

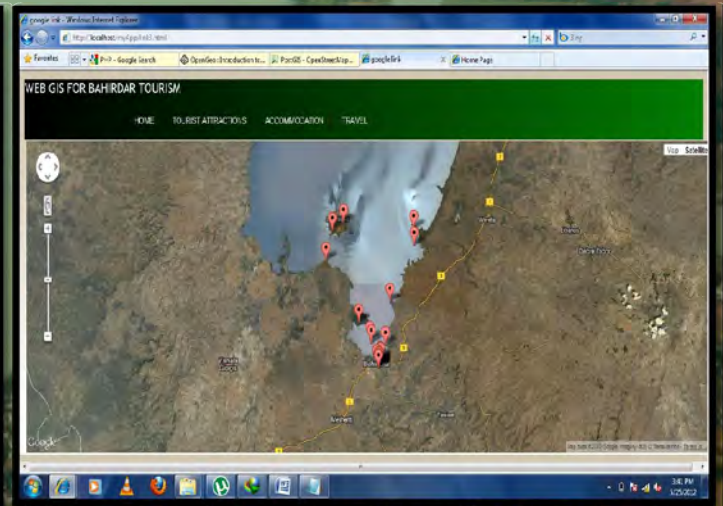
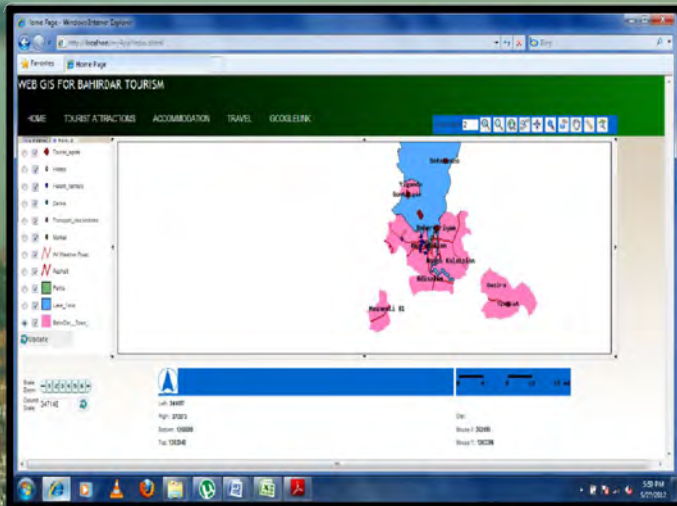


ADDIS ABABA UNIVERSITY

School of Graduate Studies

Faculty of science

**Web GIS for Tourism Development of
Bahir Dar town and Its Surroundings, Ethiopia**



*In partial fulfillment of the requirement for the degree of Masters in
Geo-information science*

Abel Markos

June 2012

ADDIS ABABA UNIVERSITY

School of Graduate Studies

Faculty of science

**Web GIS for Tourism Development of
Bahir Dar town and Its Surroundings, Ethiopia**

*In partial fulfillment of the requirement for the degree of
Masters in Geo-information science*

Under the guidance of

Dr. K.V. Suryabagavan
Assistant professor

Abel Markos

June 2012

ADDIS ABABA UNIVERSITY

School of Graduate Studies

Faculty of science

**Web GIS for Tourism Development of
Bahir Dar town and Its Surroundings, Ethiopia**

By Abel Markos

Faculty of Natural Science

Department of Earth Science

Geo-information science

Approved by Board of Examiners

Dr. Seifu Kebede

Chairman, department

Graduate committee

Dr. K.V. Suryabhagavan

Advisor

Dr. Bekele Abebe

Examiner

Dr. Asfawossen Asrat

Examiner

ABSTRACT

An efficient promotion of tourism, not only allows significant gain of foreign currency but also it has an effect in building the image of a country. The tourism industry in Ethiopia is not gaining the expected foreign currency and also it is not promoting the real image of the country as expected. One of the major problems for the development of tourism in the country is promotion for attracting people. The main objective of this study is to develop a web based GIS utility that allows the tourists to have spatial and non spatial tourism information about Bhair dar town anywhere in the internet. This study intends to develop a prototype based on a three tier architecture using client/server paradigm. Apache, Mapserver, PHP, and chameleon are the open source software that are used for developing the portal. Google API also used to enhance the query capability of the tourists directly from the Google satellite image. The developed web based GIS portal enables the tourists to get digital tourist map that contains information about the major tourist spots, hotels, health centers, and transport destinations of the town depending on their needs in easy and user interface way anywhere on the internet.

Key words: Tourism, Web GIS, Open source, Google API.

ACKNOWLEDGEMENT

First of all I would like to thank God for the grace strength provided to me for completing this course.

I would like to express the deepest appreciation to my advisor and instructor Dr. K.V. Suryabhadra in especial way for his unreserved advice, nice consultation, devotion to teach and provision of important reference materials that are much useful for this research work.

I am also thankful to Bahir dar Bureau of finance and Economics and Bahir Dar tourism bureau for their cooperation in providing me all kinds of information.

Words cannot express my feelings which I have for my friends Mahilet Adamu, Sertsedengiel Berhanu, Gethaun Mazengia and Kidanemariam Berhi. I am highly indebted to them for their advice, encouragement and support.

Finally I want to thank my family who were big sources of inspirations throughout my academic career with their valuable moral support and advice.

TABLE OF CONTENTS

Contents	page No.
ABSTRACT	iv
TABLE OF CONTENTS	vi
LIST OF FIGURES	ix
LIST OF TABLES	x
ABRIVATIONS	xi
CHAPTER I	1
1.1 Research Overview	1
1.2 Problem of the study	3
1.3 Research Objective	4
1.3.1 General objective	4
1.3.2 Specific objective	4
1.4 Limitation of the study	4
1.5 Schema of presentation	4
CHAPTER -II	5
2.1 Tourism	5
2.2 Attractions of tourist categories	5
2.2.1 Natural Attractions	5
2.2.2 Cultural attractions	6
2.2.3 Historical and Heritage Attractions	6
2.3 Tourism in Bahir Dar and its Surroundings	7
2.4 GIS applications in tourism	8
2.5 Web GIS	9
2.6 Web GIS Architecture	10
2.7 Server-side strategy	10
2.8 Client-side strategy	11
2.9 Available Technologies for Web GIS	12
2.10 Web technology for web based GIS	13
2.10.1 Web server	13
2.10.2 Scripting language and JavaScript	13
2.10.3 API	14
2.11 Open source software for web-based GIS	14
2.11.1 MapServer	15

2.11.2	Chameleon.....	16
2.11.2	PostGIS	17
2.12	Mashup	19
2.12.1	Mashup Styles.....	19
2.13	Assessment of Related work	20
CHAPTER III.....		22
3.1	The study Area	22
3.2	Climate.....	23
3.2.1	Temperature.....	23
3.2.2	Precipitation.....	24
3.3	Hydrology	25
3.3.1	Lake	25
3.4	Local human population	25
3.5	Cultural, Historical and Heritage attractions of Bahir dar	26
CHAPTER IV.....		30
4.1	Data sources and acquisition.....	30
4.2	Methodology	30
4.2.1	Requirement Analysis	31
4.2.2	Conceptual System architecture Design.....	32
4.2.3	Acquisition of GIS software	34
4.2.4	Geo spatial Database design Method	35
4.3	Data preparation	36
CHAPTER V		39
5.1	Web GIS system Integration	39
5.2	Application Development	40
5.2.1	Interface design.....	40
5.2.2	Template File.....	40
5.2.3	Preparation of Map file	41
5.3	Working with Chameleon	42
5.3.1	Initialization file.....	43
5.4	Running the application	44
5.4.1	Main map.....	45
5.4.2	Tool bar	46
5.4.3	Numeric and Graphic scale.....	47

5.4.4	Dynamic Legend.....	48
5.4.5	Reference tools	48
5.4.6	Other Elements	49
5.5	Mashe up.....	49
5.5.1	Development of a single web page	50
5.5.2	Loading the Map on to the Developed page.....	50
5.5.3	Creating a DIV element and calling the function Initializing	51
5.5.4	Adding Markers	52
5.6	Additional Pages.....	55
5.7	Developed Digital Tourist Site map of Bahir dar	55
5.8	Printable map	56
5.9	Discussion	57
CHAPTER VI.....		59
6.1	Conclusion	59
6.2	Recommendation	59
REFERENCES		61
ANNEXURE-I		63
ANNEXURE-II		65

LIST OF FIGURES

Figure 1 Server Side Architecture.....	11
Figure 2 Client Side Architecture	12
Figure 3 Basic Architecture of Mapserver Applications	16
Figure 4 A typical Configuration of a Chameleon using Mapserver	17
Figure 5 How a Server Side Mash up Works	19
Figure 6 How a Client Side Mash Up Works	20
Figure 7 Location Map of the study area	22
Figure 8 Monthly Average Temperature of Bahir dar	23
Figure 9 Monthly Average Precipitation of Bahir Dar	24
Figure 11 Web GIS Development Cycle.....	31
Figure 12 Conceptual System Architecture.....	32
Figure 13 Query Work Flow	33
Figure 14 Prototype Software Components	34
Figure 15 Data flow to the GIS Data base.....	35
Figure 16 Created and Available Data For Deveoped Web Based GIS portal	37
Figure 17 Application Directory Structure	43
Figure 18 Developed Bahir dar tourism Portal Home page	45
Figure 19 Using the Identify Button In the Developed Tourism portal	46
Figure 20 Graphic and Numeric Scale Bars for the Developed Bahir dar Tourism Portal	47
Figure 21 Dynamic Legend for the Developed Bahir dar Tourism Portal	48
Figure 22 Measured Distance from Air port to Hotel	49
Figure 23 Basic Tools To Navigate on Google Satellite Image for Finding Tourist Spots.....	56
Figure 24 Added Markers on Google Satellite Image For Showing Major Tourist Spots	57
Figure 25 Added Marks on Google Map For Showing Major Tourist Spots	54
Figure 26 Added Marks on Google Map with Terrain For Showing Major Tourist Spots	54
Figure 27 Developed Additional Pages fot the Developed Bahir dar Tourism Portal	55
Figure 28 Digital Tourist Site Map of Bahir dar Town and Its Surroundings	56
Figure 29 Options for Printing out the Map in Hard Copy Form	57

LIST OF TABLES

Table 1. Trends of Visitors Flow to Bahir Dar and its Surrounding between 1998- 2010.....	8
Table 2. Data Source and Their Descriptions	30
Table 3. Collected Data about Hotels	36
Table 4. Created and Acquired layers for the portal	38
Table 5. Tools in the Tool Bar.....	46

ABRIVATIONS

API	Application Programming Interface
CGI	Common Get way interface
CSA	Central Statistical Authority
CSS	Cascade Style Sheet
DHTML	Dynamic Hyper Text Markup Language
GIS	Geographic Information System
GUI	Graphical User Interface
HTML	Hyper Text Markup Language
HTTP	Hyper Text Transfer Protocol
OGC	Open Geospatial Consortium
PHP	Hyper Text Pre processor
SDI	Spatial Data Infrastructure
URL	Uniform Resource Locator
WCS	Web Coverage Service
WFS	Web Feature Service
WMS	Web Map Service
WTO	World Tourism Organization
WWW	World Wide Web

CHAPTER I

INTRODUCTION

1.1 Research Overview

Tourism can be defined as the act of travel for the purpose of recreation and business, and the provision of services for this act. Tourists are people who are “traveling to and staying in places outside their usual environment for not more than one consecutive year for leisure, business and other purposes not related to the exercise of an activity remunerated from within the place visited” (WTO, 2006). Tourism contributes to economic and social development of a country and has emerging potential.

As to visitors flow and revenue generated from tourism UN-World Tourism Organization (UNWTO) published in 2009 show that international tourism had grown to 922 million in arrivals and 944 billion dollars in receipts in 2008. Accordingly, when we compare the international performance of the industry in 2008 with that of 2007, it shows that tourism grew at an average annual rate of 1.9 percent in tourist arrivals and by 1.8 percent in terms of receipts. According to UNWTO's projection, the number reaching 1.6 billion arrivals generating 2 trillion dollars by 2020. This amounts to an annual average growth rate of 4.1 percent in tourist arrivals and 1.8 percent in receipts.

The tourist arrival to Africa has shown improvement (WTO: world tourism forecasting V.2).The tourism arrival in 1950 was 500,000.This number increased to 24,000,000 within fifty years. The revenue collected from this sector has also shown remarkable growth (Mesele, 2009).

UN-WTO's current analysis of tourist arrivals puts Ethiopia's average annual share of international tourists at 5.6 percent for the period 1990-2000, which grew to 10.8 percent during the period 2000- 2005. Indeed, the average growth rate achieved during these recent years represents an encouraging trend. On the contrary, the facts that, for example, in 2005 Ethiopia's share of the tourist business among the 17 countries of the east African region was only 0.7 percent shows how insignificant the country's performance is given the diversity of its historical, cultural and natural attractions (MoCT, 2009).

In Ethiopia there are potential tourist attraction sites in different parts of the regional states. Bahir dar, the capital of Amhra regional state is rich in a variety of aspects to attract tourists. To promote tourism in Bahir dar, the city administration is taking several measures through different ways. However, there is still a need to organize high performance web system for tourist attraction sites and facilities to promote and fulfill interests of tourist.

Now a day's web GIS is the first choice in promoting tourism in most of the countries. The ability of GIS to analyze and visualize spatial and non spatial data in the form of maps made it an essential tool for tourism. GIS is currently converging with several other technologies to provide new levels of accessibility and functionality (Drummond et al., 2008). As web technologies and the GIS advanced considerably and practiced widely (Tan, 2003) the web based GIS has become a popular means of information sharing and visualization.

Web GIS is a geographic information system distributed across a networked computer environment to integrate, disseminate, and communicate geographic information visually on the World Wide Web (Gillavry, 2000). Advancements in technology have changed the way tourists travel and plan their trips. Tourists need to find out the relevant distance from the airport to the hotel, the distance between different attractions and the accommodations , the exact position of tourist sites and other facilities easily. Geographic Information System (GIS) and satellite images have provided a new way of accessing location-based information. Web-based Geographic Information Systems facilitate the widespread use and dissemination of spatial information services and promote the technology to a much greater audience than it has ever been introduced before. The utility of the Internet allows information to be exchanged in a rapid and efficient manner, thereby helping tourists make important decisions quicker. The applications running on the Internet, known as the World Wide Web (WWW) give tourists countless powers for obtaining and disseminating the appropriate tourist information.

The release of Google maps in February 2005 caused a sensation in the web mapping industry. Google Maps presented a novel web-based mapping application which garnered the world's attention with its high speed and high degree of interactive mapping

capability, as well as features including high-resolution satellite images and an attractive map design.

A search of existing literature shows very little research focusing on the usability of web GIS applications for tourism in Ethiopia. This thesis will examine the usability of web GIS application for tourism by using open source software. As a result, this thesis intends to contribute to the further technical development of the usability of web GIS application for tourism.

1.2 Problem of the study

The introduction of web applications changes the way tourists gather information about their tour destinations. With the integration of web and GIS applications opportunities for inexperienced users arise to look at maps over the internet.

But the common available means of promoting tourism in Ethiopia is the use of information in books, brochures and poster. These have overtime been converted into websites. However almost all of the developed web sites about Bahir dar town and its surroundings tourism lack presenting digital maps on the internet. The absence of digital tourist maps about Bahir dar town and its surrounding on the internet makes searching spatial travel information difficult. Due to high cost and accessible only from the computer on which it is installed, using desktop GIS software for promoting the tourism industry is not gaining the expected output.

Spatial information requires for its treatment and analysis special software tools, namely geographic information systems. Geographic information system management tools have been traditionally developed as desktop standalone applications, due to the computing intensive activity typical of their role. Classic GIS software packages (desktop or professional GIS) have some drawbacks which limit their diffusion among all the users who need to use spatial information. First of all, the high costs; desktop software is then accessible only from the computer on which it is installed and their user interfaces requires training. The fact that desktop GIS are still a proprietary technology limits also the possible customization of their features. These problems along with spreading of the internet and increasing demand for spatial information have driven a rapid process of geo-enabling the Web and a rapid development of internet GIS applications or Web GIS.

1.3 Research Objective

1.3.1 General objective

- Develop a web based GIS utility that allows the tourists to have spatial and non spatial tourism information about Bahir dar town and its Surroundings.

1.3.2 Specific objective

- To develop graphical user interface
- Designing and developing a portal that provides both spatial and non spatial tourism information
- Development of a dynamic digital tourist site map of Bahir dar town and its surrounding.
- To use Google API sources code to enhance the user query capabilities on Bahir dar town and its surrounding tourism.

1.4 Limitation of the study

All efforts were made to perform the present study in a systematic and logical manner. However, these efforts were made under the constraint of limited restricted resources, financial support and lack of spatial data infrastructure (SDI).

1.5 Schema of presentation

There are five chapters in the thesis. Chapter one introduces the thesis in general, describes problem of the statement, objectives and limitation of the study. Chapter two deals with theoretical background about tourism. This chapter also describes theoretical background of web GIS technologies, open standard software, and mashe up technology. The third chapter is the general description about the study area with detailed picture of the potential of tourism in Bahir dar. Chapter four describes the materials used in the work, data sources, and requirement analysis of the prototype. This also describes methodology used in the implementation of the prototype. Chapter five deals with analysis and implementation phase. Finally the conclusion and recommendation of the thesis is described in the last chapter.

CHAPTER -II

LITERATURE REVIEW

2.1 Tourism

Tourism is traveling for predominantly recreational or leisure purposes or the provision of services to support this leisure travel. The World tourism organization defines tourists as people who "travel to and stay in places outside their usual environment for not more than one consecutive year for leisure, business and other purposes not related to the exercise of an activity remunerated from within the place visited (WTO, 2006). Tourism has become a popular global leisure activity. In 2004, there were over 763 million international tourist arrivals.

During the past few decades, tourism has emerged as one of the world's major industries, exceeding the importance of many manufacturing industries and other Services in terms of sales, employment and foreign earnings (Ajala, 2008). It is vital for many countries, due to the income generated by the consumption of goods and services by tourists, the taxes levied on businesses in the tourism industry, and the opportunity for employment in the service industries associated with tourism. These service industries include transportation, accommodation and entertainment venues, and other hospitality industry services such as spas and resorts.

2.2 Attractions of tourist categories

Tourism resources are categorized into natural and manmade attractions. Man made attractions also divided in to historical, heritage and cultural attraction. Both natural and cultural attractions can be categorized recreational attractions based on tourism products and interests of visitors (Negashe et al., 2011).

2.2.1 Natural Attractions

Tourism makes use of a whole range of natural resources. But the only natural attractions that are interested to visit by tourists are as follows: Clear environment, pure air, scenic mountains, natural faced forests, clean sea with natural state biophysical components and beautiful natural landscapes. All sorts of natural habitats with their flora and fauna, Safaris, jungle trekking. Mineral waters with healing properties and spa development for health purposes, water in lakes wild seas are warm and clear suitable for bathing. Totally,

environmental attractions can be divided into five different components derived from natural and cultural environment outputs (Negashe et al., 2011).

The natural environment:

- Landscape: mountain areas, meadows, mosaic plain land seas, rivers, lakes, caves, beaches, wetlands, hills escarpments and natural woodlands.
- Wildlife: biodiversity, land-based mammals, flora, birds and insects.
- Natural resources: water, climate, air

The natural environment

- The farmed environment: agricultural landscapes, manmade forests, animal farms.
- The built environment: buildings and structures, villages and towns, transport, infrastructure (roads, airports) dams and reservoirs.

2.2.2 Cultural attractions

Culture encompasses everything that man has produced, organized, developed, etc. Central to culture is the interaction of people and how they learn from each other. Learning can be accumulated and passed on through a range of oral and written traditions. Culture consists of both social relations and materials, artifacts, behavioral patterns, knowledge and values that have been acquired and transmitted through generations.

The main cultural Tourism Resources as described by (Negashe et al., 2011) are:

- Arts: theatres, art gallery
- Traditional crafts: pottery, traditional furniture, traditional clothing and jeweler.
- Language: dominant language of the country, minority and regional languages.
- Industry and commerce: famous shops and shopping malls, markets, farm attractions, and work place visits.
- Sport and Leisure Activities: as participant, as spectator, traditional games and sports.

2.2.3 Historical and Heritage Attractions

- Religious sites: churches, cathedrals, shrines and mosques
- Types of architecture: specific building styles
- Heritage attractions: museums, Castles, palaces, ancient monuments, historic gardens, historic landscapes, historic villages.

- **Recreational attractions:** Tourism products of attractions can be categorized recreational attractions based on tourism products and interests of visitors' enjoyment needs and satisfaction. Special interest holidays: bird watching, paragliding, hill and tree climbing, thrill-seeking holidays where people go Parachute jump, water rafting. These various types of natural, cultural and historical tourism products and management are interrelated and often revealed by recreational for example, scenic view points, bird watching, game hunting and activities of wild animals and their feeding nature, a special interest holiday focusing on 'the history of Ethiopia' will cover religious sites, heritage attractions, possibly festivals, types of architecture, tradition crafts and traditional food and drink (Negashe et al., 2011).

2.3 Tourism in Bahir Dar and its Surroundings

Bahir dar is one of the regional states of Ethiopia that has an improvement in the tourism sector. Though only with limited promotion on historical heritages still significant number of tourist and researchers are being visited attractions of Bahir Dar. Attractions and tourism products promotion materials are mainly released by leading institutions, monasteries and churches (Negashe el al., 2011). They have been promoting only through leaflets and oral interpretation in inconsistent way for visitors as well as day trip visit itinerary by tour operators. Hence promotion and all attraction inventory data bases are not well developed. So diverse promotion techniques are not used so as to draw more number of visitors and lengthen their stay so to generate expected revenue and implement conservation and development activities in various parts of destinations.

Estimated mean annual visitors flow and revenue trend that goes to Bahir dar town and its surrounding in the last 13 years are 243,095 local visitors, 114,128 international visitors and generated income is 168,385,661ET Birr. Now a days this has been increased by about three folds. Facilitation of infrastructures and promotion of tourist tourism products; proper conservation and management; controlled tourism services, increasing facilities and accommodations help to sustain tourism products. Tabel 1 Shows trends of Visitors flow to Bahir dar and its Surrounding between 1998- 2010

Table 1. Trends of Visitors Flow to Bahir Dar and its Surrounding between 1998- 2010

Years	Number of local visitors	Number of foreign visitors	Income generated in ET Birr
1990	15,712	8,938	216,128
1991	11,587	4,167	110,221
1992	12,854	5,167	149,143
1993	16,813	5,308	162,944
1994	17,608	7,474	211,142
1995	17,613	8,864	226,213
1996	15,555	7,955	197,891
1997	14,700	8,675	193,741
1998	18,960	8,824	204,474
1999	23,561	10,083	250,637
2000	26,710	11,774	53,446,472
2001	28,542	12,613	57,167,888
2002	22,880	14,286	55,848,767
Total	243,095	114,128	168,385,661
Mean/year	18,700	8779	12,952,743.15

Source:BoCTPD,2011

2.4 GIS applications in tourism

There are two categories for the use of a GIS system in tourism, public use and management use. The public wants to find geographic information about a place before they go there. They want to know where things are located, what amenities are available, what the climate is like, and be able to do site specific searches to find information. This can be achieved through Web-based GIS. The other user of the GIS is the Management side; management may be done by individual operators, a tourism group, or by the local municipality. Management users want to query the system for where customers are coming from, their socio-economic backgrounds, and good potential locations for new tourist sites etc.

Tourism destinations are usually characterized by three different landscape features Points, lines, and polygons. Point features are individual tourist attractions, for example a historic site along the highway. Coastal beaches are represented by a linear pattern, while big theme parks or natural parks are characteristics of a polygon feature. These location attributes are essential to a geographic information system (Wayne, 2003).

Geographic Information Systems (GIS) is a rapidly expanding field enabling the development of applications that manage and use geographic information in combination with other media. In the tourism industry, GIS is used to provide:

- A digital map base for printed maps
- Digital files for Internet mapping
- Digital files for mobile mapping
- Attractions map
- Website with interactive mapping

GIS technology offers great opportunities for the development of modern tourism applications using maps. This technology integrates common database operations such as query with the unique visualization and geographic analysis benefits offered by maps. (Verka, 2007)

2.5 Web GIS

Web GIS is the process of designing, implementing, generating and delivering maps on the World Wide Web by combining both the advantage of GIS and the internet (Wikipedia, 2010). GIS integrates and relates data with spatial component and supports users to view in proper format which supports in making complex spatial decisions through visualization, interactive modeling and analysis environments. GIS is thus far utilized to help with perception and understanding of spatially distributed phenomena in many areas of decision making and evaluating problems (Sakamoto et al., 2004). Generally GIS systems were considered as monolithic and platform-dependent applications (Wong et al., 2002). The development and rapid growth of web and web based application created a new platform for traditional GIS to grow and spread. Unfortunately, not everyone has access to GIS, nor would be able to spend time necessary to use it effectively. Web GIS became a cheap and easy way of disseminating geospatial data and processing tools (Alesheikh et al., 2002).

Web GIS have the highest number of users, although typically internet users focus on simple display and query tasks (Goodchild et al., 2005). The capability of Web GIS for interacting dynamically in distributed environment from cross platform to client/ server computing system made it more interesting to develop and use for accessing spatial information. The major development of cartography is using web as a distribution

medium. By the means of web, now it has opened the possibility of the availability of real-time maps, cheaper maps sharing, more frequently updated database sources and cheaper software and hardware requirement. There are some problem and difficulties for fully development of web mapping. Some technical difficulties such as bandwidth, lower resolution of image are common. Reliability issues and security issues are limited the expansion of web mapping.

The development of web cartography and GIS is steady as compare to web technologies. Web 2.0, a new generation of Internet services and technology (Deshpande et al., 2006), support user interaction significantly. This evolution leads GIS away from data browsing, analyzing and managing for individual decisions, and more towards group participating and communicating on social decision issues (Carver, 1999). As (Craig et al., 1999) describe the Public Participation GIS principles as accessibility, understandability, and accountability, Web GIS continues to draw attention as a public participation tool (Sakamoto et al., 2004). Nowadays, Google Maps, Google Earth, OpenStreet Map, Yahoo Maps, Microsoft's live search maps and other many commercial as well as non-commercial applications provide many kinds of geographical related information such as detailed maps, satellite images and terrain maps covering all over the world and allow users to use their APIs (Zhelu, 2009).

2.6 Web GIS Architecture

The basic approach for deploying Web GIS application depends on the user requirements that have to concern with which web GIS packages are suitable to accomplish their objectives (Phisan, 2001). Developments of web GIS are changing as fast as internet and Web technologies. Because one depends on the other. According to (Dang, 2000) there are basically two types of architectures for developing web based GIS applications client-side, and server-side.

2.7 Server-side strategy

In a server-side web GIS application, a Web browser is used to generate server requests and display the results on client-side browser. A web 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 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.

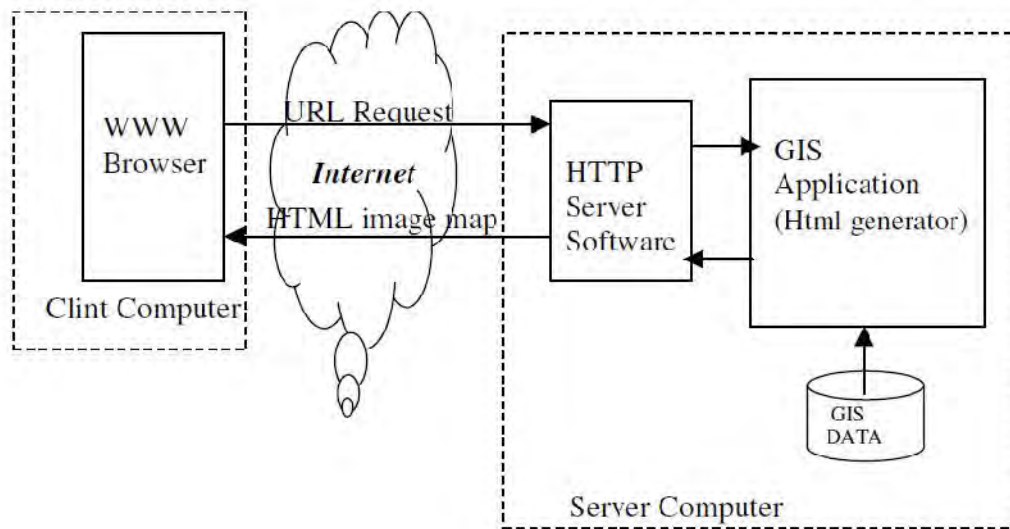


Figure 1. Server Side Architecture

2.8 Client-side strategy

Client-side Web GIS applications can provide full GIS analysis and management support to specific users within business, government or public sectors. In a client-side Web 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 Web 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 (Dang, 2000).

As it is shown in figure 2 in client-side Web 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 is improved performance.

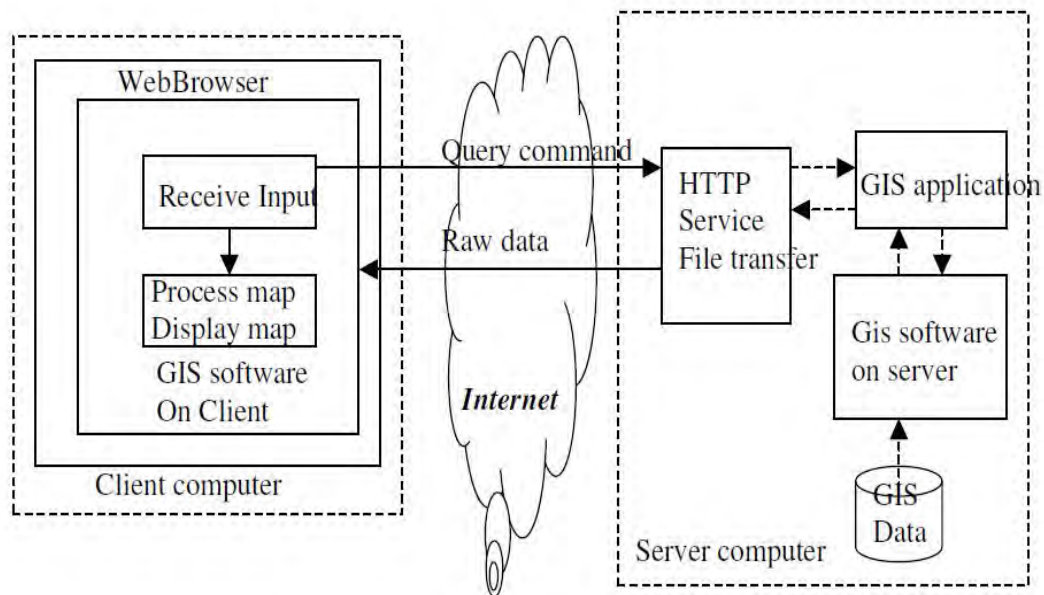


Figure 2. Client Side Architecture

2.9 Available Technologies for Web GIS

Web GIS being one of the newest fields in Geographic Information systems. Different software and technologies are being developed in both commercial as well as open source. For Commercial purposes commercial companies develop well documented software that contain advance features but the price for that technology is high while open source system is developed by communities and can be used free of charge by having poor documentation. Open source system is developing rapidly with the

involvement of large number of people. The major technologies involved in the realm of Web GIS today are (Detwiler et al., 2009)

Commercial: ArcGIS Server by Environmental Research Institute (ESRI), GeoMedia WebMap by Intergraph, MapXtreme by MapInfo and MapGuide by Autodesk.

Open source: GeoServer, MapServer, chameleon, OpenLayers, Scaleable Vector Graphics (SVG).

Public APIs: Google Maps, Yahoo Maps, Microsoft Virtual Earth (2D).

2.10 Web technology for web based GIS

2.10.1 Web server

Web server is the server that accepts HTTP requests from clients, and serves them HTTP responses along with optional data contents, which usually are web pages such as HTML documents and linked objects such as images. The most popular web server software is Apache based on Net craft survey in January 2009. Apache HTTP Server is the open source software and available for a wide variety of operating systems, including Microsoft Windows, UNIX, and LINUX. It supports many programming languages like PHP and Python.

2.10.2 Scripting language and JavaScript

A scripting language allows controlling one or more software application. Scripts are different from core programming language often interpreted from source code and embedded in other applications. In web based application scripts are embedded in HTML code. Client side scripting are executed in client-side by web browsers whereas server side scripting the scripts runs on server side or application servers. The popular server side scripts are PHP, ASP and JSP. JavaScript is a client side object oriented scripting language which is popular for developing client side application. It is developed by Netscape in 1995 and closely related with Java programming language and influenced with other programming languages but easier to program.

2.10.3 API

Application Programming Interface (API) which constitutes a language and message format is set of data structures, routines or protocols used by an application to communicate with other control program, communication protocol or operating system. Almost every application depends on the APIs of the underlying operating system to perform such basic functions as accessing the file system(Orenstein, 2000) APIs are implemented by writing function calls in the program, which provide the linkage to the required subroutine for execution. An API entails program module in computer to perform the operation or links to the existing program to perform the tasks. Based on function and interaction the API also differs in the implementation in that environment. Generic APIs are full set of APIs included in library of programming languages. These API interacts with operating system, DBMS and other applications and facilitate interaction between users and the computers. Specific API only addresses defined specific problems like yahoo API, Google API. Language specific API operate in a specific language using syntax and components of that language where as language independent APIs can operate in different application and programming language. This feature of language independent APIs is required feature of service oriented API which doesn't limit on specific system, process or platform and useful for web services. The API itself is largely abstract in that it specifies an interface and the behavior of the objects specified in that interface. The API acronym may sometimes be used as a reference not only to the full interface but also to a single function or even a set of multiple APIs provided by an organization. Thus the scope is usually determined by the person or document that communicates the information. Based on the API documents, the user could learn and combine exist functions in the application more easily and efficiently.

2.11 Open source software for web-based GIS

Open source software are programs whose licenses give users the freedom to run the program for any purpose, to modify the program, and to freely redistribute either the original or modified program without further limitations or royalty payments (<http://www.opensource.org>). There are many open source software available to develop the web based GIS. The descriptions on software below are some of them selected to be used in this paper.

2.11.1 MapServer

MapServer is an open source development environment for building spatially enabled internet applications. It can run as a CGI program or via MapScript which supports several programming languages. MapServer was developed by the University of Minnesota so, it is often and more specifically referred as "UMN MapServer", to distinguish it from commercial "map server" (David Fawcett et al., 2010).

Anatomy of a MapServer Application

A simple MapServer application consists of:

- **Mapfile** – it is a structured text configuration file for MapServer application. It defines the area of the map, tells the MapServer program where the data is and where to output images. It also defines the map layers, including their data source, projections, and symbology. It must have a .map extension or MapServer will not recognize it.
- **Geographic Data** - MapServer can utilize many geographic data source types. The default format is the ESRI shape file.
- **HTML Pages** - the interface between the user and MapServer. They normally sit in Web root. In it's simplest form, MapServer can be called to place a static map image on a html page. To make the map interactive, the image is placed in an html form on a page.

CGI programs are 'stateless', every request they get is new and they don't remember anything about the last time that they were hit by the application. For this reason, every time your application sends a request to mapserver, it needs to pass context information (what layers are on, where you are on the map, application mode, etc.) in hidden form variables or URL variables. A simple mapserver CGI application may include two html pages:

- **Initialization File** Uses a form with hidden variables to send an initial query to the http server and mapserver. This form could be placed on another page or be replaced by passing the initialization information as variables in a URL.
- **Template File** controls how the maps and legends output by mapserver will appear in the browser. By referencing mapserver CGI variables in the template html, you allow mapserver to populate them with values related to the current state of your application (e.g. map image name, reference image name, map extent, etc.) as it creates the html page

for the browser to read. The template also determines how the user can interact with the mapserver application (browse, zoom, pan, query). Figure 3 shows basic architecture of mapserver Applications.

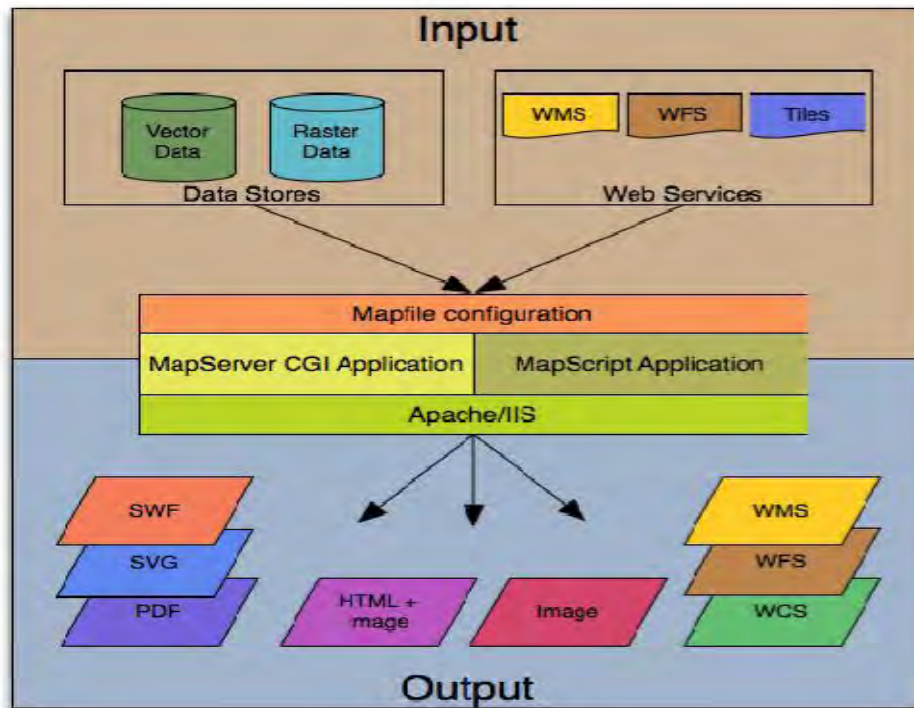


Figure 3. Basic Architecture of Mapserver Applications

- **MapServer CGI** - The binary or executable file that receives requests and returns images, data, etc. It sits in the cgi-bin or scripts directory of the http server. The Web server user must have execute rights for the directory that it sits in, and for security reasons, it should not be in the web root. By default, this program is called mapserv
- **HTTP Server** - serves up the html pages when hit by the user's browser. You need a working HTTP (Web) server, such as Apache or Microsoft Internet Information Server, on the machine on which you are installing MapServer.

2.11.2 Chameleon

Chameleon is an open source, distributed, highly configurable, environment for developing Web Mapping applications (<http://www.mapcruzin.com>). It is built on Map Server as the core mapping engine and works with all Map Server supported data formats. It also

works well with OpenGIS Consortium standards for Web Map Services WMS and Web Map Context Documents (WMC) through Map Server's support for these standards. Chameleon has a plug-in architecture. A large number of plug-ins, or widgets as they are called by the Chameleon developers, are available. A Chameleon widget can implement a mapping task such as zooming, panning, showing legends, or displaying map coordinates. Over a hundred widgets are distributed with the application and developers can easily create their own widget for any specific task. Figure 4 shows a typical Configuration of a Chameleon using Mapserver

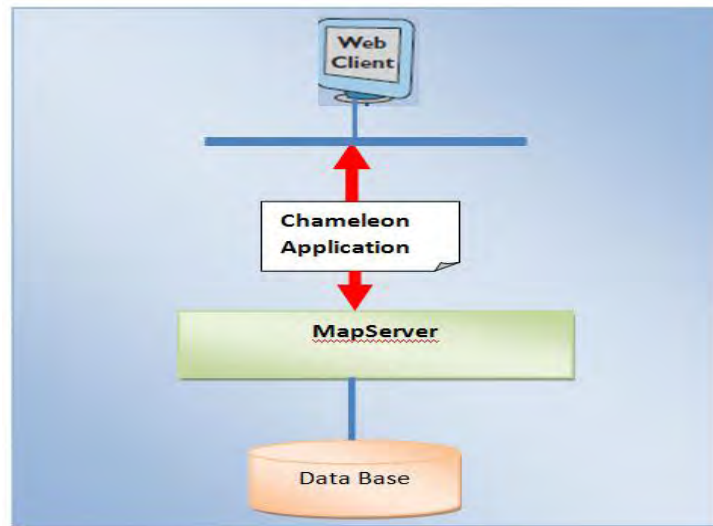


Figure 4. A typical Configuration of a Chameleon using Mapserver

2.11.2 PostGIS

PostGIS (<http://postgis.refractor.net>) is a spatial extension to PostgreSQL, enabling PostgreSQL to be used as a backend spatial database for GIS. It allows geographic objects to be stored in the database and included support for GiST-based T-tree spatial indexes and functions for basic analysis of GIS objects. PostGIS follows the OpenGIS simple features specification for SQL. PostGIS is open source software and takes advantage of the extensibility of PostgreSQL.

PostGIS is a very complete system, probably the most used actually in computer environment to use with GIS applications. There is the possibility to add pgRouting extension to provide geospatial routing functionality with routing algorithms.

As PostGIS is still under development (tough rapidly evolving), some limitations still apply

- Topological relationship can at the moment only be tested between the two objects. An exception is the = operator which compares the actual geometries.
- Named spatial relationship predicates for testing spatial relations between geometric objects are still missing, such as:

Relate(), Touches(),contains(),crosses() and disjoint. PostGIS at the moment also lacks most spatial operators that support spatial analysis, like: Buffer(), Intersection(),Union(),Difference() and symdifference().

2.12 Mashup

An influential article defining the Web 2.0 movement talks about cooperation, instead of control. This is something to keep in mind when approaching the concepts of mashups. In a nutshell, a mashup is created from several data sources and services, mashing up (combining, stitching together) the sources and services to create something new, or add value in some way (<http://wiki.developerforce.com>) .

2.12.1 Mashup Styles

Server-side mashup

The first type of mashups style is server-side mashups. Server-side mashups integrate services and content on the server. The server acts as a proxy between web applications on the client, typically a browser, and the other web site that takes part in the mashup. In a server-side mashup, all the requests from the client go to the server, which acts as a proxy to make calls to the other web site. So, in a server-side mashup, the work is pushed from the web application client to the server. Figure 5 shows how a server side mashes up works

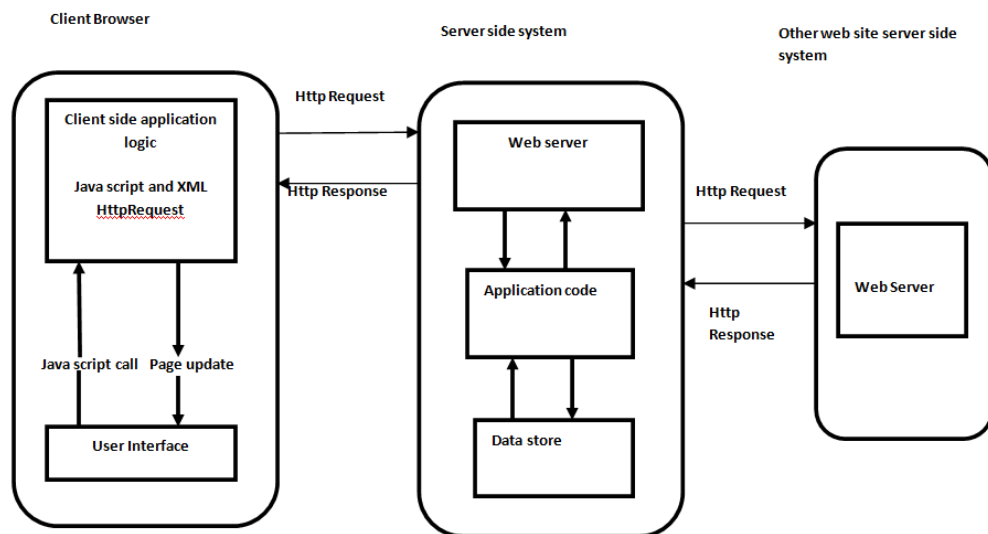


Figure 5. How a Server Side Mash up Works

Client-side mashup

In a client-side mashup, the service or content integration takes place in the client, which is typically a web browser. This is in contrast to a server-side mashup, where the service or content integration takes place in the server. Figure 6 shows how a client side mashe up works.

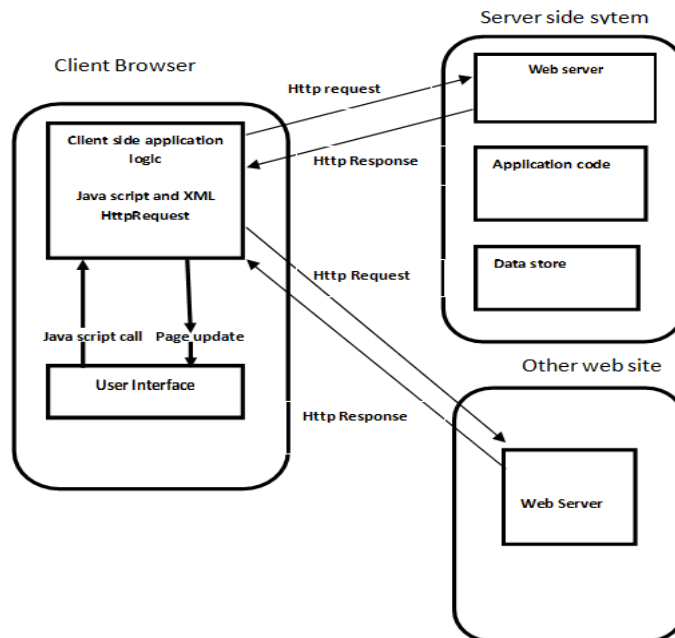


Figure 6. How a Client Side Mashups Up Works

2.13 Assessment of Related work

As described by (Fajuyigba, 2007) the tourism industry in Nigeria is growing one but it suffer from lack of appropriate promotion. To overcome this problem the researcher uses a web based GIS approach. In order to provide enhanced cartographic representation, the researcher develops the digital maps using Arc view GIS software. The developed maps were putted on the internet using an interactive user interface web page.

According to (chDodo et al., 2004) one of the problems encountered in the tourism industry is the need for quick update and maintenance of the voluminous tourism data. In

Zimbabwe, tourism authorities are continuously collecting data on tourist facilities. At the Zimbabwe Tourism Authority, most of this information is stored in hardcopy format. Some of the information gets lost after some time. The researcher uses arc view version 3.2 and visual basic programming language to overcome the problem.

The problem of tourism development in Addis Ababa city, Ethiopia was identified. According to (Mesele, 2009) the main problem for the development of Addis Ababa tourism is lack of appropriate promotion. He uses web based GIS application using open sources software for promoting the tourism facilities of the city on the internet.

The problem of ecotourism in Sundarbans Bangladesh was identified by(Azizur, 2010). He uses GIS Organize structured information about Ecotourism to planners and developers, to utilize and find location suitability under conflicting demands and facilitate monitoring and controlling of ecotourism activities.

According to (Angelina, 2008) she used GIS for bringing the georeferenced data (spatial and non spatial) of geographic location Zlatibor and Zlatar of her study area into digital maps. Each object is assigned to a thematic layer. Each layer combines related objects like roads, building, protected areas or watercourses. In this research the author used GIS in three types of applications such as inventory, analysis and evaluation of plan based on tourism development.

Web based GIS approach for disseminating the spatial and non spatial tourism information of East Java Indonesia on the internet was done by (Tran, 2006). In order to achieve his objective the researcher develops a spatial and non spatial data base. He uses mysql DBMS for storing the non-spatial data and the spatial data were stored as ESRI shape files. Finally he develops an interactive user interface by using different web site developing programming languages and he connects the developed spatial and non spatial data base with the website.

CHAPTER III

THE STUDY AREA

3.1 The study Area

Bahir dar is located in the North Western part of Ethiopia at a physical distance of 565 kilometers from Addis Ababa, the capital of Ethiopia. Astronomically, the study area is located at $11^{\circ}29' - 11^{\circ}41'$ N latitude and $37^{\circ}16' - 37^{\circ}27'E$ longitude (figure 7).The landscape is flat with some small hills to the east and west. The average elevation in the town is about 1795 m.a.s.l. According to the recently revised master plan, the town covers an area of about 16000 hectares. The foundation of Bahir dar dates back to the 14th century associated with the establishment of Kidane Mehret church near Lake Tana (Seltene, 1988).

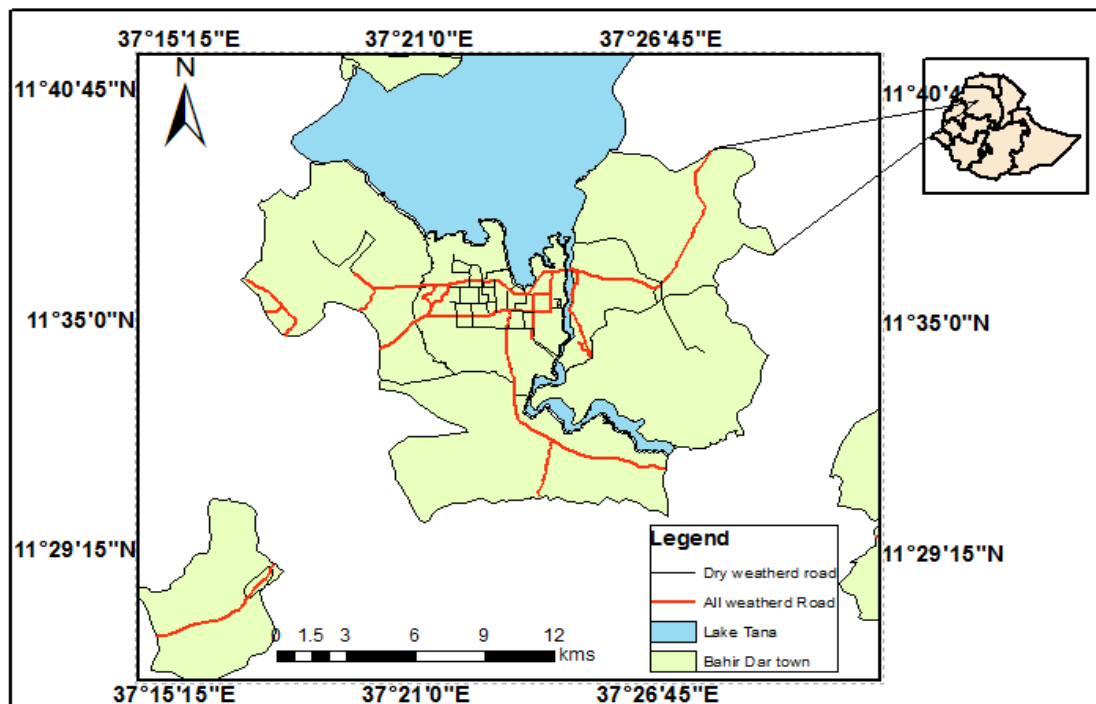


Figure 7. Location map of the Study Area

3.2 Climate

3.2.1 Temperature

The Bahir dar town temperature fluctuates from January to December. The monthly mean maximum and minimum temperature recode in the years between 1961 and 2000 (in the bare blew) indicates that the highest mean monthly maximum temperature occurs in the month of April which is about 29.7°C and the lowest is in the months of July and August which is about 23.3°C . While the mean monthly minimum temperature ranges for the lowest from 7.1°C in January to the highest 14.2°C in the month of May.

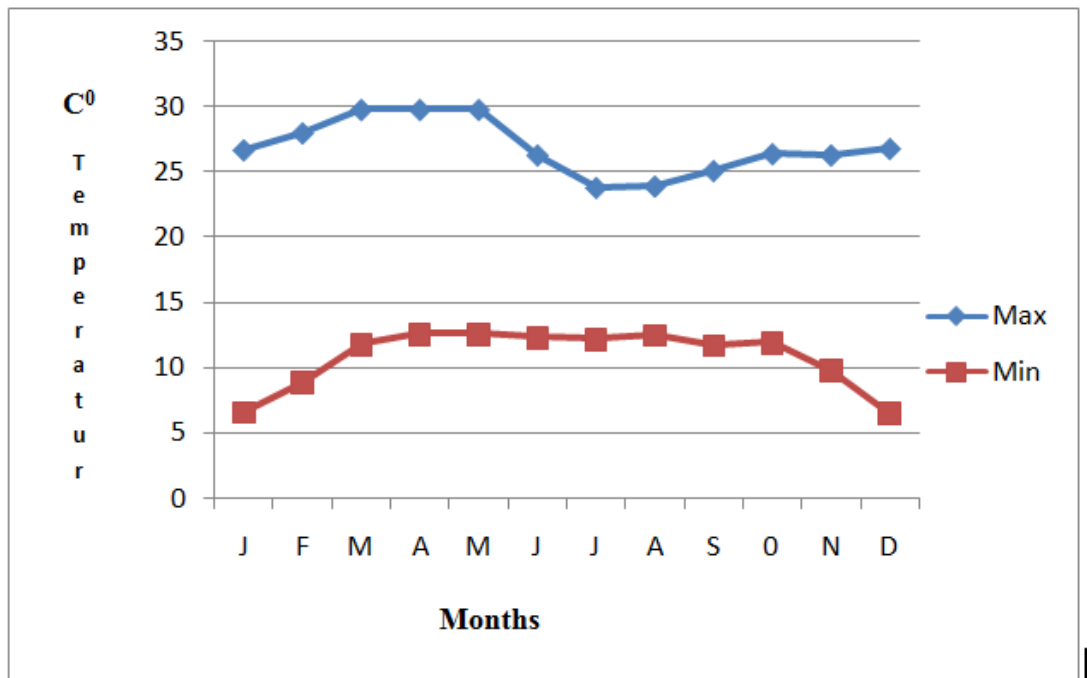
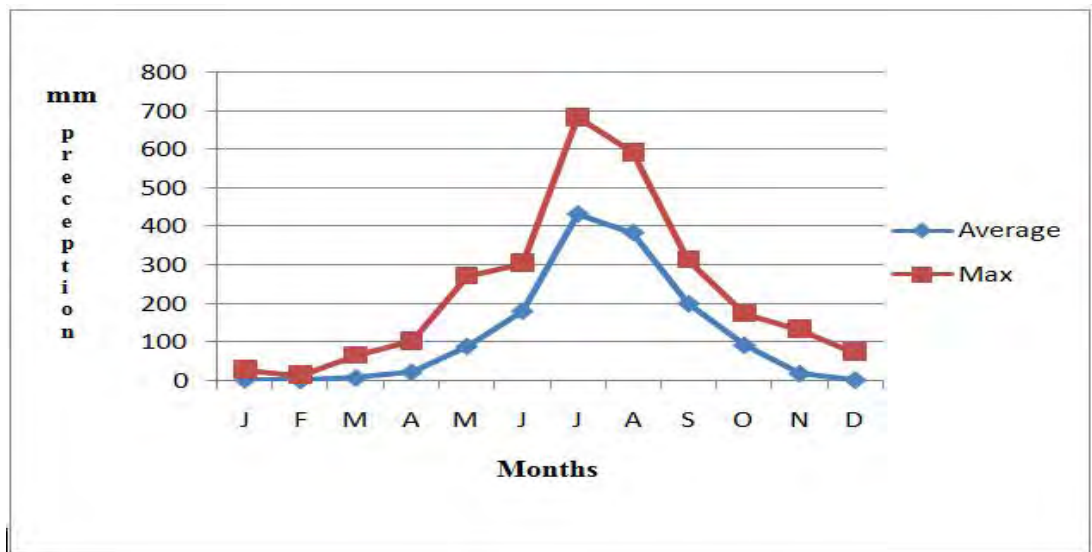


Figure 8. Monthly Average Temperature of Bahir dar

Source: Ethiopian water Resource Authority land and water studies Agency

3.2.2 Precipitation

The mean annual precipitation depth recorded at Bahir dar Station in 37 years period from 1962 to 1999 is about 1437 mm. There is a significant seasonal variation in the amount of rain fall. Almost 60.3 % percent of the mean annual rainfall occurs in two raining months of July and August with maximum mean value of more than 432 mm.



Month	J	F	M	A	M	J	J	A	S	O	N	D
Average	2.8	1.9	7.6	22.9	89.5	180.7	432.2	384.3	200.1	92.6	19.1	2.7
Max	30	15	67	104	273	306	685	593	314.6	174.4	134	76

Figure 9. Monthly Average Precipitation of Bahir dar

Source: Ethiopian water Resource Authority land and water studies Agency

3.3 Hydrology

3.3.1 Lake

Lake Tana is the primary reason that Bahir Dar exists. It is a huge lake - one of the largest in Africa and it feeds the Blue Nile River. There are several small islands on the lake. Lake Tana which is the largest lake in Ethiopia situated in the study Area. It covers 3,050 km². Lake Tana has a shallow depth with a maximum of 14 m deep and an average of about 9m. Lake Tana is among 250 important lake regions of the world. In the lake there are greater than 60 islands covering 4304.43ha of terrestrial land in side Tana Lake of which 45 have an area greater 1000m² including the biggest Deke, and Dagastifanos. Among 45 islands 19 have churches and/or monasteries that are home for monks and other service providers to the churches and monasteries.

3.4 Local human population

According to the 1984 census the population of Bahir dar was 54,766. The second national population housing census conducted 10 years latter in 1994 shows that the total population as 94, 235 in the city. The central Statistical Authority (CSA) in its Annual statistical abstract of 2004 projects the total population size of 159,796 (Male 82,498 and female 77,295) for the year 2005.

3.5 Cultural, Historical and Heritage attractions of Bahir dar

A brief survey of the most tourist attraction of cultural and historical heritages goes with the establishment of churches and monasteries in the islands and peninsulas of Lake Tana. Hence heritages in Bahir dar describe reconciling with the history of these institutions.

Kibran Gabriel Monastery: This monastery is found in the southern part of Lake Tana 7km north western of Bahir Dar town. Abune Ze Yohannis, founder of the monastery of Kibran Gabriel, came from a noble family. He was one of the seven stars born in Merha Bete, Northern Shewa.

Debremariam Island: This Island is located in the southern region of lake Tana about 5 km far from Bahir dar town. Here the monastery of Debre Mariam is founded during the reign of Amade Tsion (1314-1344) by Abune Tadewos. It was rebuilt by King Tewodros II (1855-1868). In 1688, King Iyasu chose the church as a site of council meeting which he called to try to end the quarrels of the monks, the religious dignitaries, and the archbishop Abba Sinoda. The religious controversy concerned the problems of the nature of Christ. The church owns one of the oldest manuscripts, the Tetra Gospel which dates from 1360-1380. This manuscript is beautifully illustrated as another of the same type which is dated from 1640-1660 which is also found here. The latter is an outstanding document of Ethiopian fine art. Originally the church was hut made of mud and stone but before 20 years the chanting room and the holy of the church was completely restored with cement but the holy of holy of the church kept its original style. The place or the area around the church is also called Gumare Bahir (Hippopotamus' Lake), because of the existence of many hippopotamus around the area. It is also called Abay Ras (Head of the Nile), to mean that it is mouth of the lake out of which the Blue Nile comes out. This island is one of the best attraction sites which can be accessed either by boat or on foot from Bahir dar.

Entos Eyesus Monastery: This Island is located in the southern part of Lake Tana and to the Northwest of Bahir dar. It is accessible only by boat. Here, there is Entos Eyesus monastery built by Abune Ze Yohannis during the reign of Amade Tsion in the 14th. It is located near to Kibran Gebriel and covered with dense forests. In this monastery, there is ancient building that is believed to be used for prisons, wildlife (bird), crosses made from

silver and wood, ancient books and clothes made from hides. It is best place for watching souvenir during production.

Dagaestifanos Monastery: It is found in the Daga islands, central part of Lake Tana. It is situated on the 1909m above sea level that is the highest place of the lake and easily seen from any direction of Lake Tana. The island covered with jungle forests. The monastery is founded by Abune Hirut Amlak, during the reign of Emperor Yikun Amlak in the 13th c the monastery differs from the other is that in its museum it contains the skeleton of Atse Dawit I, Atse Zeriyakobe, Atse Sesinios and Atse Fasildes.

Kristos Semera Church: The church is found in the Kristos Semera peninsula located at the eastern shore of lake Tana. The actual church of Kristos Semera was supposedly founded in the late 14th century during the reign of Emperor Dawit I (1380-1412).

Rema Medhanealem Monastery: The monastery was founded by Abune Nob during the reign of emperor Yisshaq (1414-1429). It was also rebuilt by Susenyos in the 17th c.

The Tiss Isat Falls: A good road leads from Bahir dar to the impressive Nile fall about 35 km (22 miles) away. On approaching the river, car must be parked beyond the Fasildes Bridge built in the 17th century. Higher upstream just a few minutes away the river meander across half a kilometer, but at the bridge, the force is concentrated into a narrow gully of hard, black basalt and flows with tremendous power through just one of the narrow bridge arches. Beyond the bridge a path leads steeply uphill to a natural terrace overlooking the fall. This is the fantastic sight, especially in the rainy season. The name Ṭiss Isate comes from “Ṭisoha” – the smoke of fire- and it is easy to see why the fall were so named. The divided river bed plunges down wards in two stages for almost 45 meters causing deafening, “smoking” water fall.

Zegie peninsula monasteries and culture The historical event of Zegie goes with the founder of monasteries in the peninsula. Aba Betre Mariyam, from Mugger in the province of Showa. His name and his virtue go together, “Betre” means stick. He was called Beter Mariyam because he had a stick that won the heretics and defeated the demons. Betre Mariyam freed his people from the bondage of the devil. Betre Mariyam did many miracles as the stick of Zecharias did. In the end he rested at Zegie. After the recognition Zegie given by Amade Tsion for the established monasteries traditional

natural resources, historical and cultural heritage have been passed from generation to generation and now Zegie is a place the residents established their livelihood reconciled with the monastery life in which no plow culture and clearing of natural vegetation and the people had been loyal to proscription given by the founder of the monasteries Aba Betre Mariyam (Negashe et al., 2011).

Ura Kidanemehre Monastery/church: Ura is situated south of eastern part of the peninsula of Zegie near Lake Tana which is a great monastery. The term Ura itself is believed to have been taken from the man who had land owner in the area collaborated with Betre Mariyam in allowing him to establish the monastery. The name had given in commemoration of this man name “Wura” that the term Ura adopted. It is constructed at the reign of Amde Tsion. Kidanemehret means & covenant of charity & in which many churches are dedicated. The monastery of Ura-kidane Mehret, part of the main land, its orientation is different from that Kebran Gebriel.

In this monastery many movable heritages are found; some of them are king Tekele Hymanot`s of the 19thc. Atse Tewodros of the 19th c, also Yohannes`s of the 17th c silver crowns and also the crown of queen Mitwab made from gold, crown of Atse Fasil in the 17th c, and Atse Lebene Dingel in the 16th c, Bekafa of the 18th c, and Atse T/Giorgise in the 18th c exist in this monastery. In addition, manuscripts, crown of kings, crosses and other historical heritages, are the main heritages frequently visited and impress tourist (Negashe et al., 2011).

Azwa Mariyam: It was founded in 1307 E.C. which is colorfully decorated by wall paints. The paintings were made by Aleqa Sirak of the Zegie and Aleqa Berhan of the Gonderian the 16thc. The church is made of mud and stone and wooden pillars. The church was known in the past as the “Seil Bet” which means house of paints and pictures because painters used to copy paints from Azwa to decorate other churches. It is covered with a thatched roof keeping its originality. It is rich in different types of religious heritages. Some of these are the crown of Adyam Seged Iyasu, Yohannis I, Bakafa, a sword of Bakafa, over all coat of Itege Mentwab, picture of St. Marry made in the hands of St. Luke, different manuscripts, crosses, drums, cyst rums etc... put in museum. It is one of the most frequently visited sites in the peninsula. The green campus natural beauty and more proximity to the port with associated forest under growing coffee and citrus fruits and primates, birds, squirrels impressively draw the visiting plan of tourists.

Mahal Zegie Giorgis Churches: Mahal Zegie Giorgis the earliest church built and located to the eastern outskirts of the peninsula. The founder was Abune Betremaraim who brought the Ark during the region of Amde Tsion (1314-1344). The exact period of foundation is not clear .

The above and other cultural, historical and heritage attractions have greater potentials for tourism industry if they are promoted properly. Plate 1 shows some of the pictures that are taken during the field trip.



Kiberan Geberiel Island



Paints of Ura Kidanmiheret



Tise Esat



Nerga Selasie

Plate 1. Pictures of Some of the Tourist Attractions.

CHAPTER IV

MATERIALS AND METHODS

4.1 Data sources and acquisition

The present research results were achieved with the utilization of different materials, spatial and attribute data. Both in primary and secondary data form. Table 2 shows the data sources and their descriptions.

Table 2. Data Source and Their Descriptions

Item	Data Type	Sources	Description
1	Top Map of Bahir Dar	EMA	1:50,000
2	Boundary of the study Area	BOFED of Bahir Dar	Shape file
3	Boundary of Lake Tana	BOFED of Bahir Dar	Shape File
4	GPS reading data	Field	Longitude and latitude value
5	Hotel information	Bahir Dar tourism bureau	Textual information
6	Literatures	Different books and journals	Textual information

4.2 Methodology

Web GIS development cycle

Developing a web GIS is more than simply using the appropriate hardware and software (Alesheikh & Helali, 2001). GIS based project development consists of components such as data development, data organization, and application development that are not similar and different from the standard software development processes (Mir, 2006). The web GIS development cycle is a step by step method from requirement analysis to the ongoing use and implementation of the expected portal. Figure 11 shows the web GIS development cycle which is described in terms of 6 major activities starting with requirement analysis and ending with implementation of the web GIS system.

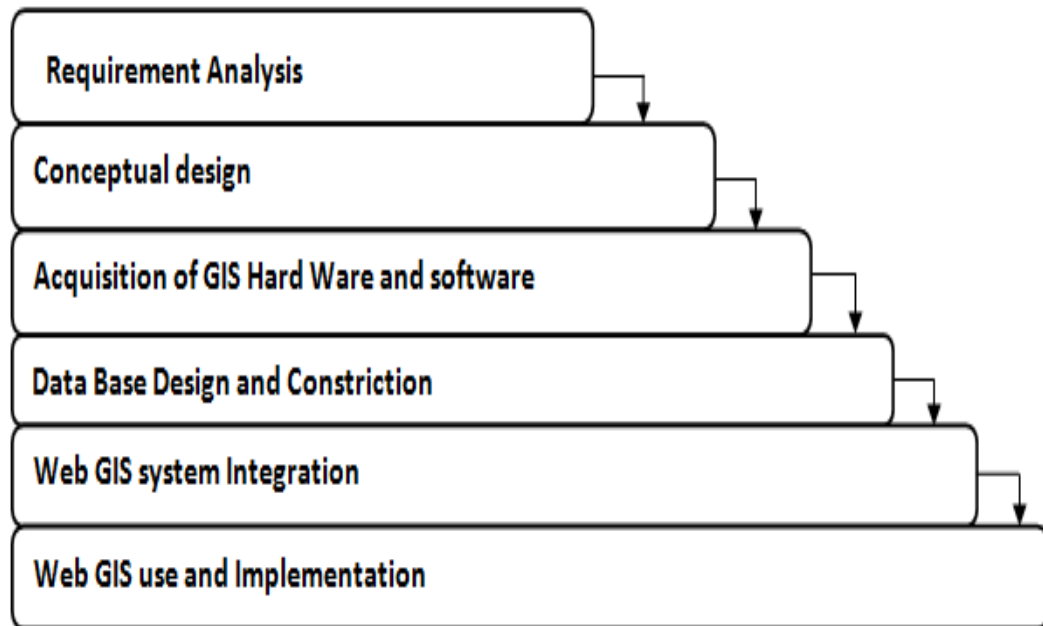


Figure 11. Web GIS Development Cycle

4.2.1 Requirement Analysis

The objective of this research is to disseminate tourism information of Bahir dar town and its surroundings through the internet so that tourists can access the data easily. The requirement analysis step has been performed by making informal interview with some people that don't have knowledge and access of GIS software and by reviewing a related literature. These steps produce two critical pieces of information.

- A list of function that is needed. The required functions are the basic visualization functions such as Pan, Zoom and more advanced functions such as object identification, spatial query and distance measurement. Tourists can use these functions to view information about the required place.
- A master list of available /needed geographic data. Several layers for tourism information were captured by using GPS. The basic once that used in these research are major tourist spots, hotels, bus station and airport. The information gained in the requirement analysis activity went directly into the conceptual system architecture design activity.

4.2.2 Conceptual System architecture Design

The main architecture principles that are the basis for creation of the ArcGIS portal are:

Interoperability - the architecture should ensure efficient system integration with relevant external system.

Openness - the architecture should be open for integration.

Flexibility - the architecture should ensure the degree of flexibility.

Scalability - the architecture should also ensures that the system implementation can be scaled efficiently in relation to possible scenarios on growth in transactions, volume of data and number of concurrent users, etc.

Portability - the hardware and the software should be open to several platforms considering hardware architecture and operating systems.

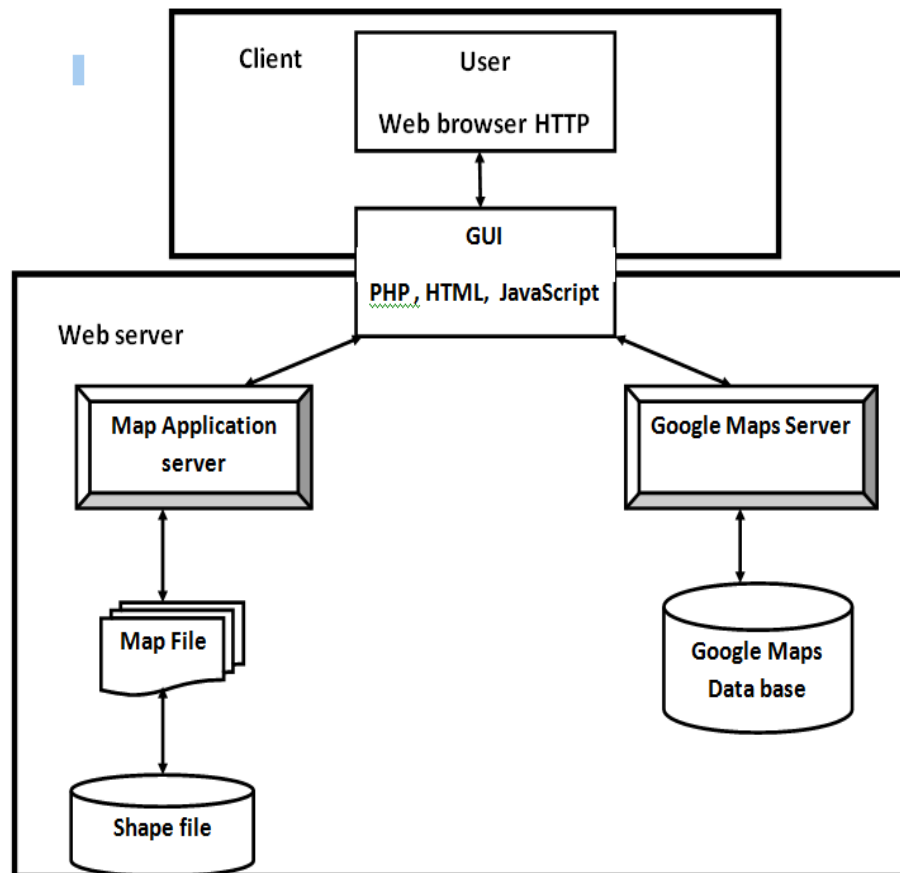


Figure 12. Conceptual System Architecture

The conceptual system architecture is designed as three tiered software architecture to full fill the main architecture principles (figure 12). It is server side architecture. It comprise of Web application, Web Service and Spatial database. In web application, there are the website using JavaScript codes to show the information with some basic GIS functions and several web interfaces for the management. In web service, there is the web server using Apache, which supports PHP script to generate the webpage dynamically. In the data base PostGIS is used to store the spatial data. Google Map Server is used to provide the external map services.

A request from the client is sent through the HTTP to the Apache web server. The PHP scripts are parsed and interpreted by the PHP CGI program or Apache module, and the result are included in to the web document. Parameters for the attribute queries are passed to PHP, which is used as an interface to the PostgreSQL database. As the result of such a query, attribute data are passed back the same way and are embedded in to the HTML code of a web document. If a map request reaches the web server (simultaneously or independently), it is passed to mapserver's PHP/mapscript module, which processes the spatial data (read either from a file or from the PostGIS database) and creates a vector PNG file. The vector file is also embedded to the client, where it is displayed by the local web browsers. Figure 13 shows the query work flow.

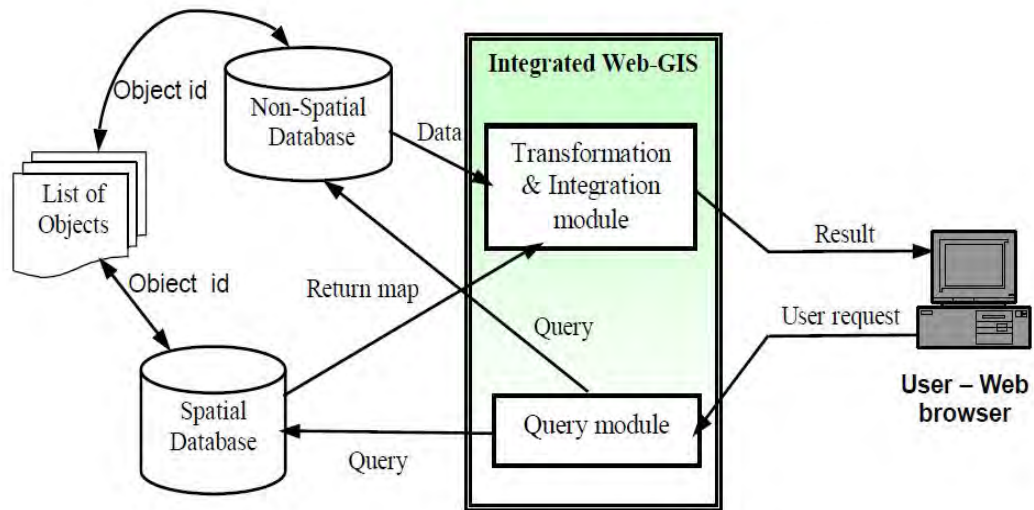


Figure 13. Query Work Flow

4.2.3 Acquisition of GIS software

Selecting suitable software is an important step in a successful implementation. The software components presented in this section form a multi-component prototype with open interfaces that could also be used for distributed applications with the components running on different platforms. Software was evaluated on functionality, performance, and independent of the hardware and operating system. Web GIS requires specific hardware and software configuration. Apache, Mapserver, PHP, postGIS, and chameleon are selected for this research. It is notable that all the selected software are under open source licenses. Figure 14 shows the prototype of selected software.

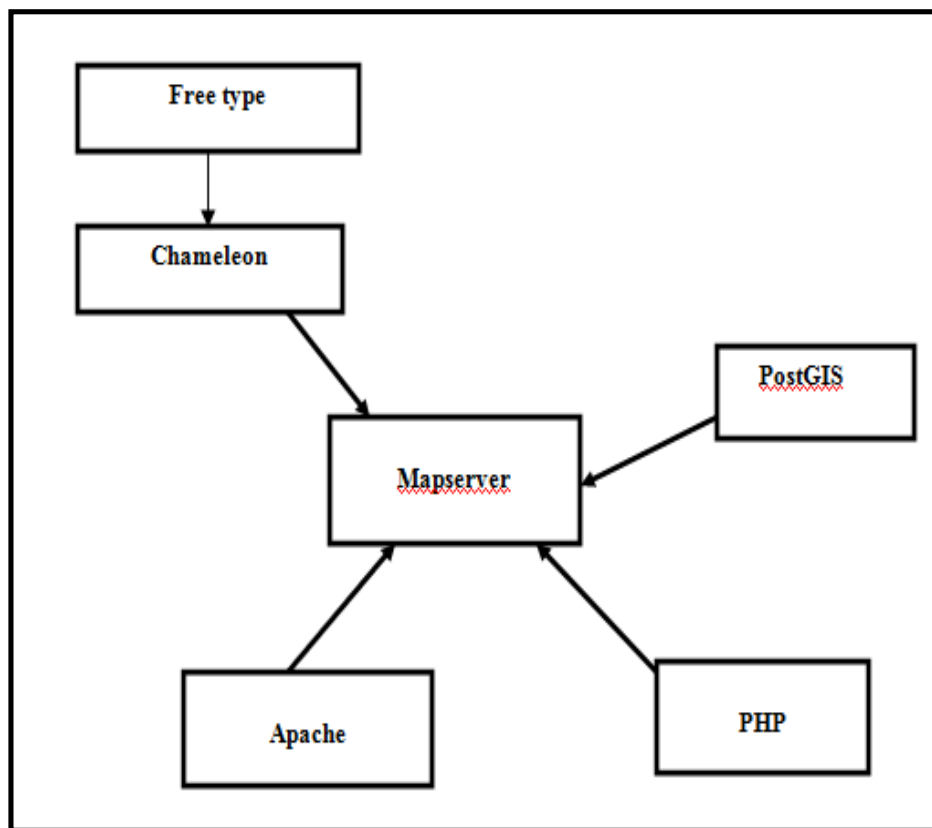


Figure 14. Prototype Software Components

4.2.4 Geo spatial Database design Method

The geospatial database design involves creating and arranging various geospatial data such as point, poly line and polygon objects with their attribute table. The color, weight, size and symbols of these objects have to be analyzed and implemented. Geo database organizes spatial data into a hierarchy of data objects. These data objects are stored in feature classes, object classes, feature datasets and raster datasets. An object class is a table in geodatabase that stores non-spatial data. All the geographical data features must contain spatial reference. The spatial reference describes the coordinate system, the spatial domain and data precision of the feature. Figure 15 shows the sources and the steps in creating the geospatial data base for this research.

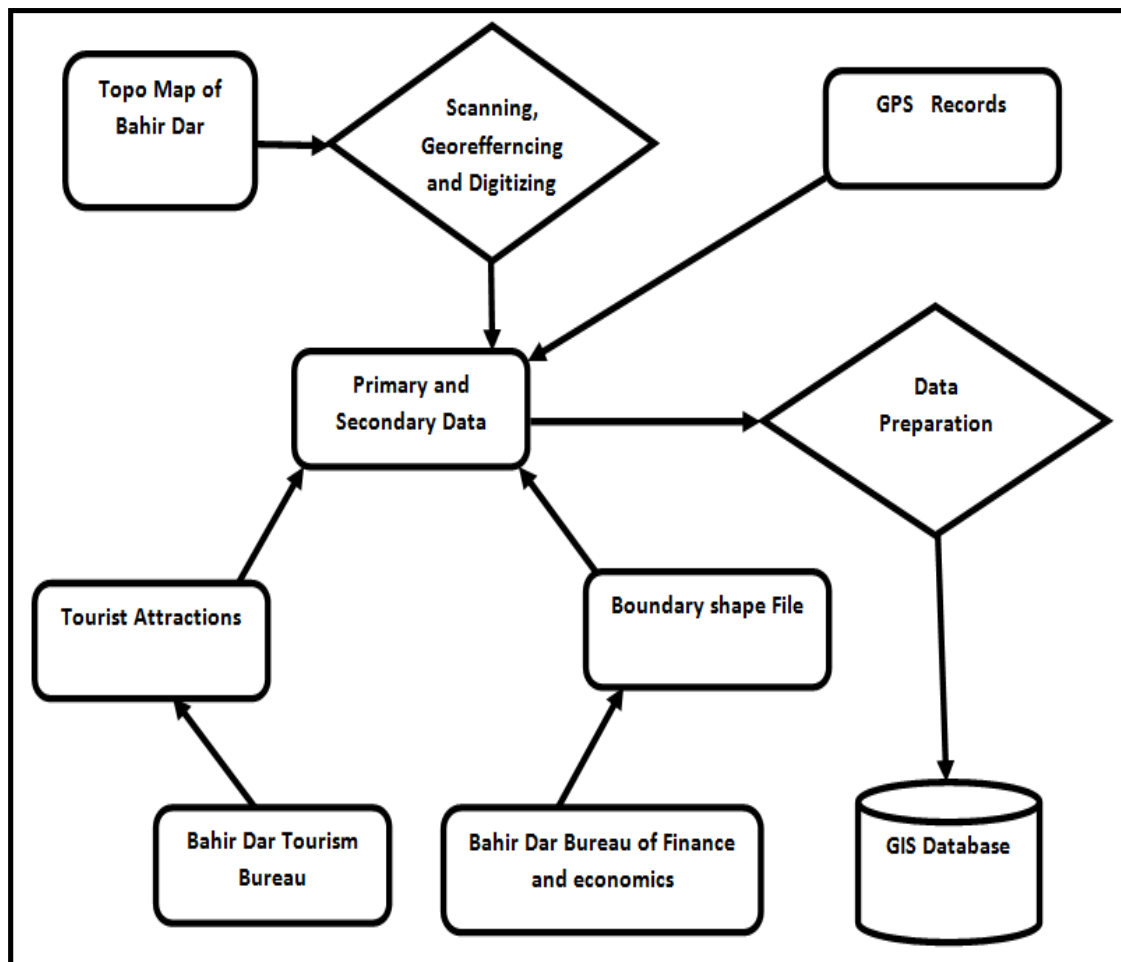


Figure 15. Data Flow to the GIS Data Base

4.3 Data preparation

After collecting the necessary data and setting the appropriate method, the data were prepared using ArcCatlog and ArcMap. Before exporting the GPS reading points in the field to ArcGIS, it is necessary to prepare the data to be fed to the ArcMap program in a usable and simple form. The collected data was stored into several columns of fields. These fields are the key feature of the data. They should be able to provide the most important information about the collected data. Table 3 shows collected data about Hotel

Table 3. Collected Data about Hotels

Field Name	Description	Data Type
Hotel	Name of the Hotel	Text
X_value	Longitude Value	Double
Y_value	Latitude Value	Double
No_of_beds	Number of beds in the Hotel	Short Integer
Hot_shower	Hot shower availability in the hotel	Text
Internet	Internet availability in the hotel	Text
Credit card	Credit card acceptance in the hotel	Text
Restaurant	Availability of a restaurant in the hotel	Text
Transport	Transport availability of the Hotel	Text
Pric_dolr	Price per night in dollar	Short Integer
Phone_no	Phone number of the Hotel	Short Integer

In the same way information about other collected data was putted in a table and made ready to be export to ArcMap. In order to export the collected data to ArcMap the next step is creating a data base file using Microsoft excel. Data base file format of the individual collected data were created.

In the processes of exporting data to ArcGIS, it is also important to use the appropriate coordinate system. There are two main classes of coordinate systems as discussed in the literature review. According to EPSG's geodetic parameter registry, Bahir dar under the projected coordinate system lies in the Adindan UTM zone 37N. After identifying the projected coordinate system of Bahir dar the next step is projecting the collected data. In ArcMap all the collected data in excel format was converted to shape file by projecting to Adindan UTM zone 37N. Figure 16 shows the created and available data for developed web based GIS Portal.

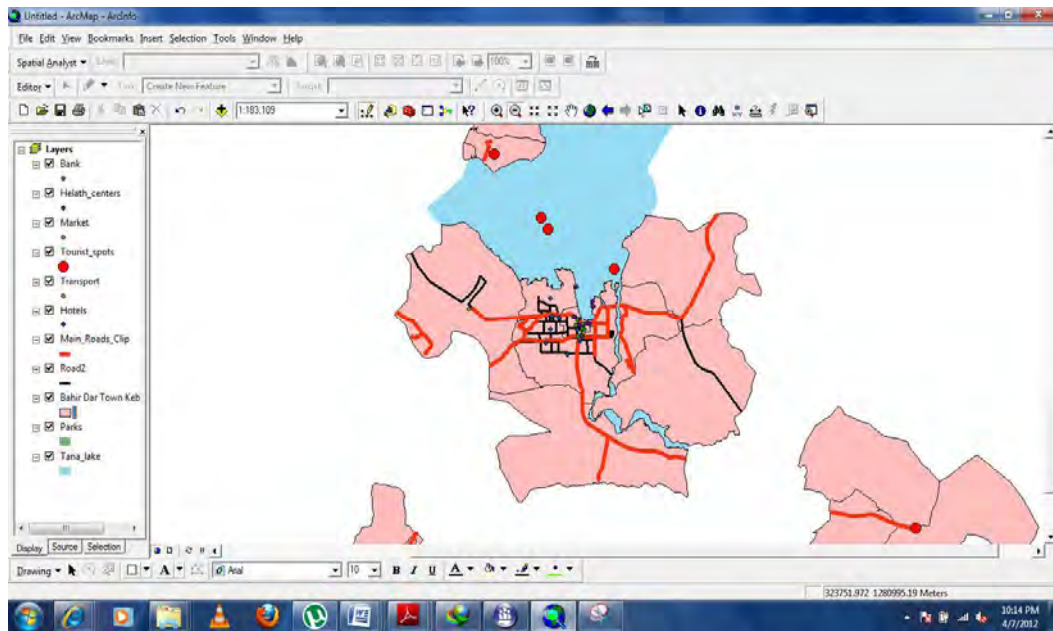


Figure 16. Created and Available Data for Developed Web Based GIS Portal

Table 4. Created and Acquired layers for the Web portal

Layer Name	Layer information	Attribute Data Information
Tourist spots	All the prominent tourist spots have been Covered in this layer.	The attribute data of this layer displays the location and relevance of the tourist spots.
Hotels	Prominent Hotels of Bahir dar are covered In this layer.	The facilities and details of the hotels have been shown in the attribute table of this layer.
Bank	Bank information covered in these layer	Location and other information about the banks have been shown.
Shopping markets	Prominent shopping markets of BahirDar have been mentioned in this layer	Major markets locations have been mentioned.
Health centers	In case of accidents , whom and where to contact have been shown in this layer	Location and type information about the different Health centers in the city
Transport destinations	All the travel hubs like airport and Bus stations of Bahir Dar are shown in this layer	Attribute table includes the details of Location.
Main Roads	The main roads within the city have bee mentioned in this layer	The names of the roads and the places they connect have been shown in this layer.
Lake Tana	As most of the tourist spots lie on the Lake Tana , the Lake is the prominent part of the tourist information Which have been shown in this layer.	Lake Tana information have been added in the attribute table.

CHAPTER V

IMPLEMENTATION AND RESULTS

GIS operations, comprising data collection, storage, manipulation, analysis, and presentation (Dangermond, 2002), are available through Web-based graphical user interfaces and can provide a range of geographical data in different forms. The uniqueness of GIS offers users specific and powerful tools for spatial analysis. The starting point for such an analysis is simply a collection of various maps and images, but the analysis of the spatial information can be made available over the Web via a number of different methods. It is necessary, therefore, to determine the most ideal method of delivering GIS over the Web. This ideal method must ensure wide accessibility to end users, as well as the ability for the user to represent, manipulate and process the images with relative ease and speed. The accompanying data for the images and maps must also be made readily available, thus requiring flexibility and convertibility of many types and formats of digital information.

5.1 Web GIS system Integration

At this point in the web GIS development process the web GIS software has been acquired and data conversation is complete. The objective of these phase was then to integrate different components of the software that are selected for these research and to test them to make sure they work as expected. Apache, PHP, Mapserver, and chameleon application which are the basic software for these research have to be integrated. The easiest way for installing this software is by using mapserver for window (ms4w). It is designed in the way to allow novice to advanced mapserver users to quickly install a mapserver development environment and also contains all the basic software together. The steps that used for installing ms4w are

- Extract the ms4w package on the root directory c:/.
- Starting MS4W Apache Web Server by running `/ms4w/apache-install.bat`. It is used for configuring the Apache part. A window will pop up with Apache MS4W Web Server service is successfully installed if it installed properly.
- Testing of the Apache was done by opening Web browser and finding the local host Web service by entering the following URL: <http://localhost/>.
- To install the chameleon web map application, unzipping the compressed file of the application was done at the same root directory as MS4W. Two things happened when uncompressing this file. First, the Web application directory

appear within `c:/ms4w/apps/`. Second, a new `httpd_*.conf` file added to `c:/ms4w/httpd.d/httpd_*.conf`.

- Restarting Apache was done in order to check the newly configured web Aliases.

5.2 Application Development

5.2.1 Interface design

The usability of Web GIS portal mostly depends on the interface design. If the interface is not designed well according to the user's expectations and does not fulfill their requirements then errors occur. Web maps are different from general web pages or other computer applications, but at the same time these maps can be accessed through web browsers in graphical user interface.

Maps can also be considered as user interfaces. (Peterson, 1995) mentioned that the word interface has the relation to maps in two ways, firstly, interfaces to the world and secondly they consist of user interface elements. The layout of the map, its legend (a small table that explains symbols used on the map), scale bars, and North arrow are all features of the map's user interface that allow the users to interact with these maps. To design user interfaces for web based GIS applications important usability issues like satisfaction, learn ability, efficiency, effectiveness and error prevention should be considered, which are highly relevant to web-based GIS applications. After software setting up and running properly, a user friendly graphical user interface was designed.

5.2.2 Template File

The template file controls the display of mapserver output in a web page. More precisely, the design of the graphical user interface (GUI) and the way how users can interact with the applications are defined here. In the most trivial case when the mapserver CGI program is used, the template file is a normal HTML page that can be design like any other web page. In the more advanced case if the PHP/MapScript module is used, the template file also contains PHP codes. Home.html is the template file that is used in this application. PHP functions are stored in a plain PHP files, which is included in to the template file. Every time the application load it includes other PHP files on demand. A number of JavaScript codes and Cascading Style Sheets (CSS) used to make the web page

dynamic and interactive. For increasing the functionality of the web page different pages have been designed and linked to the template file.

5.2.3 Preparation of Map file

The mapfile can be regarded the configuration file and controls all other aspects a mapserver application has to deal with. The layers to display, the display parameters (how shall the layer be displayed) and the query parameters (which layers can be queried). A mapfile is hierarchical. Each mapfile defines a number of other objects. These objects include scale bars, legends, map colors, map names, map layers, etc. Mapfile definitions consist of keyword-value pairs. Some values are lists of items separated by white space, and these lists must be enclosed in quotes. Single quotes and double quotes are both acceptable. Keyword values with embedded blanks must be quoted, but its good practice to quote all strings..

Mapfiles can be acquired by two manners from a manually created text file or by using free software allowing to export the data and structure of the geographic map in the a map file (Amein, 2007). For this study Map file were created manually. The projection, extent, location of map file, class and labels were coded on notepad and saved as a bahirdar.txt with map file format. The next map file syntax explains the basic elements that should be consider in developing a map file. The map file developed for this research work is found at the ANNEXURE-I.

MAP

NAME prefix attached to map, scale bar and legend GIF filenames are created using this mapfile. It should be kept short.

IMAGETYPE the format of the displayed image, gif|png|jpeg|wbmp|gtiff|swf|userdefined

EXTENT the extend of the start map in coordinates, [minx] [miny] [maxx] [maxy]]

SIZE size in pixles of the output image(i.e. the map

SHAPEPATH the path to your data folder on your computer

UNITS what units are used, feet|inches|kilometers|meters|miles|

WEB

TEMPLATE the path to HTML template

IMAGEPATH the path to a temp-folder where you keep images created

IMAGEURL the url of the temp folder

END

LAYER

 NAME name of the layer

 DATA the name of the Shape file in the data archive

 STATUS |on|off, Default turns the layer on

 TYPE the data represented be point,line,polygon

 CLASS signals the start of a CLASS object

 COLOR color of the element

END

END

5.3 Working with Chameleon

As explained in detail in the literature review chameleon is built on mapserver as the core mapping engine and works with all mapserver supported data formats. But integrating chameleon with map server is not enough to display the maps on the web. Chameleon has to be integrated with the created map file and the designed user interface.

The first step to integrate the created map file and other data with chameleon is to put them in a different folder within the ms4w. A directory myApp was created having four sub folders and putted in the app sub folder of ms4w. Figure 17 shows the application directory structure used in chameleon.

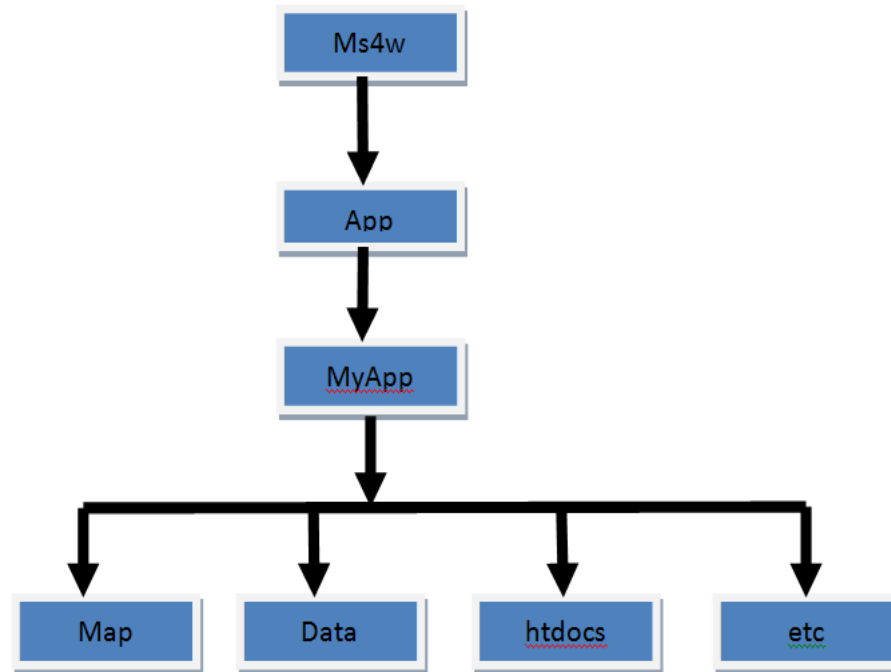


Figure 17. Application Directory Structure

Map: This folder contains the created map File.

Data: The created shape files which are used by the map file are put in the these folder

htdocs: It contains the necessary files for the designed interface . It includes the created CSS, PHP codes, HTML files, different images e.t.c.

etc: symbols.sym and Font.txt files are the basic inputs for displaying the map as image on the web . These files were put on this directory.

5.3.1 Initialization file

The Initialization file is a PHP file which contains path to the chameleon application, the template file and the mapfile. It also parses the template into an HTML-compatible application.

The following code shows how the path to the different applications is set in the initialization file

1. `<?php`
2. `include("c:/ms4w/apps/chameleon/htdocs/chameleon.php");`
3. `$szTemplate ="c:/ms4w/apps/myApp/htdocs/home.php";`

```
4. $szMapFile = "c:/ms4w/apps/myApp/map/BhairDar.map";
5. class SampleApp extends Chameleon
6. {
7. function SampleApp()
8. {
9.     parent::Chameleon();
10.     $this->moMapSession = new MapSession_RW;
11.     $this->moMapSession->setTempDir( getSessionSavePath());
12. }
13. }
14. $oApp = new SampleApp();
15. $oApp->registerSkin( 'skins/sample' );
16. $oApp->CWCInitialize( $szTemplate, $szMapFile );
17. $oApp->mnMinimumMaturityLevel = MATURITY_ALPHA;
18. $oApp->CWCExecute();
19. ?>
```

The following are explanations of what some of the more important parts of this initialization file are doing:

Line 2 : This includes the Chameleon software for use in the application.

Line 3: Application template (relative or absolute path)

Line 4: Application map file (relative or absolute path)

Line 5: A Class Extension of the Chameleon Class for use within the application

Line 14: Instantiates a new SampleApp, creating a new object called \$oApp

Line 15: Registers the default skin that comes bundled with Chameleon

Line 16: Initializes Chameleon with the specified template and mapfile

Line 18: Executes the application

5.4 Running the application

Application running was done by using internet explorer web browser. Writing the address <http://localhost/myApp/index.phtml> will give us the home page of the developed web based GIS. The following figure 18 shows the developed web GIS for Bahir Dar tourism

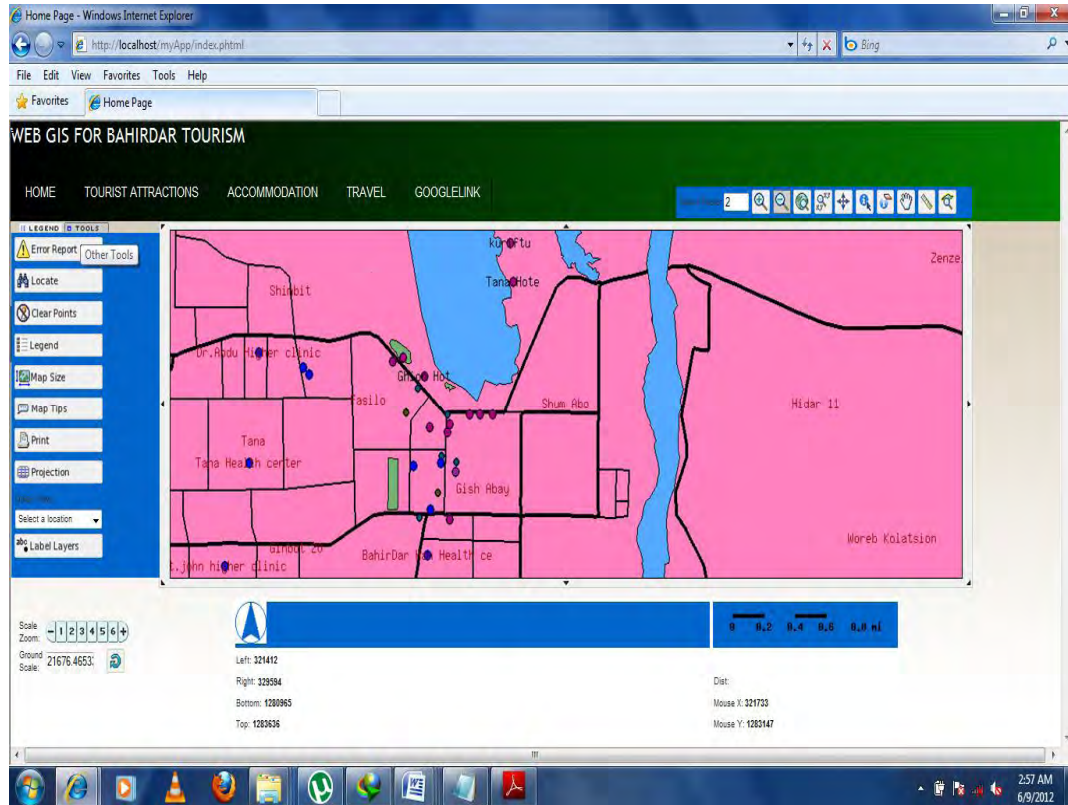


Figure 18. Developed Bahir dar tourism Portal Home page.

The layout of the default home page is shown in figure 18. There are four sections in the portal. In the top, it is the title of the portal. The main map panel is shown in the center of the portal, with a toolbar panel attached to the right corner of the title bar. Under the main map panel, the north arrow, the scale bar, reference tools are placed.

5.4.1 Main map

The activated and visible layers are displayed in the main map. The layers are created by mapserver as an image in PNG format for displaying on chameleon application. Since it is an interactive map, every click on it causes parameters being sent to the server and a reloading of the map. Its size can be changed from map size tab. Since the size of the main map influences the position of the legend and reference map, the application starts up with a fixed size allowing the user to customize the application depending on his screen size at any time.

5.4.2 Tool bar

Table 5. Tools in the Tool Bar

Zoom in	A mouse click on the map will zoom in the map.
Zoom out	A mouse click on the map will zoom out.
Zoom to Full extent	A mouse click on the map will zoom to the default zoom.
Zoom to bounding box or point	By entering the bounding co ordinates the map will be zoom in to these bound
Recenter	A mouse click on the map will recenter the map.
Identify feature	A mouse click on an object in the map queries the respective dataset
Removing existing query results	It removes all previously existing query results
Pan Map	It helps to move around the map
Measure distance	It measures the distance between two features in miles
Zoom to selected layer	A mouse click on the map will zoom to the selected layer

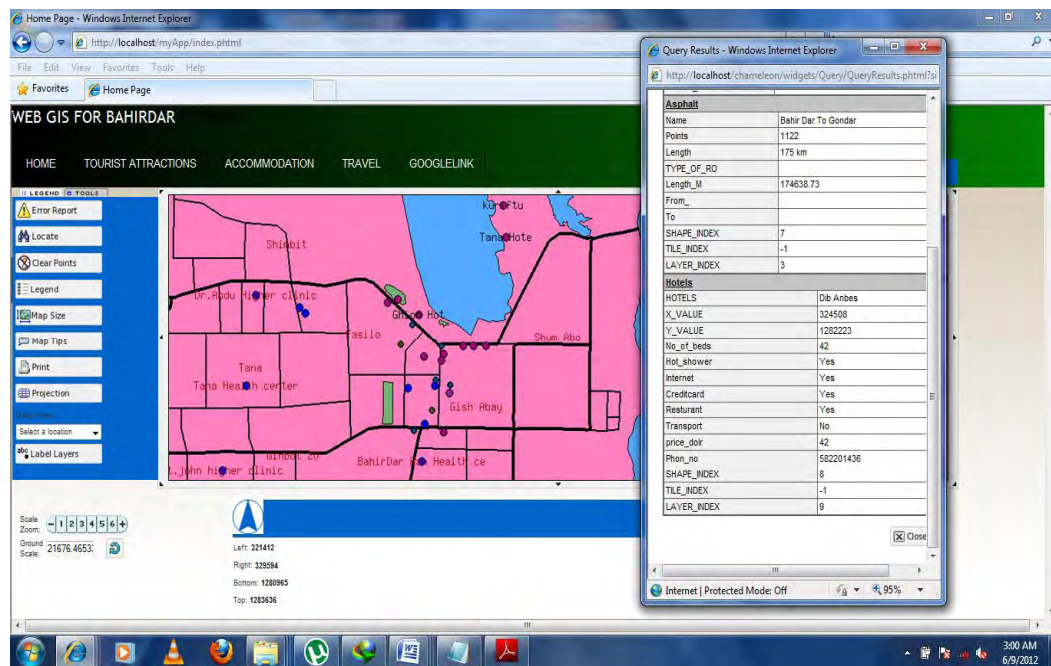


Figure 19. Using the Identify Button In the Developed Tourism Portal For Query Hotel Information

5.4.3 Numeric and Graphic scale

The numeric scale represents the relation of a distance in a map and the respective distance in nature. This works well for traditional paper maps, but becomes problematic with maps that are displayed on a computer screen. The distance on the map then is depend on the hardware of the user, since all screens have different resolutions. It is at the moment not possible to detect the user screen resolution via scripting languages, so on an estimated constant value of 72 dpi is used by mapserver. The result of a scale calculation then looks very precise, with several floating numbers after the comma. In fact this scale is only correct for screens with exactly the estimated resolution. Ironically, the numeric scale is therefore in most cases less précis than the graphical scale (scale bar). But both numeric and graphic scales are used in the developed portal. Figure 20 shows the graphical and numeric scales of the portal.

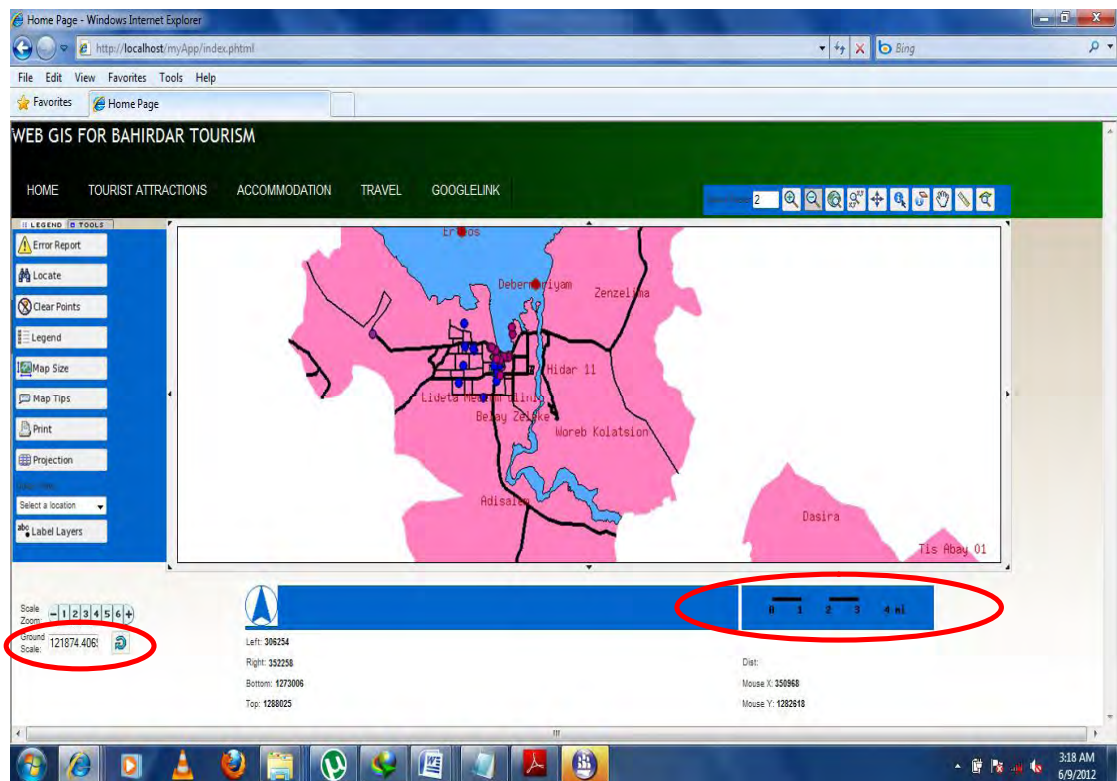


Figure 20. Graphic and Numeric Scale Bars for the Developed Bahir dar Tourism Portal

5.4.4 Dynamic Legend

In paper maps, the legend serves as a key, explaining the meaning of the symbols that occur in the map. Dynamic legend is a classic legend function which is also needed in interactive web maps. But, in difference to traditional paper maps, interactive web maps use the technique of thematic layers that can be activated or deactivated by the user. While legends provided by map server is just raster images with the activated layers, the legend presented here by chameleon application is a new development and completely dynamic. Figure 21 shows dynamic legend for the developed Bahir dar tourism Portal

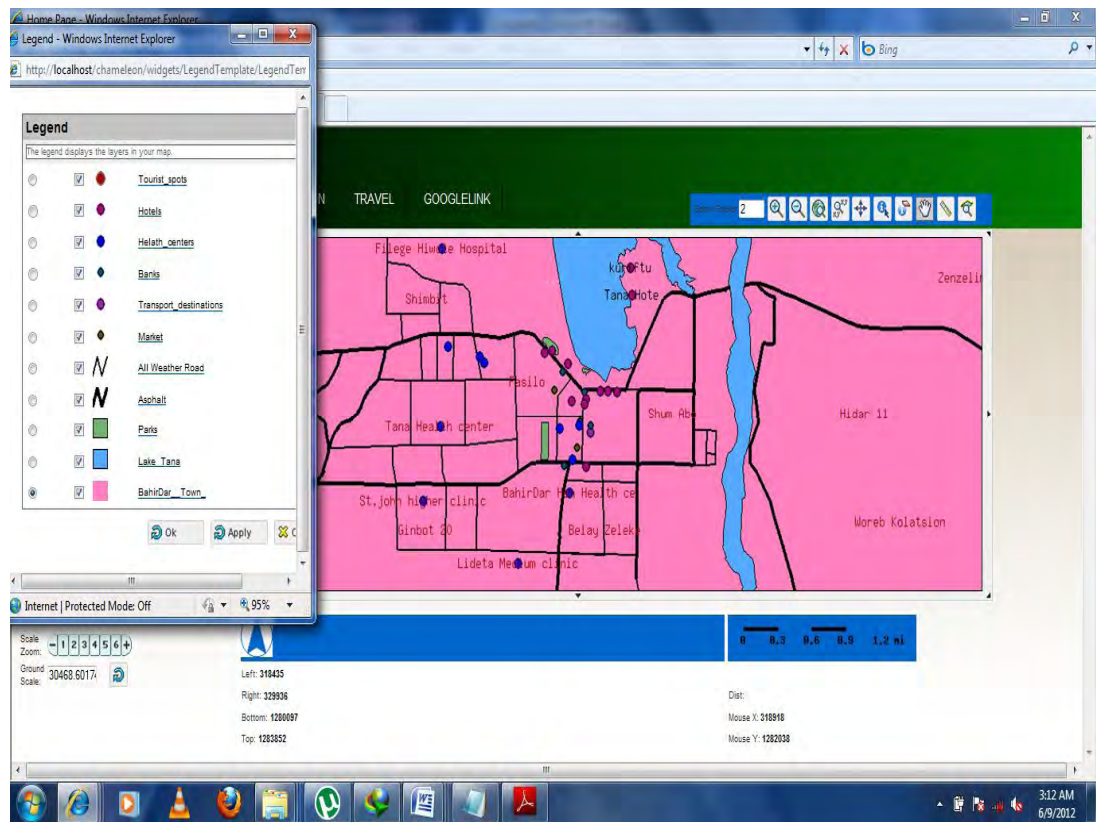


Figure 21. Dynamic Legend for the Developed Bahir dar Tourism Portal

5.4.5 Reference tools

These are important tools used for showing map coordinate on the left, right, bottom and top. Also this tool indicates information on the map units by measuring the distance between two points. Figure 22 shows the measured distance from air port to hotel using reference tool.

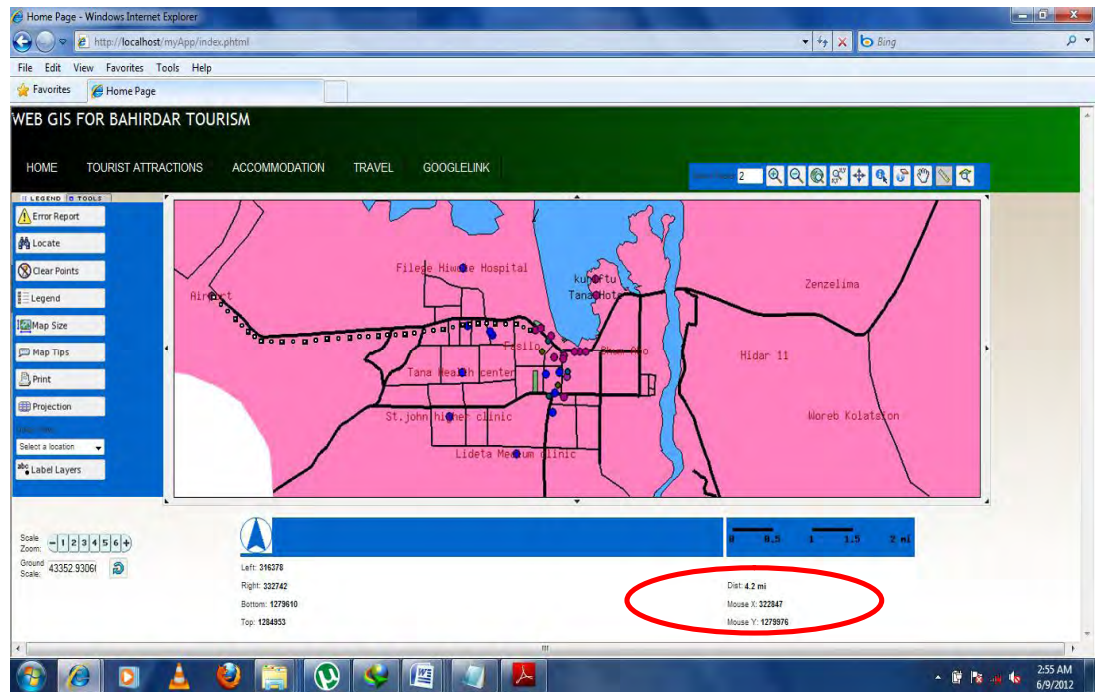


Figure 22. Measured Distance from Air port to Hotel on the Developed Tourism Portal

5.4.6 Other Elements

Other additional elements that are important for traditional paper maps are mostly missing in web maps. This mainly concerns elements that are located in the margin like the title, author /editor and the production date. The title is mostly missing inside of the website, but it can be located in the top of the border of the browsers window. The author/editor and the production date have lost their importance. The owner of the web site is responsible for its content and mostly holds the copyright. The author has become the developer of the application.

5.5 Mashe up

As I mentioned in the literature review if a web site uses data or functionality from another web site and combines it in an application, it's a mashe up. Mashe up is a method of (combining, stitching together) the sources and services to create something new, or add value in some way. The purpose of using mashe up technology on this paper is to enhance the users query capabilities in tourism information about Bahir Dar town and its surrounding.

Generally there are two types of mash up. Server side mashe up and client side mashe up. Server side mashe up is used to incorporate the Google map in to the developed web portal. In this study free Google map data were used and programmed with Application Programmable Interface of Google API version 3. This version of API didn't require API key. The steps that follow in Mashe up process in this study are

1. Development of a single web page
2. Load the Google earth API
3. Create a DIV Sand call the initialization function
4. Add markers and link the page

5.5.1 Development of a single web page

A single page was developed by writing HTML codes, JavaScript codes and CSS. The page is designed in a way appropriate to hold the Google map and the Google satellite image. It was also design to be interactive with other developed pages.

5.5.2 Loading the Map on to the Developed page

To integrate the map with the developed page we have to create a view port and tell our HTML file to get JavaScript file from Google code. These line was added between <head> and </head>

```
<meta name="viewport" content="initial-scale=1.0, user-scalable=no" />
```

```
<script type="text/javascript"src="http://maps.google.com/maps/api/js?sensor=false"></script>
```

After the URL, the sensor was put sensor=false. As I do not use any sensor, such as a GPS, to locate the location, this is set to false. This is the basic script that has to be incorporate in order to use the Google API version 3

1. <script type="text/javascript">
2. **function** initialize() {
3. **var** latlng = **new** google.maps.LatLng(11.5985, 37.3843);
4. **var** settings = {
5. zoom: 15,
6. center: latlng,

7. mapTypeControl: **true**,
8. mapTypeControlOptions: {style:
9. google.maps.MapTypeControlStyle.DROPDOWN_MENU},
10. navigationControl: **true**,
11. navigationControlOptions: {style:
12. google.maps.NavigationControlStyle.SMALL},
13. mapTypeId: google.maps.MapTypeId.SATELLITE
14. };

To split how the above code works in line 2 the function `initaliz()` is created. Inside the function the basic settings of the map were defined. In line 3 a variable `latlng` defined. `latlng` stands for latitudes and longitudes. The variable contains the coordinates that is used as the center of the map. After creating the `latlng` variable, the next steps is creating another variable setting in line 4 which give us a lot of options.

Zoom specifies how far the map will be zoom in. center specifies our center by writing `latlng`, the variable that is created earlier were referred. The last code changes the layout of the map to a bit more minimalistic look. The control in the upper right corner (Map, satellite ,Terrain) are coded to be in a drop down menu, and the scaling/navigation controls in the left size are also coded to be large controls with street view control options.

`mapTypeId: google.maps.MapTypeId.SATELLITE` defines that displayed map should be of the type satellite. Below the above code the next code putted to create variable `map` and define that the map should use the settings that was created.

```
var map = new google.maps.Map(document.getElementById("map_canvas"), settings);  
} </script>
```

5.5.3 Creating a DIV element and calling the function Initializing

After ending up the script the next step is calling the `initaliz()` function in the body of the HTML code. These will help the initialize function to execute every time when the site is loaded. A `div` tag was used to put the map style.

```
<body onload="initialize()">  
<div id="map_canvas" style="width:1200px; height:400px"></div>  
</body>
```

5.5.4 Adding Markers

The aim of using Google API in this study is to add markers on the tourist spots so that tourists can easily see the position of these spots online from Google satellite map. The above code was run and it was successful. It automatically loads the Google satellite image with the specified functionality centered at Bahir Dar. But it didn't show any markers on it. So to simplify touring around Bahir Dar, markers have to be putted. To put markers on the Google satellite image longitude and latitude value of the individual tourist spots are necessary. The next code will show how the markers are assigned values of individual tourist spots.

```
var touristSpot = new google.maps.LatLng(11.6515, 37.3641);  
var spotMarker = new google.maps.Marker({  
    position: touristSpot,  
    map: map,  
    title: "Betemenzo"  
});
```

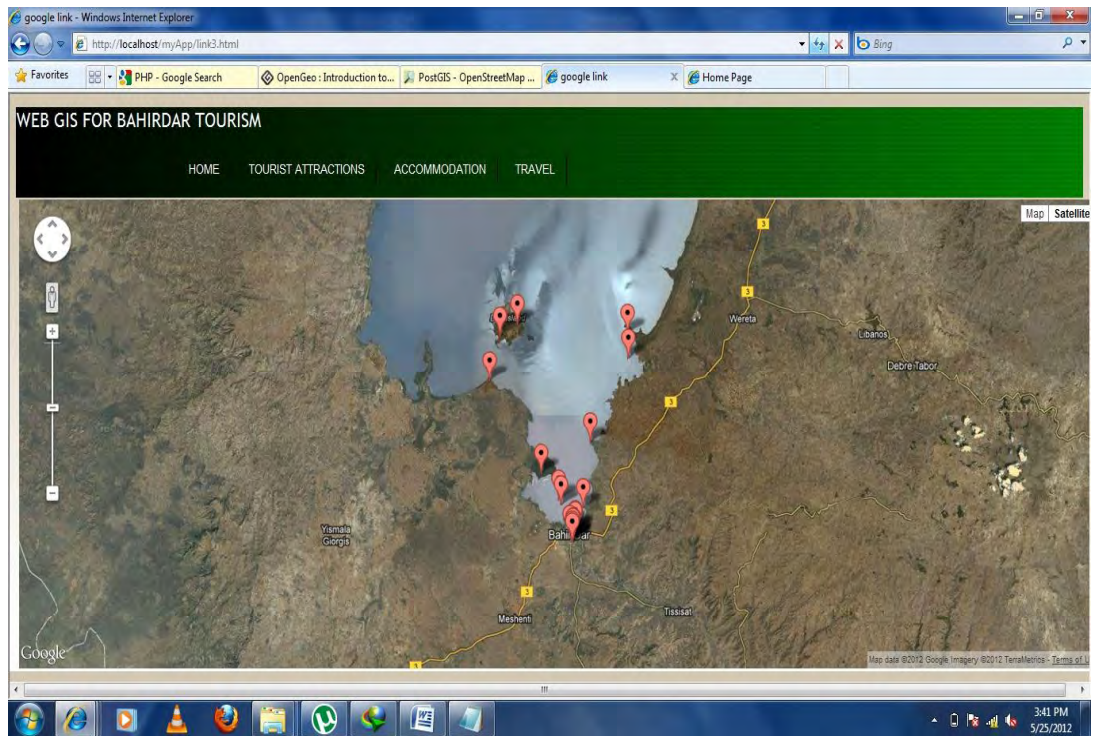
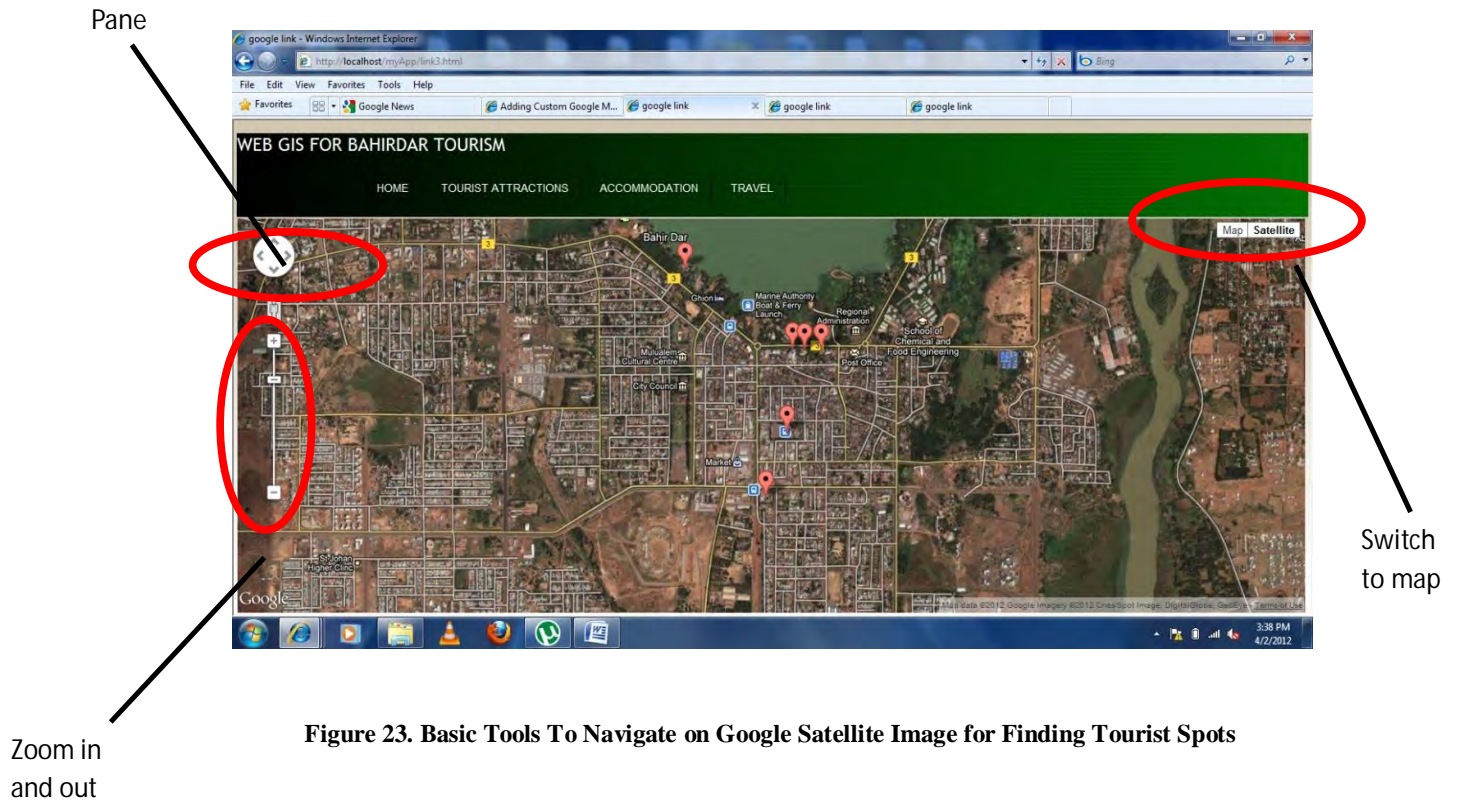
The above codes was putted write under

```
var map = new google.maps.Map(document.getElementById("map_canvas"), settings);
```

Declaring the variable `touristSpot` for specifying the position of the marker was the first step for adding markers. Next the marker itself was created using the variable `spotMarker`.

In similar ways longitude and latitude values of the other major tourist spots are assigned to markers. After assigning values to the markers the developed page was linked with other pages.

The above codes will allow tourists to find their appropriate tourist destination directly from Google Satellite image. The Google satellite image and Google map is enrich with good cartographic information which becomes easier for tourist to use as a mashed up page in the developed portal. The following figures show the Added markers on Google satellite image, Google map and Google terrain map.



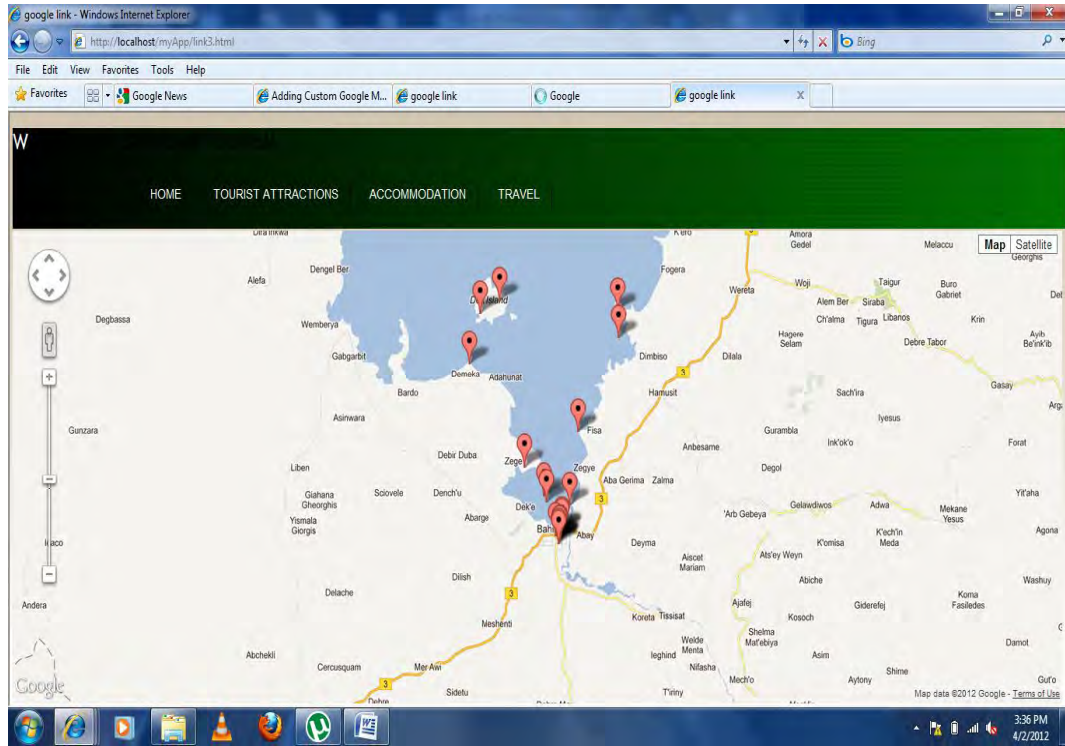


Figure 25. Added Marks on Google Map for Showing Major Tourist Spots

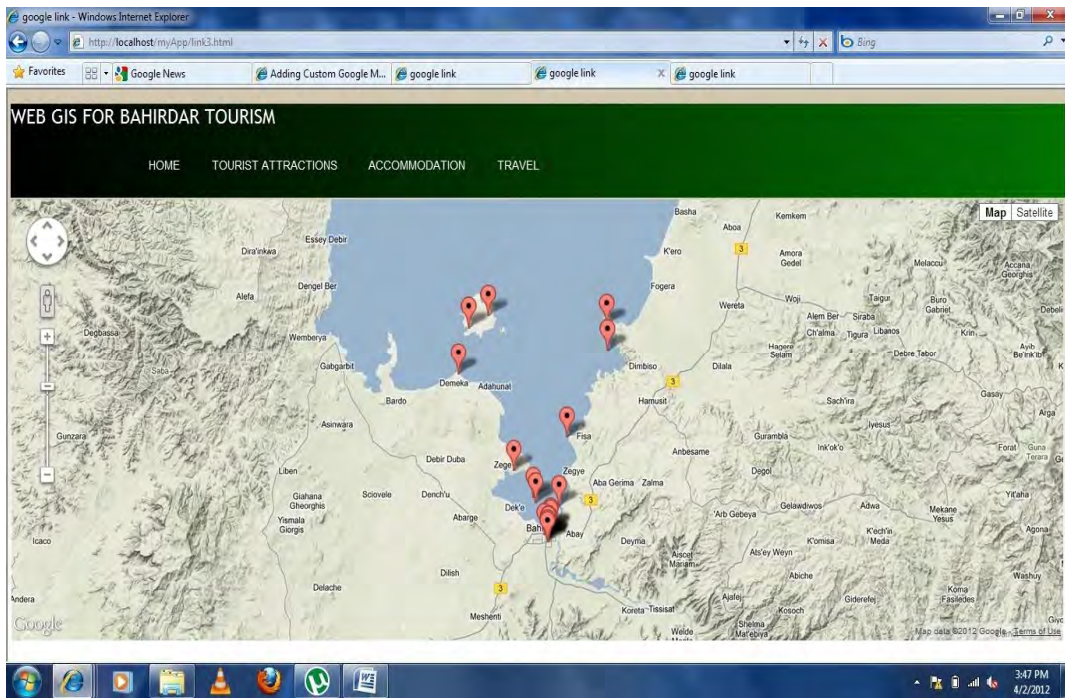


Figure 26. Added Marks on Google Map with Terrain for Showing Major Tourist Spots

5.6 Additional Pages

Additional pages with Travel, Accommodation and Tourist attractions information were developed. These pages give basic information to the user of the developed web site in a textual format. Different pictures of the main tourist spots with their way of transportation were loaded to make the web page attractive. Figure 30 shows the developed additional links.



Figure 27. Additional Pages for the Developed Bahir dar Tourism Portal

5.7 Developed Digital Tourist Site map of Bahir dar

The creation of a digital, interactive tourist site map, which can be transformed according to users' needs, is the main focus of this research. The cartographic background is enriched with information relative to tourist spots, hotels, health centers, banks, transport destinations, market and road types. This paper's interactive digital tourist sit map consists of the necessary map elements managed by a combination of databases, in order to be able to meet end user requirements both concerning search inquiries as well as concerning site promotion and sightseeing inquiries.

A geographic search lets the tourist quickly search the database using geographic criteria. In the Tourism Information System of Side, a geographic search is a mixed query which combines tourism attributes and geographic criteria to search for "What is where?". Here "What": represents attributes of touristic objects "Where": represents the geographic space that the touristic place covered. Some spatial analysis operations are added to

provide easy search operations to a tourist. These operations are geographic criterions like; nearness and distance. Nearness means; to search for nearest touristic object to given point. Distance is to find elements located within a specified distance to a given point.

Figure 28 shows digital tourist site map of Bahir dar town and its surroundings.

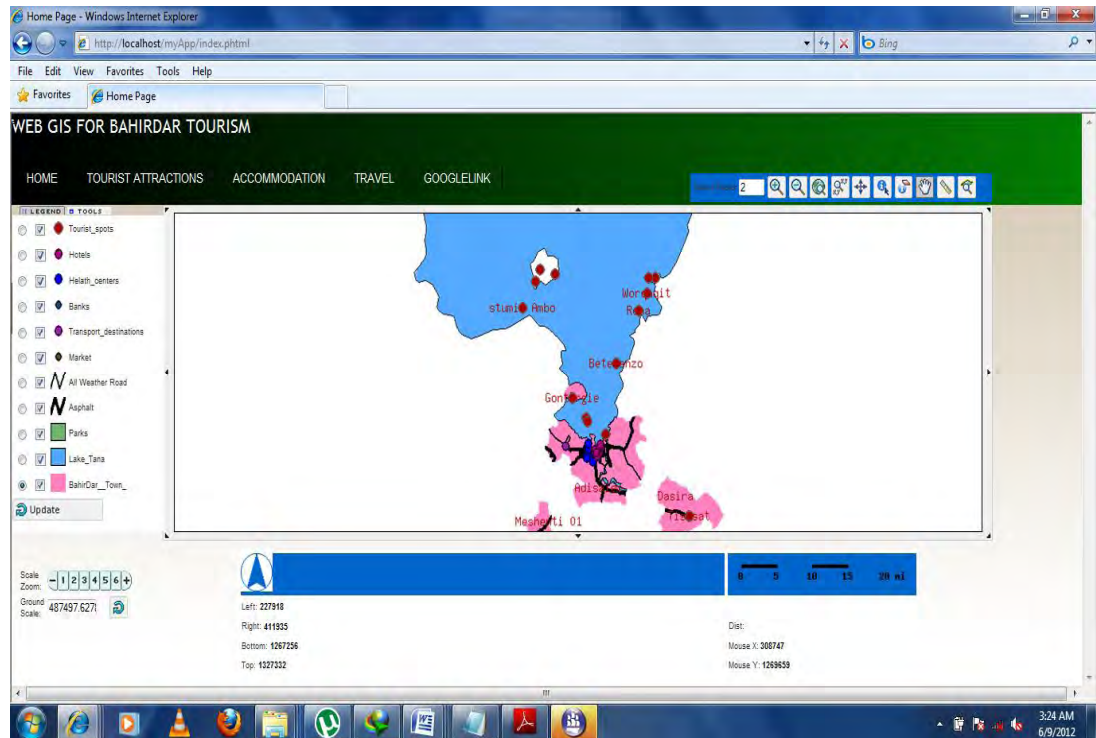


Figure 28. Digital Tourist Site Map of Bahir Dar Town and Its Surroundings

5.8 Printable map

Some tourists may need the map in hard copy. For such kind of users the developed portal has the capability of delivering a printable map. This feature is very easy and facilitate for users who want to have their maps in print form. When the users set their direction from one place to another place they can also make a printout of it. This will be the best way for tourists to have a hard copy map format of the tourist sites in the town from anywhere in the internet. The portal gives different options on how to put the legend, scale bar, title and other map elements. After selecting the appropriate positions for the map elements the print choice will allow the tourists to have the hard copy tourist site map of Bahir dar town and its surroundings in a meaningful way. Figure 29 shows options for printing out tourist map in hard copy form.

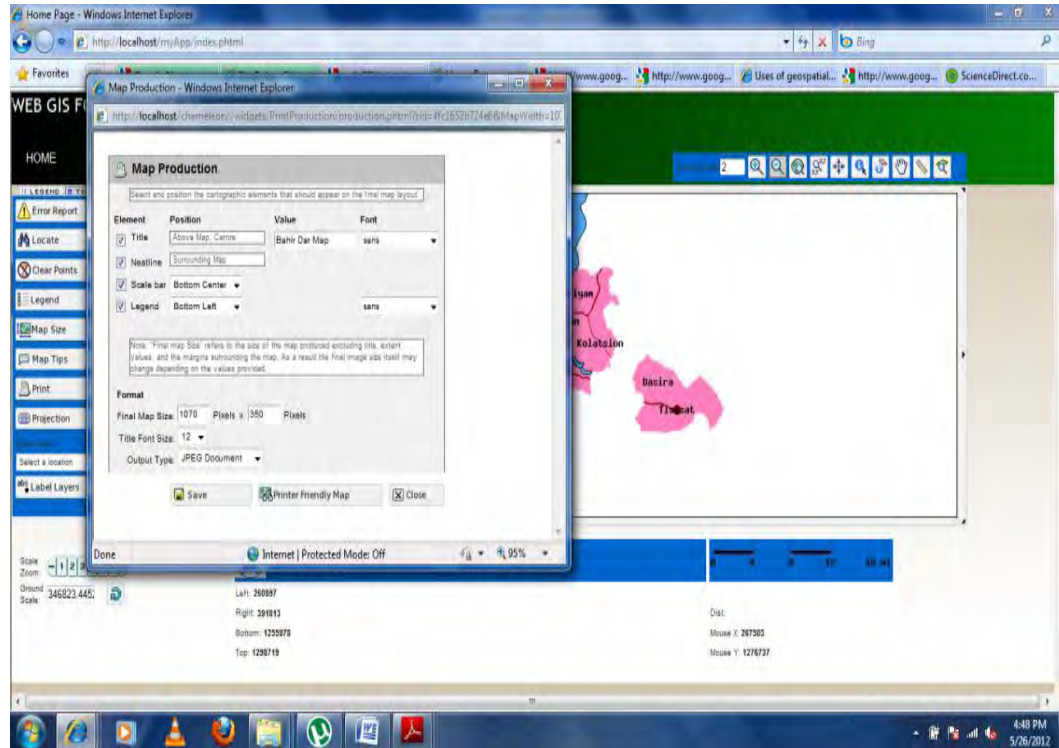


Figure 29. Options for Printing out Tourist Map in Hard Copy Form

5.9 Discussion

The purpose of the study was to develop a web based GIS for tourism development of Bahir dar town and its surrounding using open source technologies. The developed portal shows that it is possible to set up a working interoperable multi component application consisting of open source software products. Based on the literature review, it has been established that similar systems have been developed to guide tourism such as web based GIS for tourism development as sighted by (Fajuyigba, 2007), web GIS for tourism (Tran, 2006). The outcome of the review lead to the conclusion that a web based GIS can be described as a website that contains pages stored on a web server with spatial and non spatial information in a dynamic way (Tran, 2006). These web based systems are in line with the definition provided by (ch.Dodo et al., 2004) that a web based GIS was an application that not only disseminates information, but also proactively interacts with the users to aid them in their task.

The findings from the study show that the developed prototype has been able to meet the requirements of a web GIS information system. The developed system is accessible from

anywhere in the world. It is designed and developed to be a platform for global and free sharing of information as advocated by (Dang, 2000).

The main advantage of the developed portal over the traditional GIS is that traditional GIS was restricted to specific people but the developed web-based GIS is accessible to a large number of people with easy to learn and easy to use method. It don't only provide free access to maps and other tools like zooming and panning but also provide other map related services.

Although there are many on-line information systems, very few were identified that relate to web based GIS for tourism. The existing websites on Bahir dar provided plain information in form of web pages, some of them are static and the others are dynamic. But all of them lack digital maps with the necessary tools for navigation through the map. No web GIS information system on tourism in Bahir dar was sighted during the study period, which justifies the relevance of this study. The developed prototype provides information on tourism, which is accessible globally but with content limited to Bahir dar situation. It provides information on location of tourist spots, hotels, banks, transport destinations, health centers, and some additional information deemed important for tourists. Armed with this information, the tourists can then make informed decisions on which hotels to stay and which tourist sites to visit at a given estimated cost. This type of information is deemed as very important in the promotion of tourism in the town and its surroundings.

CHAPTER VI

CONCLUSION AND RECOMENDATION

6.1 Conclusion

- For Tourist database, GIS is an efficient tool for the cost effective collection, storage and analysis tasks.
- In the age of Information Technology and present focus of administration through e-governance, it is desirable to have any GIS database on the internet. The MapServer software provides an efficient environment for the tourism industry. This can be very helpful in the promotion of tourism in Bahir Dar. As a tourist planning to visit a specific place can get all the details from the web based portal.
- Some other tools are also helpful in the customization of GIS functionalities, If required for a specific task like – Google Image API. It Offers a wide variety of modification and quey handling modules that can be incorporated into a WebGIS portal to increase its effect.
- For the developing countries like Ethiopia, cost is the primary consideration for the adaptability of GIS technology. Under these circumstances, open sources software Provides all the data storage and analysis for free.

6.2 Recommendation

In view of the different capabilities demonstrated by the developed web based GIS, which incorporates web-based applications with GIS to handle both data on spatial and non-spatial, it is recommended

- To enhance the capability of the system, additional features should be integrated.
- Tourist service providers and other institutions to be engaged in promotion and use of the web based GIS tour guide method for selection of tourist sites.
- This study focused on tourism in Bahir dar town and its surroundings, as one of the tourist attractions steadily picking up momentum in the last few years, there are several important tourist attractions sites which can use and benefit from the

developed web based GIS after a few modifications. Furthermore, the output from this research can be used to develop a web based GIS tourism information system for the whole of Ethiopia under the auspices of the Ethiopian tourism organization, which has an objective to make the region as the largest tourism destination.

REFERENCES

- Ajala, O.A. (2008). Tourism development as a strategy in regional Planning. African Research Review Vol.1.no3 pp77-92
- Alesheikh, A. Helali, H. and Behroz, H.A. (2002).web GIS: Technologies and its applications. Retrieved on 5.11.2011 from
- Carver, S.J. (1999). Developing Web-based GIS/MCE: Improving access to data and spatial decision support tools. A geographic information sciences approach Ashgate, New York, pp. 49 - 76.
- Craig, W. Harris. T. Weiner, D. (1999). Empowerment, marginalization and public participation GIS. Report of Varenus Workshop, 15–17 October 1998, Santa Barbara, NCGIA, pp 22–24.
- Ch.Dondo, S.T. Bhunu, U.Rivett (2004). GIS in Tourism A zimbabwean experience.
- Dangermond, J. (2002). Web services and GIS. Geospatial Solutions,12 (7), 56.
- Dang Van Duc. (2000). A Geographical Information Service on Internet. Retrieved on 12.02.2012 from <http://www.car.busmgt.ulst.ac.uk/papers/duc.pdf>.
- Detwiler J. and Dutton J. A. (2009). Introduction to Web Mapping e-Education Institute, The Pennsylvania State University. Retrieved on 25.10.2011 from www.e-education.psu.edu/geog863/resources/l3_p5.html.
- Drummond, W.J. & French, S.P. (2008). The future of GIS in planning - converging Technologies and diverging interests. Journal of American Planning Association, 74 (2), 161-174.
- ESRI-ArcGIS 9.3 desktop help, Geographic coordinate system. Retrieved on 17.2.2012 from www.webhelp.esri.com/arcgisdesktop/9.3/index.cfm?id=132&pid=103&topicname=Geographic_coordinate_System.
- ESRI-ArcGIS 9.3 desktop help, projected coordinate system. Retrieved on 17.2.2012 from www.webhelp.esri.com/arcgisdesktop/9.3/index.cfm?id=91&pid=90&topicname=About_projected_coordinate_System
- Fajuyigba, V.F. Balogun and O.M.Obembe (2007).web based Geographic system (GIS) for Tourism in Oyu state,Nigeria,Information Technology Journal 6(5): 613-622.
- Mesele Berhanu (2009). Web GIS for tourism development of Addis Ababa city, Addis Ababa University, Addis Ababa, Ethiopia, unpublished MSc. Thesis.
- Goodchild ,M. and Kemp, K.(1991). Introduction to GIS, National Center for Geographic Information and Analysis, University of California.

Home page of mapcruzin Retrieved on 3.3.2012 from <http://www.mapcruzin.com/free-gis-software/free-chameleon-gis-web-mapping.htm>

Home page of open sources GIS Retrieved 12.3.2012 from <http://opensourcegis.org>

Ministry of Culture and Tourism (2009). Government of Federal Democratic Republic of Ethiopia Tourism Development Policy. Addis Ababa, Ethiopia.

Moreno-Sanchez, R., Anderson, G., Cruz, J. & Hayden, M. (2007). The potential for the use of open source software and open specifications in creating web-based cross-border health spatial information systems. *International Journal of Geographical Information Science*, 21 (10), 1135-1163.

Negash Atenafu., Abraham Marye., Yohannes Misgan., Fekerete Adugna., Gedefaw Amsalu and Dametie Demesie (2011). Tourism Destinations Networking Development Plan for Lake Tana and its Vicinities. Bureau of Culture, Tourism and Parks Development, Bahir Dar, Ethiopia.

Orenstein, D. (2010). QuickStudy: Application Programming Interface (API) Retrieved on 12.6.2011 from

http://www.computerworld.com/s/article/43487/Application_Programming_Interface

Phisan Santitamnon (2001). Comparative Assessment of internet GIS server system. Retrieved on 12.02.2012 from <http://www.gisdevelopment.net/utilities/htm>.

Sakamoto, A. & Fukui, H. (2004). Development and application of a livable environment evaluation support system using web GIS. *Journal of Geographical Systems*, 6, 175-195.

Seltene Seyoum (1988). A History of Bahir Dar Town (1936-1974), Addis Ababa university, Addis Ababa, Ethiopia, unpublished MSc. Thesis.

Spatial data management in an Enterprise GIS. Retrieved on 17.2.2012 from www.proceedings.esri.com/library/userconf/proc01/proffecinal/papers/pap742/p742.htm

Tran xuan (2006). Web based Geographic information system for tourism case study: East Java indonesia, Bogor university, MSc. Thesis.

Wikipedia, Retrieved on 5.2.2012 from http://en.wikipedia.org/wiki/Web_mapping

World Bank (2006). Towards a Strategy for Pro-Poor Tourism Development: Private Sector Development Country Department for Ethiopia, Africa Region, Report No. 38420-ET, Ethiopia

WTO (2001). World Tourism Organization Annual Report, World Tourism Organization, Barcelona, Spain

Zhelu, Y. (2009). A web-based Geographical Information System prototype on Portuguese traditional food products, University of wilhelms, Portugal, Msc Thesis.

ANNEXURE-I

Description of islands' location and their tourism potential

No	Direction from Lake Tana	Name of Island	Geographic Location	Churches and Monasteries	Available potential Tourisms
1	Southern	Debermaryam	326277 128550	Mariyam	Church/Monastery, Ancient, religious books, old paintings, Abay (Blue Nile) outflow, bird watch
		Kiberna Geberiel	321691 128854	Gebreal	Church/Monastery, dense forest, birds, religious paintings and books, Only men allowed
		Entos	322124 1287851	Eyesus	Church/Monastery, dense forest, birds, and religious books
2	South eastern	Betemnzo	328637 1299100	Ginjaba Michael	Recreational for Boating, bird watching and resting
		Rema	333716 130911		Church/Monastery with religious manuscripts,
4	Central	Deke Biggest Island with Seven Churches	311236 131682	Arsema, Kotamariyam, Medehanyalem, Joga Yohannes, Gardena Georges, Woba Kidanemehret	Scenic areas of lakeshore, Old trees and religious books
		Dagastfanos	314646 131596	Estifanos	Monastery icons, Museum, Emperors fossil remain, Recreation with dense old forest and bird watching
5	South Western	Gontergie	318721 129232	No building	Recreational, Boating and Bird Watching

Data used to create Hotel Information for developed web GIS portal

Hotal name	X_value	Y_value	No_of_Beds	Internet	Credit Card	Resturant	Transport	Phone no
Papyrus	324297	1281408	100	Yes	Yes	Yes	No	582205100
Summerland	324609	1282222	40	Yes	No	Yes	Yes	582206566
Ghion	324036	1282516	30	Yes	No	Yes	No	582200011
Tana	324954	1283249	60	Yes	No	Yes	No	582200554
Kuriftu	324929	1283541	45	Yes	No	Yes	No	582264868
Girum Gayent	324299	1282145	16	No	No	No	No	582200832
Enquitatshi	323711	1282632	9	No	No	No	No	582204435
Ethio Star	324740	1282221	80	Yes	No	Yes	Yes	582202026
Dib Anbesa	324508	1282223	42	Yes	Yes	Yes	No	582201436
Breezpark	323816	1282662	40	Yes	No	Yes	No	582263568
Tadesse Pension	324273	1282085	46	No	No	No	No	582245768
Tsehay pension	324090	1282122	41	No	No	No	No	582203820

Data used to create Bank Information for developed web GIS portal

Name of Banks	X_value	Y_value
Dashen bank	324277	1282217
Commercial Bank of Ethiopia	323986	1281422
Commerical bank of Ethiopia	323965	1282429
Abysinnia Bank	324366	1281854
Wegagen Bank	324213	11281897

Data used to create Health Center Information for developed web GIS portal

Health Center Name	X_Value	Y_value
Tesfa Hiwot Clinic	324102	1281482
Gambi Clinic	324203	1281848
Arsema Clinic	323925	1281819
Bahirdar Han Health Center	324067	1281131
Tana Health Center	322226	1281845
Keradiun Medium Clinic	322844	1282531
Bahir dar Model SRK-Clink	322786	1282591
Dr.Abdu Higher Clinic	322325	1282699
St.jhon higher Clinic	321972	1281049
Lideta Medium Clinic	323327	1280357
Filege Hiwote Hospital	322246	1283742

Data used to create Tourist spot Information for developed web GIS portal

Tourist Spot Name	X_Value	Y_value
Debermariyam	326277	1285503
Kiberan geberiel	321691	1288544
Ertios	322124	1287851
Betemenzo	328637	1299100
Deke Island	311236	1316820
Degaestifanos	314646	1315966
Stumit Ambo	307352	1309677
Kerstos Smera	337528	1315212
Tana Kirkios	336058	1315212
Goza	310148	1314643
Gontergie	318721	1292321
Workakit	335621	1312308
Rema	333716	1309111
Tis esat	345261	1270056
Semaetate	326761	128285

Data used to create Market Information for developed web GIS portal

Marekt Name	X_value	Y_value
Market 1	324174	1281617
Market 2	323843	1282235

Data used to create Transport Destination Information for developed web GIS portal

Transport Destination	X_value	Y_value
Airport	317133	1283240
Bus station	324360	1281774

ANNEXURE-II

Created Map file

NAME "BD-MAP"

SIZE 1070 350

UNITS meters

SHAPEPATH'C:\ms4w\apps\myApp\data'

EXTENT 259736.382472 1260099.457055 354494.009406 1302840.088417

FONTSET 'C:\ms4w\apps\myApp\etc\fonts.txt'

SYMBOLSET'C:\ms4w\apps\myApp\etc\symbols.sym'

PROJECTION

'proj=longlat'

'datum=WGS84'

'no_defs'

END

IMAGECOLOR 255 255 255

IMAGEQUALITY 95

IMAGETYPE png

OUTPUTFORMAT

NAME png

DRIVER 'GD/PNG'

MIMETYPE 'image/png'

IMAGEMODE RGBA

EXTENSION 'png'

END

LEGEND

IMAGECOLOR 255 255 255

STATUS ON

KEYSIZE 18 12

LABEL

```
TYPE BITMAP
SIZE MEDIUM
COLOR 0 0 89
END
END

WEB
IMAGEPATH 'ms4w/tmp/ms_tmp'
IMAGEURL '/ms_tmp/'

METADATA
'ows_title'      'QGIS-MAP'
'ows_onlineresource' 'http://localhost/cgi-
bin/mapserv.exe?map=C:/ms4w/apps/myApp/map/chameleon.map'
'ows_srs'        'EPSG:4326'
END
END

LAYER
NAME 'BahirDar__Town_'
TYPE POLYGON
DUMP true
EXTENT 259736.382472 1260099.457055 354494.009406 1302840.088417
DATA 'C:\ms4w\apps\myApp\data\Bahir Dar Town Kebeles Final.shp'
METADATA
'ows_title' 'BahirDar__Town_'
END
STATUS ON
TRANSPARENCY 100
PROJECTION
'proj=longlat'
'datum=WGS84'
'no_defs'
END
```

```
LABELITEM'Name'  
CLASS  
  NAME 'BahirDar_ Town '  
  STYLE  
    WIDTH 2  
    COLOR 255 130 190  
  END  
LABEL  
  SIZE medium  
  COLOR 0 0 0  
  ANGLE 0  
  BUFFER 0  
  END  
END  
END  
  
LAYER  
  NAME 'Lake_Tana'  
  TYPE POLYGON  
  DUMP true  
  
EXTENT 259736.382472 1260099.457055 354494.009406 1302840.088417  
DATA 'C:\ms4w\apps\myApp\data\Tana_lake.shp'  
METADATA  
  'ows_title' 'Lake_Tana'  
END  
STATUS ON  
TRANSPARENCY 100  
PROJECTION  
  'proj=longlat'  
  'datum=WGS84'  
  'no_defs'  
END  
CLASS
```

```
NAME 'Lake_Tana'  
STYLE  
  WIDTH 2  
  OUTLINECOLOR 0 0 0  
  COLOR 85 170 255  
END  
END  
END  
  
LAYER  
  NAME 'Parks'  
  TYPE POLYGON  
  DUMP true  
  
EXTENT 259736.382472 1260099.457055 354494.009406 1302840.088417  
DATA 'C:\ms4w\apps\myApp\data\Parks.shp'  
METADATA  
  'ows_title' 'Parks'  
END  
STATUS ON  
TRANSPARENCY 100  
PROJECTION  
  'proj=longlat'  
  'datum=WGS84'  
  'no_defs'  
END  
CLASS  
  NAME 'Parks'  
  STYLE  
    WIDTH 2  
    OUTLINECOLOR 0 0 0  
    COLOR 115 178 115  
  END  
END
```

END

LAYER

NAME 'Asphalt'

TYPE LINE

DUMP true

EXTENT 259736.382472 1260099.457055 354494.009406 1302840.088417

DATA 'C:\ms4w\apps\myApp\data\Main_Roads_Clip.shp'

METADATA

'ows_title' 'Main_Roads'

END

STATUS ON

TRANSPARENCY 100

PROJECTION

'proj=longlat'

'datum=WGS84'

'no_defs'

END

CLASS

NAME 'Main_Roads'

STYLE

WIDTH 2

COLOR 170 0 0

END

END

END

LAYER

NAME 'All Weather Road'

TYPE LINE

DUMP true

EXTENT 259736.382472 1260099.457055 354494.009406 1302840.088417

DATA 'C:\ms4w\apps\myApp\data\Road2.shp'

METADATA

```
'ows_title' 'Seconday_roads'  
END  
STATUS ON  
TRANSPARENCY 100  
PROJECTION  
'proj=longlat'  
'datum=WGS84'  
'no_defs'  
END  
CLASS  
  NAME 'Seconday_roads'  
  STYLE  
    WIDTH 1  
    COLOR 170 0 0  
  END  
END  
END  
  
LAYER  
  NAME 'Market'  
  TYPE POINT  
  DUMP true  
  EXTENT 259736.382472 1260099.457055 354494.009406 1302840.088417  
  DATA 'C:\ms4w\apps\myApp\data\Market.shp'  
  METADATA  
    'ows_title' 'Market'  
  END  
  STATUS ON  
  TRANSPARENCY 100  
  PROJECTION  
  'proj=longlat'  
  'datum=WGS84'  
  'no_defs'  
  END
```

CLASS

NAME 'Market'

STYLE

SYMBOL "circle"

SIZE 6

OUTLINECOLOR 0 0 0

COLOR 85 85 0

END

END

END

LAYER

NAME 'Transport_destinations'

TYPE POINT

DUMP true

EXTENT 259736.382472 1260099.457055 354494.009406 1302840.088417

DATA 'C:\ms4w\apps\myApp\data\Transport.shp'

METADATA

'ows_title' 'Transport_destinations'

END

STATUS ON

TRANSPARENCY 100

PROJECTION

'proj=longlat'

'datum=WGS84'

'no_defs'

END

LABELITEM"TRANSPORT"

CLASS

NAME 'Transport_destinations'

STYLE

SYMBOL "circle"

SIZE 6

OUTLINECOLOR 0 0 0

```
    COLOR 149 36 161
    END
    LABEL
    SIZE medium
    COLOR 0 0 0
    ANGLE 0
    BUFFER 0
    END
END
END

LAYER
    NAME 'Banks'
    TYPE POINT
    DUMP true
    EXTENT 259736.382472 1260099.457055 354494.009406 1302840.088417
    DATA 'C:\ms4w\apps\myApp\data\Bank.shp'
    METADATA
        'ows_title' 'Banks'
    END
    STATUS ON
    TRANSPARENCY 100
    PROJECTION
        'proj=longlat'
        'datum=WGS84'
        'no_defs'
    END
    CLASS
        NAME 'Banks'
        STYLE
            SYMBOL "circle"
            SIZE 6
            OUTLINECOLOR 0 0 0
            COLOR 0 85 127
```

```
    END
  END
END

LAYER
  NAME 'Helath_centers'
  TYPE POINT
  DUMP true
  DATA 'C:\ms4w\apps\myApp\data\Helath_centers.shp'
  METADATA
    'ows_title' 'Helath_centers'
  END
  STATUS ON
  TRANSPARENCY 100
  PROJECTION
    'proj=longlat'
    'datum=WGS84'
    'no_defs'
  END
  CLASS
    NAME 'Helath_centers'
    STYLE
      SYMBOL "circle"
      SIZE 6
      OUTLINECOLOR 0 0 0
      COLOR 0 0 255
    END
  END
END

LAYER
  NAME 'Hotels'
  TYPE POINT
  DUMP true
```

EXTENT 259736.382472 1260099.457055 354494.009406 1302840.088417

DATA 'C:\ms4w\apps\myApp\data\Hotels.shp'

METADATA

'ows_title' 'Hotels'

END

STATUS ON

TRANSPARENCY 100

PROJECTION

'proj=longlat'

'datum=WGS84'

'no_defs'

END

CLASS

NAME 'Hotels'

STYLE

SYMBOL "circle"

SIZE 6

OUTLINECOLOR 0 0 0

COLOR 170 170 127

END

END

END

LAYER

NAME 'Tourist_spots'

TYPE POINT

DUMP true

EXTENT 259736.382472 1260099.457055 354494.009406 1302840.088417

DATA 'C:\ms4w\apps\myApp\data\Tourist_spots.shp'

METADATA

'ows_title' 'Tourist_spots'

END

STATUS ON

TRANSPARENCY 100

```
PROJECTION
'proj=longlat'
'datum=WGS84'
'no_defs'
END
LABELITEM 'TOURIST_SP'
CLASS
  NAME 'Tourist_spots'
  STYLE
    SYMBOL "circle"
    SIZE 10
    OUTLINECOLOR 0 0 0
    COLOR 170 0 0
  END
  LABEL
    SIZE medium
    COLOR 0 0 0
    ANGLE 0
    BUFFER 0
  END
END
END
END
```

DECLARATION

I, the undersigned, declare that this thesis entitled " **Web GIS for Tourism Development of Bahir dar town and Its Surroundings, Ethiopia**" is my original work, has not been presented for a degree in any other university and that all source of material used for the thesis have been duly acknowledged.

Name Abel Markos Behonegn

Signature _____

Place Addis Ababa University

Date of Submission June, 2012

The thesis has been submitted for examination with my approval as university Advisor.

Dr. K. V. Suryabhagavan _____

Assistant Professor

Department of Earth Sciences

Addis Ababa University

Addis Ababa, Ethiopia

