GIS LEARNING TOOL FOR WORLD’S LARGEST EARTHQUAKES
AND THEIR CAUSES

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DEDICATION

I would like to dedicate this thesis to my entire family, especially my parents Mrs. Anjali Chatterjee and Mr. Pranab Kumar Chatterjee, my husband Mr. Kausik Ray Chaudhuri, and my dearest son Shounak Ray Chaudhuri who have inspired me to achieve my goal. Without their unconditional love and support this would not have been possible.
ABSTRACT OF THE THESIS

GIS Learning Tool for World’s Largest Earthquakes and Their Causes

by

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The objective of this thesis is to increase awareness about earthquakes among people, especially young students by showing the five largest and two most predictable earthquake locations in the world and their plate tectonic settings. This is a geographic based interactive tool which could be used for learning about the cause of great earthquakes in the past and the safest places on the earth in order to avoid direct effect of earthquakes. This approach provides an effective way of learning for the students as it is very user friendly and more aligned to the interests of the younger generation. In this tool the user can click on the various points located on the world map which will open a picture and link to the webpage for that point, showing detailed information of the earthquake history of that place including magnitude of quake, year of past quakes and the plate tectonic settings that made this place earthquake prone.

Apart from knowing the earthquake related information students will also be able to customize the tool to suit their needs or interests. Students will be able to add/remove layers, measure distance between any two points on the map, select any place on the map and know more information for that place, create a layer from this set to do a detail analysis, run a query, change display settings, etc. At the end of this tool the user has to go through the earthquake safely guidelines in order to be safe during an earthquake.

This tool uses Java as programming language and uses Map Objects Java Edition (MOJO) provided by ESRI. This tool is developed for educational purpose and hence its interface has been kept simple and easy to use so that students can gain maximum knowledge through it instead of having a hard time to install it. There are lots of details to explore which can help more about what a GIS based tool is capable of. Only thing needed to run this tool is latest JAVA edition installed in their machine.

This approach makes study more fun and interactive while educating students about a very important natural disaster which has been threatening us in recent years. This tool has been developed to increase awareness of the cause and effect of earthquake and how to be safe if that kind of disaster happens.
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CHAPTER 1

INTRODUCTION

This thesis presents the design and implementation of a GIS tool for giving an idea of world’s five largest and two most predictable earthquakes and their plate tectonic settings which makes them earthquake prone.

This tool will help to understand the cause of the largest and most predictable earthquakes in the world and their geographic distribution. By clicking on each location one can know more about the disaster caused by earthquake, its history and future prediction. The tool also predicts the safest regions to live on the Earth avoiding direct effects of major earthquakes. And last this tool will provide for safety awareness about earthquakes. The intended audience for this tool is students in college geology classes, or in high school natural science classes.

1.1 EARTHQUAKE

Earthquakes are a shaking and vibration of the land surface [1]. Such a phenomenon commonly is produced when Earth material ruptures during brittle failure along an old or new fault releasing stored up elastic strain energy as heat and seismic waves. An earthquake is the result of a sudden release of energy in the Earth’s crust that creates seismic waves. The seismicity or seismic activity of an area refers to the frequency, type and size of earthquake experienced over a period of time. Seismic waves are waves of energy that elastically distort the material that they travel through. This causes plate movements which create friction among the earth plates and as a result the surface on top of the plate boundaries experiences an earthquake. Figure 1.1 shows one of such movements.

1.2 PLATE TECTONIC

Geologists over the last 50-60 years have been able to document that the crust of our planet is cracked into seven large and many other smaller slabs of rock called plates,
Figure 1.1. Love waves move in a snake-like motion parallel to the Earth’s surface.

averaging about 50 miles thick. As they move (only inches per year), and depending on the direction of that movement, they collide, forming deep ocean trenches, mountains, volcanoes, and generating earthquakes [2]. The 7 major lithospheric plates are the Pacific, North American, Eurasian, South American, African, Indo-Australian, and Antarctic plates. Of the many microplates, the Juan De Fuca, Cocos, Nazca, Caribbean, Philippine, Scotia, and Arabian plates are 7 common ones shown on the tectonic map (Figure 1.2) [3]. Most of these 14 plates are shown on the plate tectonic map provided in this tool [4].

CHAPTER 2

TECHNOLOGY

This thesis is developed by using Java and its packages (Swing), along with Map Objects Java Edition (MOJO). Java is used for coding because it is platform independent, easy to deploy and has other important features which are discussed later in this chapter. Map Objects Java Edition is written by ESRI (Environmental Systems Research Institute) to work with GIS (Geographic Information System), and is affectionately called MOJO (Map Objects Java Objects). The main purpose of Swing is to create a GUI (Graphical User Interface) for this tool.

2.1 JAVA

Java is a programming language and computing platform. It was first released by Sun Microsystems in 1995. Java provides lots of reusable codes, a huge library and an execution environment. Since Java is platform independent, Java programmers do not need to worry about environment details where the Java application is running. Java has a component called JVM (Java Virtual Machine) which recognizes and understands the difference between operating systems. These differences are handled by JVM and Java class libraries. Instead of an executable code, Java compiler produces highly optimized ByteCode which is executed by JVM. What makes Java more portable than some languages such as C, C++ is this ByteCode.

Various advantages of Java are as follows [5, 6, 7]:

- **Java is Simple**: Java has simpler syntax than C++. There is no need for pointer arithmetic (or even a pointer syntax), structures, unions, virtual base classes, and so on.

- **Java is Object Oriented**: By using Java, we can take advantage of important features of object oriented programming such as modularity, extensibility, and reusability. All these features increase efficiency of software-development, provide improved maintainability, as a result enable lower development cost. In Java, everything must be defined in classes, making Java more purely OOP than C++.
- **Java is Secure**: Java has a lot of features that allow us to develop secure software. Java was designed to make certain kinds of attack impossible such as overrunning the runtime stack (a common attack of worms and viruses), corrupting memory outside or inside its own space (no pointer arithmetic) and reading or writing files without permission.

- **Java is Platform Independent**: JVM itself is platform independent. It can work on a wide variety of platforms. Java code is compiled into ByteCode executed by JVM and this enables Java programs to run on different kinds of environments. Once JVM is installed on a certain system, we can run all java programs.

- **Java is Robust**: Java puts lot of emphasis on early error checking, as Java compilers are able to detect many problems before making it executable. That makes Java reliable as a software development language.

- **Java is Easy for Deployment**: Java applications are translated into ByteCode and can be packaged into a Jar (Java archive) file. If whatever the application needs is packaged into an executable Jar file, the application can run by simply double clicking on the Jar file [8].

- **Java is Dynamic**: While a Java application is running, the required code can be added to the application. Libraries can freely add new methods and instance variables without any effect on clients.

- **Java is Multithreaded**: Threads enhance performance and functionality in various programming languages, including Java. Java is inherently multi-threaded. A single Java program can have many different threads executing independently and continuously. It helps Java very responsive to user input, hence it is a necessity in GIS programming [6].

### 2.2 MapObjects Java Edition

Map Objects Java Edition is a toolkit for a Java developer which enables development of server or client side GIS or mapping applications with complete functionality without having any other ESRI software. Map Objects Java Edition works well with both J2SE (Java 2 Platform, Standard Edition) and J2EE (Java 2 Platform, Enterprise Edition) environments. It consists of 100% pure Java mapping APIs (Application Programming Interface) and is distributed in the form of Jar files. By using Map Objects Java Edition, it is easy and very fast to develop applications that have functionality such as toolbars, menus, dynamic symbol control, query dialogs, overview & insert map, and intelligent legends that make the applications user-friendly. The applications built by Map Objects Java Edition give the ability to the end user to combine local data with Internet and intranet data to create their
own customized maps and integrate with existing application architecture. Map Objects is often referred to as component architecture, and is a bit similar to Visual Basic.

Important features of the Map Objects Java Edition as cited from the MapObjects Java Edition brochure are as follows [8, 9]:

- **MapObjects—Java Edition** is ideal for integrating GIS and mapping functionality into an existing or planned architecture.
- **MapObjects—Java Edition** is free set of mapping software components and allows access to more base objects and gives us much more flexibility to create our own customized GIS tools.
- **MapObjects—Java Edition** has pre-built tool bars such as SelectionToolbar and ZoomPanToolBar which give the user a lot of functionality such as accessing database to get detailed information about selected features on the map, aiding the user in defining a database SQL style query which can be used to select certain feature from a map and panning, zooming through a map.
- **MapObjects—Java Edition** allow us to easily add additional toolbars and menus using standard Java classes, borrowing MOJO methods where needed.
- **MapObjects—Java Edition** has a method to interactively add layers using the GUI, a standard feature in a dynamic interactive map. And of course we are able to remove layers as well.
- **MapObjects—Java Edition** lets us create a layer from point data, in the world coordinate system, and display this on a local base map.
- **MapObjects—Java Edition** supplies many True Type Fonts for rendering points which makes it possible to select a symbol from these fonts and use them in a point theme in a place of the usual “base symbols”, which are usually circles or rectangles. This device is particularly useful in maps which have a large number of point themes. It is also possible to show the symbols in the appropriate legend in the table of contents. Icons can also be selected that are external to MOJO.
- **MapObjects—Java Edition** has an AttributeTable class, which makes it possible to display the entire attribute table for a layer. But using the Java JTable class much more versatile attribute tables can be created. In general, the embedding of MOJO in Java allows for almost unlimited customization.
- **MapObjects—Java Edition** has a number of projection classes. This feature allows users to choose a projected coordinate system.
- **MapObjects—Java Edition** provides the ability to save the map as an ArcXML file which is ESRI’s Arc extensible markup language.
- **MapObjects—Java Edition** has a legend editor which allows layers to be displayed in transparent and opaque format. It also has polygon options like Horizontal Fill, and Vertical Fill. These options make it possible to show several
polygon layers at the same time because they are transparent with distinguishable patterns other than color.
CHAPTER 3

THE REQUIREMENTS

The objective of this interactive GIS tool is to help students learn about the world’s largest and most predictable earthquakes, their cause, and safety measures. The thesis project has been developed under the guidance of Dr. Gary Girty and Dr. Carl Eckberg from San Diego State University. Dr. Girty is from Geological Sciences Department and suggested the data related requirement of this tool in order to use this as a learning tool for one of his courses. Since this tool is GIS based, Dr. Eckberg suggested the platform and functional requirements for this tool.

Following are the three main requirements:

- Data Requirements
- Platform Requirements
- Functional Requirements

3.1 DATA REQUIREMENTS

The main data required for this tool are locational shape files for the world’s five largest earthquakes, most predictable earthquakes, and the plate tectonic distribution, actual information about the devastation caused by such earthquakes, images, and related web links to know more about the event [10]. The shape files are used to create user selectable layers on the map. The tool provides information about the magnitude of an earthquake, casualties caused by it, plate tectonic setting of the place, timings of the biggest and latest earthquakes that happened there, and precautionary measures to be taken to survive through any such earthquake. There are mainly three important kinds of data:

- Five Largest Earthquakes till now
- Most predictable Earthquakes
- Plate Tectonic Settings
3.2 Platform Requirements

Since a MOJO application is at heart a Java program, the application can be
developed in almost any environment. Any Java IDE can be used as well. The entire setup is
developed based on Windows operating system.

Following are the software platforms used for this tool:
- JAVA as Programming Language
- MapObjects Java Edition as the GIS API

3.3 Functional Requirements

Functional requirements contain all services and features that are provided by the GIS
tool. All possible scenarios, behaviors and actions that will be performed on the UI were
examined carefully to improve efficiency, functionality of the software. The GUI was
designed to be as user friendly as possible.

The most significant functional requirements are as follows [11, 12]:
- The application should be packaged into an executable user friendly Jar file that
  allows the user to run this GIS tool by simply double clicking on it independent of
  the platform.
- Each type of earthquake location set should be represented by a respective layer.
- The location of earthquake sites should be represented on the map by, e.g. colored
  star symbols from True Type Fonts by using an actual world coordinate system.
- Each location should be clickable by the hotlink tool to give brief information to
  the user.
- If more information is available, it is provided by local HTML pages and web
  links that are available on local HTML pages.
- User should be allowed to add a new layer or remove an existing one.
- It should provide a button to understand Plate Tectonic Distributions.
- It should provide a toolkit for labeling showing the name for any layer.
- It should provide a print button.
- The tool should provide a help menu which informs the user about the GIS tool
  and provides a brief description about each toolkit.
- When the application is started, the TOC (Table of Contents) should be loaded
  with all required layers with proper symbol and color.
- Tool should be provided to measure the distance between any points on the map.
- Latitude and longitude should be displayed while moving the mouse over the map.
- It should provide a tool to select a portion of any layer and save it as a shape (.shp) file.
- A pop-up box should open before actually launching the application showing details about the objective and creator of this tool.
- Earthquake Safety measures should be provided upon closing the application.
CHAPTER 4

PROTOTYPING

Prototyping is very important in case of developing a new software application. It provides the entire design process from start to end. It is a flow diagram or model from getting the idea to final deployment and again improving its functionality as requirement changes. In prototype-based programming new objects are produced by cloning existing objects. Prototyping helps to detect errors and missing functionalities much earlier by quicker user feedback.

Following are the important phases of any project development cycle (Figure 4.1).

• **Requirements:** This is the very first step where we understand the requirements for the Thesis subject. It includes data requirements, platform requirements and functional requirements.

• **Design:** After we get the requirements we need to analyze them and create the basic design for this application. This includes specifications, features, operations, layouts, etc.

• **Development:** Here begins the actual coding where we implement the functionality and other requirements through programming to get the desired output.

• **Verification/Review:** In this phase we test the functionality by different approaches to verify its robustness. For ease proper documentation is also done during this review process. Basically here we search for any kind of flaw in the application and fix it.

• **Maintenance:** Once the application is successfully created and deployed it’s our responsibility to maintain it according to future needs or changes in the existing platform. Since this is an ongoing process this is not in the scope of this thesis.
Figure 4.1. Prototype model.
CHAPTER 5

MAPOBJECTS TOOLBAR

Here we will discuss about some standard tools used in this GIS based application. Some of these tools are pretty well known, like zoom-in, zoom-out, pan, etc. We can drag each of the tool bars by holding it at the small dotted portion at the left hand side of the each toolbar and put it at a place where we like.

Following are the two main pre-built toolbars used in this application:

- Zoom-Pan toolbar
- Selection toolbar

5.1 ZOOM-PAN TOOLBAR

The Zoom-Pan toolbar is shown in Figure 5.1 and helps users to perform nine important tasks like zoom in, zoom out, zoom to active layer, zoom to full extent, pan, identify etc.

![Figure 5.1. Zoom-Pan toolbar.](image)

Following are the details of the each tool on the Zoom-Pan Toolbar.

- **Zoom In:** Zooms towards the region selected by this tool.
- **Zoom To Full Extent:** Zooms to the whole display of the map.
- **Previous Extend:** Zooms to previous display of the map has been saved on a stack.
- **Next Extend:** Zooms to previous display of the map has been saved on a stack.
- **Zoom To Active Layer:** Zooms the map to all selected features layer.
- **Pan In One Direction:** Drags the map in one direction (North, South, East, West)
- **Identify:** Identifies the features of the selected layer and shows related information from a row in the attribute table.
5.2 SELECTION TOOLBAR

Selection toolbar is another ESRI pre-built toolbar that provides certain selection facilities to the user.

With the help of the tools that are included in this tool bar we can do certain operations on the selected layer, which improve the GIS tool utility.

Following are the tools included in the Selection toolbar (as shown in Figure 5.2 from left to right respectively):

- **Search**: This can be used to locate features based on a predefined "stored query".
- **Find**: Opens a dialog window to get input for finding something in the layer, which we will select in the left hand side of the dialog window. The dialog window can be provided by a single value. This will find the subject and highlight it in a yellow color on the map.
- **Query Builder**: Opens a dialog window to help the user in run query on the selected database like we can do through SQL, which can be used to display certain feature on the map highlighted in yellow color.
- **Select Feature**: By using this tool, the user can select the desired portion of the map layer and display it on the map in yellow color. It has selection shape options such as Rectangle, Circle, Line, and Polygon. You can draw a rectangle on the map, and all features from the selected layer that intersect the rectangle will turn yellow.
- **Clear All Selections**: Clears all the above selected attributes on the map and reverts back to the original color scheme.
- **Buffer**: This tool can be used to create a buffer area of a selected distance around the selected layer.
- **Attributes**: Shows the attributes of the selected layer in a table format.

![Figure 5.2. Selection toolbar.](image-url)
CHAPTER 6

CUSTOM TOOLBAR

Custom tool bar is not a pre-built tool bar. It is custom made by the designer in order to provide addition functionality for this tool. As shown in Figure 6.1 this tool has been created using the Java swing and awt API's with MOJO methods to add additional functionalities to provide a more versatile GIS tool.

Figure 6.1. Custom toolbar.

Following are the major functionalities provided by the custom toolbar (as shown in the Figure 6.1 from left to right respectively):

6.1 HOTLINK

Hotlink tool is used to get detailed information including pictures and web links for a selected location on the map. Since this project is about the plate tectonic settings of the World causing large earthquakes, the hotlink tool has been used to show a bigger plate setting picture for each point and a link to a web file where a user can get more details about that earthquake incident. For this GIS tool, Hotlink tool is established by using a lightning bolt icon for both the tool and cursor value. A layer needs to be selected on the TOC in order for the Hotlink tool to work properly. After these steps, the user can click on any point of the selected layer to get more information about that location.

6.2 PRINT

The print tool is made up using a MOJO class named MOJOcom.esri.mo2.ui.bean.Print. When the user clicks on this tool, they will be able to print the map as shown in Figure 6.2.
6.3 ADD LAYER

This tool will help the user to add a shapefile (layer) to the table of contents (TOC). This is a very important feature of a dynamic interactive GIS based tool. The Add layer tool is made up using com.esri.mo2.ui.tb.LayerToolBar which is a class described in MOJO. When user clicks on the tool, the dialog window in Figure 6.3 will be open which allows the user to select either shapefile, image files, ARC IMS and ARC SDE to add a new layer to the TOC. The Files Type will already be selected as shapefiles in order to avoid any confusion.
6.4 Pointer

When the user clicks on some tool such as zoom in, hotlink, etc. the ability related with the tool is tied to the mouse behavior and the corresponding icon will be attached to the mouse tip. By selecting this pointer tool user can remove the special behavior of the last tool selected and will be able to return the cursor to its normal arrow icon. This tool is made up using the MOJO class com.esri.mo2.ui.bean.Tool.

6.5 Distance Tool

Using this tool one will be able to measure distance between any two points on the map in miles and Kilometers. The distance will be displayed at the bottom of the map in the status bar. I used an airplane icon attached to the mouse tip when distance tool is selected to remind the user about the selected tool in action. This will draw a line on the map which can be later removed by selecting the pointer tool.

6.6 XY Tool

XY tool is used to create a layer dynamically from a selected CSV file with the longitude and latitude of the location to be displayed on the TOC. When the user clicks on this tool a pop up window will show up allowing the user to choose the file. As shown in Figure 6.4 the Files Type will be pre-selected as .csv in order to avoid any confusion. The points will be displayed on the map with "ESRI Enviro Hazard Sites" symbol. This can be used for class assignments intended to enhance the tool.

![Figure 6.4. XY tool window.](image)
6.6 Help Tool

This tool is for learning about other tools. To use this tool one has to first left click on this tool and the right click on another tool to know more about the functionality of that tool. Once left clicked a new help icon will be attached to the mouse tool tip which can be later removed by clicking on the pointer tool.
CHAPTER 7

MENU FEATURES

There are many additional features included in this GIS based learning tool in order to elevate a student’s interest to explore the different MOJO features. Students will not only learn about causes of earthquakes, but they will also be able to know the different functionalities a GIS based tool can offer. Some of the features are described below:

- **LayerControl Menu:** This menu based tool enables the user to move a layer up or down on the map window according to their display requirements. A layer has to be selected in the Table Of Content (TOC) in order to use this functionality. Once a layer comes to the top most position, the “promote selected layer” option will be disabled for that layer. Similarly once a layer reaches the bottom part of TOC the “demote selected layer” option will be disabled. This menu option is shown in Figure 7.1.

- **File Menu:** As shown in Figure 7.2 File menu has four submenus. The “add layer” and “print” functionality have been already discussed in the Chapter 6. Along with those we have “remove layer” and “Legend Editor” tools too here. To remove a layer from TOC we need to first select the layer and then click on this remove layer submenu. To change the display features/symbols, its color, or to get the label to be displayed on the map corresponding to each point, one can use this “Legend Editor” submenu (Figure 7.3). In GIS terms we can dynamically change the ‘rendering’ of the layer.

- **Theme Menu:** This menu has two features; one to display attribute table for the selected layer on the TOC, and to create layer from the selected layer subset. Figure 7.4 shows this option.

- **Help Menu:** This menu will provide brief info about the contents of this application as shown in Figure 7.5.

- **SafePlace Menu:** This menu (Figure 7.6) will pop up a Global Seismic Hazard Map showing the safest places to live on the Earth to avoid earthquakes.

- **Earthquake Menu:** This menu (Figure 7.7) will show details about Earthquakes, what it means, how it happens, etc. as a .pdf format. Basically this will pop up an ebook written by Dr. Gary Girty, San Diego State University.
Figure 7.1. Layer control menu.

Figure 7.2. File menu.

Figure 7.3. Legend editor.

Figure 7.4. Theme menu.
Figure 7.5. Help menu.

Figure 7.6. SafePlace menu.

Figure 7.7. Earthquake menu.
CHAPTER 8

SCREEN SHOTS

This chapter introduces different features of this GIS based tool. Here almost all functionalities are captured as screenshots of this tool in order to demonstrate them comprehensively.

1. Running the World’s Largest Earthquakes and Their Causes GIS Tool
   b. A dialog window will pop up showing the Title of the Tool and the Creator Name. It will be automatically closed after 5 seconds (Figure 8.1).
   c. Then World’s Largest Earthquakes and Their Causes GIS Tool GUI will be shown on the screen having all the required layers selected (Figure 8.2) and all the plate names labeled.

2. Adding a Layer
   a. Click on the plus sign from the custom toolbar, or “Add Layer” from the file menu. It will open a pop up window. File type will be pre-selected as .shp file.
   b. Navigate to the location of file to be added.
   c. Select the shape file (.shp file).
   d. Click Open (Figure 8.3).

3. Removing a Layer
   a. Select the layer from TOC.
   b. Click on “Remove Layer” from the file menu.
   c. Selected Layer would be deleted from the existing map (Figure 8.4, Figure 8.5).

4. Adding data file to display new locations on the map by using CSV file.
   a. Click on the XY tool. The pop up window will show up. File type will be pre-selected as .csv file.
   b. Choose the CSV file which has the latitudes and longitudes of the locations to be displayed (Figure 8.6).
   c. Data points would be shown immediately on the map (Figure 8.7) with symbol as ESRI Hazard Site, TrueTypeMarkersymbol.
Figure 8.1. Introductions to the tool.

Figure 8.2. Application.
Figure 8.3. Add layer.

Figure 8.4. Remove layer menu.

Figure 8.5. Remove layer result.
5. Finding out the distance between any two points on the map.
   a. Click on Distance Tool. An airplane icon will appear on the screen indicating the mouse location. This is 'crow flies distance', hence the airplane icon.
   b. Press the mouse button down at one map point and then drag the mouse to second map point, release the mouse button. A line will become visible on the map.
   c. The distance between two points would be displayed at the bottom of the map in the status bar (Figure 8.8).

6. Getting information on each tool button using the help button.
   a. Left click on the Help tool as this will activate it.
   b. Right click on any of the other toolbar menu icons.
Figure 8.8. Distance tool result window.

c. The information about the functionality of that tool will be displayed (Figure 8.9).

7. Hotlink
a. Select some layer from the TOC.

b. Click on the hotlink icon and then click on the any point for that layer on the map.

c. This will open a dialog window which displays the zoomed view of the plate tectonic setting for that location, and gives the user the option to get more information in the form of a web page (Figure 8.10). The source location of this picture will be shown as title of the window.

d. On clicking on the “Earthquake History” button highlighted in yellow (hand pick symbol will appear near that button), the user will get more information about the largest earthquake that happened there (Figure 8.11).

e. A USGS webpage will be open showing the details.

8. Legend Editor
a. Select the layer, Click on the File menu and then Legend Editor.

b. This will show pop up window allowing user to change style and color of selected layer (Figure 7.3). Figure 8.12 shows the map after changing the symbol type and color.

c. On the same window a Label tab will be there, which can be used to show any selected attribute as label for each location on the map (Figure 8.13).

9. Zoom To Active Layer Tool
a. Select a layer from TOC and click on the zoom to active layer tool, it will zoom the map to all selected features in the selected layer (Figure 8.14).
Figure 8.9. Help tool example: Hotlink.

Figure 8.10. Hotlink tool output for Alaska.
Figure 8.11. Webpage for Alaska when clicked on the Earthquake History button in Figure. 8.10.

Figure 8.12. Legend editor.
Figure 8.13. Legend editor result window.

Figure 8.14. Zoom to active layer (predictable).
10. Zoom to Full Extent
   a. It will bring the map to the full extent (Figure 8.15).

11. Zoom In will magnify the view to the selected portion of the map (Figure 8.16).

12. Layer Control
   a. Use Promote Selected Layer/Demote Selected Layer to move layers up or down in the TOC for better view (Figure 8.17).

13. Status Bar displays the current location of the cursor in terms of longitude and latitude (Figure 8.18). A compass icon is there showing the direction.

14. Identify tool will show us the information about that location as it is there in its attribute table (Figure 8.19).

15. Open Attribute Table will show all the saved features of the selected layer in a tabular format (Figure 8.20).

16. SafePlace
   a. Click on SafePlace button to see the safest places on the Earth to avoid direct effects of earthquakes (Figure 8.21). It will pop up a dialog window showing the Hazard Map of the World.

17. Select Feature Tool
   a. Select a point layer in the TOC.
   b. Click on the select feature tool from the selection toolbar.
   c. Select the shape which can be used for selecting a part of the layer.
   d. Now select a region on the map for that layer by pressing the left click mouse button and dragging it across (Figure 8.22).
   e. It will fill the selected points with yellow color and make them active.

18. Create Layer from Selection
   a. Go to Theme menu and click on the Create Layer from Selection submenu.
   b. The selected layer on the map will start flashing with blue colored Hazard symbol (Figure 8.23).
   c. At the same time a new window will pop up asking to enter a new layer name (Figure 8.24).
   d. Write the layer name in the text area, press Enter button on the keyboard, and then press OK.
   e. It will create a new layer of the name given by you in the shape file location of your application folder. Now it will be possible to add that layer (Figure 8.25).
Figure 8.15. Zoom to full extent.

Figure 8.16. Zoom in.
Figure 8.17. Layer control: Demote selected layer (PLAT_LIN).

Figure 8.18. Status bar.
Figure 8.19. Identify tool.

Figure 8.20. Open attribute table.
Figure 8.21. SafePlace menu showing safest places on the Earth to avoid earthquake.
Figure 8.22. Select feature tool.

Figure 8.23. Create layer from selection: Flashing hazard symbol.

Figure 8.24. Create layer from selection: Name dialog.
19. Run Query on the layers
   a. Click on the Query Builder tool on Selection Toolbar. It will open a new
      query builder window asking about the layer and the condition (Figure 8.26).
   b. Click on the execute button and it will show a table of features selected as a
      result of that query inside that window (Figure 8.27).
   c. Also it will highlight the point on the map in yellow color (Figure 8.28).

20. To remove the query result from the map click on Clear All Selections tool
    (Figure 8.29).

21. On the menu bar click on the Earthquake menu and then on the What is Earthquake
    sub-menu; it will open a PDF file showing details about earthquakes as written by Dr.
    Gary H. Girty (Figure 8.30).

22. To know about Plate Settings go to Help menu and click on Plate Tectonic submenu
    (Figure 8.31).

23. To know about MOJO go to Help menu and click on About MOJO (Figure 8.32). It
    can also give system information that is being used to run this application
    (Figure 8.33).

24. To contact the owner of the application go to Help menu and click on Contact Us sub-
    menu (Figure 8.34).

25. To know about this project click on About Project... sub-menu inside Help menu
    (Figure 8.35).

26. Upon closing the application a PDF file will open showing Earthquake Safety
    Measures (Figure 8.36).
Figure 8.26. Query builder.

Figure 8.27. Query executed.
Figure 8.28. Output of query highlighted on the map.

Figure 8.29. Query cleared.
Figure 8.30. Earthquake menu: Book displayed.

Figure 8.31. Help: Plate tectonic info.

Figure 8.32. Help: About MOJO.
Figure 8.33. Help: About MOJO: System info.

Figure 8.34. Help: Contact us.

Figure 8.35. Help: About project.
EARTHQUAKE SAFETY PROCEDURES

Introduction
It is not possible to prevent earthquakes or change the likelihood of an earthquake occurring. However, we can greatly increase our chances of safety and survival, by being aware and prepared. Since knowledge and preparation are keys to your survival during and after an earthquake, you should take steps to become informed.

Dangers Associated with Earthquakes

- The actual movement of the ground in an earthquake is seldom the direct cause of injury or death. Most casualties result from falling objects and debris or collapsing structures.
- Injuries are commonly caused by:
  - Partial building collapse, such as falling masonry, collapsing walls, falling ceiling plaster, etc.
  - Flying glass from broken windows.
  - Overturned bookcases, filing cabinets, fixtures, furniture, office machines, and appliances.
  - Pipes, broken gas lines, etc. These dangers may be aggravated by lack of water due to broken mains.
  - Fallen power lines.
  - Inappropriate actions resulting from panic.

Earthquake Safety Guidelines

- Remain Calm. Sound usually precedes earthquake motion by a split second. If you have developed the correct earthquake responses in your mind before a quake, this split second is enough time to activate your automatic reactions. If you stay calm, you will be better able to assess your situation. The rolling and roaring may terrify you, but unless something falls on you, the sensations probably won’t hurt you. Try talking yourself through the violent motion phase. This will release stress and others may take courage and follow your reasoned restraint. Think through the consequences of any action you plan to take.

- If you are indoors, stay there. If you are in danger:
  - Get under a sturdy table, desk or bed.
  - Brace yourself in an inside corner away from windows.
  - Move to an inner wall or corridor. (A door frame or the structural frame or inner core of the building are its strongest points and least likely to collapse. They will also break the impact of any falling objects).
  - In an apartment building the safest place is by the central reinforced core of the building, which is usually located by the elevator well.
  - Choose shelter which will provide an airspace if it collapses. If your furniture shelter moves, stay under it and follow it around the apartment.
  - Watch for falling objects - plaster, bricks, light fixtures, pots and pans, etc.
  - Stay away from tall shelves, china cabinets and other furniture, which might slide or collapse over.
  - Stay away from windows, sliding glass doors, mirrors.
  - Grab anything handy (blanket, pillow, tablecloth, newspapers, box, etc.) to shield your head and face from falling debris and splintering glass.
  - Don’t be alarmed if the fire alarm or sprinklers go off.

Figure 8.36. Earthquake safety procedure opened up upon closing the application.
CHAPTER 9

CONCLUSION AND OBSTACLES

This tool provides an easy interactive learning environment for young students willing to know more about “Earthquake: The Most Unavoidable Natural Disaster”. All the requirements as discussed above are met. Because of its simplicity this application can be used by any person to learn more about the functionalities supported by a GIS based tool. This colorful tool can help raise general awareness about Earthquakes among small kids in an interactive way.

In this modern age when kids are more interested to play with computers, this tool can make it a good cause by providing knowledge about the cause behind any earthquake and what they can do to be safe if they face any such earthquakes.

Following are the few obstacles faced while building this tool:

- It was hard to get the plate names to show up on the map right from the beginning. After a lot of trial it was done by BaseSimpleLabelRenderer class.
- To display the natural disaster symbol while opening the layers for the first time. I used star symbols for the initial part and the Natural Hazard symbol while creating a shape file from selection on the map.
- Getting the hotlink tool to work nicely while clicking on the proper location was resolved by changing some width setting.
- Collecting the proper seismic map for each point took a lot of time since it is important to show the exact plate boundary clearly when clicking on each point using hotlink.
CHAPTER 10

FUTURE ENHANCEMENTS

This GIS based tool provides lot of information in order to better understand the reason behind any earthquake. This application can be modified further to add more interactive way for learning through using different interfaces. Following are some of the enhancements that could be done to increase the scope of this thesis:

- Making it as a mobile phone application. Can be modified as an Android, or an iPhone App.
- Making it as a fully web-based application to make it available to a larger extent.
- A set of quizzes can be introduced inside the tool for making the learning process more fun.
- Recent earthquake data can also be introduced in it and thus this tool can be modified to predict future earthquakes by analyzing the pattern of the past earthquake locations.
- This tool can also be modified as a gaming tool between two persons where each one should be able to destroy a plate which will create new plate boundaries, which will cause some locations (points) to be erased from the map. Whoever can remove more points from the map will win the game.
REFERENCES


