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联合国教育、  
科学及文化组织



## UNESCO-RELEMR

### Workshop on Seismicity and Earthquake Engineering in the Extended Mediterranean Region

ANKARA, TURKEY

21-24 JUNE 2010

## **Workshop on Seismicity and Earthquake Engineering in the Extended Mediterranean Region**

The workshop on Seismicity and Earthquake Engineering in the Extended Mediterranean Region was hosted by the Middle East University at the Ankara Hotel Plaza, and sponsored by the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the U.S. Geological Survey (USGS).

70 senior scientists from 26 countries and the Palestinian Authority, in the extended Mediterranean region participated in the workshop that was held from 21 to 24 June 2010 at the Hotel Plaza, Ankara, Turkey.

UNESCO and the USGS have been working with the Council of Europe, government agencies, and other organizations on a program for Reducing Earthquake Losses in the Extended Mediterranean Region (RELEMR). Twenty-nine RELEMR meetings have been held since the first meeting in Cairo in 1993 and during the last seven years workshops have been hosted by the Jordan Natural Resources Authority and Royal Scientific Society, the Kandilli Observatory and Earthquake Research Institute and the Middle East Technical University in Turkey, the Cyprus Geological Survey Department, the Institute of Earth Sciences 'Jaume Almera' in Spain, and the Technical University of Crete, Greece.

At these meetings, participants discussed regional approaches to improve seismic data (e.g., more accurate locations and improved magnitude estimates), probabilistic seismic hazard assessment (PSHA), engineering issues (e.g., reasons for building failures), and the production of a RELEMR seismicity map has also been discussed. Participants produced a ground shaking map of the Dead Sea region and training courses in PSHA, HAZUS, David Boore's Ground Shaking and other software have been given.

The last workshop featured special sessions on the Technical Methodology and Applications of the HAZUS-MH Earthquake Loss Estimation Model, the Protection of Historical Sites in the Extended Mediterranean Region and Open Source Software. Sessions for General Presentations in seismology, geology and earthquake engineering were also part on the agenda of this workshop.

This new workshop will feature a special "hands on" session on the Technical Methodology and Applications of the HAZUS-MH Earthquake Loss Estimation Model. This session will be held in the Laboratory of the Department of Civil Engineering of the Middle East Technical University (METU). Sessions for General Presentations in seismology, geology and earthquake engineering are also part on the agenda.

As it was foreseen, this workshop contributed to the improvement of knowledge focalized in the reduction of earthquake losses; and was an opportunity to contribute to the health and safety of the millions of people on the extended Mediterranean region.

## **Seismicity and Earthquake Engineering in the Extended Mediterranean Region**

**Ankara, Turkey  
21 - 24 June 2010**

### **Preliminary Programme**

#### **Sunday, 20 June 2010**

Participants arrive in Ankara

#### **Monday, 21 June 2010**

09:00 – 09:30 Registration

09:30 – 10:30 Opening Ceremony, Chair: **Dr. Mehmet Ersoy**

**Prof. Dr. Polat Gülkan**, METU

**Dr. Mehmet Ersoy**, Head of the Turkish Disaster and Emergency Management Authority

**Dr. Michael Foose**, USGS

**Dr. Frederick Simon**, UNESCO  
Official Representatives

10:30 – 11:00 Coffee/tea break

11:00 – 11:15 Logistical announcements

11:15 – 13:00 Keynote Presentations: Chair: **Dr. Michael Foose**

**Dr. Ahmet C. Yalçiner**

Professor of Civil Engineering, Middle East Technical University  
"An Overview of Marine Hazards in the Extended Mediterranean Region"

**Dr. Önder Çetin**

Professor of Civil Engineering, Middle East Technical University  
"Liquefaction-Induced Hazard and Its Effects on Structural Damage"

13:00 – 14:30 Lunch

14:30 – 16:00 Contributed Papers

**M. Yilmazer and N. Türkelli**: *A Model for a RELEMR Data Sharing Website*—  
Introduction

**Rami Hofstetter**: *Sayarim Infrasound Calibration Explosion*

16:00 – 16:30 Coffee/tea break

16:30 – 18:00 **Douglas Bausch**, FEMA: Technical Methodology and Applications of the HAZUS-MH Earthquake Loss Estimation Model

The technical methodology that will be used in the “hands on” session will be reviewed for each major component of the earthquake model including ground motion, ground deformation, development of the buildings and infrastructure inventory, engineering fragility functions, analysis parameters, economic and social loss approach, as well as results and uncertainties. Instruction on modifying this information with local data, and how engineering parameters can be adjusted to represent the building stock characteristic of the extended Mediterranean region will be provided. The presentation will focus on a broad variety of applications including an emphasis on how participants can remove the USA-focused databases and insert databases more appropriate to their country.

## **Tuesday, 22 June 2010**

09:00 – 18:00 **Douglas Bausch**, FEMA: Technical Methodology and Applications of the HAZUS-MH Earthquake Loss Estimation Model  
An all-day hands on session will be held in the METU Computer Laboratory

10:30 – 11:00 Coffee/tea break  
13:00 – 14:00 Lunch  
16:00 – 16:30 Coffee/tea break

## **Wednesday, 23 June 2010**

09:00 – 10:30 Contributed Papers

**Abdunnur Ben Suleman**: *The April 19, 1935, M=7.1 “Al-Qaddahiya” earthquake sequence, what did we learn after 75 years*

**Yelles A. K. , Beldjoudi H. , Haned A. , Djellit H. , Kherroubi A., Semmane F.**: *Recent seismic events in northern Algeria (2000-2010)*

**Nacer Jabour, Abdelilah Tahayt, Touria El Mrabet**: *The Seismicity of Al Hoceima and Nador regions, Northern Morocco*

**Chedly Ben M’hamed and Moncef Rajhi**: *Upgraded seismic system in Tunisia*

10:30 – 11:00 Coffee/tea break

11:00 – 13:00 Contributed Papers

**Mohamed Hamdache**: *Relations between different ground motion parameters for Northern Algeria*

**Alexander Vella**: *A Seismic Site Response Survey of the Maltese Islands*

**Mohammad Al-Haddad**: *National Plan for Seismic Evaluation and Rehabilitation of Existing Buildings in Saudi Arabia*

**A. El Mouraouah, A. Iben Brahim, A. Birouk, M. Kasmi et H. S. El Mouraouah**: *Seismic Risk Assessment and Attenuation in Morocco; Recent Developments*

13:00 – 14:30 Lunch

14:30 – 16:00 Contributed Papers

**Ramy El-Khoury**: *Earthquake Resistant Measures for Building Construction in the Middle East*

**Tadili Benaissa**: *New sismotectonic zoning of Northern Morocco*

**Noorbakhsh Mirzaei**: *Earthquake Storms in Central-East Iran*

**Marleine Brax**: *The Lebanese Seismic Network and the Activities of the Geophysical Research Centre*

16:00 – 16:30 Coffee/tea break

16:30 – 18:00 Contributed Papers

**Adel M.E. Mohamed and Abuo El-Ela A. Mohamed:** *Quarry Blasts Assessment and Their Impacts on the Nearby Oil Pipelines, South East Helwan, Egypt*  
**Cuneyt Tuzun:** *Earthquake Model for Middle East: A GEM Regional Project*  
**Karin Sesetyan:** *Rapid shake-map and loss estimation capability by eler - earthquake loss estimation routine*  
**John Coyne:** *"CTBTO in the Context of the Mediterranean Region."*

#### **Thursday, 24 June 2010**

09:00 – 10:30 Contributed Papers

**Mohsen Ashtiani:** *Earthquake Insurance Risk Management*  
**Salah M. Mahmoud and Adel M. El-Shahat:** *NRIAG's Role to Mitigate Earthquake Disasters in Egypt Using GPS and Seismic Data*  
**Ahmed Mebarki, Abderrahmane Laribi, Fattoum Kharchi, Djillali Benouar:** *Post-quake evaluation of structural damages: A probabilistic methodology*

10:30 – 11:00 Coffee/tea break

11:00 – 13:00 Contributed Papers

**Meirova T., Pinsky V., Hofstetter R.:** *Ambient Broad Band Seismic Noise Tomography across the Dead Sea Transform*  
**Shamil Habet:** *Torsional behavior of base isolated asymmetric multi-story buildings*  
**Belazougui M., Boukri M.:** *Damage Analysis and Behaviour of Beam-Column Reinforced Concrete Structures after the Boumerdes Earthquake of May 21st, 2003*  
**R. Abdel-Fattah, A. Al-Enezi, and F. Al-Jeri:** *Kuwait National Seismic Network: capabilities and applications*

13:00 – 14:30 Lunch

14:30 – 16:00 Contributed Papers

**MohammadReza Rezaee and Mohsen Ghafory-Ashtiany "EqHazard":** *Seismic Hazard Analyzer*  
**Omar Amellal:** *Determination of Seismic vulnerability index for steel structures*  
**M. Yilmazer and N. Türkelli:** *A Model for a RELEMR Data Sharing Website—Part II*

16:00 – 16:30 Coffee/tea break

16:30 – 18:00 Closing session

#### **Friday, 25 June 2010**

Depart Ankara

# **Technical Methodology and Applications of the HAZUS-MH Earthquake Loss Estimation Model.**

## **Methodology**

## An Updated GIS-Based Methodology for Exporting the HAZUS Earthquake Model for Global Applications: HAZ EM (Extended Mediterranean) Loss Estimation

Doug Bausch, FEMA Region VIII

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Rich Hansen, FEMA Region VIII

[Richard.Hansen@dhs.gov](mailto:Richard.Hansen@dhs.gov)

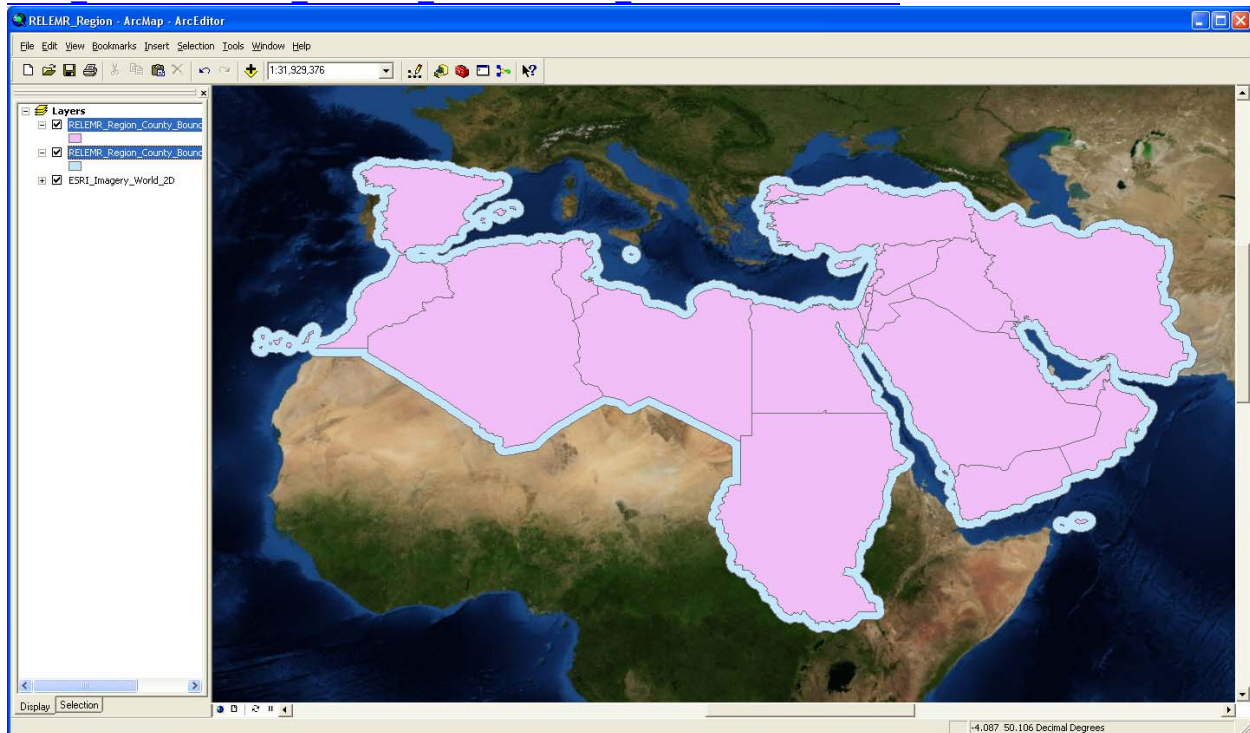
Sean CJ McNabb, FEMA Region VIII

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We have updated and enhanced the methodology first described by Hansen and Bausch (2006) [http://www.hazus.org/HAZUSorg\\_DOCUMENTS/BAUSCH\\_EXPORTING\\_HAZUS\\_nonUS.pdf](http://www.hazus.org/HAZUSorg_DOCUMENTS/BAUSCH_EXPORTING_HAZUS_nonUS.pdf) for a Sicily study region. This new application reaches across 21 Countries that participate in the joint UNESCO/USGS Reduction of Earthquake Loss in the Extended Mediterranean Region (RELEMR) [http://portal.unesco.org/science/en/ev.php-URL\\_ID=6072&URL\\_DO=DO\\_TOPIC&URL\\_SECTION=201.html](http://portal.unesco.org/science/en/ev.php-URL_ID=6072&URL_DO=DO_TOPIC&URL_SECTION=201.html):



Enhancement include the development of 3 layers of resolution, including grid sizes of 100 km, 10 km, and 1 km, based on a population threshold of 100K. A new treatment for “urban” or high population density grids (1 km) where we assign the majority of non-residential building

occupancy types was developed. Additional ShakeMap scenarios covering the area of interest have been developed by the USGS and we have formatted and developed a “500 year” Probabilistic Hazard map from the Global Seismic Hazard Map <http://www.seismo.ethz.ch/gshap/> to use for loss estimates

### **Background: The HAZUS-MH earthquake model**

The HAZUS-MH earthquake model uses Geographic Information System (GIS) software and scientifically developed algorithms to calculate, map, and display earthquake loss data for communities throughout the U.S. (United States). Once the ground motions are provided or modeled by the HAZUS software, the program uses a series of mathematical formulas, calculates the violence of ground shaking, the amount of damage, the number of casualties, the number of people displaced by damaged structures, and the disruption and economic losses caused by the earthquake. These formulas describe the relationship between earthquake magnitude, violence of ground shaking, building and utility system damage, cost of repair, and indirect economic impact.

### **Concept: An International Application**

In general we export a U.S. building stock to other areas of the world based on a user defined grid. We select a U.S. building stock that best fits the population and the built environment for the application, but the intent is that the user would replace the building stock information with their own local data. In this example we export the U.S. proxy data from the Puerto Rico building stock to the RELEMR region, which includes the Middle Eastern and Mediterranean countries of Algeria, Cyprus, Egypt, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Libya, Malta, Morocco, Oman, Saudi Arabia, Spain, Sudan, Syria, Tunisia, Turkey, United Arab Emirates, West Bank (Palestinian Authority) and Yemen. This method allows the user to benefit from an existing methodology and to concentrate resources on developing good building inventory information to replace the U.S. proxy data. In addition, the required building inventory format is readily apparent since the U.S. proxy data are in a format that can be followed by the user.

This concept requires the use of the USGS (United States Geological Survey) ShakeMaps Earthquake Hazards Program <http://earthquake.usgs.gov/earthquakes/shakemap/> as a source of ground motion and shaking intensity algorithms, the USGS PAGER (Prompt Assessment of Global Earthquakes for Response) <http://earthquake.usgs.gov/eqcenter/pager/> as a source for ground motion data based on scenario earthquakes and LandScan 2008<sup>TM</sup> as a source for a high resolution (1km) population grid. It is possible to develop ground motion and population data from other sources, but these three provide global capabilities that are already available in a useable GIS format. In the case of ShakeMaps and PAGER, hazus.zip files are provided that includes the necessary HAZUS ground motion inputs (PGA, PGV, SA 0.3 and SA 1.0).

The LandScan 2008<sup>TM</sup> Global Population Database, 2008 is produced by the Oak Ridge National



Laboratory, <http://www.ornl.gov/gist/> and requires a license agreement to utilize and has some access constraints.

*For more information on PAGER and/or ShakeMaps, please contact:*

*Dr. David Wald, [wald@usgs.gov](mailto:wald@usgs.gov)*

*For more information on LandScan<sup>TM</sup>, please contact:*

*Dr. Budhendra Bhaduri, [bhaduribl@ornl.gov](mailto:bhaduribl@ornl.gov)*

### **Steps: 3 Basic Steps**

Three basic steps are required to implement and run an analysis of losses for an international study region using HAZUS.

- 1) Create and Populate a User Defined Grid
- 2) Develop and Incorporate Ground Motion and Hazard Information
- 3) Run Analysis

These basic steps are described in more detail below, however, the user of these proposed methods should understand the technical methodology of the HAZUS loss estimation program (see HAZUS-MH Earthquake Technical and User Manuals;

[http://www.fema.gov/hazus/hz\\_manuals.shtm](http://www.fema.gov/hazus/hz_manuals.shtm) ) Step 1 requires the skills of an advanced GIS person knowledgeable in working with ArcGIS Geodatabases, as well as the ArcInfo-level software license available from ESRI [www.esri.com](http://www.esri.com). The user of this method is required to replace U.S. proxy building stock data with that developed locally and to apply or modify the loss functions that best represent their local building stock. A number of resources can help facilitate this, including EERI's World Housing Encyclopedia <http://www.world-housing.net/index.asp>, but developing building stock inventories can be a significant effort. We will describe options that allow the user to import more limit portfolios of buildings that may be available through a survey of essential facilities, such as schools or hospitals, using the HAZUS Advanced Engineering Building Module (AEBM) [http://www.fema.gov/hazus/dl\\_aebm.shtm](http://www.fema.gov/hazus/dl_aebm.shtm) or the HAZUS Comprehensive Data Management System (CDMS) <http://www.fema.gov/plan/prevent/hazus/index.shtm#2>. As noted above, a diverse set of GIS and engineering skills are required to successfully implement this method. In addition, the user community typically includes emergency managers and public policy makers. Therefore, success in utilizing HAZUS internationally, as well as in the U.S., requires a group of users. In the U.S. we have developed HAZUS User Groups across the Country to help implement the program. [www.hazus.org](http://www.hazus.org) and [www.usehazus.com](http://www.usehazus.com).

## **Step 1 – Create and Populate a User-Defined Grid**

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### **Step-by-Step Instructions**

The following instructions are divided into numbered tasks that are then followed by the detailed steps required to complete each task. Many steps are also followed by italicized comments that provide additional helpful information.

**NOTE: The following steps are associated with the creation and population of a user-defined grid for the RELEMR region to be used with FEMA’s HAZUS loss estimation software. The concepts presented here are adaptable to any global study area.**

### **Set the Working Environment**

Creating and populating a user-defined grid will take many steps. During this process we will need to create numerous temporary datasets and it is important to keep these organized. To keep our datasets in order we will first set up our working environment.

**NOTE: Because HAZUS-MH was developed for use within the United States and Puerto Rico, you must replace the Geodatabases in an existing State folder with your new regional data. For this exercise we will be replacing the Puerto Rico folder.**

1. In the working directory of your choice, create the following folders:

**FinalData** – Contains the final Geodatabases that will replace the Puerto Rico folder.

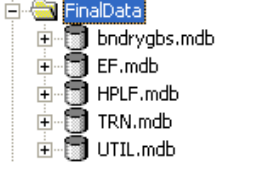
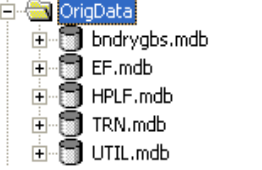
**OrigData** – Contains the original Geodatabases that will be used to import attribute table structures.

**IntData** – Contains the intermediate Geodatabases that will be loaded into the FinalData folder.

**syBoundary** – Contains the syBoundary.mdb Geodatabase to be edited.

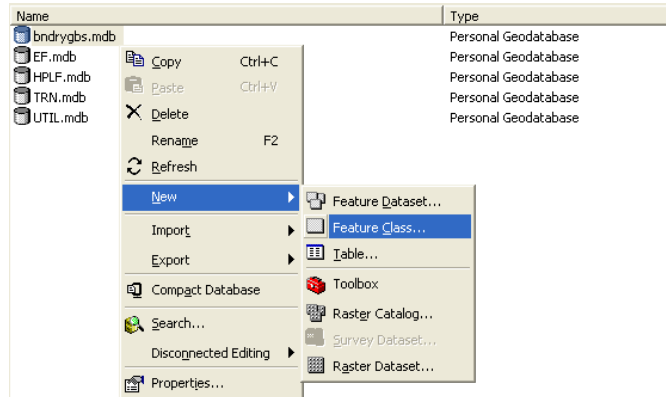
**Working** – Will be used as a working directory and store any intermediate datasets.

2. Copy the **syBoundary.mdb** Geodatabase from any of the **HAZUS data DVDs** into the **syBoundary** folder.
3. Copy the following Geodatabases from the original **PR1** (Puerto Rico) folder into the **FinalData** and **OrigData** folders:

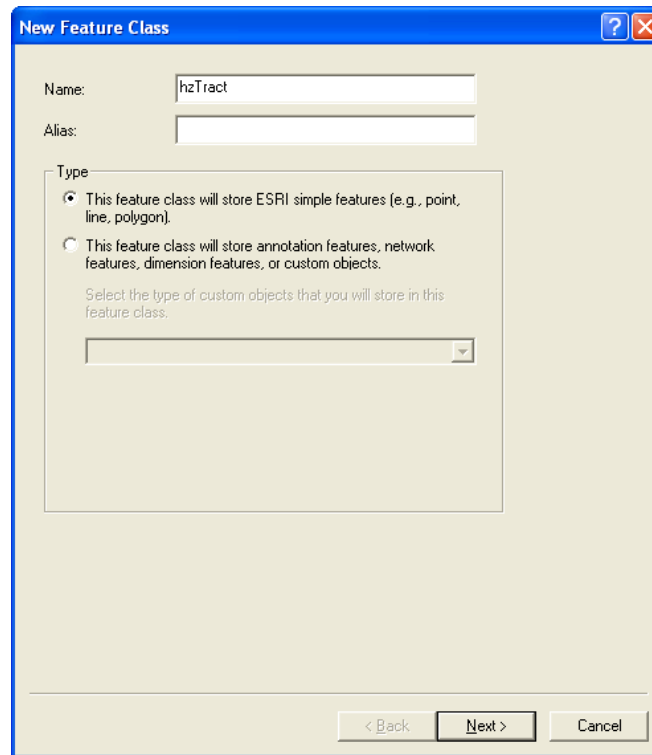
FinalData Folder	OrigData Folder
	


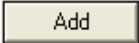
The original PR1 folder is located on Data DVD #4.

4. In ArcCatalog, delete the existing feature classes and tables in each Geodatabase in the FinalData folder.
5. Replace the deleted feature classes and tables in the FinalData folder with new empty datasets:
  - In ArcCatalog, Right-Click on the **bndrygbs.mdb** Geodatabase and select **New→Feature Class...**



- In the New Feature Class Window, enter **hzTract** as the **Name** of the new feature class.

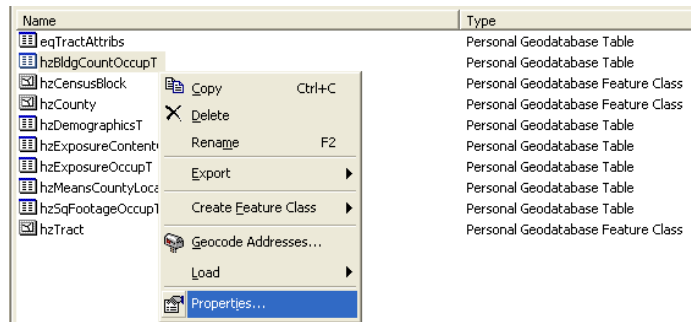


- Click **Next**.
- Leave the default settings in the Database Storage Configuration window. Click **Next**.
- In the Field Definition window click the **Import...** button. 
- Browse to the **hzTract** feature class in the **OrigData** folder and click the **Add** button. 
- Click on the **Shape** field and set the following **Field Properties**:
  - Geometry Type – **Polygon**
  - Spatial Reference – **GCS\_North\_American\_1983**
- Click **Finish**.
- **Repeat** the previous steps for the following feature classes and tables in the FinalData folder. Be sure to specify Geometry Type for each new feature class as there are polygon, polyline, and point feature classes.

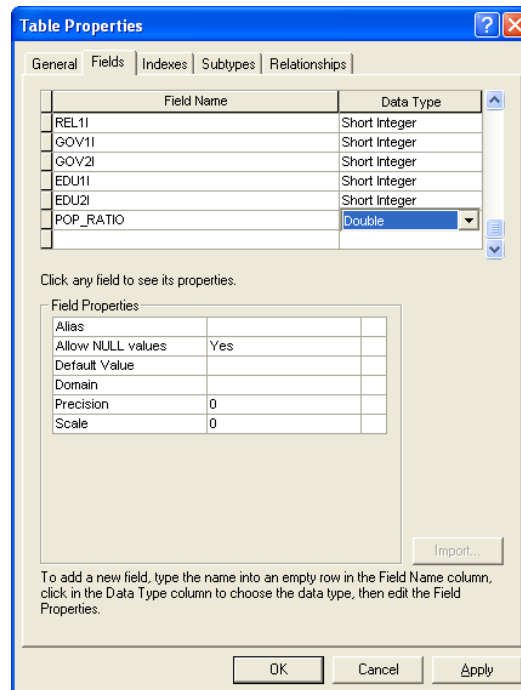
bndryGBS.mdb	EF.mdb	HPLF.mdb	TRN.mdb	UTIL.mdb
<ul style="list-style-type: none"> <li>eqTractAttribs</li> <li>hzBldgCountOccupT</li> <li>hzCounty</li> <li>hzDemographicsT</li> <li>hzExposureContentOccupT</li> <li>hzExposureOccupT</li> <li>hzMeansCountyLocationFactor</li> <li>hzSqFootageOccupT</li> <li>hzTract</li> </ul>	<ul style="list-style-type: none"> <li>eqCareFilty</li> <li>eqEmergencyCtr</li> <li>eqFireStation</li> <li>eqPoliceStation</li> <li>eqSchool</li> <li>hzCareFilty</li> <li>hzEmergencyCtr</li> <li>hzFireStation</li> <li>hzPoliceStation</li> <li>hzSchool</li> </ul>	<ul style="list-style-type: none"> <li>eqDams</li> <li>eqHazmat</li> <li>eqLevees</li> <li>eqMilitary</li> <li>eqNuclearFilty</li> <li>hzDams</li> <li>hzHazmat</li> <li>hzLevees</li> <li>hzMilitary</li> <li>hzNuclearFilty</li> </ul>	<ul style="list-style-type: none"> <li>eqAirportFilty</li> <li>eqBusFilty</li> <li>eqFerryFilty</li> <li>eqHighwayBridge</li> <li>eqHighwaySegment</li> <li>eqHighwayTunnel</li> <li>eqLightRailBridge</li> <li>eqLightRailFilty</li> <li>eqLightRailSegment</li> <li>eqLightRailTunnel</li> <li>eqPortFilty</li> <li>eqRailFilty</li> <li>eqRailwayBridge</li> <li>eqRailwaySegment</li> <li>eqRailwayTunnel</li> <li>eqRunway</li> <li>hzAirportFilty</li> <li>hzBusFilty</li> <li>hzFerryFilty</li> <li>hzHighwayBridge</li> <li>hzHighwaySegment</li> <li>hzHighwayTunnel</li> <li>hzLightRailBridge</li> <li>hzLightRailFilty</li> <li>hzLightRailSegment</li> <li>hzLightRailTunnel</li> <li>hzPortFilty</li> <li>hzRailFilty</li> <li>hzRailwayBridge</li> <li>hzRailwaySegment</li> <li>hzRailwayTunnel</li> <li>hzRunway</li> </ul>	<ul style="list-style-type: none"> <li>eqCommunicationFilty</li> <li>eqElectricPowerFilty</li> <li>eqNaturalGasDL</li> <li>eqNaturalGasFilty</li> <li>eqNaturalGasPl</li> <li>eqOilFilty</li> <li>eqOilPl</li> <li>eqPotableWaterDL</li> <li>eqPotableWaterFilty</li> <li>eqPotableWaterPl</li> <li>eqWasteWaterDL</li> <li>eqWasteWaterFilty</li> <li>eqWasteWaterPl</li> <li>hzCommunicationFilty</li> <li>hzElectricPowerFilty</li> <li>hzNaturalGasFilty</li> <li>hzNaturalGasPl</li> <li>hzOilFilty</li> <li>hzOilPl</li> <li>hzPotableWaterFilty</li> <li>hzPotableWaterPl</li> <li>hzWasteWaterFilty</li> <li>hzWasteWaterPl</li> </ul>

6. Copy the new set of earthquake Geodatabases from the **FinalData** folder into the **IntData** folder.
7. Add the Population Ratio field to the necessary tables in the **bndrygbs.mdb** Geodatabase in the **IntData** folder.

➤ In ArcCatalog, Right-Click on the **hzBldgCountOccupT** table and select **Properties...**



- Scroll to the bottom of the Fields tab and add a new field named **POP\_RATIO** as Type **Double**.



- Click **OK**.
- **Repeat** these steps to create another field called **U\_POP\_RATIO** as Type **Double** (This will represent the Urban Population Ratio).
- **Repeat** these steps for the **hzExposureContentOccupT**, **hzExposureOccupT**, and the **hzSqFootageOccupT** tables.

*The POP\_RATIO (Population Ratio) field will be used to distribute the General Building Stock throughout the study region.*

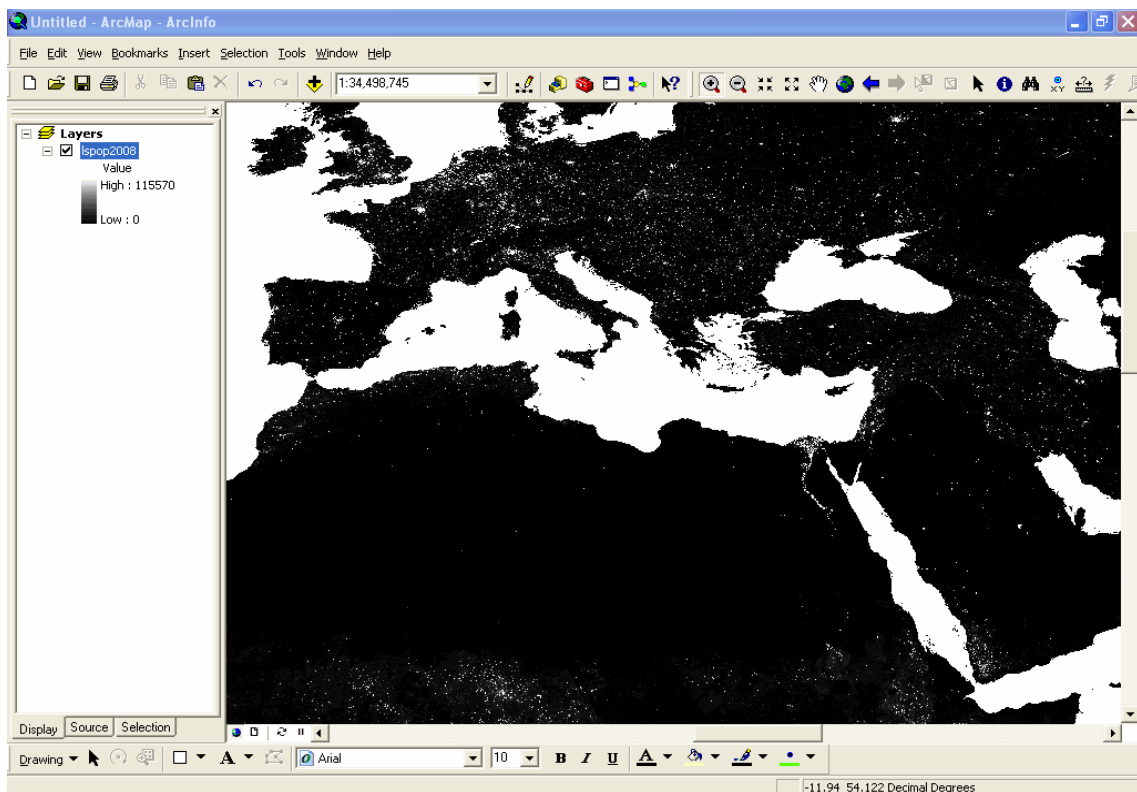
*The U\_POP\_RATIO (Urban Population Ratio) field will be used to distribute the General Building Stock throughout the designated urban areas within the study region.*

8. Perform any necessary geographic transformations to preliminary datasets (Landsan Grid, Study Region Boundary). The HAZUS software uses the **Geographic Coordinate System North American Datum 1983**.

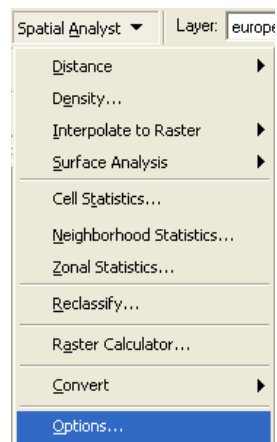
## Develop the Landscan Grid

Now that you have set up the working environment you are ready to develop the polygonal grid that will be used to define your study area. The following example will create a grid for the RELEMR region using the Landscan 2008 data. This methodology is one of many that could be used to create an International study region.

1. **Open** a new ArcMap session and **Add** the **lspop2008** Landscan Grid.



2. Set the Spatial Analyst Working Environment:
  - On the Spatial Analyst drop-down menu, select **Options...**

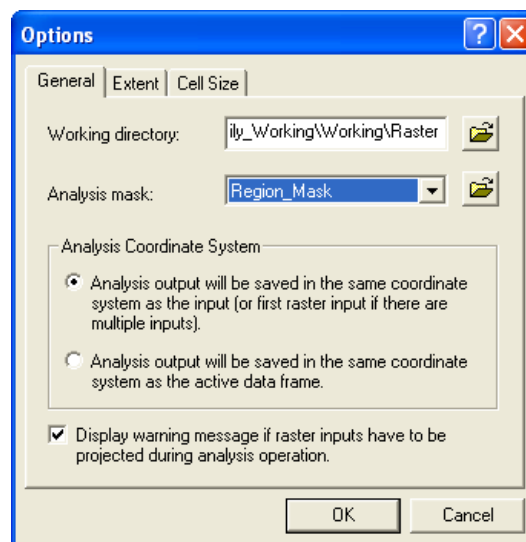


- Set the Working Directory as your **Working** folder that was created in a previous step.

*The working directory will store any grids created with the Raster Calculator.*

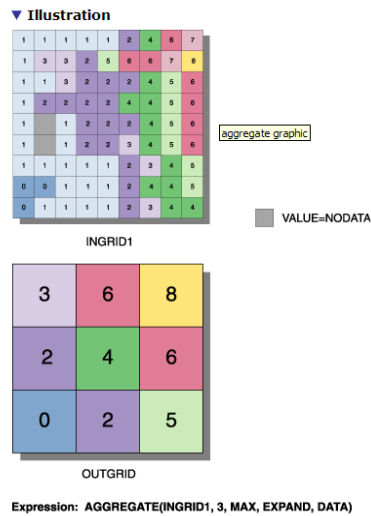
- (Optional) Set the **Analysis Mask** to a shapefile that represents your study region with a 100km buffer, the buffer will ensure that LandScan data will not be omitted along the boundaries of your study region.

*The analysis mask will limit the extent of any newly created grids to the extent of the mask. Any polygonal or raster dataset can act as a mask and should be used to reduce file size and processing time.*

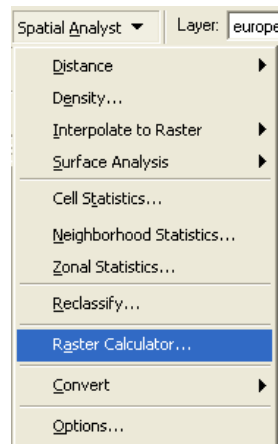


3. Aggregate three manageable grids to represent urban areas, urban/rural interface areas and rural areas. The LandScan data has a resolution of 1km grid cells and an aggregation based on a multiplier can be used to create different grid cell sizes to represent the population distribution differently throughout the study region.

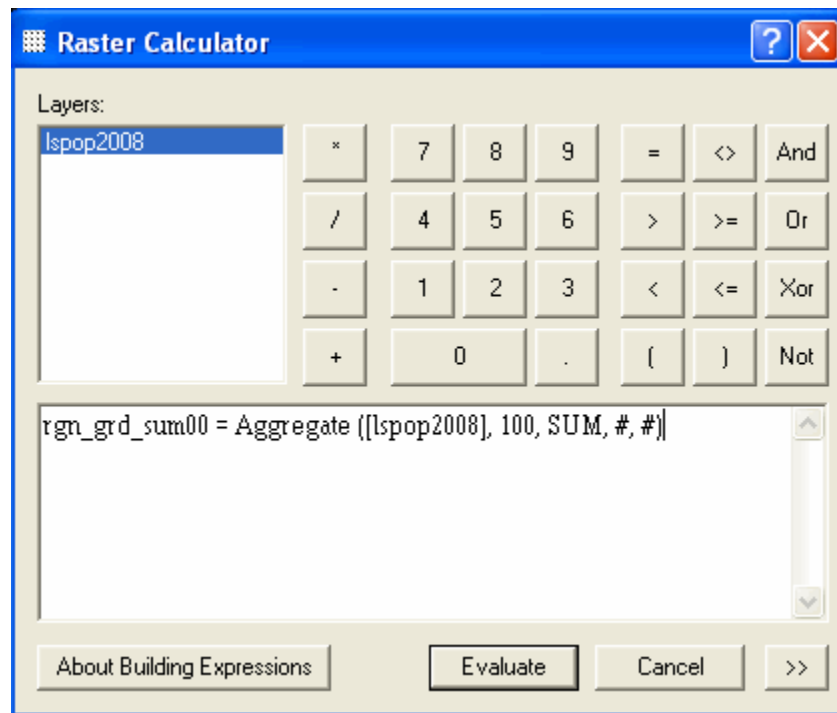




- On the Spatial Analyst drop-down menu select **Raster Calculator...**



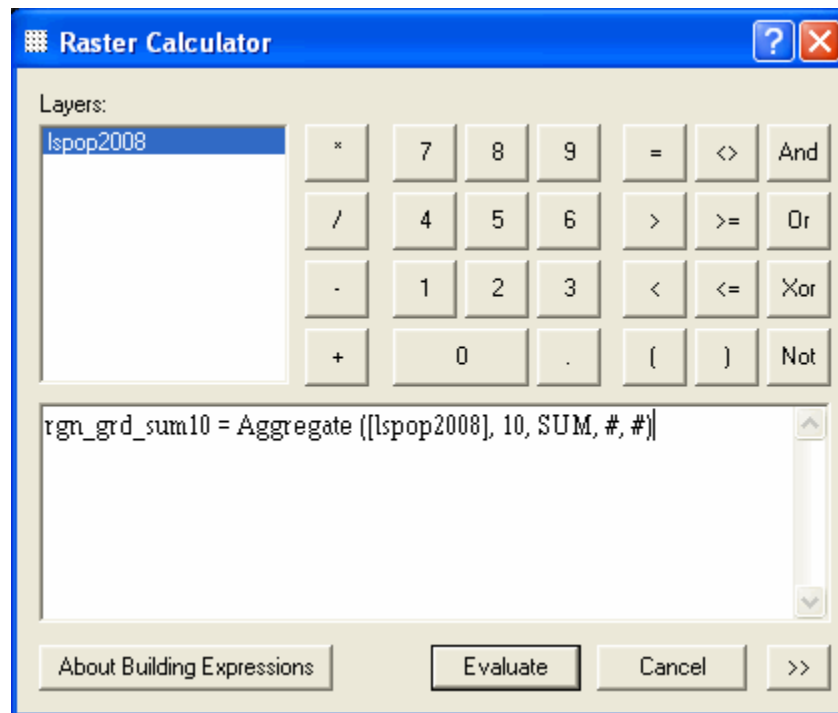
- Create the rural (100km) grid. Enter the following expression (the output will be a raster so it is important to remember to keep the name limited to 13 characters: **rgn\_grd\_sum00 = Aggregate ([lspop2008], 100, SUM, #, #).**



- Click **Evaluate**.

*This will create a new grid in the specified working directory called `rgn_grd_sum00` that is one hundred times the size of the original and represents the sum of the input cells.*

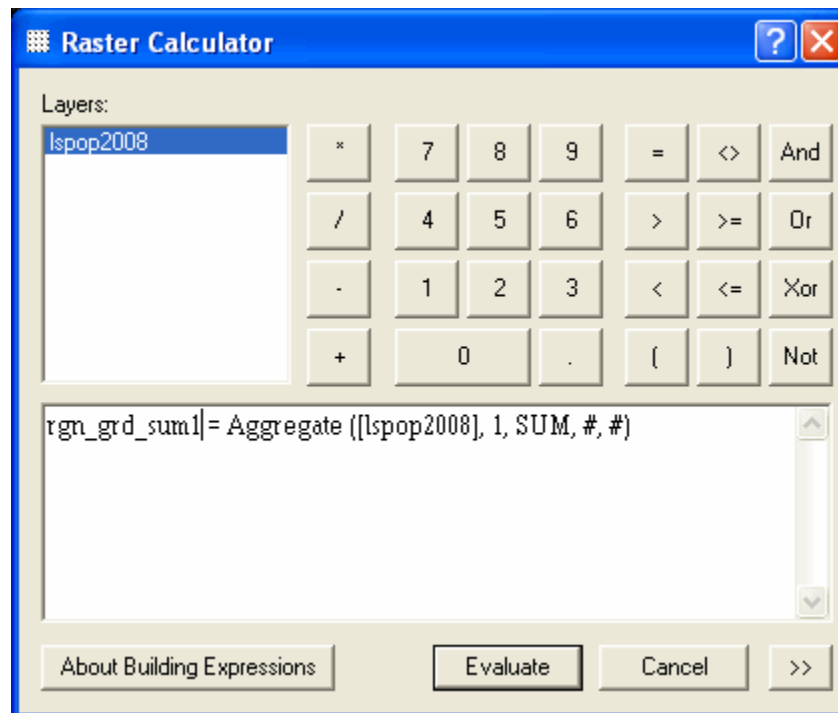
- On the Spatial Analyst drop-down menu select **Raster Calculator...**
- Create the urban/rural interface (10km) grid. Enter the following expression:  
**`rgn_grd_sum10 = Aggregate ([lspop2008], 10, SUM, #, #)`**.



- Click **Evaluate**.

*This will create a new grid in the specified working directory called rgn\_grd\_sum10 that is 10 times the size of the original and represents the sum of the input cells.*

- On the Spatial Analyst drop-down menu select **Raster Calculator...**
- Create the urban (1km) grid. Enter the following expression: **rgn\_grd\_sum10 = Aggregate ([lspop2008], 1, SUM, #, #)**.

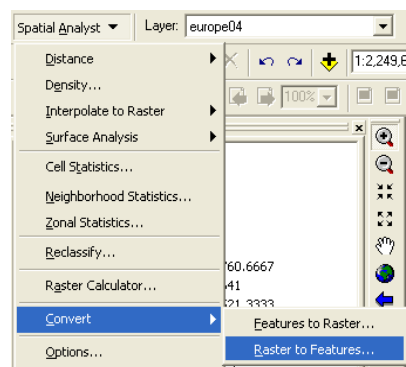


- Click **Evaluate**.

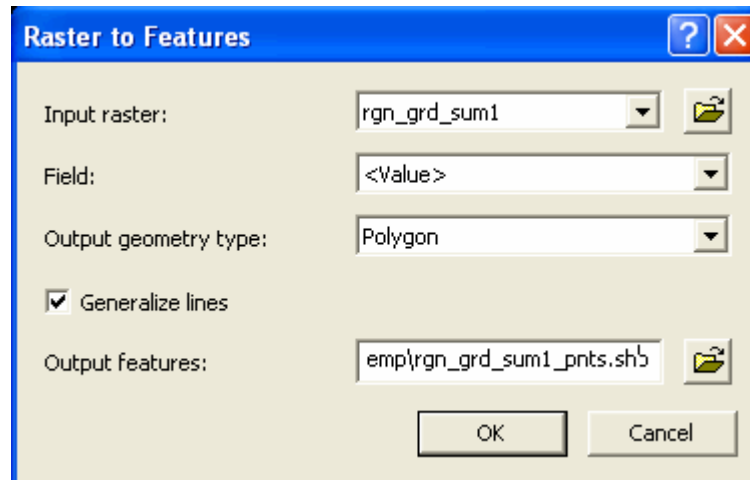
*This will create a new grid in the specified working directory called `rgn_grd_sum1` that is 1 times the size of the original and represents the sum of the input cells*

4. Convert the aggregated grids to features.

- On the Spatial Analyst drop-down menu select **Convert** → **Raster to Features...**



- Set the Input raster to **rgn\_grd\_sum1**.
- Set the Output geometry type to **Point**.
- Set the **Output features** to **rgn\_grd\_sum1\_pnts** in the working directory.

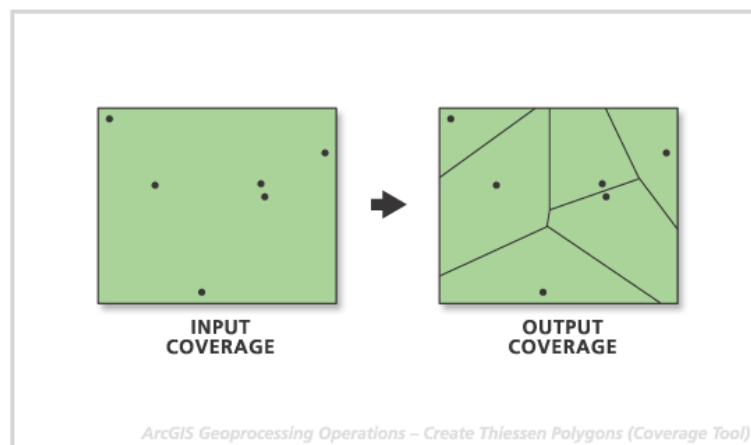


- **Repeat** steps 1 – 4 for **rgn\_grd\_sum10** saving the feature dataset as **rgn\_grd\_sum10\_pnts**.
- **Repeat** steps 1 – 4 for **rgn\_grd\_sum00** saving the feature dataset as **rgn\_grd\_sum00\_pnts**.

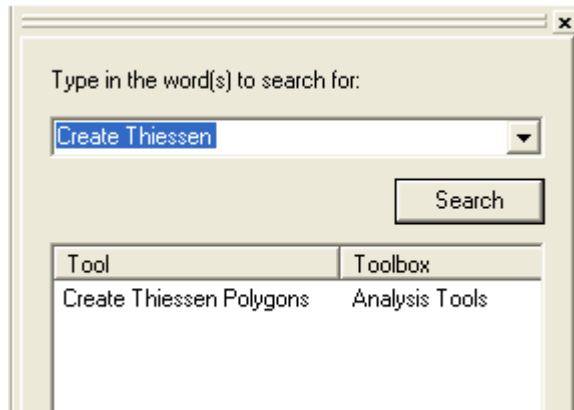
5. Create Thiessen Polygons.

*You must have an ArcInfo License to create Create Thiessen Polygons in ArcMap.*

▼ **Illustration**

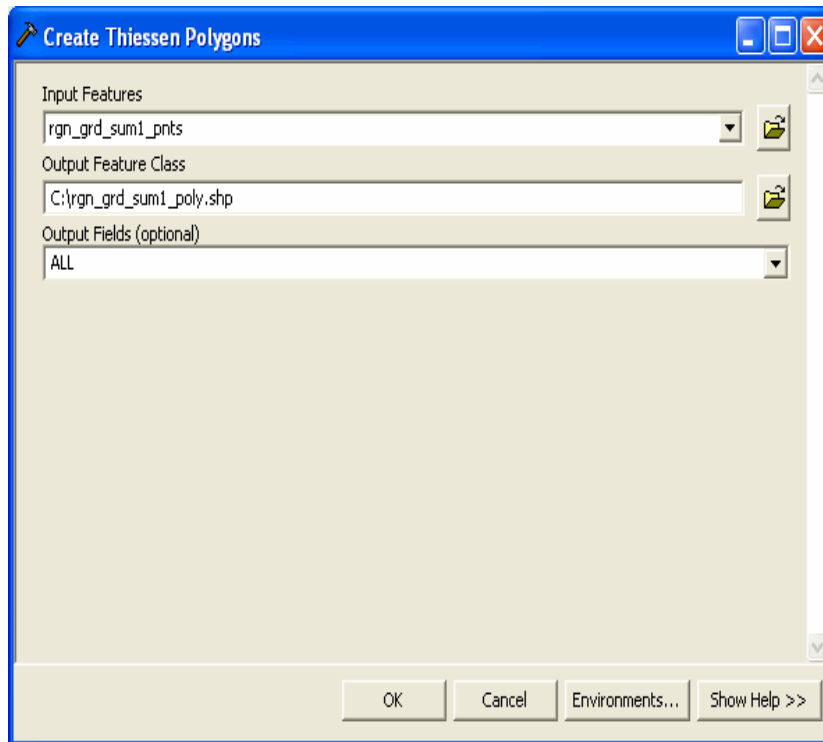


- Open ArcToolbox, click the Search tab and type “Create Thiessen” in the search box.



- Open the “Create Thiessen Polygons” tool.

*Be sure that “ALL” is selected in the Output Fields (optional) dialog.*

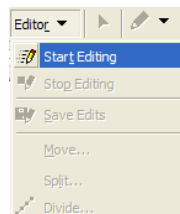


- **Repeat** steps 1 – 3 for **rgn\_grd\_sum10\_pnts** and save the output dataset as **rgn\_grd\_sum10\_poly**.
- **Repeat** steps 1 – 3 for **rgn\_grd\_sum00\_pnts** and save the output dataset as **rgn\_grd\_sum00\_poly**.
- You should now have three polygonal grids (1km, 10km and 100km) that can be combined to make your regional grid dataset.

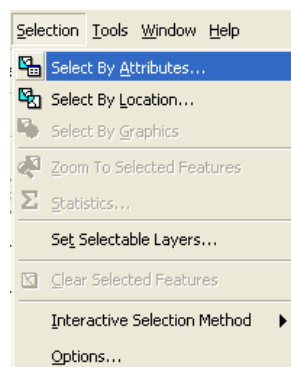
*Depending on the size of the study region a shapefile size limit can be reached when converting the 1km grid to a point and polygon shapefile. If this happens it is best to split the study region up into multiple regions for processing the 1km grid. These separate 1km point and polygon files can be merged together later in the process when they are combined with the 10km and 100km grid point and polygon files.*

6. Combine urban (1km), urban/rural interface (10km) grids and rural (100km) grids.

- Start an Editing Session in ArcMap by selecting **Start Editing** from the Editor Toolbar drop-down menu. The data location of the files that will be edited may need to be selected in the dialog box.

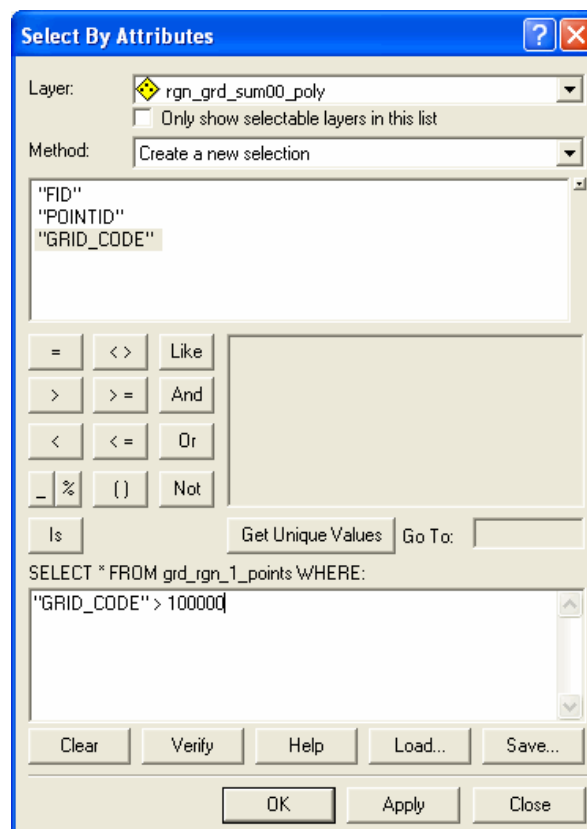


- From the Selection drop-down menu select **Select By Attributes...**



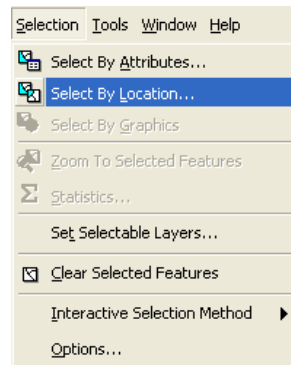
- Set the Layer to **rgn\_grd\_sum00\_poly**.
- Set the Method to “Create a New Selection”.
- Set the Population threshold. Enter “**GRID\_CODE**” > **100000** into the Query Text Box.

*The population threshold will determine where to use the finer resolution grids. This is a variable number and can be modified to match the needs of your study area. The lower the threshold the higher number of grid cells.*

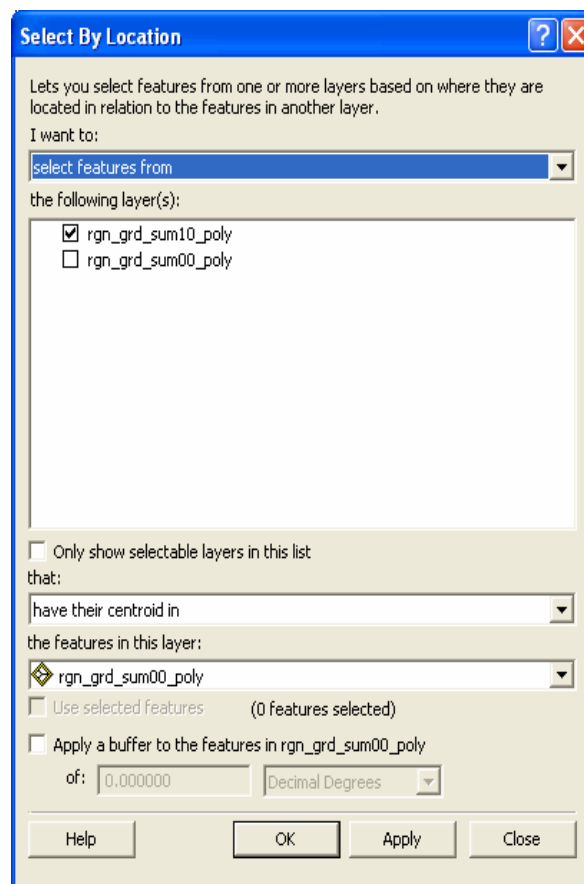


- Click **Apply**.
- Open the attribute table of the selected shapefile: **rgn\_grd\_sum00\_poly**.
- **Delete** the selected grid cells.
- From the Selection drop-down menu select **Select By Location...**



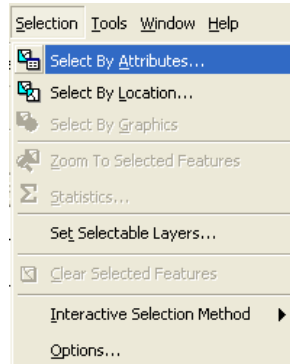


- Create the following query: I want to: **select features from** the following layer(s): **rgn\_grd\_sum10\_poly** that: **have their centroid in** the features in this layer: **rgn\_grd\_sum00\_poly**.

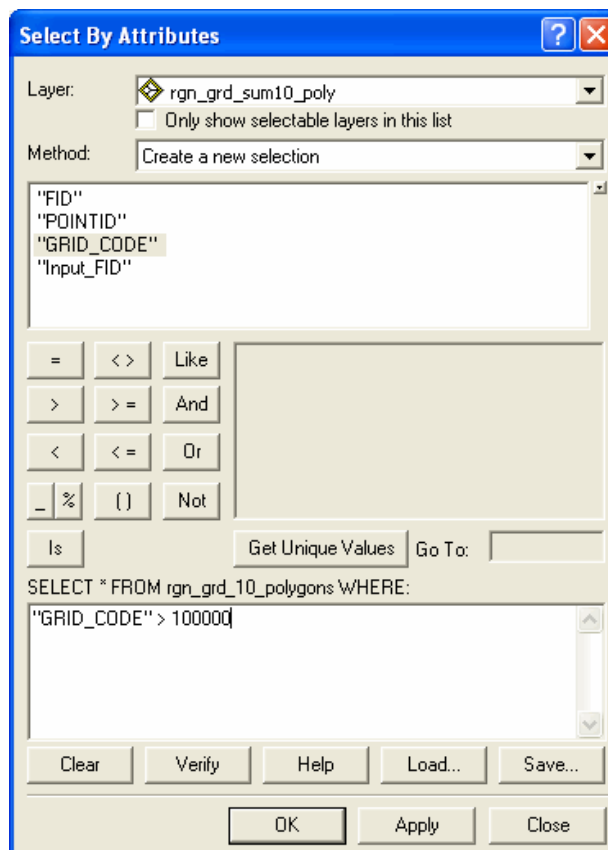


- Click **Apply**.
- Open the attribute table of the selected shapefile: **rgn\_grd\_sum10\_poly**.

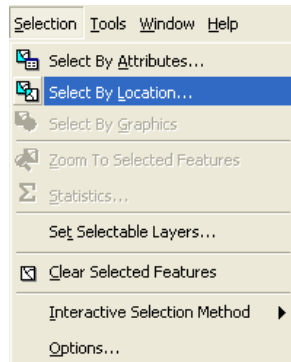
- **Delete** the selected grid cells.
- From the Selection drop-down menu select **Select By Attributes...**



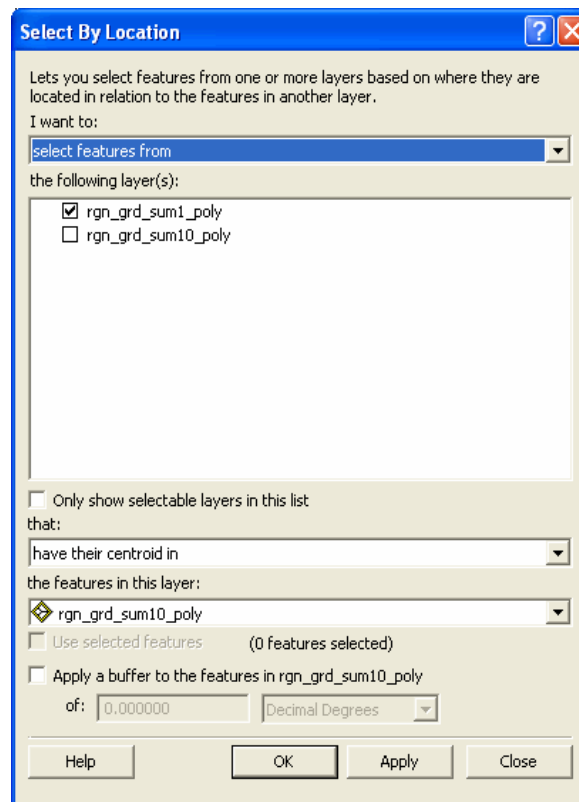
- Set the Layer to **rgn\_grd\_sum10\_poly**.
- Set the Method to “Create a New Selection”.
- Set the Population threshold. Enter “**GRID\_CODE**” > **100000** into the Query Text Box.



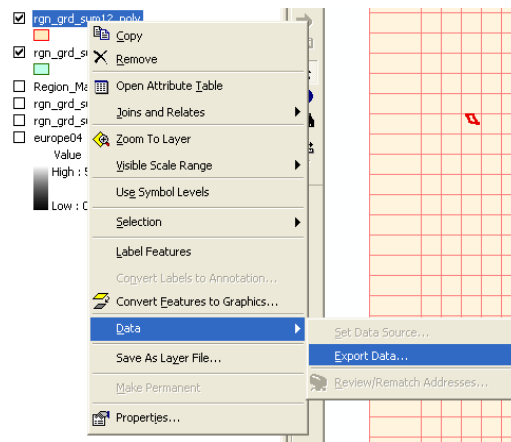
- Click **Apply**.
- Open the attribute table of the selected shapefile: **rgn\_grd\_sum10\_poly**.
- **Delete** the selected grid cells.
- From the Selection drop-down menu select **Select By Location...**



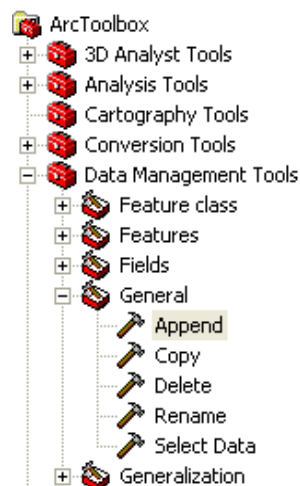
- Create the following query: I want to: **select features from** the following layer(s): **rgn\_grd\_sum1\_poly** that: **have their centroid in** the features in this layer: **rgn\_grd\_sum10\_poly**.



- Click **Apply**.
- Open the attribute table of the selected shapefile: **rgn\_grd\_sum1\_poly**.
- **Delete** the selected grid cells
- **Stop** the Editing session and **Save** your edits.
- Right-click **rgn\_grd\_sum00\_poly** and select **Data**→**Export data...**

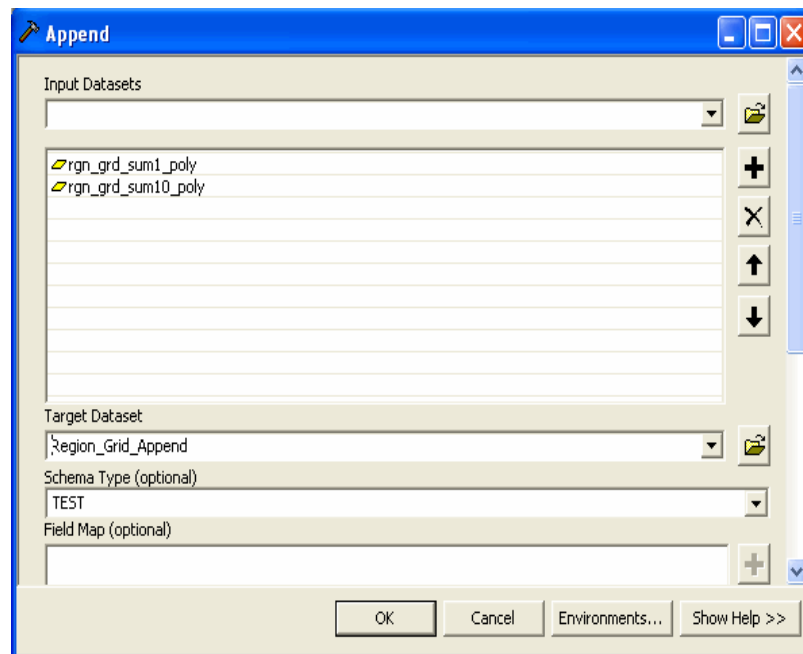


- Save the exported dataset as **Region\_Grid\_Append** in your working directory.
- Open the ArcToolbox Window.
- Double-click the **Append** Tool under **Data Management Tools**→**General** to open the Append Tool Window.




- Select **rgn\_grd\_sum1\_poly** and **rgn\_grd\_sum10\_poly** as your **Input Features**.

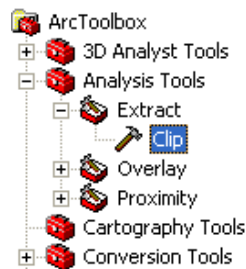
- Select **Region\_Grid\_Append** as your **Output Features**.



- Click **OK**.
- You should now have one combined polygonal grid that can be clipped to finalize the regional grid dataset.

7. Clip the Grid dataset by your regional boundary.

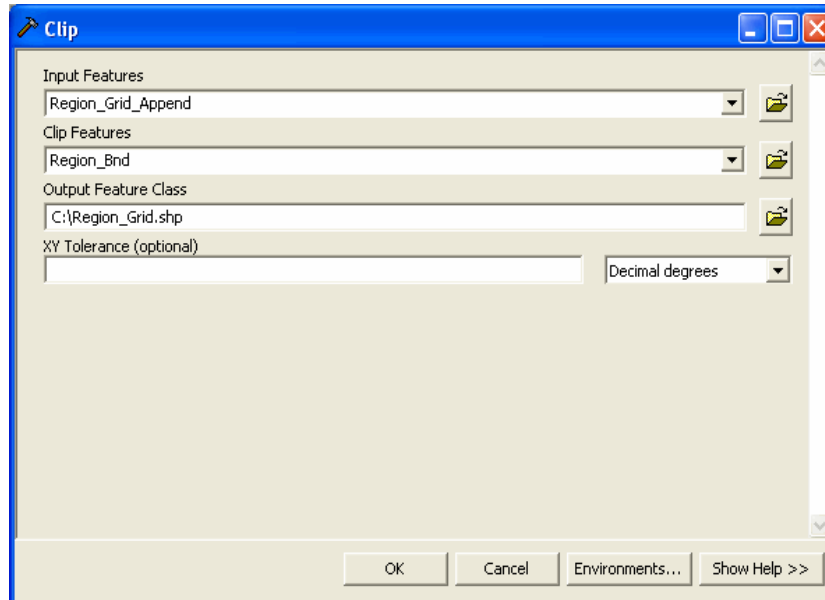
- Open the ArcToolbox Window by pressing the ArcToolbox button. 
- Double-Click the **Clip** tool under **Analysis Tools**→**Extract** to open the Clip Tool Window.



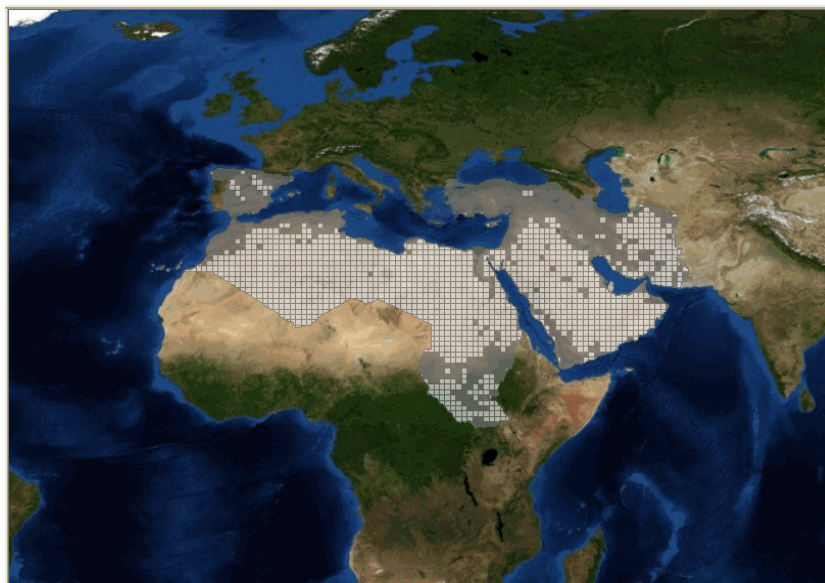
- Select **Region\_Grid\_Append** as your **Input Features**.
- Select **Region\_Bnd** (or whatever dataset defines your study area) as your **Clip Features**.

- Navigate to your working directory and set the **Output Feature Class** to **Region\_Grid**.

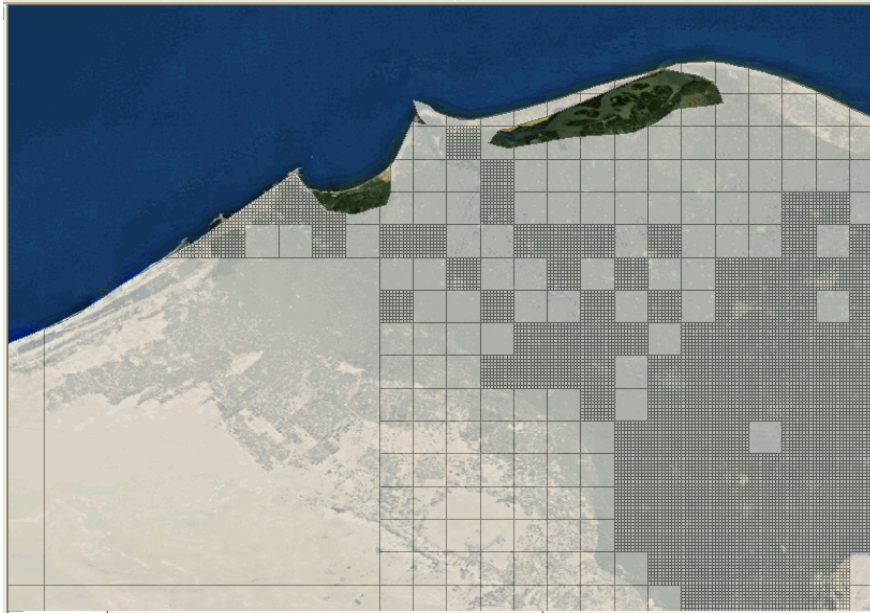
*This will create a new feature dataset named Region\_Grid which will represent census tracts in the HAZUS bndrygbs.mdb geodatabase.*



- Click **OK**.
- You should now have your regional grid dataset.



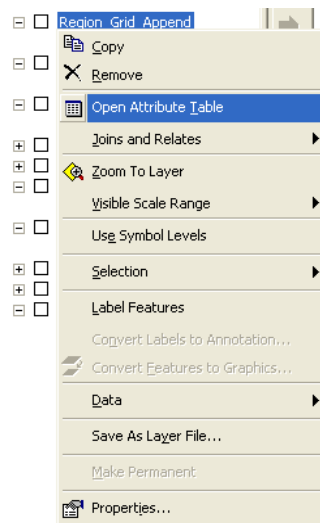
*RELEMR Region*



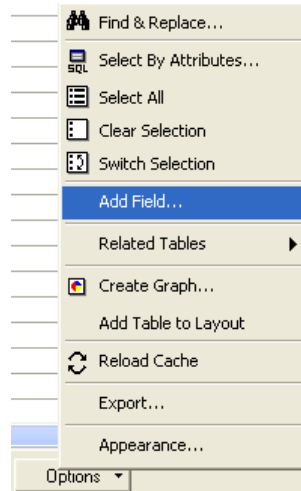
*RELEMR Region – Zoomed into an area of Egypt to show the 1km, 10km and 100km grids side-by-side.*

8. Calculate the Population Ratio.

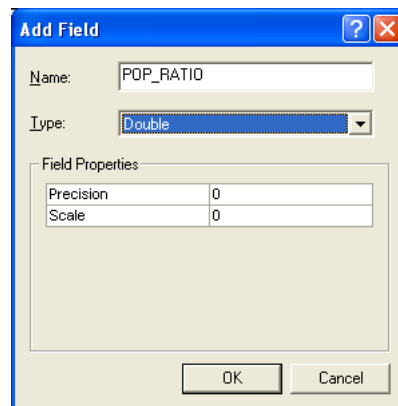
- Right-Click Region\_Grid and select **Open Attribute Table**.



- In the Attribute Table, Click the **Options** button and select **Add Field**.



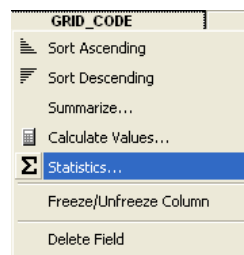
- Enter **POP\_RATIO** into the **Name** field.
- Set **Type** as **Double**.



- Click **OK**.

*A new field is created in the Region\_Grid attribute table.*

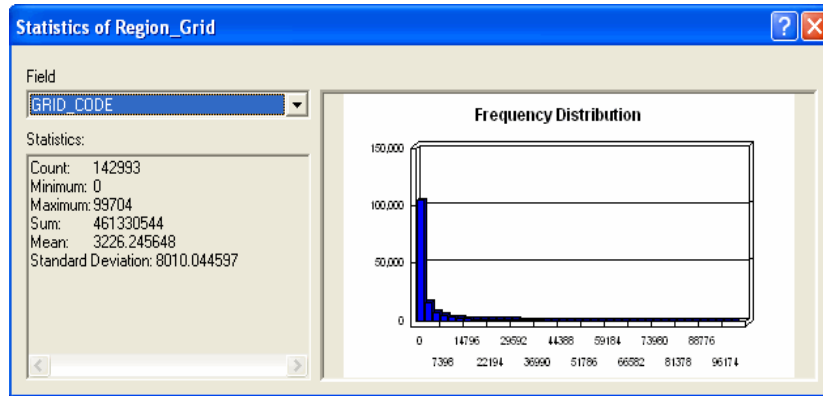
- In the Attribute Table, Right-Click on the **GRID\_CODE** field name and select **Statistics**.



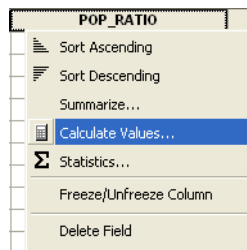


- Write down the **Sum: 461330544**

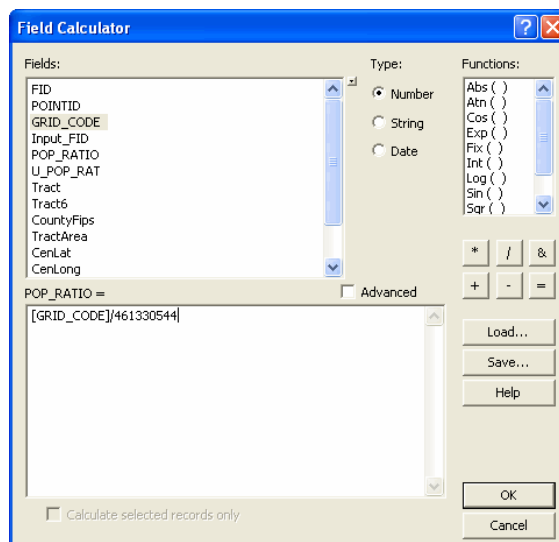
The sum of 461,330,544 represents the total population for our study area. You will use this number to calculate the Population Ratio.



- Right-Click on the **POP\_RATIO** field name select **Calculate Values...**



- Enter the following expression: **[GRID\_CODE]/461330544** in the Field Calculator.



- Click **OK**.

POP_RATIO
0.000032
0.000022
0
0.000019
0
0.000004
0.000051

- Repeat steps for **U\_POP\_RATIO** (Urban Population Ratio).
- Select out the urban (1km) grids from your Region\_Grid shapefile.
- Calculate the urban population from the selected tracts in the same way that the population for the region was calculated.
- Distribute the urban population through the selected urban (1km) grids in the same way that the population was distributed throughout the region.

*The U\_POP\_RATIO should only be distributed to the urban (1km) tracts and the POP\_RATIO should be distributed to all tracts in the region. The POP\_RATIO (Population Ratio) and U\_POP\_RATIO (Urban Population Ratio) fields will be used to distribute the General Building Stock throughout the study region.*

9. Calculate the Census Tract ID and County Identifier.

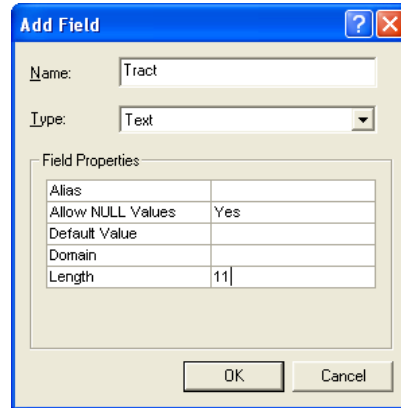
*HAZUS uses Federal Information Processing Standards (FIPS) Codes as unique identifiers for each Census Tract. This is an eleven digit number of which the first two digits identify the State, the next three digits identify the County, and the final six digits identify the Census Tract.*

*Because you will be replacing the data for Puerto Rico you will use the Puerto Rico State identifier (72) and an existing County identifier (001) to represent the first five digits of the Census Tract ID. The remaining six digits will be calculated using a simple numbering expression.*

*It is important to note that because HAZUS is designed for use within the U.S. and Puerto Rico you must maintain an existing State and County identifier in order for HAZUS to work. To go even further, you must maintain the State and County identifiers of the State data you will be replacing.*

- In the Region\_Grid Attribute Table, Click the **Options** button and select **Add Field**.
- Enter **Tract** into the **Name** field.

- Set **Type** as **Text**.
- Set **Length** as **11**.

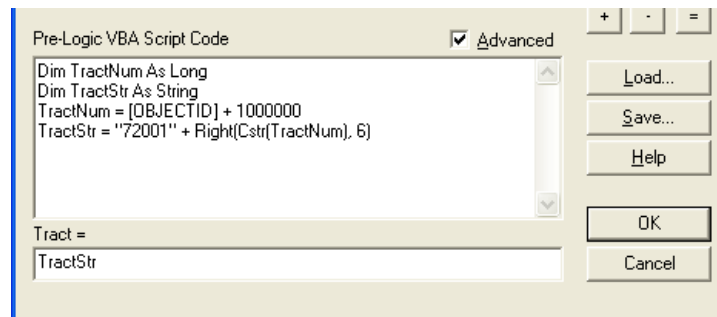


- Click **OK**.
- Right-Click on the **Tract** field name select **Calculate Values...**
- Check the **Advanced** checkbox and enter the following Expression into the Pre-Logic VBA Script Code text box:

```
Dim TractNum As Long
Dim TractStr As String
TractNum = [OBJECTID] + 1000000
TractStr = "72001" + Right(Cstr(TractNum), 6)
```

*The number "72001" is the State and County identifier for Adjuntas County in Puerto Rico. Please see the notes above for a discussion on the use of this number.*

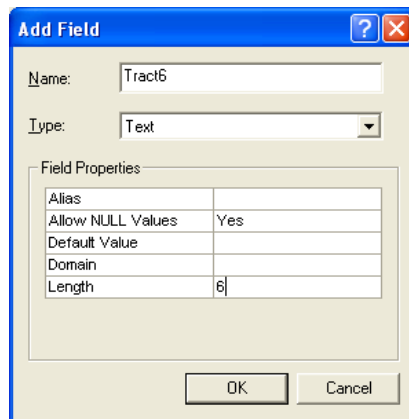
- Enter **TractStr** into the lower text box.



- Click **OK**.

Tract <sup>4</sup>
72001000001
72001000002
72001000003
72001000004
72001000005
72001000006

- In the Region\_Grid Attribute Table, Click the **Options** button and select **Add Field**.
- Enter **Tract6** into the **Name** field.
- Set **Type** as **Text**.
- Set **Length** as **6**.



- Click **OK**.
- Right-Click on the **Tract6** field name select **Calculate Values...**
- Enter the expression **Right([Tract], 6)** in the Field Calculator.

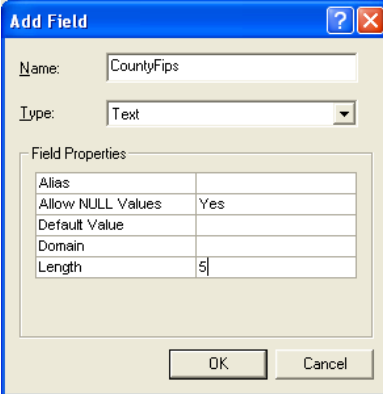
*Tract6 represents the last six digits of the Census Tract ID.*



- Click **OK**.

Tract6
000001
000002
000003
000004
000005
000006

- In the Region\_Grid Attribute Table, Click the **Options** button and select **Add Field**.
- Enter **CountyFips** into the **Name** field.
- Set **Type** as **Text**.
- Set **Length** as **5**.



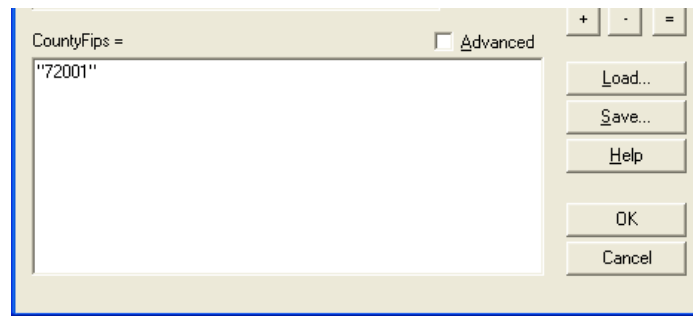
The screenshot shows the 'Add Field' dialog box with the following details:

- Name:** CountyFips
- Type:** Text
- Field Properties:**

Alias	
Allow NULL Values	Yes
Default Value	
Domain	
Length	5

- Click **OK**.
- Right-Click on the **CountyFips** field name select **Calculate Values...**
- Enter the expression **“72001”** in the Field Calculator.

*The number “72001” is the State and County identifier for Adjuntas County in Puerto Rico. Please see the notes above for a discussion on the use of this number.*



- Click **OK**.

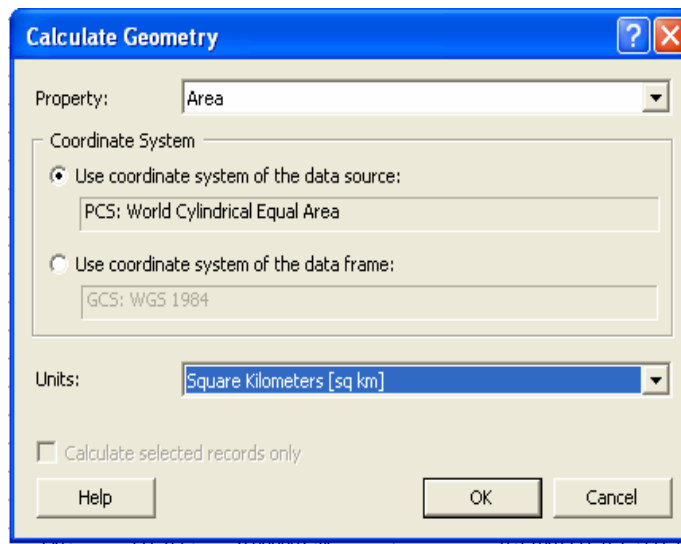
CountyFips
72001
72001
72001
72001
72001
72001

10. Calculate the Area, Latitude, and Longitude.

- In the Region\_Grid Attribute Table, Add the following three fields:

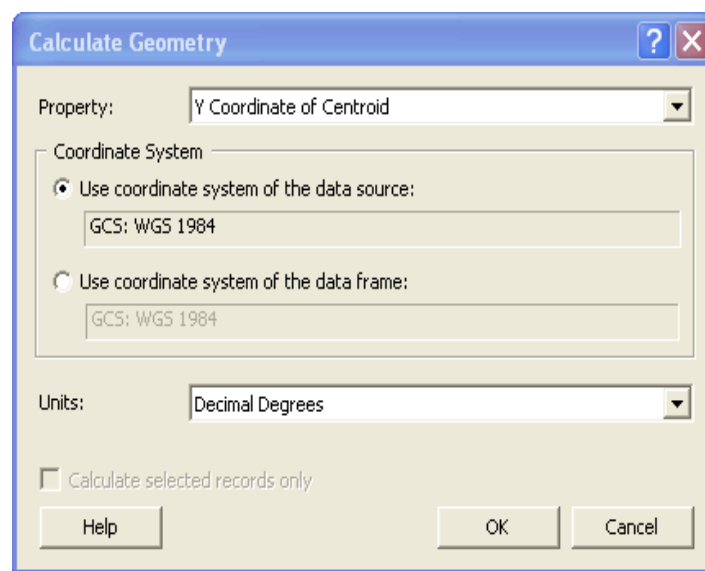
Name:	Type:
<b>TractArea</b>	<b>Float</b>
<b>CenLat</b>	<b>Double</b>
<b>CenLongit</b>	<b>Double</b>

- Calculate the **TractArea** field.
- Open the Attribute Table of the Region\_Grid shapefile, right-click the **TractArea** column and select “Calculate Geometry”.
- Select **Area** in the “Property:” field and **Square Kilometers** in the “Units:” field.

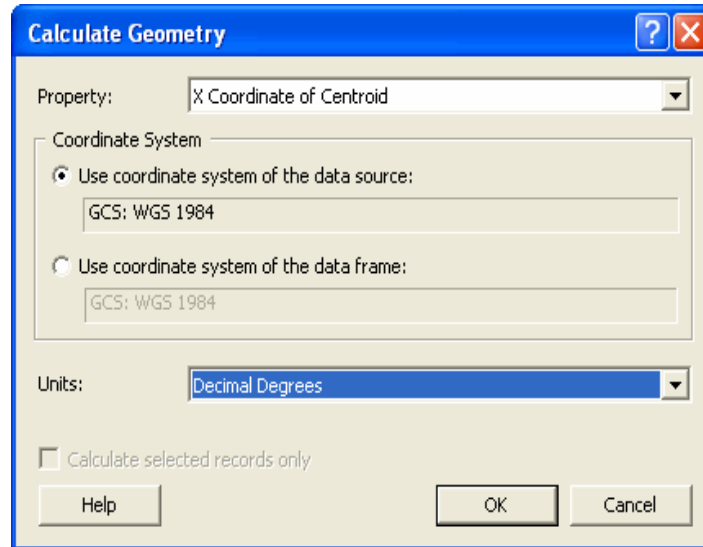


*Because HAZUS uses GCS NAD83 a projected coordinate system, the feature class must also be in a projected coordinate system to make an accurate area calculation. If Area in the “Property:” field appears as “Area – Disabled” it means that the Region\_Grid shapefile is not in a projected coordinate system and needs to be re-projected. This can be done through the Project tool in ArcToolbox.*

- Calculate the **CenLat** field.
- Open the Attribute Table of the Region\_Grid shapefile, right-click the **CenLat** column and select “Calculate Geometry”.
- Select **Y Coordinate of Centroid** in the “Property:” field and **Decimal Degrees** in the “Units:” field



- Calculate the **CenLongit** field.
- Open the Attribute Table of the Region\_Grid shapefile, right-click the **CenLongit** column and select “Calculate Geometry”.
- Select **X Coordinate of Centroid** in the “Property:” field and **Decimal Degrees** in the “Units:” field



TractArea	CenLat	CenLongit
3.05815	38.804540	15.223618
5.6935	38.708050	13.179209
0.075133	38.709134	13.200977
1.62109	38.788769	15.195019
8.0521	38.788175	15.216953
2.59057	38.695957	13.171031

11. Calculate remaining Census Tract fields.

- In the Region\_Grid Attribute Table, Add the following two fields:

Name:	Type:
<b>NumAggrBocks</b>	<b>Long Integer</b>
<b>BldgSchemesId</b>	<b>Text (length 5)</b>

- Calculate the **NumAggrBocks** field to equal **1**.

*The NumAggrBocks field contains the number of census blocks in each census tract. Because the earthquake only operates at the census tract level this number is irrelevant; however, the field does not allow for null values.*



- Calculate the **BldgSchemesId** field to equal “**PR2**”.

*The BldgSchemesId field identifies the default Building Scheme for Puerto Rico. This value was taken from the original Puerto Rico Tract feature class and will be applied to the RELEMR region. After completing your study region you will be able to alter these building schemes to better reflect local conditions. If you are using any State other than Puerto Rico as your surrogate you will need to alter this value accordingly.*

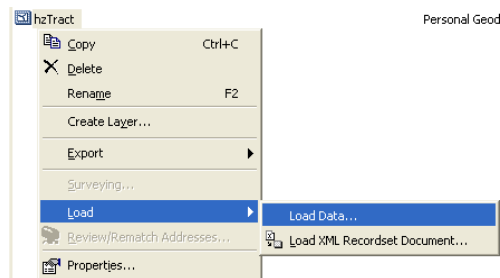
HumAggrBocks	BldgSchemesId
1	PR2
1	PR2
1	PR2
1	PR2
1	PR2
1	PR2

## Populate the Geodatabases

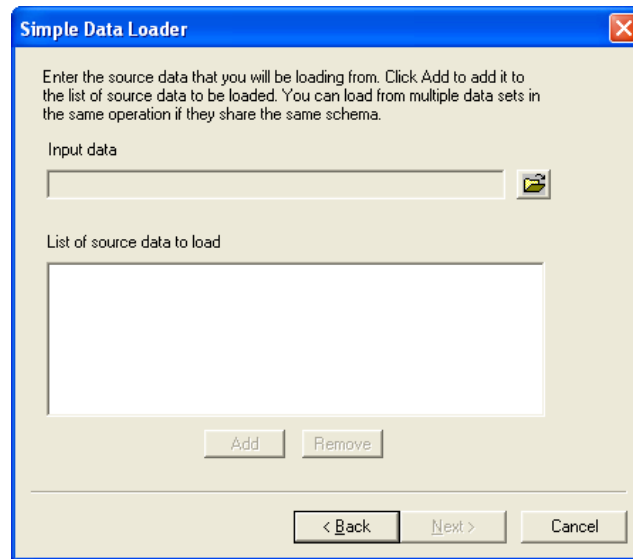
This next section will take you through the steps of populating the Intermediate Geodatabases and loading the Final Data. We will use the population ratio to distribute the General Building Stock throughout the study area. This methodology is one of many that could be used for distributing the GBS.

1. Load the data into the Intermediate Geodatabases in the **IntData** folder.

- In ArcCatalog, Right-Click on **hzTract** in the IntData folder and select **Load→Load Data...**

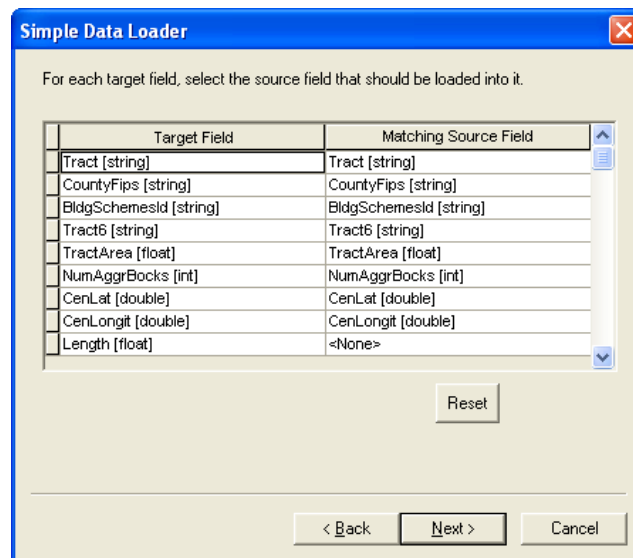


- Click **Next** in the first screen of the **Simple Data Loader**.
- Navigate to the **Region\_Grid** feature class in your Working folder and Click the **Add** button.



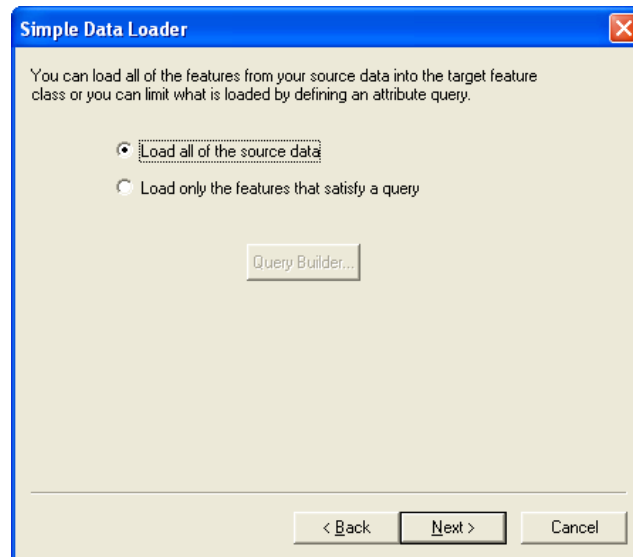
- Click **Next** twice to get to the Field Matching Window.
- Set each **Matching Source** field to match the **Target** field.

*Each field will automatically find its counterpart if there is an identical match. There should be a match for every Target Field except Length.*



- Click **Next**.
- Make sure the “**Load all of the source data**” radio button is selected and Click **Next**.

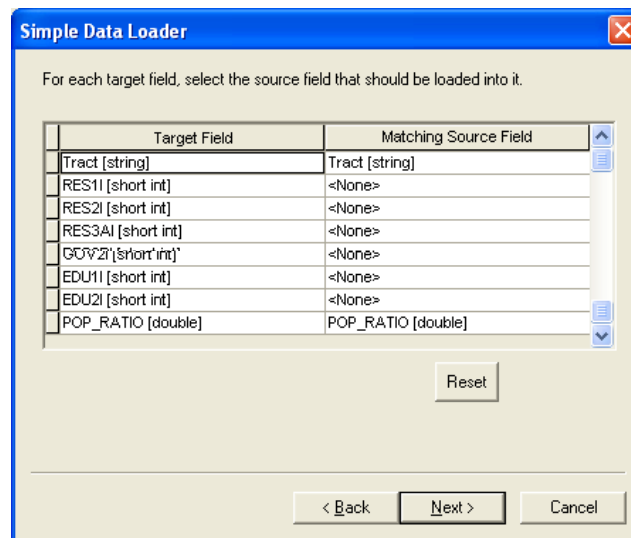
*There is a limit to the number of records you can load with the Simple Data Loader. When loading tens of thousands of records you may need to load the data in two or more batches. This can be done with the “Load only the features that satisfy a query” radio button.*



- Review the Summary window and Click **Finish**.
- The process for loading data into feature classes and tables is the same. **Repeat** these steps by loading the Region\_Grid feature class into the following tables:

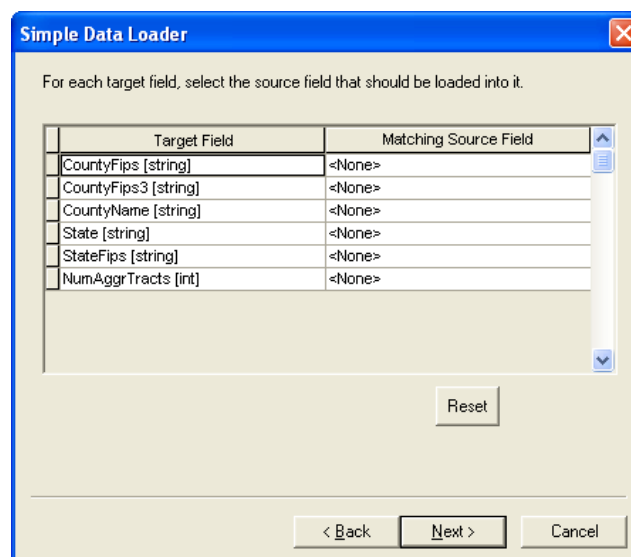
**hzBldgCountOccupT**  
**hzExposureContentOccupT**  
**hzExposureOccupT**  
**hzSqFootageOccupT**  
**hzDemographicsT**

The only matching fields should be **Tract** and **POP\_RATIO**. The rest of the fields will be calculated in the following steps.



- Load the **Region\_Bnd** (or whatever dataset defines your study area) dataset into the **hzCounty** feature class.

*You may not have any matching fields; however, the geographic feature will still be loaded. We will calculate any remaining fields in the following step.*



2. Calculate any remaining fields in the **hzCounty** feature class.
  - In ArcMap, add the **hzCounty** feature class from the FinalData folder.
  - Open the Attribute Table.
  - Calculate the following values for each field:

**CountyFips = "72001"**      *State + County Identifier*  
**CountyFips3 = "001"**      *County Identifier*  
**CountyName = "Sicily"**      *Name of Study Area*  
**State = "PR"**      *State Abbreviation for Puerto Rico*  
**StateFips = "72"**      *State Identifier*  
**NumAggrTract = 679**      *Total # of Census Tracts*

CountyFips	CountyFips3	CountyName	State	StateFips	NumAggrTracts
72001	001	Sicily	PR	72	679

3. Calculate the General Building Stock and Demographics distribution.

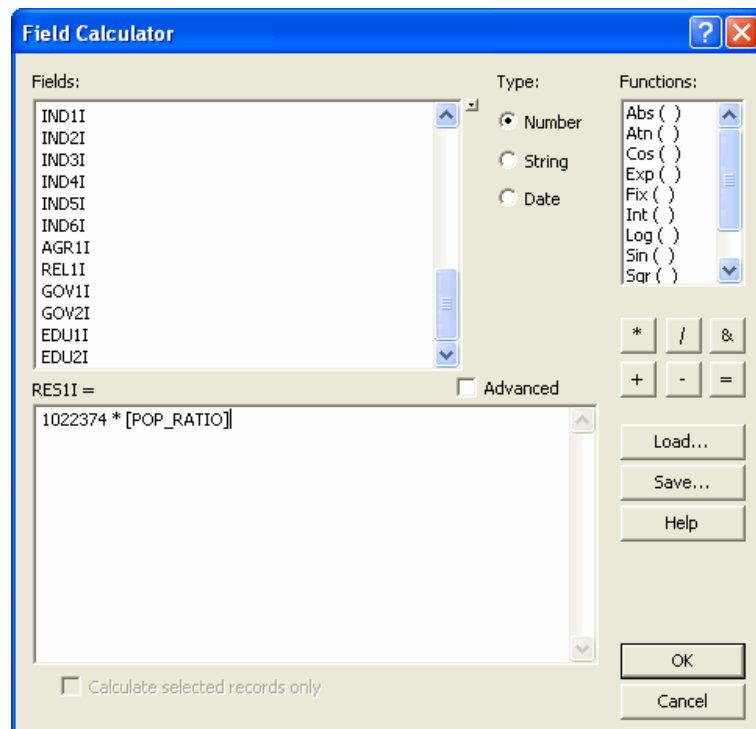
- (Optional) Create a summary table containing total values for each of the HAZUS GBS attribute tables. This will provide a quick reference when calculating the General Building Stock distribution and Demographics distribution.

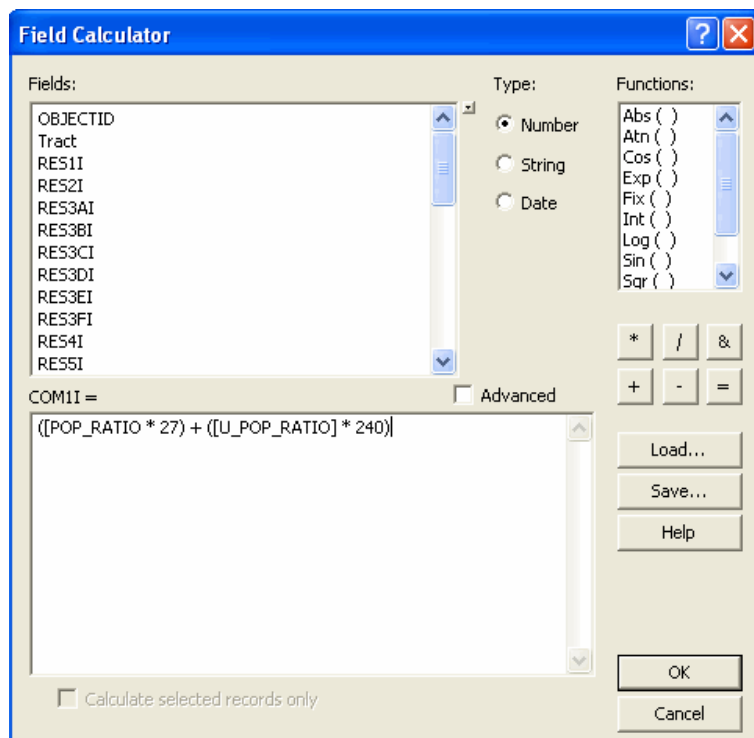
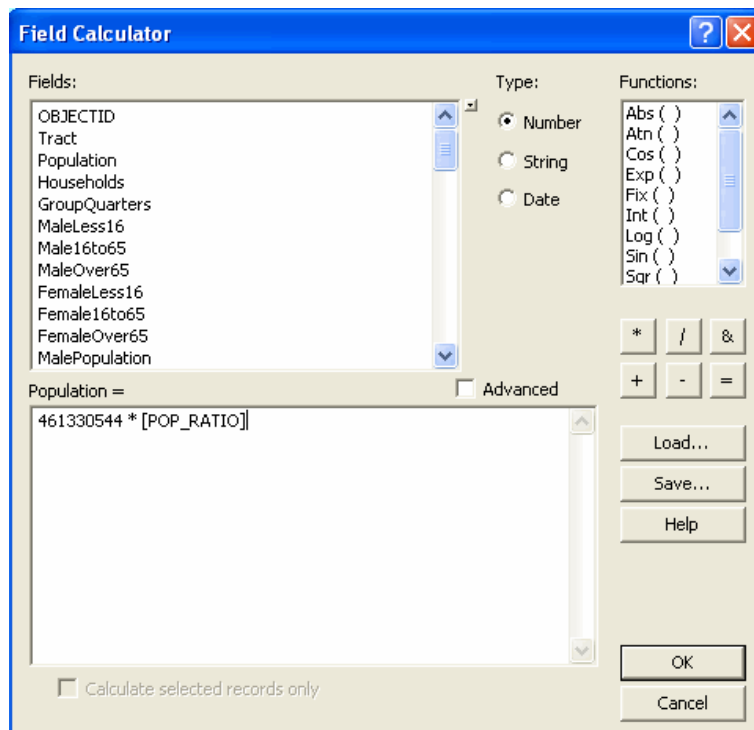
General Building Stock Totals by Occupancy				
Occupancy	hzBldgCountOccupT	hzExposureOccupT	hzExposureContent	hzSqFootageOccupT
RES1I	1022374	111670824	56845945	1635083.97
RES2I	4602	184469	95071	5972.07
RES3AI	13528	2787205	1401364	48191.79
RES3BI	7672	1865429	940337	29673.86
RES3CI	3391	3916231	1962727	36245.81
RES3DI	1842	2770523	1387808	28577.17
RES3EI	160	1235579	619254	13197.69
RES3FI	420	3258578	1630950	35700.17
RES4I	17	290182	145103	3224.90
RES5I	801	2231679	1116156	21839.70
RES6I	10	35394	17707	393.40
COM1I	267	1989179	1989179	32330.93
COM2I	1133	1860408	1860408	34942.30
COM3I	546	419320	419320	5616.57
COM4I	260	1973705	1973705	23191.11
COM5I	488	264789	264789	1999.70
COM6I	51	381602	572411	3068.60
COM7I	473	391781	587733	3509.29
COM8I	999	592851	592851	5031.01
COM9I	12	14453	14453	164.20
COM10I	0	0	0	0.00
IND1I	308	598589	897916	9428.70
IND2I	548	894148	1341265	16793.69
IND3I	325	1523691	2285571	14825.00
IND4I	14	76981	115482	748.99
IND5I	8	41792	62691	406.60
IND6I	189	341771	341771	6419.19
AGR1I	107	184621	184621	3467.51
REL1I	140	243019	243019	2477.03
GOV1I	383	329978	329978	4249.09
GOV2I	14	17076	25616	145.90
EDU1I	13	246271	246271	3085.75
EDU2I	45	243149	364735	2465.40

- To accommodate the large difference between the population of Puerto Rico and The RELEMR Region a multiplier was used to correct for the population differences, the multiplier was applied to all General Building Stock and Demographic data in the RELEMR study region. The multiplier was applied to the Puerto Rico data and logged in a table similar to the one pictured above. The values established with the multiplier were then distributed as described below.

- Distribution of General Building Stock and Demographics data through the use of the POP\_RATIO and U\_POP\_RATIO.
  1. POP\_RATIO is applied to all Residential Building Types through the use of the field calculator, for example:  $RES1 = 1022374 * [POP\_RATIO]$ . See example below.
  2. POP\_RATIO is applied to all Demographic Data through the use of the field calculator, for example:  $Population = 461330544 * [POP\_RATIO]$ . See example below.
  3. POP\_RATIO and U\_POP\_RATIO are applied to all Commercial, Industrial, Religious, Agricultural and Educational Building Types through the use of the field calculator, for example:  
 $COM1 = (27 * [POP\_RATIO]) + (240 * [U\_POP\_RATIO])$ . See example below.

*In this example the total number of COM1 locations would be 267, we took 10% of that number (27) and distributed those locations throughout the entire region though the use of the POP\_RATIO which is applied to all grids in the study region. The remaining 90% (240) COM1 locations were distributed throughout the urban areas through the use of the U\_POP\_RATIO which is applied to only the urban grids in the area.*

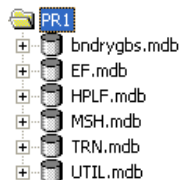




- In ArcMap, add the **hzBldgCountOccupT**, **hzExposureContentOccupT**, **hzExposureOccupT**, **hzSqFootageOccupT** and **hzDemographicsT** tables.
  - Open the attribute table of **hzBldgCountOccupT**.
  - Right-Click the field name **RES1I** and select **Calculate Values**.
  - Apply the methodology outlined above to properly distribute General Building Stock and Demographics Data throughout the region using POP\_RATIO and U\_POP\_RATIO.
  - Repeat these steps for the **hzExposureContentOccupT**, **hzExposureOccupT**, **hzSqFootageOccupT** and **hzDemographicsT** tables.
4. Load the data into the Final Geodatabases in the FinalData folder:
- In ArcCatalog, use the Simple Data Loader to load data from the Intermediate Geodatabases in the IntData folder to the Final Geodatabases in the FinalData folder. Do this for the following feature classes and tables:

**hzTract**  
**hzCounty**  
**hzBldgCountOccupT**  
**hzExposureContentOccupT**  
**hzExposureOccupT**  
**hzSqFootageOccupT**  
**hzDemographicsT**

5. Copy the Geodatabases in the **FinalData** folder to the **PR1** data aggregation folder. The five newly created Geodatabases should replace five of the existing Geodatabases. Your final PR1 folder should look like this.:



6. Edit the **syBoundary.mdb** Geodatabase.

*Numerous fields in the syBoundary.mdb Geodatabase contain indexes. These indexes may need to be removed in order to delete features in ArcMap.*

- In ArcMap, add the **syState**, **syCounty**, and **syTract** feature classes from the syBoundary folder.



- Start an Editing Session and delete all features for Puerto Rico in each feature class. Use the following queries for each dataset to select the appropriate features:

**syState** – SELECT \* FROM syState WHERE **StateFips** = '72'

**syCounty** – SELECT \* FROM syCounty WHERE **CountyFips** LIKE '72\*'

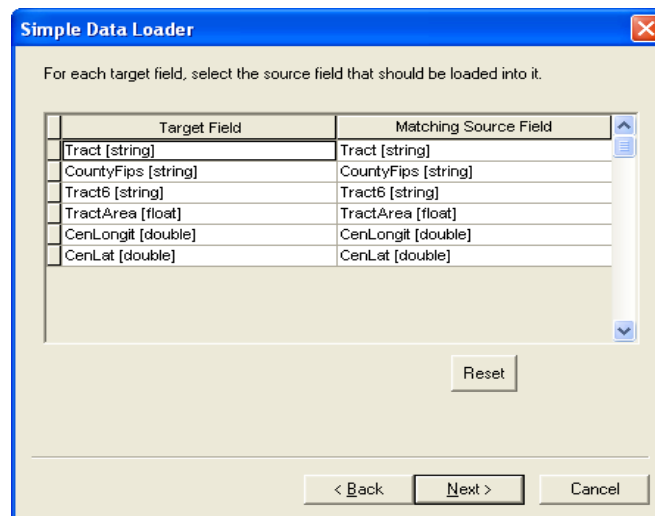
**syTract** – SELECT \* FROM syTract WHERE **Tract** LIKE '72\*'

- Stop the Editing Session and Save your edits.

7. Load data into the **syBoundary.mdb** Geodatabase.

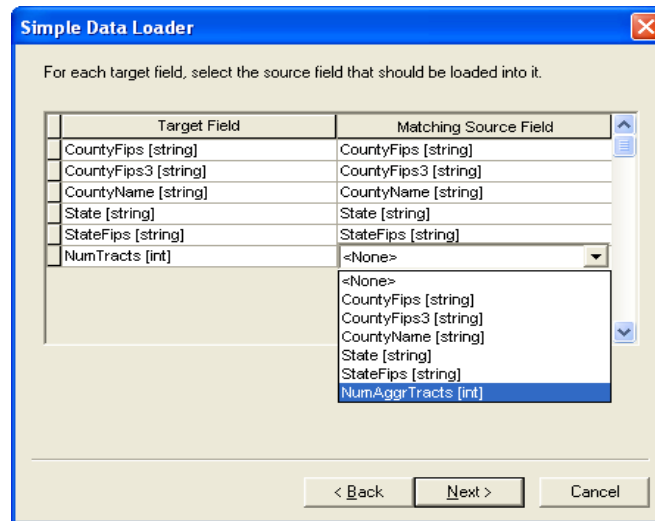
- In ArcCatalog, use the Simple Data Loader to load the **hzTract** feature class from the FinalData folder into the **syTract** feature class in the syBoundary folder.

*All Target fields and Matching Source fields should automatically match.*



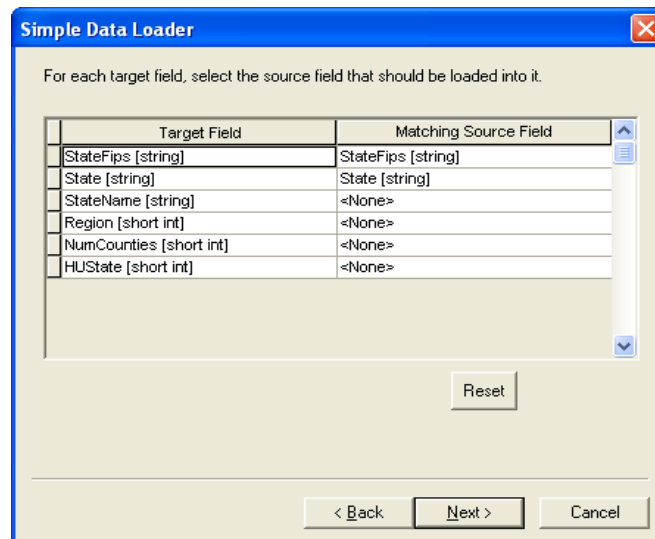
- Load the **hzCounty** feature class from the FinalData folder into the **syCounty** feature class in the syBoundary folder.

*All Target fields and Match Source fields should automatically match except **NumTracts**. You should manually select the Matching Source field as **NumAggrTracts**.*



- Load the **hzCounty** feature class from the FinalData folder into the **syState** feature class in the syBoundary folder.

*You will not have matching fields for StateName, Region, NumCounties, and HUState. We will calculate these remaining fields in the following step.*



8. Calculate any remaining fields in the **syState** feature class.

- In ArcMap, add the **syState** feature class from the syBoundary folder.
- Open the Attribute Table.
- Calculate the following values for each field:

**StateName = "RELEMR"**      *Broad Name of Study Area*  
**Region = 0**                      *Identifies PR as an Eastern State*  
**NumCounties = 1**                *Total # of Counties*  
**HUState = 0**                      *Identifies Ineligibility for the Hurricane Model*

9. Copy the new syBoundary.mdb Geodatabase in the syBoundary folder to the HAZUS data aggregation folder and replace the existing Geodatabase.
10. (Optional) Replace any indices for large feature classes (e.g. syTract, hzTract, hzBldgCountOccupT. Although this step is not required, it may improve processing time while building your study region.

**NOTE:** As discussed these steps provide users outside the United States with a sophisticated earthquake loss estimation tool. One of the critical next steps will be to adjust the U.S. building type information to better represent the building stock of the local Country. We start with the Puerto Rico building types as the best proxy mainly because a relatively low percentage is assigned to the wood frame categories so prevalent elsewhere in the U.S:

Parameters for PR2. Right-click cell for context menu.

Occupancy	Wood %	Concrete %	Steel %	Masonry %	Manu. Housing %	Total
RES1	5	45	0	50	0	100
RES2	0	0	0	0	100	100
RES3A	5	55	0	40	0	100
RES3B	5	55	0	40	0	100
RES3C	5	55	0	40	0	100
RES3D	5	55	0	40	0	100
RES3E	5	55	0	40	0	100
RES3F	5	55	0	40	0	100
RES4	5	55	0	40	0	100
RES5	5	55	0	40	0	100
RES6	5	55	0	40	0	100
COM1	5	60	15	20	0	100
COM2	5	60	15	20	0	100
COM3	5	60	15	20	0	100
COM4	5	60	15	20	0	100
COM5	5	60	15	20	0	100
COM6	5	60	15	20	0	100
COM7	5	60	15	20	0	100
COM8	5	60	15	20	0	100
COM9	5	60	15	20	0	100
COM10	5	60	15	20	0	100
IND1	5	55	20	20	0	100
IND2	5	55	20	20	0	100
IND3	5	55	20	20	0	100
IND4	5	55	20	20	0	100
IND5	5	55	20	20	0	100
IND6	5	55	20	20	0	100
AGR1	5	60	15	20	0	100
REL1	5	60	15	20	0	100
GOV1	5	60	15	20	0	100
GOV2	5	60	15	20	0	100
EDU1	5	60	15	20	0	100
EDU2	5	60	15	20	0	100

Yellow= default building type distribution. Green= user-defined building type distribution.

Print    OK    Cancel

## Build the Study Region

This section involves the creation of a study region in Sicily, Italy for which you will model the impact of a user-defined scenario and simulation in this course.

1. Create a New Study Region
  - Start HAZUS-MH and choose **Create a New Region**.
  - Click **Next** to open the Create New Region window.
  - Enter **RELEMR** for the study region name.

**Create New Region**

**Study Region Name**  
Each study region needs to be identified with a unique name.

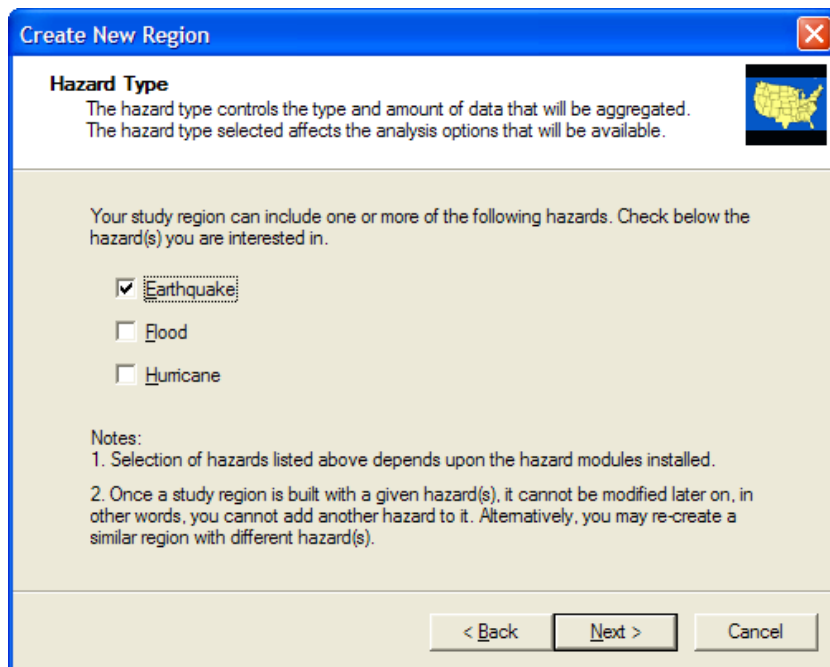
Enter below a name which uniquely identifies your region. The name can be up to 50 characters long.

RELEMR

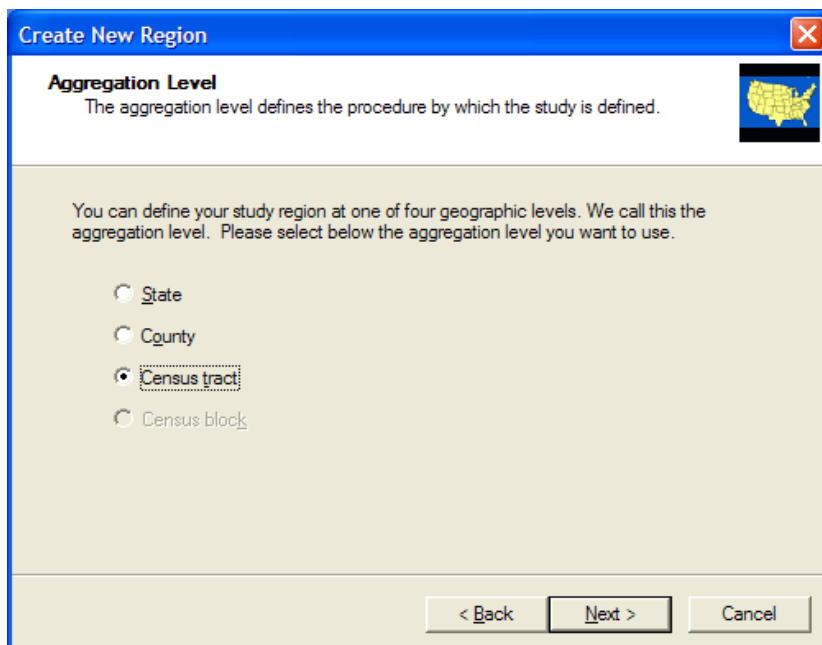
Region description (optional):  
Study Region Creation Example

< Back   Next >   Cancel

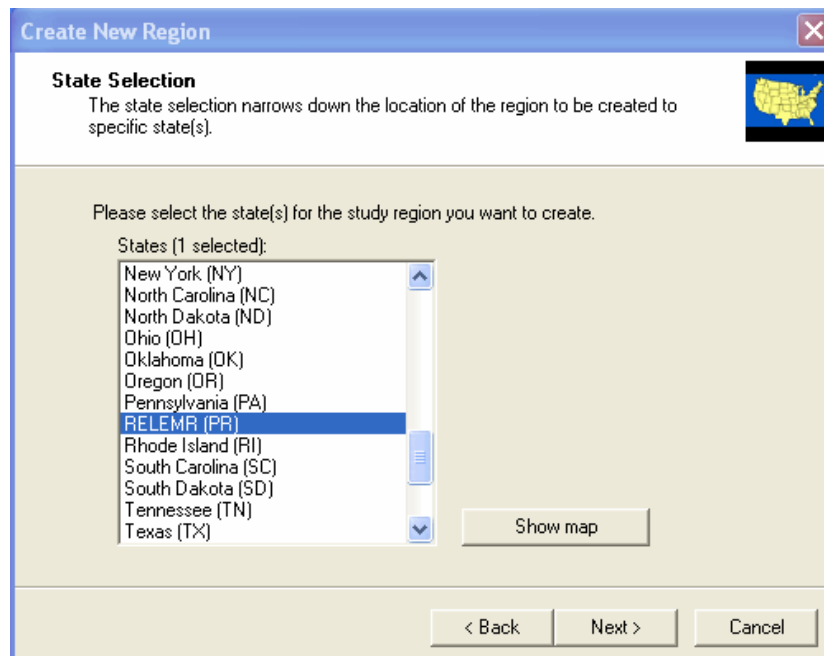
- Click **Next** to move to the Hazard Type window.
- Verify that ONLY the **Earthquake** option is checked,



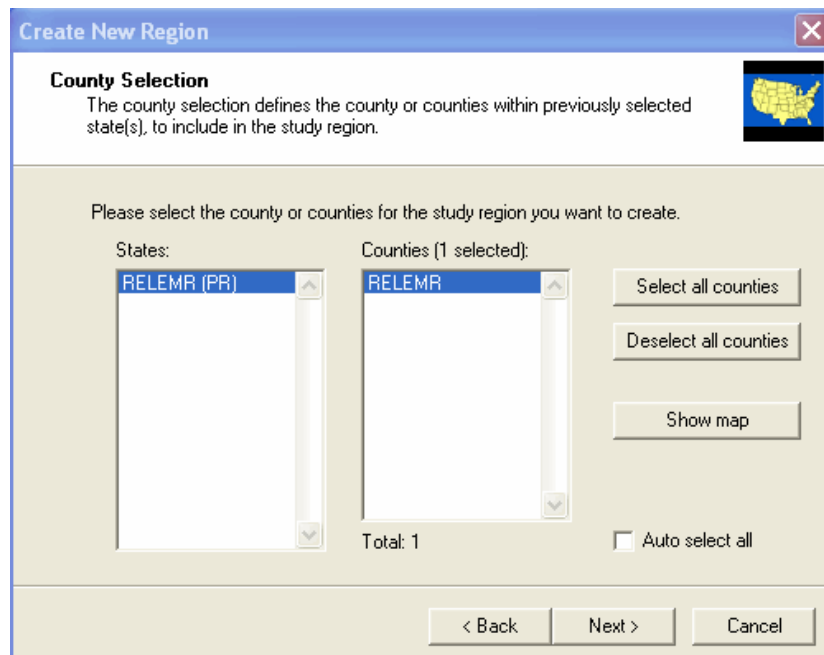
- Click **Next** to move to the Aggregation Level window.
- Choose **Census Tract** as the aggregation level.



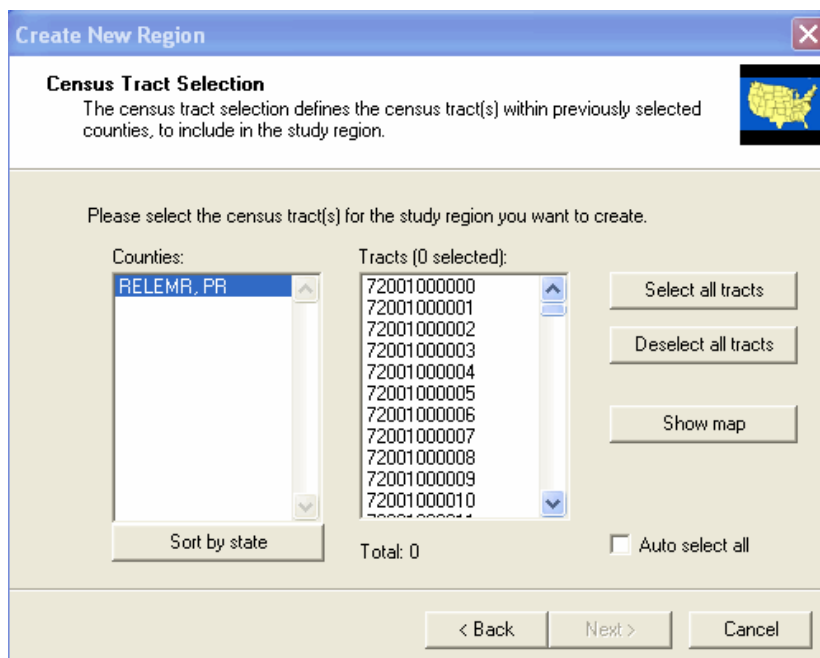
- Click the **Next** button to move to the State Selection window.
- Choose **RELEMR (PR)** for the state to include in your study region.



- Click the **Next** button to move to the County Selection window.
- Choose **RELEMR** for the county to include in your study region.



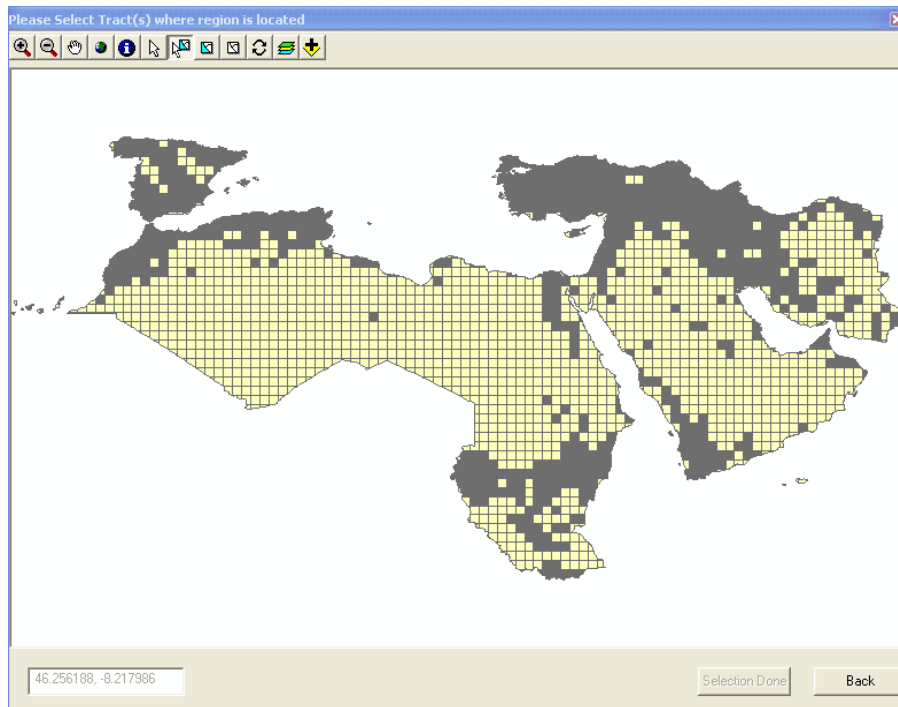
- Click the **Next** button to move to the Census Tract Selection window.



*There are two ways to select Counties or Tracts. The first is by selecting the County Names (as we did above) or the Tract numbers. The second is by selecting the Counties or Tracts from the Map View. We will use the second method in the following step.*


- Click the **Show Map** button to move to the Map Selection window.

**IMPORTANT NOTE:** Because of the large number (140K) of grid cells in the RELEMR Region the Map View will take about 5 minutes to display in window on a typical machine

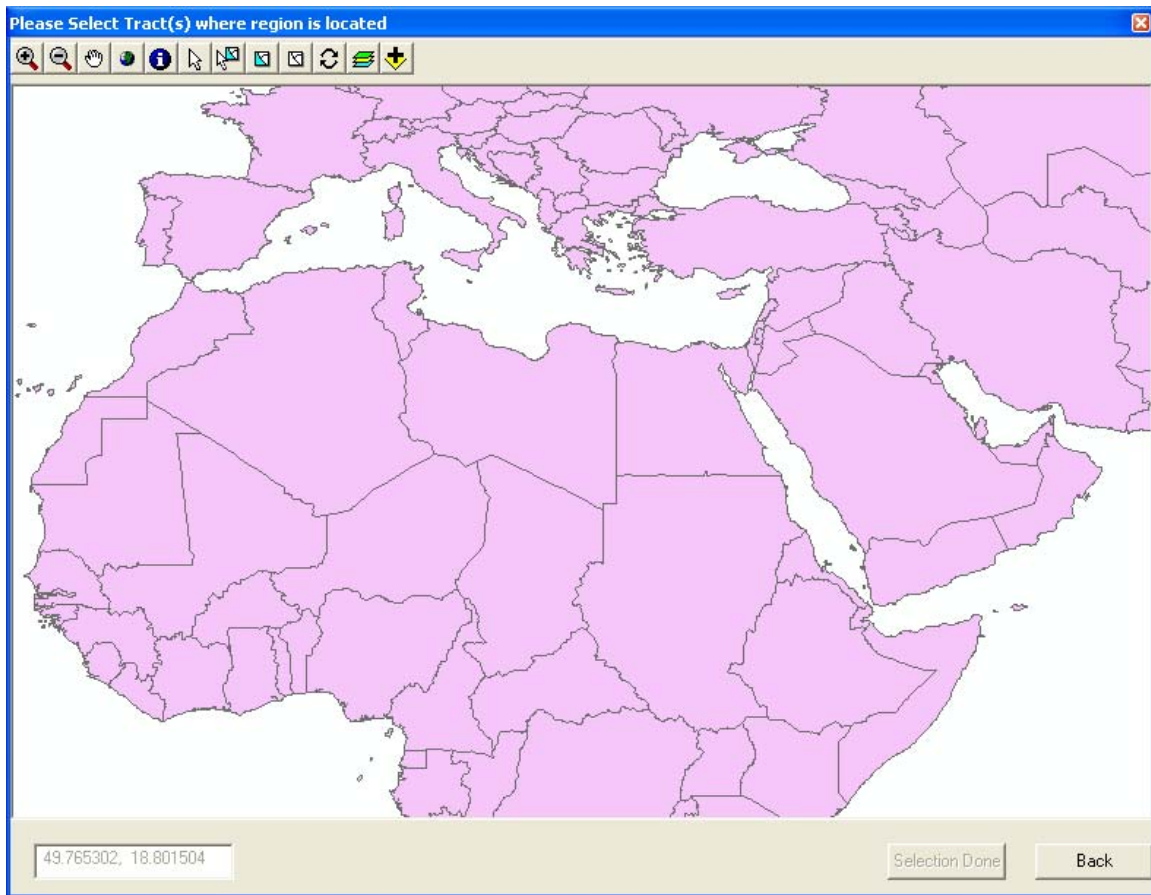



- Use the **Select Features** button to select tracts of interest.

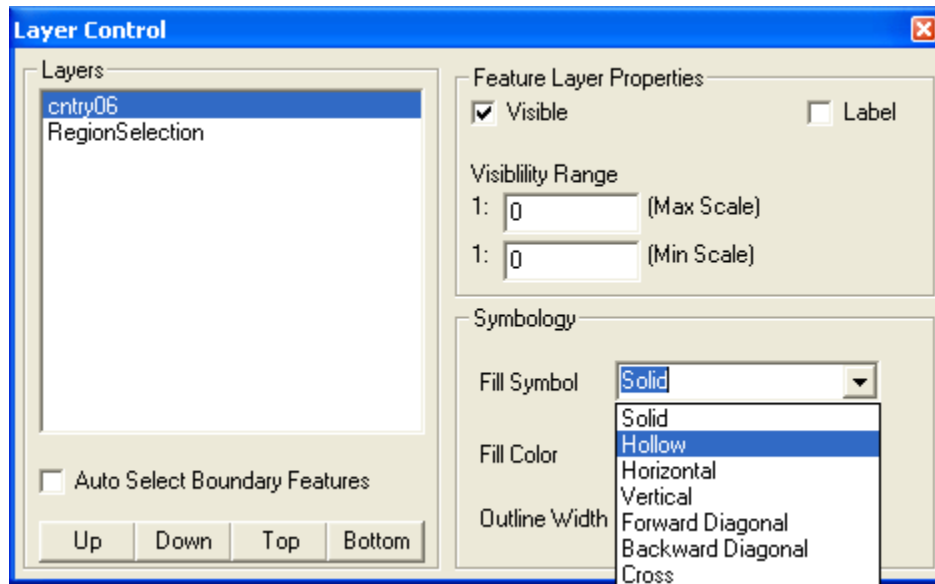
The Map View provides simple tools such as pan, zoom, info and add data to enable you to navigate through and select the data. Data can be added to the dialog box to make selections easier, data such as county boundaries, administrative boundaries or jurisdiction boundaries can be added.

- For this example, we will use the **Add Data** button  to add a Country boundaries layer for guidance in selecting a study region incorporating Amman, Jordan. Navigate to the folder containing a Country boundary file. For this example, it is at `\\RELEMR\WorldData\data\cntry06`.

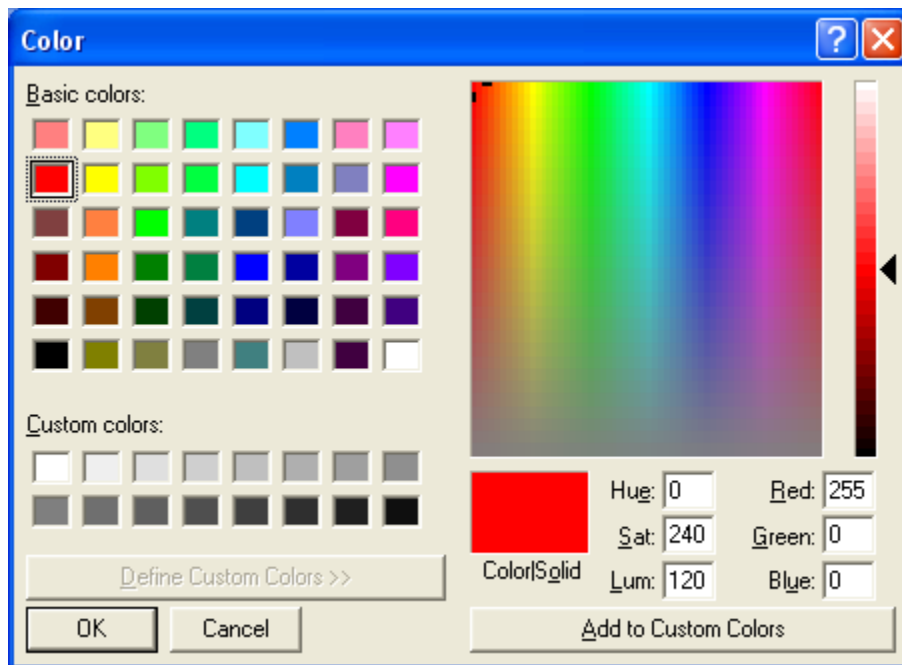




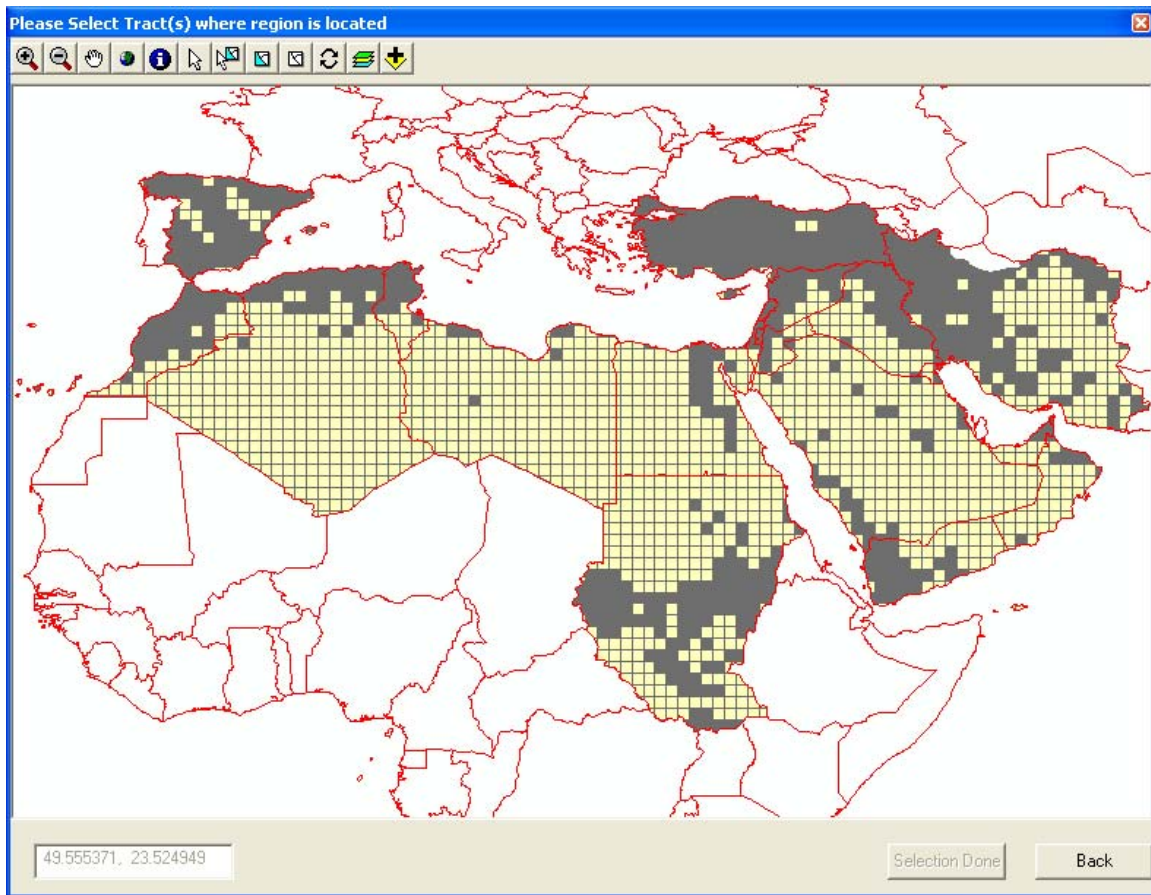
- To set the Country boundaries layer so that fill does not display, click on the **Layer Control** tool 




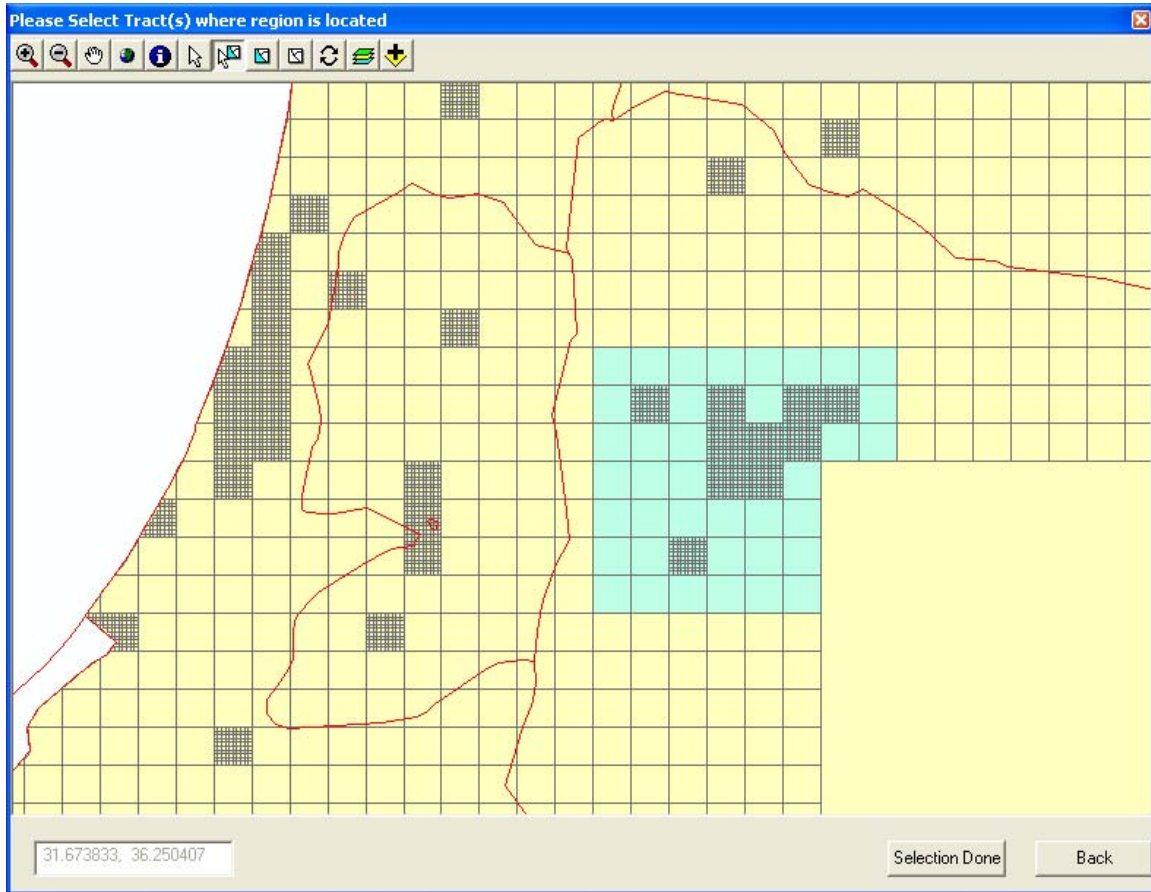
- Change the **Fill Symbol** to **Hollow** as shown above.




- It also helps to change the **Outline Color** to something brighter as shown above.



- Use **Zoom Tool**  to zoom into your area of interest.

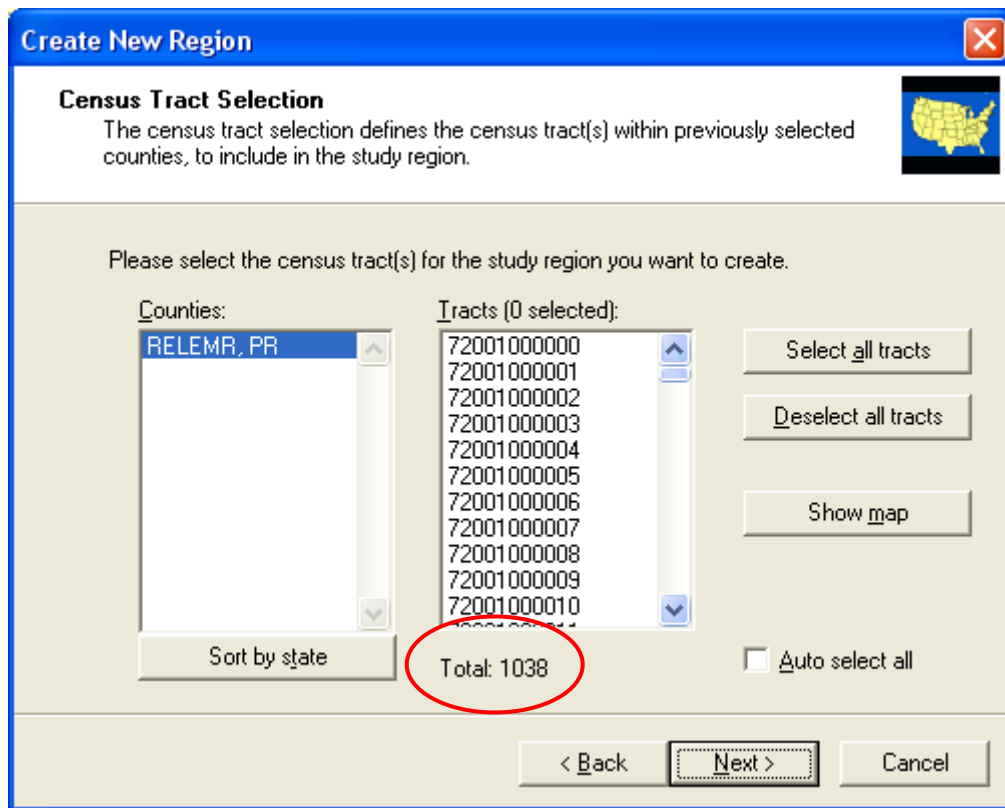


- Use **Select Key**  to select the grid cells you wish to analyze.

**Hint:** Hold the shift key to highlight areas for selection or de selection.

**NOTE:** When using the free version of SQL Express that ships with HAZUS, try to keep the area of analysis to **fewer than 4,000 grids**. Otherwise the 4GB SQL limitation may be exceeded and some of the analyses results will be excluded.

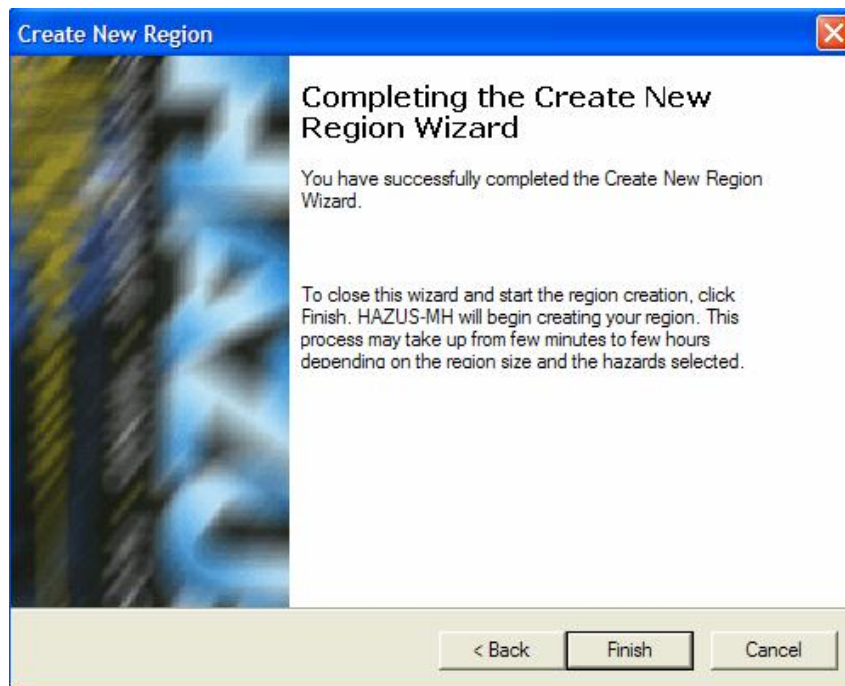
- Click on **Selection Done** button



- After selecting it will take a few minutes to process and return back to the Census Tract Selection window.

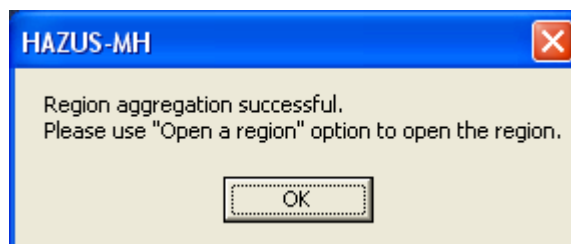
**NOTE:** At this point it is a good idea to confirm that the **Total** number of tracts (grids) selected is **less than 4,000** depending on the user's license restrictions with SQL Server.

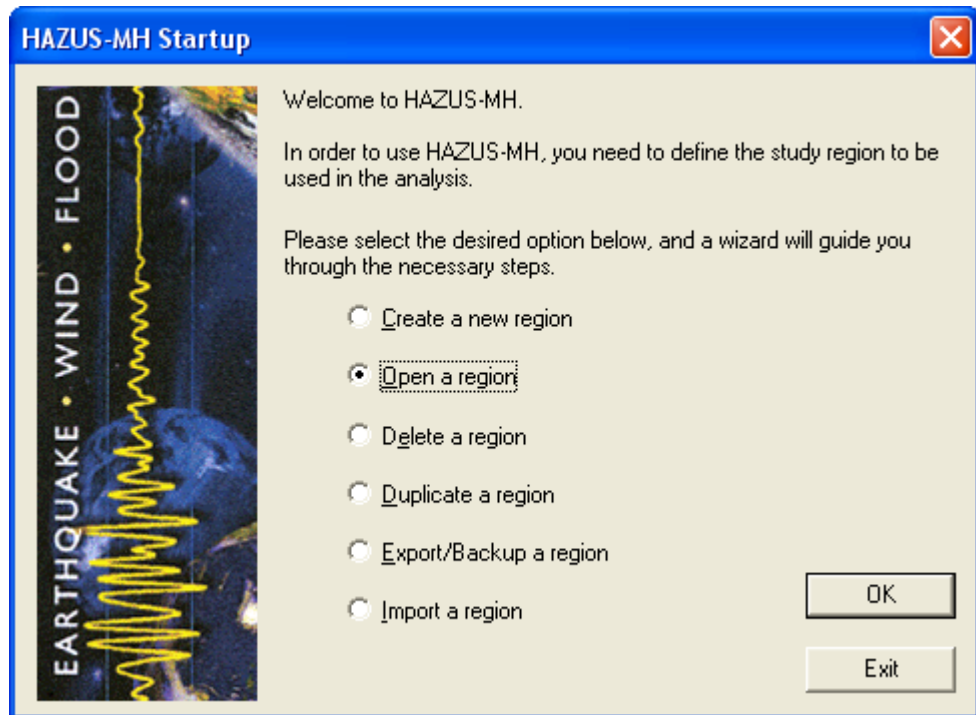
- Click the **Next** button to move to the final screen of the Study Region Creation wizard.



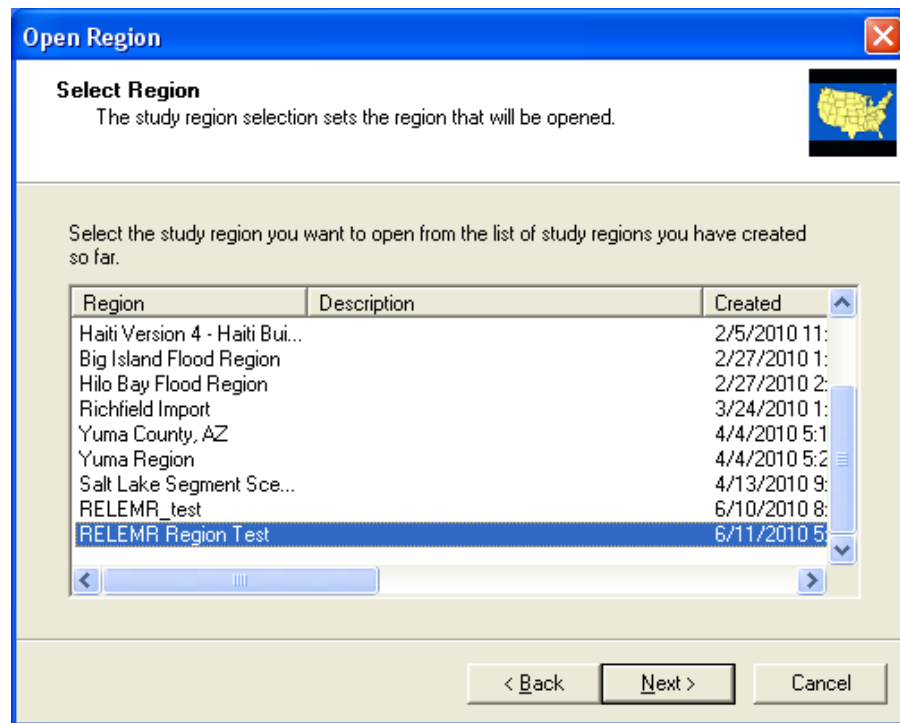
- Click **Finish** to complete the new region creation process.

*When the region creation has completed, the HAZUS-MH startup screen will appear.*

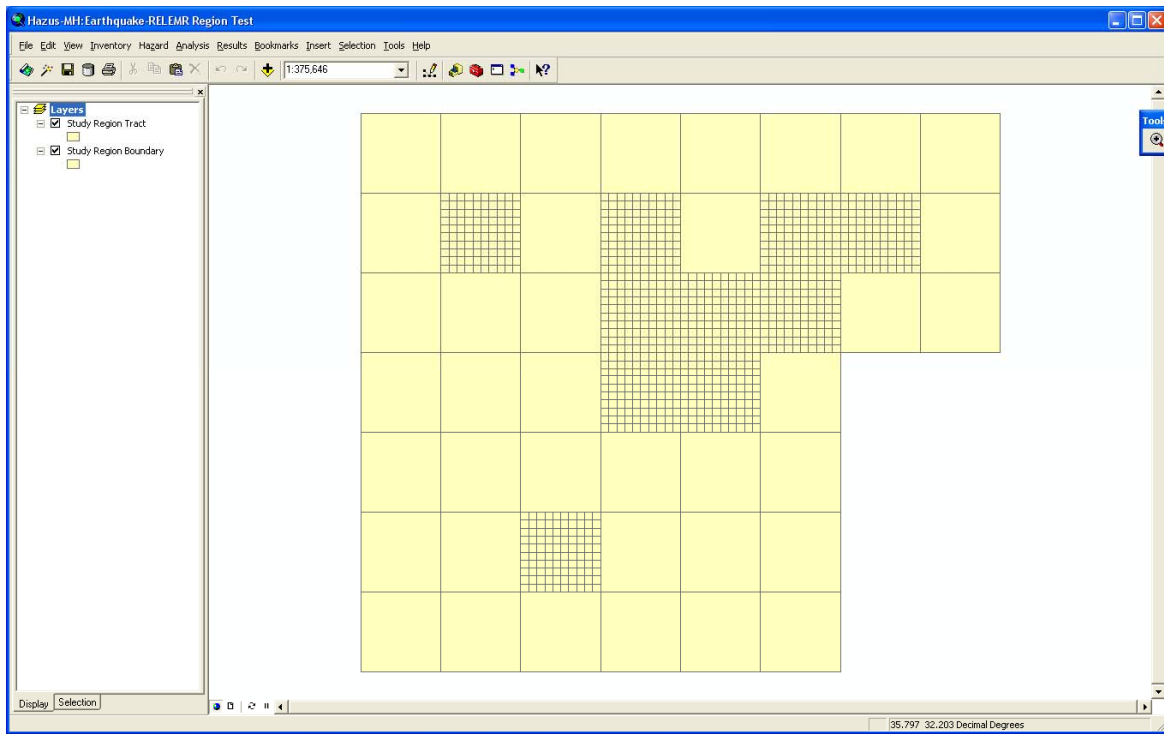





2. Open the study region
  - Open the **RELEMR** region.



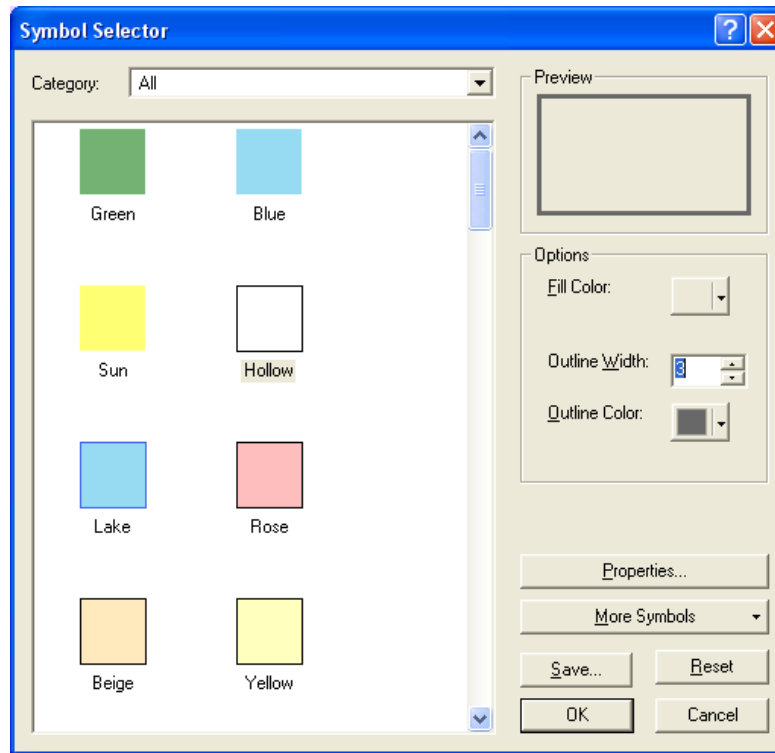





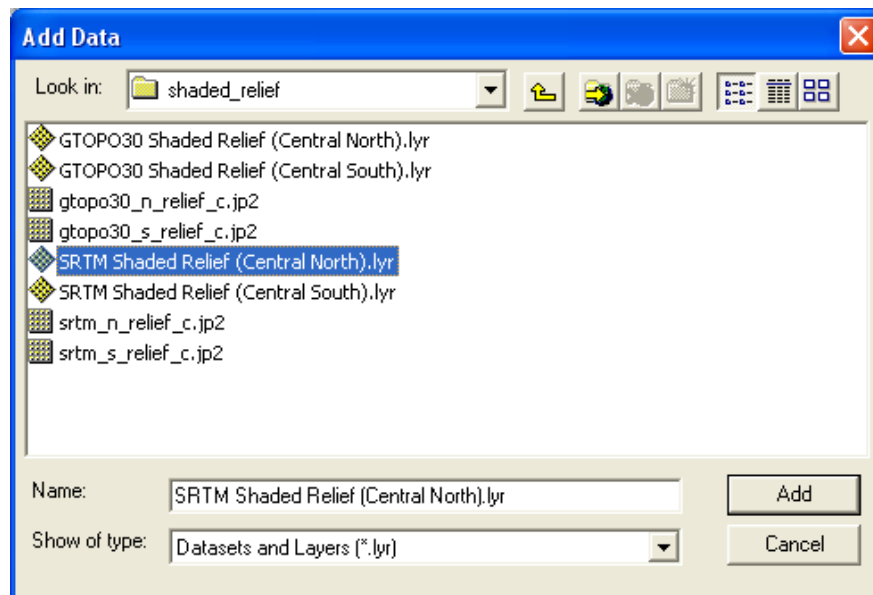
## Adding Base Map Layers

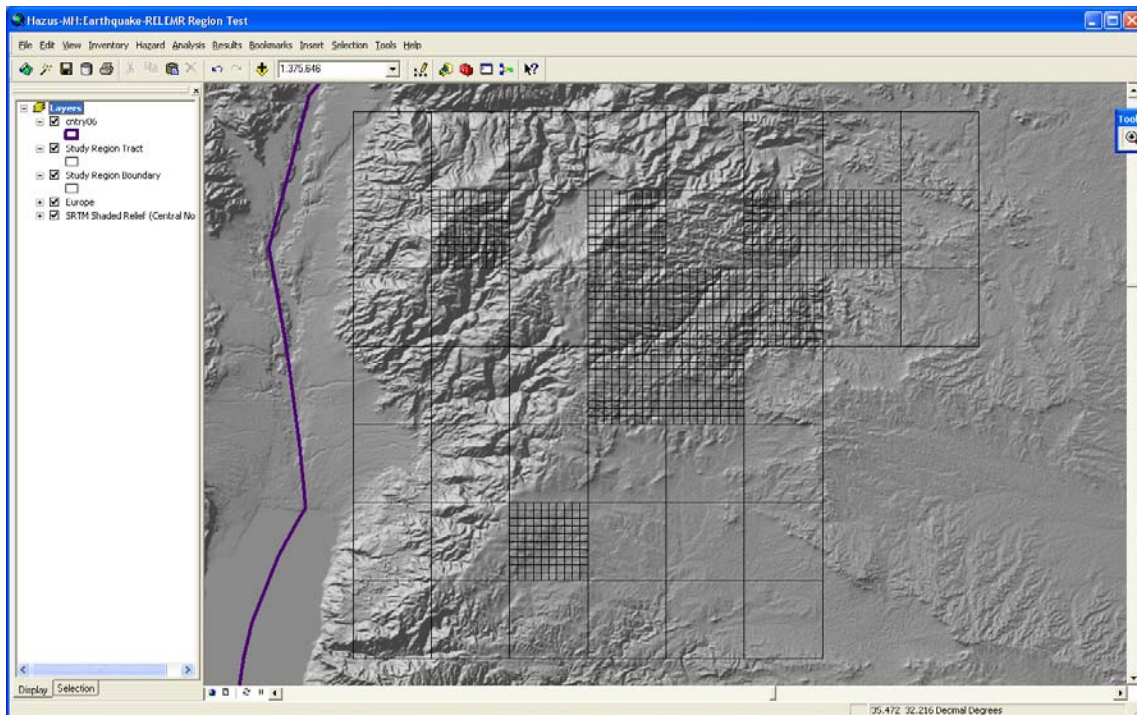
- While not required for an earthquake loss estimation analysis, the view can benefit from base layers added to the ArcMap Table of Contents
- For this example, we will use the **Add Data** button  to add a Country boundaries layer from <\\RELEMR\WorldData\data\cntry06>
- Double click on the symbol beneath the Country layer in the Table of Contents to change the symbology to hollow and increase the line width:





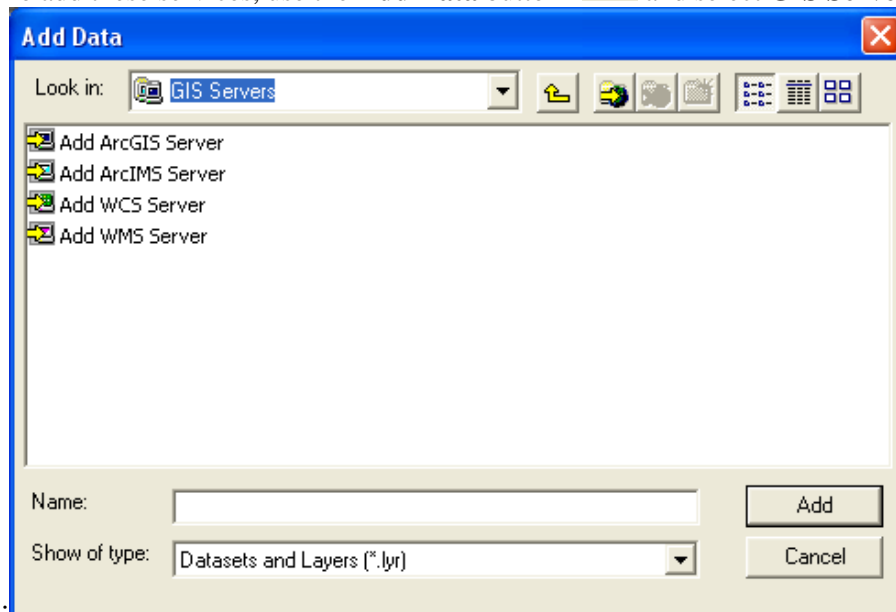
- We will use the **Add Data** button  to add a hillshade located here \\RELEMR\WorldData\shaded\_relief\SRTM Shaded Relief (Central North).lyr that will illustrate the important role topographic relief will play later when we utilize ground motion maps.



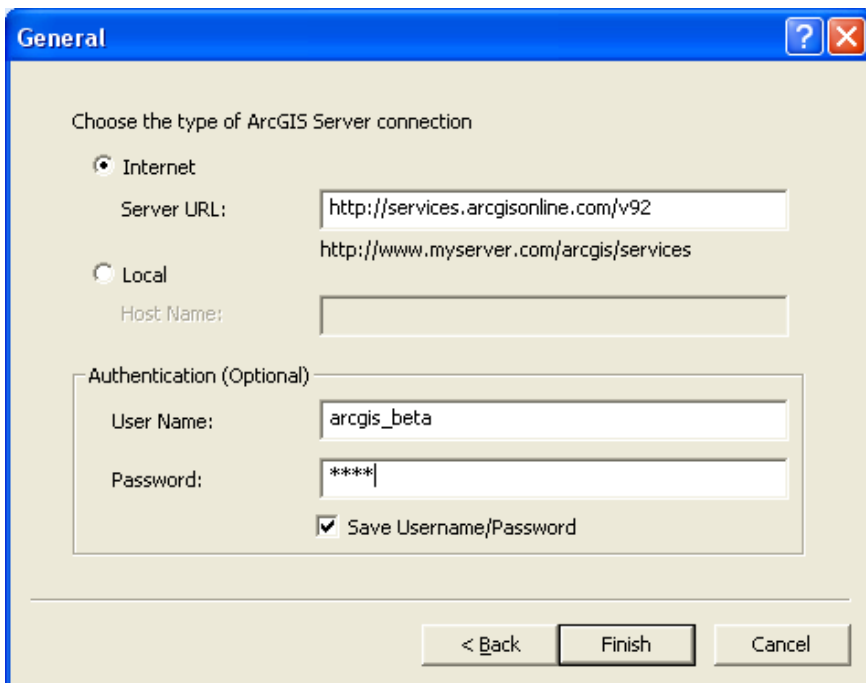
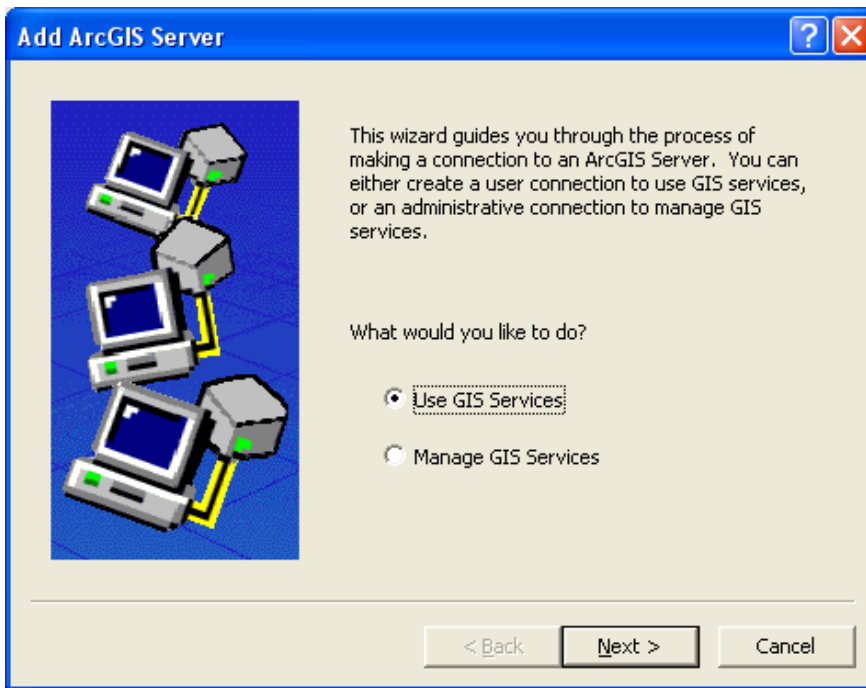


- Another extremely useful way to add base data is to use **ArcGIS Online Services**, such as those available from ESRI .

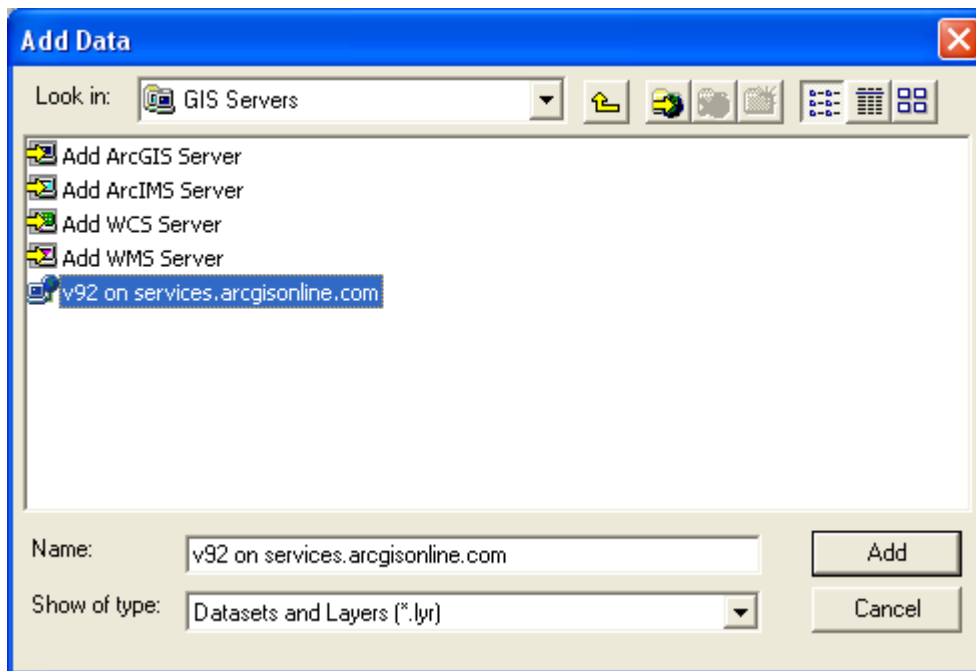
- To add these services, use the **Add Data** button  and select **GIS Server**



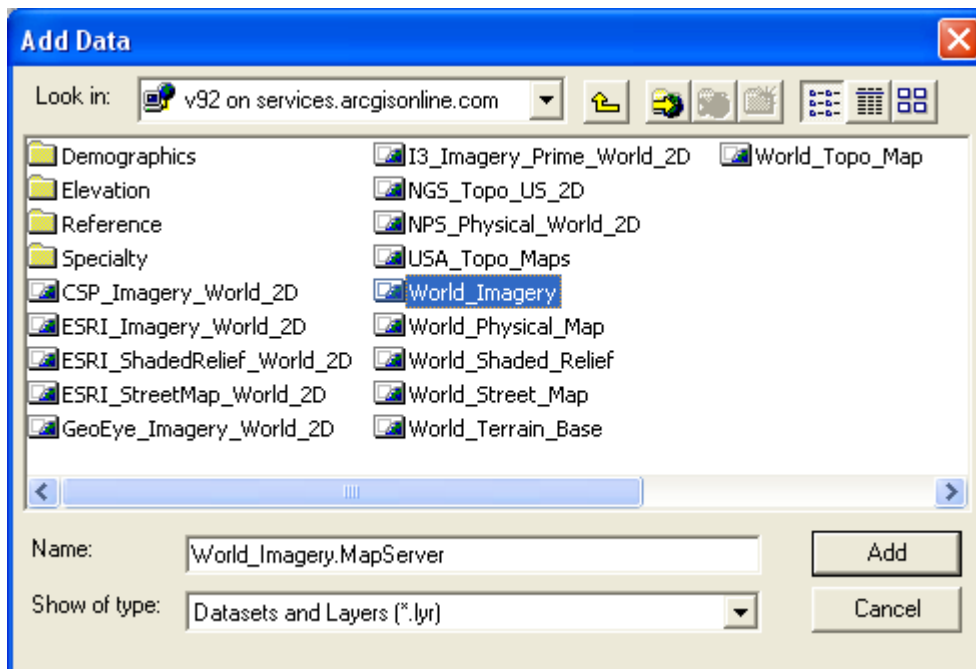
- Select **Add ArcGIS Server** and select the radio button for **Use GIS Services**:



- This service is provided streaming over the internet using:  
<http://services.arcgisonline.com/v92>
- **User Name:** *arcgis\_beta* and **Password:** *beta*



- Select the new **ArcGIS Server** and add **World Imagery** and/or other layers to your base map:



## Step 2 – Developing and Incorporating Ground Motions and Hazard Information

In the U.S., there are many options available for a HAZUS earthquake model user to define a scenario or utilize ground motions from a real event. These options include selecting from a database of historical earthquakes, from a set of fault sources used in the development of the USGS National Hazard Map, selecting a probabilistic or annualized loss ground motions based on USGS probabilistic mapping, and inputting user defined ground motions from a network of ground motion monitoring instruments such as ShakeMap [www.shakemap.org](http://www.shakemap.org) or developed by users outside the HAZUS program. The user supplied ground motions are required to be in a geodatabase format and include layers of ground motion: peak ground acceleration, peak ground velocity (in/sec), and spectral accelerations at 0.3 and 1.0 seconds to represent short and long period ground motions, respectively.

For this application, we recently created an M 7.0 Dead Sea scenario that is both credible and will impact our Amman area study region

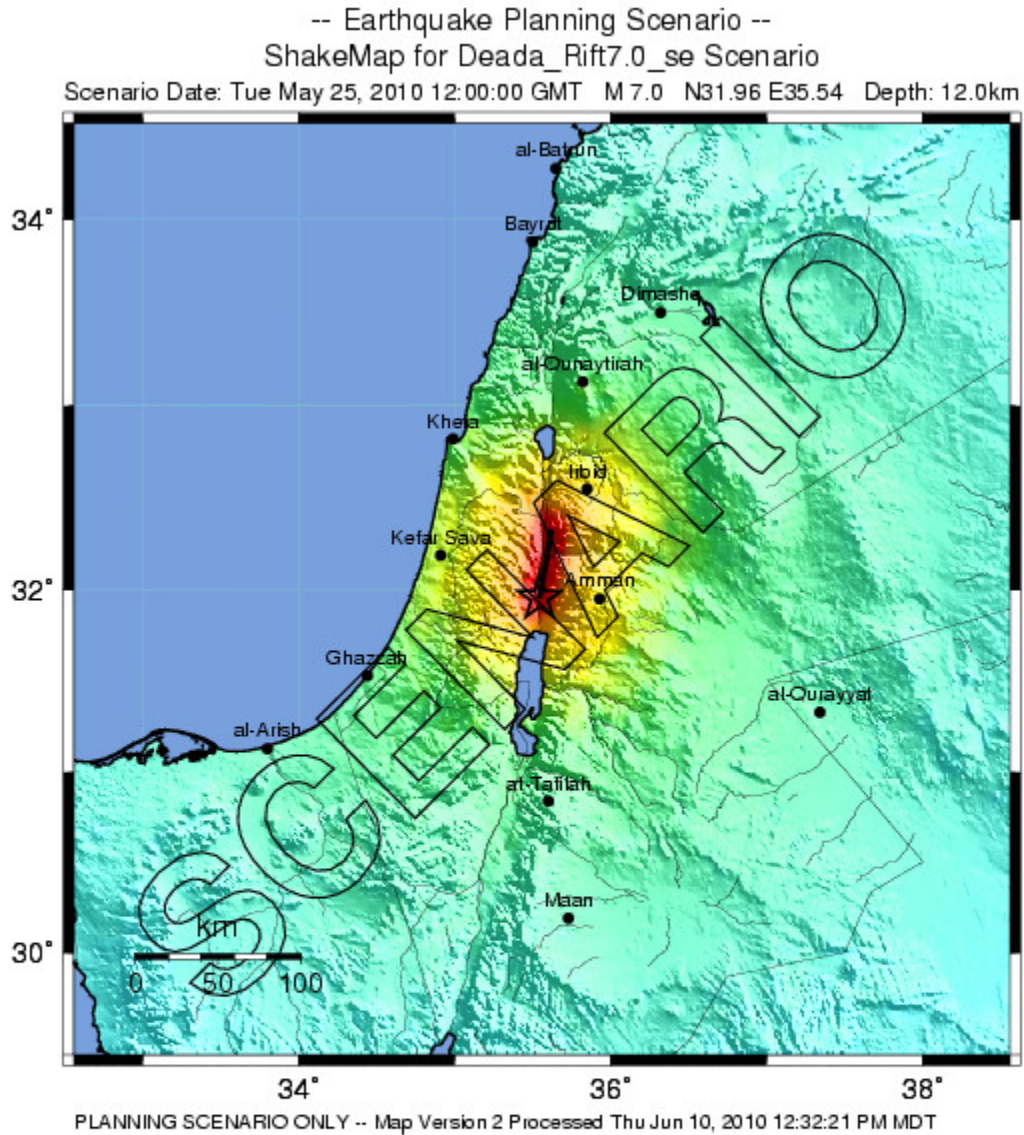
<http://earthquake.usgs.gov/earthquakes/shakemap/list.php?s=1&n=global&y=2010>

The screenshot shows the USGS ShakeMap Archive website. The page title is "ShakeMap Archive" and it displays search results for "ShakeMap Scenarios in Global during 2010". The results table shows two entries:

MagName/Epicenter	Date	Time	Lat	Lon	Event ID
7.0 Dead Sea Rift M7.0 Scenario	May 25 2010	12:00:00 UTC	31.95535	543	Dead_Sea_Rift7.0_se
7.2 Teton Fault M7.16 Scenario	May 19 2010	12:00:00 UTC	43.800-110.700		Teton7.16_se

The website also features a navigation menu with categories: EARTHQUAKES, HAZARDS, LEARN, PREPARE, MONITORING, and RESEARCH. The footer includes links for Accessibility, FOIA, Privacy, Policies and Notices, and the U.S. Department of the Interior and U.S. Geological Survey logos.





PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<.17	.17-1.4	1.4-3.9	3.9-9.2	9.2-18	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	16-31	31-60	60-116	>116
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

The ground motions above are based on modeling a M 7.0 rupture along the Dead Sea rift and are further constrained by using soil amplification parameters based on topography as described by Wald and others: <http://earthquake.usgs.gov/hazards/apps/vs30/>.

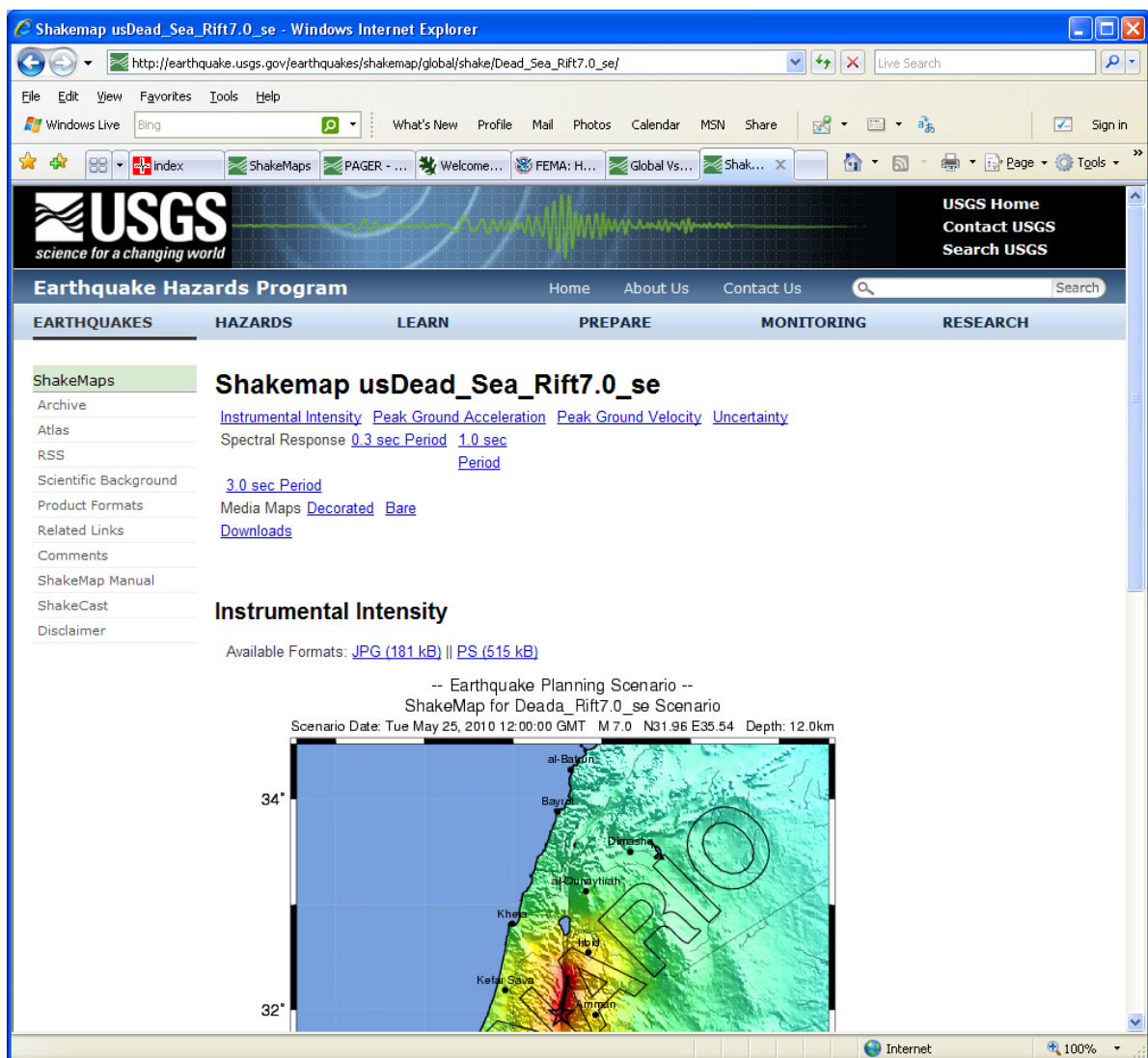
## Step-by-Step Instructions

The following instructions are divided into numbered tasks that are then followed by the detailed steps required to complete each task. Many steps are also followed by italicized comments that provide additional helpful information. Be sure to ask your instructor for clarification or assistance whenever you are unclear about a step in the exercise.

**NOTE: Completion of the exercise requires internet access.**

1. Select the “**Downloads**” section of the ShakeMap scenario.  
[http://earthquake.usgs.gov/earthquakes/shakemap/global/shake/Dead\\_Sea\\_Rift7.0\\_se/#download](http://earthquake.usgs.gov/earthquakes/shakemap/global/shake/Dead_Sea_Rift7.0_se/#download)

*Ask your instructor if you need assistance with this task.*



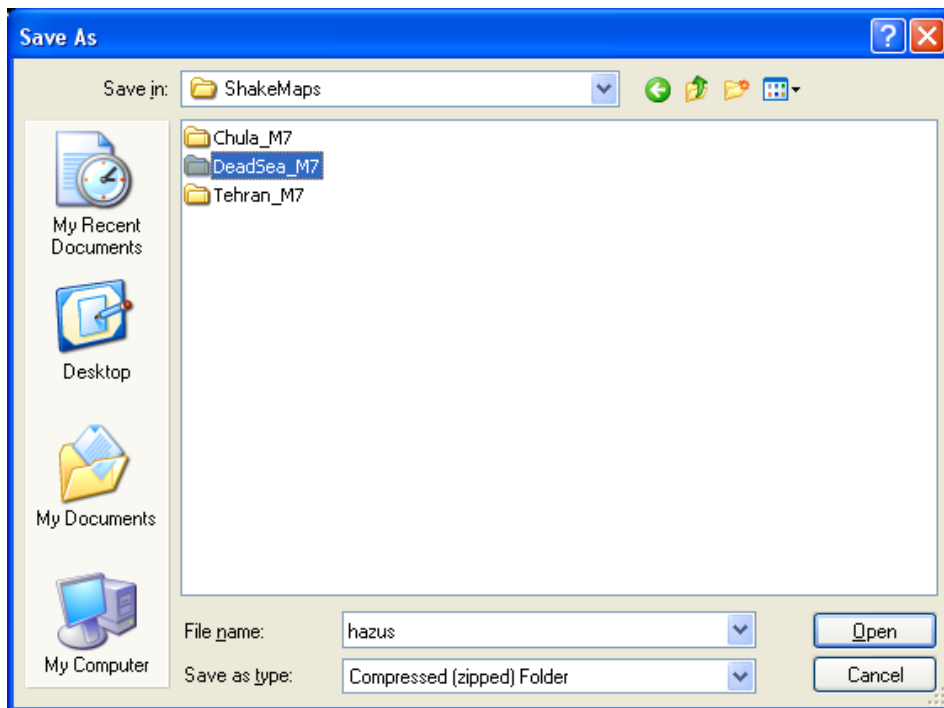
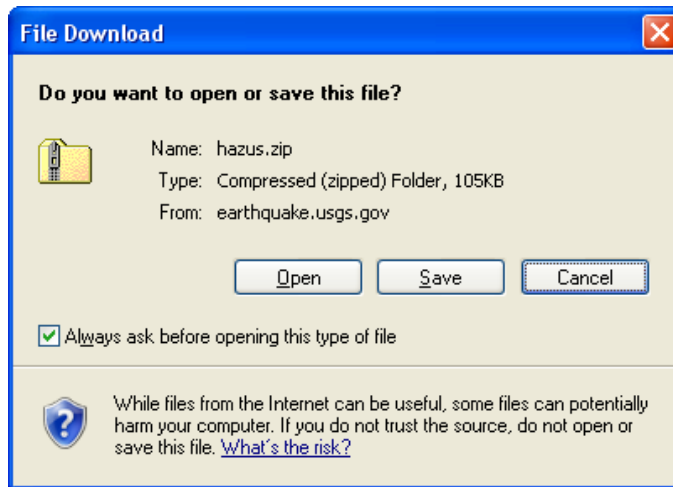
2. Scroll down to the “GIS Files” and select the **HAZUS Zip File – hazus.zip**.

Also note the .kml file format that works with the free GoogleEarth viewer. First download and install GoogleEarth [www.googleearth.com](http://www.googleearth.com) then simply double click on the .kml file and “fly into” Jordan while overlaying the semi-transparent event intensity map. Note that you can also sign up for the automatic service and have these delivered and opened automatically on your desktop [http://earthquake.usgs.gov/eqcenter/shakemap/rss\\_info.php](http://earthquake.usgs.gov/eqcenter/shakemap/rss_info.php)



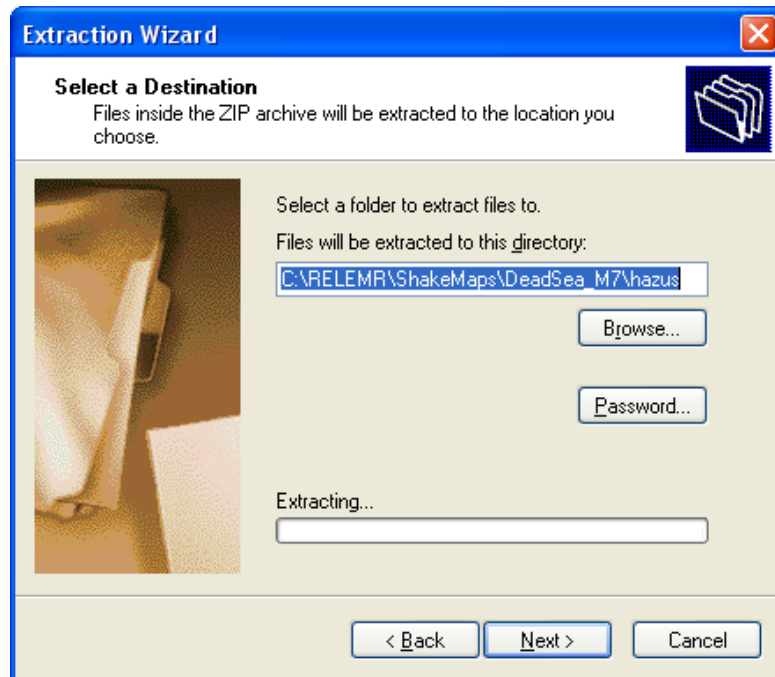
3. **Save** into a data folder:



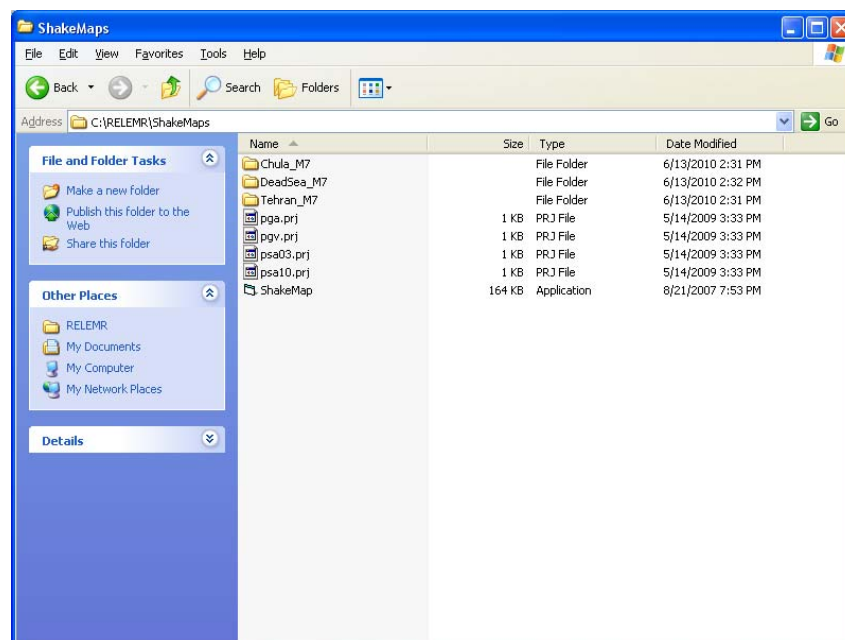


4. **UnZip and Extract** the .shp files to a data folder.

*Note these include ground motion layers for the four inputs required by HAZUS (PGA, PGV, SA 0.3 and SA 1.0). However, they are in the older ESRI shape file format and need to be converted to a geodatabase as outlined in the following steps to work with the new 9.x version of the software.*

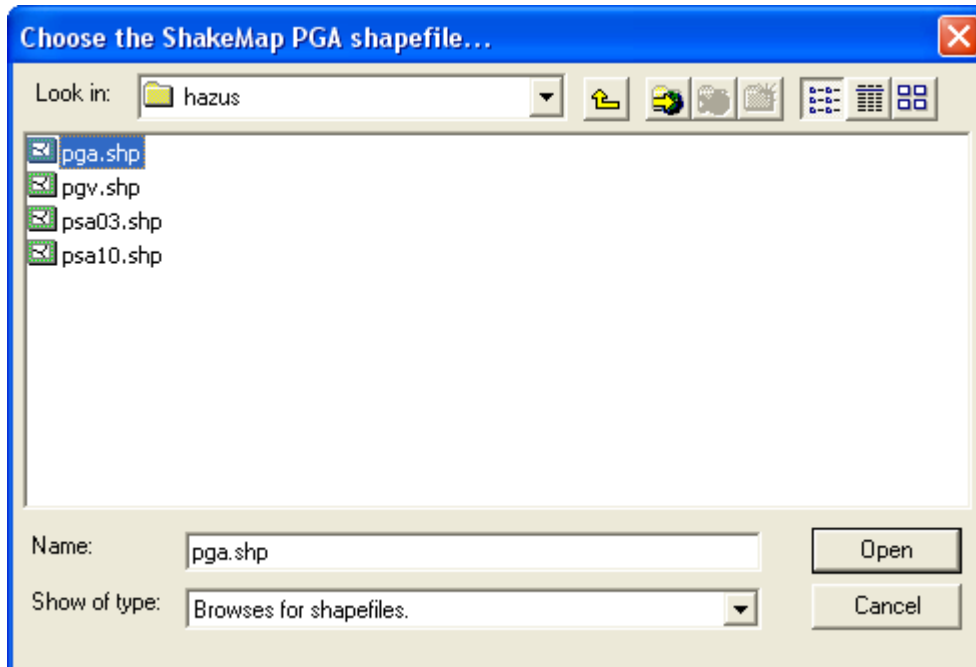


5. To use these ground motion files in HAZUS the user needs to define the projection of these files. We have already created the four necessary **projection files (.prj)** that can be directly copied to the folder containing the ground motion .shp files. This will automatically provide the correct NAD '83 Geographic projection required by HAZUS when the **ShakeMap.exe** utility creates the geodatabase in the next step.



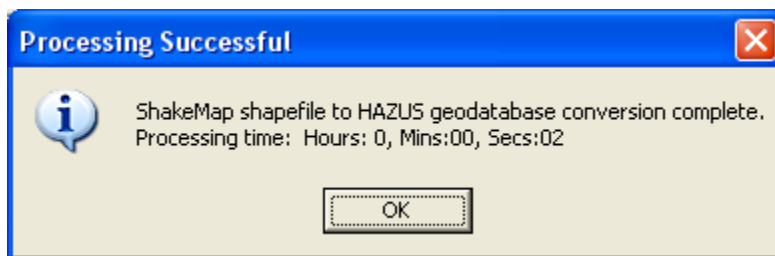
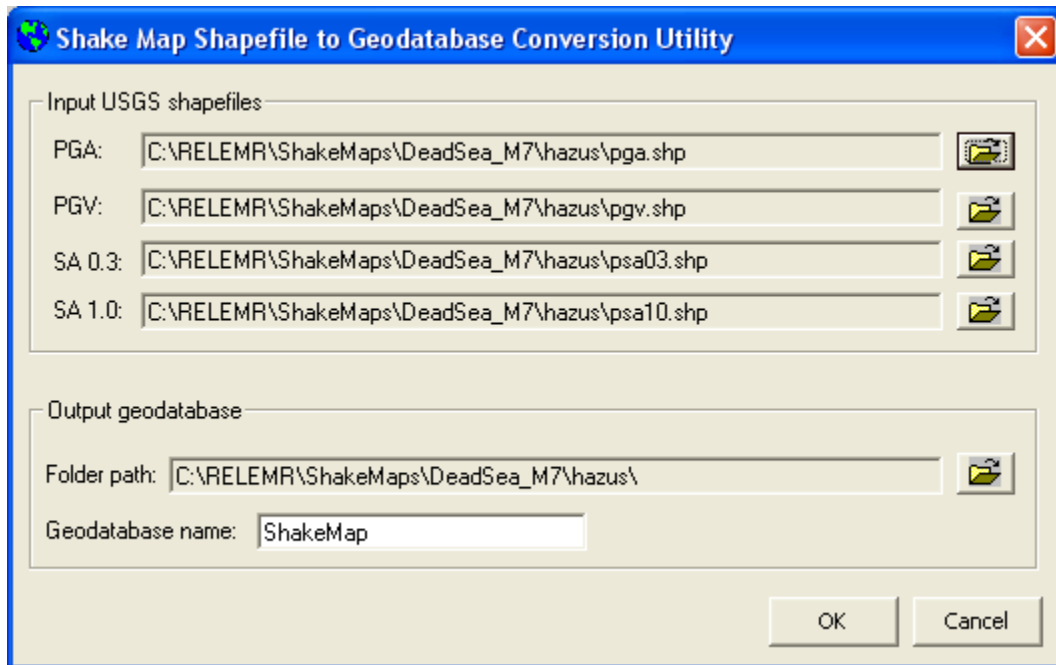
6. To convert the ShakeMap shape files to the correct geodatabase format, double click on the **ShakeMap.exe** utility.

*Note that this utility is provided free with the HAZUS-MH program and is located in the ShakeMap Utility folder on the Setup DVD. These do not automatically move to the local machine during a typical program installation, therefore, the user will have to manually copy the file or run it from the Setup DVD. More detailed instructions on using this utility are provided in the ShakeMap Instructions.doc.*



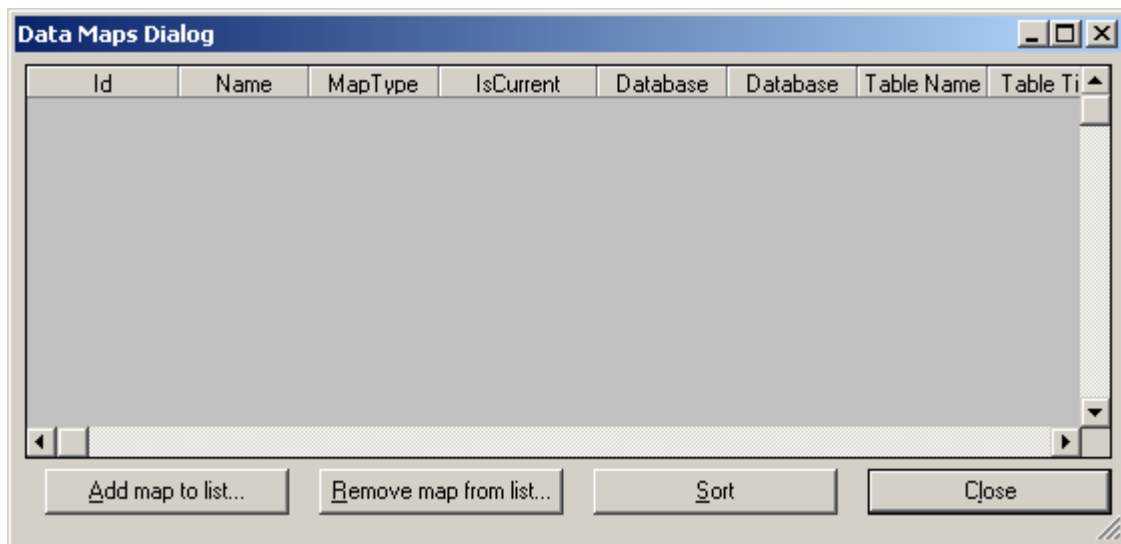
7. Select the folder icon to browse to and upload the 4 shape files as shown.

*Be extra careful not to enter a file on the wrong line, for example if pgv.shp is loaded in pga.shp the loss calculation results will be erroneous. Note that it will automatically create and name the geodatabase we need to utilize for the loss estimation. An error may occur at this utility looks for a specific filename that includes “\_data”, however, the global ShakeMap product may be named slightly differently. Please see solution below.*

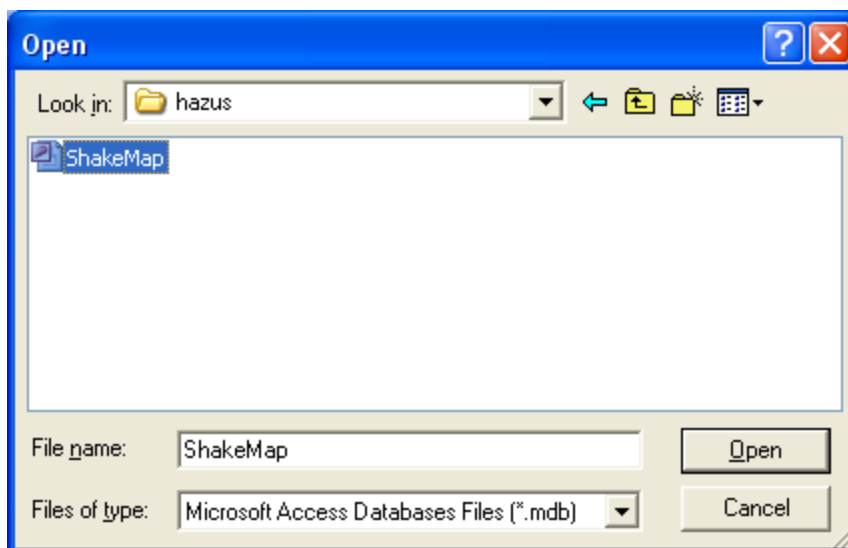


**Note:** There are two processes that will now need to be completed in the HAZUS program. These include pointing the program to the ShakeMap geodatabase and then selecting the ShakeMap scenario as the user-supplied earthquake scenario.

8. Open your HAZUS study region and from the **Hazard** menu choose **DataMaps** to open the Data Maps Dialog:

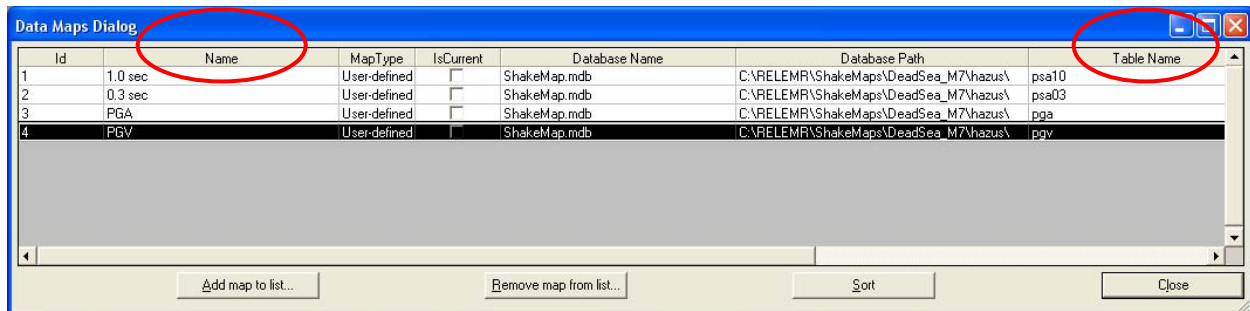
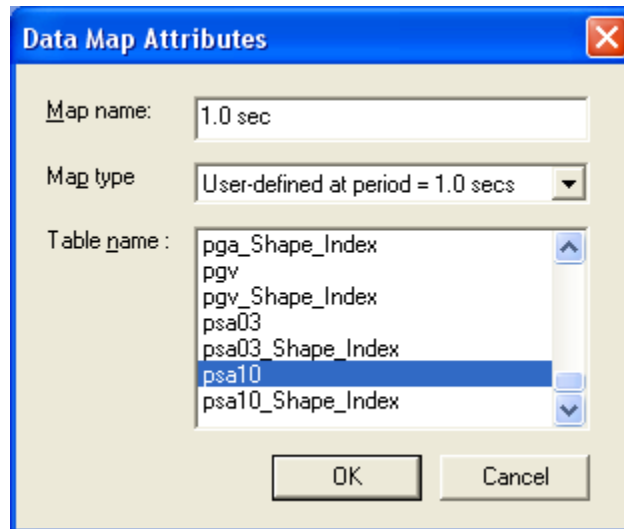


- Select the **Add map to list...** button on the bottom left corner. Browse to and open the **ShakeMap.mdb** geodatabase that we created above. In this case it is located at [\\RELEMR\ShakeMaps\DeadSea\\_M7\hazus](\\RELEMR\ShakeMaps\DeadSea_M7\hazus)

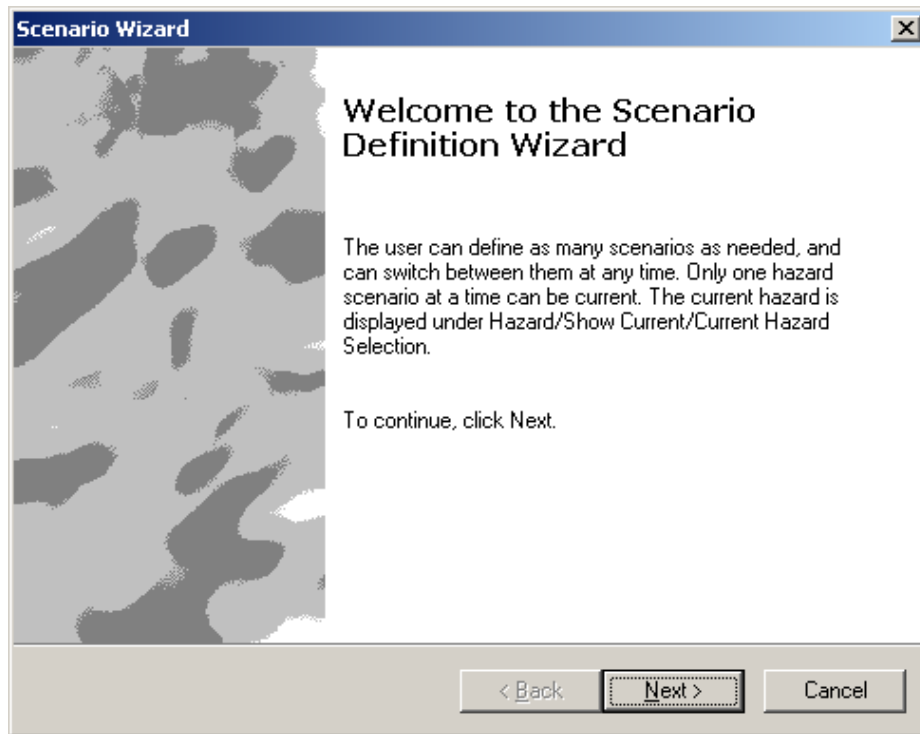


- The program needs to be pointed to each of the 4 data tables to define the ground motions used by HAZUS. The Data Map Attributes dialog will automatically open when the **ShakeMap.mdb** file is opened. The **Map name** (*typed by the user*), **Map type** (*selected using the combo box and scroll arrows*) and **Table name** (*scroll toward bottom of list and do not select the Shape\_Index files*) need to be defined as shown below. This process needs to be completed until all four map table names are defined.

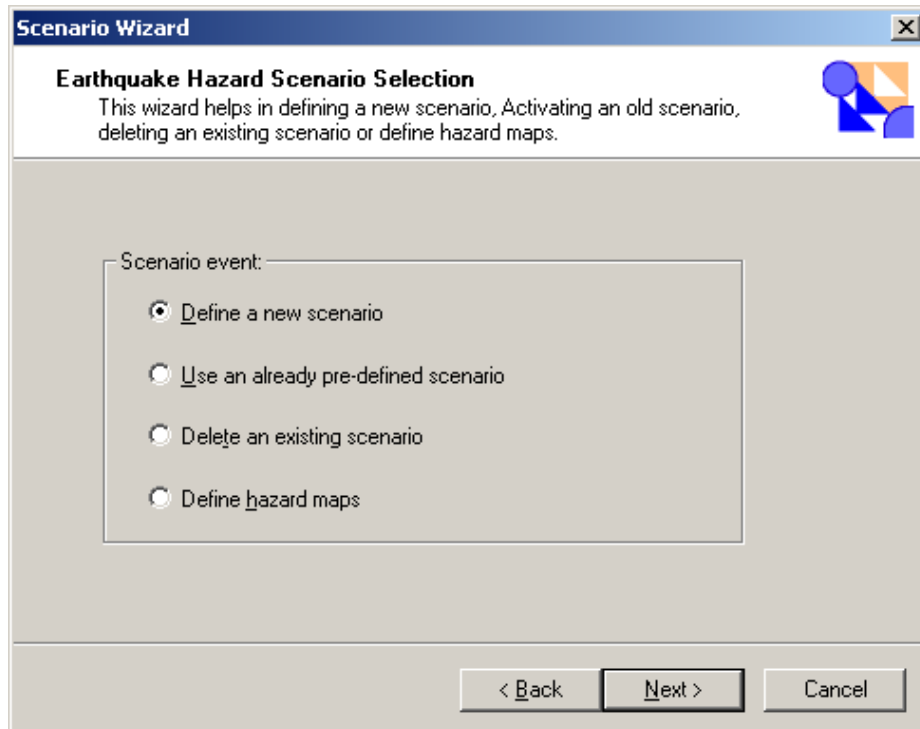
Note: This dialog is also the interface for adding hazard maps such as landslide, liquefaction, tsunami and dam inundation if available for your study region.



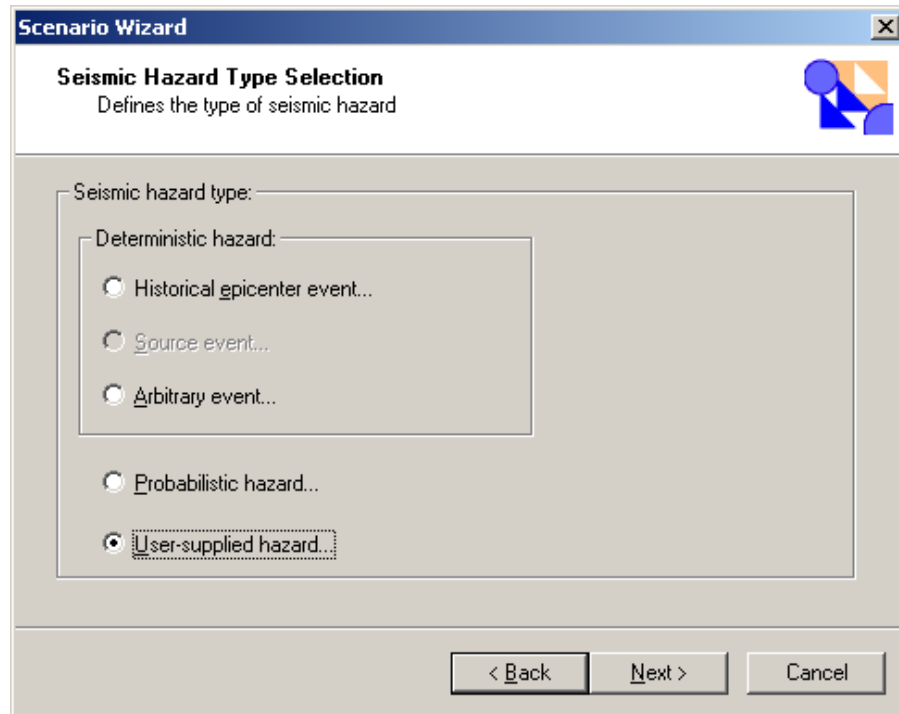
- Review the Data Maps Dialog box to confirm no layers were entered into the wrong ground motion types. Make certain the **Table Names** and the user entered **Name** fields match for each ground motion type.
- From the **Hazard** menu choose **Scenario** to define the earthquake scenario for this analysis:



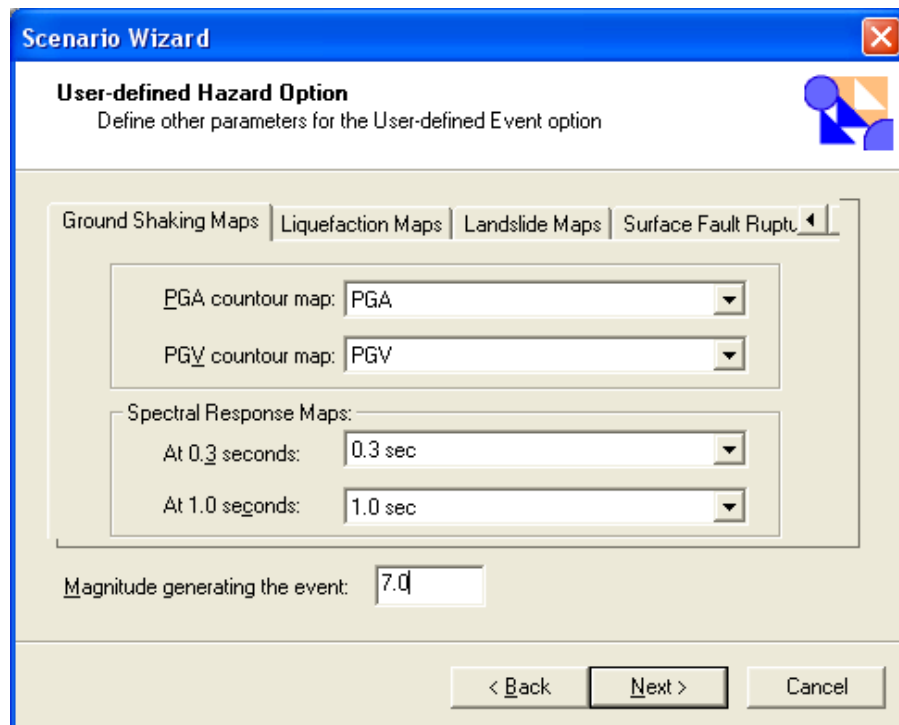
- Select the **Next** button.



- Use the radio button to **Define a new scenario.**

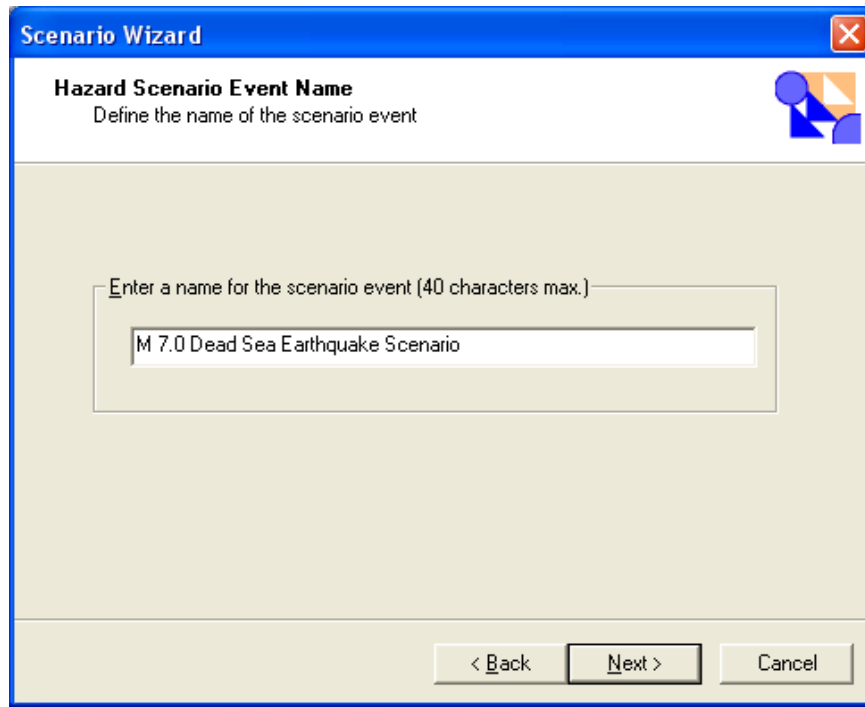


- For Seismic Hazard Type select the **User-supplied hazard...**

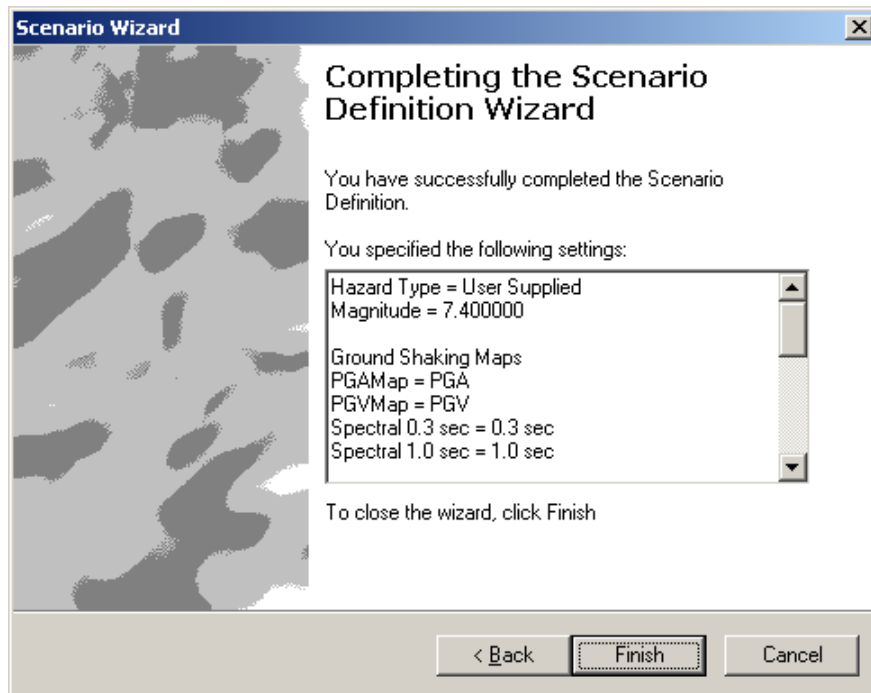




- Point each combo box to the ground motion tables we named earlier in the exercise and indicate the magnitude generating the event.

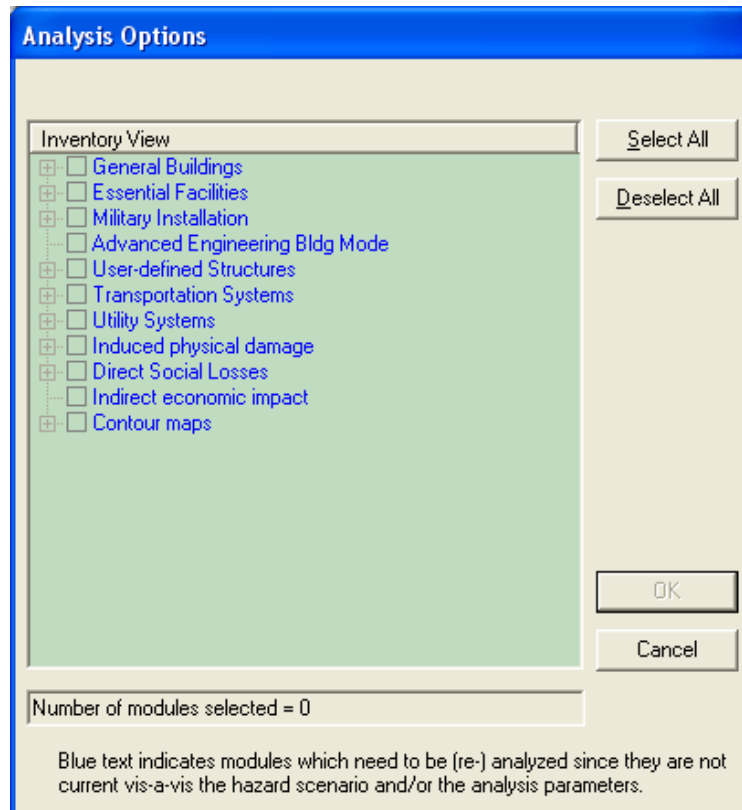


- Clearly name the event being careful not to make typographical errors as each results page will include the event name then press **Next**.

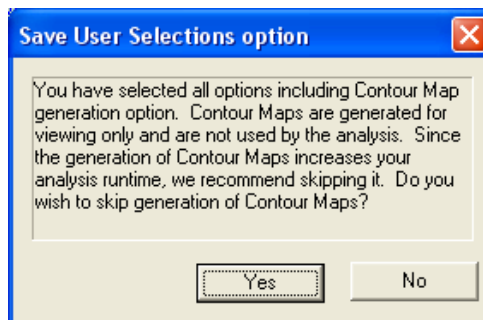


## Step 3 – Run Analysis

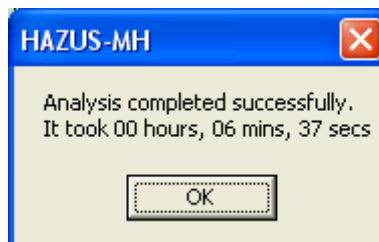
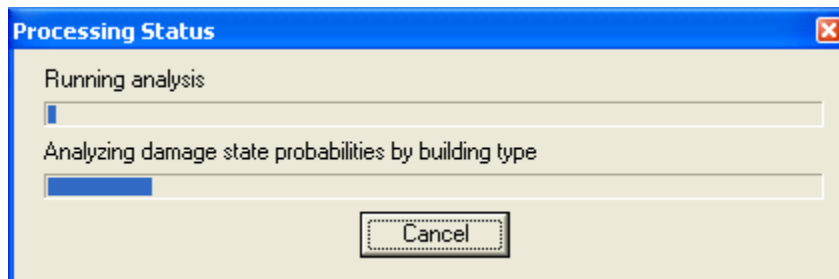
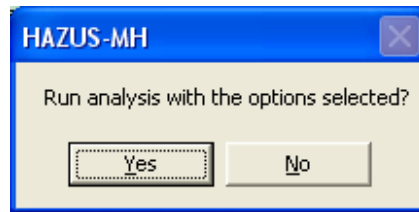
Under the **Analysis** drop down menu-select **Run** and the **Analysis Options** screen will pop up:



- Choose the **Select All** button and answer **Yes** to skipping the creation of ground motion contour maps since you are providing these:



- Then select **Okay** and **Yes** to running the analysis:



- For this scenario the analysis completed in 6 minutes and 37 seconds.
- A broad range of results including tables, thematic maps and reports are now available under the **Results** drop down menu.

# **Earthquake Loss Reducing Earthquake Losses in the Extended Mediterranean Region (RELEMR): Ankara, Turkey 2010**

## **Abstracts**

## **An Overview of Marine Hazards in the Extended Mediterranean Region**

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### **Abstract**

Population growth, large utilization of coastal areas for several purposes, environmental degradation, climate change, some poorly regulated industries, and continued economic uncertainties cause the coastal communities become more vulnerable against marine hazards. The life and property losses by earthquakes, tsunamis, storms, floods, volcanic eruptions, landslides, wildland fires, droughts, cyclones, storm surges and erosion show that there still are long way in front us for assessment, preparedness for disasters and evaluation of disaster mitigation policies and tools.

Mediterranean have been utilized by humanity since antiquity, and where the coastal utilization has become greatest in the last decades. There is a wide variety of types of coastal zones, with different natural, cultural, economic and social characteristics. Mediterranean grew out of the Mediterranean breezes, sea and sun. The breeze, clear waters and sun in the Mediterranean connected the peoples, ideas, patterns, developments, organizations, wars, religions, art, architecture, food and drink. The general evaluation of the available meteorological, oceanographical, geographical, geological, geophysical and historical data about Extended Mediterranean Region provides valuable information about the numerous marine hazards. Those have affected human life and property, marine environment, economy and social life of the coastal communities for several millenniums.

Although it has not been proved that the Noah Flood which is a legend in many cultures is now believed to be a real event which took place in the Black Sea region approximately 7000-5000 years before present. In late 1997, oceanographers William Ryan and Walter Pitman of the Lamont-Doherty Earth Observatory in Palisades, New York, published evidence from sediment cores that about 5500 B.C., the rising Mediterranean Sea topped the shallow Bosphorus straits and began gushing into the nearby Black Sea, until then a landlocked lake. The flood raised water levels 15 centimetres a day; by the time it ended, the sea was up about 150 meters and an area the size of Florida was underwater (Science, 20 February 1998, p. 1132). Many oceanographers consider this flood scenario credible, but archaeologists are sceptical that the deluge altered the course of civilization.

Earthquakes and tsunamis have taken role of mega events in history among the marine hazards in Extended Mediterranean. Tsunamis are generally triggered by earthquakes and/or submarine-sub aerial landslides. There are recent considerable efforts establishing tsunami watch systems but still there are much work, time and efforts necessary to establish them (Tinti, 2003). The coastal areas in the region have experienced earthquakes and tsunamis many times in history (Altinok and Ersoy, 2000, Papadopoulos, 2000). The generation mechanisms and characteristics of these tsunamis have not been well described. According to the historical information, or distribution of fault zones, volcanos, and other probable tsunamigenic sea bottom deformations, there are numerous source areas which may be considered responsible for some of those tsunamis (Yalciner et. al, (2003), Tinti et. al.(2005). The arc shaped subduction zone of about 1000 km in length starts from south west of Greek mainland and follows a curve at south of Crete and south east of Rhodes island and directs towards Anatolia along North East direction near Dalaman town (Kuran and Yalciner, 1993). One of the deepest region of Mediterranean with a depth of more than 4000 m is located in between Rhodes and Dalaman region. This region can be called Rhodes - Dalaman trench and might be one of the most important tsunami prone areas in the Extended Mediterranean Basin (Minoura et. al. (2000).

Santorini, Colombus, Christiana and Nisyros were active volcanoes in the region and may be considered as the sources of potential marine hazards. The Santorini (Thera) Eruption and Tsunami in Minoan Age in Aegean Sea is the first documented tsunami in Mediterranean. One of the main centers of explosive eruptions is located on Thera (Santorini), and the eruption of the Thera volcano in late Minoan time (1600–1300 B.C.) is considered to have been the most significant Aegean explosive volcanism during the late Holocene. The last eruptive phase of Thera resulted in an enormous submarine caldera, which is believed to have produced tsunamis on a large scale. Some evidences were found however, the cause of the tsunami and its effects on the area have not been well

understood. On the Aegean Sea coast of western Turkey (Didim and Fethiye) and Crete (Gouves), the traces were found to be related to the Thera eruption. The sedimentological consequences and the hydraulics of a herca caused tsunami indicate that the eruption of Thera volcano was earlier than the previous estimates and the tsunami did not have disruptive influence on Minoan civilization (Minoura et. al., 2000).

In this study the historical earthquakes, tsunamis, volcano activities, and other coastal related disasters and marine hazards are extracted from the catalogues and from the available historical data. The results of some paleotsunami studies are interpreted to understand the locations and characteristics of probable sources, and to determine approximate intensities of some historical earthquakes and tsunamis.

In order to estimate the risk areas several tsunami events related to the major tsunami sources are modelled (Yalciner et. al. 2002, 2004, 2006). As for the preparation and development the mitigation strategies against marine hazards, the recent developments, countermeasures and motivation, the results of modeling efforts will be presented and discussed.

### **Acknowledgements**

Prof. Nobuo Shuto, Prof. Fumihiko Imamura, Prof. Costas Synolakis, Prof. Efim Pelinovsky, Prof. Stefano Tinti, Prof. Koji Minoura, Dr. Gerassimos Papadopoulos, Geophysicist Ugur Kuran, Dr. Andrey Zaytsev are kindly acknowledged for their long term, endless, valuable, cooperation, discussion and collaboration in several studies based on this presentation.

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Yalçiner, A.C., Pelinovsky, E., Talipova, T., Kurkin, A., Kozelkov, A. and Zaitsev, A. (2004). "Tsunamis in the Black Sea: Comparison of the historical, instrumental, and numerical data", *J. Geophys. Res.*, 109, C12023, doi:10.1029/2003JC002113.

Yalciner A. C., Karakuş H., Kuran U., (2006) Modeling of Tsunamis in the Eastern Mediterranean and Comparison with Caribbean, *Proceedings of NSF Workshop*, held in March in 2004 Puerto Rico, publishing by World Scientific (Eds: A. Mercado and Liu P.L.F) (in press)

## **Liquefaction-Induced Hazard and Its Effects on Structural Damage**

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### **Abstract**

Over the past decade, major advances have occurred in both understanding and practice with regard to engineering treatment of seismic soil liquefaction and assessment of seismic site response.

Seismic soil liquefaction engineering has evolved into a sub-field in its own right, and assessment and treatment of site effects affecting seismic site response has gone from a topic of controversy to a mainstream issue addressed in most modern building codes and addressed in both research and practice. This rapid evolution in the treatment of both liquefaction and site response issues has been pushed by a confluence of lessons and data provided by a series of earthquakes over the past eleven years, as well as by the research and professional/political will engendered by these major seismic events.

Although the rate of progress has been laudable, further advances are occurring, and more remains to be done. Engineers are increasingly well able to deal with important aspects of these two seismic problem areas. This presentation will highlight a few major recent and ongoing developments in each of these two important areas of seismic practice, and will offer insights regarding work/research in progress, as well as suggestions regarding further advances needed.

## **A model for a RELEMR Data Sharing Website**

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### **Abstract**

We have constructed a website that would allow data sharing between all institutions in RELEMR. The website allows the participants to upload and/or download data for the time periods before and after RELEMR meetings under the auspices of UNESCO. The exchange mechanism of the website is hosted by Kandilli Observatory and Earthquake Research Institute (KOERI) of Bogazici University and it is currently under development and evaluation. Lawrence Livermore National Laboratory (LLNL) will assist contributors in the conversion of data formats for institutions that do not provide data in specified formats. We anticipate that the process will be efficient and useful for all RELEMR participants.



## **Sayarim Infrasound Calibration Explosion**

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### **Abstract**

The large-scale calibration explosion was successfully conducted by the Geophysical Institute of Israel at Sayarim Military Range on August 26, 2009. A charge of about 82 tons of HE explosives, assembled as a pyramid on the soft sediment surface, was detonated upwards. High-pressure values were measured in the range 200-600 m, and high speed video was recorded. Preliminary analysis showed higher recorded peak pressures than the estimated values. The created crater and seismic magnitude estimated by Israel Seismic Network were smaller than expected for this on-surface charge. These results confirm that the charge design provided the necessary explosion energy generation and partition: maximum of energy to the atmosphere and minimum to the ground. The high-pressure observations were utilized for a preliminary estimation of TNT equivalent yield of about 0.1 kT (based on positive impulse in air-shock wave), considered as an important Ground Truth parameter. Thus the Sayarim Explosion provided the first full GT0 source dataset for on-surface large-scale explosions, recorded by infrasound stations of International Monitoring System (IMS).

Infrasound signals were well observed at distances up to 3,500 km, at numerous portable and permanent stations in Israel, Mediterranean countries and north-central Europe, including two IMS stations I26DE and I48TN and two portable arrays in Austria and Northern Italy deployed by the CTBTO team. Far-regional portable stations were deployed westward, due to seasonal favorable conditions of infrasound propagation, caused by the westerly stratospheric winds. Obtained records were already used for analysis of infrasound signal propagation, source location and yield estimation.

## **The April 19, 1935, M=7.1 “Al-Qaddahiya” Earthquake Sequence. What Did We Learn After 75 Years?**

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### **Abstract**

Libya, located at the northern margin of the African continent, underwent many episodes of orogenic activity of the Caledonian and Hercynian in the Paleozoic during Cretaceous, Middle Tertiary, and Holocene time. These episodes of orogenic activity affected the region and shaped the geological setting of the Country. As a result a number of sedimentary basins were formed separated by intervening arches. The present day deformation of the country is the result of the Eurasia-Africa continental collision. Libya is not commonly thought of as a seismically active country; however, several earthquakes of magnitude greater than 6.0 on the Richter scale have been recorded, including the April 19, 1935, M=7.1 Al-Qaddahia earthquake sequence, one of the largest events on the African continent.

Investigating the seismicity before 2005, one can clearly notice that the recorded number of earthquakes in Libya is not representative of the actual total number, due to a number of reasons among which is the absence of national seismograph network before 2005. This fact was proven correct after the establishment of the Libyan National Seismograph Network (LNSN) operated since November of the year 2005. The LNSN consists of 15 broadband stations, utilizing VSAT communication technology, and a Central Processing Center, located in the City of Gharyan.

This study aims to explain in detail the Seismotectonics of the Hun Graben area, the site of the 1935 earthquake sequence. The area's recent seismicity is also explained with the aim of improving the earthquake hazard assessment. A NW-SE trend of seismicity was quite noticeable, coinciding with the eastern border of the Hun Graben. The 1935 earthquake sequence was first relocated and focal mechanisms for the 7.1 main shock and the two largest aftershocks were determined. The mechanisms were used as a priori estimate of the focal mechanisms during the body waveform inversion process. Results suggest that the majority of the earthquakes of the 1935 sequence occurred along the eastern side of the Hun Graben and seems to align very well in a NW-SE trending fashion along the margin of the Graben. Earthquake activity recorded by the LNSN seems to take the same trend. In general the strike-slip mechanism was predominant.

The same area was hit by an earthquake in 1941. A number of earthquakes were recorded by the LNSN since 2005 proving that this area was indeed active. In December of last year an earthquake of magnitude 4.8 on the Richter scale was recorded to hit in an area 20 km NW of Musratak which might be an extension of the 1935 earthquake sequence.

## **Recent Seismic Events in Northern Algeria (2000-2010)**

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### **Abstract**

During this last decade, Algeria experienced several moderate to strong seismic events with a magnitude greater than 5.0 . The most representative was the Boumerdes earthquake of May 21<sup>st</sup>, 2003, Mw 6.8. The other seismic events occurred in several regions of the country. Among them, we can events of Bordj-Bou-Argeridj (August 18<sup>th</sup>, 2000, Md 5.0), Beni Ouartilane (November 10<sup>th</sup>, 2000, Md 5.4), Kherrata (March 20<sup>th</sup>, 2006, Mw 5.3), Djelfa (Avril 01<sup>st</sup> , 2006, Md 5.4), Tiaret (October 19<sup>th</sup>, 2006, Md 5.3), Chlef (December 16<sup>th</sup>, 2006, Md 5.1), El Oued (July 09<sup>th</sup>, 2007, Md 5.2), Mostaghanem (August 08<sup>th</sup>, 2007, ML 5.1), Medea (August 22<sup>nd</sup>, 2007, ML 5.2), Boumerdes (February 01<sup>st</sup>, 2008, ML 5.2), Oran (January 09<sup>th</sup>, 2008, ML 5.3. June 06<sup>th</sup>, 2008, ML 5.5) Ben Ilmane (May, 14<sup>th</sup>, 2010, Mw:5.2. This number of moderate events in very few years was never recorded before.

The study of all these events demonstrated:

- 1) The existence of important seismogenic sources along the margin (Boumerdes and Oran earthquakes)
- 2) The evidence of the Boukadir fault in the Chlef region. Before, studies concentrated mainly on the El Asnam fault
- 3) The activity of the High plateaus represented by the occurrence of the Djelfa event of April 1 st, 2006 . This event represents the strongest one occurring in this region
- 4) The occurrence of moderate seismic event along the Atlasic flexure. The El Oued event of July 9<sup>th</sup>, 2006 is the most import earthquake happening not so far from the oriental erg. In the past, only minor events were recorded along this major tectonic feature separating the northern region from the Saharan platform.

Studies of all these events contribute to better knowledge of the seismic activity of Algeria. They also allowed reevaluation of the seismic hazard in many region of Algeria ( Djelfa, EL Oued, ...) Their occurrence indicate the importance to make significant efforts to reduce the seismic risk in the different regions of Algeria.

## **The Seismicity of Al Hoceima and Nador regions, Northern Morocco**

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National Research Center - Rabat - Morocco  
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### **Abstract**

The seismicity of Morocco is regarded as the result of the African–eurasian plates convergence. The ongoing crustal deformation is producing a moderate seismicity with some strong earthquakes observed in an average rate of one event per decade.

The major part of this seismicity is taking place in Northern Morocco which is located within the plates boundary. This seismic activity is also mentioned in historical documents that can be used to define some seismic cycles and to separate seismic crises from seismic swarms as they are actually observed.

The descriptions of historical tsunamic events are also confronted with the geographical conditions of each exposed site such as the shape of the coast and the topography.

## **Upgraded Seismic System in Tunisia**

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### **Abstract**

Monitoring seismicity in Tunisia was based on telemetered analogic short period seismic stations. Analysis of seismograms and dissemination of earthquake parameters were carried in Tunis, at the main centre, the "Institut National de la Météorologie (INM)". A DOS desktop computer hosting IASPEI software equipped with a DT2821 A/D PGH board was used for digitizing waveforms of triggered events.

Through national development program based on a very consistent project named "Warning Seismic Network for Tunisia" (RAST), this analogic technology is progressively left, leading the place to digital seismic systems which offer better dynamic range and better tools for seismic processing, rapid dissemination of earthquake parameters and providing data for scientific and engineering purposes.

INM has undergone the upgrading of the existing seismic network. Partnerships opportunities between Tunisia, the "Principauté de Monaco" and EMSC have been a suit trigger to start the modernization of the existing seismic network. Under this frame, three broad band seismic stations were installed at remote sites, equipped with STS2 sensors and logged to Kephren digitizers' model, manufactured by Agecodagis (France). Tamra (TAMR) in the north part of Tunisia, Thala (THTN) located in the west central part of the territory and Tataouine (TATN) at the extreme south of the country.

To insure effective, timely and robust system, a server running the Seismological Communication Processor (SeisComP3) developed originally for the GEOFON network was installed at the main centre in Tunis. The data are transmitted from the INM to GFZ through a VSAT system set-up by GFZ for its GEOFON network.

INM have implemented a based Earthworm system with the technical and scientific assistances of the laboratory of GeoAzur. QWIDS/EIDS was also implemented.

Upgraded Tunisian seismic network will lead to more accurate seismicity monitoring locally, regionally and globally and will allow the providing of real time waveforms to neighbor agencies and to prepare, also, an infrastructure for an early warning system for Tsunami, leading then to better understand of the seismicity genesis and the geodynamic setting at the Tunisian scale and at larger scale of the Mediterranean.

## Relations between Different Ground Motion Parameters for Northern Algeria

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### Abstract

This study is an attempt to derive characteristic properties of ground motion parameters in northern Algeria. We have computed spectral acceleration (SA) values for rock ( $V_s > 750\text{m/s}$ ), corresponding to soils type S1 in the Algerian building code, damped at 5% for different periods. The compilation of seismic hazard in term of SA at different periods, damped at 5%, for three different types of soils (rock, soft and stiff), and for return periods of 100 and 475 years has been carried out. Interesting relationships between SA(0.2 s) vs. PGA and SA(1.0 s) vs. PGA have been obtained, independently of the considered return period. In addition, uniform hazard spectra (UHS) have been obtained for different return periods at different locations in northern Algeria. The computed UHS for different types of soils and for 100 and 475 years return period have been proposed as design spectra. We have used the well known Newman-Hall approach with certain modifications. As proposed in the most recent International Building Code, the SA (0.2 s) is used to establish the spectral region for lower periods (region controlled by acceleration), while the SA (1.0 s) is used to establish the spectral region for intermediate periods (region controlled by the velocity). We obtained a linear relation between the values of SA (0.2 s) and the given PGA for a return period of 100 and 475 years. This dependency implies that we can use, to derive the proposed design spectra the pair (SA (0.2 s), SA (1.0 s)) or the pair (PGA, SA (1.0 s)) with equal reliability. Finally, the Uniform Hazard Spectra performed at the 33 cities of northern Algeria, and the design spectra derived at such cities have been compared to the design proposed in the Eurocode EC8.

### Keywords:

Peak ground acceleration, spectral acceleration, uniform hazard spectra, design spectra

## **A Seismic Site Response Survey of the Maltese Islands**

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### **Abstract**

The Maltese Islands in the Central Mediterranean are composed of a simple 5-layer sedimentary sequence of Oligocene - Miocene age. The sequence is highly disturbed by syn-sedimentary to recent faulting, and the islands are characterized by a variety of outcropping rock types and underlying lithology. The seismic history of the Maltese islands includes a number of earthquakes in which serious building damage was experienced, the maximum intensity being of EMS98 VII - VIII in 1693. A correspondence is observed between building damage and areas underlain by soft clay layers, for example, but a seismic risk assessment of the islands that takes into account such site effects has never been attempted. Since the last damaging earthquake, the building density has increased dramatically, and the building footprint extended to regions of diverse lithologies, while general building practices have not undergone any upgrade in standards. In this study, an extensive ambient noise survey of the two major islands (Malta and Gozo), utilizing the Nakamura method, has been undertaken, covering all outcrop types and major morphological features. Clear correlations between geology, topography and response frequency / amplitude are observed and their implications in the light of building vulnerability and seismic risk discussed.

## **Seismic Risk Assessment and Attenuation in Morocco; Recent Developments**

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### **Abstract**

Historical seismicity studies have shown that Morocco has experienced hundreds of historical earthquakes, dozens of which were destructive. The Agadir 1960 earthquake remains the deadliest seismic disaster in Morocco with 12,000 deaths. Since then, the first seismic network of Morocco was installed.

Real-time seismic monitoring in Morocco began with the deployment by the National Institute of Geophysics (ING) under the CNRST, of a national telemetered seismic network, consisting of thirty seismographs, in the late 80s.

Following the Rissani-Erfoud ( $M = 5.4$ ) earthquake in 1992, and on instructions of the Prime Minister, the ING has been entrusted in 1993 with the mission of national seismic monitoring. This was the beginning of the operation of this new network as a seismic early warning system. With this new mission, the ING has been in charge of the seismic monitoring and warning 24/7 of the national territory. In this work, we present the results of these operations for the period 1993-2008.

Following the Al Hoceima earthquake of 2004, the ING has been mandated to undertake the upgrading of the national seismological network, by installing seismic stations of the new generation, using satellite links. This new early warning system will be supplemented by a network of tide gauges and GPS stations connected to Rabat in real time.

Prevention against tsunamis: towards a close cooperation at the regional: The maritime domain in Morocco is open to the North East Atlantic Ocean and to the western Mediterranean. This vast ocean space, shared by several neighboring countries, has so far remained among the rare regions of the globe not yet equipped with a tsunamis warning system, although in the past, this region has experienced destructive earthquakes and tsunamis particularly in 1755.

Although the frequency of strong oceanic earthquakes and tsunamis disaster is rather low, the National Geophysical Institute has taken in recent years actions at the national and regional levels to develop scientific knowledge on tsunami risks. The ING currently contributes to the establishment of a regional network for tsunamis observation with real-time measurements of sea level from coastal tide gauges and data integration in a geophysical data collector operational 24/24 dedicated to tsunamis warning.



## **Earthquake Resistant Measures for Building Construction in the Middle East**

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### **Abstract**

This presentation will cover the following:

- Earthquake Design – Common Practice: Design offices in the Gulf are in their majority designing for earthquakes  
Usually:
  - 1) Spectral Analysis is used for high rise buildings and special structures,
  - 2) Static Force Analysis for regular medium height buildings and
  - 3) For small ordinary structures the common practice is to only adopt earthquake dispositions.
- Legal Issues and Approvals
- Case Studies of Projects designed by Rafik El-Khoury & Partners – Description of earthquake resisting concept and structural system (example with a core alone, example with dual system, example relying on a frame system, small structures enhanced seismically...)
- Seismic Detailing Photos and Execution Issues

## **New Sismotectonic Zoning of Northern Morocco**

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### **Abstract**

In this work, a new seismotectonic zoning of the north of morocco is proposed. It is based on a new database which includes recent work in the fields:

- geology (active faults, geometrical characteristics, chronology of the various recent tectonic phases).
- geophysics (instrumental and historical seismicity, focal mechanisms, nature crust).
- as well as the geodynamic context of the convergence of the plates africa-europe.

New zoning seismotectonic suggested is not limited to the borders of the north of morocco. It takes into account all the seismic sources able to generate strong earthquakes destroying purposes on morocco, such that of lisbon in 1755 on the level of the transforming fault azores-gibraltar.

New catalogues of the historical seismicity from 1045 to 2005 (peláez and al 2006), and instrumental from 1900 to 2008 as well as active faults data base were elaborated.

New elaborate zoning that includes 10 seismotectonic zones. The data were used to determine its static and dynamic states. Each seismotectonic zone presents homogeneity of the seismogene potential and its mode of deformation obtained with using seismicity, strain and the stresses data.

This new zoning was of a great contribution for the probabilistic studies and seismic hazard map for Mrocco.

## **Earthquake Storms in Central-East Iran**

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### **Abstract**

The Iranian plateau is a relatively wide zone of compressional deformation along the Alpine-Himalayan active mountain belt that is entrapped between two stable platforms, the Arabian plate in the Southwest and the Turan platform (Eurasia) in the Northeast. Iran is one of the seismically active areas of the world and is frequently affected by destructive earthquakes, imposing heavy losses in human lives and widespread damage. Central-East Iran major seismotectonic province is an intracontinental environment, in which Eastern part displays earthquake storms since 1968. The east-west Dasht-e-Bayaz fault, demonstrated by 80 km of left-lateral strike-slip surface faulting in Dasht-e-Bayaz earthquake of 1968.08.31, Ms 7.3 and 60 km in Kowli-Bonyabad earthquake of 1979.11.27, Ms 7.1. The Korizan earthquake of November 14, 1979, Ms 6.7, involved a curiously shaped fault of 20 km with predominantly north-south right-lateral strike-slip mechanism, The 20 km Korizan fault rupture extended for another 10 km northeastward by the Kowli-Bonyabad earthquake of November 27, 1979. Destructive earthquake of 1997.05.10, Ms 7.1, in Qaen-Birjand region, was accompanied by 125 km of right-lateral strike-slip surface faulting on the Korizan Fault.

The 1976.11.07, Ms 6.2, south of the Dasht-e-Bayaz Fault, also involved right-lateral strike-slip in the north-south direction. To the west, the Ferdows Fault, a northwest-southeast trending reverse fault, reactivated by the occurrence of Dasht-e-Bayaz earthquake of 31 August 1968. The Ferdows earthquakes of 1968.09.01, Ms 6.3, involved thrust faulting with a northwest strike. The Tabas-e-Golshan destructive earthquake of 1978.09.16, Ms 7.4, caused multiple frontal thrust faulting at the surface and bedding-plane slips of thrust mechanism in the hanging-wall block along Tabas Fault. The Gowk Fault system is a major structure which extends for about 180 km from northeast Kerman to southwest Bam in a NNW trend, made up of several distinct en echelon segments. Destructive shocks occurred in the northern part of the Gowk Fault System in 1981.06.11, Ms 6.6 and 1981.07.28, Ms 7.0.

The earthquake of 1989.11.20, Ms 5.7, was associated with a surface deformation that followed the mapped traces of the southern Gowk active fault system. Right-lateral strike-slip faulting during 1998.03.14, Mw 6.6 Fandogha earthquake, and 2003.12.26, Mw 6.6, Bam Earthquake (at least 30,000 deaths) on Bam fault segment are other examples of large earthquakes along the Gowk fault system. In 1994.02.23-26 three earthquakes of magnitude larger than 6 and another large earthquake of , Mw 6.4 ,in 2005.02.22 destroyed Sefidabeh and Zarand regions of eastern Iran, respectively. It seems that occurrence of Doublet events and earthquake storms are characteristics of eastern part of central-East Iran seismotectonic province in present-day geodynamic regime.

**Keywords:** Central-East Iran, Earthquake storms, intracontinental environment, destructive earthquakes.

## **The Lebanese Seismic Network and the Activities of the Geophysical Research Centre**

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### **Abstract**

The Geophysical Research Centre CRG, affiliated to the National Council for Scientific Research CNRS, was established under the decision of the Council of Ministers to ensure the continuity of the seismological observatory of Ksara. The terms of this government's decision are reflected in several scientific disciplines: seismology, terrestrial magnetism, gravimetry, spatial geodesy and active tectonics.

Since its establishment in 1975, the CRG's observatory is monitoring in real time the seismic activity in Lebanon and worldwide through a seismological network. The presentation will focus on three parts. The first one will highlight the present situation of the Lebanese seismological network after its recent developments following the seismic crisis that occurred at the south of Lebanon in 2008. The second part will review the actual research projects conducted by the CRG on the seismic risk in Lebanon. The third part will include a summary of the undergoing project for the assessment of the seismic hazard in Beirut.

## **Quarry Blasts Assessment and Their Impacts on the Nearby Oil Pipelines, South East Helwan, Egypt**

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### **Abstract**

Ground vibrations induced by blasting in the cement quarries are one of the fundamental problems in the quarrying industry and may cause severe damage to nearby structures and pipelines. Therefore, a vibration control study plays an important role in the minimization of environmental effects of blasting in quarries. This research paper presents the results of ground vibration measurement induced by blasting at the National Cement Company (NCC) south east of Helwan, Egypt. The aim of this study is to investigate the influence of the quarry blasts on the oil pipelines of SUMED Company. The seismic refraction either for P-waves and surface waves (MASW) are used to evaluate the closest site of the two pipelines to the quarry blasts. The results demonstrate that the closest area of the two pipelines is of class B according to the International Building Code (IBC) and the safe distance to avoid any environmental effects is 650 m follow the deduced Peak Particle Velocity (PPV) and scaled distance (SD) relationship ( $PPV = 265.25 \times SD^{-1.334}$ ) in mm/s and the Air over Pressure (Air Blast) formula ( $Air\ Blast = 150.56 \times SD^{-0.074}$ ) in dB. In the light of the prediction analysis the maximum charge weight per delay was found to be 592 kg.

**Key Words:** Peak particle velocity; Air blast; Seismic refraction; MASW and site evaluation.

## **EMME Earthquake Model of the Middle East Region: Hazard, RiskAssessment, Economics & Mitigation Implementation Plan**

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### **Abstract**

It is a well known fact that earthquakes cause, not only direct damage on built environment such as buildings, infrastructure or lifeline systems and result in human life and economic losses but have also secondary effects such as social and economic losses. As a consequence of the high probability of earthquake occurrence combined with high population growth, poor construction standards and practice and lack of proper mitigation strategies, Middle East represents one of the most seismically vulnerable regions worldwide.

Especially starting from 1990's, seismic risk and associated mitigation strategies have been assessed in worldwide scale through different initiatives funded and coordinated by international organizations such as United Nations and World Bank. As one of the latest initiatives, GEM (The Global Earthquake Model) aims at carrying former studies a step further by allowing meaningful comparisons between different regions through uniform data, methodologies, models and training. The results of the project both in terms of risk evaluation and the developed IT structure will be widely used throughout the world especially in developing countries located in high seismicity regions.

EMME (Earthquake Model of the Middle East Region) aims at the assessment of seismic hazard, the associated risk in terms of structural damages, casualties and economic losses and also at the evaluation of the effects of relevant mitigation measures in the Middle East region in concert with the aims and tools of GEM. The EMME will encompass several modules such as the Seismic Hazard Module, Risk Module, SocioEconomic Loss Module and the development of an IT infrastructure or platform for the integration and application of modules under consideration. The methodologies and software developments within the context of EMME will be compatible with GEM in order to enable the integration process.

EMME will be a living model, rather than a static study, with a flexible, modular architecture to allow addition and updating of components and datasets, and to maintain it continuously as stateofheart and in conformance with national developments and new international standards. As such, EMME will allow multiple user types to derive updated products and outputs, and keep up with changing requirements.

The users and beneficiaries of EMME will be broad, and include all those who make decisions based on seismic risk: seismic agencies, engineers and practitioners, government officials, insurance and finance industries, emergency responders, risk professionals, homeowners, investors, and the population at large.

EMME is jointly directed by Eidgenössische Technische Hochschule Zürich (ETHZ) and Kandilli Observatory and Earthquake Research Institute (KOERI) and is composed of the following work packages.

The institutions participating to EMME are:

Boğaziçi University, Middle East Technical University and Sakarya University from Turkey, IIEES from Iran, NDMA and NED University of Engineering and Technology from Pakistan, Yarmouk University from Jordan, Cyprus University of Technology, ACNET from Georgia, SCI from Armenia, ANAS from Azarbaijan and ETHZ from Switzerland.

## **Rapid Shake-Map and Loss Estimation Capability by ELER - Earthquake Loss Estimation Routine**

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### **Abstract**

Rapid loss estimation after potentially damaging earthquakes is critical for effective emergency response and public information. The Joint Research Activity 3 of EC FP6 NERIES Project has developed a methodology and software, ELER© - Earthquake Loss Estimation Routine, for rapid estimation of earthquake shaking and losses throughout Euro-Mediterranean region (Erdik et al. 2008, 2010, Hancilar et al. 2009, Sesetyan et al. 2009, 2010). Recently, a new version (v2.0) of the software has been released.

The ground motion estimation (Shake mapping) methodology encompasses:

1. Given the basic parameters of an earthquake (e.g. magnitude and epicentral location), estimation of the spatial distribution of selected ground motion parameters at engineering bedrock through region specific ground motion prediction equations (GMPEs).
2. Automatic association of the large events with the most probable fault trace in the region.
3. Refinement of the estimated ground motion distributions with incorporation of the strong ground motion data.
4. Refinement of the estimated ground motion distributions as the rupture parameters become available.
5. Estimation of the spatial distribution of site-specific ground motion parameters using regional geology (or urban geotechnical information) data-base using appropriate amplification models.

The multi-level methodology developed together with researchers from Imperial College, NORSAR and EMSC is capable of incorporating regional variability and sources of uncertainty stemming from ground motion predictions, fault finiteness, site modifications, inventory of physical and social elements and the associated vulnerability relationships. Loss estimation (damage, casualty and economic) is performed at different levels of sophistication (Level 0, 1 and 2) that are commensurate with the availability of inventory of human built environment (Loss Mapping).

The Level 0 and Level 1 loss assessment modules of ELER software, aim at near real-time assessment of the earthquake generated probable damage, both in terms of building damage and casualties, at regional scale. As the density of instrumentation, quality of building inventory and population databases vary throughout the region of interest, a multi level analysis methodology is incorporated. Differently from Level 2 where spectral displacements are used, intensity is used as the ground motion parameter in both Level 0 and Level 1 analyses. The ultimate goal of the development of this tool is the rapid estimation of losses and the associated geographic distributions for effective emergency response and public information after potentially damaging earthquakes. The validation studies conducted throughout the development phase show a good agreement between the estimated and observed damage distributions. Additionally, the urban earthquake loss assessment module (Level 2) aiming at near real-time assessment of the earthquake damage in urban areas, where the building inventory is known in detail, is also equally capable of incorporating scenario based earthquake risk assessments including building damages and associated direct economic losses and related Monte-Carlo type simulations and earthquake insurance applications.

## **CTBTO in the Context of the Mediterranean Region**

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### **Abstract**

The Comprehensive Nuclear Test Ban Treaty Organization (CTBTO) was formed to monitor compliance with the Comprehensive Nuclear Test Ban Treaty (CTBT). This mission is carried out with a global network of seismic, infrasound, hydroacoustic and radionuclide stations, which are referred to as the International Monitoring System (IMS). The network includes several very high quality seismic arrays, which provide accurate estimates of time, azimuth and slowness for events throughout the world. All State Signatories of the CTBT are entitled to data collected by the IMS, as well as the resulting products made by the International Data Centre (IDC). Each State Signatory may nominate a National Data Centre (NDC), and affiliated organizations, which may use IMS data and IDC products for their national needs, which may include civil and scientific applications. The presentation will review how this is currently being done in the Mediterranean region, as well as future opportunities.



## **Earthquake Risk Management Insurance**

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### **Abstract**

In general, Earthquake risk is defined as the probability of consequences (physical damage, human and property loss, etc.) due to probable occurrence of an earthquake in a given area and a period. Risk management is the process that integrates all of the contributing factors and actions that can cause to improve the safety and the welfare of people, saving human lives and resources, minimizing the disruption of services and economic flow. Today, Earthquake insurance is an integral part of the risk management process, both as a catalyst and incentive for risk reduction and mitigation, as well as the method for risk transfer and setting up a financial security for the post disaster recovery period. The time that a government can act as free insurer is rapidly diminishing. That is mainly due to the rapid growth of the developing countries and the expansion of wealth of the built environment and unfortunately their exposure to high level of disaster risk; and inability and lack of enough resources by government to fully recover direct and indirect economic losses and social impacts; the disaster insurance system is the solution; and the promoting the insurance culture is the key to safety.

Implementation of an effective earthquake insurance system requires a solid national strategy in order to withstand the potential and inevitable financial risk due to disaster. Thus, the risk management programs requires an appropriate model and tools that can accurately and reliably quantify the potential loss and the level of risk that can be understandable, manageable and affordable both for property owner (insured) and the insurer. Therefore, the integration of solid strategy with the reliable risk model in insurance companies in writing the insurance policy is the key to the success. This paper provides the basic concept and describes the need for its promotion in the Mediterranean and Middle East region. Here, the important role of risk insurance in encouraging the risk mitigation as a financial incentive for all by providing affordable earthquake insurance coverage, and reducing the government dependency to financial risk to disaster has been discussed.

## **NRIAG's Role to Mitigate Earthquake Disasters in Egypt Using GPS and Seismic Data**

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### **Abstract**

It has been estimated that, during historical time more than 50 million people have lost their lives in earthquakes during ground shaking, such as soil amplification and/or liquefaction, landslides and tsunamis or its immediate aftereffects, as fires. The distribution of population takes generally no account of earthquake risk, at least on a large scale. An earthquake may be large but not destructive, on the other hand, an earthquake may be destructive but not large. The absence of correlation is due to the fact that, great number of other factors entering into consideration: first of all, the location of the earthquake in relation to populated areas, also soil conditions and building constructions. Soil liquefaction has been identified as the underlying phenomenon for many ground failures, settlements and lateral spreads, which are a major cause of damage to soil structures and building foundations in many events. Egypt is suffered a numerous of destructive earthquakes as well as Kalabsha earthquake (1981, Mag 5.4) near Aswan city and the High dam, Dahshour earthquake (1992, Mag 5.9) near Cairo city and Aqaba earthquake (1995, Mag 7.2). As the category of earthquake damage includes all the phenomena related to the direct and indirect damages, the Egyptian authorities do a great effort to mitigate the earthquake disasters.

The seismicity especially at the zones of high activity is investigated in details in order to obtain the active source zones not only by the Egyptian National Seismic Network (ENSN) but also by the local seismic networks at, Aswan, Hurghada, Aqaba, Abu Dabbab and Dabbaa. On the other hand the soil condition, soil amplification, soil structure interaction, liquefaction and seismic hazard are carried out in particular the urbanized areas and the region near the source zones. All these parameters are integrated to obtain the Egyptian building code which is valid to construct buildings resist damages and consequently mitigate the earthquake disasters. Since the year of 1994 till now, the geodetic observations by means of Global Positioning System (GPS) were applied instead of the terrestrial ones to cover some other regions of the country. These regions include Sinai, Gulf of Suez, Greater Cairo, Aswan and the Middle part on the River Nile. Data adjustment and analysis of the repeated GPS campaigns from the different networks prevailed significant movements which may help in more understanding the geodynamics of these regions.

In the meantime, GPS measurements of crustal motions for 189 sites extending east-west from the Caucasus Mountains to the Adriatic Sea and north-south from the southern edge of the Eurasian plate to the northern edge of the African plate were carried out for the period from 1988 till 2005. Estimate of plate motions at stations located at different plates were determined.

## **Post-Seismic Evaluation of Structural Damage: An Integrated Probabilistic Methodology**

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### **Abstract**

The authors propose a new integrated methodology that aims to evaluate the global damage caused to constructions after earthquakes occurrence. The damage is defined as equivalent to a residual probability of failure ranging from 0 (no damage) up to 1 (complete damage). The global damage for a given structure is then derived, within a probabilistic framework, from the components damage: structural i.e. main components (columns, beams, etc) as well as secondary i.e. non-structural components (stairs, partition walls, etc).

The methodology efficiency is validated for a set of more than 54,000 buildings damaged (mainly RC structures) and evaluated after the earthquake occurred on May 21, 2003 (Algeria, Boumerdes, Mw=6.8). The probabilistic methodology provides theoretical results that are in good accordance with the observed results collected by the engineers during the post-earthquake evaluation process.  
**KEYWORDS:** Earthquake, Constructions, structural components, non structural components  
Damage, Risk, Evaluation, probabilistic methodology, GIS, Computer-aided Decision

## **Ambient Broad Band Seismic Noise Tomography across the Dead Sea Transform**

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### **Abstract**

Dead Sea Transform (DST) is an active one, which poses a considerable seismic hazard to Israel, Jordan, Lebanon, Syria and other adjacent countries. Numerous recent geophysical and seismological studies were addressed to understand the geodynamic setting, and the crustal and uppermost mantle structure beneath the central part of the DST. As a continuation of these studies we present a surface-wave tomographic study in the Dead Sea region.

Ambient noise tomography is a rapidly emerging field of seismological research. The method is based on computing the cross-correlation of long-term continuous broad band recordings at pairs of stations to estimate the 3D seismic velocity structure of the region. The method was applied to continuous (6-12 months) broadband recordings of 30 stations of DESERT2000 experiment distributed across the Arava Fault (South of the Dead Sea basin) as well as 6 permanent (data from several years) broadband stations of Israel Seismic Network spread throughout the country. The data have been bandpass filtered in the 5-50 sec range and pre-processed to eliminate influence of earthquakes and explosions according to the methodology developed at Colorado University, Boulder.

As a result of the method application we obtain the group wavespeed maps that display prominent features and 3D velocity structure on both sides of the DST zone. We compare our preliminary results with those obtained using teleseismic tomography, reflection and refraction profiles, imaging of scattered body waves acquired from the DESERT2000 experiment. A narrow low velocity anomaly in the crust coincides with the Dead Sea transform that is interpreted as sediments in the shallow layer and a zone of fractured and deformed rocks in the middle and lower crust. The zone of high velocities on the eastern flank of the DST fits well the previous reporting based on body wave tomography, seismic refraction studies and field observations of exposed crystalline basement in southwestern Jordan.

## **Torsional Behavior of Base Isolated Asymmetric Multi-Story Buildings**

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### **Abstract**

The main objective of this study is to contribute a better understanding of the torsional behavior of base isolated asymmetric multi-story buildings. The torsional response of asymmetric base-isolated buildings subjected to EL-Centro earthquake when eccentricities are set in the superstructure and in the isolation system is presented. A symmetric Reinforced Concrete (RC) frame building isolated by Lead Rubber Bearing (LRB) base isolation system is considered as a benchmark system. Appropriate LRB properties are designed according to AASHTO specifications with post yield stiffness of 25% their elastic stiffness ( $k_p/k_e = 0.25$ ). Nonlinear dynamic time history analysis is used to study the response for different ratios of static eccentricities between the centers of mass and the centers of stiffness in the superstructure due to asymmetries related to: (a) the position of the centers of stiffness (C.R) by changing concrete walls locations, and (b) the position of the centers of mass (C.M) by shifting the joint masses assigned on each floor of the superstructure toward X or X&Y directions; and between the center of mass and the center of stiffness at the isolation system (C.KI), due to asymmetries in the stiffnesses of the isolators. The results show that the eccentricities related to the position of the centers of mass in the superstructure lead to torsional amplifications or deamplifications on energy input, energy dissipation, base shear, displacements, and rotations of the isolation system higher than that when the eccentricities are related to the position of the centers of stiffness in the superstructure or in the isolation system. In addition, this study demonstrates that the asymmetry in the superstructure cannot be ignored, even if the isolation system is symmetric.

## **Damage Analysis and Behaviour of Beam-Column Reinforced Concrete Structures after the Boumerdes Earthquake of May 21st, 2003**

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### **Abstract**

A destructive earthquake of magnitude  $M_w = 6.8$  struck the province of Boumerdes and the eastern part of Algiers city (Algeria) on May 21st, 2003. This is among the strongest seismic events of the Mediterranean region and the most important event in Algiers since 1716. It caused the loss of 2278 human lives, injuring more than 11450 others and it destroyed or seriously damaged at least 128 000 dwellings making about 200000 homeless.

The great majority of the built environment of the affected region is constituted by reinforced concrete beam-column structures which are the most widely used building system in Algeria.

In this paper, a short characterization of this important earthquake will be briefly presented. Then, the building damage will be analyzed in terms of nature and degrees of damage to different categories of beam-column structures and the main weaknesses and insufficiencies of such structures and the main causes of damage will be underlined.

Finally the main lessons learned from this very important event, in terms of beam-column building system behavior will be presented and some recommendations will be given in order to improve Algerian building practice and Algerian seismic code requirements related to such a system.

## **Kuwait National Seismic Network: capabilities and applications**

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### **Abstract**

Kuwait National Seismic Network (KNSN) started functioning in March 1997 with a full duplex radio communication system. KNSN consists of seven short-period stations and the one broad-band station. The encoded data are continuously sent by radio communication to the recording/analysis center at Kuwait Institute for Scientific Research (KISR). The received data is decoded, isolated, checked for error, displayed in real time and analyzed offline. An abnormal seismic wave is detected and plotted automatically. REF TEK software (e.g. RTPD, RNC, RTTC, RT\_Disply,...) is installed to perform the tasks of data acquisition, buffering, event detection and back-up archiving. The antelope software was installed to enhance the database quality and merge records from overseas stations within KNSN database. Currently KNSN exchange real time data with Oman Seismic Network and Dubai Seismological Network and receiving 22 stations from the Global Seismic Network. It is proposed to upgrade the KNSN. The 72A-07 recorder/digitizer has to be replaced by the latest versions and to replace the current radio communication by a more stable type. Two new broad band stations have to be installed to reduce the coverage gap in the network. Installing a dense seismic network within oil fields is also suggested. KNSN data is required for local, regional and global research. Locally, it was used for seismic hazard assessment in the State of Kuwait. Worldwide, KNSN plays a part in the construction of the world and regional seismicity maps. Currently, KNSN data is required for oil reservoir characterization, and for deep seismic risk studies in Kuwait.

## **“EqHazard”, Seismic Hazard Analyzer**

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### **Abstract**

The purpose of this paper is to introduce the content and methodologies that has been used in EqHazard, a seismic hazard analyzer software that has been developed by the authors. In summary EqHazard has the following capabilities:

- Calculating the probability of earthquake ground shaking at the surface or in the bedrock beneath a site based on the location of surrounding faults with fast algorithms.
- Full access to graphical GIS objects.
- Multi GIS layer with different graphical information.
  - Different geo-referencing for every layer.
  - Using UTM and Lat-Lon coordinate for every layer.
- Using seismic source as area, line, background with 3 dimensional depth definition.
- Digitizer simulation with various background image for source and seismicity identification.
- Reading and processing GIS shape files for the fault map.
- Create seismic group involve:
  - Monte Carlo, Declustering and/or Poisson distribution
  - Recurrence function as: One order single line, N order multi line, or Kijko–Sevelov approach
- Using spectral and nonspectral attenuation with string processing
- Drawing GIS annotation and create perimeter information
- Using automatic logic tree in five branch:
  - Source shapes, Seismicity, Magnitude, Attenuation and Distance
  - Perform manual logic tree with adding seismic layer
- Operating site soil types
- Deterministic and Probabilistic seismic hazard analysis for Spectral and Nonspectral values
- Seismic hazard result can be presented as:
  - Hazard curves, Hazard zoning, Zoning profile, Uniform hazard spectra
  - Variety in contour type and graphical zoning
  - Graphical and Text report maker

The program has capability of being integrated with any vulnerability and risk analysis program.



## **Determination of Seismic Vulnerability Index for Steel Structures**

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### **Abstract**

In Algeria, Steel frame structures are more and more used in industrial constructions particularly in the industrial parks. This is because of their quick realisation and the great length that can be reached.

These structures can suffer significant damage after an earthquake. Thus the economic sector will run under capacity without forgetting casualties.

We propose, in the framework of the present study, to quantify the seismic vulnerability of the steel buildings, by developing the vulnerability index method. This requires the definition of the parameters have an influence on the seismic vulnerability of this structures, thus that there coefficients of weighting. The index, thus calculated, will allow the classification of these buildings.

A technical data sheet and an associated developed calculating computer program named Vulnerability Index Program (VIP) using "Delphi" have been used and validated to get the structural and non structural parameters and the vulnerability index of such structure.

The results show that the established classification confirmed what has been observed in situ.

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