Constructing a Web-based GIS for Earthquake Monitoring in Turkey

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Key words: Internet-GIS, Earthquakes, Computer Programming, Data Transformations.

SUMMARY

This study representing the interactivity of the users and the spatial data combines the advantages of both GIS and the Internet. The aim of the study is to provide public access to information about earthquakes over the Internet due to spatial and attribute query. A dynamic map browser was designed for interacting with the earthquake information. This method provides easy access on the Internet for users to GIS data and its basic functions with low requirements. In order to built such an independent system, programming an interface is required. Also GIS data was processed and generated by using ArcView and ArcInfo softwares. As a conclusion a GIS application was developed and a web site was configured to serve the system on the Internet.

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1. INTRODUCTION

Advances in web-based technology make it possible to serve spatial data over the Internet. Web-based GIS becomes a powerful solution for distributing GIS data and functions on the Internet. Geographic information is being distributed in a variety of forms and shared by public users on the Internet. This provides users ability to easily search and view spatial data. 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 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). 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.

The most important aspect of Web GIS is the relationship between the server and the client. Interactive Web technologies rely on the requests from the client being processed by the server. Client side processing means the request is processed within the browser locally. Server side processing means the request is processed within a web server, remotely.

- Client side models generally require an applet or a plugin
- Slow initial download times
- Use feature data within the browser
- Does not need to constantly communicate with the server
- Interactive requests performed within the browser
- Restricted use with large data sets
- Server side models load quickly, as applets, if used are small in size
- Features are represented by pixels in a GIF or JPEG image
- Only simple point click requests are possible
- All requests must be sent to the server for processing and then the reply read by the browser
- Large data sets can be used as they are stored and processed on the server (Holliday, 2005).

2. STRUCTURE & TOOLS

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. 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.

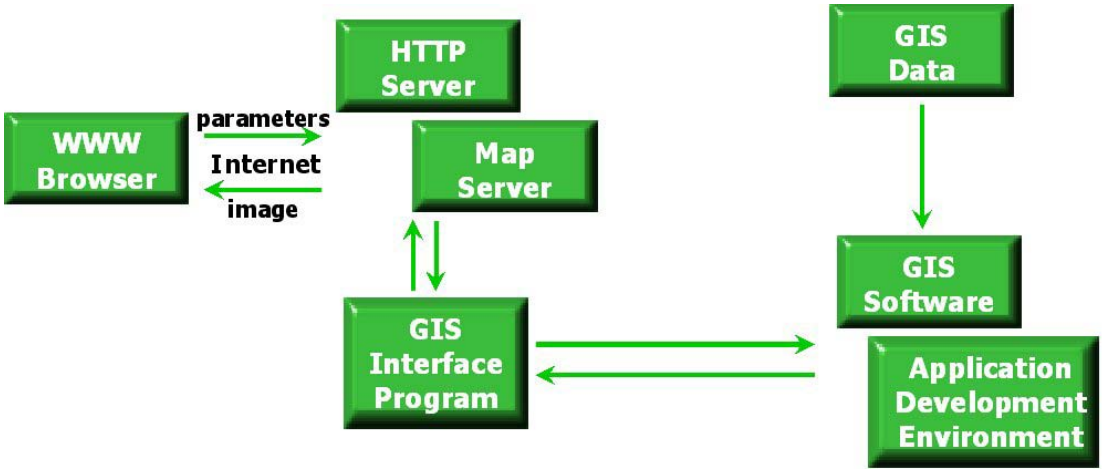

Figure 1: Dynamic Web Browser

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.

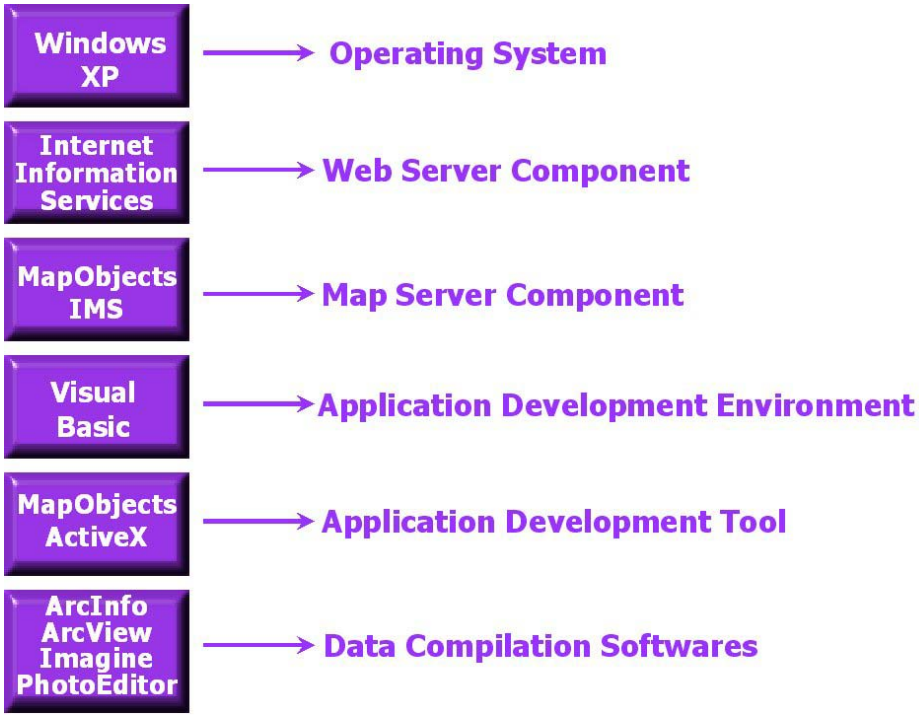

Figure 2: Tools

3. APPLICATION DEVELOPMENT

The merging of Visual Basic and the ability to tie into real-time, distributed information using the Internet produces an interesting and very powerful tool. In the constant flux of the Internet, Visual Basic becomes a very practical choice for Web application. Visual Basic can be used to create both client-side and server-side Web applications. As a Web programming tool Visual Basic makes sense for the following reasons:

- *Database Connectivity* - By using ODBC or RDO, you can easily wrap database accessibility into a Visual Basic Web application. The question is no longer what can be done via the current set of Web tools but what can be done using Visual Basic.
- *Up-to-date custom controls* - The market for third party custom controls in Visual Basic is huge. At least 10 different companies currently make OCXs or VBXs for Internet programming. This is reassuring because a change in an Internet specification used somewhere in your application doesn't mandate a change in the application's code. Instead, it means upgrading a custom control and then performing the much easier task of verifying that the control works as intended with the application.
- *OLE* - The ability to control and to access data from other applications is a big plus to application development. Not only can a Visual Basic application control several OLE-enabled Web Browsers, but you can also relay information from the Web to an OLE-enabled application.
- *The Windows user interface* - The usability of a Windows application far exceeds the current set of HTML tags that allow for textboxes, comboboxes, and buttons. This, coupled with the large Windows install base, ensures that the learning curve of a properly designed Visual Basic application will be close to that of any other Windows application (Eddy, 1996)

The codes below shows how created html using Visual Basic.

```
Private Sub CreateHTML(ext As MapObjects2.Rectangle)
 Dim imgURL As String

 ' create image and return image HTML refrence
 imgURL = "/temp/" & CreateMap(ext)

 ' write out an HTML document
 With WebLink

  ' add an HTML FORM here
  .WriteString "<HTML>" & vbCrLf
  .WriteString "<BODY bgcolor=white> <P>" & vbCrLf

  .WriteString "<TABLE cellPadding=0 cellSpacing=0 width=100% noborder >"
  .WriteString "<TBODY>"
  .WriteString "<TR>"
  .WriteString "<TD align=left vAlign=center width=5%> <img border=0 src=" & Tirnak &
"../images/earthrotate12_e0.gif" & Tirnak & "></A></TD>"
  .WriteString "<TD align=left vAlign=center width=95%><FONT face=arial size=+1><B>INTERACTIVE
EARTHQUAKE MAP OF TURKEY</B></FONT></A></TD>"
```

```
   .WriteString "<TR>"
   .WriteString "<TD colSpan=2>"
   .WriteString "<HR color=#B0C4DE noShade SIZE=2 width=100%>"
   .WriteString "</TD></TR></TBODY></TABLE>"
.
.
.
.WriteString "</BODY>" & vbCrLf
  .WriteString "</HTML>" & vbCrLf
End With

End Sub
```

Map Objects is an ActiveX software component. It is a unit of executable code such as an exe or dll. It provides more functions to form custom mapping applications. Once installed on a system and registered in a development environment such as Visual Basic, Map Objects component can be added to a form and used to develop applications. A Visual Basic project was created and Map Objects was added to the project to form the application.

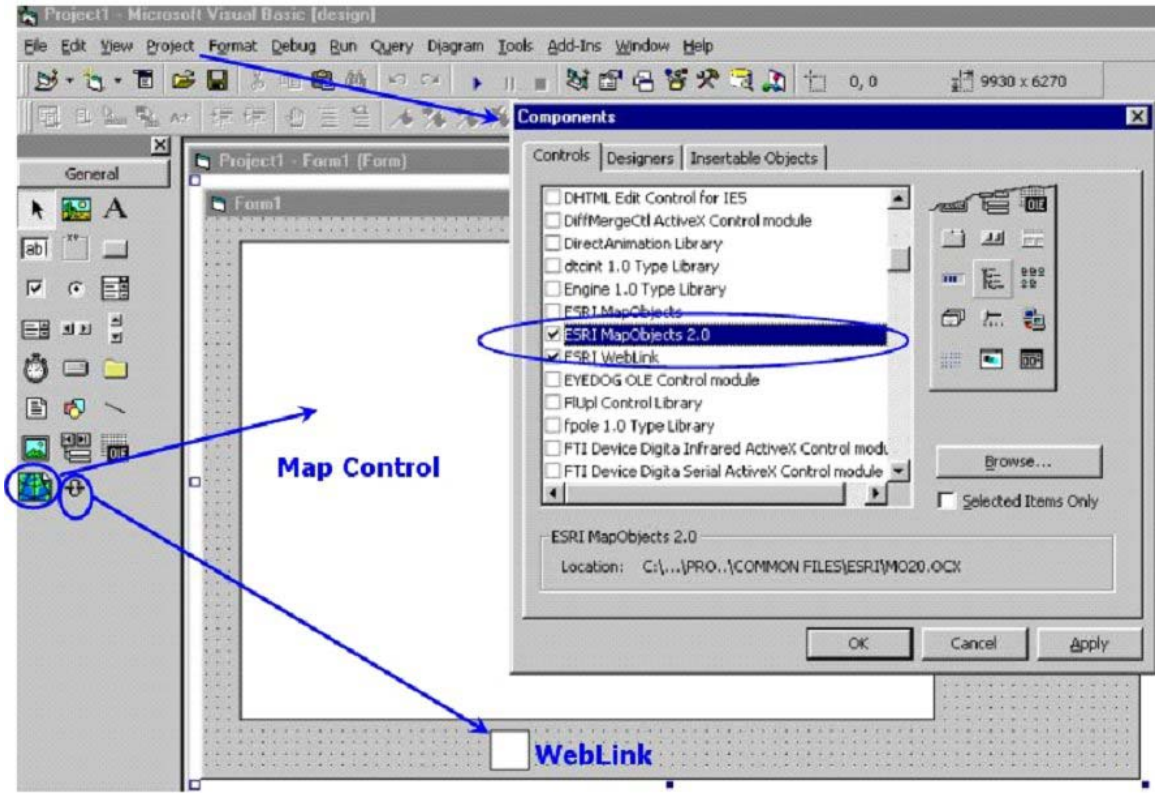

Figure 3: Visual Basic Project with Components

Following functions can be implemented in programs built with MapObjects control:

- Display a map with multiple map layers, such as roads and boundaries.
- Pan and zoom throughout a map.
- Draw graphic features such as points, lines, rectangles and polygons.
- Draw descriptive text.

- Identify features on a map by pointing at them.
- Select features along lines and inside boxes, areas, and polygons.
- Select features within a specified distance of other features and more…

JavaScript was used for adding interactivity on the Web page. JavaScript was created by Netscape. It is known as Object Orientated Programming (OOP). JavaScript cannot stand alone. It must be running inside of a Web page, and the Web page must be displayed in a browser that understands the JavaScript language. Writing JavaScript are similar to the rules of writing HTML. Sample scripting is shown below:

```
.WriteString "<SCRIPT LANGUAGE=JavaScript>" & vbCrLf
  .WriteString "<!--" & vbCrLf
       .WriteString "function backgroundselectfunc(form1)"
      .WriteString "{"
         .WriteString "form1.BACKGROUNDTHEMEINDEX.value = form1.bkgroundselect.selectedIndex;"
      .WriteString "}"
..
.WriteString "//-->" & vbCrLf
  .WriteString "</SCRIPT>" & vbCrLf
```

4. DATA ACQUISITION & MANIPULATION

Entire Turkey is the study area. Both raster and vector geographic data types are used in the study. 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.

Data Set	Data Type	Data Source
DEM (for Topography)	Raster	US Geological Survey Web Site
Population Values (for Density)	Raster	National Statistics Ins. Web Site
Boundries, Rivers, Lakes, Roads	Vector	Digital Chart of the World
Current Earthquakes	Vector	Kandilli Observatory & ERI Seismology Lab. Web Site
Historical Earthquakes	Vector	Kandilli Observatory & ERI Seismology Lab. Web Site
Earthquake Record Stations	Vector	Kandilli Observatory & ERI Seismology Lab. Web Site
Fault Lines	Vector	Kandilli Observatory & ERI Geophysics Department
GPS Stations	Vector	Kandilli Observatory & ERI Geodesy Department
Displacements by GPS	Vector	Kandilli Observatory & ERI Geodesy Department
Map Index	Vector	Using ArcView

Figure 4: Data and Sources

DEM 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 IMS 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 its 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.

All of 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.

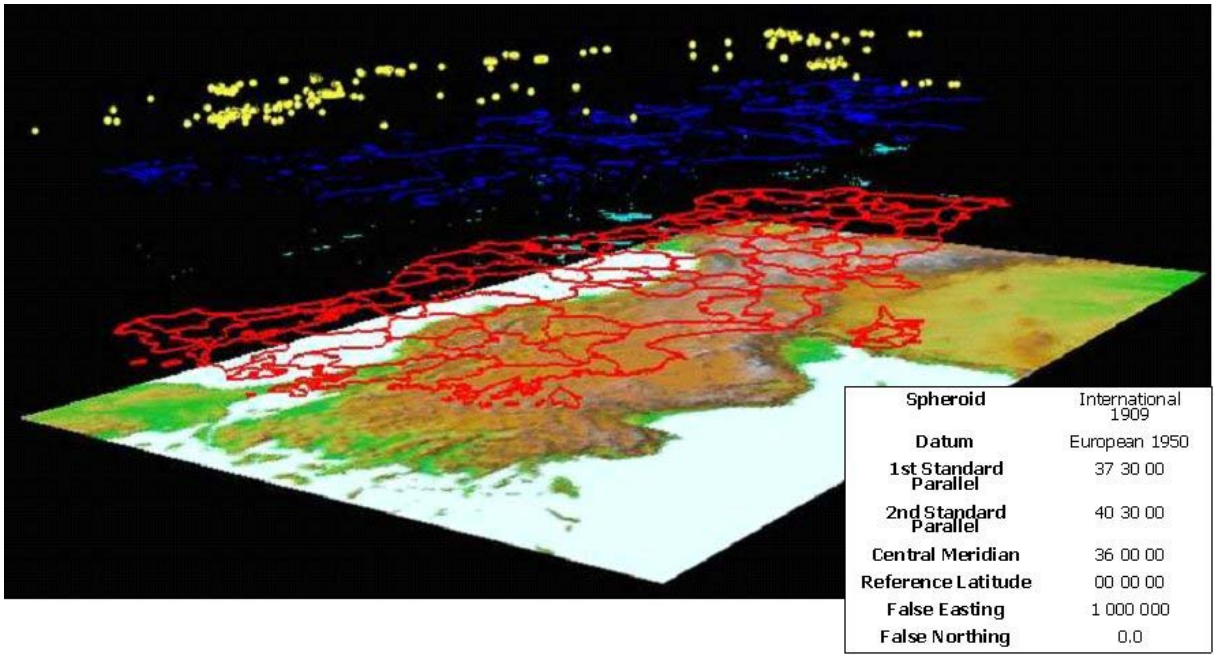

Figure 5: Lambert Conformal Conic Projection Parameters

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.

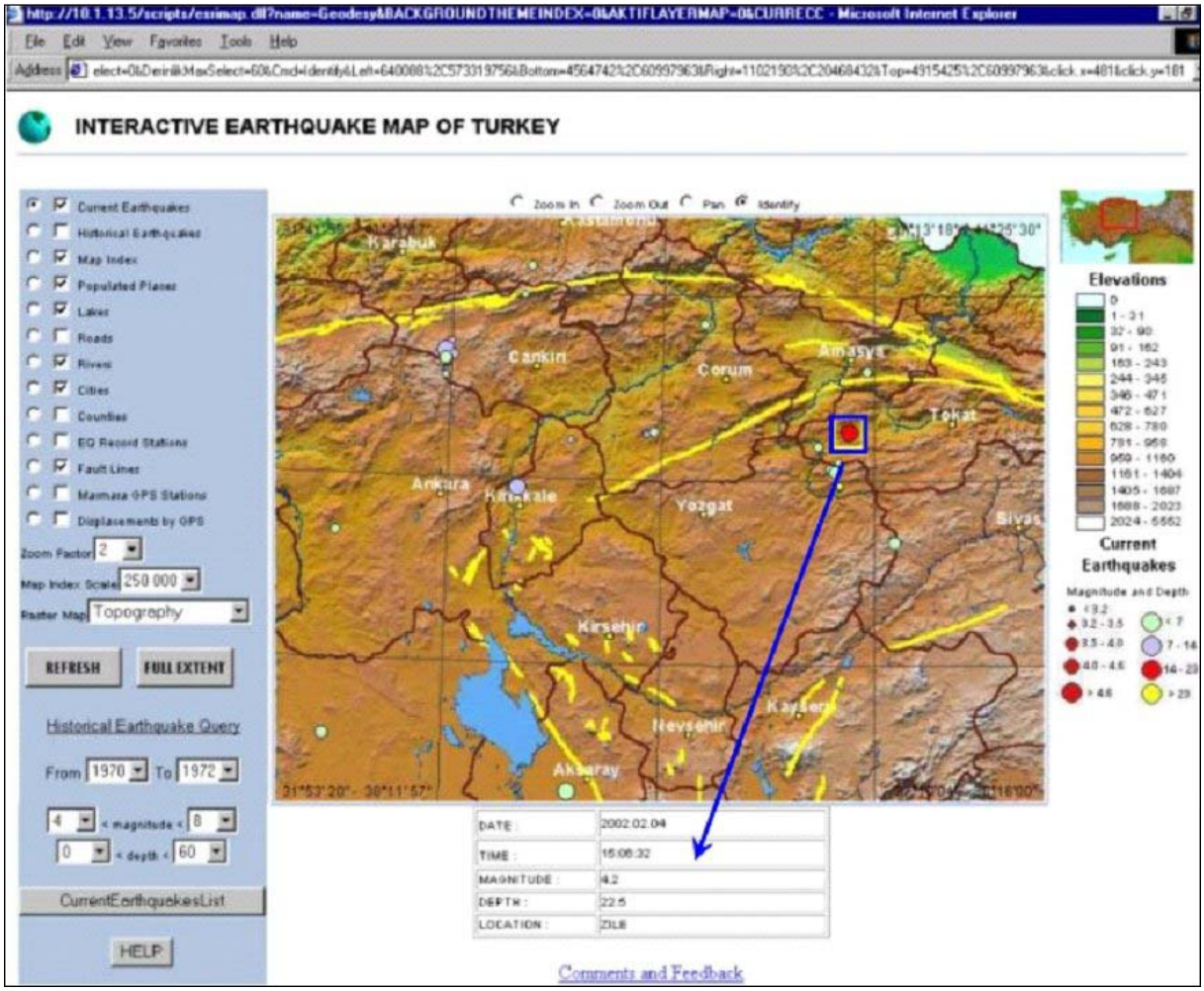

Figure 6: Application Web Page

5. 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.

REFERENCES

Anonymous, JavaScript Primer, http://www.htmlgoodies.com/primers/jsp/hgjsp_1.html, access date: January 17, 2005

Eddy, C., 1996. Web Programming with Visual Basic, Sams Publishing.

Holliday, D., Adelaide University's Web Site: http://www.gisca.adelaide.edu.au/education_training/lectures/sdvis5014/lectures/web_gis_lect_03.ppt, access date: January 17, 2005

Selcuk, T., 2001. Interactive Earthquake Information on the Internet, M.Sc. Thesis, Bogazici University K.O.E.R.I Geodesy Department, Istanbul, Turkey.

BIOGRAPHICAL NOTES

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