DEVELOPING A WEB-BASED GIS APPLICATION
FOR EARTHQUAKE INFORMATION

A. Garagon Dogru [a, *], T. Selcuk [b], H. Ozener [a], O. Gurkan [a] , G. Toz [c]

[a] BU, Kandilli Observatory and Earthquake Research Institute, Geodesy Department, Cengelkoy Istanbul, Turkey - (garagon, ozener, gurkano)@boun.edu.tr
[b] Turkish Land Forces Command, Ankara, Turkey - tselcuk@kkk.tsk.mil.tr
[c] ITU, Civil Engineering Faculty, 34469 Maslak Istanbul, Turkey - tozg@itu.edu.tr

YF (Youth Forum Session)

KEY WORDS: Earthquakes, GIS, Internet/Web, Retrieval, Programming, On-line, Web based

ABSTRACT:

The Internet has been changing the access and transmission of GIS data, applications and visualizations. Online GIS combines the advantages of both GIS and the Internet. Geographic information can be distributed in a variety of forms on the Internet. Moreover as the Internet technology takes progress, web-based GIS applications also change. This paper focuses on development and implementation of a web-based GIS application for earthquake information. In this study, a dynamic map browser type of web-mapping applications was designed for interacting with the earthquake information. This method provides users easy access to GIS data and basic functions on the Internet with low technological requirements. The user is not required to learn anything beyond the basics about how to interact with the system as well. In the study, a GIS application and a web site was developed to serve the system on the Internet. By integrating various data from different sources, this study aims to provide public users can access information about earthquakes doing spatial and attribute query. Furthermore this model enables easy data management including maintenance and updating.

1. INTRODUCTION

1.1 Internet GIS

Geographic Information Systems (GIS) are tools for acquiring, managing, analyzing, and presenting spatially related information (Coors, 1998). GIS convert diverse data into easy-to-read and easy-to-access maps and information. In addition, the advantages of the world wide web are numerous, the two primary being time independence and spatial independence (Mohler and Duff, 1999). Distributing data over the Internet is more efficient than transmitting data through disks. Both Internet and GIS changed the processes of accessing, sharing, disseminating and analyzing data. Technology to share GIS data, such as Web GIS, Open GIS and Distributed GIS on the Internet is rapidly progressing (Honda, 2003).

1.2 Approaches to Internet GIS

Internet GIS includes any application that uses the Internet technology to make geographic data available. Geographic information can be distributed in a variety of forms on the Internet. There are several basic approaches to transmit geographic data (Garagon, 2002). The first is raw data download. If the user has GIS software capability, he/she will not request finished maps. After the data sets have been put on the user's local disk, the GIS work is done off-line. Maps is the most common way of distributing geographic information. Maps may be static with a predesigned symbology or may be dynamic where the map itself or the viewing perspective of it can changed by the user, such as with a zoom-in/out feature for seeing a region of particular interest (Selcuk, 2001). Simple searches are also performed in a database according to a set of criteria. These criterias can be either spatial or thematic. The records that match the criteria are then returned to the user, either in a map or a text report format. In another type of distribution, users can perform complex multi-theme queries, create buffers and customized maps, perform statistical spatial analysis, and so on. It allows users to create new data sets without altering the data.

For designing web-based GIS applications, variety of programs and forms are available. But the web applications are based on the same model called client/server (Plewe, 1997) (**Figure 1**). The client makes a request to a server. The server processes the request and returns the information to the client. In this model, the process is shared between the client and the server, with different ratios. This sharing process is generated in various forms which have advantages and disadvantages. A thick client (interacting with a light server) provides powerful analysis. But it is hard to maintain the service. A thin client (interacting with heavy server) is limited with simple applications. However, it can be used by many people (Garagon, 2002).
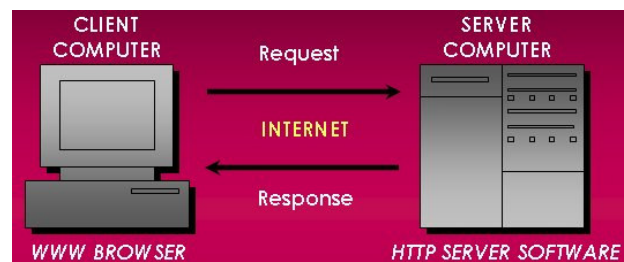

Figure1: Client-server model

---

* Corresponding author.

2. CASE STUDY

2.1 Structure and Tools

In this study, mapping application type is dynamic web browser. Dynamic maps enable to choose features that will be displayed, such as the scale, location etc. In this type of applications, maps are drawn according to preset parameters. And then the web browser displays the map as an image. By changing the parameters, users can generate and view a new map. This type causes heavy load on the server side. The server side has geographic data, GIS softwares, and an interface program (**Figure 2**). It requires also programming to provide a map service. In this study, activex control is used to extend the browser capabilities. When users visit the site, the control is downloaded automatically and temporarily.
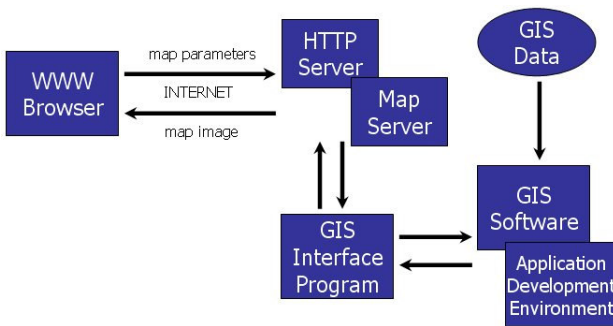

Figure2: Server side model

MapObjects ActiveX software component and MapObjects Internet Map Server (MOIMS) software are used in the study. MapObjects is used to build the GIS application and MOIMS is used as a gateway program. MapObjects and MOIMS are used together with Visual Basic application development environment. Windows XP is choosed as the operating system and Microsoft Internet Information Server (IIS) is it's web server. It is used to share information over the Internet. Also Microsoft Internet Transfer Control is used to connect other web servers and retrieve HTML documents for the application. In order to listen requests from the users, WebLink ActiveX Control is used. For the preparation of the spatial data ArcView, ArcInfo, Erdas Imagine, and Microsoft Photo Editor programs were used (**Figure 3**).
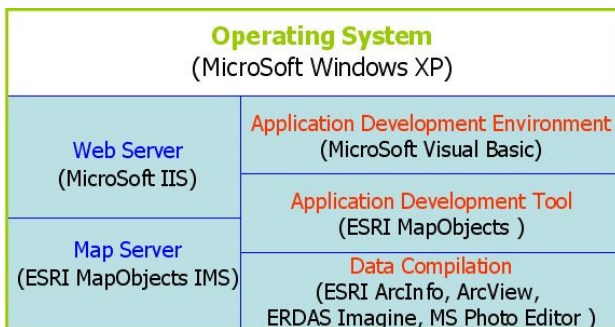

Figure 3: Tools

2.2 Data Acquisiton and Manipulation

Entire Turkey is the study area. Both raster and vector geographic data types are used in the study. Raster data represent topography and population density. Vector data represent current earthquakes, historical earthquakes, earthquake record stations, fault lines, GPS stations, displacements by GPS, city boundaries, city centers, county boundaries, map index, lakes, rivers, and roads. GIS data come from different sources and in a variety of formats. For combining multiple files on the same display, data must be in the same spatial reference system. **Figure 4** displays data from different sources in different datums and forms.
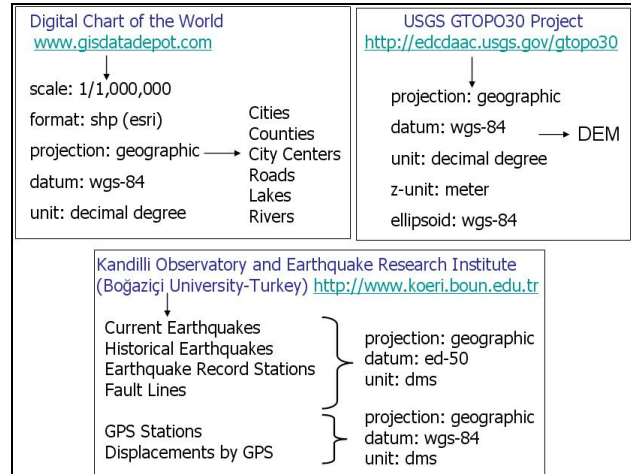

Figure 4: Data, sources, and formats

Digital Elevation Model were exported to cell based grid format. ArcView was used to classify grid data according to its height values. In order to use raster data in MapObjects Internet Map Server application, data were converted from grid format to JPEG image format. And then it was converted to TIFF format using Microsoft Photo Editor software. Because MapObjects displays TIFF format more efficiently than JPEG format. For population density map, ArcView and it's scripting language were used to calculate areas of the boundary polygons and colorize shape file according to the population density values. Population values of districts were added to districts dBASE table. Density image was exported to JPEG format. And then JPEG file was converted to TIFF format. Current Eartquakes and Historical Earthquakes layers were symbolized using their magnitude and depth values. Other vector layers were symbolized with single values.

In the study, vector data format is ArcView shape file format. Vector data downloaded from http://www.gisdatadepot.com DCW web site were acquired in shape file format. For other ASCII text files which include coordinate information of stations and earthquake parameters information, ArcView scripting was used to convert text file to shape file format.

All of these data were in geographic coordinates relative to the WGS-84 and ED-50 datums. Datum transformations and coordinate conversions were performed. Data were projected to Lambert Conformal Conic map projection. It is one of the best for middle latitudes. ArcView can not export maps to georeferenced images. So topographic map image and population density map image were georeferenced to the Lambert Conformal Conic projection by using image processing software ERDAS Imagine.

2.3 Application Development

In this study a GIS application was developed and a web site was configured to serve the earthquake information on the Internet. MapObjects activex component was added to a form in Visual Basic project file and used to develop the application (**Figure 5**). WebLink.ocx is also an activex control. This control is installed automatically with MOIMS. Its role is to listen on an assigned port for requests from a client and communicate with the esrimap.dll. Esrimap.dll is a dynamic link library component that extends web server software. It can manage requests and responses from map server and administer map services (ESRI, 1998). Following functions can be implemented in programs built with Map Objects control:

- Display a map with multiple map layers, such as roads, streams and boundaries.
- Pan and zoom throughout a map.
- Draw graphic features such as points, lines, ellipses, rectangles and polygons.
- Draw descriptive text.
- Identify features on a map by pointing at them.
- Select features along lines and inside boxes, areas, polygons, and circles.
- Select features within a specified distance of other features and more…(ESRI, 1999).
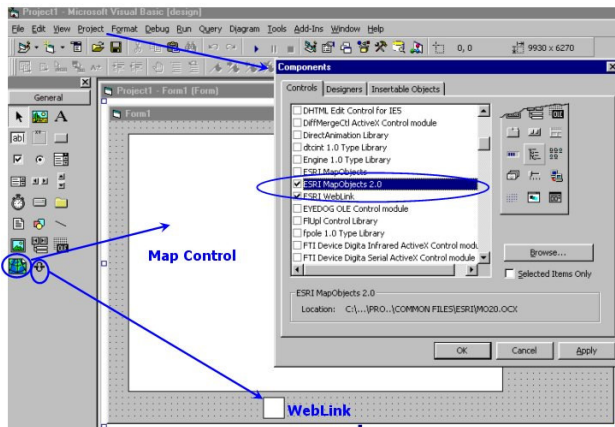

Figure 5: Visual Basic project with components

The map control is the main object of the MapObjects. The map control is a container for the maps. Maps are displayed on this container. MapObjects ActiveX control has lots of properties, events and controls. Main properties are CoordinateSystem, Extent, FullExtent, MousePointer and Visible. Main methods are DrawShape, ExportMap, Pan, Refresh and TrackRectangle. Main events are AfterLayerDraw, BeforeLayerDraw, MouseDown and MouseMove. Before adding any vector layer a data connection must be established. A data connection represents a connection to a source of geographic data. In this study a folder containing shapefiles is the data source. A connection can return a GeoDataSets collection. Each member of the collection, referred to as GeoDataset, represents a discrete set of geographic data that can be retrieved from the data source. Geographic data in a GeoDataset is used by assigning it to the GeoDataset property of a new MapLayer object. The Connect method of the DataConnection object will attempt to connect to the data source specified in the Database property. Following is the codes for adding layers to the application:

```
' add shapefiles
Dim dc As New DataConnection
Dim Lyr As MapObjects2.MapLayer
dc.Database = ImsDataPath
If Not dc.Connect Then
MsgBox "ims_data set not found"
End
End If
Set Lyr = New MapLayer
Set Lyr.GeoDataset = dc.FindGeoDataset("Seismic")
Lyr.Symbol.SymbolType = moPointSymbol
Lyr.Symbol.Style = moSquareMarker
Lyr.SymbolColor = moRed
Lyr.Symbol.Size = 9
Lyr.Visible = False
Map.Layers.Add Lyr
```

2.4 Serving on the Internet

GIS application runs together with MapObjects Internet Map Server components. MapObjects Internet Map Server acts as a gateway between Web Server and the mapping application. The request made by the client is passed to the web server first. The server recognizes that this request is about creating a map, so it directs it to the map server. The map server executes the application according to the type of mapping demand (this demand can be a display operation like a zoom-in function or a query about a feature) and sends the result (a picture of the map in JPEG format) to the web server. The web server brings the HTML page created to the client. MapObjects IMS has three different components that runs one after the other. IMS Catalog, IMS Launch, and IMS Admin are connected to each other. IMS Admin communicates with IMS Catalog to manage the state, running or not, of a map service. IMS Catalog communicates with IMS Launch. When starting a map service, IMS Catalog sends the path and file name of the map service to be started and the number of instances to start. IMS Launch responds by starting the map service.
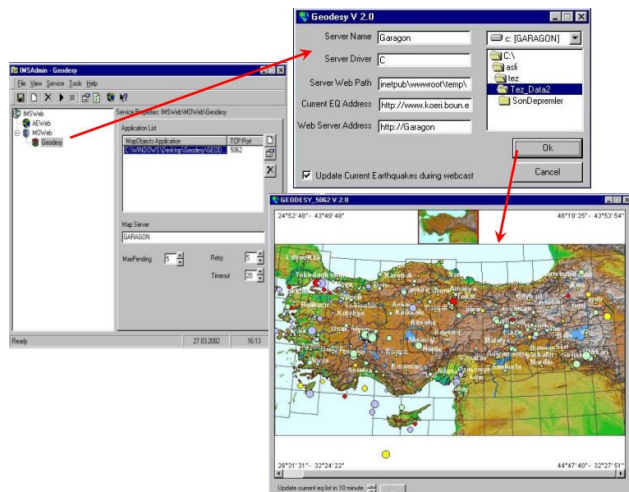

Figure 6: Server side of the application

When a client sends a URL request to the server that hosts esrimap.dll, it determines which map service to communicate to respond the request. The URL address : http://ServerName/scripts/esrimap.dll?Name=MapServiceName&Cmd=Map. Each argument and value pair is referred to a query parameter. The first query parameter in the URL is used to determine which

application the client wants to communicate. The application name follows the "?" sign. Each argument and value pair is seperated with "&" sign. Arguments and values are used to call the functions that perform specific mapping operations. In this URL address, "Name" is the argument and "MapServiceName" is the value. Arguments transmit the information to the application that which function will be executed by the GIS application. Values are the parameters for these functions.

The GIS application transmits an HTML page to the user for the request. HTML code is generated in the GIS application by using WriteString method of WebLink activex control. Requested map is also sent in HTML code. Before transmitting the map, it is exported to a bitmap image file by Map Objects. Since the bitmap image file format is not a compressed one, it is converted to JPG image file using BMP2JPG method of WebLink activex control (Selcuk, 2001).

Microsoft Internet Transfer Control and a Timer Object were also used as components to update the current earthquake information. The timer control that runs at intervals is used to update the current earthquake information. In every ten minutes, the application connects the URL address using the Microsoft Internet Transfer Control. After the connection, the text file that contains current earthquake information is downloaded from the web page and converted to shape file.

The application is easy to use and it provides a valuable resource for accessing spatial datasets. On the client side of the application, a web browser and a network access only is needed. Client side of the application is shown in **Figure 7**.
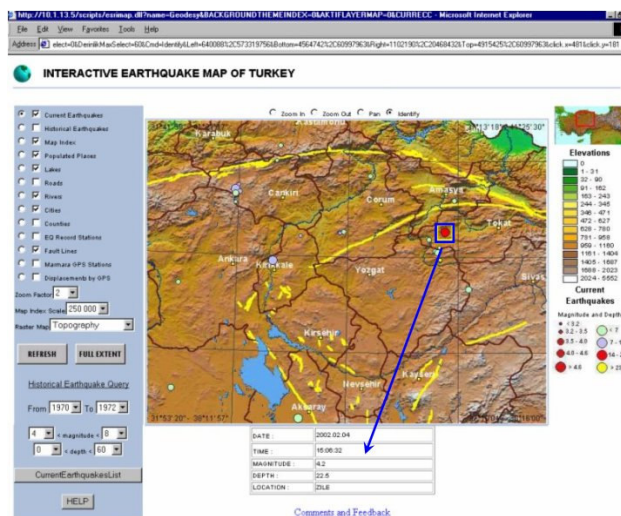

Figure 7: Client side of the application (Web page)

The map is at the center of the page. Map Layers are located on the left and the legand is on the right side of the page. A thumbnail map marks the displayed zone with a red rectangle Combo boxes, check boxes, and radio buttons are used for user interaction. Geographic features can be identified by clicking on the map and a query can be made by defining criterias.

3. CONCLUSIONS

This study is a web-based geographic information system that provides access to spatial datasets pertaining to earthquakes in Turkey. It is designed to allow viewing, querying, and analysis of geographic information. There are two aspects of the Internet

GIS. One is the web-based application and the other is Server/Client balance. This application is a software-independent system that users do not have to buy a GIS software and do not have to read manuals to use it but they can access GIS data and analysis functions over the Internet. It offers maximum functionality with the minimum effort.

The drawback in such a distributed system is that data come from different sources based on different forms and datums which cause havoc in a GIS. It causes that the web-based application does not represent an online service entirely. Since all the spatial information stored and displayed in a GIS depend on a geodetic datum for their meaning, it is necessary to compile data before the development of the application. For this reason, it is online partially. Only current earthquakes layer is created automatically during the application, the other layers were prepared before. It means the study has both offline and online data sources.

The response time for generating maps is related to the map server configuration (memory, disk, and processor). The map is also depending on the network connection. It can take a while to download the maps. In addition, system downtime for maintenance and updates for a web site is unavoidable. But this sytem is designed for easy maintenance and repair without interruption.

An entrance page will be created to make a simple presantation of the service. This provides users an option for choosing a specific area of interest to start with. Furthermore, new datasets and functions will be added to the service.

REFERENCES

Coors, V., 1998. Extended Abstract on International Workshop for Interactive Applications of Mobile Computing "Using Wearable GIS in outdoor applications", Germany. http://www.igd-r.fraunhofer.de/veranstaltungen/workshops/imc98/Proceedings/ (accessed 26 Apr. 2004)

ESRI, Inc., 1998. MapObjects Internet Map Server User Guide, California, USA.

ESRI, Inc., 1999. MapObjects 2.0 Online Help.

Garagon, A., et al., 2002. International Symposium on GIS, "Interactive Earthquake Information on the Internet", Istanbul-Turkey.

Honda, K., 2003. Proceedings of the Regional Conference on DIGITAL GMS "Digital ASIA Concept and Activity", Thailand. http://www.star.ait.ac.th/~honda/pub.html (accessed 26 Apr. 2004)

Mohler, J.L. and Duff, J.M., 1999. *Designing Interactive Web Sites.* Publishing, NY, USA.

Plewe, B., 1997. *GIS Online, Information Retrieval, Mapping and the Internet*, Onword Press, Santa Fe, NM, USA.

Selcuk, T., 2001. "Interactive Earthquake Information on the Internet", M.Sc. Thesis, Boğaziçi University KOERI Geodesy Department, Istanbul, Turkey.