What is an Extension/Module

Global Mapper Extensions and Modules can add new functionality to the Global Mapper application and enhance existing measurement and analysis capabilities. These specialized tools allow you to perform more sophisticated tasks such as raster calculation, volumetric calculations and LiDAR classification and data management.

Extensions are available at no additional cost.

Available Extensions

COAST (Coastal Adaptation to Sea Level Rise Tool)
Overview

Global Mapper modules* are developed to significantly enhance certain types of data analysis and add specific tools that benefit those users working with these data types.

Available Modules

Lidar Module
Global Energy Mapper
OTF Reader

Global Mapper modules require an additional license for each module, these may be applied to a registered instance of Global Mapper through the **Extension/Add-In Module Manager**. The Lidar and OTF modules are sold as an addition to the base Global Mapper license.

**Global Mapper modules are not available for use in Global Mapper versions prior to Global Mapper v15.*

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Global Energy Mapper
OTF (Open Terrain Format)

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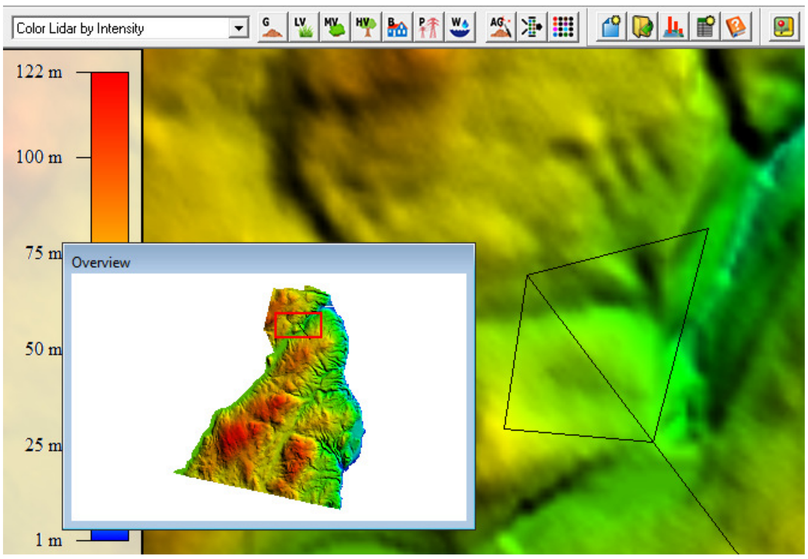
The COAST Extension - Coastal Adaptation to Sea Level Rise (COAST) is a tool that helps coastal communities anticipate damage from storms of varying frequencies and intensities, assisting in the evaluation of the relative benefits and costs associated with different response strategies.

The Overview Extension - This extension enables use of the Overview Window, which can be used to maintain an overview of loaded data coverage and extent.

 Clicking the Show the Overview Window button on the Global Mapper toolbar to open the Overview Window.



The Lidar Module - Activating the Lidar Module, enables the Lidar toolbar for easier management and editing of Lidar pointcloud data, in addition to adding new functionality to existing tools.

Global Energy Mapper - This module adds additional functionality to the Global Mapper application, with supplementary terrain analysis tools, access to Spatial Energy on Demand data, and the ability to use GeoCalc coordinate transformation libraries in GEM**.

The OTF Module - Adds support for OTF (Open Terrain Format) Import and Export. This module is used by military personnel for mapping simulation exercises.

**Global Mapper modules are not available for use in Global Mapper versions prior to Global Mapper v15.*
**The GeoCalc Projection Tools require both a Global Energy Mapper v15 license and a Geographic Calculator 2013 license. Access to these tools is not enabled through older versions of Geographic Calculator.

Lidar Support in Global Mapper

Lidar has become an integral part of GIS mapping and analysis. Global Mapper is well known for its ability to import, analyze, edit and export Lidar datasets. With Global Mapper's Lidar Module, advanced functionality is leveraged through an easy to use **Lidar Toolbar**. This optional module was released in conjunction with Global Mapper version 15.

New display options enables users to view points by height above ground to visualize vegetation and building heights. Access to the **Lidar Module** tools require a separate license*.

Lidar Data

Light detection and ranging (Lidar) mapping, sometimes called 3D laser scanning, is a method for gathering precise geospatial information on the shape and surface characteristics for a specific collection area. The method for collecting Lidar data produces very dense, large files that can be cumbersome to handle. Global Mapper's **Lidar Module** manages these large files with superior speed and efficiency.

Lidar data is commonly delivered in two standard file format types: .LAS and .LAZ. The LAS file format is a public file format for the interchange of 3-dimensional point cloud, it is a binary file that retains the information specific to Lidar data (unlike a generic ASCII). The .LAZ file format is a compressed version of .LAS.

Lidar Module Overview

After an extensive research and development effort into some of the leading LiDAR software applications on the market today, we are pleased to announce the release of the Global Mapper LiDAR Module. This new module will be an optional purchase for those interested in the advanced functions which may be leveraged through the toolbar. If you are interested in evaluating this Module you can request an evaluation license for it under the help menu. If you are interested in purchasing this Module visit the purchase page on our website. Some of these new features include (but are not limited to),

- A LiDAR toolbar for easier management and editing of data.
- New functionality in the Path Profile Viewer allowing users to view LiDAR points directly in the path profile display window. Users can also directly edit LiDAR points and manipulate LiDAR classifications from the path profile view, rather than from a sub-menu.
- Dramatically faster gridding of point cloud data and support for min/max/average gridding operations on Lidar point clouds.
- Automatic classification of ground points from unclassified point clouds.
- E57 LiDAR format support.
- The ability to display Lidar points by height above ground to visualize vegetation and building heights.
- A LiDAR Options tab in the configuration window to allow easily filtering by classification and/or return type.
- Support for reporting Lidar statistics via script to a text file to facility QA processes.
- A new Lidar module toolbar button to colorize Lidar points from loaded imagery in memory, no export required.
- New feature to color loaded elevation data (including Lidar) with the shader using the elevation range on-screen rather than all loaded. This makes it easy to see terrain differences even in flat areas while zoomed in.

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Importing Lidar Data

Importing lidar data has been made easy in Global Mapper. Global Mapper offers native support for LiDAR data. All ASPRS supported file formats (.las, .las, .gz, .laz, .tar, .gz, .tgz, .zip) can be directly imported through the **Open Data Files** option in the File Menu. After navigating to the saved file location and clicking open, the user will be presented with the **Lidar Load Options** dialog box. The Lidar Load Options dialog box enables users to filter and grid a point cloud prior to loading data into Global Mapper.

Analyzing and Classifying Lidar Data

The .LAS file format is a binary file format that maintains information specific to a lidar dataset, without being very complex. Files with the extension named as LAS should conform to the American Society of Photogrammetry and Remote Sensing (ASPRS) LIDAR data exchange format standard.

Global Mapper has numerous tools for displaying and utilizing ASPRS LAS classifications, starting with the **Lidar Load Options** which allows customized importation of the ASPRS defined point classifications listed below.

0 Never classified
1 Unassigned
2 Ground
3 Low Vegetation
4 Medium Vegetation
5 High Vegetation
6 Building

7 Low Point - Noise
8 Model Key-Point
9 Water
10 Bridge
11 Road
12 Overlap
13–31 Reserved for ASPRS Definition

Further classification tools can be used after the Lidar data has been loaded into the application. These are distributed throughout the application, and will become visible once a LAS file has been loaded into the application.
Lidar data processing can also utilize the multiple return signals from each laser pulse. Intensity is a measure, if the number of lidar returns generated for a single point. Most topographic lidar systems record the intensity of the return pulse, measuring the strength of the return. The number of returns will be determined by the composition of the surface object reflecting the return.

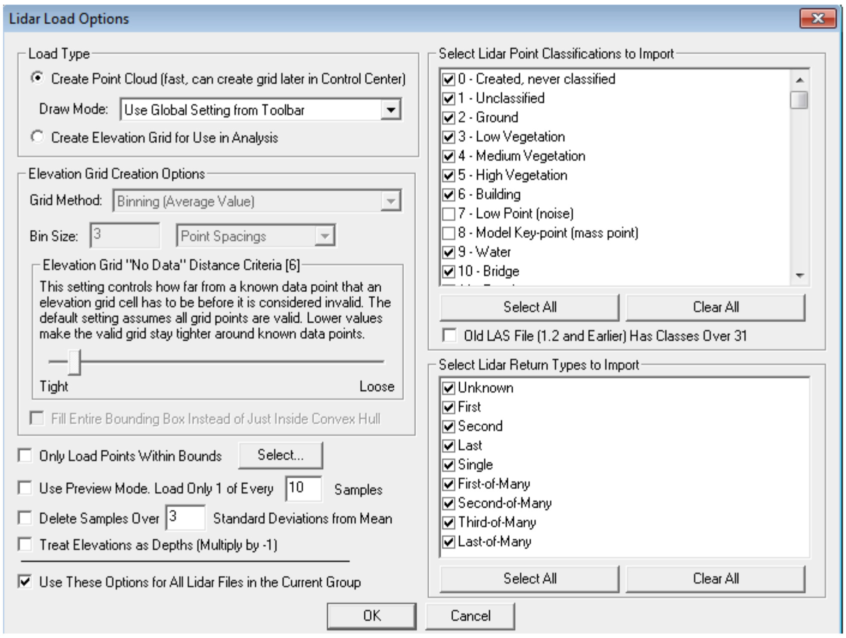
The Intensity values can be used to create an image, and are commonly used in for identifying and classifying different ground features and can be used as a substitute for aerial imagery.

Among the Lidar tools for editing classification, classification display and analysis are; **Lidar Display**, the Configuration **Lidar** tab. Additional options for advanced classification, and feature creation and analysis based on LAS elevation and intensity values are activated with the **Lidar Module**.

* The Lidar Module license may be activated in the Global Mapper application.

Lidar Load Options

To import a Lidar dataset into Global Mapper, go to the Open Data File(s) Command and select the Lidar file(s) to load. The Lidar Load Options dialog (pictured below) will then show.



This dialog allows the user to specify how the Lidar file is formatted, so that they can be imported.

Load Type

Create Point Cloud - The 3D points in the file will be loaded as a point cloud that can be rendered by elevation, intensity (if present), or classifications. You can load a XYZ file like this to use much less memory and render it much faster than loading as full point features. If you have a XYZI (XYZ + intensity) the intensity is also applied to the point cloud. To access different rendering options for these categories click on the Draw Mode menu and select: Color by Elevation, Color by Intensity, Color by Classification, Color by Return Number.

Create Elevation Grid for Use in Analysis - All lines from the file which are determined to contain 3D coordinate data will be use generate a triangulated terrain which is then gridded to create a elevation grid. This grid has all the capabilities of an imported DEM, including contour generation, line of sight and view shed analysis, and raster draping. When selecting this option, the Create Elevation Grid dialog will appear after setting up the Lidar import options to allow setting up the gridding process.

Only Load Points Within Bounds - Allows you to select the boundaries for importation. If you have an area feature you would like to crop the Lidar file to, select the Area Feature with the Digitizer Tool prior to choosing the Open Data File(s) Command. This will enable you to select the Crop to Selected Area Feature(s) option in the Lidar Bounds dialog. *

Use Preview Mode - Load Only X of Every Samples - Samples the Lidar data, allowing for quicker import of Lidar data for preview.

Delete Samples Over X Standard Deviations from Mean - can remove point outliers from Lidar data sets. *

Treat Elevations as Depths - Can be used for certain types of bathymetric Lidar data *

Use These Options for All Lidar Files in the Current Group - Will apply Lidar import settings to all Lidar files in current group *

Select Lidar Point Classification to Import - Option to load Lidar point Classifications

Select Lidar Return Types to Import - Limits the import of Lidar files based on the return type (i.e. first return, last return, first of many, last of many, etc.)

These Lidar import options are only available with the *Lidar Module

Lidar Module Overview

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- New feature to color loaded elevation data (including Lidar) with the shader using the elevation range on-screen rather than all loaded. This makes it easy to see terrain differences even in flat areas while zoomed in.

The Lidar Module, will add the Lidar Toolbar as an additional component to the Global Mapper User Interface.

This module that allows the user to quickly classify selected points, change the draw mode, and auto-classify Lidar points.

The Lidar Toolbar features a drop down menu that allows users to easily select the display characteristics of the point cloud.

Color Lidar by RGB/Elev - Colors the Lidar points by Red, Green, Blue (RGB) values if present, otherwise will use the elevation values.

Color Lidar by Elevation - Applies a color spread to the range of elevations found in the Lidar data.

Color Lidar by Intensity - Color lidar points from black to white by the intensity of the return pulse. Lidar classified with this method can sometimes be used in place of aerial imagery.

Color Lidar by Classification - Colors Lidar points by the ASPRS defined classification values.

Color Lidar by Return Number - Applies a color spread to the range of return values, which typically range from 1 to 5.

Color Lidar by Height Above Ground - The ground height is calculated from the Lidar point cloud, either from classified ground/water points or by the minimum elevation in large chunks. This is not exact and the process may take a few moments to calculate the first time, as ground height is determined.

Color Lidar by Point Source ID - This value will indicate the file from which the point originated, valid values are between 1 and 65,535. Allows for flight paths for Lidar data collection to be visualized.

The Lidar Module also allows the user to manually classify or re-classify Lidar points. To utilize the classification buttons found on the Lidar Toolbar, select a group of lidar points with the Digitizer Tool and click the button corresponding to the classification you wish to use.

The classification options are:

Classify- Ground

Classify- Low Vegetation

Classify- Medium Vegetation

Classify- High Vegetation

Classify- Building

Classify- Power Line

Classify- Water

Auto-Classify Ground Points

 Auto-Classify Ground Points - Specify the minimum height in meters (above the local average) that a point has to be in order to be considered a non-ground point.

 Filter Lidar Data - Allows the user to filter out Lidar points by Classification.

 Apply Color to Lidar Points - Applies color values from loaded imagery to Lidar points based on X, Y location values.

Also found on the Lidar toolbar is the ability to automatically classify ground points based on an elevation value.

Lidar Module: Additional Functionality

The addition of the Lidar Module adds Lidar functionality to the Path Profile/LOS command.

Lidar classification colors can be changed and customized in Lidar tab found in the Configure tab.

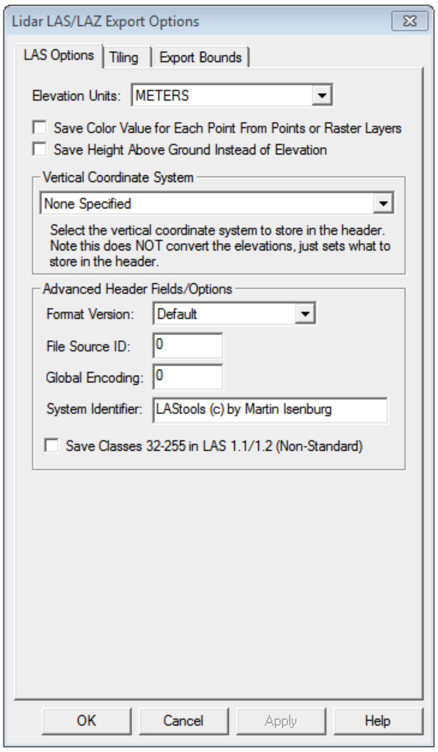
Specialized Lidar import options will be included in Lidar Load Options that allow for quicker import.

Additional Export Elevation Data options for the Lidar LAS format.

Lidar LAS

The **Export Lidar LAS** command can be accessed through **Export Vector Format...** Select Export Format submenu.
This export option allows the user to export any loaded 3D vector data sets (like 3D point clouds loaded from other LAS files) to new Lidar LAS format files. If the source data came from a LiDAR format file, like a LAS, MrSid or LiDAR file the attributes from the original data will be maintained.

When selected, the command displays the **Lidar LAS/LAZ Export Options** dialog which allows the user to setup the export.



The LAS Options allows the user to specify the Elevation Units, the Vertical Coordinate System to be stored in the export's Header field, and Header formatting options.

Tiling will allow the user to set up the grid spacing and vertical units, a Gridding panel, and the Export Bounds panel allows the user to set up the portion of the loaded data they wish to export.
For other (non-Lidar) points being exported to a LAS/LAZ format, in addition to the base position and elevation, if there is an INTENSITY attribute available for the point, the value of that attribute will be exported as the intensity for the point in the exported LAS file.

If you choose the Lidar LAS option then a compressed LASzip (LAZ) file will be created. This offers lossless compression for Lidar data that makes your Lidar files much smaller.

Export Bounds will allow the user to specify export boundaries for the Lidar data by corder coordinate values, a drawn box, the Military Grid Reference System, or the data may be cropped to a selected feature.

Batch Conversion - Apply Color from Imagery to Lidar

This option will be available with **Batch Conversion** exports if you have imagery loaded before you do the batch conversion and choose to create a Lidar LAS or LAZ file from vector data. (This option requires a Lidar Module license.)

About Global Energy Mapper

Global Energy Mapper (GEM) adds additional functionality to the Global Mapper application, with supplementary terrain analysis tools, access to Spatial Energy on Demand data, and the ability to use GeoCalc coordinate transformation libraries in GEM*.

Global Energy Mapper users will need a license for Geographic Calculator 2013 SP1 in order to enable this functionality in GEM.

Using the Geographic Calculator GeoCalc library in GEM will give users access to:

- Worldwide in-depth coverage of any type of coordinate system or geodetic definition
- Vertical datum transformation support for dozens of local geoids, ellipsoids, and

- local offset models

- VDatum support for Tidal vertical references in North America
- Custom coordinate system support and easy sharing of custom parameters between multiple users
- Administrative control of geodetic parameters so users only see and use what you decide via Geographic Calculator.

Global Energy Mapper has enhanced Volume Measurement capabilities, a Pile Volumes command in the Digitizer Tool and a Pad Site feature template.

GeoCalc Projection

The **GeoCalc Projection** mode allows Global Energy Mapper users administrative control of geodetic parameters through Geographic Calculator*. **Once enabled, Global Energy Mapper will access the Geographic Calculator datasource (GeoCalc Library) for data re projection and coordinate transformations.**

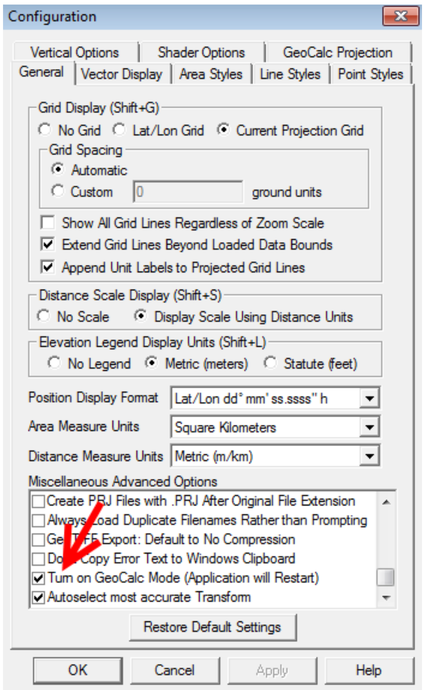
Additional support is enabled for:

- Vertical datum transformation support for an expanded library of local geoids, ellipsoids, and local offset models
- Vertical datum support for Tidal vertical references in North America
- Custom coordinate system support and easy sharing of custom parameters between multiple users

The Administrative control of geodetic parameters allows administrators to limit Global Energy Mapper access to the GeoCalc Coordinate Transformation Library through Geographic Calculator, so that users only see and use what you decide via Geographic Calculator.

For Example: If users only work with data in Canada, you can shut off all non-Canadian systems in Geographic Calculator and these would then be unavailable in GeoCalc Projection.

If you have registered Global Energy Mapper and Geographic Calculator, the GeoCalc Projection mode may be enabled by going to Tools > Configuration.



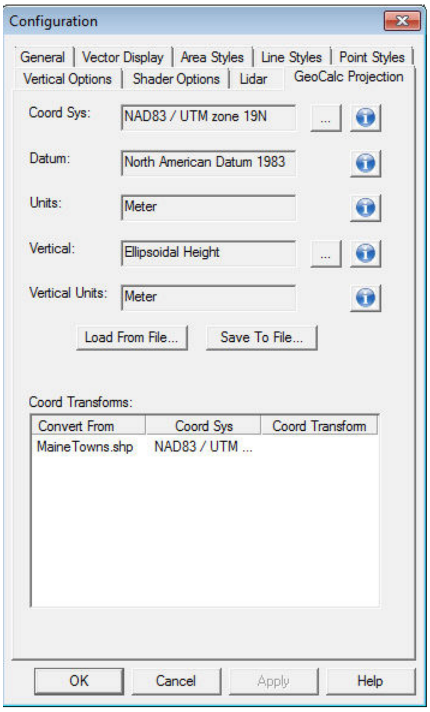
From the General tab of the Configuration window go to Miscellaneous Advanced Options and check off 'Turn on GeoCalc Mode'. At this point Global Mapper will shut down and restart.

Auto-select most accurate Transform - In Geographic Calculator, Datum Transformations have an Accuracy field. Datum Transformations from EPSG have been updated to include the accuracy values specified in the EPSG dataset, the user may also set these to set a known, numerical, accuracy value through the Datasource menu in Geographic Calculator.

*The GeoCalc Projection Tools require both a Global Energy Mapper v15 license and a Geographic Calculator 2013 license. Access to these tools is not enabled through older versions of Geographic Calculator.

Performing a Projection change or a Transformation using GeoCalc Projection

To perform a Projection change or Coordinate Transformation using the Geographic Calculator datasource go to Tools > Configuration and select the GeoCalc Projection tab.



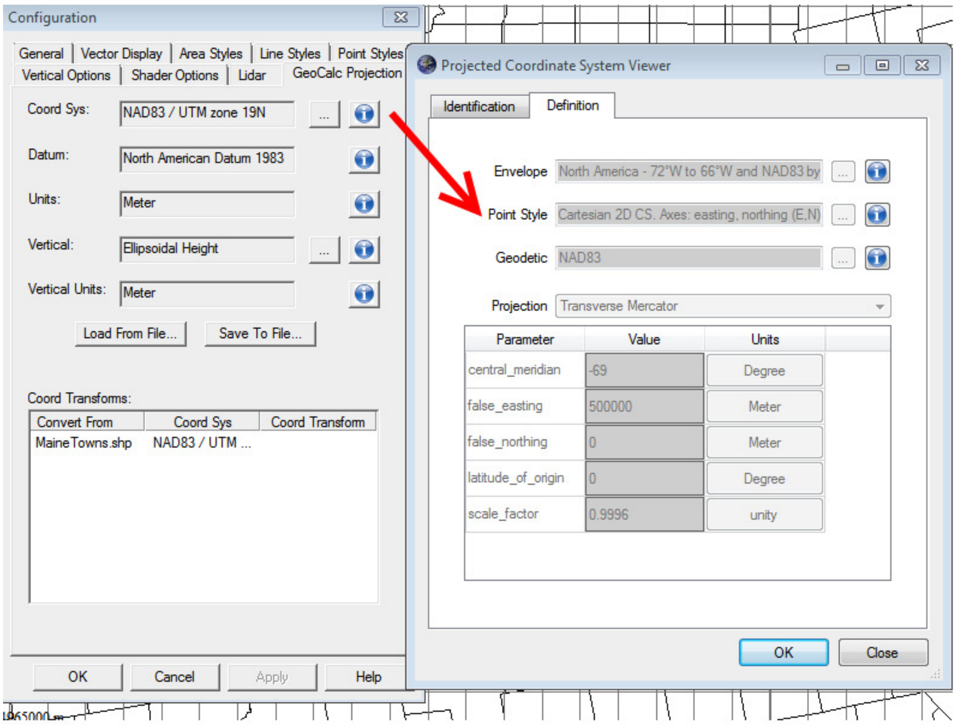
By default, this tab will display the current Coordinate System, Datum, Units, Vertical Reference and Vertical Units. Changing these values will initiate a Projection change, or a Coordinate Transformation.

To save any changes made to the data's Projection, or to perform a Coordinate System/Datum Transformation, hit the Apply button after configuring the Coordinate System, Datum, Units, and Vertical Reference.

Load From File... this may be used to load a coordinate system contained with in a Projection (.prj), .txt or Esri aux.xml file format.

Coord Transforms: - When a coordinate transformation is performed, the transformation from Geographic Calculator will populate in this window. Double-clicking on the transformation line will bring the details of the transformation up in the Geographic Calculator datasource window.

For more information on any of the Coordinate Systems, Units or Datums available hit the blue 'I' button next to that field. This will bring up a description from the Geographic Calculator datasource (See below).



The information window for a Coordinate System, will display the EPSG code (if available) the Identification tab and specific information about the Coordinate System's geographic Envelope (region), Point Style, Datum, Projection and Parameters can be found on the Definition tab.

Layer Projection

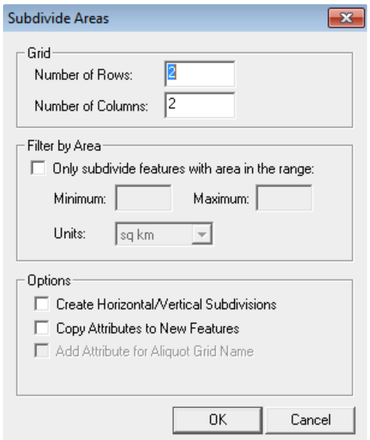
To use the GeoCalc Library to correct the Projection for an imported data layer, highlight the layer in the Overlay Control Center and select Options... and Layer Projection to select the appropriate projection for the data layer.

Though the data layer's current Projection may be corrected or defined from this option, however it is not possible to setup Coordinate Transformations from this dialogue.

Subdivide Quadrilateral Area

If one or more areas are selected, the Subdivide Quadrilateral Area option will appear in the Advanced Feature Creation Options and Crop/Combing/Split Functions sub-menus of the right-click menu. This option is available to Registered users of the **Global Energy Mapper (GEM) Module** and will allow the user to subdivide the selected areas using a user-defined grid.

When the user selects the **Subdivide Quadrilateral Area** menu option, the Subdivide Areas dialog will be displayed: In the Subdivide Areas dialogue (below), a range of areas can be specified - only features with a calculated area in that range will get subdivided. Features larger or smaller than that will be left intact.



Define the dimensions of the grid by filling in the Number of Rows and Number of Columns fields. The values must be positive integers. At least one of the values must be greater than 1.

Filter by Area - Place a check next to 'Only subdivide features with area in the range' to enable this functionality.

The user must specify the minimum value, maximum value, or both.

Minimum: Put the value that represents the minimum area for a feature to be subdivided. If no minimum value is specified, then all features with an area less than the maximum will be divided.

Maximum: Type the value that represents the maximum area that a feature to be divided can have. If no maximum is specified, then all features with an area greater than the minimum will be divided.

Units: Select the unit used for the minimum and maximum values.

If the user checks the Create Horizontal/Vertical Subdivisions option, Global Mapper will produce a grid using purely horizontal and vertical lines to define the requested number of rows and columns. In this case, the resulting horizontal and vertical grid lines will be parallel to each other.

If this option is not checked, then Global Mapper will divide the sides that run in a generally north/south direction into the specified number of rows, and the other two sides (the east/west sides) into the requested number of columns. Whether or not the resulting grid lines are parallel to each other depends on whether or not the sides of the area are parallel.

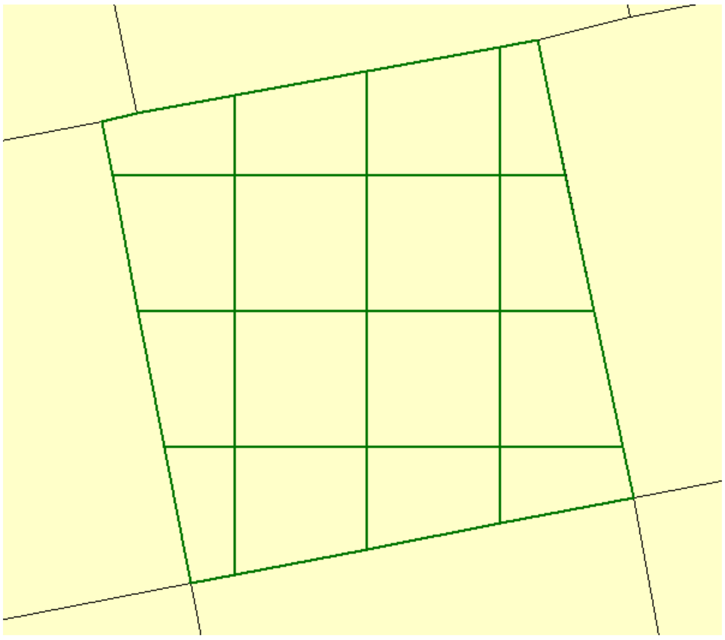
If the user selects the Copy Attributes to New Features option, then the attributes associated with the original feature will be copied to each of the subdivisions.

If the Add Attribute for Aliquot Grid Name option is selected, then Global Mapper will add a new attribute representing the Aliquot grid name (e.g., "NWNE", "SENW") to each new subdivision. This option is only available when both the number of rows and the number of columns are set to 4.

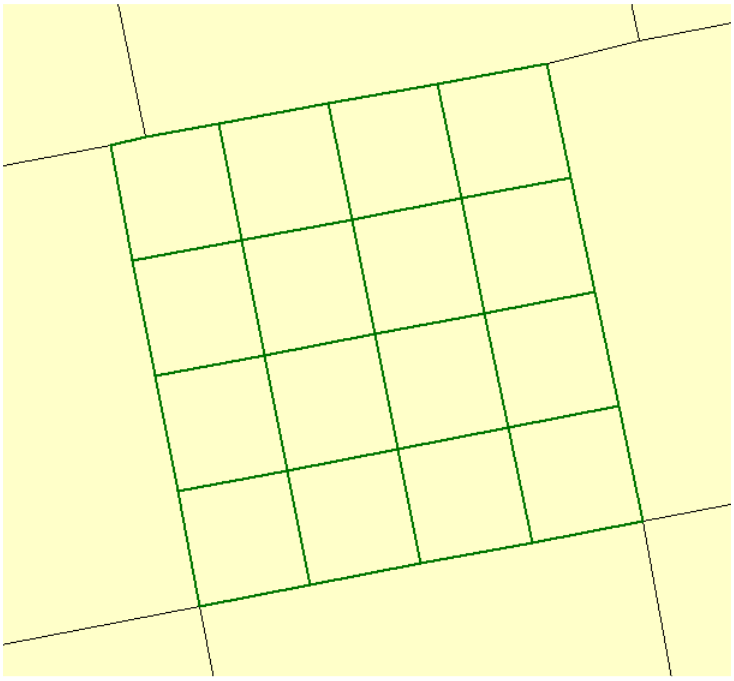
If the Add Label Suffix to New Subdivision Features option is selected, Global Mapper will add a numeric suffix to the label for each new subdivision feature. The base value will come from the label on the feature being subdivided. If the label is generated from a single attribute, and the Copy Attributes to New Features option is selected, then that attribute value on the new feature will also contain the suffix.

After the user clicks OK on the Subdivide Areas dialog, the Modify Feature Info dialog will be displayed. This allows set up of the label, classification, drawing style, and attribution for the area. The perimeter and enclosed area of the area feature will be added as default attributes. The units for these measurements can be modified on the General tab of the Configuration dialog. See **Editing Feature Attributes and Drawing Styles** for more details. The options chosen on this dialog will be applied to all of the new subdivision features created during this operation.

The following image illustrates the result of subdividing an area into a grid containing four rows and four columns, with the Create Horizontal/Vertical Subdivisions option checked. Note that the lines that define the subdivisions run horizontal and vertical, rather then following the direction of the sides of the area.

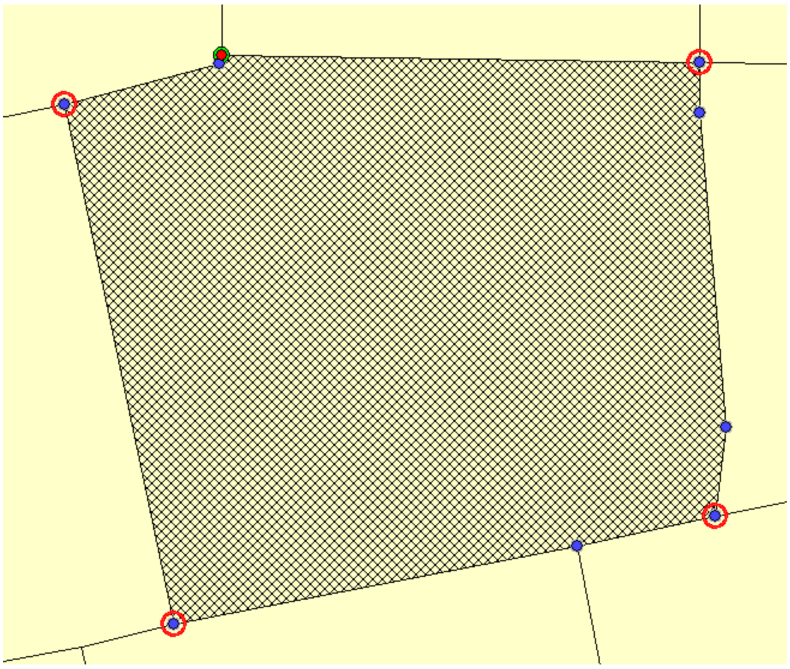


The following image illustrates the result of subdividing the same area without checking the Create Horizontal/Vertical Subdivisions option. In this case, the lines that define the subdivisions run more or less in the same direction as the sides of the original area.

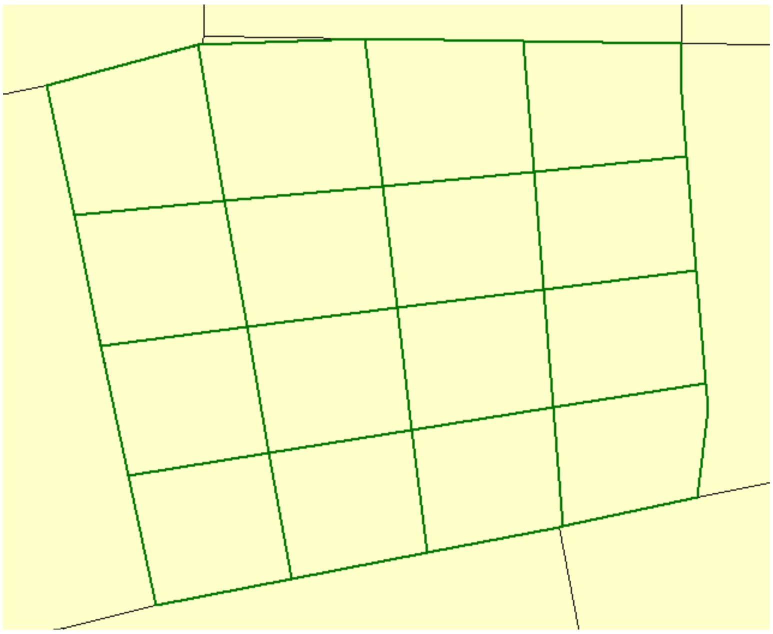


The **Subdivide Quadrilateral Areas** command can operate on areas that are not, strictly speaking, quadrilaterals (i.e., areas that have more than four vertices.) When the input area has more then four vertices, and the Create Horizontal/Vertical Subdivisions option is not checked, Global Mapper will attempt to determine which vertices should be used to represent the corners.

In most cases, Global Mapper will be able to correctly determine the corners, but, on occasion, the choices that Global Mapper makes may not be optimal. In this case, specify the vertices to be used as corners by selecting them before right-clicking on the selected area, as shown in the following figure. Note: specifying the corners will apply only when a single area is selected.



As you can see, the area to be subdivided is not strictly a quadrilateral, but by selecting the corners, a reasonable subdivision can be accomplished, as indicated below:



Create Whisker Lines from Points

Whisker lines are lines going some distance from a selected point in a given bearing and opposite bearing. So basically a line centered on the point of some length in some bearing. They are useful in seismic surveys to determine the coverage of seismic survey points.

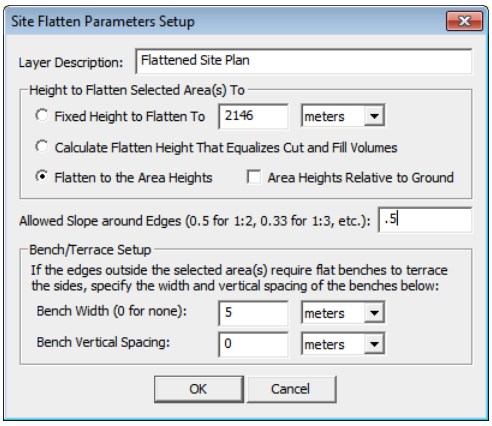
You can create a new whisker lines centered on selected point features by right clicking and selecting the **Advanced Feature Creation** submenu option Create Whisker Lines from Selected Point(s). You will then be prompted to enter the bearing and length in one direction of the whisker line. The opposite direction will be added to the whisker line as well.

Calculating the Volume Between Two Area Surfaces

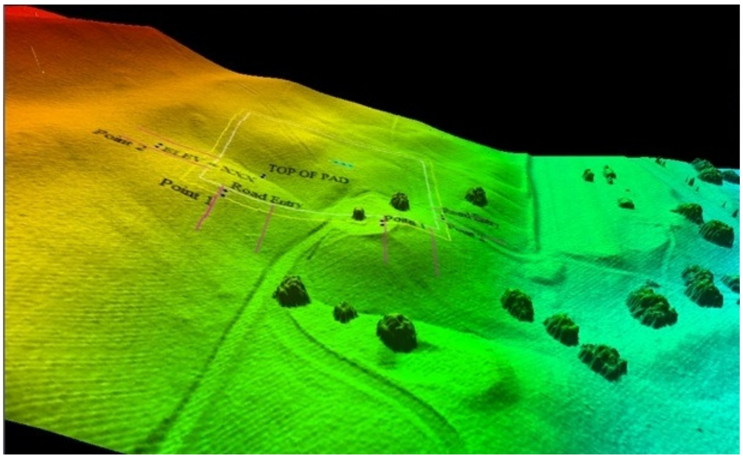
If you have one or more area features selected with the digitizer tool, use the right-click menu to access PILE VOLUMES- Calculate the Volume of Selected Piles /Areas under Analysis/Measurement. This will measure the cut and fill volume relative to how the edges / vertices of the area feature(s) cut the terrain surface.

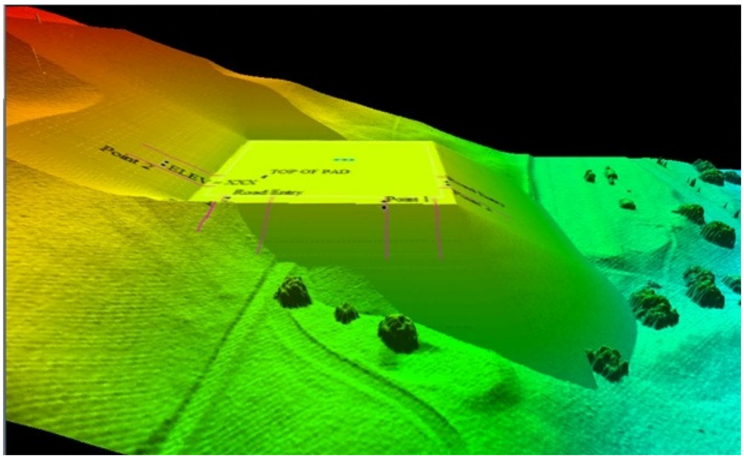
Creating a Flattened Site Plan

If one or more area features is selected and terrain data is loaded, the Advanced Feature Creation submenu will contain the Calculate Flattened Site Plan Grid from Selected Area(s) option. When selected the Setup Site Flatten Parameters dialog (pictured below) appears, allowing you to setup the site flattening operation. You can specify the height at which you wish to flatten the areas to or allow a height to automatically be calculated that results in an approximately equal amount of terrain needing to be cut and filled. This is useful in estimating real-world build site materials so little or no material will not to be brought in or hauled out. If the selected areas already contain elevation values you can also choose to flatten to them, allowing flattening to non-level surfaces. You can also setup the allowed slope from the site edges to the terrain surface as well as what width and vertical separation of benches/terraces to use if required.

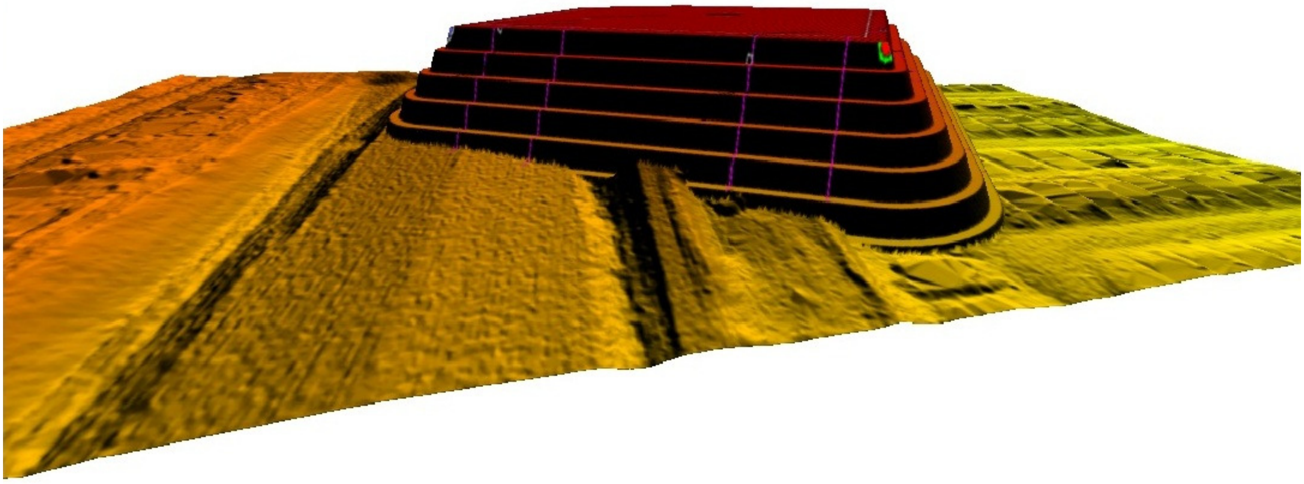


The images below show the 3D viewer before and then after performing a flattening operation on a hillside:





The images below shows the 3D viewer after an operation to flatten a site high above the terrain surface, mainly to illustrate how the terracing works. Note how the new surface matches up with the original terrain surface:



Built on the Global Mapper SDK

COAST Damage Assessment Extension User's Manual

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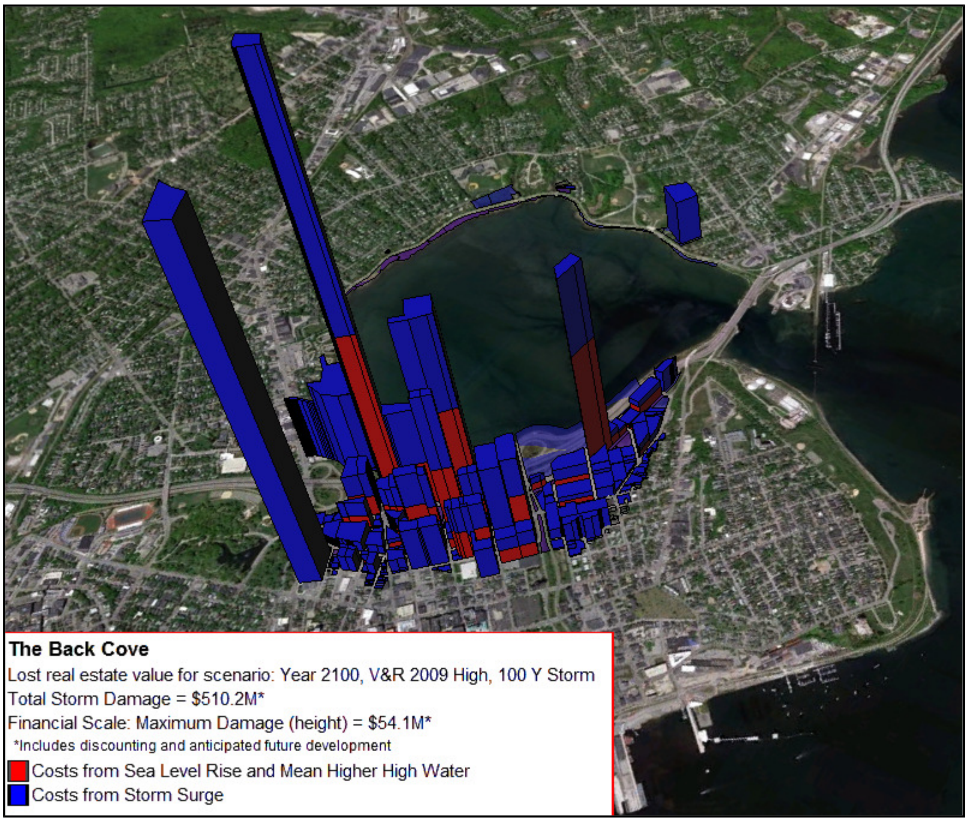
Built on the Global Mapper SDK

COAST DAMAGE ASSESSMENT EXTENSION

As more cities and regions are hit hard by storms, public pressure for better infrastructure planning is growing. A consensus is emerging that in many cases, “putting it back the way it was” is not the right answer. Community leaders may be ready to take new actions to adapt to changing conditions, but may also be unsure whether such new ideas are good investments. They may well ask: “How much should we pay to lower risks, and where is the line between a wise choice and a foolish one?” Coastal Adaptation to Sea Level Rise (COAST) is a tool that helps communities answer these questions. It predicts damages from varying numbers of storms of different intensities, and evaluates relative benefits and costs of response strategies that stakeholders select.

The COAST process uses two types of information to help communities evaluate their options when planning their response to these changing conditions. The first is a map that contains a graphical representation of the damages caused by a specific storm scenario. This map is useful to help people visualize the areas that will be flooded, and the monetary effects of that flooding. Each group of stakeholders can use different criteria to define "damages" in the context of their local population. For example, they might want to look at lost tax revenue or the costs for businesses that may have to close or relocate. The second type of output is a chart of expected cumulative damages over time from repeated storms and rising sea level. The chart can be customized to include multiple different scenarios for sea-level rise (including no sea-level rise) and the effects of mitigating actions taken by the community in future years.

An example of COAST graphic output is below, showing a no-adaptation-action scenario for 1.8 meters of sea level rise and a 100-year flood event in the year 2100, for a portion of downtown Portland, Maine. The z-axis polygons represent cumulative expected lost real estate and building contents value of over $500 million (maximum loss per parcel is over $54.1 million). Adaptation actions subsequently modeled in this location included installing a surge barrier and a levee, each of which could provide some protection to the vulnerable areas.



Visually, each adaptation action is then represented in maps showing reduced or eliminated polygons extruding out of the landscape. Numerically, this is an effective way of showing up front and maintenance costs of hard-structure approaches versus expected damages from particular inundation events. Soft-structure approaches may also be modeled, such as flood-proofing, rezoning over time, and others.

Importantly, the approach allows modeling of ranges of SLR and storm surge frequency and intensity. Combining multiple future scenarios provides stakeholders an opportunity to select their expectation of future conditions and then visualize damages under action versus no-action scenarios. COAST output is in the form of files compatible with Google Earth, and tables showing cumulative expected damages for the selected vulnerable asset under the adaptation scenarios stakeholders have developed, that allow cost-benefit analysis of candidate adaptation actions.

The COAST Damage Assessment Extension is an add-on to Global Mapper that can be used to produce the maps and cost estimates used in the COAST process. It is easy to use, but the COAST process requires that a certain amount of data preparation specific to the local environment be completed before it can be used effectively.

THE COAST MODEL

The COAST model can be used to manage assets with regard to specific climate change scenarios, such as sea level rise, coastal area flooding, and local disaster projection. The user can create a specific exceedance curve attaching probability of occurrence to water-level rise for a given climate change scenario over a certain time period. Multiple climate change and adaptation scenarios, each with multiple time periods, are possible (e.g., 2020, 2040, 2070, and 2100). The COAST model calculates the expected value (EV) of the damages for that climate change scenario and cumulative damages over the time period leading up to the event.

The COAST model requires three categories of data.

1. Spatial data representing land elevation and assets to be modeled.
2. Model scenarios that are tied specifically to the spatial data. These scenarios define the storms, sea-level rise and adaptations used to produce the model outputs.
3. **Model parameters that control the execution of the model, but are not tied to specific data layers. This includes definitions of exceedance curves, base water level, and adaptations. It also includes a depth-damage function (DDF) for each asset and adaptation strategy. A DDF defines the percentage of the assets value that is lost for each increment in flood depth, and is used to calculate the EV for damages.**

Once the input layers, climate-change scenario, and DDFs have been identified, the tool will produce the following outputs:

1. A KML layer showing the flooded area and the calculated damages for the defined flooding scenario. The assets will be extruded to indicate the relative amount of damages.
2. A KML layer showing the flooded area and calculated damages based only on rise in sea level (without storm surge) for the scenario. Again, the assets will be extruded to show the relative damage amounts.
3. An Excel spreadsheet containing the cumulative expected damages for the base "no action" scenario, and for each specified adaptation.

Spatial Data

In order to estimate damages caused by sea-level rise and storm surges, the COAST model requires two types of spatial data:

1. A land-elevation data set that defines the area to be modeled. This is typically a raster generated from LIDAR data.
2. A vector layer defining the asset to be included in the model, e.g., land parcels, building footprints, drainage facilities, etc. This layer must contain an attribute defining the asset value to be used in the damage calculations. This data can be loaded from an Esri Shapefile.

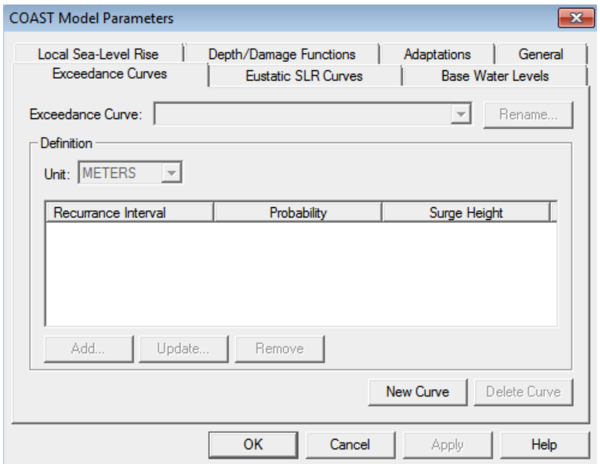
The spatial data must conform to the following requirements. If your data does not meet these requirements, you will need to modify the data using an external tool such as Global Mapper before using it in the COAST tool.

- All of the layers must be represented in the same spatial reference system.
- **For the elevation layer:**
  - Pixels that represent the base water level must have an elevation value of zero. For example, in an elevation file representing coastal New Hampshire, all of the pixels in the ocean must have a value of zero.
  - The elevation value vertical unit must be feet or meters.
  - **Elevation data must be stored in either a GeoTIFF file or an ERDAS Imagine file.**
- For the vector layer:
  - Data features must be area (polygon) features.
  - The vector layer must contain an attribute representing the dollar value of the asset. This data will be used, along with the expected flood depth on the feature and the DDF, to calculate dollar value of damages associated with the scenario. For example, when calculating damages to land parcels, the value attribute might be the assessed value or expected property tax revenue.
  - The vector data can only be loaded from an Esri Shapefile.

The COAST Damage Assessment Tool is built on capabilities provided by Blue Marble Geographics Global Mapper SDK, and can import Global Mapper workspace files. Global Mapper is an excellent choice for preparing your data for use in the COAST model.

Model Parameters

COAST model parameters dialogue (below) defines data elements that are used to define the water-level rise scenario to be modeled, but are not specific to a particular data layer. Model parameters can be used in both types of COAST model scenarios. Model parameters are stored in a file that is separate from the workspace file.



Exceedance Curve - An Exceedance Curve maps storm surge to the probability of a storm of that severity happening. For example, a "100 Year" storm would have a probability of 0.01 associated with it expected surge height. The COAST tool adds these storm surge values to the base sea-level rise when calculating the total water-level rise effects of a storm event.

Eustatic Sea-Level Rise Curve - A Eustatic Sea-Level Rise curve defines the expected, cumulative global sea-level rise over a specified time period, typically split into decades (but not required to be). These values are usually derived from published research, such as that published by Vermeer and Rahmstorf in 2009. This data is used to calculate the eustatic SLR for a perticular year, and is part of the base sea-level rise calculation.

Base Water Level - Base Water Level is the value used to adjust sea level (zero elevation) to the water level used as a starting point for sea-level rise calculations. Typically, this is mean higher high water (MHHW) or mean high tide for the area in question.

Local Sea-Level Rise - Local Sea-Level Rise is the water level increase per year specific to a local area, sometimes based on subsidence. It is used to add a local component to base sea-level rise for a particular year.

Depth/Damage Function - A Depth/Damage Function (DDF) maps the estimated percentage of value that will be lost at each defined interval of sea-level rise. Typically, the intervals are 1 foot, 2 feet, etc.

Adaptations - A modification of some sort that will mitigate the effects of flooding, e.g., building a levee or changing building codes. An adaptation is represented in the COAST model by changes to a depth/damage function. When an adaptation is used in the model, damages will be determined using the adaptation DDF instead of the default scenario DDF.

Elevation Grid Processing - This allows the user to determine how to process large elevation grids. Large grids can increase the amount of time it takes to process a COAST scenario. This option will allow the user to indicate whether COAST should prioritize faster processing or accuracy when computing the area that is flooded due to the defined rise in water level. To emphasize processing speed, the calculations will use a larger grid size. In rare cases, this can result in an asset erroneously being considered flooded or not flooded. When accuracy is emphasized, these calculation will use the grid size defined in the data. If the elevation data uses a small cell size (e.g., 1 meter), and includes an area several kilometers square, then processing will take longer, but there is a smaller probability that an asset will be considered flooded or not flooded by mistake. By default, this setting emphasized processing speed.

Scenarios

COAST model scenarios define how the spatial data, model parameters, and other event-specific information will be used to model the effects of sea-level rise on the asset in question. The scenario definitions are stored in the workspace file when it is saved. There are two types of scenarios available in the COAST model:

1. A one-time storm event during a specific year.
2. Cumulative expected damages from sea-level rise and storms over a specified time period.

A one-time storm event provides an estimate of asset damages that occur as a result of a single storm during a specified year. The model will calculate the rise in sea-level for that year and add the storm surge from a storm of the specified severity, and use the resulting water-level rise to simulate a flood in the area containing the assets. For assets that are flooded, asset value and specified DDF will be used to calculate the damage. The one-time storm event model requires the following pieces of information in addition to the spatial data and model parameters:

Year	**This is the year in which the modeled storm is to take place. Total sea-level rise will be calculated for this year.**
Recurrence Interval	**This is the severity of the storm, expressed using the indicator of how often a storm of this magnitude would be expected to happen. For example, the storm could be designated as a "10-year" storm, meaning that a storm of this power usually occurs once every 10 years. The recurrence interval definitions are part of the Exceedance Curve.**

Once all of the information has been provided, the COAST tool will perform its flood scenario calculations to produce the KML/KMZ map, along with a legend describing the event and the map contents, suitable for display in Google Earth. The map consists of a collection of 3D solids, where the height of the solid represents the damage for the associated asset relative to the rest of the assets on the map. Comparing the maps associated with different scenarios provides a visual indicator of the relative damages.

The cumulative expected damages model estimates the total damages, over time, to the assets involved in the scenario. An adaptation can be applied to determine how much damages would be reduced if that adaptation action were to be implemented. A cumulative expected damages scenario requires several items beyond the spatial data and model parameters:

Start Year	**This is the year in which the cumulative damages will begin.**
End Year	**This is the year in which the cumulative damage calculations end.**
Eustatic SLR	**A cumulative damage scenario can calculate expected damages for more than one eustatic SLR scenario. In addition, it also calculates damages due to storms in an environment where there is no sea-level rise.**

The COAST tool uses these values, along with the spatial data and model parameters, to iterate through the defined time period and compute the expected damages for each year based on the likelihood of storms of differing severity happening. The output is an Excel spreadsheet that summarizes the expected damages for each eustatic SLR scenario chosen, and the effects of applying an adaptation, if one is chosen for the model run.

USING THE COAST EXTENSION

The COAST Extension is represented by a toolbar containing the following functionality:

COAST Toolbar

- Create Model Parameters File Command
- Edit Model Parameters File Command
- Estimate One-time Storm Damages Command
- Estimate Cumulative Storm Damages Command

Create Model Parameters File Command

When you select the *Create Model Parameters File* command, you will be prompted for a new model parameter file name. The tool will create the new file and display the Edit Model Parameters dialog. Since the model parameters file being edited is new, all of the parameter definitions will be empty.

Edit Model Parameters File Command

When you select the *Edit Model Parameters File* command, the COAST tool will prompt you for the name of an existing model parameters file (the default is the currently active file, if there is one.) It will then display the Edit Model Parameters dialog to allow you to edit the existing model parameter definitions.

Estimate One-time Storm Damages Command

A one-time storm event provides an estimate of asset damages that occur as a result of a single storm during a specified year. The model will calculate the rise in sea-level for that year and add the storm surge from a storm of the specified severity, and use the resulting water-level rise to simulate a flood in the area containing the assets. For assets that are flooded, asset value and specified DDF will be used to calculate the damage.

The *Estimate One-Time Storm Damages* command displays the Estimate One-Time Storm Damage window.

Estimate Cumulative Storm Damages Command

The cumulative expected damages model estimates the total damages, over time, to the assets involved in the scenario. An adaptation can be applied to determine how much damages would be reduced if that adaptation action were to be implemented.

The *Estimate Cumulative Storm Damages* command displays the Estimate Cumulative Storm Damage window.

Editing Model Parameters

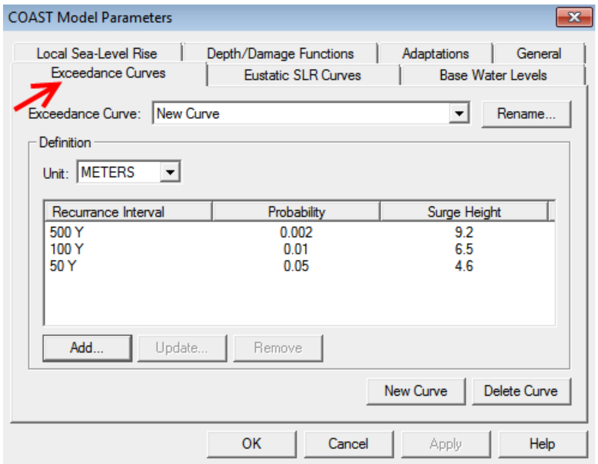
The *Edit Model Parameters* dialog allows you to create or modify definitions for the following model parameters:

- Exceedance Curves
- Eustatic SLR Definitions
- Base Water Level
- Local SLR
- Depth Damage Functions
- Adaptations

The parameter definitions created here can be used in both one-time event damage scenarios and cumulative damage scenarios.

Exceedance Curve

The Exceedance Curves tab on the Edit Model Parameters dialog allows you to create and modify exceedance curve definitions. An Exceedance Curve maps storm surge to the probability of a storm of that severity happening. For example, a "100 Year" storm would have a probability of 0.01 associated with its expected surge height, i.e., a storm of that severity usually happens once ever hundred years, or has a 1% chance of happening in any given year.



The Exceedance Curves tab contains the following fields and data:

Exceedance Curve

This is the name of the curve definition currently being edited. To change to a different curve definition, select it from the drop-down list. To create a new curve, click the *New Curve* button.

Rename...

Click the *Rename...* button to assign a new name to the current curve. When you click this button, the tool will display the *Rename Model Parameter* dialog, where you can specify the new name.

Unit

Choose the vertical unit that is being used for the Surge Height values in the table. Note that changing this value will not change the displayed surge height value, rather it is simply telling the model what unit the height data is using.

Definition Table

This table lists the definition for the curve. Each line contains three items:

1. The *Recurrence Interval* is a string describing how often this surge height is expected to occur during a storm. Note that the recurrence interval strings will be used in the Recurrence Interval field on the Estimate One-Time Storm Damage dialog.
2. *Probability* contains the numeric chance that the associated storm surge will occur in a year. The probability should match the Recurrence Interval text, e.g., if the Recurrence Interval is "10 Y", the Probability should be 0.1 (i.e., once every 10 years is a 10% chance.) The entries in the table are sorted by the Probability field.
3. Enter the expected storm surge associated with the storm event in the *Surge Height* field. Be sure that the value you enter is in the vertical unit specified in the Unit field.

Use the *Add...*, *Update...*, and *Remove* buttons to modify the data in the table.

Add...

Adds a new recurrence definition to the table. When you click the *Add...* button, the COAST tool pops up the Add Line Dialog. Use this dialog to enter the definition.

Update...

When you select a line in the table, the *Update...* button will be enabled. Click this button to change the data in the selected definition entry. The tool will display the *Update Line* dialog with the current values filled in. (The Update Line dialog works the same as the Add Line dialog.)

Remove

When you select a line in the table, the *Remove* button will be enabled. Click this button to remove the selected line from the definition. You will be prompted to confirm the deletion.

New Curve

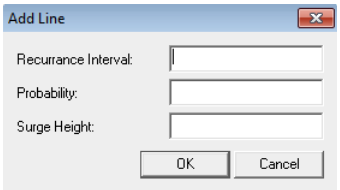
Click the *New Curve* button to create a new Exceedance curve. You will be prompted for a new name, and then the current definition will be cleared so a new one can be entered.

Delete Curve

Click the *Delete Curve* button to delete the current curve definition. You will be prompted to confirm that you want to delete the curve.

Add Line Dialog

The *Add Line* dialog is used to update an entry in the Exceedance Curve definition. The COAST tool displays this dialog when you click the *Add...*, or *Update...* button on the Exceedance Curve property page.

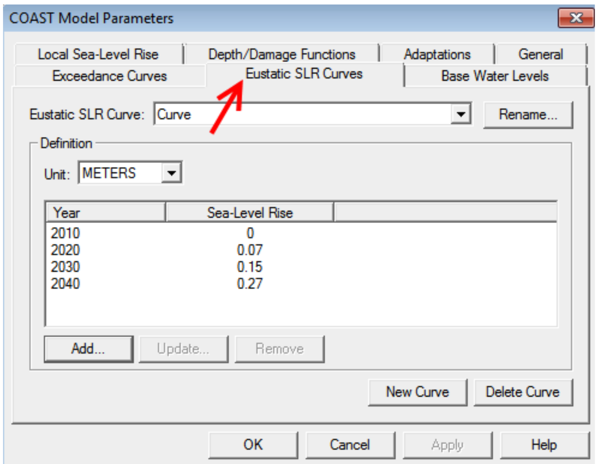


The Add Line dialog contains the following fields and data (note that all of the fields are required):

Recurrence Interval	**The *Recurrence Interval* is a string describing how often this surge height is expected to occur during a storm. Note that the recurrence interval strings will be used in the Recurrence Interval field on the [Estimate One-Time Storm Damage] dialog.**
Probability	***Probability* contains the numeric chance that the associated storm surge will occur in a year. The probability should match the Recurrence Interval text, e.g., if the Recurrence Interval is "10 Y", the Probability should be 0.1 (i.e., once every 10 years is a 10% chance.)**
Surge Height	**Enter the expected storm surge associated with the storm event in the *Surge Height* field. Be sure that the value you enter is in the vertical unit specified in the Unit field.**
OK	**Click the *OK* button to close the dialog and enter the new or updated data into the definition.**
Cancel	**Click the *Cancel* button to close the dialog without changing the definition.**

Eustatic SLR

The Eustatic SLR Curves tab on the Edit Model Parameters dialog allows you to create and edit eustatic sea-level rise definitions. Eustatic Sea-Level Rise is the expected, cumulative, global sea-level rise over a specified time period, typically split into decades. These values are usually derived from published research, such as that published by Vermeer and Rahmstorf in 2009.



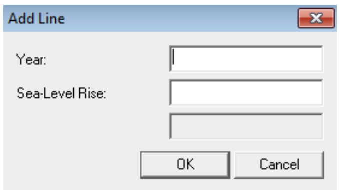
The Eustatic SLR Curves tab contains the following fields and data:

Eustatic SLR Curve	**This is the name of the curve definition currently being edited. To change to a different curve definition, select it from the drop-down list. To create a new curve, click the *New Curve* button.**
Rename...	**Click the *Rename...* button to assign a new name to the current curve. When you click this button, the tool will display the *Rename Model Parameter* dialog, where you can specify the new name.**
Unit	**Choose the vertical unit that is being used for the Sea-Level Rise values in the table. Note that changing this value will not change the displayed sea-level rise value, rather it is telling the model what unit the height data is using.**
Definition Table	**This table lists the definition for the curve. Each line contains the following items:** 1. The *Year* is a year from the eustatic SLR definition. The entries in the table are sorted by the Year field. 2. *Sea-Level Rise* contains the expected, cumulative sea-level rise for that year. When you enter a sea-level rise value, be sure that the value you enter is in the vertical unit specified in the Unit field. **Use the *Add...*, *Update...*, and *Remove* buttons to modify the data in the table.**
	Adds a new SLR definition to the table. When you click the *Add...* button, the

Add...	**COAST tool pops up the Add Line Dialog. Use this dialog to enter the definition.**
Update...	**When you select a line in the table, the *Update...* button will be enabled. Click this button to change the data in the selected definition entry. The tool will display the *Update Line* dialog with the current values filled in. (The Update Line dialog works the same as the Add Line dialog.)**
Remove	**When you select a line in the table, the *Remove* button will be enabled. Click this button to remove the selected line from the definition. You will be prompted to confirm the deletion.**
New Curve	**Click the *New Curve* button to create a new eustatic SLR curve. You will be prompted for a new name, and then the current definition will be cleared so a new one can be entered.**
Delete Curve	**Click the *Delete Curve* button to delete the current curve definition. You will be prompted to confirm that you want to delete the curve.**

Add Line Dialog

The *Add Line* dialog is used to update an entry in the Eustatic SLR Curve definition. The tool displays this dialog when you click the *Add...* or *Update...* button on the Eustatic SLR Curve property page.

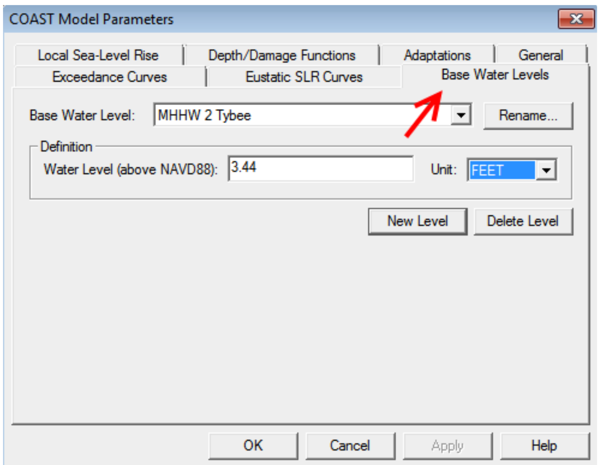


The Add Line dialog contains the following fields and data (note that all of the fields are required):

Year	**The *Year* is a year from the eustatic SLR definition.**
Sea-Level Rise	***Sea Level Rise* contains the expected sea-level rise for the associated year. This value will be taken from the published model data. Be sure that the value you enter is in the vertical unit specified in the Unit field.**
OK	**Click the *OK* button to close the dialog and enter the new or updated data into the definition.**
Cancel	**Click the *Cancel* button to close the dialog without changing the definition.**

Base Water Level

The Base Water Levels tab on the Edit Model Parameters dialog allows you to create and edit base water level definitions. Base Water Level is the value used to adjust sea level (zero elevation) to the water level used as a starting point for sea-level rise calculations. Typically, this is mean higher high water (MHHW) or mean high tide for the area in question.



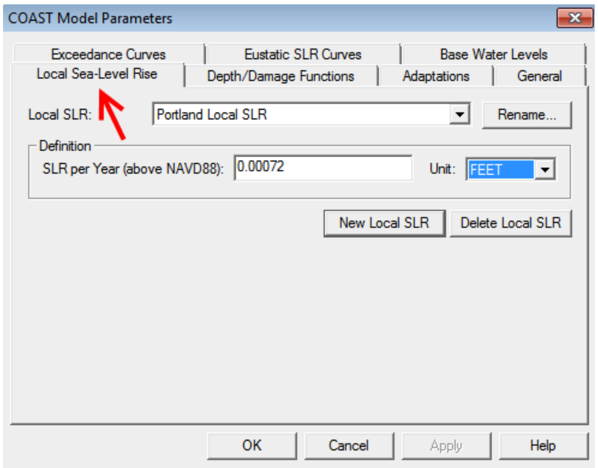
The Base Water Levels tab contains the following fields and data:

Base Water Level	**This is the name of the definition currently being edited. To change to a different definition, select it from the drop-down list. To create a new definition, click the *New Level* button.**
Rename...	**Click the *Rename...* button to assign a new name to the current definition. When you click this button, the tool will display the *Rename Model Parameter* dialog, where you can specify the new name.**

Unit	**Choose the vertical unit that is being used for the Water Level value. Note that changing this value will not change the displayed water level value, rather it is telling the model what unit the height data is using.**
Water Level (above NAVD88)	**The *Water Level* field contains the value used to adjust zero value elevations to the starting level for sea-level rise calculations. When you enter a water level value, be sure that the value you enter is in the vertical unit specified in the Unit field.**
New Level	**Click the *New Level* button to create a new definition. You will be prompted for a new name, and then the current definition will be cleared so a new one can be entered.**
Delete Level	**Click the *Delete Level* button to delete the current definition. You will be prompted to confirm that you want to delete the definition.**

Local SLR

The Local Sea-Level Rise tab on the Edit Model Parameters dialog allows you to create and edit local SLR definitions. Local Sea-Level Rise is the water level increase per year specific to a local area, sometimes based on subsidence.

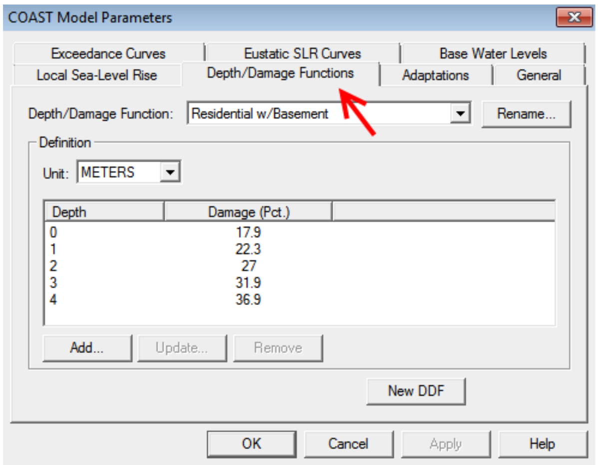


The Local Sea-Level Rise tab contains the following fields and data:

Local SLR	**This is the name of the definition currently being edited. To change to a different definition, select it from the drop-down list. To create a new definition, click the *New Local SLR* button.**
Rename...	**Click the *Rename...* button to assign a new name to the current definition. When you click this button, the tool will display the *Rename Model Parameter* dialog, where you can specify the new name.**
Unit	**Choose the vertical unit that is being used for the SLR value. Note that changing this value will not change the displayed local SLR value, rather it is telling the model what unit the height data is using.**
SLR per Year (above NAVD88)	**The *SLR per Year* field contains the value for yearly water-level rise specific to the local area. When you enter a SLR value, be sure that the value you enter is in the vertical unit specified in the Unit field.**
New Local SLR	**Click the *New Local SLR* button to create a new definition. You will be prompted for a new name, and then the current definition will be cleared so a new one can be entered.**
Delete Local SLR	**Click the *Delete Local SLR* button to delete the current definition. You will be prompted to confirm that you want to delete the definition.**

Depth Damage Function

The Depth/Damage Functions tab on the Edit Model Parameters dialog allows you to create and edit depth/damage function definitions. A Depth/Damage Function (DDF) maps the estimated percentage of value that will be lost at each defined interval of sea-level rise. Typically, the intervals are 1 foot, 2 feet, etc.



The Depth/Damage Function tab contains the following fields and data:

Depth/Damage Function

This is the name of the DDF definition currently being edited. To change to a different definition, select it from the drop-down list. To create a new function, click the *New DDF* button.

Rename...

Click the *Rename...* button to assign a new name to the current DDF. When you click this button, the tool will display the *Rename Model Parameter* dialog, where you can specify the new name.

Unit

Choose the vertical unit that is being used for the *Depth* values in the table. Note that changing this value will not change the displayed depth value, rather it is telling the model what unit the height data is using.

Definition Table

This table lists the definition for the DDF. Each table entry contains the following information:

1. The *Depth* is an interval for depth values. When you enter a depth value, be sure that the value you enter is in the vertical unit specified in the Unit field. During processing, if the COAST tool calculates a depth that is greater than the largest depth interval, it will use the damage percentage associated with the largest depth interval. This means that once you get to a depth that results in 100% loss, you don't need to add any more entries to the table. The entries in the table are sorted by the Depth field.
2. *Damage (Pct.)* contains the percent of damage at the associated depth. Express this value as a percentage (e.g., 25%).

Use the *Add...*, *Update...*, and *Remove* buttons to modify the data in the table.

Add...

Adds a new depth/damage interval to the table. When you click the *Add...* button, the COAST tool pops up the Add Line window. Use this dialog to enter the definition.

Update...

When you select a line in the table, the *Update...* button will be enabled. Click this button to change the data in the selected definition entry. The tool will display the *Update Line* dialog with the current values filled in. (The Update Line dialog works the same as the Add Line dialog.)

Remove

When you select a line in the table, the *Remove* button will be enabled. Click this button to remove the selected line from the definition. You will be prompted to confirm the deletion.

New DDF

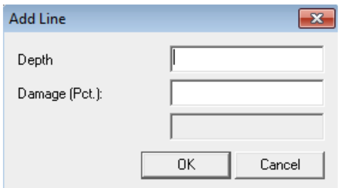
Click the *New DDF* button to create a new depth/damage function. You will be prompted for a new name, and then the current definition will be cleared so a new one can be entered.

Delete DDF

Click the *Delete DDF* button to delete the current definition. You will be prompted to confirm that you want to perform the deletion.

Add Line Dialog

The *Add Line* dialog is used to update an entry in the DDF definition. The tool displays this dialog when you click the *Add...* or *Update...* buttons on the Depth/Damage Function property page.

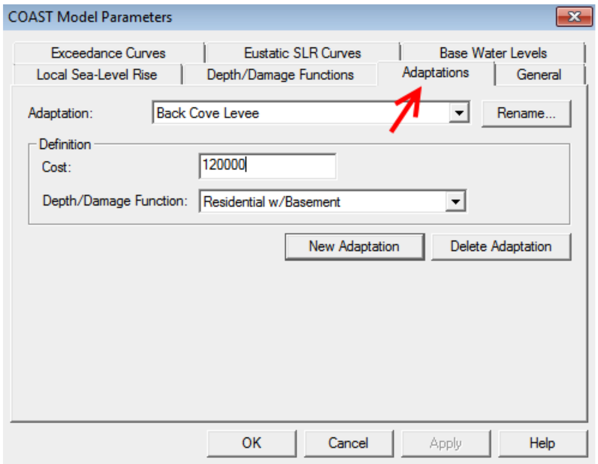


The Add Line dialog contains the following data (all of the fields are required):

Depth	***Depth*** **defines the end point of an interval for depth values. When you enter a depth value, be sure that the value you enter is in the vertical unit specified in the Unit field.**
Damage (Pct.)	***Damage (Pct.)*** **contains the percent of damage at the associated depth. Express this value as a percentage (e.g., 25%).**
OK	**Click the *OK* button to close the dialog and enter the new or updated data into the definition.**
Cancel	**Click the *Cancel* button to close the dialog without changing the definition.**

Adaptations

The Adaptations tab on the Edit Model Parameters dialog allows you to create and edit adaptation definitions.



The Adaptations tab contains the following fields and data:

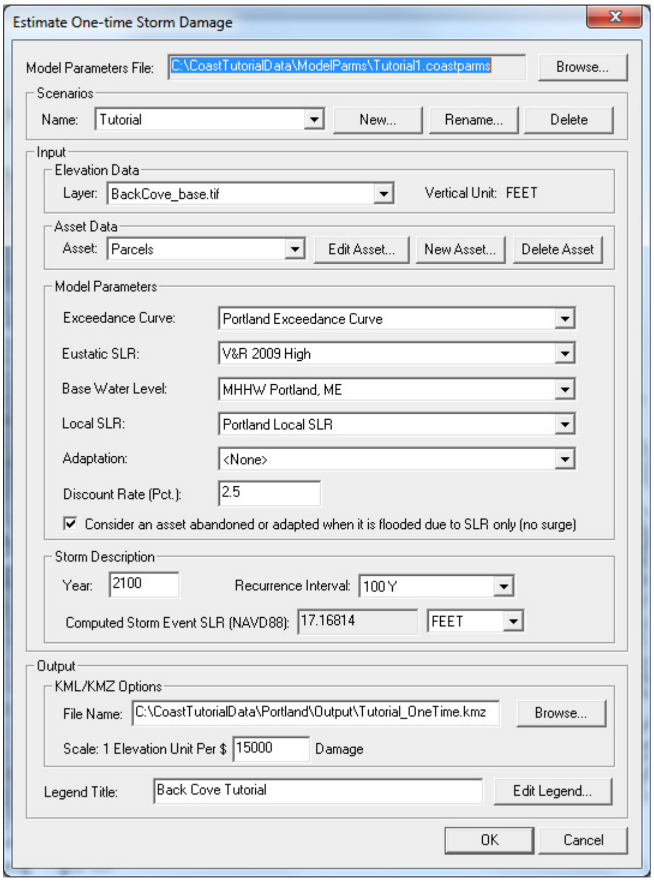
Adaptation	**This is the name of the definition currently being edited. To change to a different definition, select it from the drop-down list. To create a new definition, click the *New Adaptation* button.**
Rename...	**Click the *Rename...* button to assign a new name to the current definition. When you click this button, the tool will display the *Rename Model Parameter* dialog, where you can specify the new name.**
Cost	**Enter the cost of implementing the adaptation in local currency.**
Depth/Damage Function	**Choose the DDF that that would apply after this adaptation is implemented. If a DDF has not yet been created, use the Depth/Damage Functions tab to create it.**
New Adaptation	**Click the *New Adaptation* button to create a new definition. You will be prompted for a new name, and then the current definition will be cleared so a new one can be entered.**
Delete Adaptation	**Click the *Delete Adaptation* button to delete the current definition. You will be prompted to confirm that you want to delete the definition.**

Running the One-Time Storm Event Model

The One-Time Storm Event model estimates the total damage from a single storm surge event in a given year. It calculates the total water-level rise based on the model parameters and the storm definition, then determines which assets will be flooded under that scenario. For each flooded asset, the model calculates the maximum flood depth and uses that, along with the asset value and a DDF, to calculate the damage. It performs these calculations for both the water-level rise due to sea-level rise only, and the increase due to both sea-level rise and storm surge.

The output is a KML file containing two layers; one for damage due to SLR only, and another for damage due to SLR and storm surge. The KML layers contain 3D shapes, whose height represents the relative damage cost for that asset. The One-Time Storm event model also produces output map layers that represent the flooded area for a particular increase in water level. When running the model, if a layer containing the flooded area already exists, the model will use that layer instead of creating a new one. This reduces significantly the time required to run the model. These flood area layers are hidden by default when they are created, but you can use the Layer Manager to make them visible.

Storm event scenario definitions can be stored in a workspace, along with the input data layers, so that the same scenarios can be run multiple times, if necessary. The flood area layers can also be stored in the workspace, so that future iterations of the model can be completed more quickly.



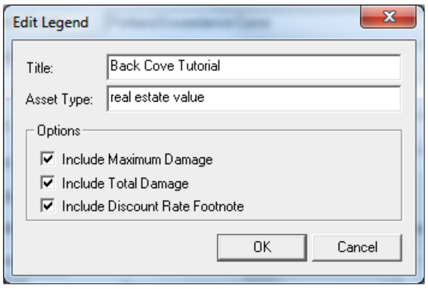
When you choose the Estimate One-Time Storm Damage menu item, the *Estimate One-time Storm Damage* dialog will be displayed. The Estimate One-time Storm Damage dialog contains the following fields and data:

Model Parameters File	**This indicates which model parameters file is currently in use. If a scenario is already defined, changing this is likely to cause problems, since the model parameter definitions being used by the scenario are specific to the model parameter file that was used to define it.** **If the current scenario definitions were loaded from a workspace file, then the associated model parameters file was loaded automatically.**
Browse...	**If you are creating a new set of scenarios, use this button to select the model parameters file that you will use as a basis for the new scenarios.**
Name	**This is the name of the scenario currently being edited. To edit a different scenario, select it from the drop-down list. To create another scenario, click the *New...* button.**
New...	**Click this button to create a new scenario. The COAST tool will prompt you to type in the name of the new scenario, and then clear the current scenario definition so you can fill in the details.**
Rename...	**Click the *Rename...* button to assign a new name to the current scenario. You will be prompted to type in the new name.**
Delete	**Use this button to delete the current scenario from the collection. You will be prompted to confirm that you want to delete this scenario definition.**
Layer	**The list contains all of the elevation layers that are currently loaded. Select the layer to be used in this scenario from the list. If there is only one elevation layer in the list, it will be automatically selected.**
Vertical Unit	**This field displays the vertical unit defined for the selected elevation layer. If the value listed is not correct, you can unload the elevation layer using the Layer Manager, then reload it and specify the correct unit on the Elevation Layer Options dialog.**
Asset	**This list contains all of the asset definitions that have been created. Select the definition that you would like to use with this model scenario. To see the details of the current asset definition, click the *Edit Asset...* button. If there are no assets defined, or you need to create a another one, click the *New Asset...* button.**
Edit Asset...	**Click this button to view or change the currently selected asset definition. The COAST tool will display the Edit Assets window, where you can see or change the definition.**
New Asset...	**Click the *New Asset...* button to specify a new asset definition. The COAST tool will display the Edit Assets window, where you specify the new asset definition.**

Delete Asset	**Use the *Delete Asset* button to remove the current asset definition from the asset list. You will be prompted for confirmation before the asset is deleted.**
Exceedance Curve	**This list contains the exceedance curves defined in the current model parameters file. Select the curve that you want to use in this scenario.**
Eustatic SLR	**This list contains the eustatic SLR curves defined in the current model parameters file. Select the curve that you want to use in this scenario.**
Base Water Level	**This list contains all of the Base Water Levels defined in the current model parameters file. Select the definition that you want to use in this scenario.**
Local SLR	**This list contains the Local SLR amounts defined in the current model parameters file. Select the definition that you want to use in this scenario. This parameter is optional. If you don't want to include it in the model, select "<None>" from the list.**
Adaptation	**This list contains the Adaptations defined in the current model parameters file. Select the adaptation definition that you want to use in this scenario. If you don't want to include an adaptation in the model, select "<None>" from the list.**
Discount Rate (Pct.)	**Calculated damage amounts can be discounted back to Net Present Value (NPV). Specify the percentage that you would like to use. If you do not want to discount future values, specify zero in this field.**
Consider an asset abandoned...	**This option allows you to designate an asset as "abandoned or adapted" when it is flooded due to sea-level rise without including storm surge.** **When an asset is flooded due to SLR only, it means that a normal high tide causes the asset to be inundated. This means that the flooding happens frequently, perhaps every day. Selecting this option tells the model to assume that once this happens, the asset will no longer be used or has been adapted in some way. For example, if the asset is a residence, the owner might move out. If you use this option, the model will estimate the year in which an asset will be abandoned or adapted, and 100% of the value of the asset will be lost in that year. In subsequent years, the asset will be considered to have zero damage. Flooded assets appear in the KML map colored in brown with no extruded height.**
Year	**Specify the year to be used for the storm event. This year will be used to calculate the expected water-level rise and for discounting back to NPV (if discounting is being used.) The year must be within the range defined in the selected eustatic SLR curve.**
Recurrence Interval	**Choose the severity of the storm event by choosing one of the recurrence intervals from the list. The intervals come from the currently selected exceedance curve.**
Computed Storm Event SLR (NAVD88)	**Once you have selected an Exceedance Curve, Eustatic SLR, Base Water Level, Recurrence Interval, Local SLR (optional) and Year, the COAST tool will calculate the expected water-level rise and display it here. When you change any of the parameters that affect this calculation, it will be updated. If the value is "N/A", then not enough parameters have been selected to perform the calculation.** **Use the associated list to choose the unit you want to use for the calculated value. This unit only affects how the computed depth is displayed.**
File Name	**Enter the name of the KML or KMZ file in which the model output will be stored. The KML/KMZ file will contain two layers: one for damage due to SLR only, and another for damage due to SLR and storm surge. The KML layers contain 3D shapes, whose height represents the relative damage cost for that asset.**
Browse...	**Click this button to select an output KML or KMZ file by selecting it from the file system.**
Scale: 1 elevation unit per	**This field contains a value used to scale elevation values in order to flatten the extruded polygons that represent the flood damages. When damage values are large, flattening makes the output map easier to view. The elevations will be divided by this value, which must be numeric, and greater than zero.**
Legend Title	**Use this field to enter the title to be used in the legend that is part of the output KML/KMZ map.**
Edit Legend...	**Click this button to choose other options for the data to be included in the legend. The Edit Legend dialog will be displayed.**
OK	**Click the *OK* button to perform validation and run the model as it is currently defined.**
Cancel	**Click the *Cancel* button to close the dialog without running the model.**

Editing the Legend

The *Edit Legend* dialog allows you to specify a legend title and options for data to be included in the legend.



The Edit Legend dialog contains the following fields and data:

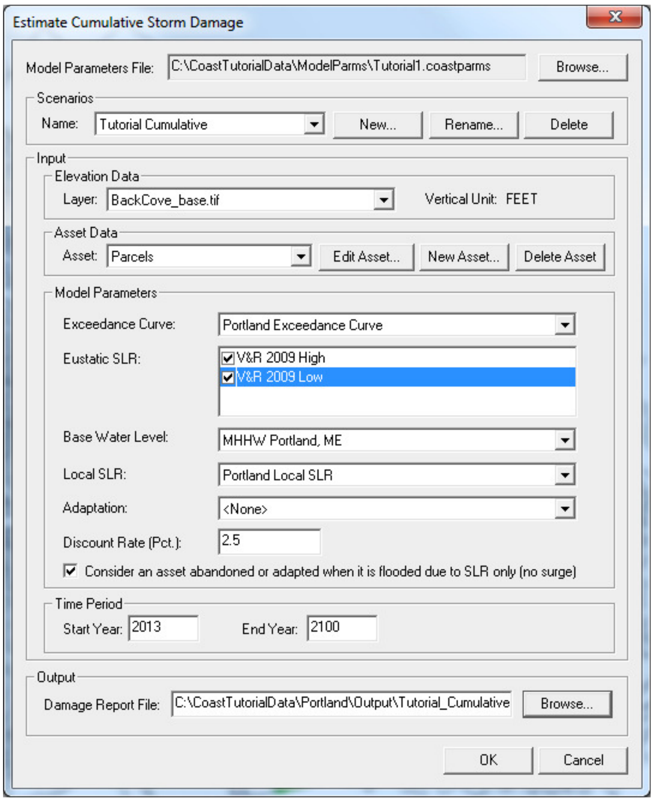
Title	**Type the title to be used on the legend in this field.**
Asset Type	**Type a brief description of the kind of data that is associated with this asset. If the asset is a parcel of real estate, you might use something like "real estate value" or "assessed value" for the Asset Type. This value will be included in the main descriptive statement on the legend that begins with, "Lost <asset type> for scenario: ". See the sample image below for an full example.**
Include Maximum Damage	**Check this box if you want to include the maximum asset damage value in the legend.**
Include Total Damage	**Check this box if you want to include the sum of all asset damages in the legend.**
Include Discount Rate Footnote	**Check this box if you want to include a footnote indicating that the damage values have been discounted to NPV.**
OK	**Click the *OK* button to close the dialog and save the legend options.**
Cancel	**Click the *Cancel* button to close the dialog without saving the legend options.**

The following image shows a sample of the legend with all of the options selected:

Running the Cumulative Damage Model

The Cumulative Storm Damage model calculates the expected damages from storms and sea-level rise over the specified time period. For each year in the time period, it computes an expected damage curve for each probability in the exceedance curve, and uses that to determine the expected damages for the year. The output is an Excel spreadsheet containing expected damages for a "No SLR" scenario, as well as for each selected eustatic SLR model. If you include an adaptation, then the costs and damage reductions resulting from the implementation of the adaptation will be included in the results.

Cumulative damage scenario definitions can be stored in a workspace, along with the input data layers, so that the same scenarios can be run multiple times, if necessary.



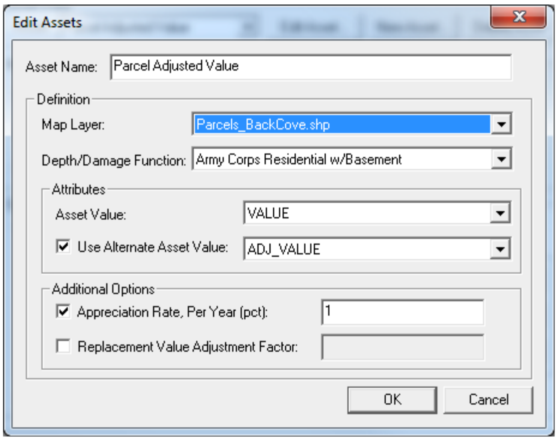
When you choose the Estimate Cumulative Storm Damage menu item, the *Estimate Cumulative Storm Damage* dialog will be displayed. The Estimate Cumulative Storm Damage dialog contains the following fields and data:

Model Parameters File	This indicates which model parameters file is currently in use. If a scenario is already defined, changing this is likely to cause problems, since the model parameter definitions being used by the scenario are specific to the model parameter file that was used to define it. If the current scenario definitions were loaded from a workspace file, then the associated model parameters file was loaded automatically.
Browse...	If you are creating a new set of scenarios, use this button to select the model parameters file that you will use as a basis for the new scenarios.
Name	This is the name of the scenario currently being edited. To edit or run a different scenario, select it from the drop-down list. If you want to create another scenario, click t he *New...* button.
New...	Click this button to create a new scenario. The COAST tool will prompt you to type in the name of the new scenario, and then clear the current definition so you can fill in the details.
Rename...	Click the *Rename...* button to assign a new name to the current scenario. You will be prompted to type in the new name.
Delete	Use this button to delete the current scenario from the collection. You will be prompted to confirm that you want to delete this scenario definition.
Layer	The list contains all of the elevation layers that are currently loaded. Select the layer to be used in this scenario from the list. If there is only one elevation layer in the list, it will be automatically selected.
Vertical Unit	This field displays the vertical unit defined for the selected elevation layer. If the value listed is not correct, you can unload the elevation layer using the Layer Manager, then reload it and specify the correct unit on the Elevation Layer Options dialog.
Asset	This list contains all of the asset definitions that have been created. Select the definition that you would like to use with this model scenario. To view or modify the asset definition, click the *Edit Asset...* button. If there are no assets defined, or you just need to create another one, click the *New Asset...* button.
Edit Asset...	Click this button to view or change the currently selected asset definition. The COAST tool will display the Edit Assets dialog, where you can see or change the definition.
New Asset...	Click the *New Asset...* button to create a new asset definition. The COAST tool will display the Edit Assets dialog, where you specify the new asset definition.
Delete Asset	Use the *Delete Asset* button to remove the current asset definition from the asset list. You will be prompted for confirmation before the asset is deleted.
Exceedance Curve	This list contains the exceedance curves defined in the current model parameters file. Select the curve that you want to use in this scenario.
Eustatic SLR	This list contains the eustatic SLR curves defined in the current model parameters file. Place a check next to each eustatic SLR definition you would like to include in the model.
Base Water Level	This list contains the Base Water Levels defined in the current model parameters file. Select the definition that you want to use in this scenario.
Local SLR	This list contains the Local SLR amounts defined in the current model parameters file. Select the definition that you want to use in this scenario. This parameter is optional. If you don't want to include it in the model, select "<None>" from the list.
Adaptation	This list contains the Adaptations defined in the current model parameters file. Select the adaptation definition that you want to use in this scenario. If you don't want to include an adaptation in the model, select "<None>" from the list.
Consider an asset abandoned...	This option allows you to designate an asset as "abandoned or adapted" when it is flooded due to sea-level rise without including storm surge. When an asset is flooded due to SLR only, it means that a normal high tide causes the asset to be inundated. This means that the flooding happens frequently, perhaps every day. Selecting this option tells the model to assume that once this happens, the asset will no longer be used, or will be adapted in some way. For example, if the asset is a residence, the owner might move out. If you use this option, the model will estimate the year in which an asset will be abandoned or adapted, and 100% of the value of the asset will be lost in that year. In subsequent years, the asset will be considered to have zero damage.
Discount Rate (Pct.)	Calculated damage amounts can be discounted back to Net Present Value (NPV). Specify the percentage that you would like to use. If you do not want to discount future values, specify zero in this field.
Start Year	Specify the beginning year to be used for the cumulative damage report. This year must be in the range of all of the checked eustatic SLR curves.

End Year	**Specify the end year to be used in the cumulative damage report. This year will be used to calculate the expected water-level rise and for discounting back to NPV (if discounting is being used.) The end year must be in the range of all of the checked eustatic SLR curves, and greater than the Start Year.**
Damage Report File	**Enter the name of the Excel spreadsheet file in which the model output will be stored.**
Browse...	**Click this button to select an output file by selecting it from the file system.**
OK	**Click the *OK* button to perform validation and run the model as it is currently defined.**
Cancel	**Click the *Cancel* button to close the dialog without running the model.**

Editing Asset Definitions

The *Edit Assets* dialog is used to provide information about an asset that will be used in a COAST model scenario. Asset definitions will be stored in the workspace file, along with the scenario definitions and map layers.



The Edit Assets dialog includes the following fields and data:

Asset Name	**Type the name of the asset in this field. This asset name will be used in the lists on the model scenario definition screens.**
Map Layer	**This list contains all of the vector layers that are currently loaded in the COAST tool viewer. Choose the layer that represents the asset you wish to include in the model scenario. If only one vector layer is in the list, it will be automatically selected.**
Depth/Damage Function	**This list contains all of the DDFs that are defined in the model parameters file. Choose the DDF that you want to use in the model scenario.**
Asset Value	**This list contains all of the attributes associated with the selected Map Layer. Choose the attribute that contains the asset data that you want to include in the damage calculations. The asset value attribute must contain numeric data.**
Use Alternate Asset Value	**Place a check in the box if you want to use an alternate asset value in your scenario.** **In some scenarios, a second asset value might be needed. For example, you might have an asset layer that includes both the current property value (the asset value) and extra data for anticipated future development (the alternate asset value). In order to determine the asset value, the COAST tool will first look at the alternate asset value, and will use it if the value is not zero. If the alternate asset value is zero, then the COAST model will use the original asset value instead. The list contains all of the attributes associated with the selected Map Layer. Choose the attribute containing the data that represents the alternate asset value.**
Appreciation Rate, Per Year (pct.)	**Place a check in the box if you want to have the assets in your scenario appreciate over time. Specify the yearly percentage in the text field. If you want to have the assets appreciate by 1% per year, type "1" in the field. This is assumed to be appreciation above inflation, so asset values will be appreciated using this value before the damage is calculated and NPV calculations using the discount rate are performed.**
Replacement Value Adjustment Factor	**Place a check in the box if you want to adjust the asset value amounts to reflect replacement value instead of assessed value. If assessed value should be reduced by 10% to reflect replacement value, type ".9" in the field. This asset value will be multiplied by this factor before it is used in the model calculations.**
OK	**Click the *OK* button to close the dialog and enter the new or updated data into the definition.**
Cancel	**Click the *Cancel* button to close the dialog without changing the definition.**

developers of photogrammetric mapping systems

DAT/EM's Global Mapper Extension

DAT/EM Systems International® develops world-class photogrammetric software and advanced software tools to efficiently extract and edit 3D vector features from stereo imagery and point clouds. DAT/EM Systems works to meet the needs of its clients by staying on the cutting edge of photogrammetric software development and collaborating with organizations to provide 3D stereo mapping solutions.

DAT/EM's new Global Mapper Extension connects Blue Marble Geographics ®' Global Mapper® with the Summit Evolution™ stereoplotter. With the extension, Summit Evolution (Summit) displays ground-referenced photogrammetric imagery in stereo, tracks ground coordinates in both Summit and Global Mapper, and collects and edits 3D data directly in Global Mapper.

The initial photogrammetric project is created and oriented by Summit Evolution Professional edition or imported by the Professional, Feature Collection, or Lite editions. Any Summit Evolution edition can open the prepared project and activate the Global Mapper extension. Summit Evolution also provides tools for panning, zooming and 3D positioning with some measurement and terrain following tools.

With Summit and the Global Mapper extension, the user has the ability to activate Summit functions from Global Mapper's home window. Existing buttons include settings for Summit Evolution, syncing of Global Mapper data with Summit, superimposition of the data vectors on the stereo imagery, panning options, display options, and more.

The extension is available with the Global Mapper Version 15.0 or higher and Summit Evolution version 7.0 or higher. For more information about Summit Evolution and which edition best suits your needs with Global Mapper, please email sales@datem.com or call 1.800.770.3681.

DAT/EM's Global Mapper Extension Features

- Connect Blue Marble Geographics®' Global Mapper® with DAT/EM's Summit Evolution™stereoplotter
- Compatible with Global Mapper Version 15.0 or higher and Summit Evolution version 7.0 or higher
- Use any Summit Evolution edition to open the prepared project and start the Global Mapper extension
- Activate some Summit Evolution functions from Global Mapper's home window
- Display ground-referenced photogrammetric imagery in stereo
- Track ground coordinates in both Summit Evolution and Global Mapper
- Collect and edit 3D data directly in Global Mapper
- Utilize Summit Evolution's tools for panning, zooming and 3D positioning with some measurement and terrain following tools