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Introducing the ESRI ModelBuilder
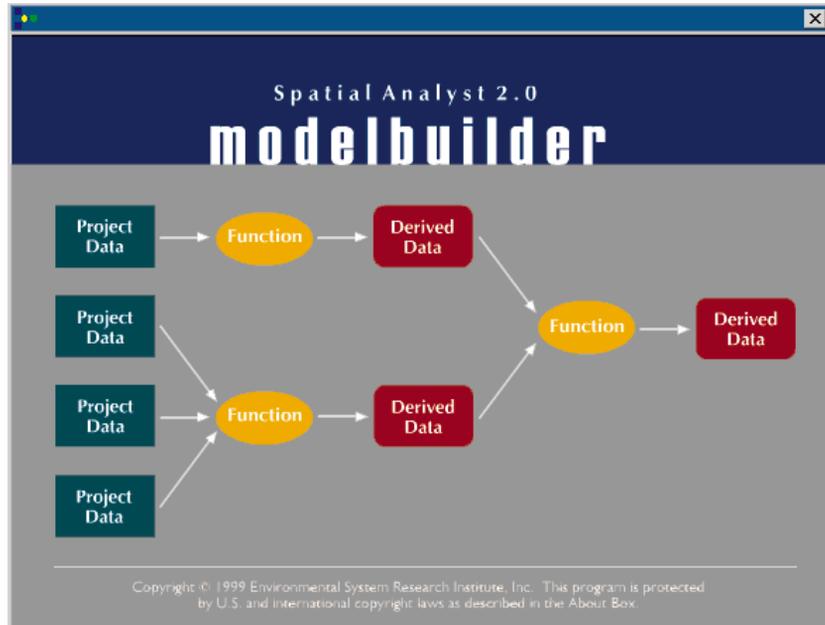
How ModelBuilder works

ModelBuilder components

Build your own model

BY NOW YOU KNOW

that most ArcView Spatial Analyst sessions involve a series of analytical procedures and many different data sets. So far, the only way to keep track of these projects has been to take good notes and keep your data well organized. In this chapter, you'll learn about a new tool that automates selected spatial processes in an ArcView Spatial Analyst 2 session and keeps them in a working model that you can run as often as you like. The model can then be distributed to others, who can easily alter it to fit their needs.

How ModelBuilder works

ModelBuilder operates in conjunction with ArcView Spatial Analyst 2, and is designed to work primarily with grid data sets. It groups selected ArcView Spatial Analyst functions into eleven wizards that guide you step by step through the procedures necessary to create a final map. As you work through the wizards, ModelBuilder also creates a model diagram, or flow chart, of the session that captures the geographic data, the spatial functions that operate on the data, and the order of those functions. When you run the model, all of the spatial functions in the project created by ModelBuilder are executed in sequence, so that the project essentially runs itself. You can add, delete, or replace any data set, any spatial operation, or any variable within a spatial operation, then run the model again. You can retain the model for future use or distribute it to others, who can then use it to analyze their own data sets or alter it as they see fit.

A process is a complete spatial operation, such as buffering streams or overlaying vegetation and rainfall data. Each process is divided into three parts: project data, a spatial function performed on the project data, and derived data. The derived data from one process can become the project data for another process. As with any ArcView GIS project, all data is stored on disk and referenced through the ArcView GIS project file.
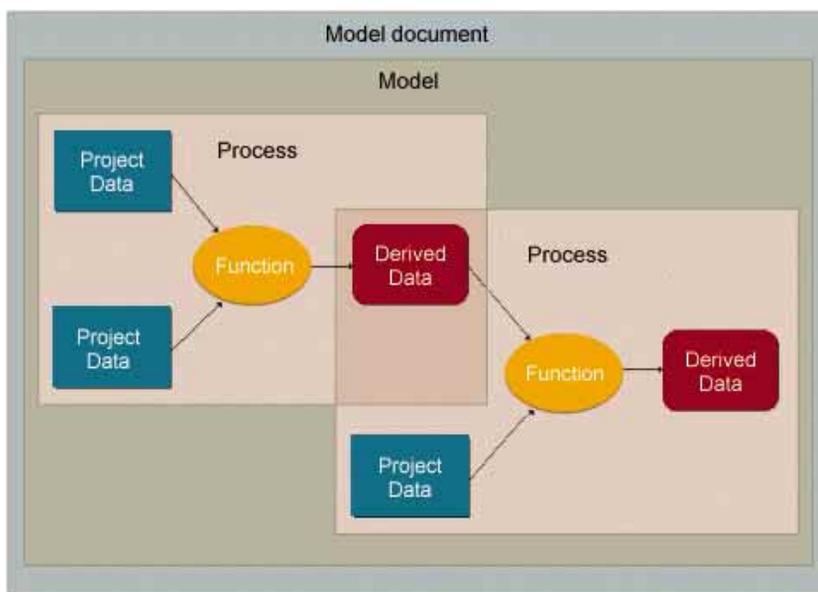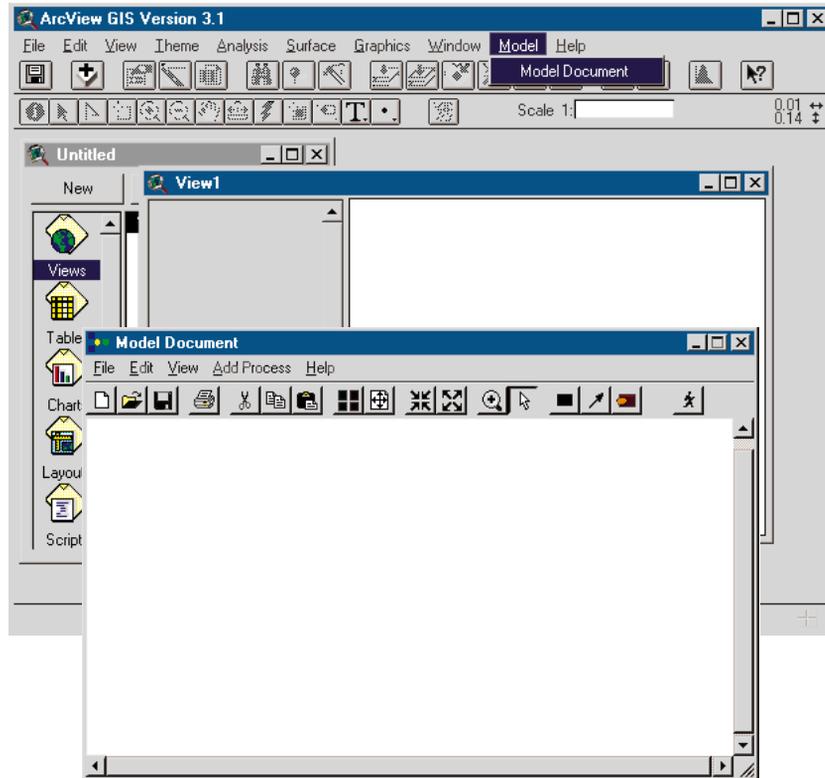

A model is a collection of processes. A process is a spatial function that accepts project data and produces derived data.

ModelBuilder components

The Model Document The Model Document is a new type of ArcView GIS document, and is accessed from the View GUI when ArcView Spatial Analyst is loaded.


The Model Document is accessed from the View GUI.

Every ModelBuilder operation is initiated from the Model Document window. Here, you construct individual processes from project data, spatial functions, and derived data, and then link the processes together to create a working model. Each process is symbolized in the Model Document window by one or more Input icons, one Function icon, and one Output icon. The arrows on the lines connecting the icons indicate the flow of data through the model. When you run the model, the processes are executed to produce the final maps as grid themes in ArcView GIS.
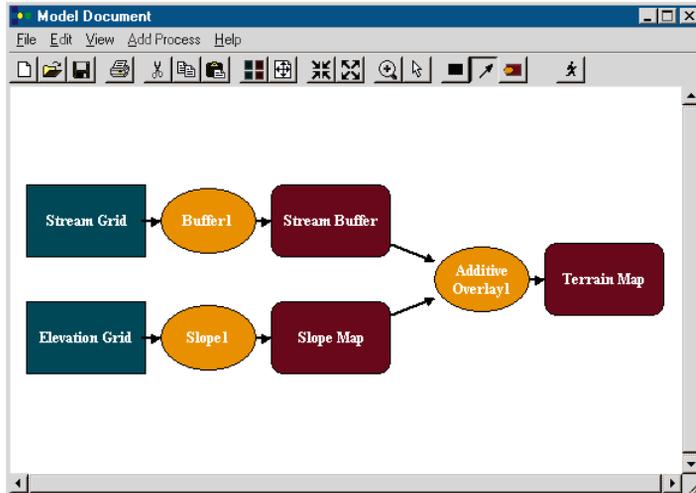
Say that you want to find out which bear, mountain lion, and deer habitats are most in need of conservation management. You don't want to create a conservation area that's too close to roads, and you don't need to consider habitat that's already being managed inside national parks. For the analysis, you'll need geographic data sets of the roads and the national parks in your study area, and individual data sets of the bear, mountain lion, and deer habitats.

First, you create buffer zones around the roads to keep the conservation areas away from them.
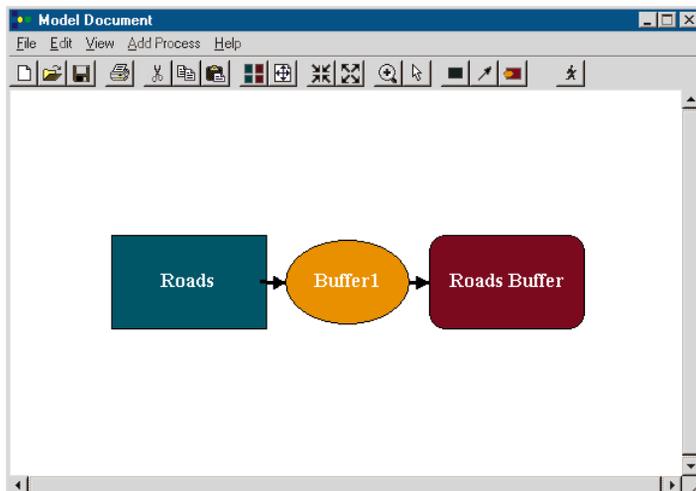
Next, you overlay your maps of the bear, mountain lion, and deer habitats to create a Habitat Range map of the areas that are critical for all three species.
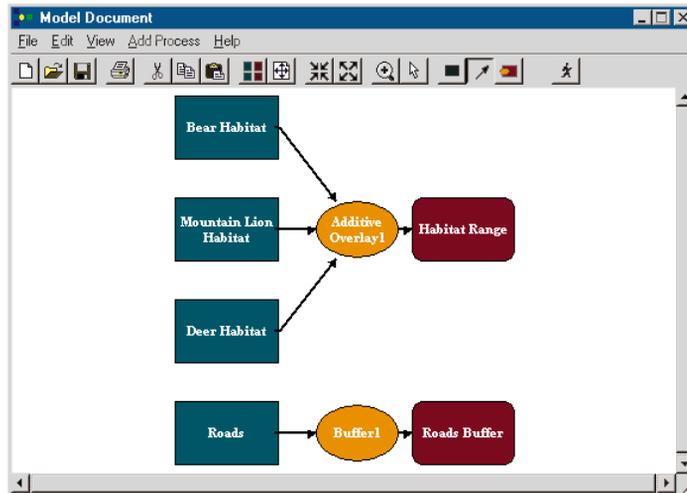
Habitat areas within national parks are already being managed, so you overlay the Habitat Range map, Roads Buffer map, and National Parks map to show areas lying outside the national parks and away from roads.

The model is complete. If you were to click the Run button, the processes would be activated in the ArcView GIS interface and you'd get a set of output maps showing the road buffers, the total habitat range for all three species, and a final map of the selected habitat areas that most need attention.
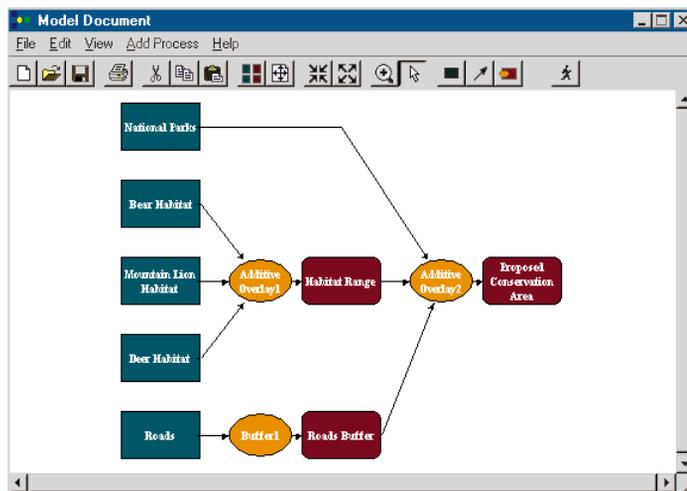
Properties

Each Input, Output, and Function icon has its own set of variables, or properties, that must be defined before a process can run. A full list of properties is beyond the scope of this chapter, but an Input icon requires information such as a grid or DEM name, and a field in the grid theme's table that can be used to classify the grid for analysis. The Output icon requires a grid extent, grid output cell size, legend color, legend table, and output file name. The information that you supply for each Function icon depends on the type of spatial operation you're using. The following table describes the spatial operations available.

| Spatial operation category	Function	Description
Data conversion	Vector to integer grid	Converts a point, line, or polygon theme to an integer grid
	DEM to floating-point grid	Converts a Digital Elevation Model file to a floating-point grid
	Point interpolation to floating-point grid	Converts a point theme to a floating-point grid
Reclassification	Reclassification	Groups the values in a grid theme into new classes and assigns them new values
Terrain	Contour	Converts a floating-point elevation grid to a contour line theme
	Slope	Converts a floating-point elevation grid to a slope grid
	Aspect	Converts a floating-point elevation grid to an aspect grid
	Hillshade	Converts a floating-point elevation grid to a hillshade grid
Distance	Buffer zones	Reclassifies all cells within a specified distance from a feature into a single buffer zone
Overlay	Additive overlay	Multiplies the values of two or more input themes by influence factors, then adds the values to produce an output grid
	Weighted overlay	Reclassifies the cell values of two or more input themes to a common scale, then multiplies the reclassified values by influence factors and adds the values to produce an output grid

Wizards

ModelBuilder provides wizards that allow you to add complete processes to the Model Document. The wizards, located in the Add Process menu, reflect the categories listed in the preceding table. Each wizard presents a series of dialogs that ask for the input properties of the process first, the function properties next, and the output properties last. When the wizard finishes, it adds the new process to the Model Document.

From the Add Process menu in the Model Document you select a wizard, which prompts you for the properties of each icon in the process. When it finishes, the process is added to the Model Document.

To change one or more properties of an existing process, right-click on the Function icon for that process to bring up the wizard again.
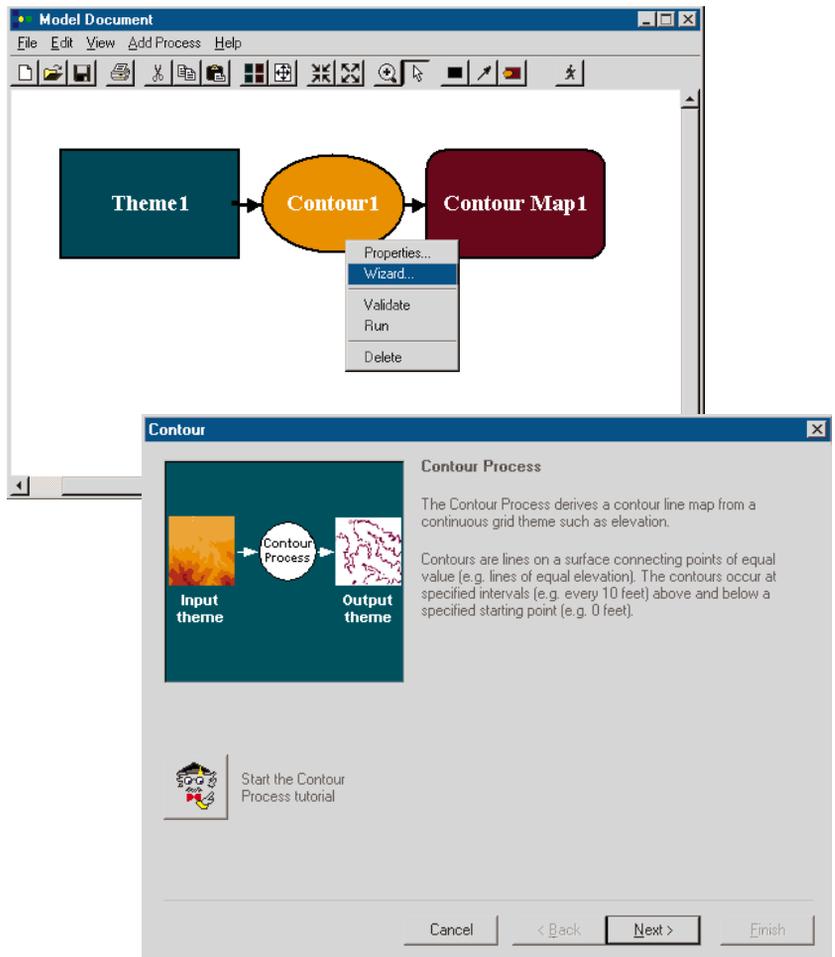
To edit the properties for an existing process with its wizard, right-click on the Function icon and select Wizard from the menu.
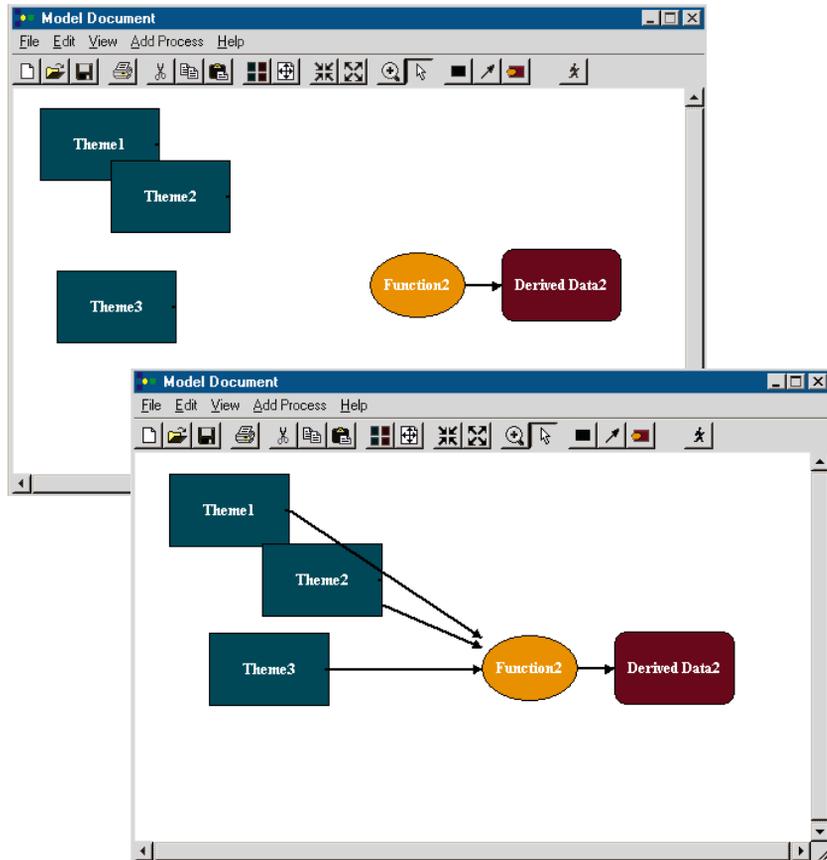
Drag-and-drop tools

When you become comfortable with the way ModelBuilder works, you may want to bypass the wizards and build parts of your model piecemeal, adding processes icon by icon without setting the properties of an entire process right away. This is very convenient if you're not sure what the properties are going to be, or if you don't want to go through an entire wizard to edit one property.

To create processes without using the wizards, drag and drop individual icons onto the Model Document with the Add Data tool and the Add Function tool. You can place as many icons as you need in the Model Document, anywhere you like.
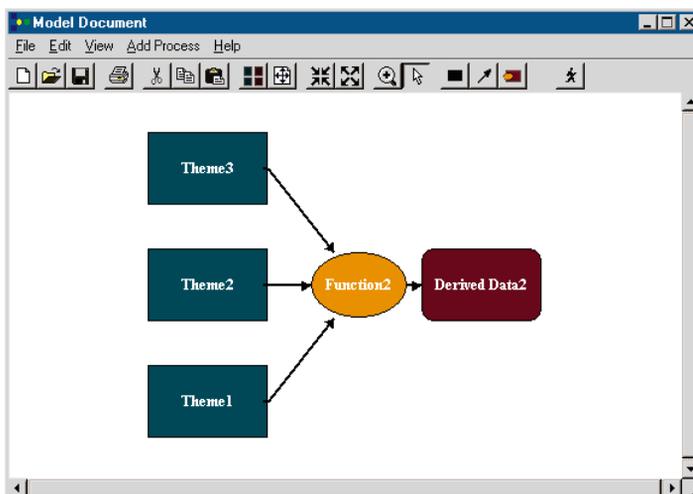
Next, connect the Input icons to the Function and Output icons with the Add Connection tool. For each process, you can have several Input icons, but only one Function icon and one Output icon.

When you're finished, click the Auto Layout tool to arrange the way the processes are displayed in the Model Document.

Property sheets

When you add an icon using the drag-and-drop tools, you can define its properties right away, or you can add it as an "empty" icon and set its properties later. Before you can run a model, however, you have to set the properties for each icon in the Model Document. You can use the wizards to do this, as you saw in the last section, or you can use the ModelBuilder property sheets. The property sheets resemble the wizards in that they present dialogs from which to set an icon's properties. Each icon—Input, Function, and Output—has its own property sheet, which can be accessed by right-clicking on that icon. A wizard, on the other hand, only applies to an entire process, and can only be accessed by right-clicking on the Function icon for that process.

To set the properties for any icon, right-click it, select Properties, and open its property sheet.
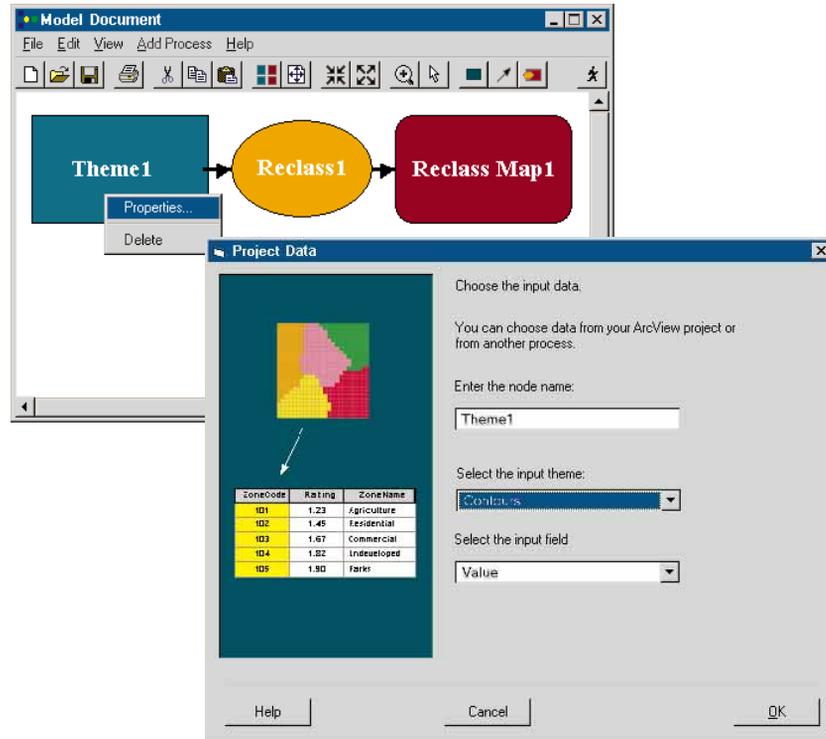
Access the property sheets by right-clicking on the icons in the Model Document. Here, the property sheet for the Input icon has been selected.

Validating the model

If you're not sure that you've defined all the properties in your model, select Validate Model from the File menu. It will tell you whether or not the model is ready to run. If you right-click on the Function icon of a single process and select Validate, it will tell you if all the processes up to and including that process are ready to run.

Build your own model

Creating a model begins with deciding what question you're trying to answer, what factors will affect the answer, and what data is needed to measure those factors.

Suppose you're buying land to build homes. You want to make sure that the land you buy isn't prone to soil erosion or landslides. Your goal is to determine which areas are suitable for building and which ones should be avoided.

To find the areas that are safe to build on, you need to identify the factors that weaken soil and estimate their influences across the site. The factors that affect erosion in this area are the slope and the type of soil. You can't build on slopes greater than 20 degrees, and you prefer slopes less than 10 degrees. The site has clay soil, sandy soil, gravel, and bedrock. Clay soil doesn't drain well and is prone to landslides. Sandy soil drains well and is less difficult to grade than gravel or bedrock. Therefore, the most desirable areas will have a slope of less than 10 degrees and a sandy soil type. Less desirable areas will have a slope of 10 to 20 degrees and clay, gravel, or bedrock soil types. Areas with slopes greater than 20 degrees are not suitable.

You already have an elevation grid for the site, but no slope data. Though the elevation data isn't what you need, you can use ModelBuilder to convert it to a slope grid.

To get the soil data, you send a geologist to the site to map the soil types. You store the soil data as an ArcView GIS polygon shapefile.
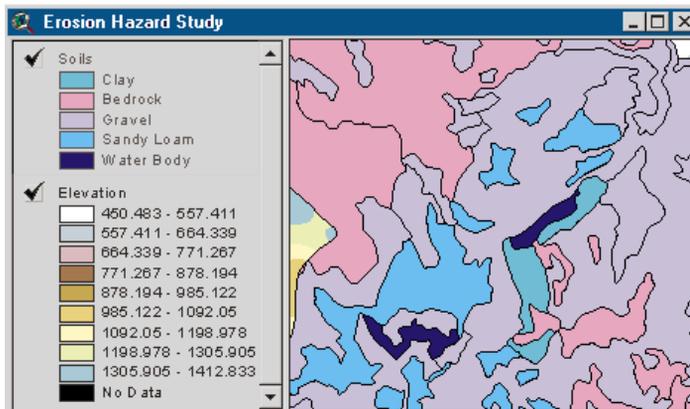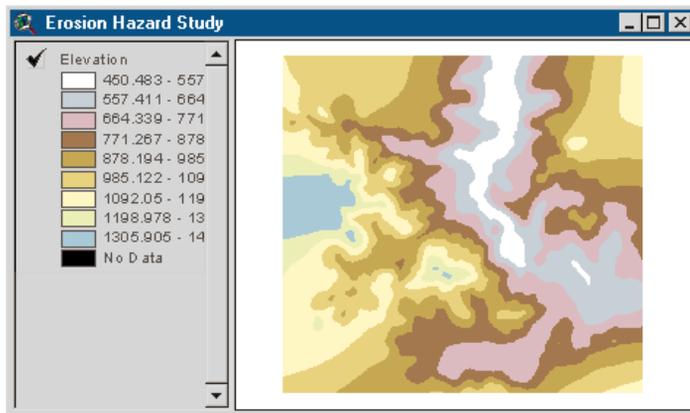
*Elevation and soil data are stored as themes in ArcView GIS.*

Now you can use ModelBuilder to process the elevation and soil data so you can see which areas are suitable for building.

First, you start ModelBuilder and use the Slope wizard to create a process that will convert the elevation grid to a slope grid. In the wizard, you define which project data will be used, how the slope will be measured (percent or degrees), and what the output theme will look like. When the wizard finishes, a slope process is added to the Model Document. The slope theme won't be created in ArcView GIS until you run the model.
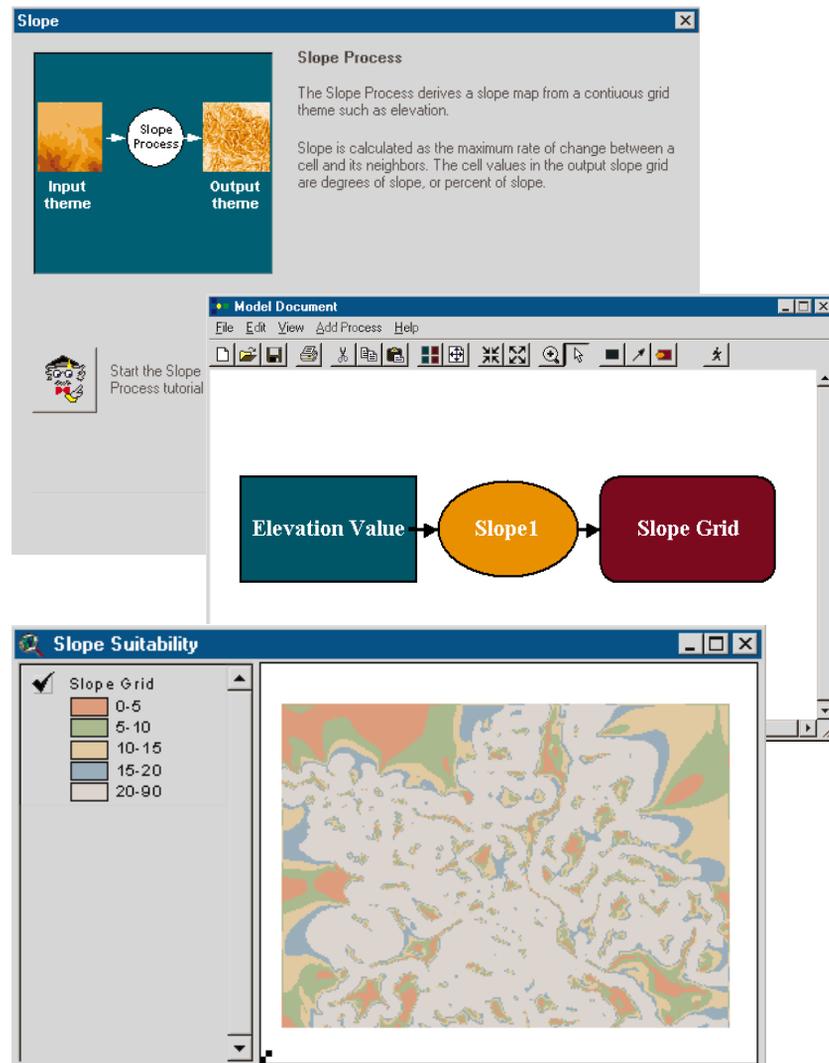
After working through the Slope wizard, a slope process is created in the Model Document. Right-click on the Function icon to run the process.

ModelBuilder requires grid themes for most operations. Since the soil data is stored as a shapefile, you use the Data Conversion wizard to convert it to a grid.
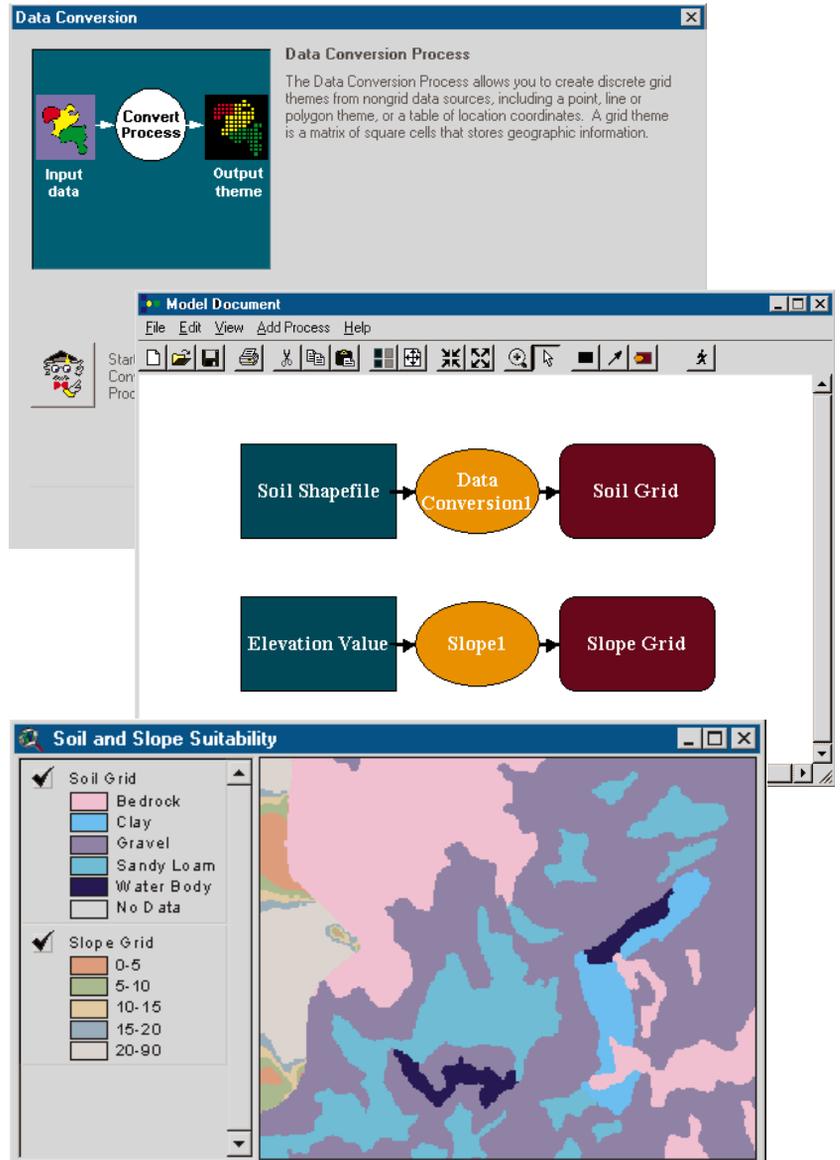
There are now two processes in the Model Document: the Slope process that converts the elevation grid to a slope grid and the Data Conversion process that converts the soil shapefile to a soil grid.

Now you want to combine the slope and soil data to map the suitability for building across the site. Combining different themes of geographic data is called overlay. But how do you overlay data that isn't alike? The slope data is measured in degrees, and the soil data defines soil type. With ModelBuilder you can assign a common suitability scale to each type of data, then add the suitability values together. For example, you might choose a scale of one to three, three being highly suitable for building, one being the least suitable. You assign the slope and soil data suitability values as shown in the two tables below.

Soil	Suitability value
Sandy soil	3 (highly suitable)
Bedrock	2 (suitable)
Gravel	2 (suitable)
Clay	1 (somewhat suitable)
Water body	Restricted (not suitable)

Slope	Suitability value
0–10 degrees	3 (highly suitable)
11–15 degrees	2 (suitable)
15–20 degrees	1 (somewhat suitable)
Greater than 20	Restricted (not suitable)

Once the slope and soil data are converted to a common scale, the values can be combined to establish an overall suitability rating. If the slope and soil data were equally important to you, you could just add their values and divide by two to get an overall rating. But you determined earlier that although you prefer sandy soil, you could build on any of the four soil types. Slopes steeper than 10 degrees are undesirable, however, and those greater than 20 degrees are unacceptable. The incline of the land has more influence on erosion than soil type. Therefore, you want slope data to weigh more heavily than soil data in your model.

You use the Weighted Overlay wizard in ModelBuilder to add a process to the Model Document. It asks you to define the common scale, the suitability values for the data, and the weight assigned to each data type. You assign a weight factor of 75 percent to the slope suitability values, and a weight factor of 25 percent to the soil suitability values.

The complete suitability model is displayed in the Model Document.

When you run the model, the slope and overlay processes are applied to the project data to create an overall suitability map. The map shows how prone each area is to erosion and landslides. Now you can choose those areas with the highest suitability value as the best sites to build on. If you like, you can change the weighting factors, suitability values, and other processing properties to produce several possible outcomes.
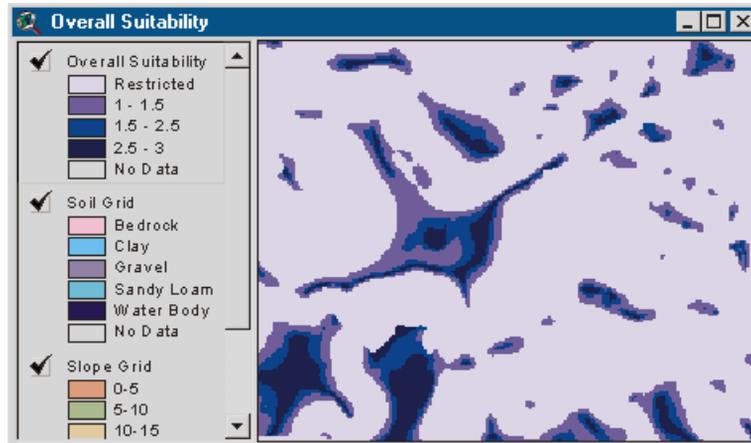
When you run the model, the results are displayed in ArcView GIS. The Weighted Overlay process created an overall suitability map that shows you where it's safe to build.