

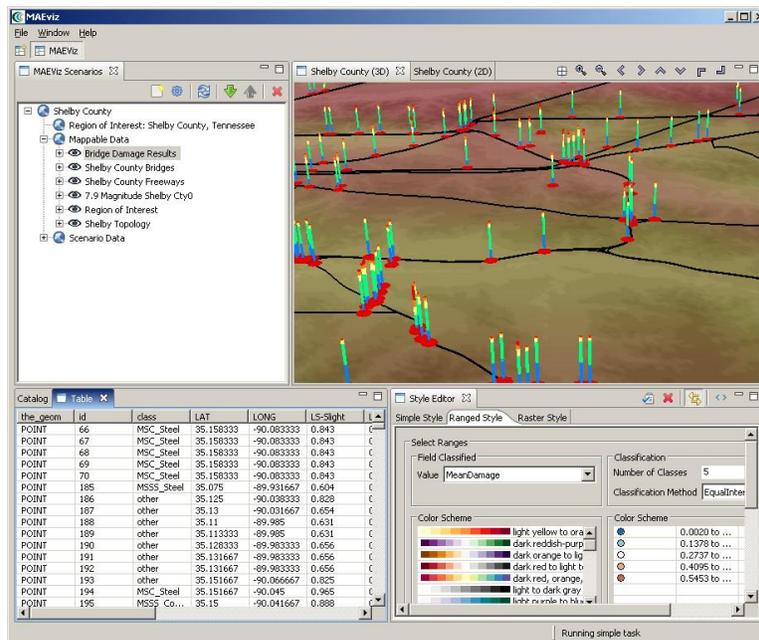
# MAEviz Introduction & Tutorial

Mid America Earthquake Center

University of Illinois at Urbana-Champaign

February 2007

## Earthquake Risk Assessment Using MAEviz 2.2: A Tutorial



## Charleston County Bridges

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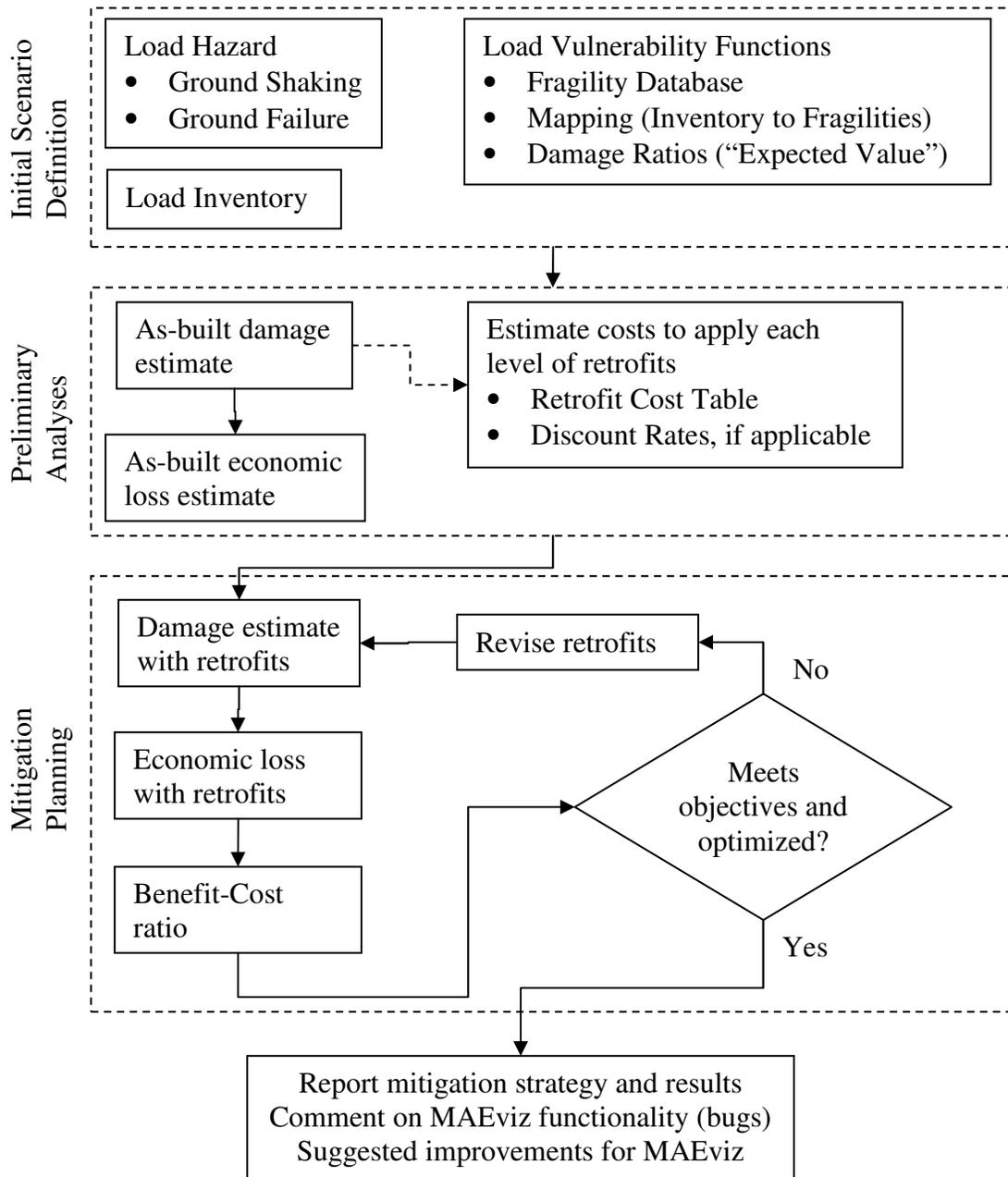
Mid-America Earthquake Center

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## ***Executive Summary***

The following pages will give you an introduction on MAEviz. First, descriptions of the layout of the program which will help you get familiar with the work environment before you start using MAEviz. Then, a tutorial where you'll be able to run an earthquake risk assessment analysis. The purpose of this tutorial is to help you feel comfortable using the program and to also give you a clear idea of what MAEviz can do. The last part covers a user's guide where you can find a more extensive explanation of MAEviz capabilities that were not covered on the tutorial.

## Exercise Overview



# 1. MAEviz Overview

## Welcome

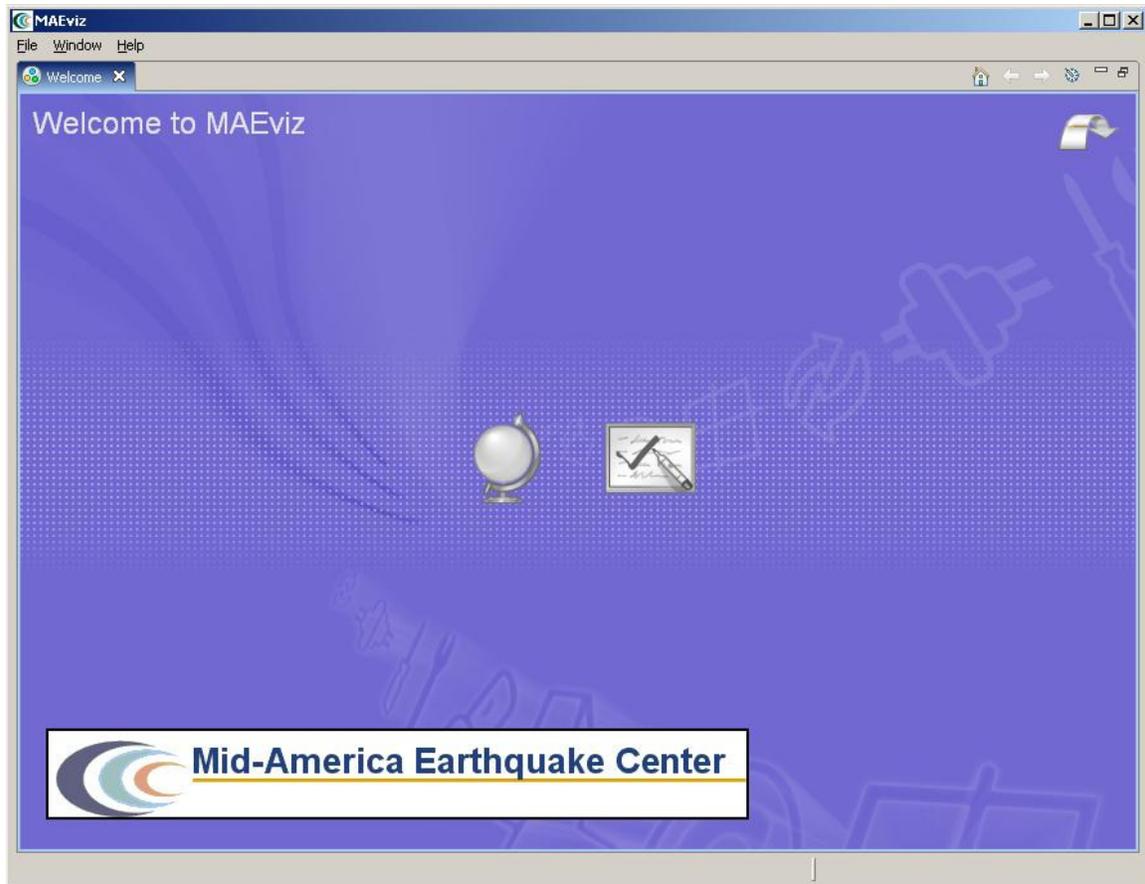


Figure 1

When MAEviz is first launched, the welcome screen appears. From the welcome screen, users can select to read an overview of information about MAEviz, follow built-in tutorials, or just begin working in MAEviz (by selecting *Workbench* which will take you to the main MAEviz screen, also known as the *Workbench*).

## 1.1 Workbench Layout

The MAEviz workbench consists of a number of *Views* which each contain information about a specific part of MAEviz. Each view is like a sub-window within the MAEviz workbench window, and can be minimized, maximized, moved, or even torn away from the main window into its own window. These interactions are done by clicking the minimize and maximize view icons in the view's title bar, or by clicking and dragging on the view's border or title bar.

Figure 3 shows some of the most commonly used views in MAEviz.

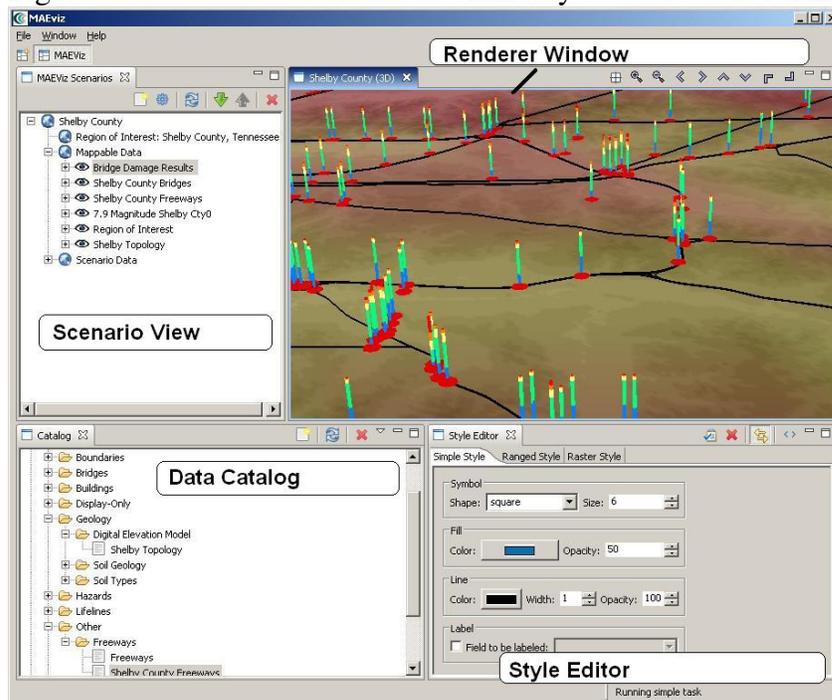


Figure 3

### ***Scenario View***

The Scenario View is where you find a list of all the data for the scenario or scenarios that you are currently working with. Each scenario that you are working with is listed as a top-level item in this view, which can be expanded by clicking the plus (+) icon next to its name, to see the details of the scenario. Inside each scenario, you can see a list of the Mappable scenario data, which are the layers of data that appear in your rendered map, as well as a list of Scenario Data, which includes all other data for the scenario, that isn't renderable.

The Scenario View is also where you would go to do the major operations on your scenarios: adding an earthquake hazard or other data, running damage analyses, etc.

## ***Visualization View***

The Visualization Window Views are where the rendered maps of your scenario will appear. Each scenario can have its own rendered 2d and 3d map, so you can see the visualization of your scenario. It is here that you can get a quick visual overview of the results of your analyses. You can control the camera position by using the mouse, or click the view control buttons in the toolbar.

## ***Data Catalog View***

The Catalog is a list of all the data that is available for you to use in your scenarios. It is organized first by *repositories*, which are stores of MAEviz data. Repositories can represent local data, or data stored on a remote server. Within each repository, the data is organized by the type of data that it is. To add data to a scenario, you can navigate to and find the data within this view, then drag it into either the Visualization View for your scenario, or onto the scenario's name in the Scenario View.

## ***Style Editor View***

The Style Editor is used to adjust the way in which a layer of data is displayed in the Visualization View. If the Style Editor is not visible, you can show it by right clicking a Mappable Data layer in the Scenario View, and selecting *Change Layer Style*. Once this view is showing, you can adjust the color, shape, opacity, etc of the map layer. To apply your style changes, you must click the *Apply* button () in the view's toolbar.

## **1.2 Other Views**

Although these are some of the main views you will use, there are a few other views that are shown at various times while using MAEviz.

### ***Table View***

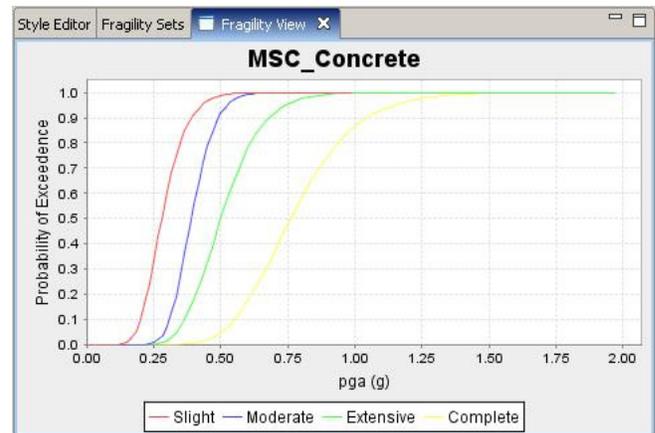
The Table View is used to display tabular data, generally the attributes of a set of inventory data or analysis results. The most common way to see this view is by right-clicking a Mappable Data layer in the Scenarios View and selecting *Show Attribute Table*.

### ***Reports View***

By right-clicking on a scenario name in the Scenarios View, and selecting *Reports*, you can access the Reports View. From the Reports View, you can select a report to run, right-click and run it. Then the selected report will be generated and displayed. From that point, you can choose to print or save the report.

## ***Fragility View***

If you right-click a fragility dataset from the Catalog View, you can select *View Fragility* to access the Fragility View. The Fragility View shows a list of fragility types, that you can drill down into to select and view a particular fragility curve. When you have found the fragility curve that you want to view, right-click it and select *View Fragility Set* to view a graph of the fragility curve.



## **2. MAEviz Tutorial**

The tutorial covers the typical steps that will be needed in order to perform an earthquake risk assessment. Here are the steps:

- Create a New Scenario
- View the Scenario and Add Data
- Running an Analysis
- Analyzing the Results

### ***Example Scenario***

In this demonstration, we will use MAEviz as a specific stakeholder would use the tool. The South Carolina DOT has contracted with your group to perform a seismic risk assessment of the transportation network in Charleston, SC. Using recently developed bridge fragility curves, and damage-functionality relationships for bridges, you are to perform an analysis of the approximately 340 bridges in the region. The bridge fragility curves are developed for 9 classes of bridges, which cover over 90 percent of the bridge inventory in Charleston. The Hazard which will be evaluated is a magnitude 7.3 earthquake in Charleston (Summerville).

In the process, we will see how the Emergency Manager will launch the MAEviz application, load the GIS data for Charleston County, and then generate earthquake hazard information based on the scenario he wants to investigate. After he has loaded this base information, he can interactively choose and display information for the specific items he wants to evaluate – the bridges, as well as load fragility information about these particular structures. From there, we will witness an analysis of the impact of the hazard. This analysis will assist the stakeholder in evaluating the impact of the damage to the transportation network and consequently, emergency routes. These factors have important social and economic impacts.

## 2.1. Creating a New Scenario

- When you start MAEviz for the first time, you will be shown the welcome screen (Figure 2). To begin working with MAEviz, click the rightmost icon (  ) which will take you directly to the MAEviz workbench.
- From the application's menu bar, click File->New, then expand MAEviz and choose MAEviz Scenario (See figure 4). Alternatively, you can click the New Scenario button (  ) from the Scenario View's tool bar.

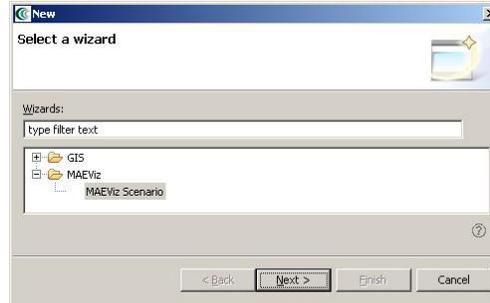


Figure 4

- The New Scenario Wizard will now be showing. This is where you define the scenario that you would like to work with. Enter a name for your scenario, such as “Charleston”, and then optionally enter any descriptive information about the scenario in the large text box. Click *next*.
- At this point, you will be selecting the region of interest that you would like to work with. We will be analyzing Charleston County, SC, so select United States of America from the Country menu. Then select South Carolina and Charleston County from the sub-region dropdown menus that appear. (See Figure 5 below) Click *next* when finished.

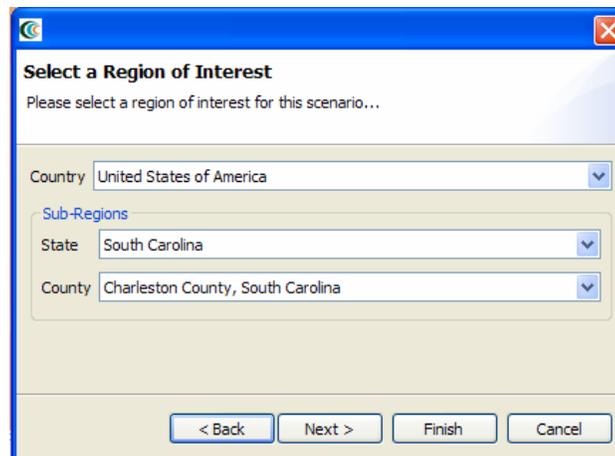


Figure 5

- The next screen of the wizard allows you to select an analysis to run immediately. If we wanted to run an analysis first, we could continue with this screen. But for this tutorial, we will add some other data to our scenario first, then come back and run an analysis later. So at this point, just select *Finish* to complete the wizard and have MAEviz initialize your new scenario.

## 2.2. Viewing the Scenario and Adding Data

At this point, your scenario has been created. You will see your scenario listed in the Scenario View and a blank outline of Charleston County has appeared in the Visualization View. See Figure 6.

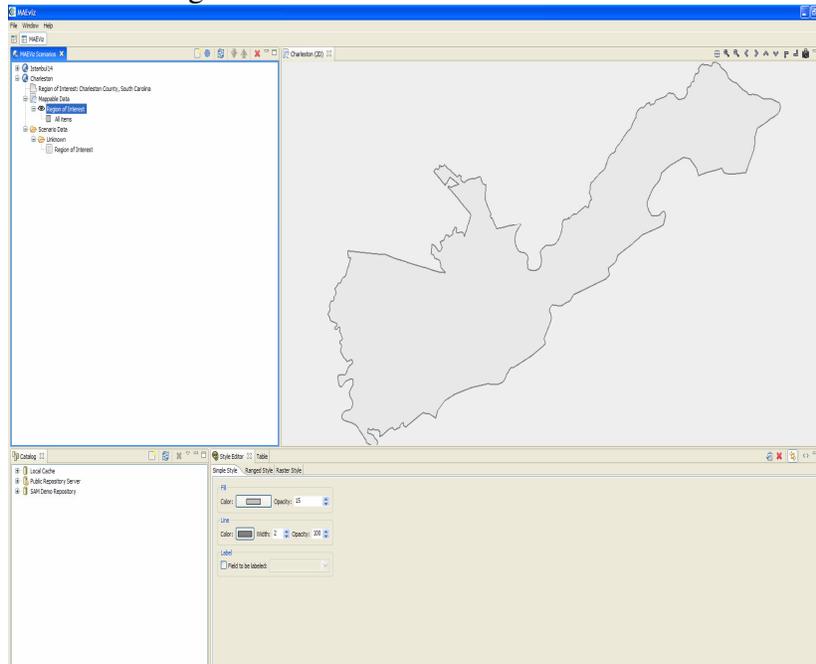


Figure 6

At this point, we will learn how to add data to our scenario, and how to manipulate the Visualization View.

- First, we will add bridge data to the scenario. In the Catalog view (the lower-left view if your workbench is arranged in the default setting, as shown in Figure 6), expand the *MAEviz Demo Data* item, then *Bridges*, *Bridges*, then all the required bridge datasets for study area like *Charleston Bridges*. Click and drag the Bridge datasets into the Visualization View. Alternatively, you can right-click the item and select *Load Dataset*.

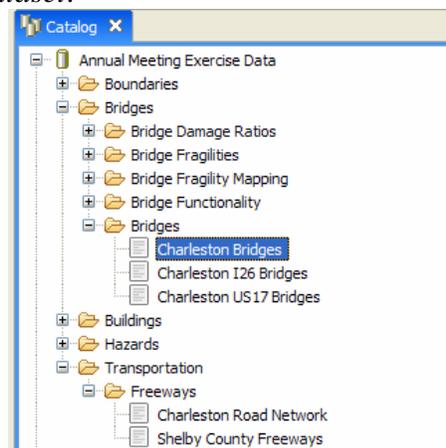
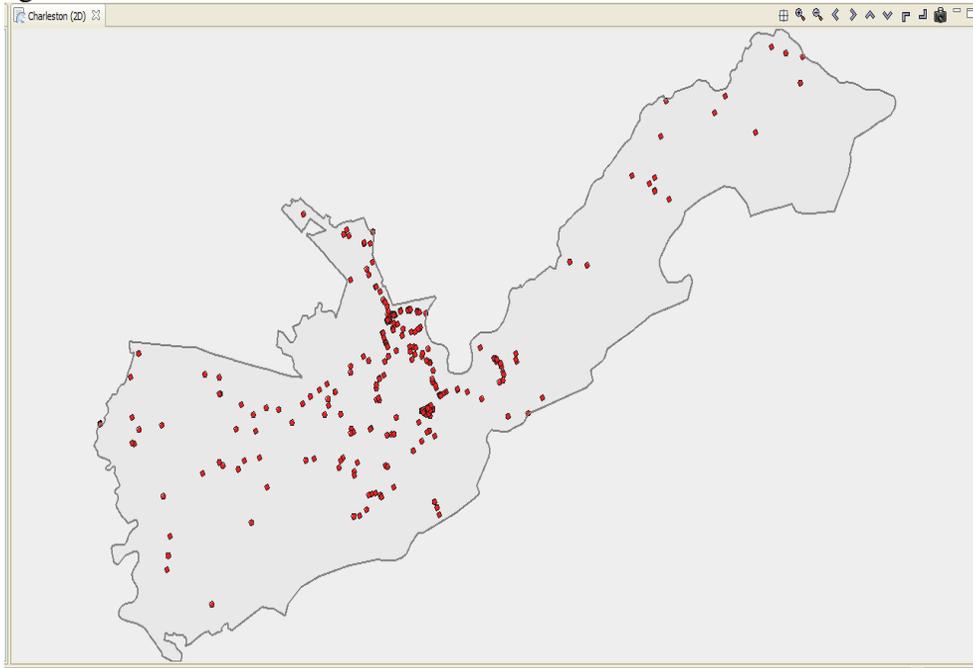


Figure 7

- At this point, bridges of the Charleston County should have been added to the Visualization View, and your Visualization View should look something like Figure 8.



**Figure 8**

- To zoom/pan/etc, use the controls at the top of the Visualization View. Use these to adjust your view.
- To view a 3d rendered view of the same information, right click the entry for your Scenario, and choose *Render Project in 3d*. This will bring up a second Visualization View that shows the same map, but from a 3d rendered perspective.
- After adjusting your view, if you want to restore to the original default view in the Visualization, click the *Zoom to full extent* button in the toolbar (  ). This will make the view like in Figure 8.

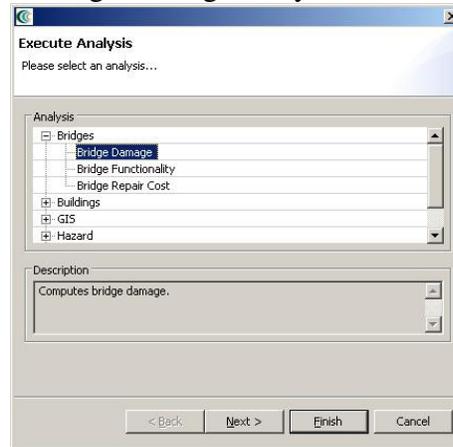
## 2.3. Running an Analysis

Now that we have a basic map to look at, we will learn how to run an analysis. Analyses in MAEviz consist of any sort of calculation that generates data. For example, generating a deterministic earthquake map based on a magnitude and epicenter would be considered one type of analysis. The other type that we will use in this exercise is to load pre-generated hazard map. Using that earthquake map as well as bridge inventory data to generate information about bridge damage would be another type of analysis.

In this example, we want to find bridge damage results based on a deterministic earthquake hazard that was pre-generated.

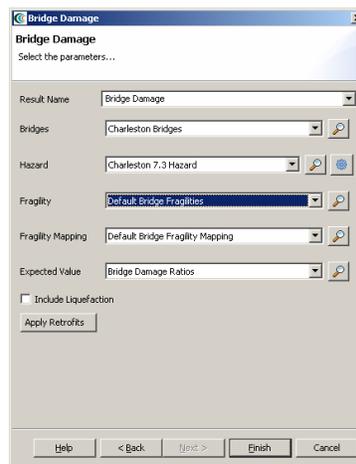
- First, we will launch the Run Analysis Wizard. To do so, either click the Execute Analysis toolbar button (  ), or right click your scenario and select *Execute Analysis*.

- This causes the Run Analysis Wizard to be shown. See Figure 9. Here you can select which analysis you want to run. (this is the same as the page that was displayed in the last step of the New Scenario Wizard). From this page, expand Bridges, and select the Bridge Damage analysis. Click *next*.

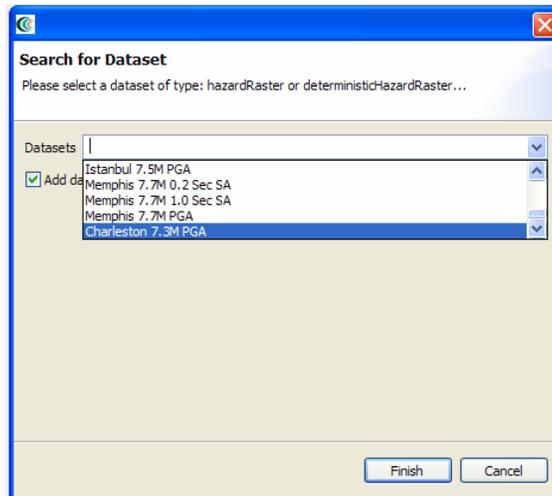


**Figure 9**

- The next page (Figure 10) prompts you to select the data you want to use in running your Bridge Damage analysis. If it tells you that no datasets containing Bridge or Hazard or Fragility Data have yet been loaded into your scenario, to run this analysis, you must load datasets that contain this data.
- To help you locate or generate the necessary input data, the Analysis Wizard provides two types of buttons, the *Find Dataset* button (🔍), and the *Generate Dataset from Analysis* button (⚙️)
- For our hazard, we want to use a pre-generated hazard earthquake. To find a hazard dataset to run your bridge damage with, click the *Find Dataset* button (🔍). The window that appears contains a list box of all Hazard Datasets that could be found in any of the data repositories that you are connected to. Select *Charleston 7.3M PGA* from the list like in Figure 11, and click Finish.



**Figure 10**



**Figure 11**

- When finished, we return to our Bridge Damage dialog. You can see that the Hazard input field has been filled in with text indicating that it will use the selected dataset.
- At this point, we still need to select a datasets for the bridge damages that No datasets were found for. If you don't have a bridge fragility set loaded into our scenario yet, use the *Find* button again (🔍) to locate and add the *Default Bridge Fragility Mapping* dataset to the scenario.
- Now we should choose a name for the results dataset. Enter a descriptive name, such as “Charleston County 7.3 As-built Bridge Damages”.
- If you had wished to apply retrofits, you can use the *Apply Retrofits* button. In this case, we will use the as-built state, so we won't use the *Apply Retrofits* button.
- Click *Finish* to run the bridge damage analysis.
- Once the progress bar has finished, you should see new datasets added to your Scenario View and map: The Bridges dataset that you selected to use, a Bridge Damages dataset which will contain the damage information, and the earthquake hazard dataset. Your Visualization should now look similar to Figure 12.
- Using the same way as executing the *Bridge Damage* you can execute *Bridge Functionality*, *Bridge Retrofit Cost Estimation Analysis*, *Bridge Damage (using retrofits)*, *Bridge Repair Cost Analysis* and *Bridge Cost Benefit Ratio Analysis*. For the *Bridge Functionality Analysis* follow the same steps and enter a descriptive name for the analysis result. The default values are fine, so click *finish*.
- To run the bridge retrofit cost estimation analysis, first, we will launch the Run Analysis Wizard. To do so, either click the Execute Analysis toolbar button (⚙️), or right click your scenario and select *Execute Analysis*. Then, select the *Bridge Retrofit Cost Estimation Analysis* under the Bridge. You should see a similar window with the Figure 13. Enter a descriptive name, such as “Charleston Bridge Retrofit Cost Estimation”, and then click *Finish*.

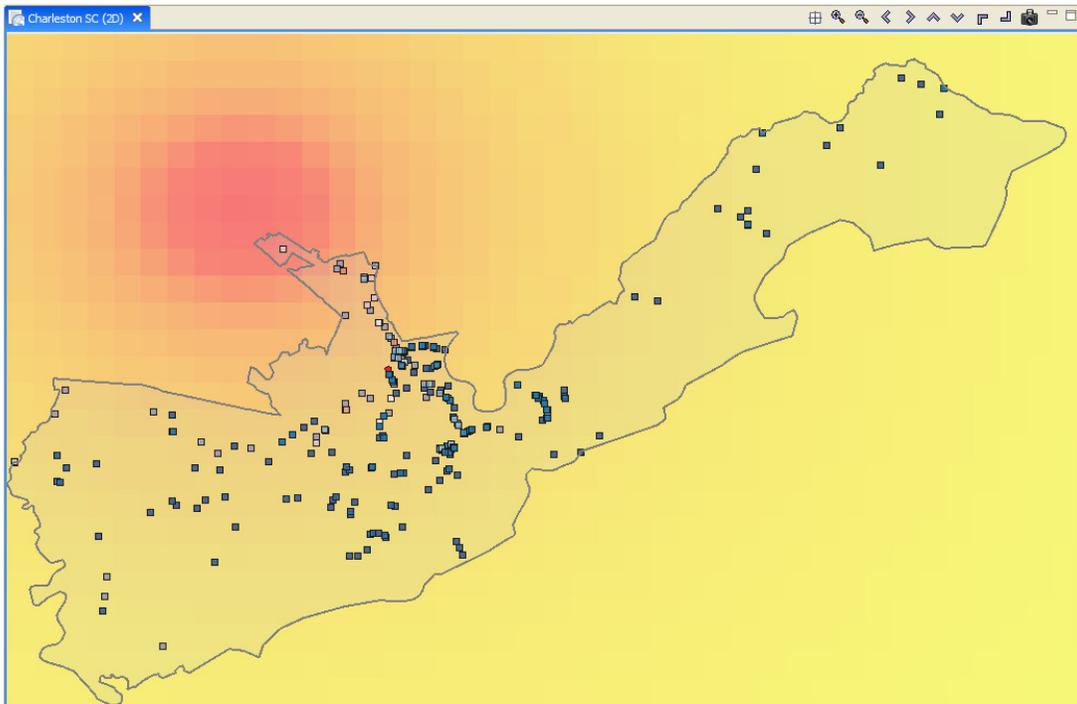


Figure 12

Figure 13

- To run the bridge retrofit damage, first, we will launch the Run Analysis Wizard again. Then, again select the *Bridge Damage* under the Bridge. Enter a descriptive name, such as “Charleston Retrofitted Bridge Damages”. Then click *Apply Retrofits*.
- The next page will ask for the result from your Retrofit Cost Estimation. Select the dataset you had just created, and click *Next*.
- The next page (Figure 14) shows a selection window for the bridges to be retrofitted. You can select and sort the bridges from three fields that you can

choose. Then, select the retrofitting option and see the retrofitting costs to decide what type of retrofit you will do. After completing your selection click Finish.

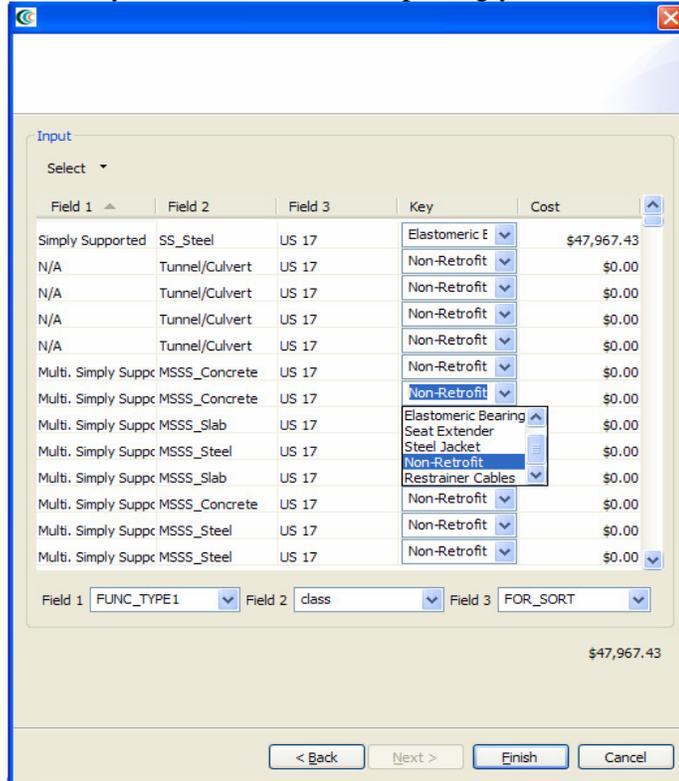


Figure 14

- To run the bridge repair cost analysis, we will follow the same steps above, but, we will choose *Repair Cost Analysis* under the Bridge. Enter a descriptive name, such as “Charleston Bridge Repair Cost”, defaults values for the other fields are fine like in Figure 15-a, so we can click *Finish*. We must run the *Bridge Repair Cost Analysis* again for the retrofitted bridge damages. This will be required for the *Bridge Retrofit Cost-Benefit Ratio Analysis*. This time we must select the resulting dataset of the *Bridge Retrofit Analysis* for the Bridges field like in Figure 15-b and enter a descriptive name, such as “Charleston Retrofitted Bridge Repair Cost”.

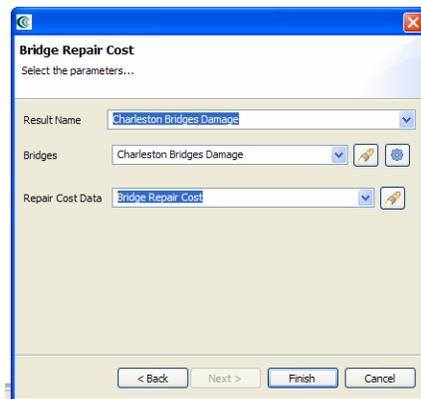
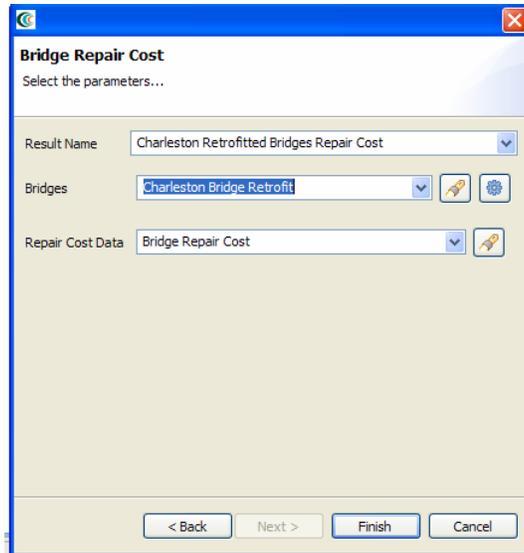
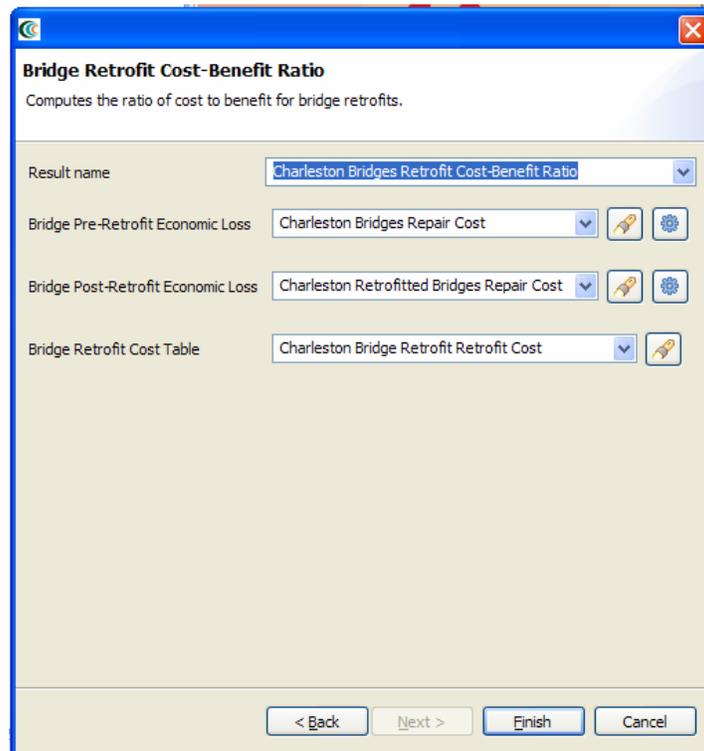


Figure 15-a



**Figure 15-b**

- The last analysis type for the bridges is the *Bridge Retrofit Cost Benefit Ratio Analysis*. This analysis requires the *Pre- and Post-Retrofit Economic Losses*, which are the results of previous two steps. Select the appropriate datasets for these fields like in Figure 16 and enter a descriptive name like “Charleston Bridges Retrofit Cost-Benefit Ratio” and click finish.



**Figure 16**

## 2.4. Analyzing Results

Now that the analysis has completed that we were interested in, it's time to analyze and try to make sense of the results. There are various ways of viewing and visualizing the results, which we will learn now.

### 2.4.1. Table View Results

- First, we will view the results in a tabular grid, similar to excel. In the Scenario View, right click on the *Bridge Damage* layer, and select *Show Attribute Table*. The Table View should appear in the bottom right of the application window. Like other windows, you can move or resize it to make it easier to view.
- Now we will use the Table View to locate the bridges that suffered the most damage. Scroll to the right edge of the table view, and click the column header labeled *ExpectVal*, which is the column for the expected damage value for the bridge. This will sort the table by the expected damage value.
- Now that we can see which bridges in the table have an expected value of Complete damage, let's locate those bridges in our map of the area. Make sure the Bridge Damage layer is still selected in the Scenario View, and make sure you are viewing the 2D Visualization View.
- Then, in the Table View, click on the first row with expected Value of complete. You will one of the dots representing a bridge in the Visualization View change color to show that this is the selected bridge.
- Hold shift and click the last row with Complete expected value. This will select all the bridges in between. You will see these bridges all change color in the Visualization View. This way, you can see which bridges will suffer the most damage. See figure 17.

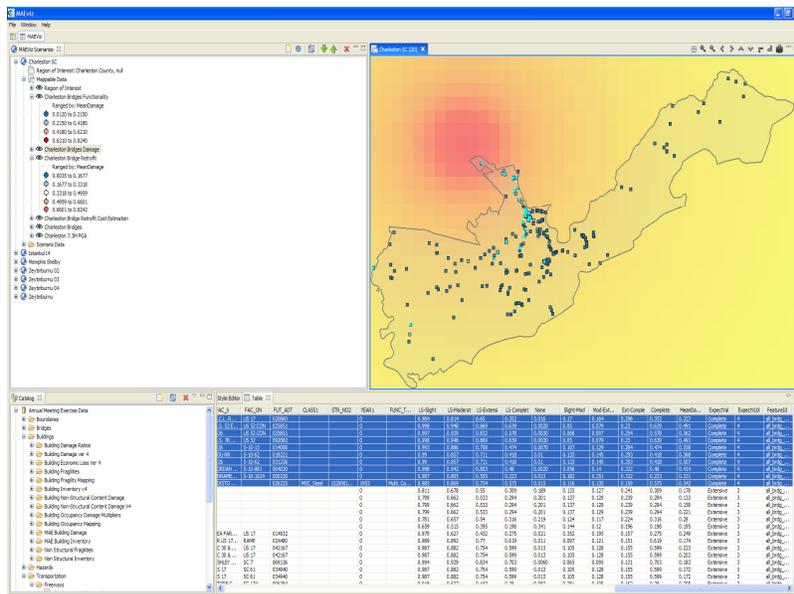


Figure 17

## 2.4.2. 3D Damage Bars

- Now let's add 3d damage bars to the bridges to make it easier to visualize damage across the entire map. Right click the Bridge Damage layer in the Scenario View, and choose *Ranged 3D Visualization...*
- Now we can choose which fields we want to display 3D damage bars for. For this example, we will want to see the chance of each damage state, so select *None*, *Slight-Mod*, *Mod-Extens*, *Ext-Comple*, and *Complete*. See Figure 18

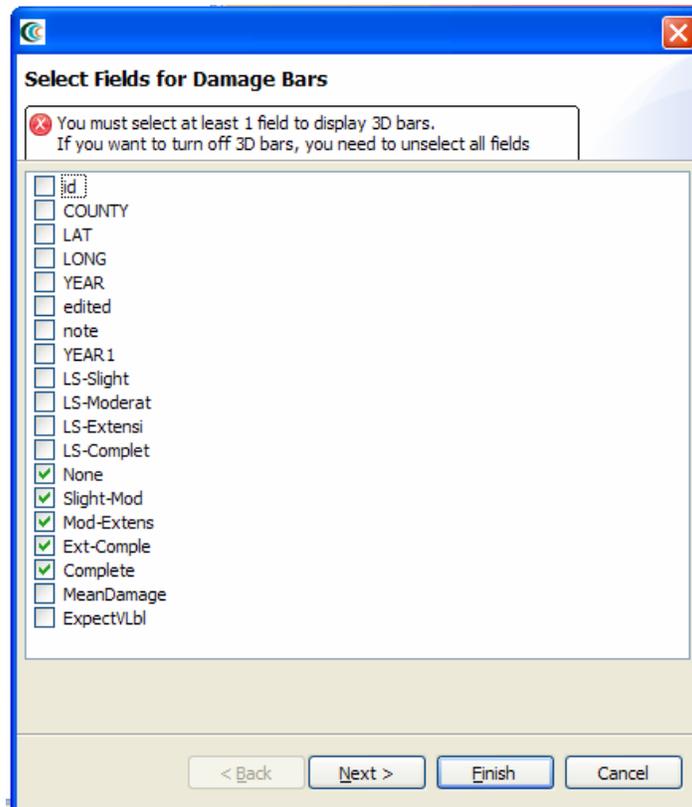


Figure 18

- Click *next*. At the next screen, you can choose colors for the various fields. Choose a reasonable set of colors, or use the defaults, then press *finish*. Then, right click your scenario and select *Render Project in 3D (VTK)*.
- This will bring the 3D Visualization View to the front, and you will see that damage bars have been added for each bridge. Zoom in and you can quickly see the probable damage states for each bridge based on the bars. The size of each color in the bar represents the likelihood that the bridge will be in that damage state. (Figure 19)

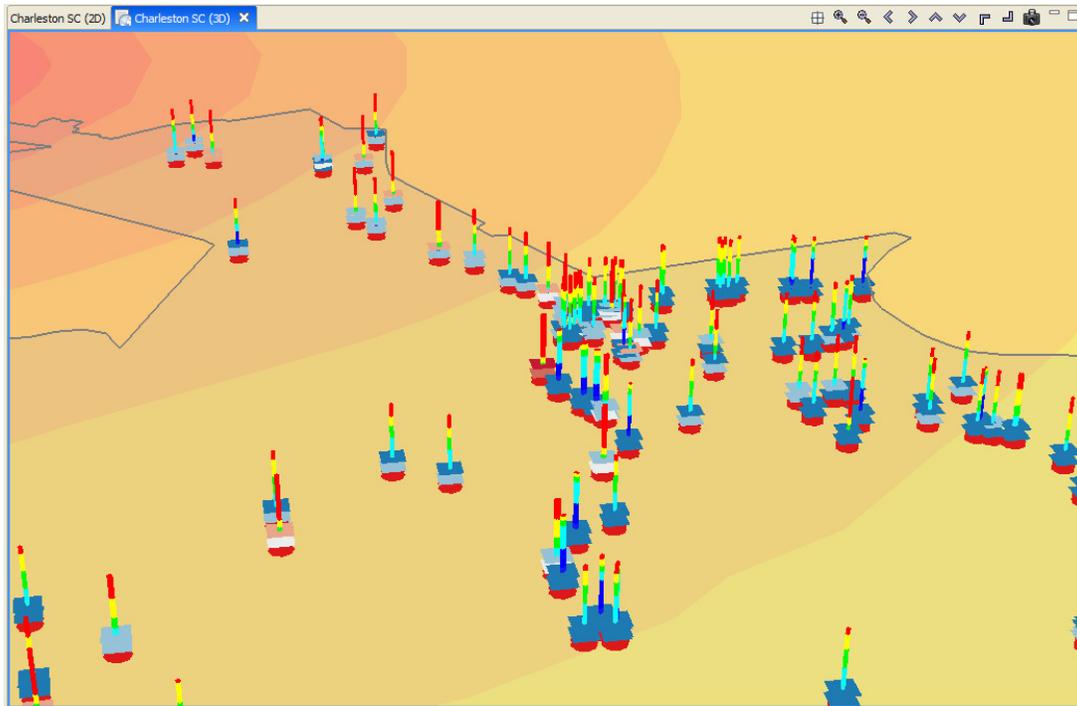


Figure 19

### 2.4.3. Filtering Data

- Now let's look at just those bridges along route I26. Right click the Bridge Damage layer, and select *Filter*.
- This brings up the filters dialog
- In the Create a Filter dialog, you must pick a field and value to filter by. Find and double-click *FOR\_SORT* from the fields box at the top. This adds this field to the query at the bottom. Click the = button, then we want to find the value to filter by.
- Click the *Get Unique Values* button to see all possible values, then double-click *I26*. The dialog should look like Figure 20.

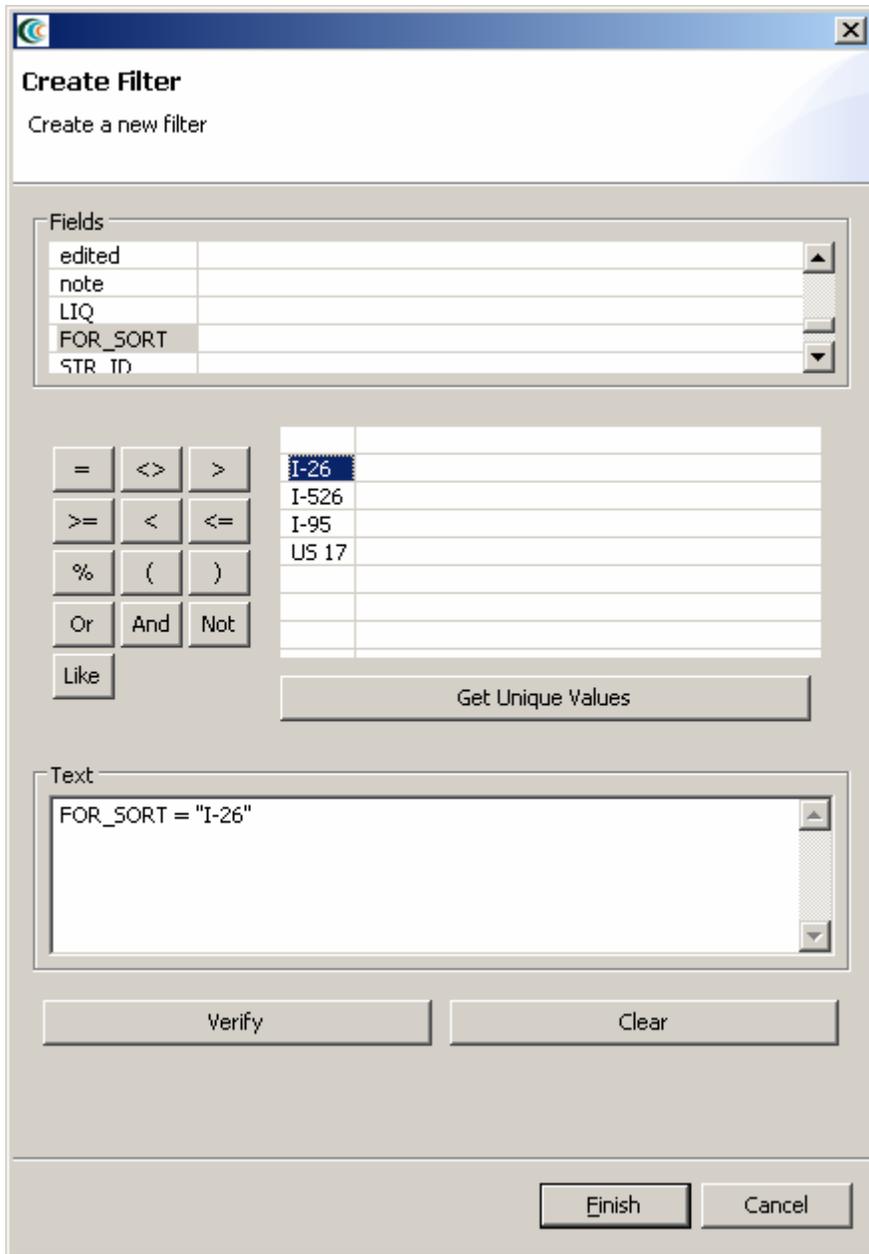


Figure 20

- Press *Finish*.. When it finished, you should see that many of the damage bars have been removed. This is because it is only displaying the damage bars for bridges along route I26.

## 2.4.4. Reporting

- Now we have finished generating and looking at the data, we will generate a printable report of the information that we have learned. Right click the name of your Scenario in the Scenario View, and select Reports This will open the Report Selection View. This gives us a list of reports that MAEviz can generate.
- In this tutorial, we only want a summary of the bridge damage, so we'll use the Bridge Damage Summary. If we wanted a detailed report of all the bridges, we could use the Bridge Functionality report. There are three different types of reports that can be useful in the exercise. Those are; Bridge Damage Report, Bridge Repair Costs Report and Bridge Cost-Benefit Ratio Report.
- To run the Bridge Damage Summary report, double click that entry in the list. The Report View will appear, with a preview of your bridge damage summary report. (Figure 21)

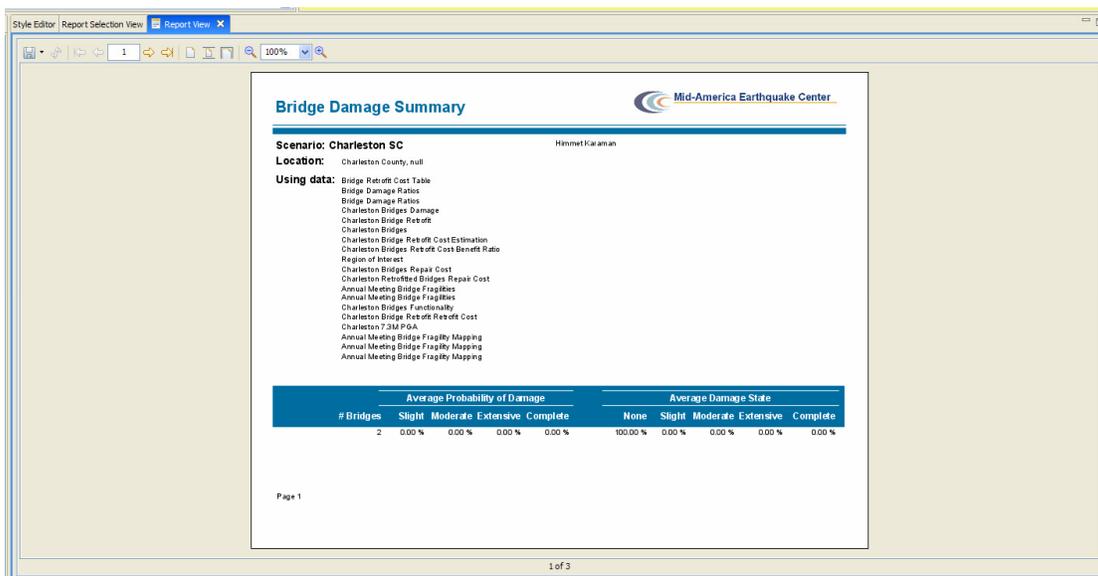


Figure 21

- You can save this report by using the save button (  ). Use the small arrow next to the save button if you want to select a different format for saving the report (such as PDF, HTML, etc). You can then print it out from the resulting file.

### 3. Conclusion

Based on this simple bridge damage analysis, we can conclude that the MAEviz tool helps to identify areas of high risk. MAEviz could also have been used to look at some mitigation options that may be beneficial to consider. The Emergency Manager in our example is able to take the information and results from this analysis and evaluate detailed options for specific bridges base on proprietary information in the department's databases and files. Furthermore, probabilistic scenarios can also be evaluated in addition to a deterministic earthquake such as the one we used in this example. The analysis could also be expanded to look at other components in the region such as the utility networks, schools (since these typically serve as temporary shelters), hospitals, police stations, etc. Some of these data are available with the default installation of MAEviz and is left as an exercise to the user.

The MAEviz tool provides an environment for visual exploration, analysis and evaluation of engineering options pertinent to investigating bridge and building retrofit options. In future version of MAEviz, these results will feed into the traffic models and the decision support to aid in selecting retrofit options, emergency routing, and pre/post mitigation planning. Furthermore, the use of cyberenvironments will enable MAEviz users to more effectively collaborate and share results and the use of web services will allow MAEviz to move computationally intensive analyses to bigger machines when available.

Please contact the Mid-America Earthquake Center for further information on MAEviz.

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## APPENDIX

### *Important Information for first time users*

#### ***Running MAEviz***

First, ensure that you have Java version 5.0 (also known as 1.5.0) installed. (available from <http://java.sun.com/>)

#### ***The MAEviz Portal***

The primary means of running MAEviz is via the MAEviz web portal. To login to the portal and run MAEviz:

- Point your browser to <http://maeviz.ncsa.uiuc.edu>
- If this is your first time logging in, click the “New Account” link from the left hand navigation menu, and create a new account.
- Now, MAEviz should appear as a choice in the top bar, next to “My Workspace.” Click this choice to enter the MAEviz area of the portal.
- Links should be available for downloading and using MAEviz.

## **Tips**

MAEviz includes a variety of capabilities which can help the user more effectively analyze and visualize seismic risk. The following is a list of capabilities that may be useful when performing an assessment.

The following commands are accessed by right-clicking on a layer in the scenario view (located to the upper left by default).

**Show Attribute Table** opens up a table tab with all of the attributes associated with the selected dataset. For buildings, the data includes structure type, occupancy, square footage, appraised value, and various other attributes. Also note that when a column header is selected, the data is sorted by that column, and when a row is selected, the corresponding data point is highlighted in the Visualization pane. Data can also be copied and pasted from the Attribute table to Microsoft Excel. *Note that performance will be improved if an existing attribute table is closed before opening a new table.*

**Toggle Visibility** switches a layer from visible to invisible and vice-versa. Use this when there are multiple layers of data in the Visualization that you don't need to see. For instance, after running a damage analysis, there will be a new data layer with points corresponding to the buildings in the inventory, so there will be two points shown for each building: one for the original inventory dataset, and one for the damage dataset. In that case, it would be useful to toggle the visibility for the original inventory dataset to hide it, leaving only the damage dataset visible, and avoiding clutter in the Visualization. *Hiding datasets can also improve performance of MAEviz since there is less data to render in the Visualization.*

**Delete** removes the dataset from the scenario, although not necessarily from the Local Cache.

**Export Dataset** exports data for manipulation outside of MAEviz. The type of output depends on the data being exported. For example, building inventory would be exported as a shapefile, while building fragilities would be a comma-delimited text file.

**Filter** allows the user to parse the data viewed in datasets using logical statements (e.g., Structure Type equals W1 to hide rows of data for building types other than W1). The data is not removed from the dataset, only hidden. To return to the full data, remove the filters that were specified and click on Show Attribute Table.

**Publish Dataset** exports data to a repository selected by the user. The data remains in xml format and maintains usability in MAEviz. This is as opposed to an "exported" dataset, which would have to be re-ingested into MAEviz to convert the data to xml format and set up the appropriate directory structure in MAEviz. *Datasets that are published with filters applied retain only the data that passes the filter.* For example, if a filter is applied so that only W1 structures are shown and the dataset is then published, the published dataset will contain only W1 structure data.

