

U.S. DOT Vulnerability Assessment Scoring Tool User's Guide



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Contents

Contents	2
Table of Figures	3
1. User Instructions	4
Getting Started	4
Microsoft Excel Settings	4
Microsoft Excel Security	4
2. Tool Overview	5
Common Sheet Features	6
Navigating the Tool	8
Important: Updating the Tool	8
3. Sheet Instructions	9
Contents	10
Step 1. Select Climate Stressors and Asset Types	10
Step 2. Enter Specific Assets	12
Step 3. Background Information on Evaluating Exposure	14
Step 3a. Exposure Indicator Library	14
Step 3b. Select Exposure Indicators	15
Step 3c. Sensitivity and Adaptive Capacity Indicator Library	16
Step 3d. Select Sensitivity and Adaptive Capacity Indicators	16
Step 4a. Collect Climate Data	18
Step 4b. Collect Asset Data	20
Step 5a. Adjust Exposure Scoring	21
Step 5b. Adjust Sensitivity Scoring	26
Step 5c. Adjust Adaptive Capacity Scoring	30
Step 6. View Results	31
Dashboard	32
Asset Score Query	32
Advanced Topics	33

Table of Figures

Figure 1. How to enable macros	5
Figure 2. Vulnerability Assessment Scoring Tool approach diagram	6
Figure 3. Common sheet features	7
Figure 4. How to delete assets from the asset list	13
Figure 5. How to remove an indicator	18
Figure 6. How to enter climate data for indicators that do not vary by asset	19
Figure 7. How to copy data collection sheet to separate workbook	20
Figure 8. Depiction of how climate data entered in Step 4a are linked to exposure indicators in Step 5a.....	22
Figure 9. Example from Use Case showing how exposure indicator data values were entered for each asset	22
Figure 10. How to adjust exposure scoring approach.....	23
Figure 11. Indicator scoring bin definitions.....	26
Figure 12. Example from Use Case of how to score an indicator with both numerical and non-numerical values	27
Figure 13. Example from Use Case of how to copy scoring approach from Indicator Library to sensitivity scoring tabs	29
Figure 14. How to add additional scoring “bins”	34

1. User Instructions

Getting Started

The U.S. DOT Vulnerability Assessment Scoring Tool (VAST) was developed using Microsoft® Excel 2010. The tool will only operate properly using Excel 2007 or later. Before you use the tool, make sure your computer meets the system requirements. In order to install and run the tool, you must have:

- IBM-PC compatible computer with the Windows XP operating system or later;
- Microsoft® Excel 2007 or later, with calculation set to automatic and **macros enabled**;
- Hard drive with at least 20MB free; and
- Monitor display setting of 800 x 600 or greater.

Microsoft Excel Settings

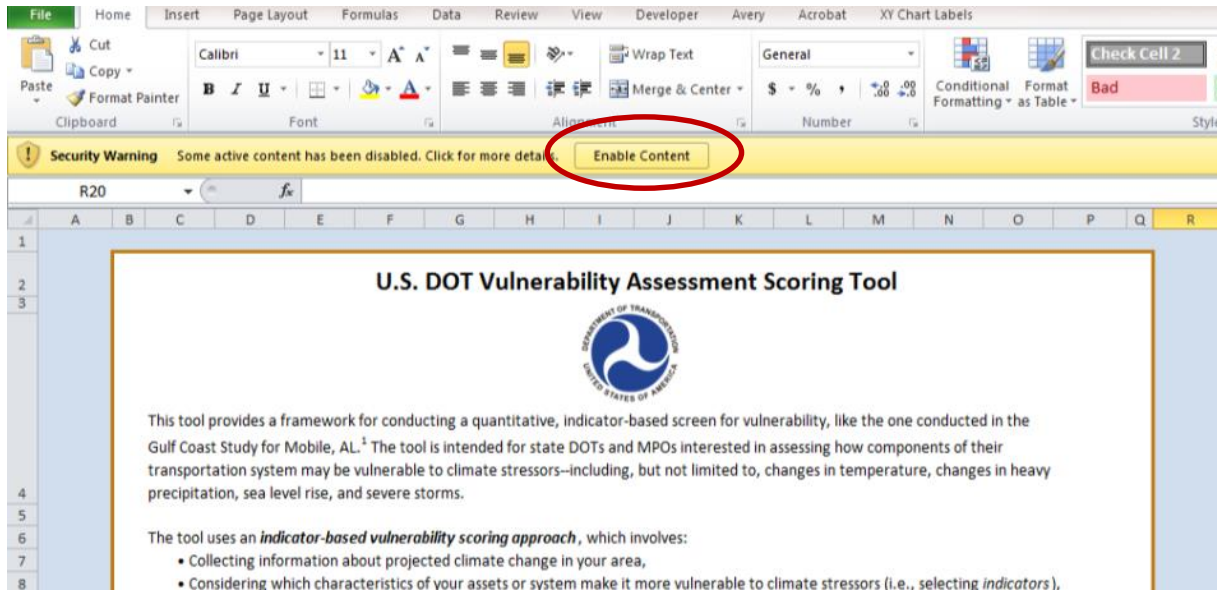
For the tool to function properly, Excel must be set to automatic calculation. Go to the Formulas ribbon and select “Calculation Options.” Make sure that the box next to the “Automatic” option is checked from the pop-up menu.

Microsoft Excel Security

Macros must be enabled to use the tool. If Excel’s security settings are set at the default level, a Security Warning appears above the formula box in Excel when the tool is initially opened (Figure 1). Click the “Enable Content” button to begin using the tool.

If the Security Warning does not appear when the tool is first opened, it may be necessary to change the security settings for macros. To change the setting, first exit out of the tool and re-launch Microsoft Excel before opening VAST. Next, click on the Microsoft Excel icon or File menu in the top left of the screen. Scroll to the bottom of the menu and select the “Excel Options” button to the right of the main menu. When the Excel Options box appears, select “Trust Center” in left hand menu of the box. Next, click the gray “Trust Center Settings” button. When the Trust Center options box appears, click “Macro Settings” in the left hand menu and select “Disable all macros with notification.” Once the security level has been adjusted, open the tool and enable macros in the manner described in the preceding paragraph. (Note: the above description corresponds to Excel 2010. Exact buttons and labeling may be different in other versions, but the same process will apply.)

Figure 1. How to enable macros



Alert: Are the “Update” buttons not working for you?

January 2015: A recent Microsoft security update has caused these buttons to be deactivated for some users. Microsoft is aware of the issue and is working to resolve it. In the meantime, they have issued an easy workaround you can use to correct the issue if you are one of the affected users. This will allow VAST to work on your computer. Please follow the instructions here:

http://blogs.technet.com/b/the_microsoft_excel_support_team_blog/archive/2014/12/11/forms-controls-stop-working-after-december-2014-updates-.aspx.

2. Tool Overview

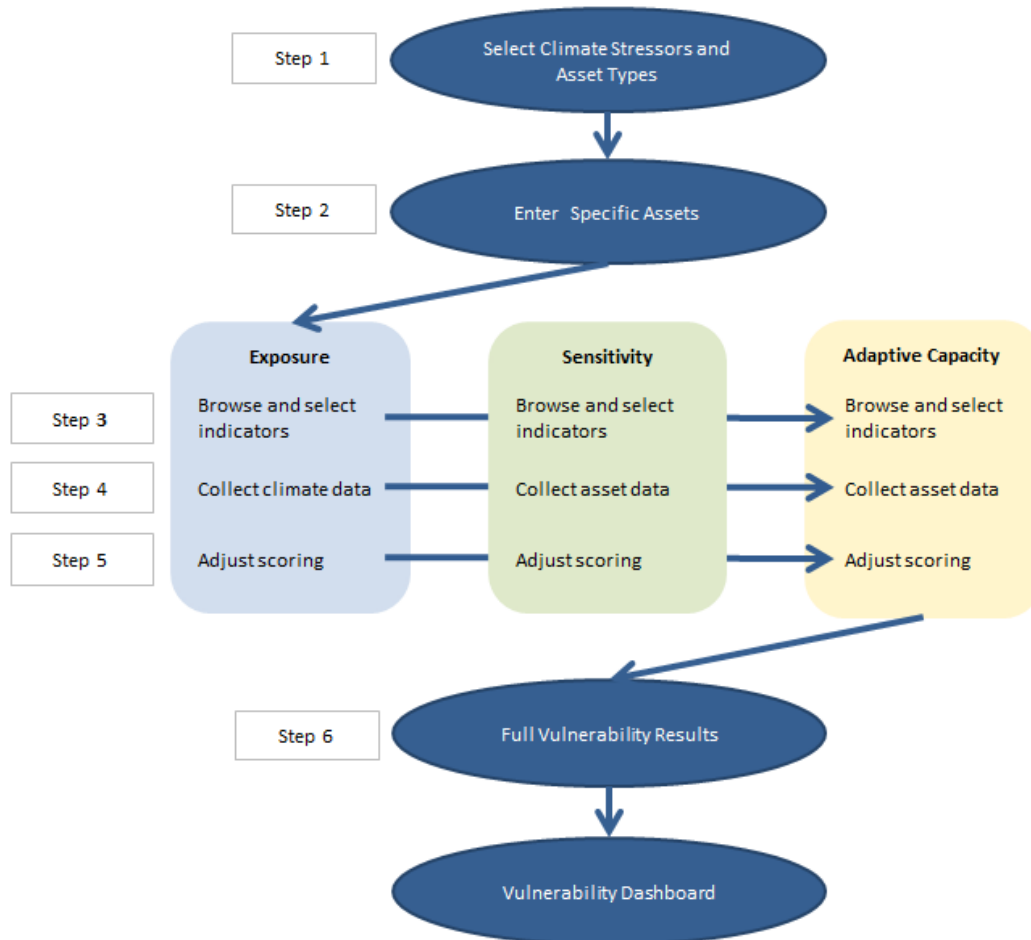
This guide accompanies the Vulnerability Assessment Scoring Tool (VAST) and explains how to use the tool. The tool was developed to help State DOTs, MPOs, and other organizations implement an indicator-based vulnerability screen. An indicator-based screen is one method for assessing vulnerability, and relies on two key premises:

- 1) Vulnerability is a function of exposure, sensitivity, and adaptive capacity.
- 2) Certain characteristics of assets can serve as indicators of their exposure, sensitivity, or adaptive capacity.

Thus, the approach involves collecting information about indicators of each vulnerability component and operationalizing that information into relative vulnerability scores. This can be done for any combination of stressors and asset types, and involves several steps: determining the scope of the vulnerability assessment (VAST Steps 1 and 2), selecting

indicators (Step 3), collecting data about those indicators (Step 4), and devising an approach to convert raw data about indicators into scores (Step 5). The result is a set of vulnerability scores that can be used to rank assets by vulnerability or inform other analysis of the results (Step 6). See Figure 2.

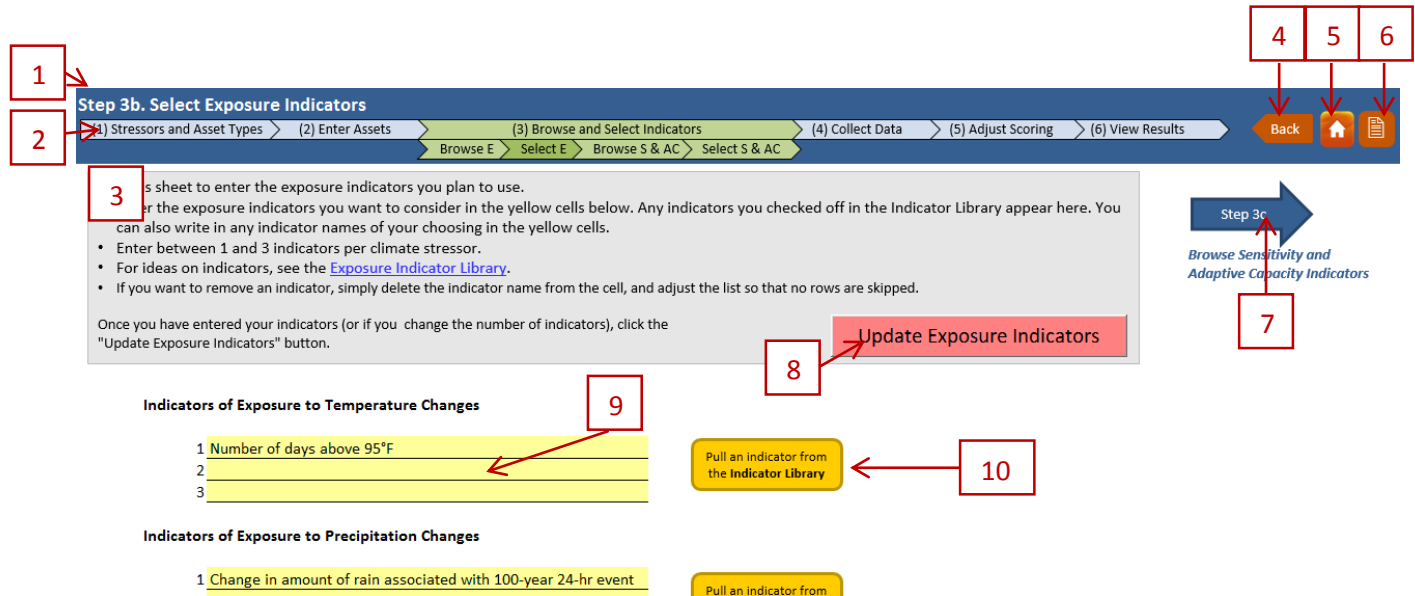
Figure 2. Vulnerability Assessment Scoring Tool approach diagram



Common Sheet Features

Several common sheet features are labeled in Figure 3 and explained below.

Figure 3. Common sheet features



1. **Sheet title** – Includes the step number and description
2. **Navigation bar** – Dark green shading indicates where you are within the process. Light green shading appears if you are within a sub-step (e.g., Step 3b). You can click on other segments of the bar to jump to those steps. Be careful about jumping forward in the process, however, until you have completed the previous steps.
3. **Instructions** – Gray text boxes on each sheet provide instructions for completing the sheet. In some cases, a plus sign appears in the lower right-hand corner of the box for users to expand the instructions.
4. **Back button** – Click this button to return to the previous sheet you were on (not necessarily the previous step)
5. **Home button** – Click this button to go to the Table of Contents, where you can track your progress and navigate to other parts of the tool
6. **Notes button** – Click to go to a page where you can keep notes on your assessment.
7. **Blue arrow** – Click this button to go to the next step in the tool. The description of the next step is shown below the arrow.
8. **“Update” button** – An “Update” button appears on five sheets in the tool. Click this button to propagate changes made on those sheets to other places in the tool. On sheets without this button, changes will automatically be reflected in other locations.
9. **Yellow cells** – Pale yellow shading indicates cells where users should enter data.
10. **Help buttons** – Yellow ‘help’ buttons appear throughout the tool and link to helpful hints, additional information, examples, and other tool features.

Navigating the Tool

Multiple navigation options are available to help you move between steps.

- 1) The blue arrows on each sheet take you to the next step. We recommend you use these blue arrows to navigate the first time you use the tool.
- 2) The navigation bar at the top of each page shows where you are within the process. You can click on other segments of the bar to jump to those steps.
- 3) The Table of Contents provides links to each sheet of the tool. Click the “home” button in the upper right-hand corner of any sheet to take you to the Contents page. On the Contents page, you can navigate using the diagram or the list of sheets.
- 4) You can also navigate as you would in an Excel spreadsheet by clicking on the different tabs. Just make sure that you click the “Update” button where applicable before leaving a sheet.

To go “back” to the previous sheet you were on, click the orange “Back” button in the upper right-hand corner of any sheet.

Sheet Naming Convention

All sheet names begin with the step number to help you keep track of your progress, followed by a brief version of the sheet name (e.g., 2_Enter Assets, 3a_Exp Indicator Library).

Within the Asset Data, Exposure, Sensitivity, Adaptive Capacity, and Vulnerability sheets (Steps 4b through 6), there are tabs for each asset type. These are identified using the notation “**AType**” followed by the asset type number. Each asset type is matched with an AType number on the “1_Set Up” sheet.

Within the Sensitivity tabs, there are tabs for each combination of asset type and climate stressor. These are identified using the notation **AType#-Stressor#**. Each asset type and stressor is matched with a stressor number on the “1_Set Up” sheet.

The sheet name and numbering conventions are critical to the functioning of the tool. DO NOT change sheet names.

Important: Updating the Tool

On five sheets, you must press the pink “Update ___” button in the instructions box. This will make any changes to the sheet take effect throughout the tool. On sheets without this button, updates to the sheet will automatically propagate to other parts of the tool. The five sheets with the “Update ___” button are:

- 1) “1_Set Up” – Click the “Update Stressors & Asset Types” button if you If you change the number of climate stressors or asset types. This will configure the tool for the correct number of stressors and asset types.
- 2) “2_Enter Assets” – If you change the number of assets within any asset type, clicking the “Update Assets” button will apply the correct number elsewhere in the spreadsheet.
Note: you do not need to click this button if you only change the asset IDs, names, or other attributes.
- 3) “3b_Exp Indicators” – If you add or remove indicators, clicking the “Update Exposure Indicators” button will apply the correct indicators elsewhere in the spreadsheet. **You do not need to click the button if you only changed names of existing indicators.**
- 4) “3d_S&AC Indicators” – If you add or remove indicators, clicking the “Update Indicators” button will apply the correct indicators elsewhere in the spreadsheet.
- 5) “4a_Exposure Data” – The first time you complete this sheet, clicking the “Update Climate Data” button will apply the indicator values you provided for the indicators that do not vary by asset.

See also the “Updates” section within the Sheet Instructions section below for additional information on making updates to any sheet in the tool.

3. Sheet Instructions

These Sheet Instructions supplement the instructions provided within the tool itself. Screenshots and some explanations are based on the “use case” of the tool, in which the tool is populated with data from the Gulf Coast study to serve as an example. For each sheet, the User’s Guide includes instructions for two ways you may use the sheet:

- **Initial set-up** – These instructions explain how to complete each sheet the first time
- **Updates** – These instructions explain how to make changes to each step if you have already configured the tool based on the initial set-up.

Rules of Thumb

Do not add or remove rows or columns unless the tool explicitly instructs you to do so.

In general, it is easier to add to the tool—stressors, asset types, assets, indicators, data—than to delete. Keep this in mind when doing the initial tool set-up.

Contents


Use this sheet to navigate throughout the tool and/or track your progress. You can click the diagram to take you to that step of the tool or click a specific sheet within the complete list to go to that sheet. As you complete a sheet, check the box next to that sheet in the sheet list.

Step 1. Select Climate Stressors and Asset Types

Initial Set-Up

Select the climate stressors and asset types you will use in the vulnerability screen.

Select Climate Stressors

Read the instructions provided in the tool. Click the  button to jump to a page with additional information on how to know which stressors to choose and other common questions. Click the “Back” button to return to the set up sheet.

- Click the “up” arrow on the spinner button to add space to enter additional climate stressors. You may enter up to 5 stressors.
- In the yellow cells starting in D18, select a stressor from the drop-down menu. If you select “Other,” write in the name of the stressor in the yellow cell in column F. Do not skip rows. For example, if you only enter two stressors, enter them in cells D18 and D19.

Make sure that the number shown in cell D15 matches the number of stressors you entered. Use the “down” arrow on the spinner button to remove extra blank spaces if necessary.

Select Asset Types

Read the instructions provided in the tool. Note that “asset type,” as defined in this tool, means assets with the same vulnerability indicators. In the Gulf Coast study, the asset types are “Roads,” “Ports,” “Airports,” “Rail,” and “Transit.” Even though there are different kinds of assets within these modes, the study was able to use similar indicators.

- Click the “up” arrow on the spinner button to add space to enter additional asset types. You may enter up to 6 asset types. If you need more than six asset types, you can use a fresh version of the tool to house them.
- In the yellow cells starting in D38, select an asset type from the drop-down menu. If you select “Other,” write in the name of the asset type in the yellow cell in column F. Do not skip rows. For example, if you only enter two asset types, enter them in cells D38 and D39.

Make sure that the number shown in cell D35 matches the number of asset types you entered. Use the “down” arrow on the spinner button to remove blank spaces if necessary.

Click the “**Update Stressors & Asset Types**” button when you are done entering climate stressors and asset types. This will create the necessary spreadsheet structure for the tool and assign each stressor name and asset type name a number (see *Note on Stressor and Asset Type Numbers*) below. Then proceed to Step 2.

Updates

To add a new stressor or asset type:

Use the spinner button(s) to increase the number of stressors and/or asset types. Write in the new stressors and/or asset types, and hit the Update Stressors & Asset Types button. Add new stressors or asset types to the bottom of the list.

Note on Stressor and Asset Type Numbers

Once you click the “Update” button on the Set Up sheet for the first time, the climate stressors and asset types you have entered become permanently linked to the stressor number and asset type number, which define the names of all of the tabs. For example, the “5b_Sensitivity AType1-Stressor2” tab houses the sensitivity scoring information for Asset Type 1 (e.g., Bridges in the Use Case) and Stressor 2 (Precipitation Changes in the Use Case).

As a rule, **do not rearrange the stressors or asset types once you have done the initial set-up.** You can add stressors or asset types to the end of the list. You could rearrange the stressors or asset types if you have not yet completed any other steps (such as listing assets, selecting indicators, or entering data), but avoid this if you have already progressed in the tool.

To remove a stressor or asset type:

Delete the name of the stressor or asset type you want to remove from the list. Adjust the spinner button so it matches the new number of stressors and/or asset types.

Manually delete any tabs that are no longer relevant. For example, if you delete Asset Type 4, hold down the Ctrl key and select the 4b_AssetData_AType4, 5a_Exposure AType4, 5b_Sensitivity AType4-Stressor1-x, 5c_Adaptive Capacity AType4, and 6_Vulnerability AType4. When all tabs are selected, right click on one of the tabs and select Delete from the menu.

To change a stressor or asset type:

To keep the same number of asset types or stressors but change them, take one of two approaches:

- 1) Change the name of the stressor or asset type you want to change in the fields on the Set Up tab. This will change the name of the stressor throughout the tool, but will not make any other changes. For example, any indicators and data already entered will still be associated with that stressor or asset type.
- 2) Manually delete the stressor or asset type you are replacing and add the stressor or asset type you want to add, following the procedures above.

Remember to hit to the Update Stressors & Asset Types button after making any changes!

Step 2. Enter Specific Assets

Initial Set-Up

Enter the specific assets you will evaluate for vulnerability. Enter a list for each asset type. You can type the list or paste one from an existing database. You can enter an unlimited number of assets.

For each asset, enter a **unique Asset ID** and name or description of the asset. If you do not already have shorthand IDs for your assets, assign one.

If you would like to enter any additional information about your assets, such as their latitude and longitude, additional descriptors, or other fields, insert columns and add this information. Click the “How to add columns?” help button for an explanation of how to do this.

Click the “**Update Assets**” button once you have entered assets. If you have not provided a unique ID for each asset, a pop-up box will appear. You will not be able to update the tool until all assets have a unique Asset ID.

Importance of Asset IDs

The tool relies on Asset IDs to keep track of assets and data throughout the tool. For example, the tool uses the unique IDs to pull data for the correct asset from the Asset Data sheet to the Sensitivity Scoring tabs and the component scores for the correct assets on the Vulnerability tabs.

Thus take care when making changes to the Asset IDs and be sure to provide a unique Asset ID for each asset.

Updates

Changing asset information:

To make any changes to asset information (such as Asset ID, Asset Name, or other fields), revise the cells directly—as long as you would still consider this the same asset. The changes will be reflected throughout the tool. You do not need to click the “Update Assets” button if you only make changes to existing assets.

Adding assets:

To add assets, type them in at the bottom of the asset list. You cannot add assets in the middle of the list (you will have the opportunity to sort in different ways later). Click the

“Update Assets” button once assets have been added to make the updates throughout the tool.

Removing assets:

Once the tool has been set up with the initial list of assets for any asset type, it is recommended that you try to avoid deleting assets. However, if necessary, assets can be deleted by following these steps for one asset type at a time:

- Save the file (this is so just in case an error occurs while deleting you can recover your progress).
- For the asset(s) you want to delete, select the entire row(s) within the asset list table for that asset type. For example, to delete an asset from Asset Type 1 that is in row 18, select cells B18:E18 (see Figure X). To delete non-contiguous assets, hold down the Ctrl key while selecting multiple groups. **It is very important that you select all cells within the table.** The cells will be deleted using Excel’s “Delete cells: Shift Cells Up” functionality – this means that if you only select one cell, the asset IDs and names will be misaligned. You will not be able to undo this.
- After you select the cells you want to delete, click the gray “Delete Selected Assets” button above the asset list for that asset type. This will delete the assets from the asset list on this tab and in all other tabs in the tool.
- Note that you **cannot delete the first asset** using this feature. If you want to change the first asset listed, change it using your keyboard.

Figure 4. How to delete assets from the asset list

The screenshot shows an Excel spreadsheet with the following structure:

Asset ID	Asset Name	Latitude	Longitude
R1	Road 1		
R2	Road 2		
R3	Road 3		
R4	Road 4		
R5	Road 5		
R6	Road 6		
R7	Road 7		
R8	Road 8		
R9	Road 9		
R10	Road 10		

Callout box text: "Select all cells related to the asset(s) you want to delete. The example shown is the cells to select in order to delete assets R5, R6, R7, and R8. Once these cells are selected, click the “Delete Assets” button."

Step 3. Background Information on Evaluating Exposure

This sheet provides background information on using indicators to evaluate exposure. Read the information on this sheet and proceed to the next step.

Step 3a. Exposure Indicator Library

The Exposure Indicator Library provides ideas for exposure indicators. These ideas are based on lessons learned during the Gulf Coast Study and related efforts to evaluate vulnerability using indicators.

Use the drop-down menu to browse exposure indicators by climate stressor. The Indicator Library includes the five stressors evaluated in the Gulf Coast Study: temperature changes, precipitation changes, sea level rise, storm surge, and wind.

For each indicator, the indicator library provides:

- Indicator Name
- Description and Rationale – Additional information about why this can serve as an indicator of exposure
- Potential Data Source(s) – Ideas for places where you may find information about this indicator
- Example Scoring Approach – For use in Step 5a (Adjust Exposure Scoring Approach), provides example value ranges that can be used to convert raw data about the indicator to scores on a scale of 1-4. Units are provided if applicable. Example scoring approaches are not available for indicators that were not used in the Gulf Coast Study.

Note on Certain Indicator Names

In the Exposure Indicator Library, not all indicator names are specific. For example, the first temperature exposure indicator is “*Change in Number of Days per Year above/below a Threshold Temperature.*” If users select this indicator, they should add more specificity. For example, in the Use Case, the exposure indicator used was ***Change in Number of Days per Year above 95°F.***

To add an indicator from the Indicator Library to your assessment, check the box next to that indicator name and click the “Add Selected Indicators to My Vulnerability Assessment” button. You can also click buttons that will automatically check all indicators used in the Gulf Coast Study or deselect all indicators.

As you will see in the next step, these checkboxes are just one of several ways to add indicators.

Step 3b. Select Exposure Indicators

Initial Set-Up

Enter the exposure indicator(s) you plan to use for each stressor. You can enter up to three indicators for any stressor, but you do not need to use all three. There are three ways to add indicators:

1. Click the checkbox next to an indicator in the Indicator Library and click “Add Selected Indicators to My Vulnerability Assessment”
2. Click the “Pull an Indicator from the Indicator Library” help button next to each field.
 - This will pull up a menu of indicators from the indicator library. Select the type of indicator (temperature, precipitation, etc.) and then the specific indicator. Click “Add” to add the indicator name to your list. If you already have three indicators, clicking “Add” will do nothing.
3. Write in an indicator name in the yellow cells.

Note that even if you add an indicator from the Indicator Library using method 1 or 2, you can revise the indicator name if desired.

Once you have entered the indicators you plan to use, click the “Update Exposure Indicators” button.

Updates

Changing an indicator name:

To change the name of an indicator, simply change the indicator name on the “3b_Exp Indicators” sheet. You do not need to click the “Update Exposure Indicators” button if you do not change the number of indicators.

Adding an indicator:

Use any of the three methods described for the initial set-up to add an indicator later on. Click the “Update Exposure Indicators” button to make the change take effect throughout the tool.

Removing an indicator:

Select the cell with the indicator you want to remove and, using your keyboard, click “delete.” Then, make sure there are no gaps in the indicator list by copying and pasting the indicator values. See Figure 5 (example shown for sensitivity indicators, but applies to the exposure indicators as well). **DO NOT delete rows or cells on the Select Indicators sheet.**

When you change the number of indicators, click the “Update Exposure Indicators” button.

Remember to hit the Update Exposure Indicators button after making any changes!

Step 3c. Sensitivity and Adaptive Capacity Indicator Library

The Sensitivity and Adaptive Capacity Indicator Library provides ideas for sensitivity and adaptive capacity indicators. These ideas are based on lessons learned during the Gulf Coast Study and related efforts to evaluate vulnerability using indicators.

Use the drop-down menus to browse indicators by asset type and climate stressor. Sensitivity indicators are specific to asset-stressor combinations, while adaptive capacity indicators are specific only to asset types. The Indicator Library includes the six asset types evaluated in the Gulf Coast Study (roads, bridges, airports, ports, rail, and transit) and five stressors (temperature changes, precipitation changes, sea level rise, storm surge, and wind).

For each indicator, the indicator library provides:

- Indicator Name
- Description and Rationale – Additional information about why this can serve as an indicator
- Potential Data Source(s) – Ideas for places where you may find information about this indicator
- Example Scoring Approach – For use in Step 5b and 5c (Adjust Sensitivity/Adaptive Capacity Scoring Approach), provides example value ranges that can be used to convert raw data about the indicator to scores on a scale of 1-4. Units are provided if applicable. Example scoring approaches are not available for indicators that were not used in the Gulf Coast Study.

To add an indicator from the Indicator Library to your assessment, check the box next to that indicator name and click the “Add Selected Indicators to My Vulnerability Assessment” button. You can also click buttons that will automatically check all indicators used in the Gulf Coast Study or deselect all indicators.


As you will see in the next step, these checkboxes are just one of several ways to add indicators.

Step 3d. Select Sensitivity and Adaptive Capacity Indicators

Initial Set-Up

There are three ways to add indicators:

1. Click the checkbox next to an indicator in the Indicator Library and click “Add Selected Indicators to My Vulnerability Assessment”

2. Click the “” button to pull up a menu of indicators from the indicator library and click “Add.”
3. Write in an indicator.

Note that even if you add an indicator from the indicator library using method 1 or 2, you can revise the indicator name if desired.

Once you have entered the indicators you plan to use, click the “Update Indicators” button. This will generate a Data Collection Template you can use to collect data about these indicators for all assets.

Updates

Changing an indicator name:

To change the name of an indicator, simply change the indicator name on the “3d_S&AC Indicators” sheet.

Then, make the same change in the indicator name on the appropriate “4b_AssetData-AType#” tab.

Adding an indicator:

Follow the same process to add an indicator on subsequent steps.

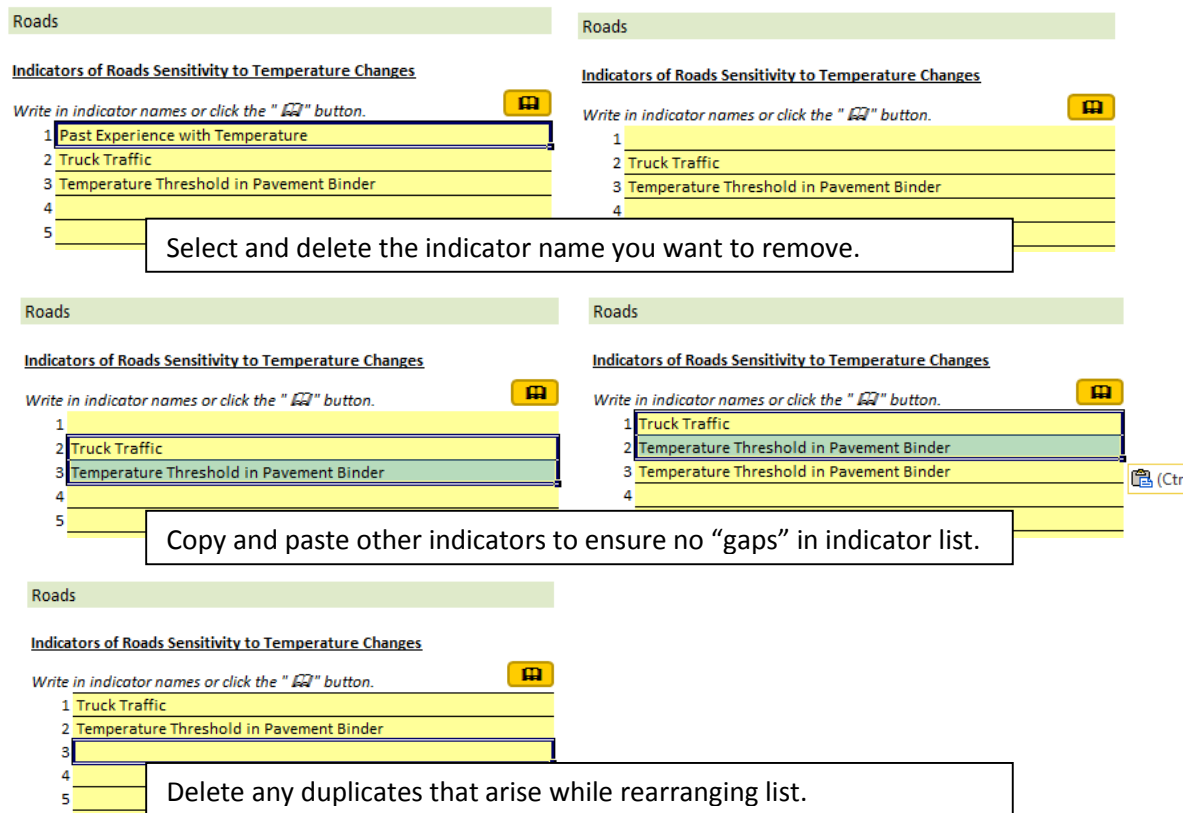
Removing an indicator:

Select the cell with the indicator you want to remove and, using your keyboard, click “delete.” Then, make sure there are no gaps in the indicator list by copying and pasting the indicator values. See Figure 5. **DO NOT delete rows or cells on the Select Indicators sheet.**

The indicator you deleted will still appear on the data collection sheet (flagged in red font), but you can manually delete the column there or simply ignore it. If the indicator is not listed on the “3d_S&AC Indicators” sheet, the data will not be pulled anywhere.

Remember to hit the Update Indicators button after making any changes!

Figure 5. How to remove an indicator (example shown: remove “Past Experience...” indicator)



Step 4a. Collect Climate Data

Initial Set-Up

On this sheet, decide whether to consider multiple scenarios for each stressor and enter climate data for applicable indicators.

Entering climate scenarios

For each climate stressor, you can enter names for up to two scenarios. It is best to keep these names short and simple; you can record in a comment or a note elsewhere in the tool detailed definitions of the scenarios. You may want to consider multiple scenarios to compare vulnerability under different circumstances. If you only want to consider one scenario for each stressor, click the box titled “I want to consider only one scenario for each climate stressor.” You do not need to name the scenarios if you use only one.

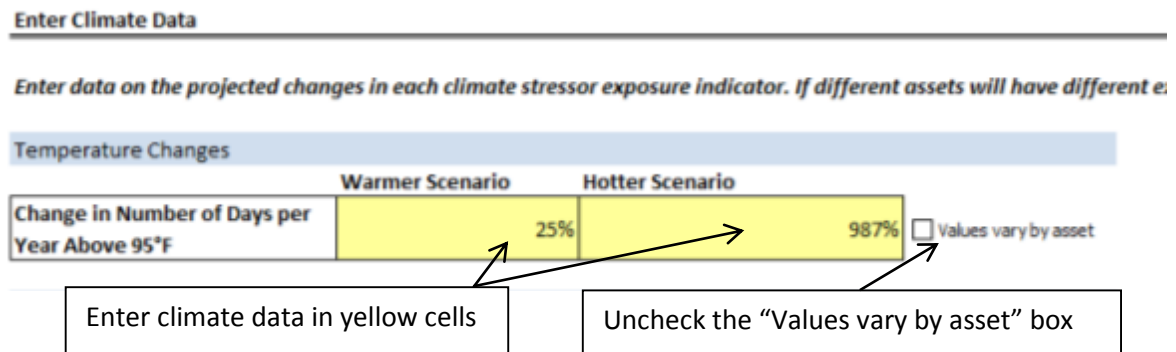
Checking this box will configure the remainder of the tool for one stressor. You can return at any time, uncheck the box, and add a second scenario. Similarly, you can return at any time and remove a second scenario by checking the box.

Entering climate data:

On this sheet, enter any climate data that does not vary by asset (or asset type). For example, in the Use Case, the temperature exposure indicator “Change in number of days per year above 95°F” is the same for all assets. Uncheck the box next to the indicator titled “Values vary by asset” and enter the data in the yellow cells.

If desired, use the available menus in Excel to adjust the formatting of the cell to show the value as a percent or to show a specific number of decimal places.

Figure 6. How to enter climate data for indicators that do not vary by asset



When you are done, click the “Update Climate Data” button. This will apply the climate data entered to all assets on the exposure scoring sheets for indicators where the “Values vary by asset” box is unchecked.

Updates

Updating climate scenarios:

To change the name of a climate scenario, simply revise the name on this sheet where you first entered it. This change will propagate throughout the tool.


To change from one to two scenarios, uncheck the “I want to consider only one...” checkbox and write in scenario names. To change from two scenarios to one, check the “I want to consider only one...” checkbox. No other changes are necessary.

Updating climate data:

To change the value of any climate data already entered on the climate data sheet, simply change the value in the yellow cells where you entered it. This change will propagate throughout the tool.

To change an indicator from varying by asset, uncheck the “Values vary by asset” box next to that indicator and enter appropriate data in the yellow cells. Click the “**Update Climate**

Data” button to overwrite any data you may have entered for that indicator on the exposure scoring sheet(s) with the new climate data.

To change an indicator *to* vary by asset after you have initially set up the indicator otherwise, check the “Values vary by asset” box next to that indicator and use your keyboard to delete any data you had entered (**do not delete rows or cells**). Then, overwrite the formulas in the gray columns for that indicator on the exposure scoring sheets (e.g., “5a_Exposure AType#”). Enter the values under each indicator as you would for an indicator that varies by asset (see instructions under Step 5a, Adjust Exposure Scoring). You can also change the formatting back from gray to yellow using Excel’s cell shading function ().

Step 4b. Collect Asset Data

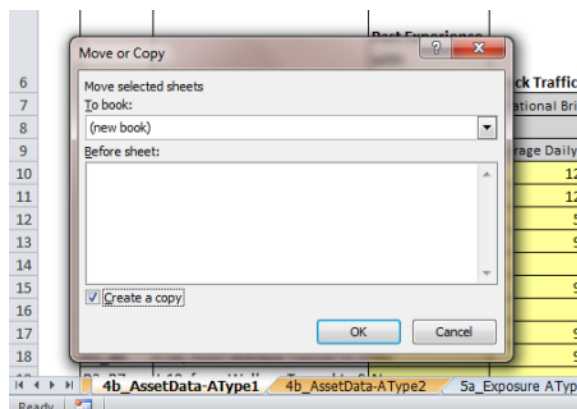
Initial Set-Up

Populate the data collection sheet with data for each asset and indicator. Do this by linking the sheet to external databases, pasting or writing in data from other sources, or any way that you prefer. Also see the data collection tips by clicking the yellow help button.

If you want **to create a copy of this data collection sheet in a separate workbook** to distribute to others within your organization or for any other reason, complete the following steps:

- Right-click on the tab name and select “Move or Copy...”
- In the window that appears, under To book: select “(new book)” from the drop-down menu.
- Check the “Create a copy” box, and click OK.

Figure 7. How to copy data collection sheet to separate workbook



Ultimately, you should compile all data and enter it in the sheet within the tool.

Data Collection Notes

You can insert any additional columns desired on the data collection sheets to help you arrive at the right data for each indicator. For example, in the Use Case, you can see how the column “Year Built” was added to facilitate calculation of the indicator “Bridge Age.” For a more complicated example, see how the columns “Classification” and “NBI Item 71” were added to help determine the right value for the indicator “Frequency that Water Overtops a Bridge.” As shown in the Use Case, you can also use additional space within the tool either on the data collection sheets or in new sheets to store any intermediate calculations or background steps.

Updates

To make changes to any data, simply change the data as you entered it originally in the yellow cells.

For information on how to change the structure of the data collection template, see the sections on updating the asset list (Step 2) and updating sensitivity and adaptive capacity indicators (Step 3d).

Step 5a. Adjust Exposure Scoring

Initial Set-Up

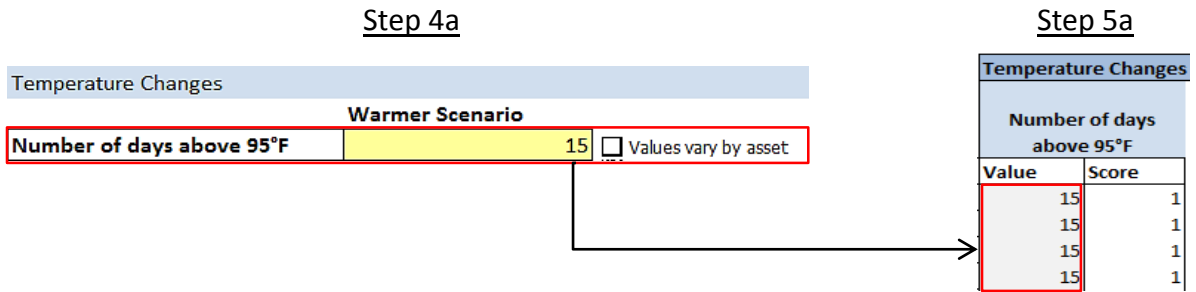
For each asset type, use these sheets to (a) enter data for indicators that vary by asset, and (b) determine how to convert indicator values to scores on a scale of 1-4.

Troubleshooting Note: If it looks like there may be extra columns on this sheet (like for indicators or scenarios that you didn't use), go back to the Step 3b Select Exposure Indicators tab and press the “Update Exposure Indicators” button.

Entering data for indicators

If the indicator **does not** vary by asset, the “Value” column pertaining to the indicator is populated with the value entered in Step 4a.

Figure 8. Depiction of how climate data entered in Step 4a are linked to exposure indicators in Step 5a



If the indicator does vary by asset, then the “Value” column will be blank. Enter data here (the cells are shaded yellow). For example, in the Use Case (and in Figure 9), see how values were entered for each asset for the storm surge indicator Modeled Surge Inundation Depth. You can modify the Value column (as shown) or insert a comment to denote units and any additional information if needed.

Figure 9. Example from Use Case showing how exposure indicator data values were entered for each asset

Show Scoring Approach

Storm Surge			
Katrina Base		Katrina Shifted, Intensified, SLR	
Modeled Surge Inundation Depth			
Value (feet)	Score	Value (feet)	Score
2.23	1	18.19	2
2.23	1	18.19	2
2.23	1	18.19	2
5.20	1	20.10	3
5.20	1	20.10	3
5.20	1	20.10	3
5.20	1	20.10	3
5.20	1	20.10	3
5.20	1	20.10	3
5.20	1	20.10	3
5.20	1	20.10	3
5.20	1	20.10	3
5.20	1	20.10	3
5.20	1	20.10	3

Units noted here

Data entered

Adjusting indicator scoring

Once all the data has been entered, click the “Show Scoring Approach” button above the indicator column. The following box appears to the right of the indicator column (see Figure 10).

Figure 10. How to adjust exposure scoring approach

Change in Number of Days per Year Above 95°F Scoring Approach ?

Review and adjust value range for each score:
(Default scoring ranges based on range of all values)

Value range:		=	Score:	
0%	247%		NE	
247%	493%		1	
493%	740%		2	
740%	987%		3	
			4	

Restore Defaults

If indicator has non-numeric values:
 Enter all possible values for the indicator and the appropriate score (NE, 1, 2, 3, 4):

Pull Possible Values

Possible Values	Score
No data	No data

1. If values are numeric, these cells are automatically populated by equally dividing the range of values into 4 "bins." In the Use Case, the values range from 25% to 987%, and the default scores break down this range into four equally sized bins. Based on your judgment, enter in the appropriate bins for each score. For example, in the Use Case, the bins were adjusted to be based on equal-sized bins between 0 and the maximum value. More information on this is provided below.
2. "NE" stands for "not exposed." Manually enter in the data range which corresponds to NE. More information on this is provided below.
3. If you've changed the bins or scores and want to revert back to the default settings, click this button.
4. If this indicator is not scored numerically (e.g. yes/no), then click "Pull Possible Values" and assign each value a score.

To adjust the scoring bins for numerical values, type in the appropriate bins in the yellow cells (labeled with #1 in Figure 10). **The bins must be written in ascending order.** Therefore, if higher values equate with lower exposure scores, change the order of the score values to 4, 3, 2, 1, NE. Also note that the first value of each bin is included in that bin. For example, bins shown in Figure 10 translate to the following conversion:

Value Range	Score
$0\% \leq \text{value} < 247\%$	1
$247\% \leq \text{value} < 493\%$	2
$493\% \leq \text{value} < 740\%$	3
$\text{Value} \geq 740\%$	4

Example from Use Case: Scoring 0 values to be “NE”

To set a 0 value equal to NE (Not Exposed), you have to make a slight revision to the next bin. This is demonstrated in the Use Case on the “5a_Exposure AType1” tab in the Storm Surge scoring approach (column FO:FT). The process used to achieve this result is outlined here:

- First, enter a value range of 0, 0 in the first row, and set the score equal to NE
- Second, enter a value range of 0.000001 (or a similarly small number) in the second scoring bin, and set the score equal to 1. This ensures that 0 values are scored as NE rather than as 1.
- Set the remaining scoring bins as desired. For example, the Use Case creates bins of equal size between zero and the maximum surge value experienced, 37.7 feet.

Modeled Surge Inundation Depth Scoring Approach

Review and adjust value range for each score:
(Default scoring ranges based on range of all values)

Value range:			Score:	
0	0	=		NE
0	9	=		1
9	19	=		2
19	28	=		3
28	38	=		4

Restore Defaults

Exposure Scoring Helpful Hints

The scoring approach is highly dependent on the indicator and stressor under consideration. As such, the default scoring approach will not be appropriate for all indicators. Here are some guiding questions to consider in formulating your scoring approach:

- Are there certain thresholds of exposure above which damage is incurred, and below which there is no damage (for all assets in the analysis)?
- Is there evidence to back up what is considered “not exposed”? For example, a ski resort atop a mountain can be deemed not exposed to sea level rise due to its elevation. However, just because a certain asset was not affected by a storm surge in the past, it does not mean that a “not exposed” rating is validated.
- If you are considering two scenarios, one of which is less extreme and the other more extreme, is it appropriate to score one scenario at “1” and one scenario at “4”? This could be a simple way of establishing a range of results for stressors that do not vary by asset. On the other hand, if even the less extreme scenario corresponds to a high level of exposure, scores of 3 and 4 may be more appropriate.

Once you have scored all the indicators for a given stressor, the column with the green heading “Exposure Score” will show the composite exposure score for each asset.

Adjusting indicator weights

To see how the indicators are weighted in arriving at this overall exposure score, click the “Show Indicator Weights” button. As an initial default setting, the tool assigns equal weights to all indicators. Make any changes to indicator weights directly in the yellow shaded cells. You will see these changes reflected in the pie chart and the results will update automatically. The indicator weights should be assigned based on expert judgment. **Make sure weights sum to 100%.**

Important Notes on Completing Step 5a

“Not Exposed” Scores

The “not exposed” score should be used only with high levels of confidence that the asset will not experience the given climate stressor – even under a variety of future climates. Exposure is a prerequisite to vulnerability; that is, if an asset is not exposed, it automatically has zero vulnerability. In this tool, in order for an asset to be deemed not exposed to a stressor, all indicators for that stressor must be scored NE.

Missing Data

If you are missing data, enter “**No data**” in the Value column. The Score column should fill in automatically with “No data.” If it does not, simply show the scoring approach and enter in “No data” in the table of possible values at the bottom of the box. Enter “No data” in the right-hand Score column as well. This way, any “No data” values for the indicator will be scored as “No data.”

A “No data” score is not scored as a zero. Instead, the indicator weight is assigned to zero, and the weights of the other indicators are increased to compensate for the missing indicator. For example, imagine that there are four indicators, each with a 25% weighting. If Indicator 3 has a “No data” score, then the weight for Indicator 3 will go to 0. The weights for Indicators 1, 2, and 4 will increase from 25% to 33.3% so that the total remains 100%.

Updates

If you would like to make changes to the data values and the indicator **does not** vary by stressor, simply go back to Step 4a and enter in the appropriate value there. If the indicator **does** vary by stressor, simply make changes in the yellow shaded cells in Step 5a.

Changes to the scoring approach, both for individual indicators and the indicator weights, can be made at any time directly in the yellow shaded cells. The changes will propagate through the rest of the tool automatically. There is no “Update” button to press on this tab.

Step 5b. Adjust Sensitivity Scoring

Initial Set-Up

For each asset type and stressor, use these sheets to determine how to convert indicator values to scores on a scale of 1-4.

The values for each indicator are populated on these tabs based on put in Step 4b, the asset data collection step. Click the “Show Scoring Approach” button above each indicator to adjust how the values are scored.

Scoring numerical values:

If the indicators are numerically scored, the default scoring bins will automatically populate by equally dividing the range of values into four “bins.” Based on your judgment, enter in the appropriate bins for each score.

To adjust the scoring bins for numerical values, type in the appropriate lower and upper bounds of the bins in the yellow cells (labeled with #1 in Figure 10). **The bins must be written in ascending order.** Therefore, if higher values equate with lower sensitivity scores, change the order of the score values to 4, 3, 2, 1. Also note that the first value of each bin is included in that bin. For example, the value ranges you enter in the “scoring approach” boxes translate as shown in Figure 11.

Figure 11. Indicator scoring bin definitions

Value	Score		Value Range	Score
0	50	=	0 ≤ value < 50	4
50	100	=	50 ≤ value < 100	3
100	150	=	100 ≤ value < 150	2
150		=	Value ≥ 150	1

Scoring non-numerical values:

If the indicators are not numerically scored (e.g. yes/no, high/medium/low), then click the Pull Possible Values button. The yellow cells will populate with all unique values entered for that indicator. Assign a score on the scale of 1-4 for each value. **For any values representing unknown or missing data, assign the score as “No data.”** See the example shown in Figure 12.

Scoring a mix of numerical and non-numerical values:

Some indicators may feature a mix of numerical and non-numerical values. For example, Navigation Vertical Clearance, a bridge sea level rise sensitivity indicator, could feature numerical values (the navigational clearance in feet) or text, such as “No navigational control” or “Not applicable.”

In such instances, complete the following procedure:

- Adjust the numerical scoring bins as you would for a purely numerical indicator
- Enter the possible non-numerical values and assign scores to them for the indicator in the yellow cells in the bottom portion of the scoring approach pane. It is recommended that you do this manually. Alternately, if one of the non-numerical values appears in the first five values of the indicator, you can click the “Pull Possible Values” button. This will pull all values for the indicator, including the numerical ones. Delete the numerical values using your keyboard until all that remains is a list of the non-numerical values. Assign scores for those values, recalling to assign any value representing a lack of data as “No data.”

See Figure 12 for an example from the Use Case. The indicator features numerical values as well as three non-numerical values: No data, No navigation control (permit required), and Not applicable, no waterway. Each of these represents a situation where there is no value for the indicator to be scored, so “No data” is entered in the score column next to each possible value.

Figure 12. Example from Use Case of how to score an indicator with both numerical and non-numerical values

Hide Scoring Approach

Navigational Clearance of Bridge	
Value	Score
No navigation control	No data
7.6	3
8.0	3
Not applicable, no wa	No data
No Data	No data
Not applicable, no wa	No data
22.3	1
No navigation control	No data
Not applicable, no wa	No data
No Data	No data
Not applicable, no wa	No data
No Data	No data
Not applicable, no wa	No data
No Data	No data
No Data	No data
No Data	No data
No Data	No data
Not applicable, no wa	No data
No Data	No data
No Data	No data

Navigational Clearance of Bridge ?

Scoring Approach

Review and adjust value range for each score:
(Default scoring ranges based on range of all values)

Value range:		Score:
0	5	4
5	10	3
10	15	2
15	122	1

Restore Defaults

OR

if indicator has non-numerical values...

Enter all possible values for the indicator and the appropriate score (1-4):

Pull Possible Values

Possible Values	Score
No data	No data
No navigation control (permit	No data
Not applicable, no waterway	No data

Using the Example Scoring Approach from the Indicator Library

If you are using an indicator from the Indicator Library, you can use the example scoring approach provided in the indicator library.

Jump to the indicator library using the navigation bar or selecting the “3c_S&AC Indicator Library” tab. Find the indicator you used and copy the cells containing the example scoring approach. If the scoring approach is numerical, the approach will feature the “=” between the value and score.

Use “Paste Values” to paste the scoring approach into the correct cells in Step 5b. See the example in Figure 13.

Figure 13. Example from Use Case of how to copy scoring approach from Indicator Library to sensitivity scoring tabs (Step 5b)

Scour Rating
Bridges that have already been identified as having problems with scour are more likely to be damaged during storm surge events.

- National Bridge Inventory, Item 113 (Scour Critical Bridges)
- Asset management system

Condition of Bridge Substructure
Bridges that are in poor condition are more likely to be damaged during storm surge events.

- National Bridge Inventory, Item 60 (Substructure Condition Rating)

Scour Rating Scoring Approach

Review and adjust value range for each score:

Default score: 8.0

Value: 123

Paste options: 123, %, %>

Paste special: ...

Insert Copied Cells...

Delete...

Clear Contents

Filter

Sort

Insert Comment

Format Cells...

Pick From Drop-down List...

Define Name...

Hyperlink...

Value	Score
8.0	2
8.0	2
8.0	2
N	1
No Data	No data
N	1
No Data	No data
8.0	2
N	1
No Data	No data
N	1
No Data	No data
N	1
No Data	No data
No Data	No data
No Data	No data
No Data	No data
N	1
No Data	No data
No Data	No data
No Data	No data
N	1
5.0	2
8.0	2
8.0	2
N	1
No Data	No data
8.0	2

Value	Score
N	1
U	No data
T	Likely low risk
9	Likely low risk
8	Stable
7	Countermeasures
6	Not evaluated
5	Stable
4	Stable
3	Scour critical
2	Scour critical
1	Scour critical
0	Scour critical
99	Miscoded data

Adjusting indicator weights:

Once you have scored all the indicators for a given stressor, the column with the green heading “Sensitivity Score” will show the composite sensitivity score for each asset. To see how the indicators are weighted in arriving at this overall sensitivity score, click the “Show Indicator Weights” button. As an initial default setting, the tool assigns equal weights to all indicators. Make any changes to indicator weights directly in the yellow shaded cells. You will see these changes reflected in the pie chart and the results will update automatically. The indicator weights should be assigned based on expert judgment. For example, historical performance coping with that stressor may be identified as one indicator to be weighted more

heavily than others. There may also be certain critical thresholds (such as design standards) that are more strongly correlated to damage than others. **Make sure weights sum to 100%.**

Note: adjusting indicator weights can also be done once you have completed your vulnerability assessment as a way to test how sensitive the results are to changes in indicator weighting assumptions.

Sensitivity Scoring Helpful Hints

The scoring approach is highly dependent on the indicator and stressor under consideration. As such, the default scoring approach will not be appropriate for all indicators. Here are some guiding questions to consider in formulating your scoring approach:

- While this is a relative scoring system, it is important to consider the scores in a broader context. For example, if the asset ages range from one to five years old but all have a 50-year lifetime, it may not make sense for a five-year old asset to be scored a 4 just because it is the oldest asset. In this case, it may be preferable for all assets to score a 1, or perhaps a 1 and a 2.
- Are there certain thresholds of an indicator above which damage is incurred, and below which there is no damage (for all assets in the analysis)?
 - Note that there is no option to score an asset as “not sensitive.” This is intentional. While exposure can be modeled spatially, sensitivity is highly asset-specific and it is easy to confuse “very low sensitivity” with “no sensitivity.” Therefore the lowest possible score to assign for sensitivity is a 1. However, if you want to revise this approach, see the “Advanced Topics” section of the User’s Guide.

Updates

All changes to the scoring approach and the indicator weights can be made directly in this tab’s yellow shaded cells. The changes will propagate automatically throughout the rest of the tool.

Changes to the data values themselves should not be made in this tab. Instead, use Step 4b to modify data.

Step 5c. Adjust Adaptive Capacity Scoring

Initial Set-Up

The adaptive capacity scoring tabs function in exactly the same way as the sensitivity scoring tabs. See the instructions for Step 5b.

Adaptive Capacity Scoring Helpful Hints

Note that unlike exposure and sensitivity, adaptive capacity is *inversely* correlated with vulnerability. An asset with a low adaptive capacity has higher vulnerability than an asset with high adaptive capacity. Adaptive capacity scores, however, are directly correlated with vulnerability. In other words, the lower the adaptive capacity, the higher the adaptive capacity score and the higher the vulnerability score.

Updates

All changes to the scoring approach and the indicator weights can be made directly in this tab's yellow shaded cells. The changes will propagate automatically throughout the rest of the tool.

Changes to the data values themselves should not be made in this tab. Instead, use Step 4b to modify data.

Step 6. View Results

Initial Set-Up

This tab displays the full results of the vulnerability assessment. The sheet is mostly for viewing data, but there are a few areas where you can make changes:

Adjusting component weights:

The composite vulnerability scores for each asset are calculated using a weighted average of the exposure, sensitivity, and adaptive capacity scores. The default weighting is assigning equal value to each component. These weights can be directly modified in those cells. **Make sure the weights sum to 100%.**

Adding cost or other comparative data:

The blank column to the right of the asset list gives you the option of filling in another value for each asset (note that this is not required). This is provided to allow users to crosswalk another factor—such as cost or criticality—with asset vulnerability.

Exploring results:

This sheet has several features to help you review the results:

- Sorting – click the radio button above each column to sort the table by that column
- Source buttons – click the “Source” buttons above any column to return to the relevant scoring tab, where you can review and refine the scoring approach
- Asset Score Query and Dashboard – links to additional resources to help you explore the results
- “Damage” – The “Damage” column is a combination of exposure and sensitivity only, providing a measure of impact, or how likely an asset is to be damaged by a stressor (combining the issues of whether it will experience a stressor and whether it would be damaged by a hypothetical stressor). This is distinct from the vulnerability score, which also encapsulates the asset's adaptive capacity. An alternate way of looking at vulnerability is comparing Damage vs. Adaptive Capacity.

- **Data Availability Scores** – These columns explain the percentage of possible indicator data available for each asset. The score is on a range of 0 to 100% and represents the percentage of the overall score weight for which indicators were available. For example, if an asset’s score was determined by two indicators weighted equally, but one of them was missing for an asset, the asset would get a data availability score of 50%. If the asset’s score was determined by two indicators where one accounted for 75% of the vulnerability score and the other accounted for 25% of the vulnerability score and the second was missing, the asset would get a data availability score of 75%.

Updates

The vulnerability component weights can be modified at any time, and changes will be reflected automatically in the scores below.

The “?” column can also be modified in the tab at any time.

Dashboard

The Dashboard provides a brief summary of the results for each asset type in the assessment. Use the drop-down menu at the top to select the asset type. The graph allows you to compare vulnerability across different climate stressors to identify, for example, that ports are much more sensitive to sea level rise than temperature changes. The list below the graph highlights specific assets that are most vulnerable.

Finally, the bottom graph disaggregates vulnerability and maps damage vs. adaptive capacity for an asset type and stressor. It illustrates whether a specific asset’s vulnerability is driven by adaptive capacity, potential for damage, or both. Use the drop-down menu to select the climate stressor (the asset type can be changed with the drop-down menu at the top of the tab).

You can click the button at the top of the sheet to generate a PDF of the dashboard page.

Asset Score Query

The Asset Score Query tab can be used to track exactly how an asset got its vulnerability score for a given stressor. By selecting the appropriate asset with the drop-down menus at the top, the Score Report reveals the three component scores and the individual indicator scores and weights. This can be particularly useful if one asset’s vulnerability score seems unusually high or low.

Advanced Topics

The Vulnerability Assessment Scoring Tool provides a ready-built framework for implementing an indicator-based vulnerability screen, based on scores on a scale of 1-4. The scale of 1-4 was chosen for two primary reasons. First, because having an even number of “bins” prevents people from instinctively assigning everything to a “middle” number (and thus avoiding making decisions about relative vulnerability). Second, the number of bins corresponded well with the level of detail that was available in the datasets. In the Gulf Coast Study, for example, the study team felt that a higher number of bins (e.g., a scale of 1-10) would have required greater specificity in assigning scores that would not have been possible given the available data.

However, if you want to modify the tool to accommodate a different number of bins, you can do so using the following steps. For example, you may follow these steps if you want to add a “Not Sensitive” category. Users should only attempt these changes if they are relatively comfortable with Excel.

- On the Step 5 sheets (for Exposure, Sensitivity, and/or Adaptive Capacity), for each indicator scoring approach that you want to add additional “bins” to:
 - Select cells in row in the middle of the numerical scoring approach (not above or below), making sure to span the entire “scoring approach” pane (e.g., columns G:L for the first indicator on a sensitivity sheet). See Figure 14.
 - Right-click within the selection and insert cells by clicking “Insert...” then “Shift cells down” (see Figure 14).
 - Repeat as many times as needed.
 - Enter bins as normal, but change score values to reflect desired score range and options.
 - No change should be necessary within the non-numerical values scoring area. Simply change the scores that you assign to the values.
- If adding a NS/Not Sensitive category (similar to NE/Not Exposed), users will have to revise the Damage and Vulnerability formulas in Step 6 in columns I, J, and others, adding a condition for when the sensitivity value is 0 or NS.
 - For example, the formula in cell J15 to account for whether an asset is “NS” would read:
`=IF(OR(E15="NE",G15="NS"),0,E15*C6+G15*C7+H15*C8)`

Figure 14. How to add additional scoring “bins” (example shown: Step 5b, sensitivity tabs)

		Past Experience with Precipitation	
Asset ID	Asset Name	Value	Score
R2_B1	I-10, intersection with I-65	No	1
R2_B2	I-10, intersection with I-65	No	1
R2_B3	I-10, intersection with I-65	No	1
R3_B1	I-10, from Wallace Tunnel to S Bro	No	1
R3_B2	I-10, from Wallace Tunnel to S Bro	No	1
R3_B3	I-10, from Wallace Tunnel to S Bro	No	1
R3_B4	I-10, from Wallace Tunnel to S Bro	No	1
R3_B5	I-10, from Wallace Tunnel to S Bro	No	1
R3_B6	I-10, from Wallace Tunnel to S Bro	No	1
R3_B7	I-10, from Wallace Tunnel to S Bro	No	1
R3_B8	I-10, from Wallace Tunnel to S Bro	No	1
R3_B9	I-10, from Wallace Tunnel to S Bro	No	1
R3_B10	I-10, from Wallace Tunnel to S Bro	No	1
R3_B11	I-10, from Wallace Tunnel to S Bro	No	1
R3_B12	I-10, from Wallace Tunnel to S Bro	No	1
R3_B13	I-10, from Wallace Tunnel to S Bro	No	1
R3_B14	I-10, from Wallace Tunnel to S Bro	No	1
R3_B15	I-10, from Wallace Tunnel to S Bro	No	1
R3_B16	I-10, from Wallace Tunnel to S Bro	No	1
R3_B17	I-10, from Wallace Tunnel to S Bro	No	1
R3_B18	I-10, from Wallace Tunnel to S Bro	No	1

Past Experience with Precipitation Scoring Approach

Review and adjust value range for each score:
Default scoring ranges based on range of all values

Value range:	0	=	0	=	1
Value range:	0	=	0	=	2
Value range:	0	=	0	=	3
Value range:	0	=	0	=	4

Restore Defaults

OR
if indicator has non-numerical values

Past Experience with Precipitation Scoring Approach

Review and adjust value range for each score:
Default scoring ranges based on range of all values

Value range:	0	=	0	=	1
Value range:	0	=	0	=	2
Value range:	0	=	0	=	3
Value range:	0	=	0	=	4

Restore Defaults

OR

Past Experience with Precipitation Scoring Approach

Review and adjust value range for each score:
Default scoring ranges based on range of all values

Value range:	0	=	0	=	1
Value range:	0	=	0	=	2
Value range:	0	=	0	=	3
Value range:	0	=	0	=	4

Restore Defaults

OR

1. Select cells (spanning all “scoring approach” columns)

2. Insert... Shift cells down

the appropriate score (1-4):

Possible Values	Score
No data	No data
No	1
Yes	4

Enter an possible values for the indicator and the appropriate score (1-4):

Possible Values	Score
No data	No data
No	1
Yes	4