MAEviz Interdependent Network Tutorial

Introduction

In this demonstration, we are going to demonstrate the Interdependent Network Analysis to compute the connection loss and service flow reduction of an interdependent network composed of an electric power network and water network. Alternatively, we could also compute the connection loss and service flow reduction for an electric power network and gas network.

Tutorial Example

This advanced tutorial is going to look at how the damage to one utility (a power network) could effect another utility (water network) that might rely on the power network to run, for example, water pumps. Because of this interdependency, looking at the physical damage to the water network is not enough to determine if it can still operate at full capacity after an earthquake event. Using the Interdependent Network Analysis, we can determine connection loss and service flow reduction. To get started, we will need to create a new scenario.

Create Scenario

- If you have not already done so, launch the MAEviz application.
- Go to *File -> New Scenario* and this should bring up the new scenario dialog.
- Create a scenario with Shelby County, Tennessee as your region of interest and choose the MAEviz 3.1.1 Analysis Defaults as your default set. If you have been following other tutorials you might want to provide the scenario a name such as *INA Shelby County*.
- After doing this, click **Finish** to create the new scenario.

Interdependent Network Analysis

First, we will need to determine the physical damage to our water network. To do this, go through the following steps:

- Click on the *Execute Analysis* ( ) icon to bring up the *Execute Analysis* wizard.
- Expand the *Lifeline* category and select *Water Utility Network Damage Analysis*. Click the *Finish* button.
- This should bring up the analysis graph for the *Water Utility Network Damage Analysis*. To bring up the form page, click on the water utility network damage box in the graph.
    1. For the *Result Name* field, specify a name such as *Water Network Damage for INA*.
    2. For the *Water Network* field, click the *Search* ( ) button and find the dataset named *Memphis Water Utility Network for INA* and click the *Finish* button.
- For the *Hazard* field, click the *Create* button to add the *Create Scenario Earthquake* box to the analysis graph. Click on the box to bring up the form page.
    1. For the *Result Name* field, specify a name such as *Memphis 7.3 Scenario Earthquake*.
    2. For the *Magnitude* field, specify *7.3*.
- Go back to the *Water Utility Network Damage Analysis* form page so we can fill in the last few required fields.
    1. Under *Advanced Parameters* you will find the *Pipeline Fragilities* field. Click the *Search* ( ) icon and find the dataset called *Buried Pipeline Fragilities v1.1* and click the *Finish* button.
    2. For the *Pipeline Fragility Mapping* field, click the *Search* ( ) icon and find the dataset called *Buried Pipe Fragility Mapping 1.2*.
    3. Click the *Execute* button to run the analysis.

Now that we have determined the damage to the water network, let's do the same for the power network.

- Click on the *Execute Analysis* ( ) icon to bring up the *Execute Analysis* wizard again.
- Expand the *Lifeline* category and select *Electric Power Utility Network Damage (Hazus Style)*. Click the *Finish* button.
- In the analysis graph, click on the *Electric Power Utility Network Damage (Hazus Style)* icon to bring up the form page.
    1. For the *Result Name* field, specify a name such as *Electric Power Network Damage for INA*.
    2. For the *Power Network* field, click the *Search* ( ) button and find the dataset called *Memphis Electric Power Network for INA* and click the *Finish* button to add it to your scenario.
    3. For the *Hazard* field, click the *Search* ( ) button and locate the scenario earthquake we just created for the water network damage. If you used the example name previously specified, it should be called *Memphis 7.3 Scenario Earthquake*. Click the *Finish* button after you have located the dataset.
- All other required fields should be filled in so you can now click the *Execute* button to run the analysis.

One thing to note here is that our network dataset inputs (e.g. *Memphis Electric Power Network for INA*) contain both a link and a node dataset; however, MAEviz can only display the links in the visualization view even though nodes are present as well. The drawback of this is that even though the *Electric Power Utility Network Damage (Hazus Style)* and the *Water Utility Network Damage Analysis* computed damage to both links and nodes, only the damage to the links can be displayed and viewed in the tabular view. The damage to the node dataset is there and will be used in the *Interdependent Network Analysis* even though they cannot be viewed. Now that we have our power network damage and water network damage, let's proceed to find what the effects are from their interdependencies.

- Click on the *Execute Analysis* ( ) icon again to bring up the *Execute Analysis* wizard.
- Expand the *Lifeline* category and select *Interdependent Network Analysis*. Click the *Finish* button.
- In the analysis graph, click on the *Interdependent Network Analysis* icon to bring up the form page.
    1. For the *Water (or Gas) Connectivity Loss Result Name* field, specify a name such as *Water Network Connectivity Loss*.
    2. For the *Power Connectivity Loss Result Name* field, specify a name such as *Power Network Connectivity Loss*.
    3. For the *Water (or Gas) Service Flow Reduction Result Name* field, specify a name such as *Water Network Service Flow Reduction*.
    4. For the *Power Service Flow Reduction Result Name* field, specify a name such as *Power Network Service Flow Reduction*.

    5. For the *Water (or Gas) Utility Network Damage* field, select the result we just created from the drop down menu. If you followed the tutorial explicitly, then you should have a dataset called *Water Network Damage for INA*, select it.
    6. For the *Electric Power Utility Network Damage* field, select the result we just created from the drop down menu. If you followed the tutorial explicitly, then you should have a dataset called *Electric Power Network Damage for INA*, select it.
    7. For the *Network Interdependency Table* field, click the *Search* ( ) button and find the dataset called *INA - Memphis interdependency table*, click the *Finish* button to add it to the scenario.
    8. For the *Number of Simulation* field, choose enough simulations to get a reasonable sampling. Something around 500 should be sufficient.
    9. Under the *Advanced Parameters* section, you can leave the *Use Homogeneous Interconnectedness Level?* box unchecked.
- Click *Execute* to run the analysis.

After running the analysis, you should now have 4 new result tables under *Scenario Data*. You should have two connectivity loss tables, one for the water network and one for the power network and you should have two service flow reduction tables, one for the water network and one for the power network.

Results

Now that we have some results, let's open up the datasets to see what we have. The connectivity loss tables have the following 3 columns:

- alpha
- meanconnloss
- stdconnloss

The service flow reduction tables have the following 3 columns:

- alpha
- meansfr
- stdsfr