table 4.2. Updatemap Usecase description

### Quermap usecase.

Usecase name	Quermap
Participating Actors	Client communicating with Internet-GIS.
Entry condition	1. Uses the “viewmap” usecase, which displays the house map to the client to view, zoom and pan.
Flow of events	2. The client clicks the query button. 3. HISAA displays the query result. 4. The client views and saves the result
Exit condition	5. Client closes /logs out from the system.

Table 4.3. Quermap Usecase description

## 4.2.2. Dynamic Model

### 4.2.2.1. Sequence Diagram

The sequence diagram represents the sequence of actions that will be performed in the system.

#### *Sequence diagram for viewmap usecase.*

The sequence of actions for the viewmap usecase is that the client will type the URL of the HISAA site on the client Browser. The HISAA displays login form for authentication. The client will type the userID and password and submits it. HISAA displays the Housing map for authenticated users. The user can then view, pan Zoom or press query button to see the features of that particularly selected block. The diagrammatic representation is shown in figure 4.3.

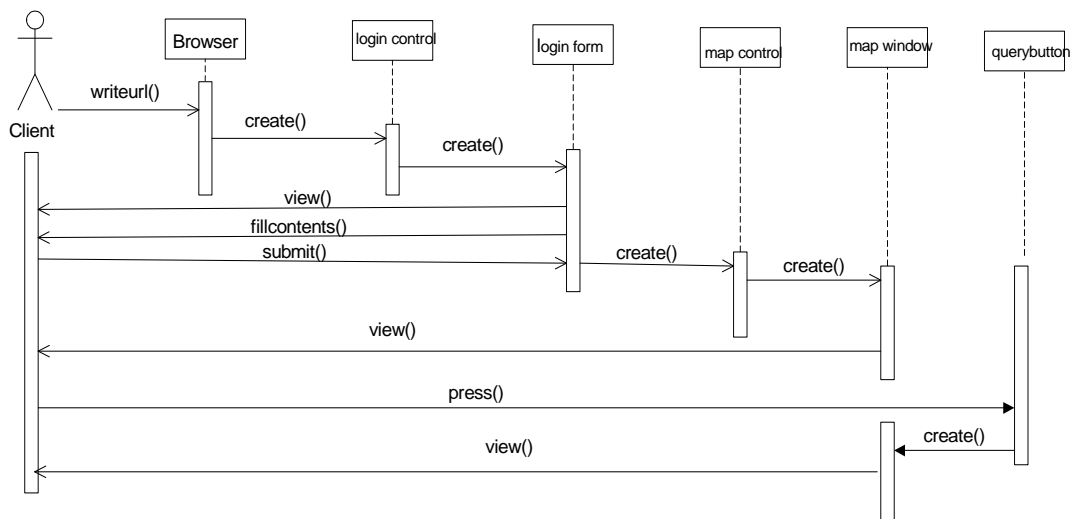


Fig.4 .3. Sequence diagram for viewmap use case.

## Sequence diagram for updatemap use case

The sequence of actions for the updatemap usecase is that the administrator will type the URL of the HISAA site on the client Browser. The HISAA displays login form for authentication. The administrator will type the userID and password and submits it. HISAA displays the Housing map after the authentication. The administrator can then modify the colors, contents, extents, add layers, remove layers etc and commits changes. The diagrammatic representation is shown in figure4.4.

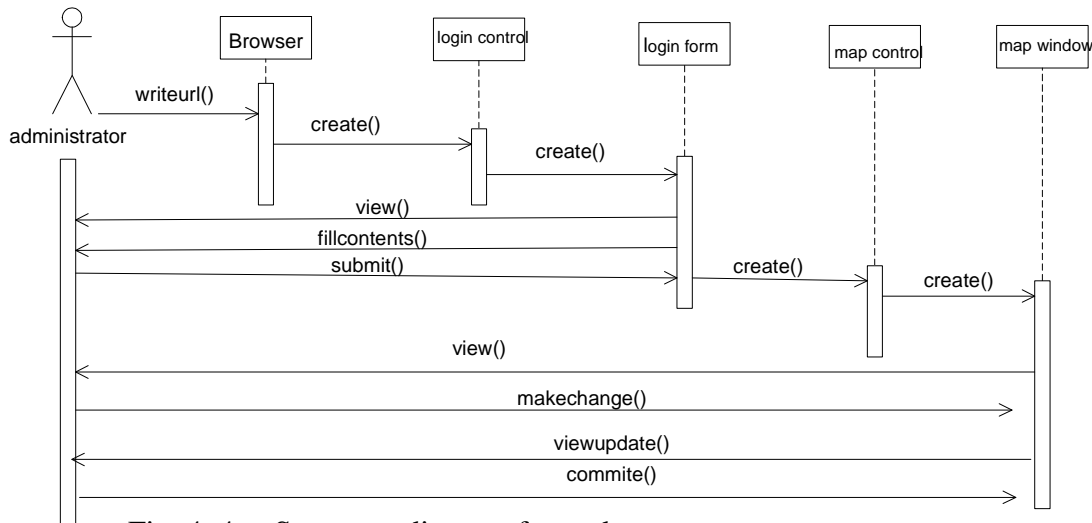


Fig. 4 .4. Sequence diagram for updatemap use case

### 4.2.2.2. Activity Diagram

The activity diagram depicts the activities performed on the House map. These are view map, update map and archive map as shown in figure4.5.

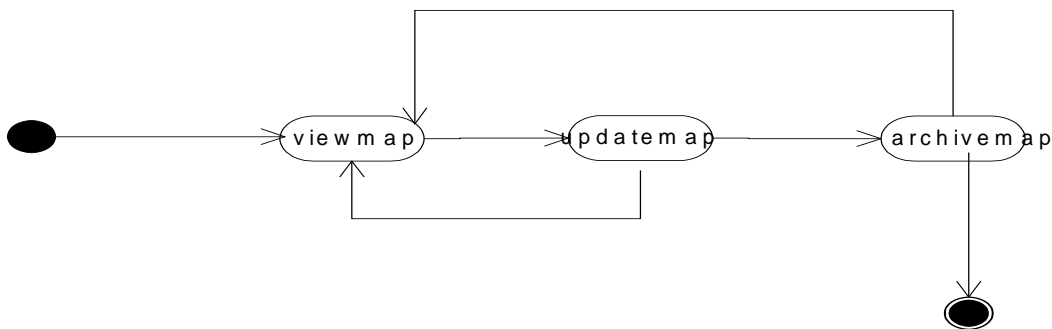


Fig.4 .5. Activity diagram for house map

### 4.2.2.3. State Diagram

The state diagram shows the different states that could occur on the house map from the beginning to the end. The states of the house map are shown in figure 4.6.

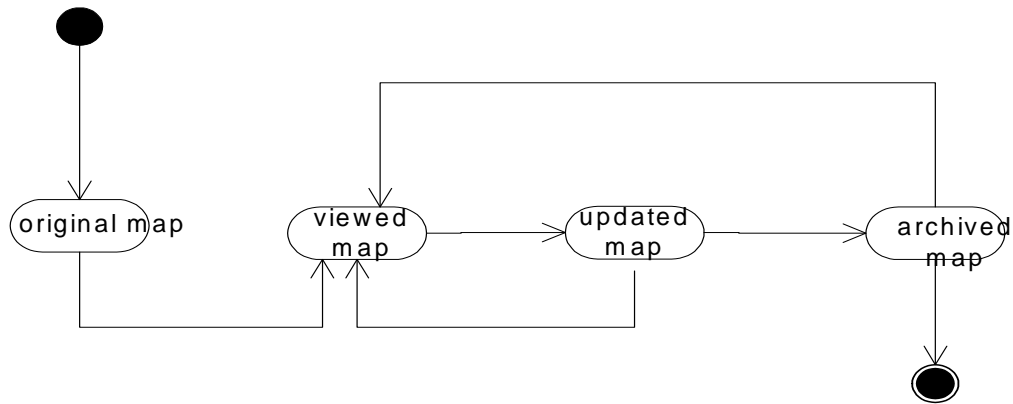


Fig. 4 .6. State diagram for house map.

### 4.2.3. Object model

This object model represents the real objects that are found in the system. The objects of the proposed system are:

**Client:** The client has name (ID), password as an attribute and can view and create query.

**Administrator:** Like any Client administrator has attributes name (ID), password and can view, create query, update and commit changes.

**House Map:** It has attributes house No, Kebele, location, etc and method post.

The object model/class diagram is shown in figure 4.7.

### 4.2.3.1. Class Diagram

The class diagram depicts these objects together with their relationship.

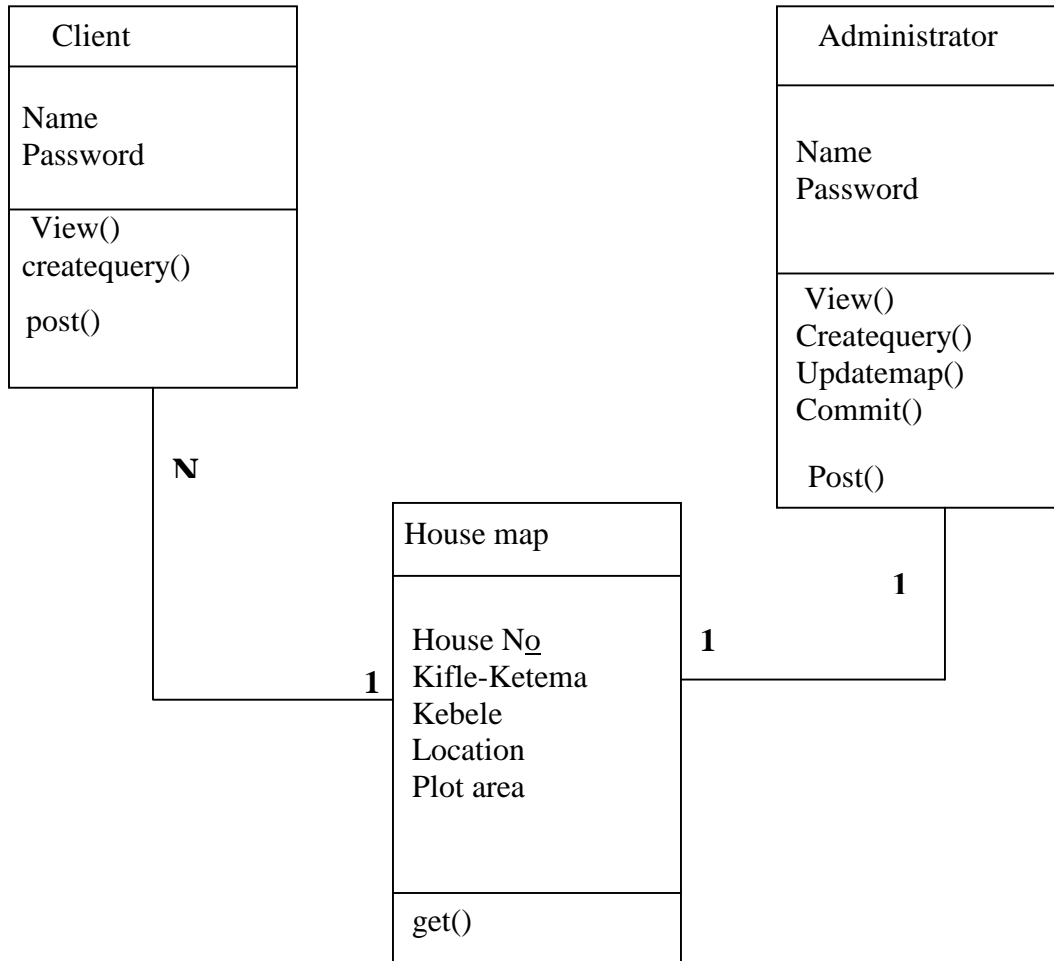


Fig.4.7. Class diagram for the proposed system.

### 4.3. Design of the System

The system design based on the requirements identified will have a client/server approach in which the client will have web browser used for the interaction with the server and display image map to the client. On the server side there will be secured web server with map server software to convert the shape file format to HTML image generator. The system design is depicted in figure.4. 8.

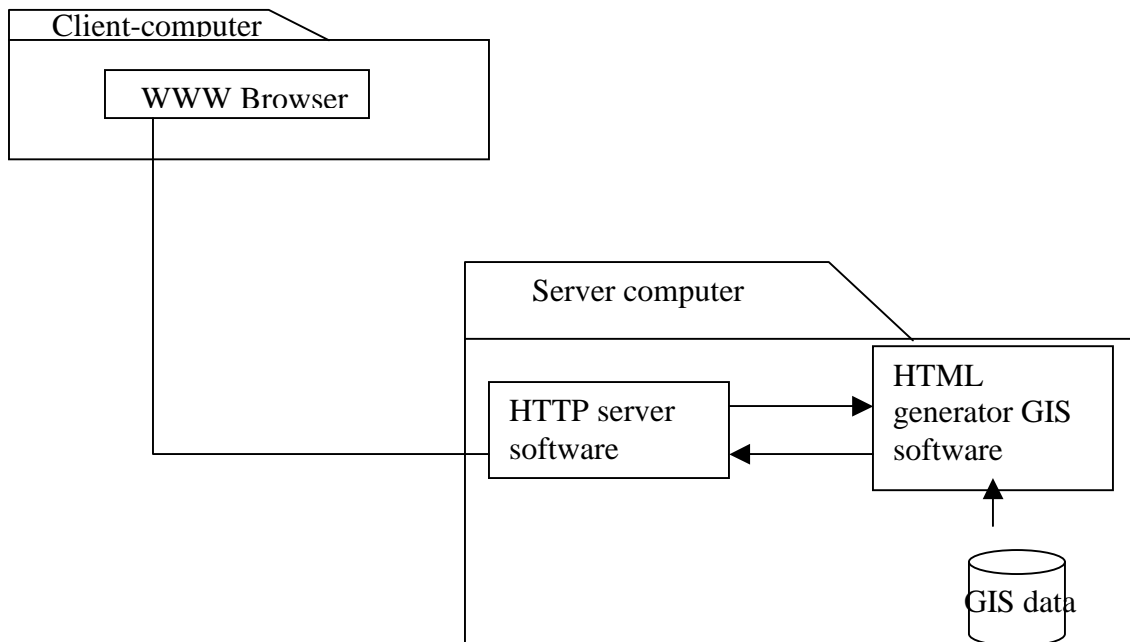


Fig.4.8. System design of the proposed system

#### 4.3.1 Hardware Software mapping

Internet-GIS enables to distribute geographic information in a variety of forms, including maps, images, datasets, spatial analysis operations, and reports. Since Internet-GIS runs on top of the Internet, it uses World Wide Web technology. To develop an Internet-GIS a browser on the client side, secured web server that interacts with the browser and the database will be integrated as shown in figure.4.9.

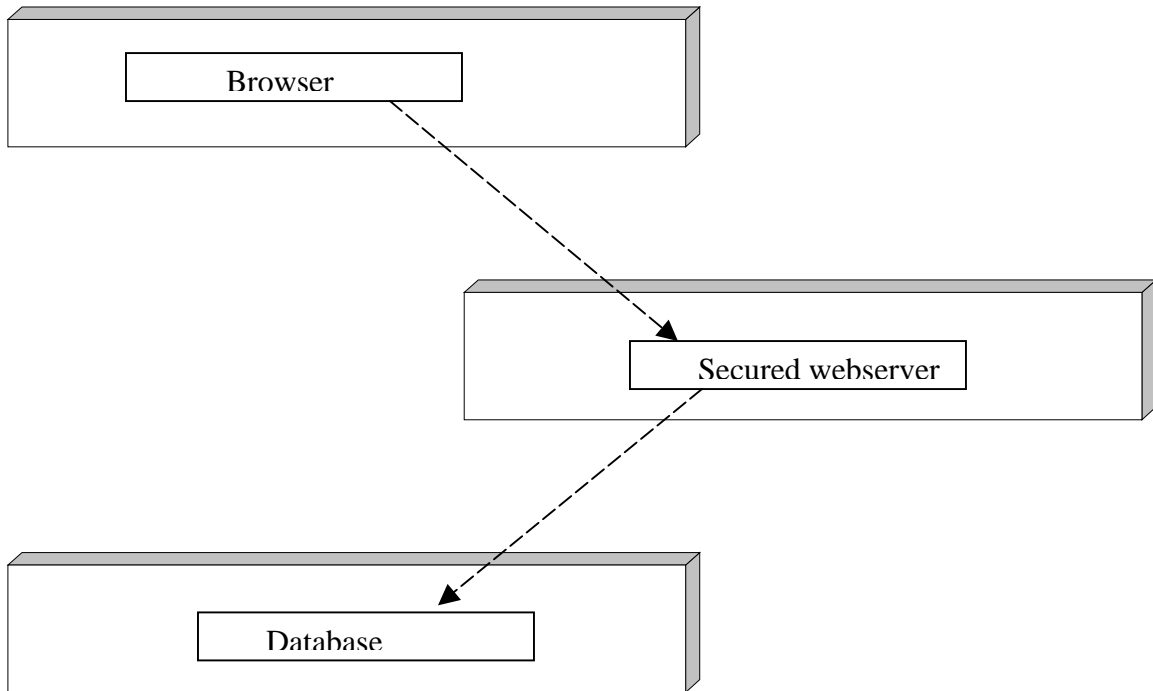


Fig. 4.9. Hardware-software mapping for the proposed system.

### **Browser**

Web browser is a client program that uses the Hypertext Transfer Protocol (HTTP) to make requests of Web servers throughout the Internet on behalf of the browser user.

The browser, shown in figure.4.9, enables the client to interact and display house map of the city. This software requests texts and images from the web server and executes on the clients machine.

The browser acts as an interface to the web server and represents multimedia information. These interfaces are used to send map request to the web server and receive response to view the map.

### **Web server**

Web server delivers Web pages to browsers and other files to applications via the HTTP protocol. The web server processes requests for maps and related information. When a request is received, the web server performs functions such as creating Cartographic map image files (e.g. in JPEG or PNG format), streaming map features, searching to query the database and extracting data to create a subset that can be sent back in shape file format.

## Database

The database represents spatial and non-spatial house data together with client and administration data. The database has an interface with the web server to provide raw spatial and non-spatial data. The data, which are represented in the database, are shown in figure.4.10.

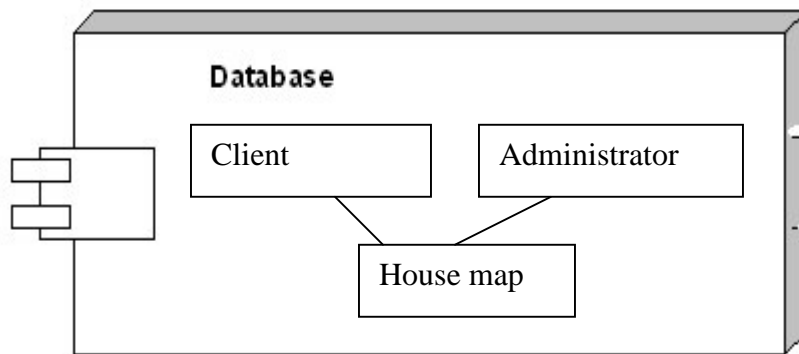


Fig.4 .10.database representation of the Agency

The high level database design as it is given in [15] for the Housing agency that integrates spatial and non-spatial information and which works together with other systems of the city should full fill the following criteria.

**Extensibility:** for the system to work with other systems it should extensible.

**Utility:** the system should simplify the task of the workers, as the housing information is critical.

**Security:** housing information is highly related to valuation and costing. So, it needs higher security.

Based on this the database design should include the following components as it is given in figure.4.11.

## City address

City address as a separate entity should be developed and used by other systems. So standardized city address can be enforced.

### **Renters database**

This is within the scope of housing Agency and is used to manage rental information for governmentally owned houses. It represents renting agency address, Renter information, and payment history.

### **Socioeconomic database**

This database represents the socioeconomic aspect like owner of the house, number of residents, detail information of the house.

### **Other municipal information systems**

This refers to any information system that will be developed by the CGAA.

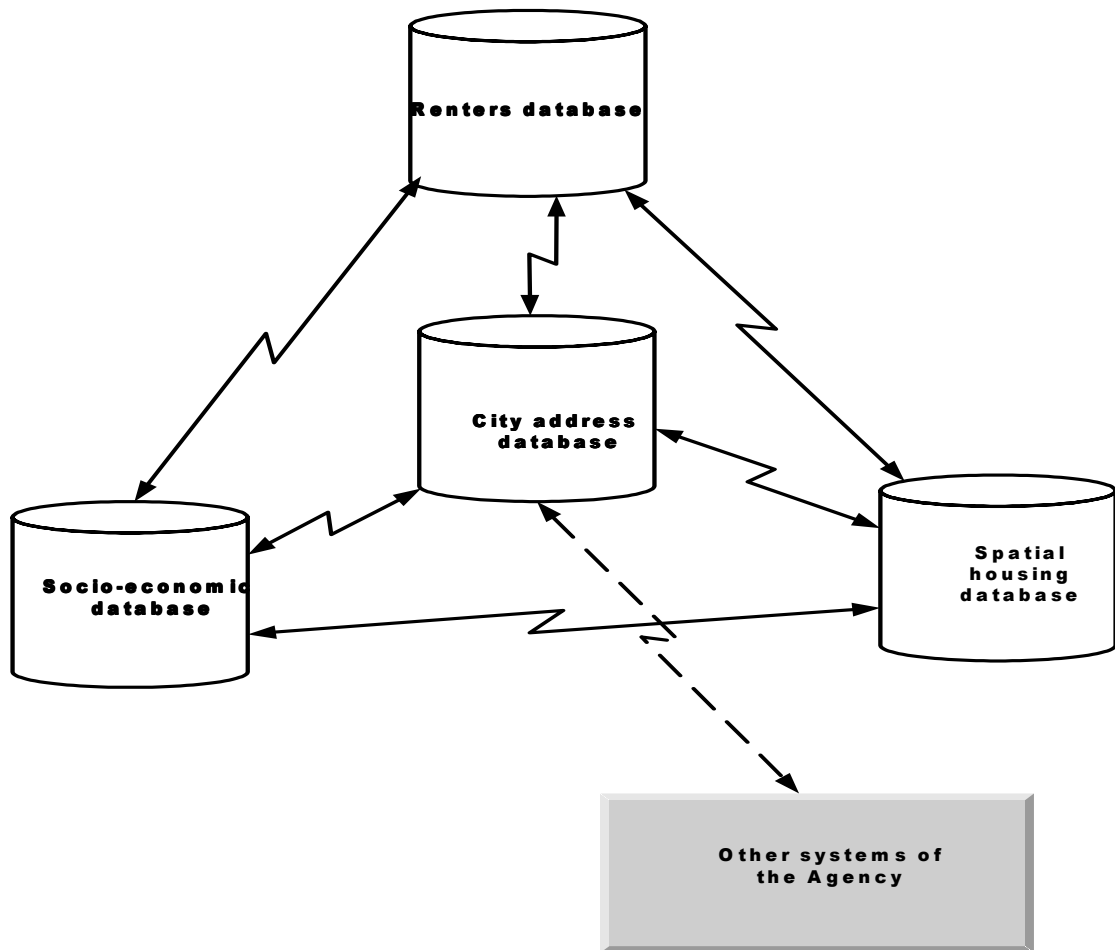


Fig. 4 .11.High level database Design [15]

### 4.3.2. Deployment Diagram

The deployment diagram for the Internet-GIS as shown in figure4.12, represents the configuration of the run time processing nodes and other components of the system.

The different clients like Kifle-Ketemas , Land Administration office ,NGO's etc can access housing map of the city using the local area network connecting them.

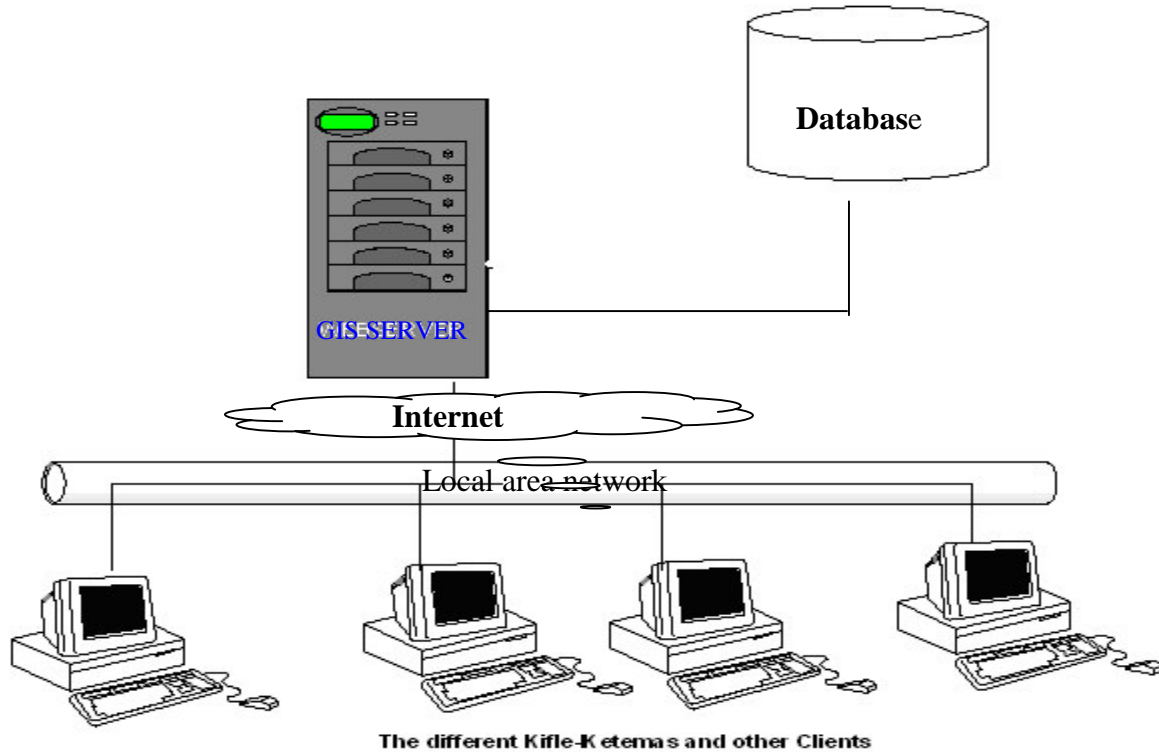


Fig.4.12, Deployment diagram for the proposed system.

## **CHAPTER FIVE**

### **5. The Prototype HISAA**

#### **5.1. Overview**

Internet technologies are offering advanced solutions for GIS problems. With Internet-GIS spatial and non-spatial datasets can be provided to a broad range of users. Internet – GIS has a lot of applications with different functionalities. Some of them could be Simple functionalities like interactive mapping (zoom and pan) with spatial queries of the actual data and a visual overlay of the information and also functionalities like measuring distances, analysis and intersections of the data etc.

Nevertheless costs are playing an important role. So, a cost-effective Internet-GIS solution for communities and counties based on Open-Source-software (OSS) is desirable. Using OSS is advantageous in that it is possible to maintain the source code, freely available and also will make independent from the sole-source company.

After investigating the problem of the Housing Agency of the CGAA and selecting the appropriate tools and strategies to solve the problems, I have developed a prototype called HISAA (housing Information system of Addis Ababa). With HISAA I demonstrate the validity of the proposals I put forward to solve the problem of the housing Agency. HISAA is an Internet-GIS based system developed using Map server. Map server is an open-source-software that enables to publish map files on the web.

## 5.2. The environment and the tools used for the development of HISAA

The prototype is developed for Real Estate and Housing management of CGAA. As it is shown on the questionnaire analysis, the housing Agency doesn't have an integrated geographic information system with housing data set. Currently the Agency performs its activities based on AutoCAD data stored on data CD. The CAD data represents Housing maps for different Woredas of the city [17]. In this work I have considered only Woreda 01, which is one of the Woredas in the ARADA Kifle-Ketema.

### 5.2.1. CAD Viewer.

The CAD Viewer allows viewing and printing CAD drawing files. It can be used either as a stand-alone application, or as a 'Helper Application' for an Internet Browser. The CAD viewer can be used to display CAD data as well as shape file. I have used this tool to view the CAD data and compare it with the converted shape file.

The trial version of this software is available freely on [www.guthcad.com](http://www.guthcad.com). The operation could be using menu or tabs as shown in figure.5.1.

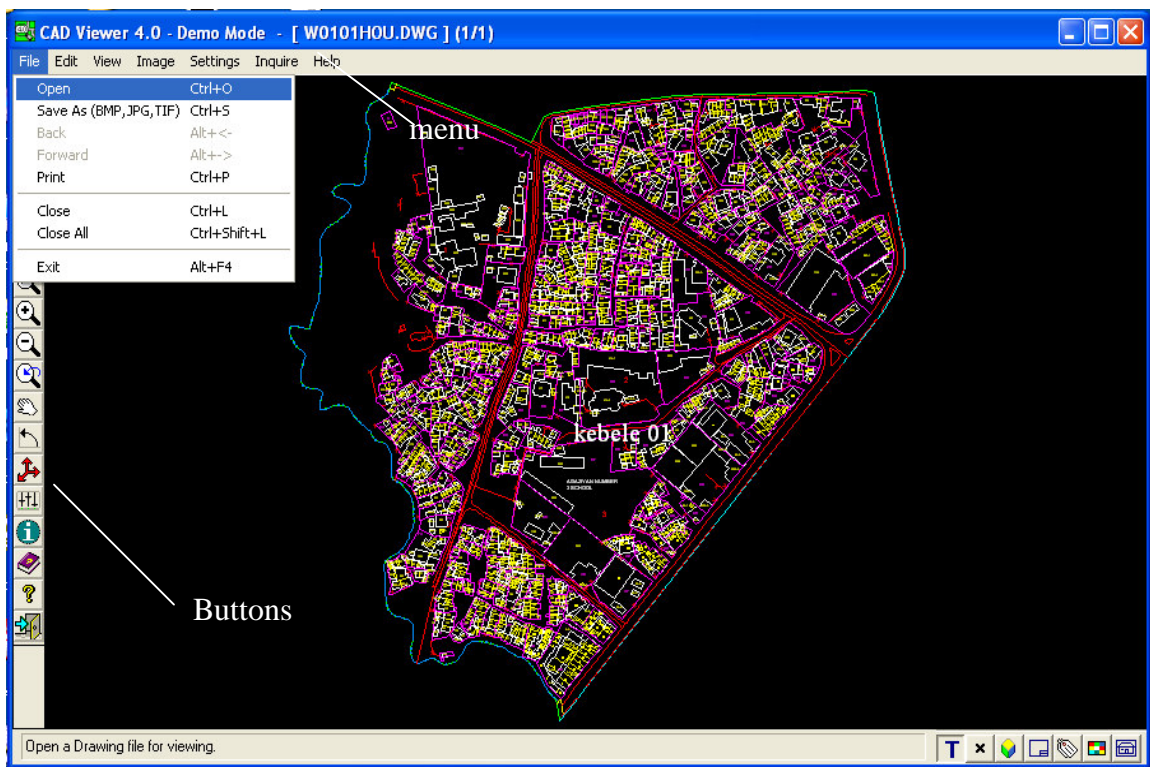


Fig.5.1. Woreda01 House map on CAD Viewer.

## 5.2.2. CAD to Shape file converter

In order to make the CAD map usable in a GIS environment, the CAD files should be converted to shape files. A CAD2Shape converter converts AutoCAD DXF or DWG formats to ESRI / Arc View Shape files. This software is completely stand-alone i.e. does not require Arc View. The trial version of the software can freely be downloaded from [www.guthcad.com](http://www.guthcad.com).

I have used CAD2Shape converter to convert CAD data of Wereda01House map to shape file. To convert CAD to Shape file, CAD2Shape presents a number of dialog boxes as shown in figure.5.2, from which nearly all of its operations can be performed directly.

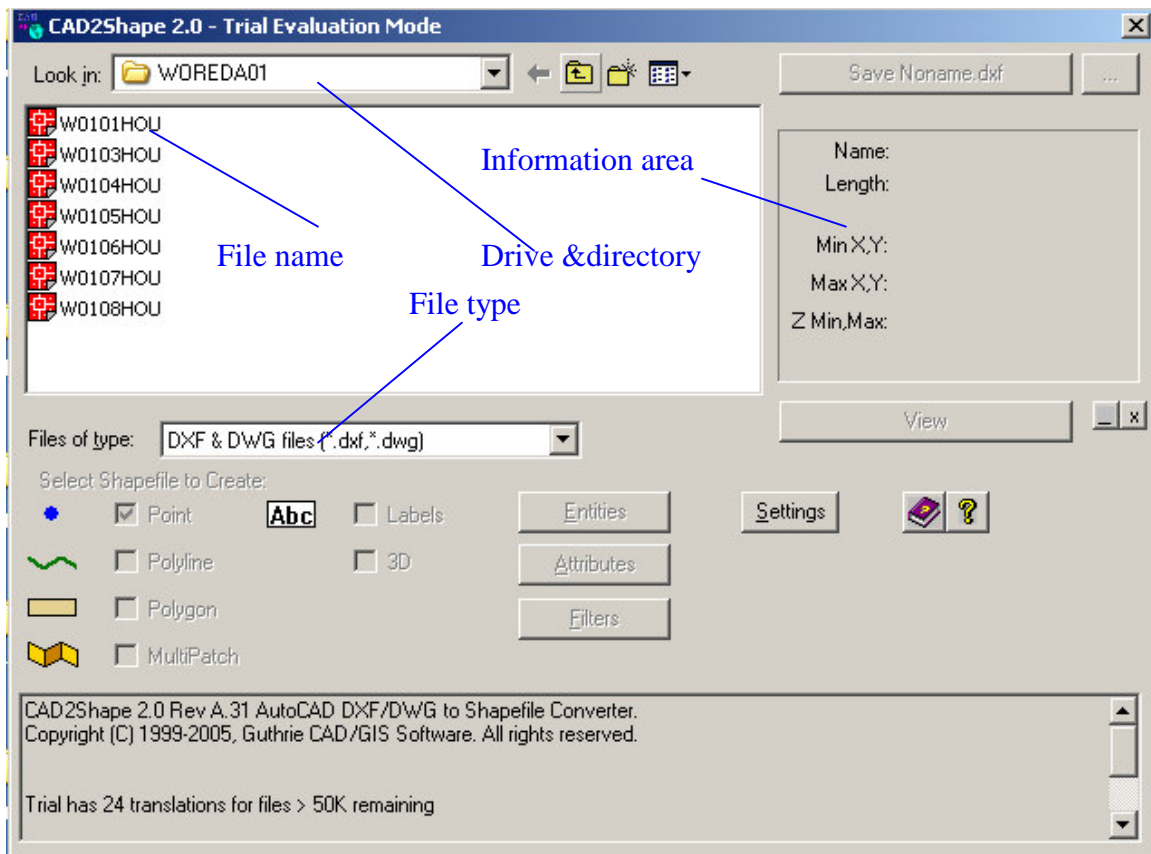


Fig.5.2 CAD2shape file converter user interface.

As it is shown in figure.5.2, the top left hand corner of the CAD2Shape main dialog consists of a built in Browse facility for locating the file for conversion. There are 4 list boxes for selecting the Drive, Directory, File Type, and File name.

Select the DXF/DWG file to be converted by locating the file in the File Name list box. When a file is selected, details about the file are displayed in the 'Information Area'.

The information that will be displayed are:

- Name:** The name of the file selected for conversion.
- Length:** The length in bytes of the file.
- Min X,Y, Max X,Y:** The minimum and maximum X,Y coordinate pairs of a box that completely encloses the geometry contained in the CAD file.
- Z Min,Max:** The minimum and maximum Z coordinate values.

The Minimum and Maximum X, Y, Z values are all obtained from the DXF/DWG file header EXTMIN, EXTMAX variables.

After this conversion setting will be selected. The Conversion settings are the options that are going to applied to the conversion, such as which entities in the CAD file to translate using the various Filter settings or Entity settings, and also the Attributes that should be produced, and whether the output shape file should be 2D or 3D.

An important consideration when doing a translation from a CAD file to a Shape file is that a single CAD file will generally contain many different entity types, whereas a shape file can only contain entities of the same type (e.g. Points, Polylines, Polygons.) Therefore typically a translation from CAD to Shape may require several separate conversions, one for each shape file type. This is because when converted to polyline, point and polygon data will not be considered .

Drawing.DWG	—————▶	Drawing_pt.SHP	Translate	Point	entities
Drawing.DWG	—————▶	Drawing_lin.SHP	Translate	Polyline	entities
Drawing.DWG	—————▶	Drawing_pol.SHP	Translate	Polygon	entities

I have converted the Wereda01 house CAD file (W0101HOU) in to polyline shape file, polygon shape file and point shape file. The shape files when seen in CAD Viewer are shown in figure.5.3, figure.5.4 and figure.5.5 respectively.

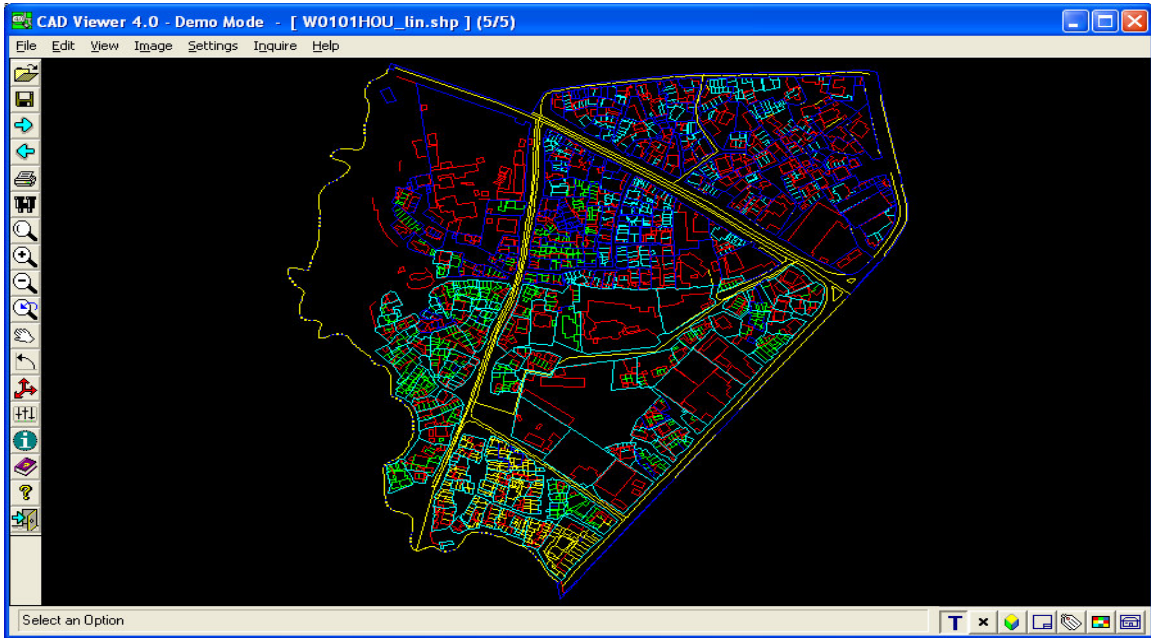


Fig.5.3.polyline Shape file form of Woreda01 CAD house map

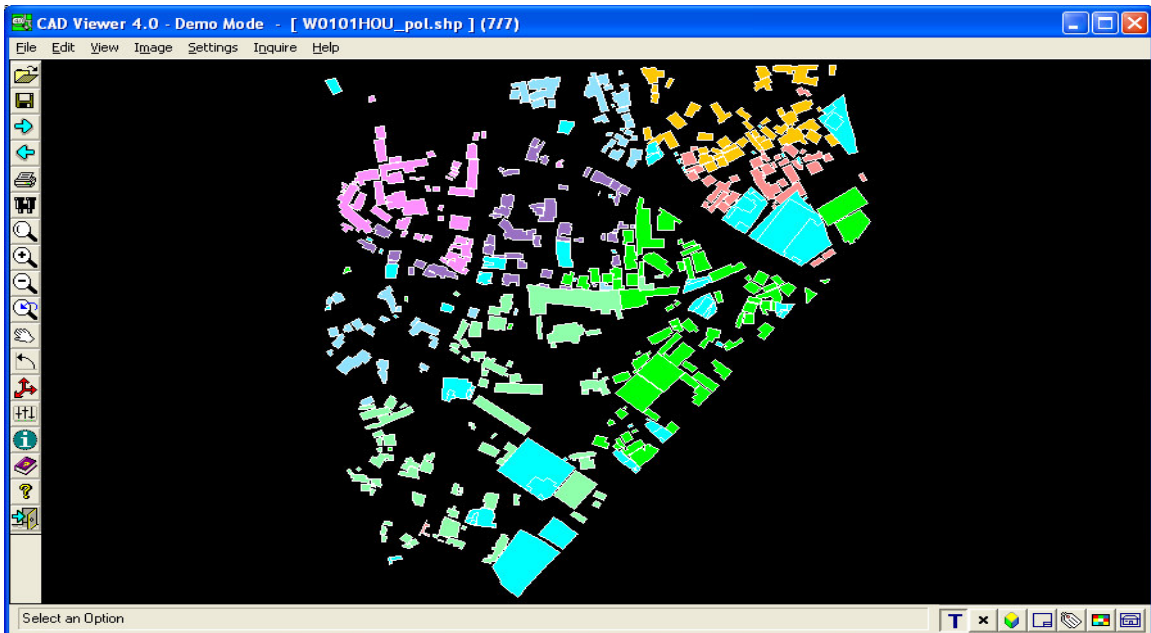


Fig.5.4. Polygon shape file form of Woreda01CAD house map

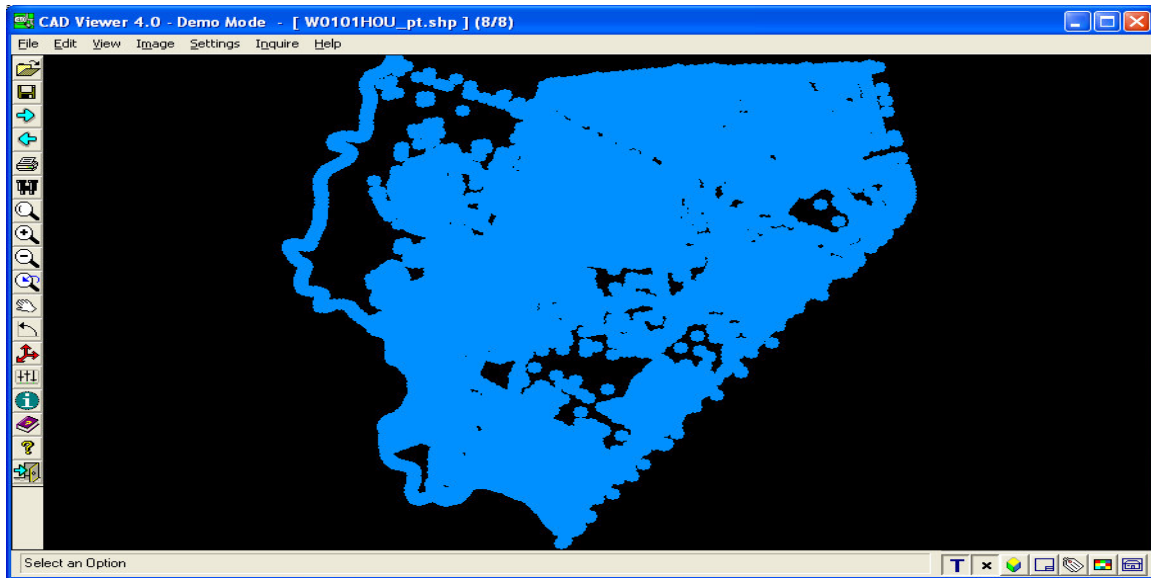


Fig.5.5. Point shape file form of Woreda01CAD house map

When we see the converted shape files, the CAD2Shape software did not include texts written to the house map like House No, Kebele, etc.

### 5.2.3. Map server

Map Server is an Open Source development environment for constructing spatially enabled Internet-web applications. The software is build upon other popular Open Source or freeware systems including Shape library, Free Type, Proj.4, GDAL/OGR

Map Server is known to compile on most versions of UNIX/Linux, Microsoft Windows and even MacOS. The basic Map Server CGI application provides a significant number of "out-of-the-box" features. The most important once as shown in [16] include Vector formats like ESRI shapefiles, PostGIS, ESRI ArcSDE and many others via OGR and Raster formats like TIFF/GeoTIFF, EPPL7 and many others via GDAL

Map Server supports several Open Geo-spatial Consortium web specifications. The Map Server system includes Map Script that allows popular scripting languages such as PHP, Perl, Python, and Java to access the Map Server API. Map Script provides a rich environment for developing applications that integrate disparate data.

If the data have a spatial component, then it is possible to get the data via the favorite scripting environment, and map it with Map Script. For example, using PHP it is possible to integrate data from MySQL database.

Map Server allows creating geographic image maps. This is possible because it includes the following utilities.

- Map Server Workbench – It is set of cooperative tools for development of Map Server web mapping applications.
- Map Lab – It is an Open Source suite of web-based tools that allow for the easy creation and management of Map Server web mapping applications and map files.
- Chameleon - A highly customizable and adaptable environment for deploying and managing Web mapping applications. Chameleon incorporates the ability to quickly set up new applications from a common pool of widgets that can be placed in an HTML template file.

Map server software includes lots of packages like Apache version 2.0.50, PHP version 4.3.7, Map Server CGI 4.2.1, 4.4.0, PHP Map Script 4.2.1, 4.4.0, etc.

### 5.2.3.1. Maplab

**Maplab is an open source tool for the creation of Web-mapping applications. Maplab is comprised of three components (MapEdit, MapBrowser and GMapFactory) and offers a user-friendly alternative to manually editing mapfiles and programming PHP mapscript in the creation of MapServer applications. MapLab 2.2 works with MapServer version 4.0. It is also possible to access mapfiles from earlier versions. Maplab environment is shown in figure.5.5.**



Fig.5.5 Maplab environment

As it is shown in fig.5.5, Maplab contains the following developing components.

#### **MapEdit**

MapEdit is a visual administration tool for the editing and management of map files. MapEdit gives full control over all aspects of a map file and provides validation to ensure the map file structure is correct. It also features a form-based interface for modifying mapfile parameters, a fully navigable map preview, access to the raw mapfile, and symbol, colour, font, and file selector dialogs.

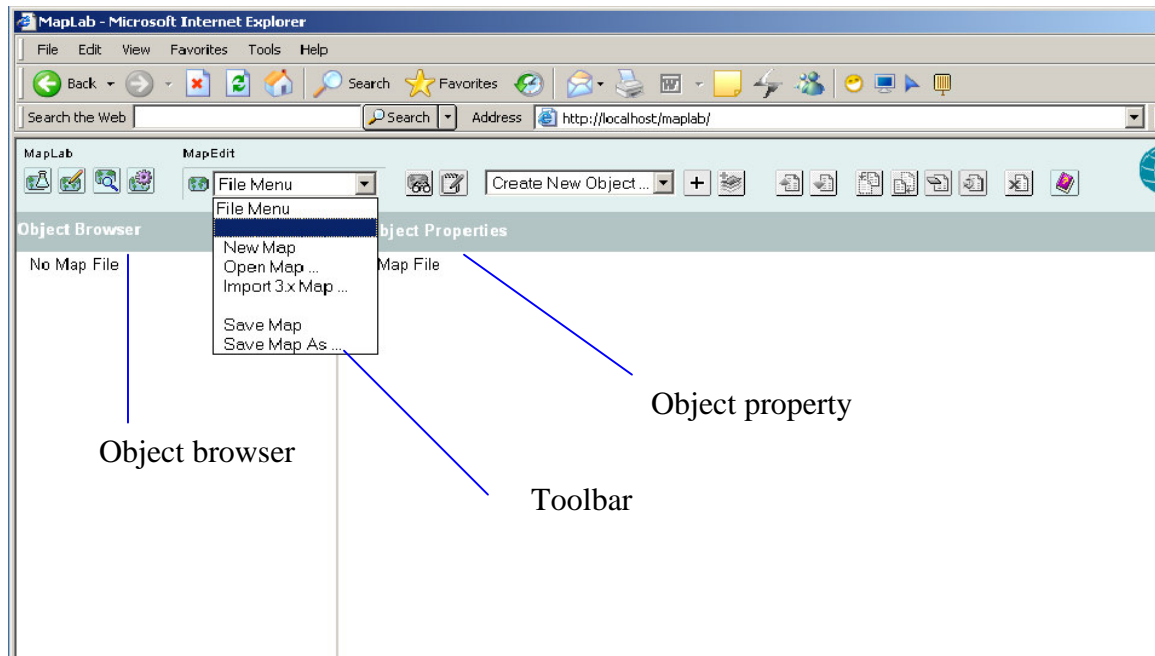


Fig. 5.6, map edit work area.

As it is shown in figure 5.6, MapEdit is devised of three major parts: the Object Browser, the Object Properties Frame and the Toolbar. The maplab buttons helps to navigate other components of maplab. MapEdit works with map files, which are the basic configuration mechanisms for MapServer.

In developing the mapfile of HISAA, MapEdit is used to represent the extent of the mapfile, select the type of mapfile, path of the shape file, color of the mapfile, size of the mapfile and create different layers of the mapfile. It is also possible to modify mapfile and access raw data of the mapfile.

## MapBrowser

MapBrowser is a tool for the visual selection of spatial data from local and web Map Service (WMS) sources. It can also be used to specify a key map view, map size and map projection. Using this module, MapLab acts as a browser of WMS compliant servers.

As it is shown in figure 5.7, MapBrowser is made up of four distinct areas: the toolbar, the legend, the data stores and the map preview area.

The toolbar can be found across the top of the window and it is divided into MapLab buttons and MapBrowser buttons. The legend will be in the upper left-hand corner and contains all the map layers. The data stores will lists all the servers that are available to include data from and the map preview area displays the map

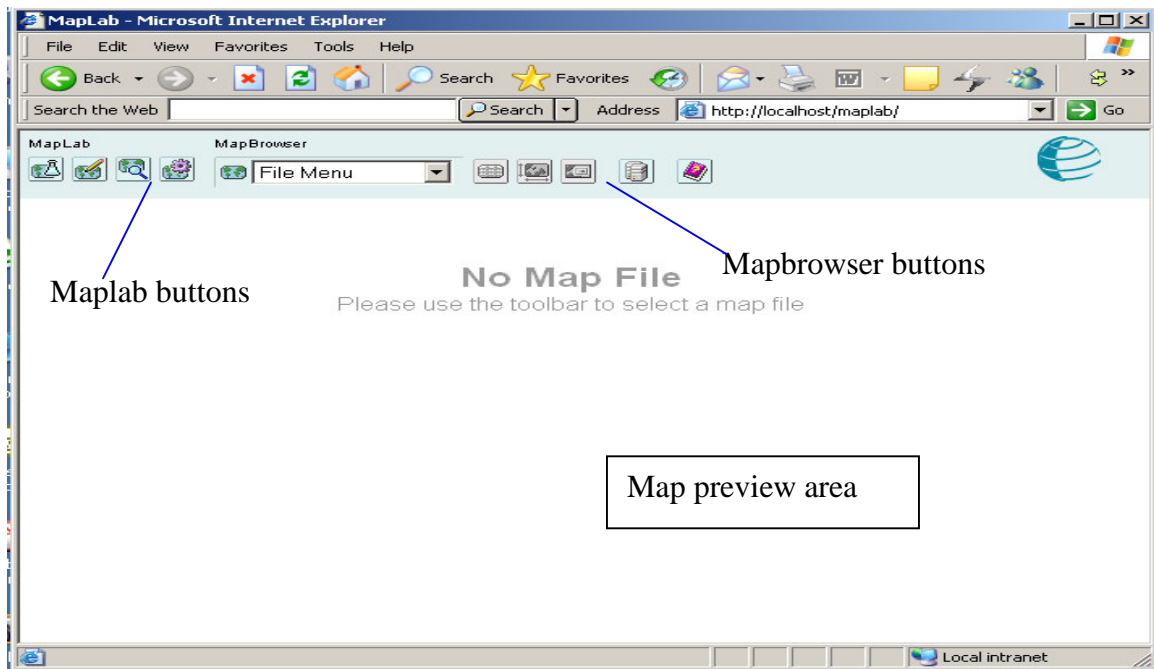


fig.5.7. MapBrowser work area.

As it is described above MapBrowser enables to select shape file from local and web map service sources that can be used as a reference to the mapfile. So, in developing HISAA MapBrowser is used to locate local wereda01 shape file to be used as source for the HISAA mapfile.

## GMapFactory

GmapFactory is an intuitive tool for the rapid creation and deployment of mapping applications. GMapFactory can be used to define the layout of an application and specify which mapping interface components to include.

To use GmapFactory, the first step is to create a folder to contain the project. There are two ways to create an application depending on whether or not there is an application open in MapLab. If the application is opened in mapLab, the path of the application will be written on the project field of the GmapFactory and then the legend, map title and pan and Zooming of the map will be adjusted. The other way of creating the application on GmapFactory is by explicitly writing the path using the Browse button on the GmapFactory. The work area of GmapFactory is shown in figure.5.8.

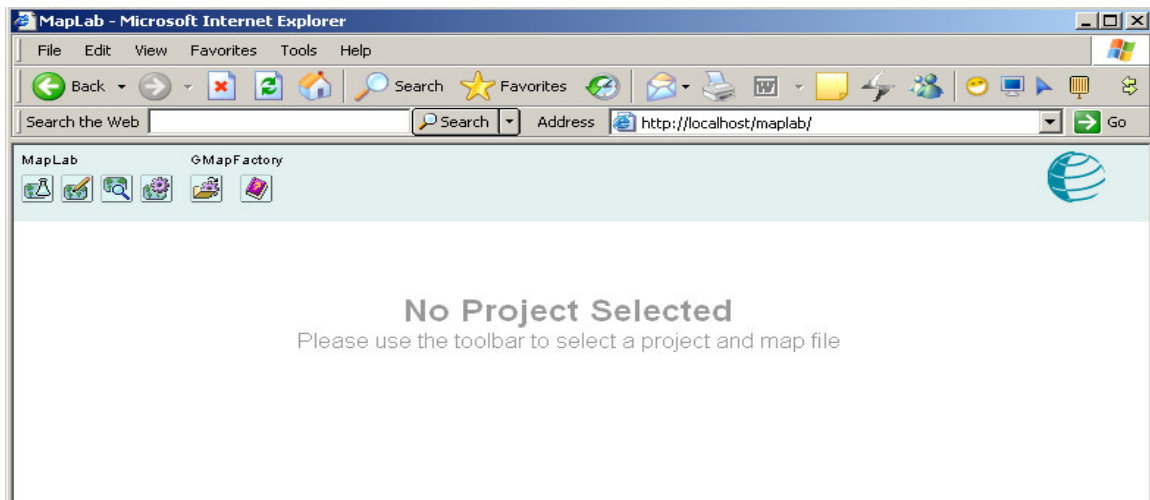


Fig.5.8. GmapFactory work area

The layout of the mapfile for HISAA is created using GmapFactory. The interfaces of the mapfile of HISAA, the legend, scale, position of the mapfile, buttons are determined using GmapFactory. This component of the Maplab will result with a URL. Publishing of the mapfile on the web is possible due to this component.

### 5.3. Architecture of HISAA

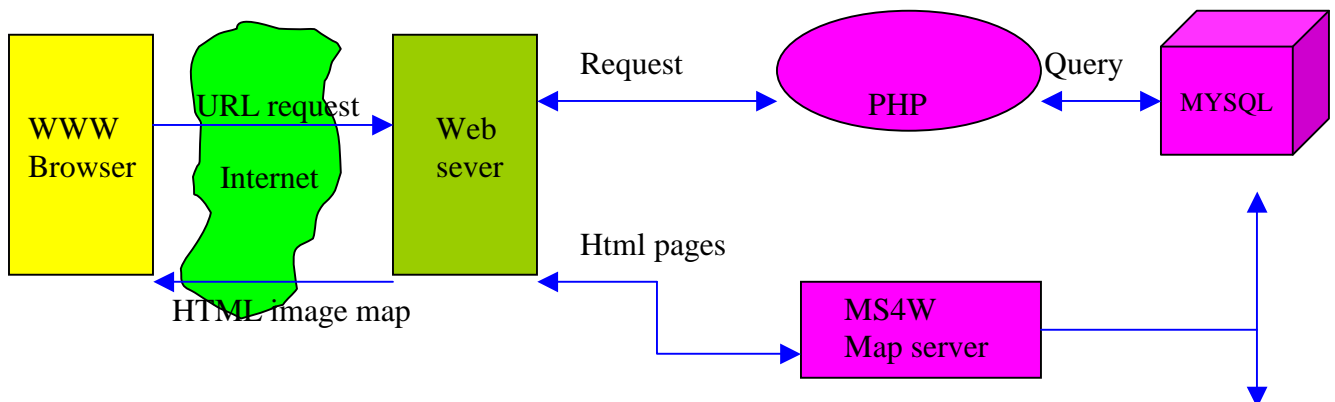
Internet-GIS architecture is focused on a static environment in which users sit at workstations to perform spatial analysis. Technologies such as the Internet are changing the way GIS is being used.

This project is developed using OpenGIS map server software along with the Internet where Web Mapping Service (WMS) produces maps of geo-referenced data.

The system profile for the development of this project is as follows

Software	Function
Apache server 2.0.50	HTTP Web server
MS4W	Map server
PHP 4.3.2	Server side scripting language
MYSQL	RDBMS

The architecture of the HISAA is Client/server architecture. As it is shown in figure 5. 9, the client sends URL request to the Web server and the Web server passes the request to the GIS application server (map server), which runs an address matching routine, generates a map graphic, convert the graphic to Web format, wraps the image in HTML and sends it back to the Web server, which then returns the response to the client as a standard Web page.





**Fig.5.9, HISAA Architecture**

### **5.4. Prototype Implementation**

As it is described above to develop the prototype, the CAD file of Wereda 01 is used. One of the issues that any such system should support is security. So, any user of HISAA should be authenticated before the housing map is displaying. Hence the user will be asked for userID and Password depending on the privileges given.

To see as well as modify the map file the user/administrator should visit the Housing agency website by typing the agency URL on their browser. The page that will be displayed will require them to choose the privilege to login as it is shown in figure 5.10.

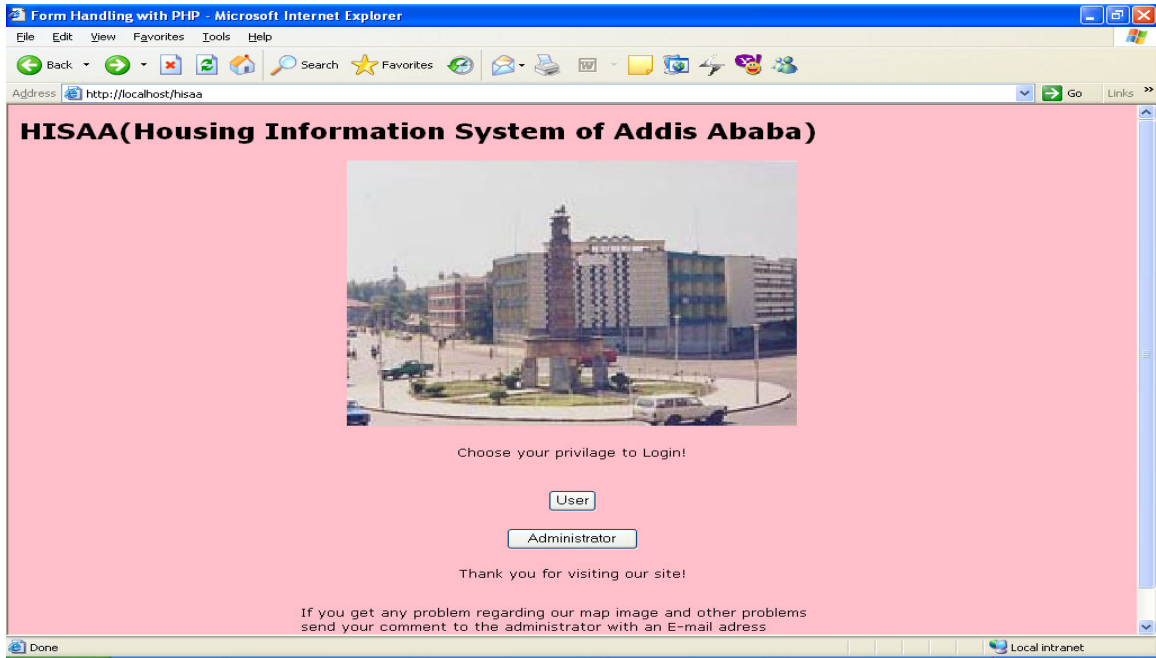


Fig.5.10. A screen shoot of the page that will be displayed to the user/administrator when visiting the Housing agency site.

The user visiting the site will select and click either user button or Administrator button.. If the administrator button is clicked the administrator login form will be displayed, figure 5.11. If the user button is clicked the user login form will be displayed, figure 5.12.

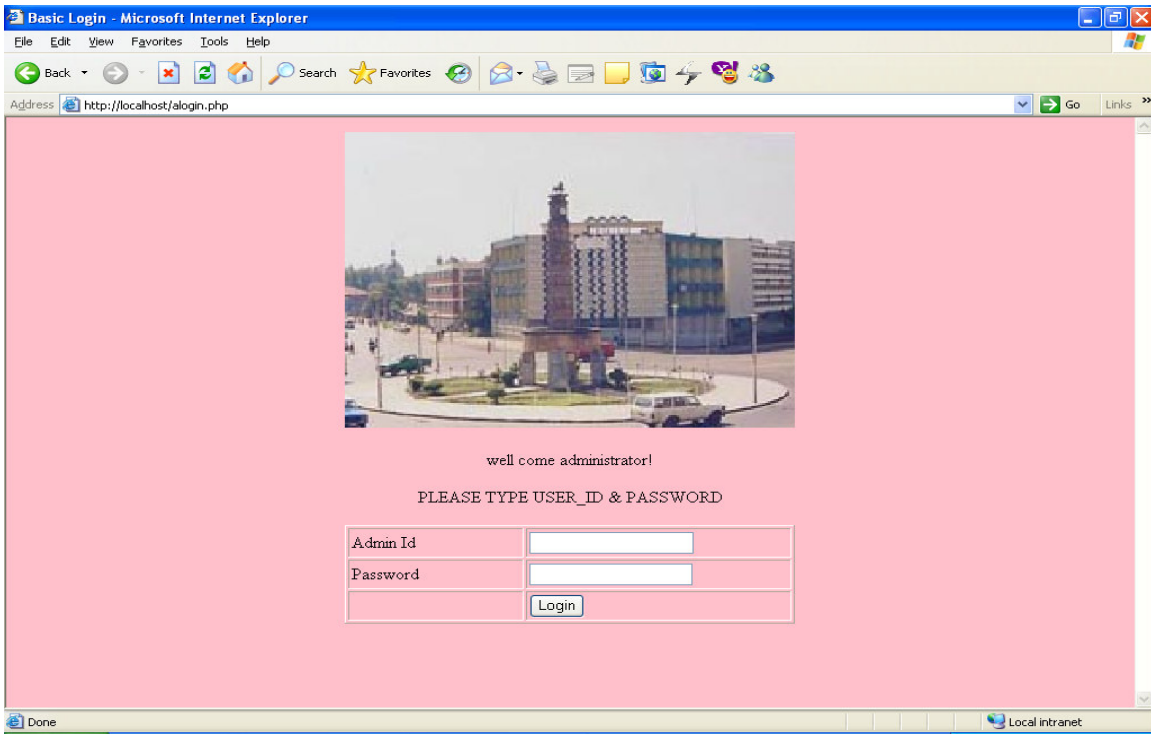


Fig.5-11 administrator Login page

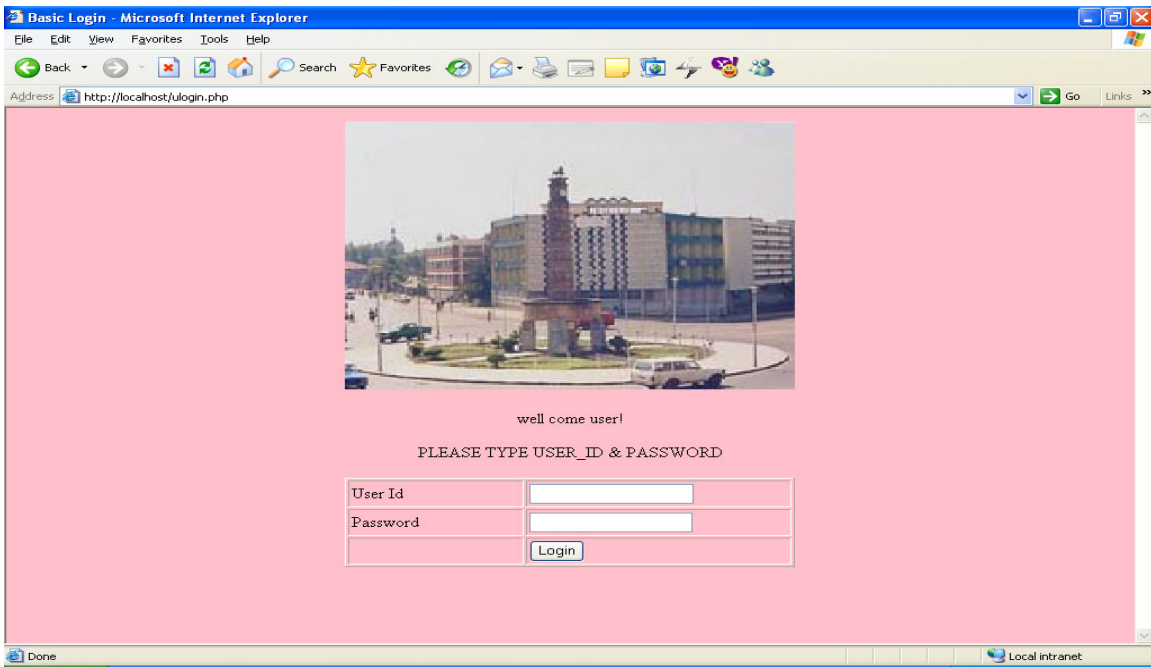


Fig.5.12 user Login page

After the user types userID and Password if it is incorrect Login error message will be displayed. But the user also will be asked to type the correct userID and Password as shown in figure 5.13.

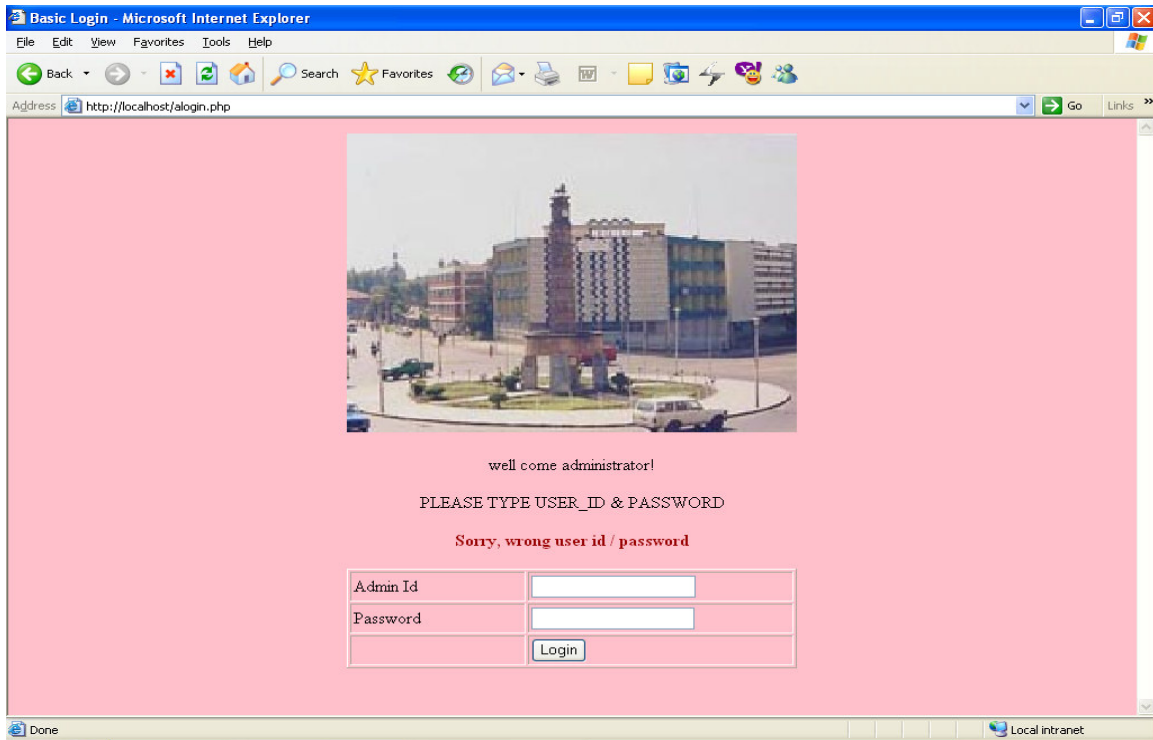


Fig.5.13 Re-Login page with error message

After the administrator is authenticated the Maplab page with its components will be displayed, figure 5.14. The administrator can access the mapfile so that changing and modifying the mapfile will be possible. The administrator clicks Mapedit to edit and manage the House mapfile, MapBrowser to select spatial data and Gmapfactory to create and deploy map application .

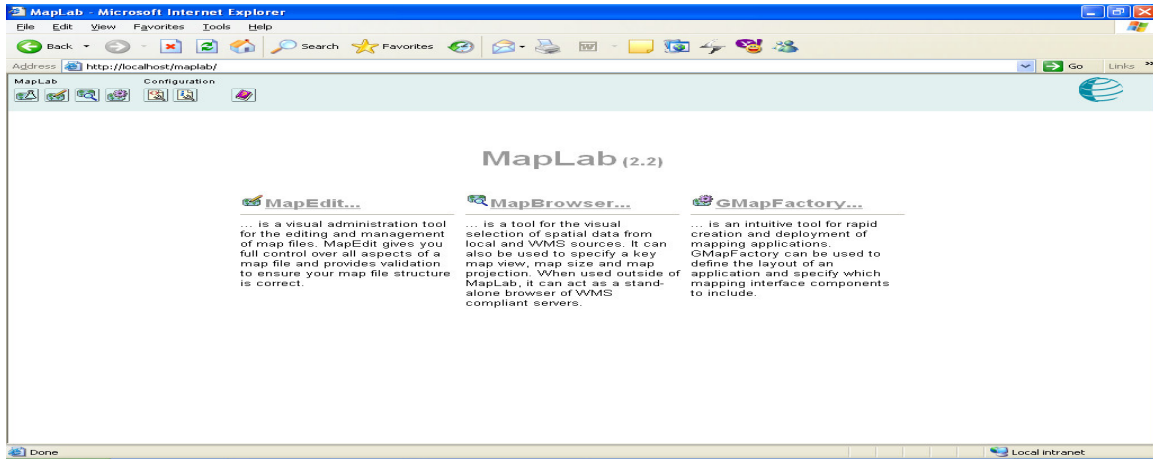


Fig.5.14 Maplab environment that will be displayed for authenticated administrator.

On the other hand for authenticated user the mapfile of HISAA will be displayed on his/her own client machine. This mapfile, as shown in fig.5.15, is very easier to use and get the necessary information out of it.

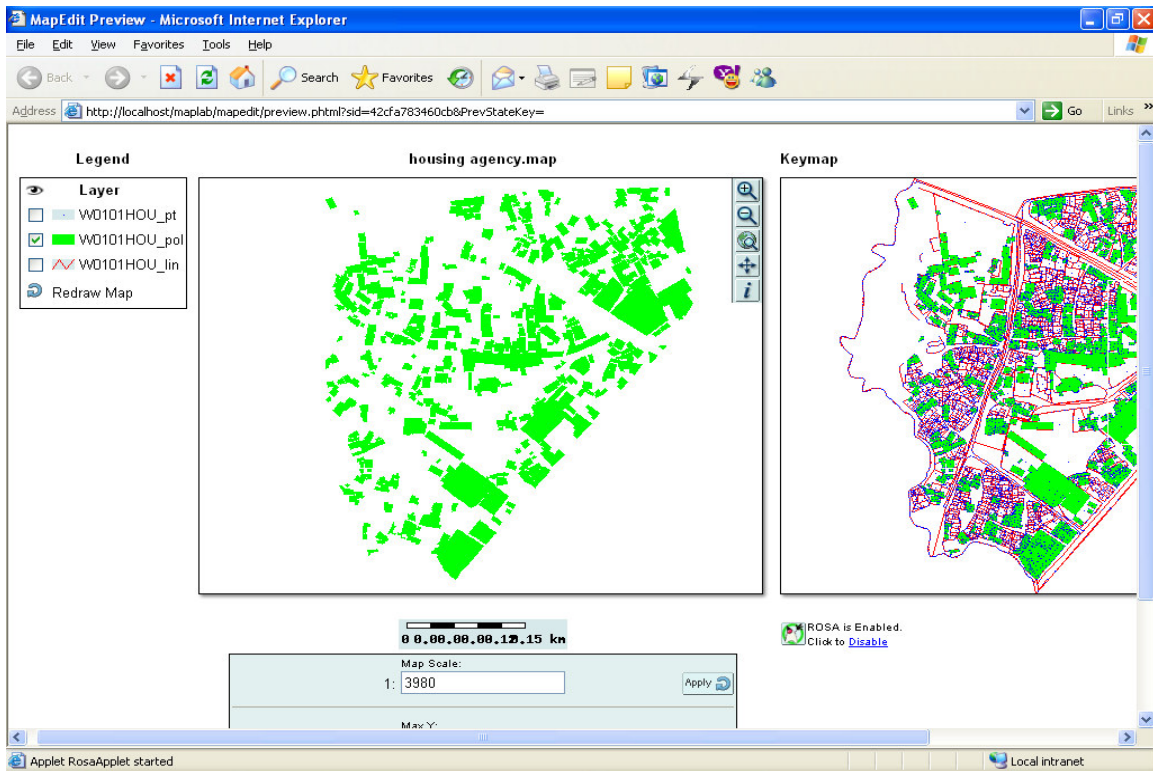


Fig.5.15 Woreda01 House map that will be displayed to authenticated user.

On the left corner there is a legend using which the user can add /remove layers found in it. The map displayed is the active layer on the legend, which is the Wereda01 House-pol map. If the user adds the Wereda01house\_lin map on the legend and clicks the re-draw map hyperlink on his own machine, the mapfile with two layers will be displayed which is shown in figure.5.16. And with the three layers together is shown in figure 5.17.

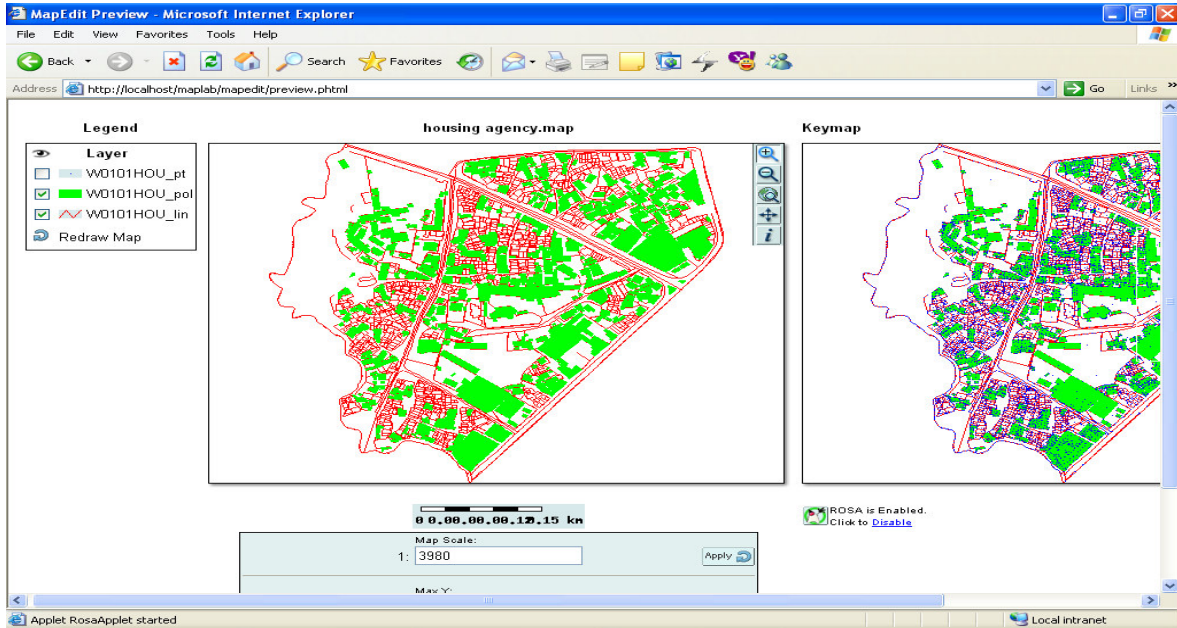


Fig. 5.16. Map file with Wereda01-pol and wereda01-lin layers together.

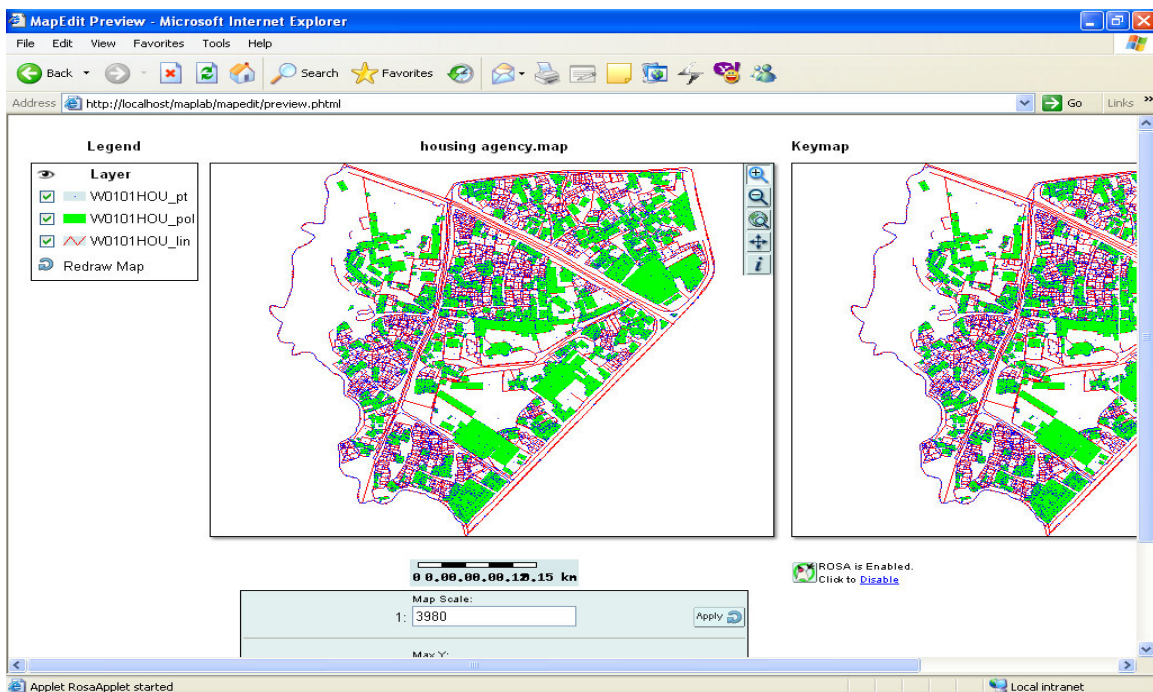


Fig. 5.17. Map file with Wereda01-pol, wereda01-lin and Wereda01-pt layers together. 58

On the right corner the keymap, which incorporates all the layers is displayed. The user can click any necessary part of keymap. So, that part will be visualized in more magnified form. Equivalently Zoom In, Zoom Out, Re-center and previous Buttons can be used. The Map in figure 5.18 is a result of Zooming out the layers of Wereda01-pol and Wereda01-lin map

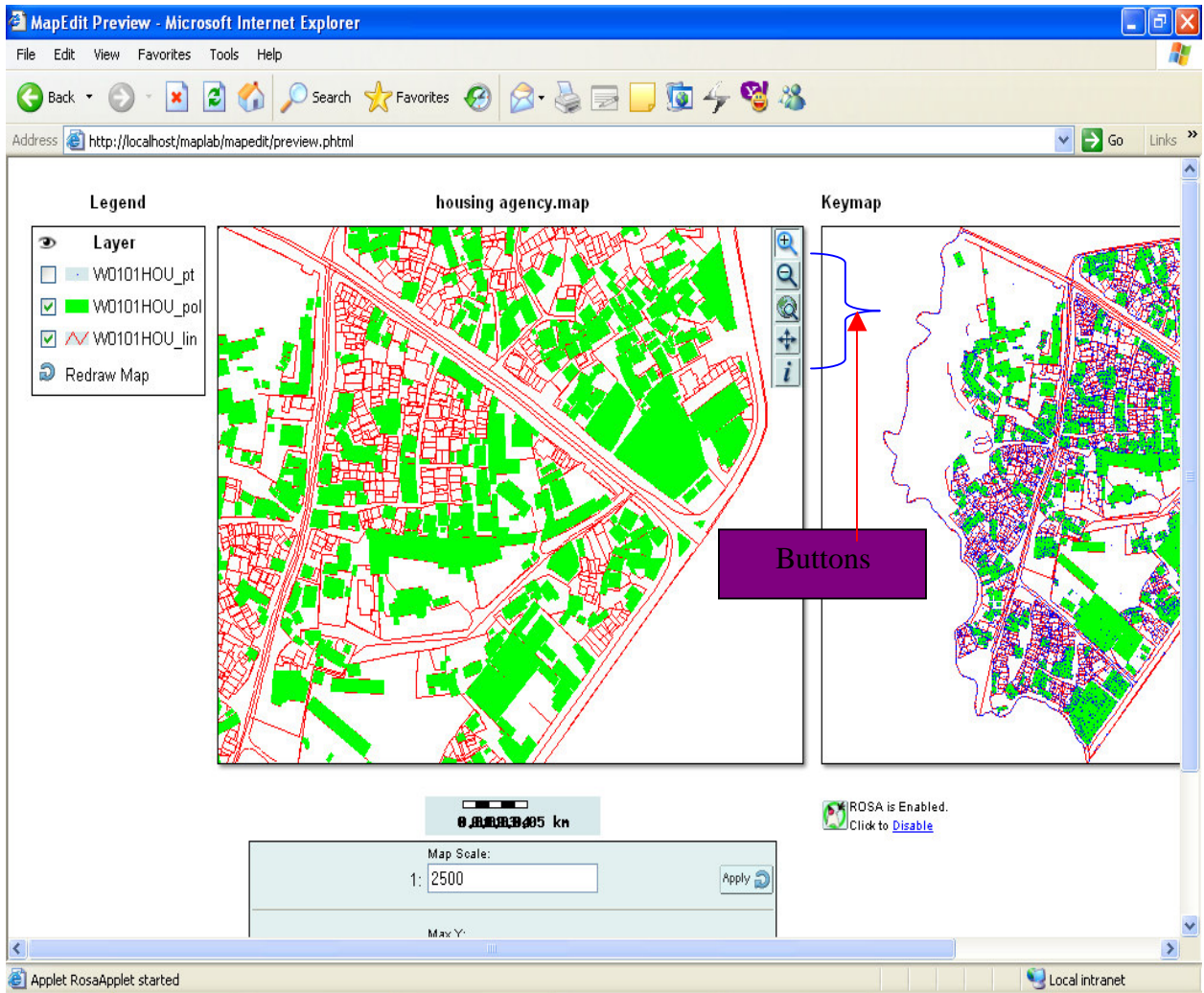


Fig.5.18.Zoomed IN wereda01-pol and wereda01-lin map

## Querying map file

To query the map file the user simply clicks **i**-button found on the map. This simply displays a query result for that particular point /rectangle selected. The query point/rectangle or **i**-button is shown in figure.5.19.

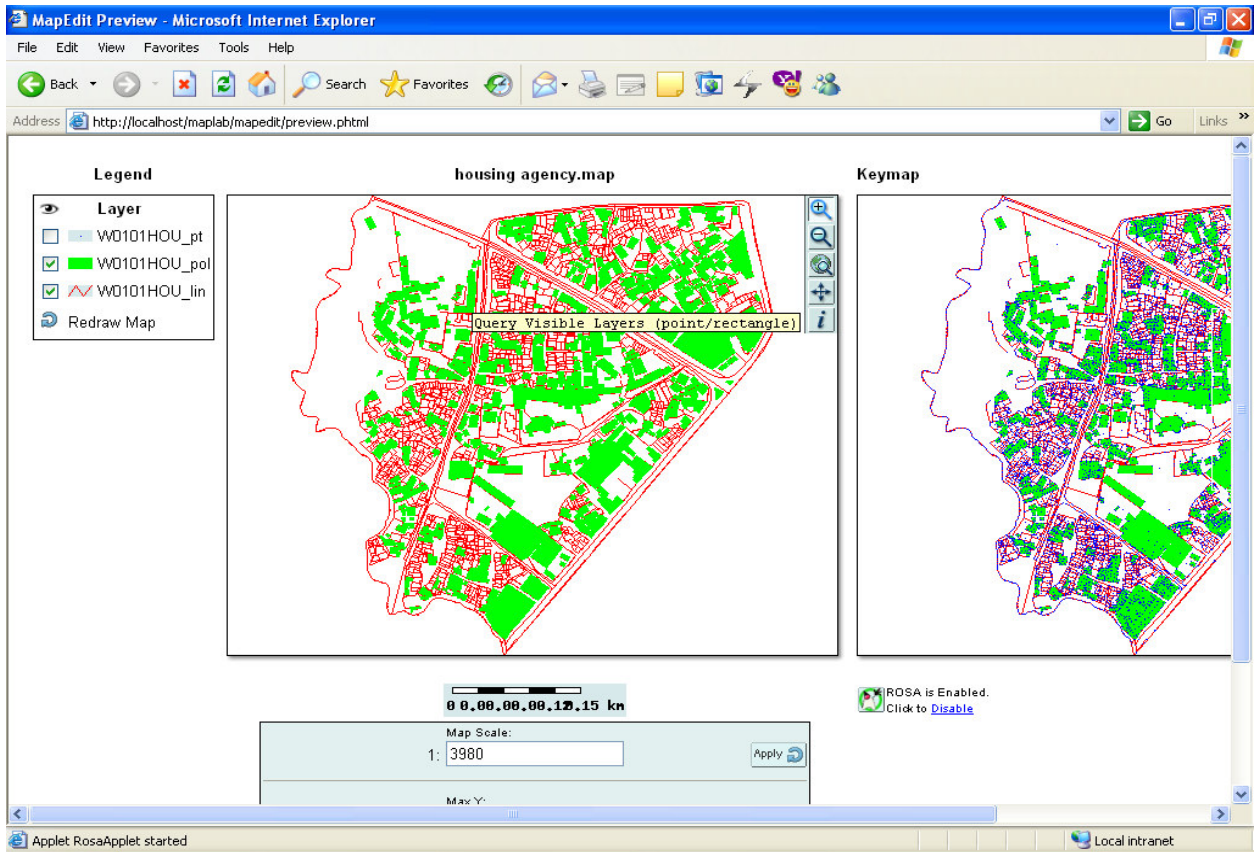


Fig.5.19 Query visible layers button on the displayed map

After clicking the **i**- button, the user clicks a point or encloses a rectangle from the visible layers of the mapfile. The result of the query about that particular point or rectangle will be displayed. Figure.5.20 shows a query result on wereda01-poly map layer when block No 353 is enclosed.

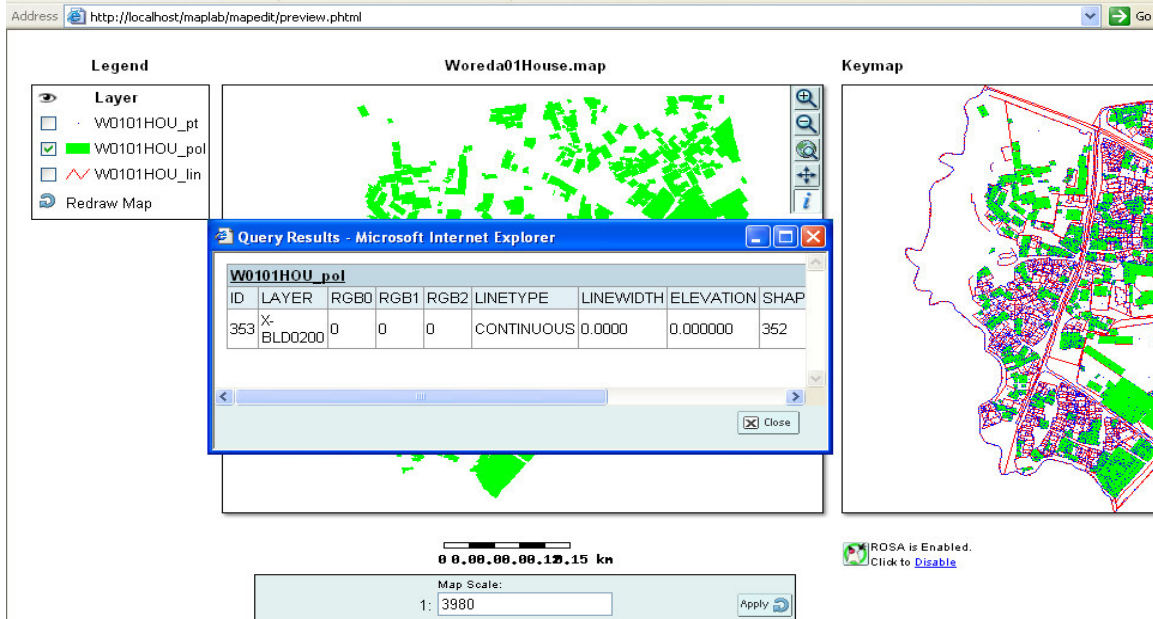


Fig.5.20. Query result when block No\_353 is enclosed.

When the visible layers are two or more, the query result will be for each of them for that particularly selected point or enclosed rectangle. Figure.5.21 shows query result for two visible layers, Woreda01-pol and Woreda01-lin.

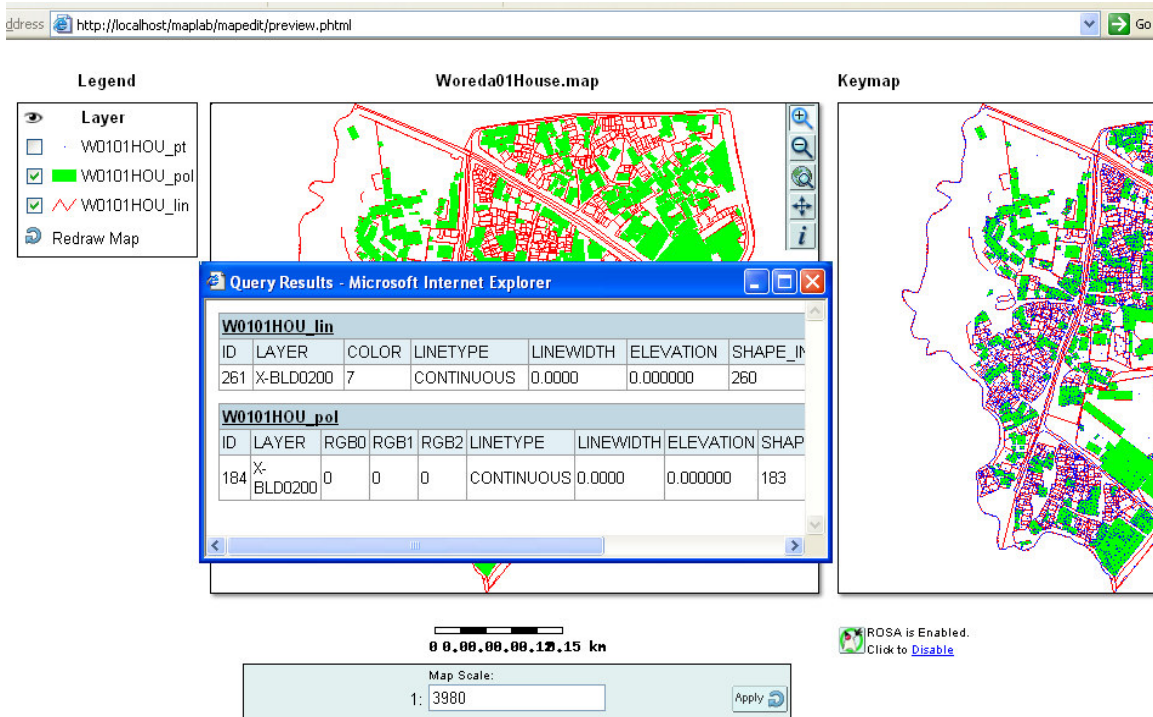


Fig.5.21. Query result for two visible layers.

## CHAPTER SIX

### *6. Conclusions and future works*

#### 6.1. Conclusion

The Housing Agency of the city government of Addis Ababa is responsible for the organization and management of governmentally and privately owned houses. The current administration of the city decided to decentralize its functions into Kifle-Ketema and Woreda level. This however requires a very high need of communication between the Kifle-Ketemas, the weredas, the agency and the other Authorities of the city such as Land Administration Authority.

With the help of questionnaires and close observation, I have identified the major problems of the Agency related to data management and communication requirement. The problem analysis shows that the Housing Agency doesn't use integrated geographic information system. But the Agency is responsible for the management and policy development for house ownership and constructions in the city. In order to facilitate this activities efficiently, the Agency decentralized the responsibilities to Kifle-Ketema level. But each of the ten Kifle-Ketemas, even if it needs geo-referenced data for proper site selection and site plan development, uses CAD data only to use it as a visualization application. Which makes their activities redundant and prone to errors.

Further more a close observation is conducted to investigate the current functioning and the system that the Agency and the Kifle-Ketemas are using. From this observation, I have identified that what they are using is a CAD map file for housing and land management. A CAD file however is not query-able and is difficult to use when it comes to the current decentralized functioning of the Agency.

The housing Agency of the CGAA as a service provider should be able to develop geo-spatial database containing interrelated data sets as shown in the database design of the project. More over all the offices and other stake holders of the Agency should have network connection to the Agency

In this work an appropriate system using Internet-GIS is recommended for Real Estate and house management of the CGAA. For the realization of the proposed system:

- The necessary tools required for the development of the prototype are identified.
- The existing models are investigated and the one with better advantage is selected.
- A general architectural design and detailed database and network design are presented.
- Considering the importance of existing CAD based map file, the necessary tools needed to convert this CAD file to proposed system file is identified.

Most importantly for the proposed system, appropriate open source software is identified. By using Open Source solutions the opportunities for participation of others at the development stage exists. The solutions often fit better to the needs of the users, because users may themselves be developers of system components. Open source software are cost free, easy for maintenance and users will not be dependent on the source code developer company.

To demonstrate the validity of my proposal a prototype called HISAA is developed. HISAA is developed using mapserver, which is open source software. HISAA has user-friendly interface and incorporates the necessary security mechanisms. A user on a client machine having connection to the network can display mapfile on his/her standard browser from HISAA and can zoom, pan or query the map as needed.

## 6. 2. Future Work

HISAA is developed using CAD file of only one Woreda of the ARADA Kifle-Ketema. So, for the full-fledged development of the system it needs to be done using the house map of the city.

The other one is that, Mapservcer, an open source software, can support different languages. So an Internet-GIS application in Ethiopic language can further be developed based on this project.

Wireless technology now a days is developing rapidly through out the world and also here in our country too. So, Wireless GIS ensures that it can provide users with more meaningful and timely information. By empowering field personnel with the responsibility of data acquisition, uploading, editing and verification, Wireless GIS applications have the capability of bringing field and office activities into a collaborative environment that can further improve productivity, reduce costs and minimize project completion timeframes. So wireless-GIS can be other related application that can be considered later.

At last it can be an initiative to other cities of the country and if all are networked it could be possible to have a system for all housing map in country level, which will have importance in allocating investors that can construct industries and other public service giving organizations.

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This Project work has not been presented for a degree in any other university, and that all sources of material used for the project have been duly acknowledged.

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Ayalew Belay

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Name

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