School of Earth and Environment
Te Kura Aronukurangi

GEOG-DIGI205

Introduction to Geographic Information Systems

Lab 9. Spatial Analyst: Locate a new school.

Objectives

The town of Stowe, Vermont, USA, has experienced a substantial increase in population. Demographic data suggests this increase has occurred because of families moving to the region, attracted by the many recreational facilities located nearby. It has been decided that a new school must be built to take the strain off existing schools, and you as a town planner have been assigned the task of finding suitable sites based on the criteria of relatively flat slope, distance away from existing schools, proximity to recreation centers, as well as current patterns of land use.

Don't be put off by the page count of this handout – it has a lot of graphics. You will need approximately 90 minutes of focused time to complete the tutorial. Work reasonably quickly through task 1 & 2, as task 3 is the biggie.

You have several tasks to complete while exploring the functionality of the ArcGIS Spatial Analyst extension (which performs analysis using cell-based raster data), and the ModelBuilder application (which strings together geoprocessing tools in a workflow that uses the output of one tool as the input for another). This lab provides a good model for preparing and solving other spatial problems.

- In Task 1 you prepare for analysis by making a copy of the tutorial data and creating a geodatabase to hold your results.
- In Task 2 you learn the location of the Spatial Analyst tools, create a hillshade from a digital elevation model (DEM), and explore the data.
- In Task 3 you use ModelBuilder to: derive raster datasets of distance and slope; reclassify them to a common scale; weight them to reflect their relative importance; and finally combine them to find the most suitable locations. You'll then modify the weightings and rerun your model.

Assessment

Lab online quizzes are due by 09:00 on the Monday following the lab. Answer the numbered questions highlighted in red in the lab handout via the LEARN> GEOG-DIGI-205-GISC422> (Weekly) Modules. *Tip: Multi-choice and matching-answer questions have clues in their answers!*

Lab reports for labs 8-10 are submitted as one hand-in in PDF format to preserve formatting, with your username in the file name. Always check how your PDF looks before submitting – it needs to be clear and legible. Due dates are in the course handout.

The required hand-in is a single document with a cover page with the course code, your name, student ID, lab stream (day), and date, followed by two pages per lab starting with its title. GEOG205 lab reports are limited to two pages per lab and they are comprised of 2 parts: the first part is summarizing each lab without the fine detail (max 300 words); and the second part includes required graphics with short descriptive captions (excluded from word count), and referred to in the summary. The first part (summary) should incorporate a brief introduction, your method and results, and any concluding observation, so that the reader understands and can potentially repeat the exercise in conjunction with the lab handout. Please be succinct without repeating the lab instructions, and do NOT include the quiz questions and answers.

Due dates and assessment values are in the course outline, while information on lab report hand-ins are in LEARN> GEOG-DIGI-205-GISC422> (Weekly) Modules. You'll submit this lab as a batch under "GIS Analysis II: Labs 8-10" at the end of week 12.

Required graphics

- Your completed model.
- The two different results produced by your model.

Note: Capture graphics using the Snipping or Snip&Sketch tool, after making them as large as possible on screen to ensure good quality resolution for your hand-in. Copy and paste directly into a Word document and add text to identify which is which - you can resize and arrange later.

Task 1: Preparing for analysis

In this task you prepare for analysis by making a local copy of the tutorial data, and establish separate workspaces for inputs and outputs, many of the latter being intermediate results.

Important!

1. **Please work locally in your PC (better processing speed) but don't forget to backup your lab report work or do your report in OneDrive.** Relatively slow network speed makes ArcGIS Pro unstable when working with ModelBuilder and raster data.
2. Folder and file names **MUST NOT** contain **S P A C E S** or other special characters such as ~@#$.%^&*()+!. Use alpha characters '**a to z**' or '**A to Z**', while **trailing numbers** and underscores '**_**' are OK too. (e.g. 'some_name_01' is good, '01 some-name' is bad).

Copy the folder for this lab from the Geog205 class folder to your OneDrive - Geog205 folder, or download it from Learn. Downloads are in *.ZIP format and must be uncompressed for use with ArcGIS – full instructions are on the download page.

Start ArcGIS Pro with a new blank map, and ensure the View menu is set to Data View. Save the ArcGIS Pro document to your current lab folder (alongside the SpatialAnalyst folder, not in it) with a meaningful name (e.g. G205_SpatialAnalyst_Lab). Catalog Home now provides a direct connection to your work.

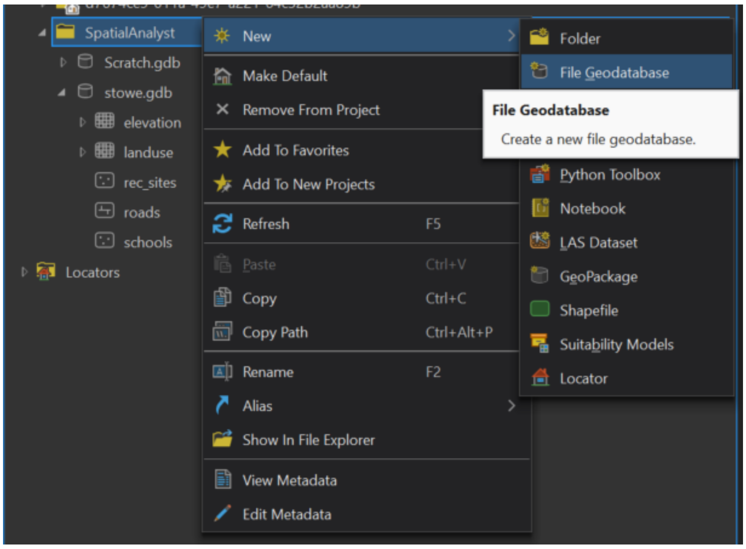
Set up your workspace environment

Setting up your workspace environment is a prerequisite to performing geoprocessing tasks with ModelBuilder, as some outputs are only required as intermediate data (also referred to as temporary or scratch data), best kept separate from your inputs.

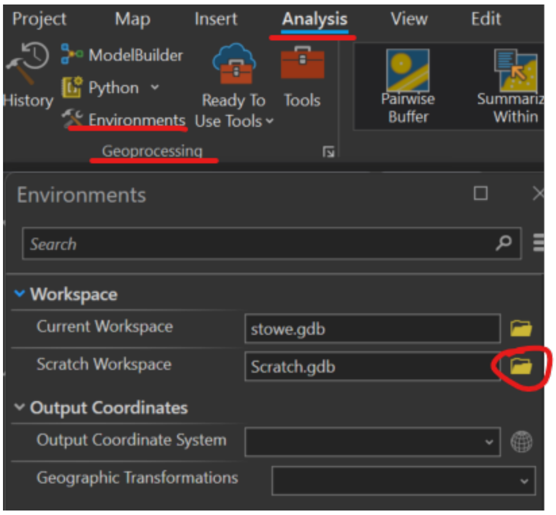
The input data for this lab is in the SpatialAnalyst folder in a file geodatabase called stowe.gdb. You are going to create a second file geodatabase for your outputs called scratch, and set these as the default 'current' and 'scratch' workspaces for this project.

Steps:

1. In Catalog expand the SpatialAnalyst folder to see its contents.
2. Right-click the SpatialAnalyst folder and select New> File Geodatabase.



3. Rename this New File Geodatabase as Scratch (it gets the .gdb extension by default).
4. In the main ArcGIS Pro menu click Analysis > Geoprocessing > Environments …
5. Click Workspace to expand the environment settings related to workspaces.
6. Set Current Workspace to stowe.gdb, and Scratch Workspace to scratch.gdb. Click OK.



Q1. What does setting the Scratch Workspace environment setting do? (Search the Help for scratch workspace)

Add data to your ArcGIS Pro document

In Catalog Home expand your SpatialAnalyst folder and then stowe.gdb, and drag all the datasets into the ArcGIS Pro data frame. You should have two rasters and three feature classes in your table of contents, as described in the following table.

Elevation	Raster dataset representing the elevation of the area
Landuse	Raster dataset representing the land-use types over the area
Roads	Feature class representing the linear road network for the town of Stowe
Rec_sites	Feature class representing point locations of recreation sites
Schools	Feature class representing point locations of existing schools.

Save your map document and proceed to Task 2.

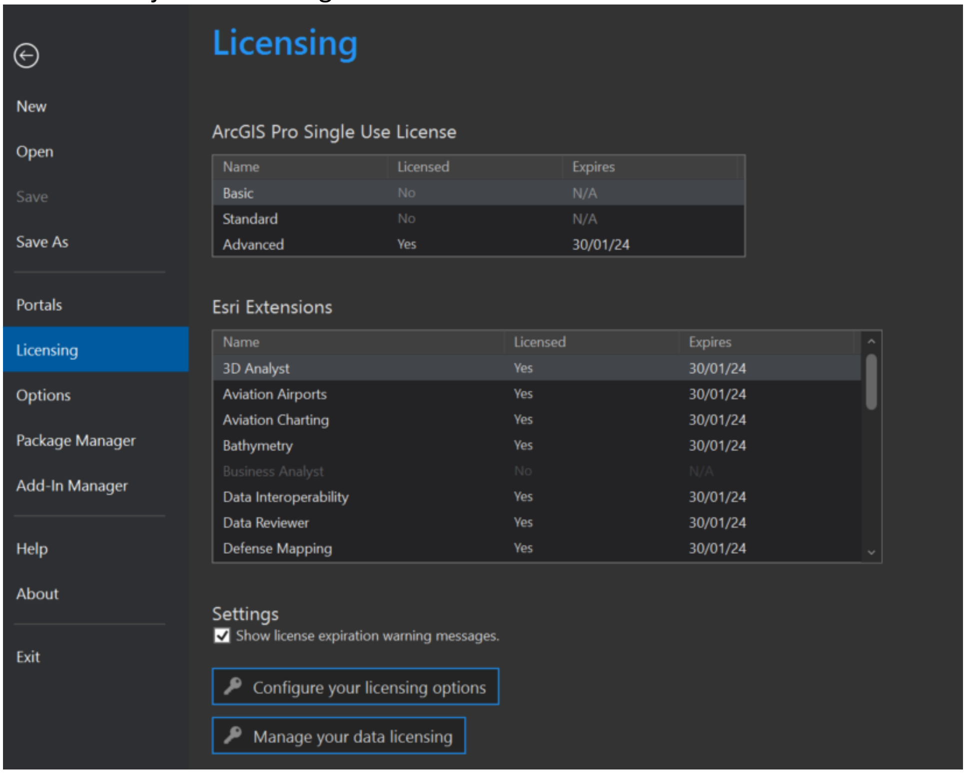
Task 2: Enable an ArcGIS extension and explore your data.

In this task you will learn how to enable the Spatial Analyst extension, and search for and run a geoprocessing tool to create a hillshade to show surface relief. You will then explore the attributes of a land-use layer and select elements on your map. This task will take approximately 15 minutes to complete.

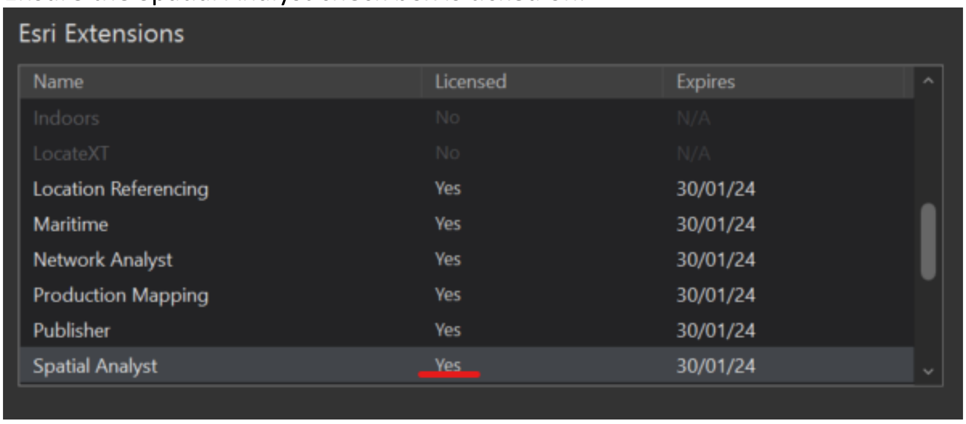
Checking out a Spatial Analyst license

Steps:

1. Click the Project > Licensing menu.



2. Ensure the Spatial Analyst check box is ticked on.



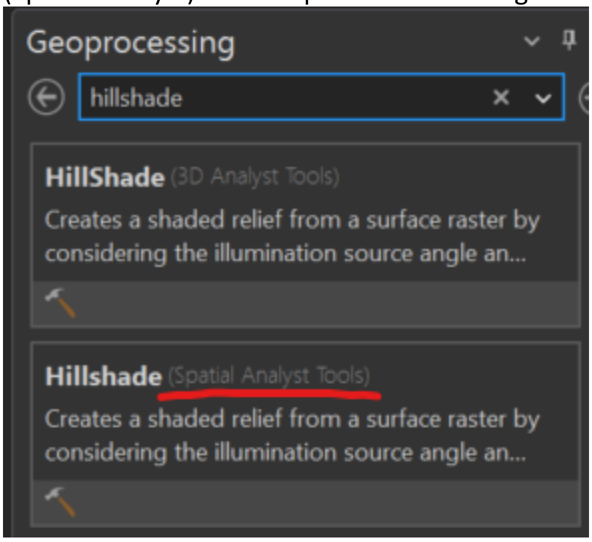
3. Return to your project.

Create a hillshade

A hillshade is a shaded relief raster created by using an elevation raster and setting an illumination source (typically the sun) at a user-specified azimuth (the angular direction of the illumination source, in positive degrees from 0 to 360) and altitude (the angle of the illumination source above the horizon). The visual effect of a hillshade can be dramatic when it is displayed under other layers with transparency set in your ArcGIS Pro display. You'll run the Hillshade tool so you can view and explore the output from this tool with the rest of your input data later in this task.

Steps:

1. Open the Analysis toolbar from the main menu
2. Click Tools.
3. Type Hillshade into the geoprocessing search box.
3. The Hillshade tool appears in two toolboxes, indicated by (brackets). Click the Hillshade (Spatial Analyst) tool to open the tool dialog.



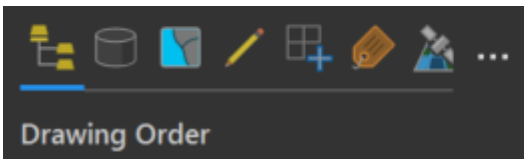
4. Select elevation from the drop-down list for the Input raster.
5. Leave the defaults for the Output raster (which should go to your scratch.gdb), Azimuth, and Altitude parameters.
6. Leave Model shadows unchecked, so the local illumination of the surface will be calculated whether or not a cell falls in the shadow of another cell.
7. For the Z factor enter a value of 0.3048. This is because the tutorial data is American, with the x,y units in meters, but the z-values in feet. Since there are 0.3048 meters in one foot, multiplying the z-values by a factor of 0.3048 will convert them to meters.

   Dive-in: If your x-, y-, and z-values are all in the same unit of measure (for example, if they are all in meters), you can accept the default Z factor of 1, so the z-units are not converted. Setting an appropriate z-factor is critical for good results if your input surface is stored in a geographic coordinate system (for example, the x,y units are a spherical measurement, such as decimal degrees or decimal seconds). The z-factor can also be used for exaggeration of the terrain.
8. Run the tool, and on completion the hillshade should be added to your display.

Displaying and exploring data

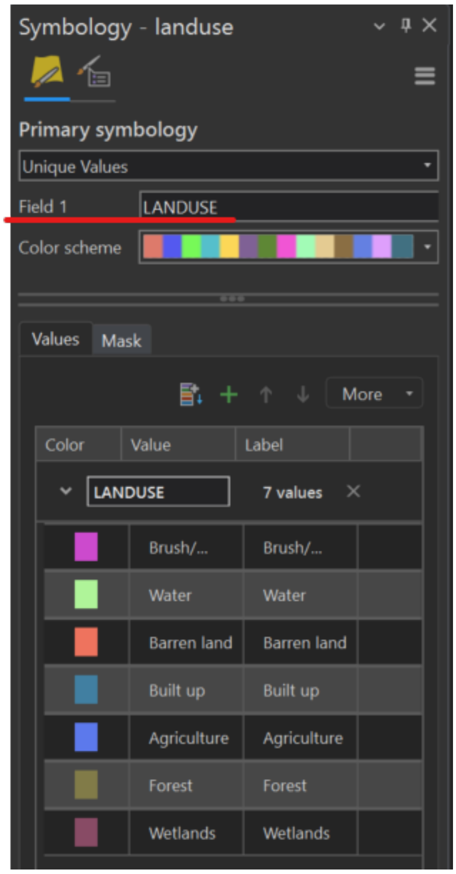
You will now change the symbology of the landuse layer and apply transparency so you can see the effect of the hillshade, after which you will explore the data.

1. Ensure the Contents Pane is set to List By Drawing Order, then drag the hillshade result below the landuse layer.



2. Uncheck the elevation layer in the Contents Pane.

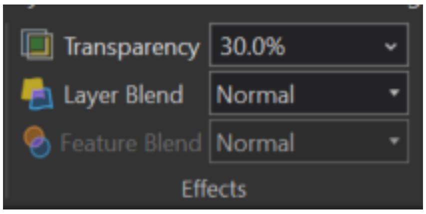
3. Right-click landuse in the Contents Pane and then Symbology. By default, the land-use categories are drawn in random colours with the Unique Values renderer. In this case there are three Value Fields: numeric fields called COUNT (i.e. number of cells of a particular value) and VALUE (i.e. cell values); and one text field called LANDUSE that contains descriptive labels



5. Ensure that LANDUSE is selected in Field 1.

6. Click each symbol and choose a suitable colour to represent each land-use type (e.g. forest = green; water = blue; agriculture = orange; built up areas = red; and wetlands = purple). The changes you make are reflected in the Contents Pane and in the map display.

8. With 'landuse' selected, click on Raster Layer from the main toolbar and change the transparency to 30%.



The hillshade layer is now visible through the landuse layer, showing the surface relief.

Land use and hillshade map

Save the document.

Q2. What does the hillshade give an impression of?

Select features on the map

Examining the attribute table gives you an idea of the number of cells of each attribute in the dataset.

Steps:

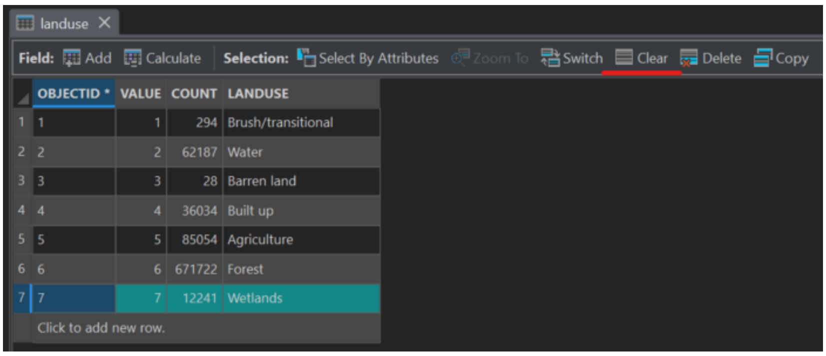
1. Right-click the landuse layer in the Contents Pane and open its Attribute Table.

	OBJECTID *	VALUE	COUNT	LANDUSE
1	1	1	294	Brush/transitional
2	2	2	62187	Water
3	3	3	28	Barren land
4	4	4	36034	Built up
5	5	5	85054	Agriculture
6	6	6	671722	Forest
7	7	7	12241	Wetlands
	Click to add new row.			

The COUNT field identifies the number of cells in the dataset of each value. Notice that Forest (value of 6) has the largest count, followed by Agriculture (value of 5), then Water (value of 2).

2. Click the row representing Wetlands (value of 7). This selects all cells where the land-use type is Wetlands, and highlights them on the map.

3. Click the Clear Selection button in the menu of the Table window, otherwise later processes will only work on the selected set of cells.



	OBJECTID *	VALUE	COUNT	LANDUSE
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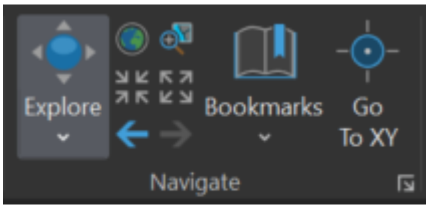
5	5	5	85054	Agriculture
6	6	6	671722	Forest
7	7	7	12241	Wetlands
	Click to add new row.			

4. Close the attribute table for landuse layer and the Table window.

Identify features on the map

Steps:

1. Click the Explore tool on the Main toolbar under the Map tab and click any location on your map.

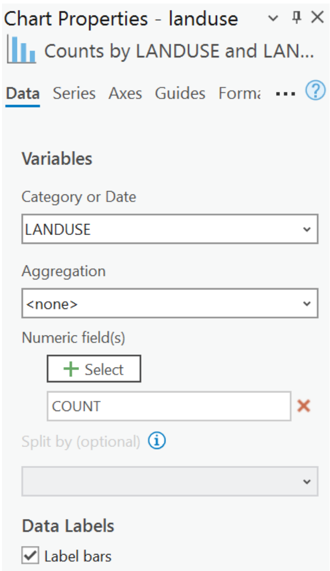


2. Click the Explore drop-down menu on the and click <Visible Layers>.
3. Click a rec_site point to identify the features in this particular location.
4. Click a landuse cell to identify the classification and total cell count in the raster.
5. Close the Identify window.

Examine a Bar Chart

Graph the number of cells relative to each other by right clicking the Landuse layer > Create Chart > Bar Chart

1. From Category or Date and select the Landuse column
2. Under the Numeric field(s) select the Count column.



Check on the Label bars. The graph now clearly shows the dominant landuse type.

Q3. What is the dominant landuse type and its cell count?

Close the bar chart of landuse window.

Save your map document.

Summary

In this task you learnt how to access and run Spatial Analyst tools and explore your data. In the next task you will build a model by adding Spatial Analyst tools to a workflow to locate areas that are suitable for a new school.

Task 3: Finding a site for a new school

In this task you will string together a sequence of geoprocessing tools using ModelBuilder - a visual programming app for modelling workflows. Once a model is built you can edit and re-run it to answer 'what if?' questions. Models are useful in automating and recording geoprocessing workflows, and you can even share them with a friend. To learn more about ModelBuilder search the help for What is ModelBuilder.

Your input datasets in this task are elevation, rec_sites, schools, and landuse. You will derive slope from the elevation layer, then distance from recreation sites and existing schools, then reclassify these to a common scale of suitability ranging from 1 (least suitable) to 10 (most suitable). You will then combine these with the landuse dataset using a percentage of influence weighting to produce a map of suitable locations for a new school. This task will take approximately 45 minutes to complete.

Create a new toolbox to contain your model

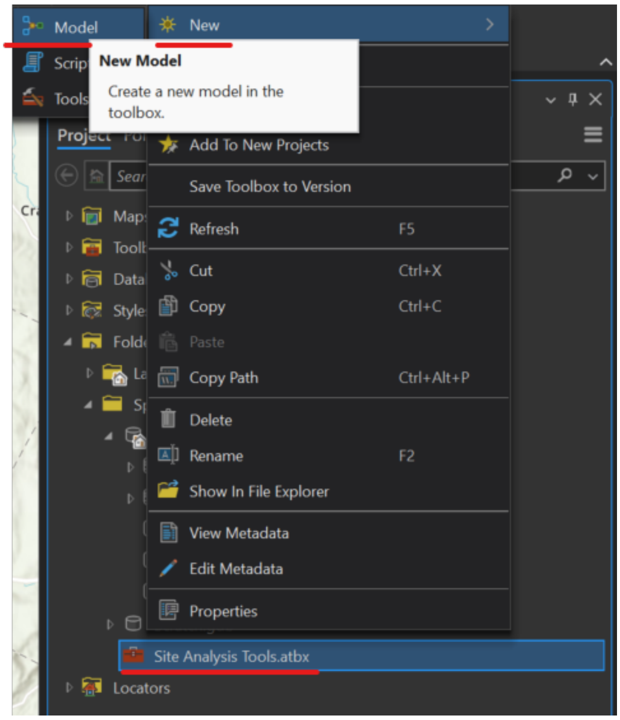
Steps:

1. In Catalog > Folders - right-click your SpatialAnalyst folder to create a new toolbox.
2. Rename the toolbox Site Analysis Tools (in this case, spaces in the name are OK).

Create a new model

Steps:

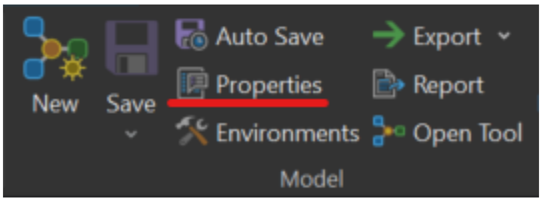
1. Right-click the Site Analysis Tools toolbox and click New > Model to open a new blank ModelBuilder window.



Set the model properties.

Steps:

1. On the model's main menu, click Model Properties.



2. Click the General tab.

3. Type FindSchool in the Name text box and “Find location for school” in the Label text box. The name is used in scripting and cannot have any spaces, while the label provides a more meaningful display name for the model.

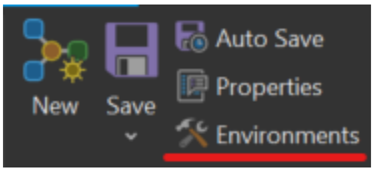
Specify environment settings

Before you start to perform analysis on your data, you should set any relevant environment settings. More information on how to set environments and the hierarchy between analysis environments can be found in the help by searching for ‘The analysis environment of Spatial Analyst’.

Because your environment settings apply to each process of this model only, you'll set environment settings for the model.

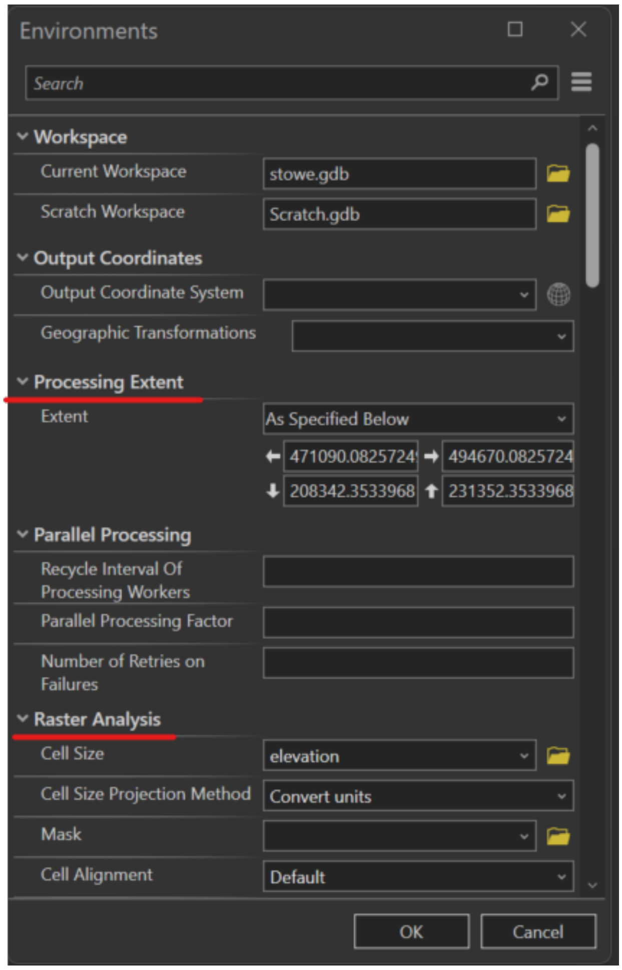
Steps:

1. Open the environments settings from the main toolbar.



Tip: The Current Workspace and the Scratch Workspace are already set, as these environment settings are inherited from the map document.

2. Expand Processing Extent. Set the Extent by clicking the drop-down arrow and selecting Same as Layer: elevation.



3. Expand Raster Analysis. Set the Cell Size by clicking the drop-down arrow and selecting Same as Layer elevation. The cell size of your elevation layer will be applied to all subsequent raster outputs. Your elevation dataset has the largest cell size (30 meters).

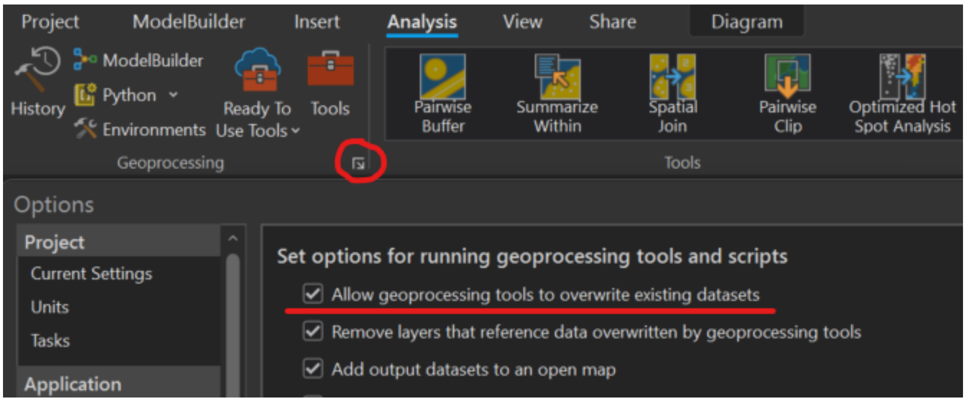
Caution: Setting a smaller cell size than your largest input will not mean you have more detailed information in subsequent raster results; you will just have more cells of the same value, which may affect your display and calculation speeds.

4. Click OK on the Environment Settings window.

5. Click the Save button on your model toolbar, or under the Model menu.

Tip: If at any time you need to close and reopen your model, right-click on the model in Catalog and select Edit (selecting Open runs the model).

This is important - to enable repeated running of your model for testing, return to the main toolbar and select Analysis > Geoprocessing Options… and check on `Allow geoprocessing tools to overwrite existing datasets'.



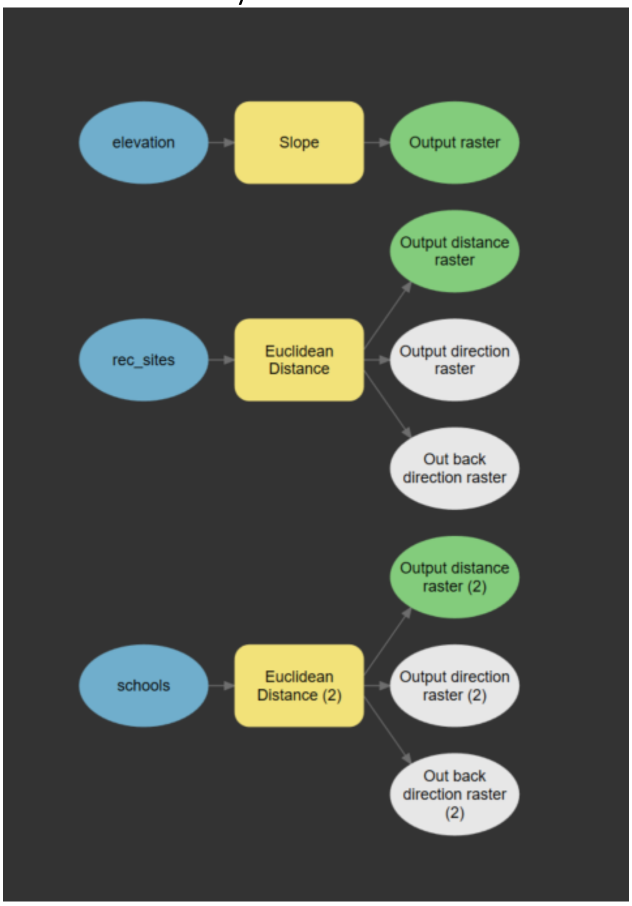
Q4. When setting Raster Analysis Cell Size for different resolution raster inputs, what size should you use and why?

Derive new datasets

You are now ready to start building a model that processes your data to locate suitable areas for a new school. You'll derive the following from your project data:

- Derive Slope from the elevation dataset.
- Derive Distance from recreation sites from the rec_sites dataset.
- Derive Distance from existing schools from the schools dataset.

This first section of your model will look like the following:



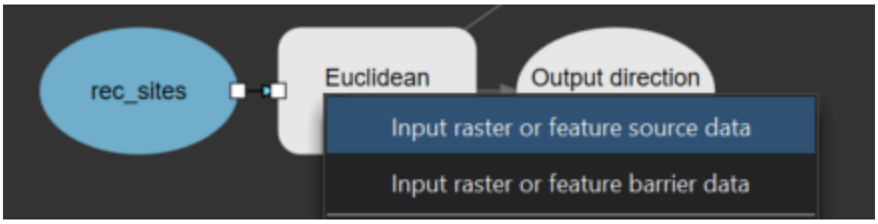
Steps:

1. Drag the layers elevation, rec_sites, and schools from the Contents Pane onto your model.

2. Use the Geoprocessing view to find the Slope (Spatial Analyst) tool, and drag it onto your model in line with elevation. An element that references the Slope tool is created on the display window.
3. Search to find the Euclidean Distance (Spatial Analyst) tool and drag it on to your model, in line with rec_sites. Notice that there is more than one output, some of which are optional and remain unused – in this case you will only use the Euclidean Distance> Output distance raster.
4. Repeat step 3, but this time place the Euclidean Distance tool in line with schools. Notice that each time the same tool is added to a model, the name of the tool element is appended with a number. The second time Euclidean Distance was added to your model, the label consisted of the tool name followed by (2). Leave these labels as is.

4. Click on each input (ie. Elevation, rec_sites, schools) and without releasing your finger, drag the arrow to connect to the corresponding tools.

6. Drag the elevation dataset to the Slope tool and select Input raster from the pop-up menu.
7. Repeat the previous step, this time connecting rec_sites to the Euclidean Distance tool and schools to the Euclidean Distance (2) tool, this time selecting 'Input raster or feature source data'



Note: The process (consisting of the input data, tool, and output data elements) is now filled with a solid color, meaning all tools are ready to run. However, you first need to change some default parameters.

8. Click the Auto Layout button from the model builder toolbar, then the Fit to Window button to arrange the current diagram elements and place them within the display window.
10. On the toolbar, click the Save button.

Derive Slope from elevation

Since the area is mountainous, you need to find areas of relatively flat land on which to build, so you will take into consideration the slope of the land.

Steps:

1. Right-click the yellow Slope tool and click Open, or double-click the Slope tool.
2. Leave the default values for Input raster and the Output measurement.
3. Change the Output raster name to slope_out to help identify it later.

4. For the Z factor, type 0.3048 to convert the z-values to the same unit of measure as the x,y units (i.e. from feet to meters).
5. Click OK.
6. Right-click the green output from the Slope tool and click Rename.
7. Type Slope Output and hit enter.

Note: This is just a label and does not alter the output name. Labels can contain spaces to make the model and layers added to the Table of Contents more readable.

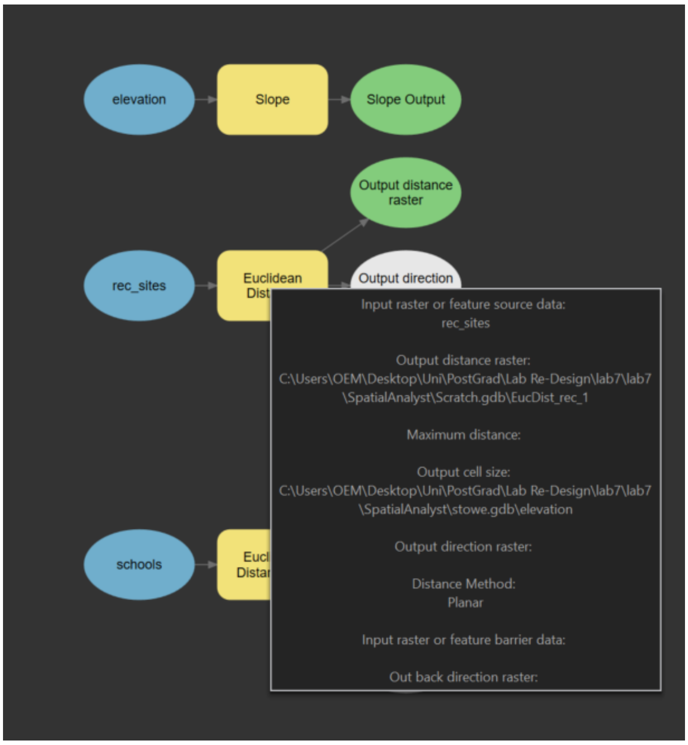
Q5. What Z factor value did you use for slope in this case, and why? *(Show Help to find the answer)*

Derive distance from recreation sites

To find locations close to recreation sites, you must first calculate the Euclidean (straight-line) distance from recreation sites.

Steps:

1. Hover over the Euclidean Distance tool connected to rec_sites to easily see all the default parameters set for this tool.



There is no need to change any of these parameters. You accepted the default for the Maximum distance, thus leaving this parameter empty. Therefore, the edge of the output raster is used as the maximum distance. The Output cell size is taken from the environment setting previously set to that of your elevation data. In this task, the Output direction raster is not required.

2. Right-click the green 'Output distance raster' output to Rename it Distance to recreation sites.

Deriving distance from schools

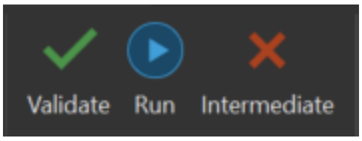
To find locations away from existing schools, you must first calculate the Euclidean (straight-line) distance from schools.

Steps:

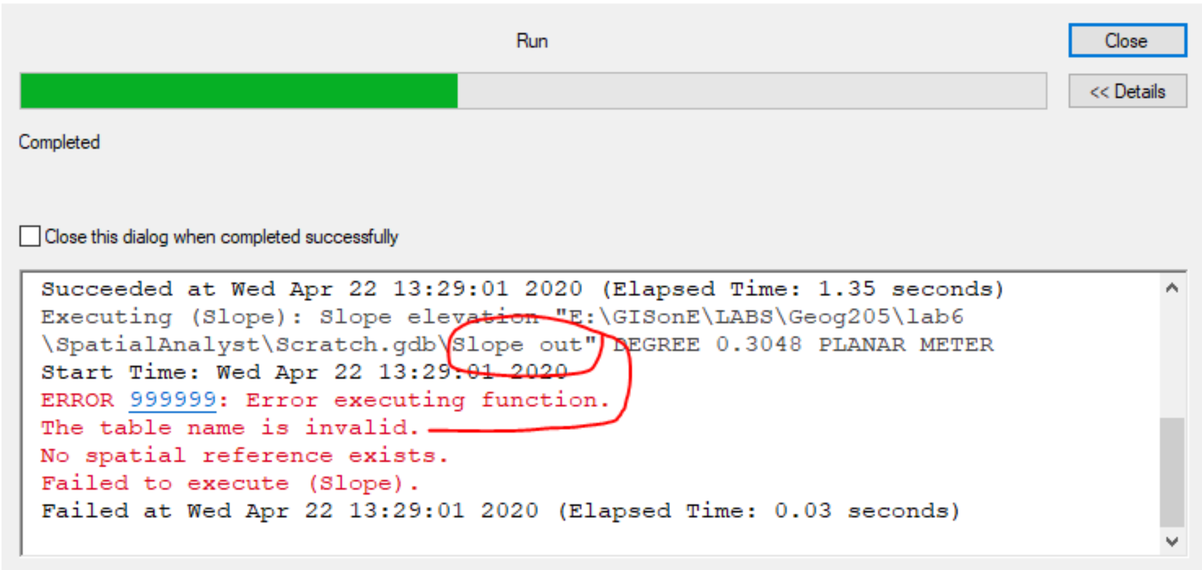
1. Hover over the Euclidean Distance (2) tool connected to schools to easily see all the default parameters set for this tool. There is no need to change any of these parameters.
2. Right-click the output from the Euclidean Distance (2) tool to Rename it Distance to schools.

Run Model to Derive Datasets

Steps:

1. Right-click each of the green output variables (Slope output, Distance to recreation sites, and Distance to schools) and click Add To Display. With Add To Display switched on, the output should automatically display and refresh each time the model is run. BEFORE RUNNING THE MODEL ensure that nothing is selected in the map frame by selecting clear features.
2. Click the Run button 

on the model toolbar to execute all three tools in your model. As each tool runs it is highlighted in red in the model, and progress is documented in a dialog box. If there's an error it will be highlighted in red in the progress dialog box (e.g. ERROR 999999: , in which case expand the progress box to look for clues to help you fix the error (e.g. an invalid character/space in the output name as shown below).



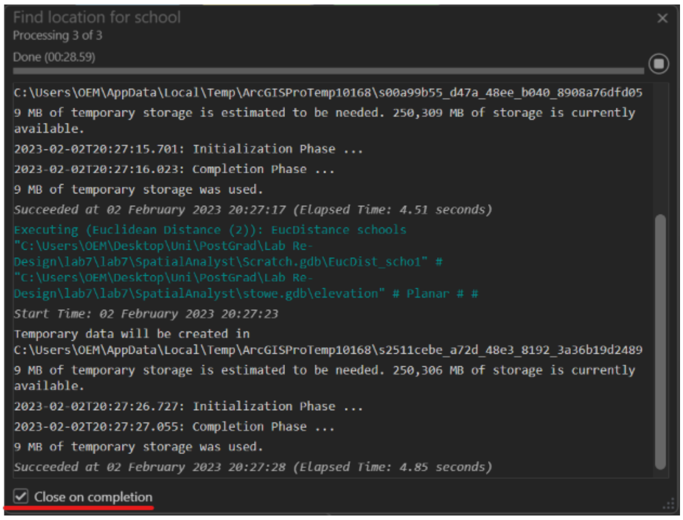
When the tools have finished running, the tool and its output become shaded, indicating that the output has been created.

If the outputs are not added to the display, then turn their Add To Display property off and on again in the model.

If you get ERROR 999999: Error executing function. The table already exists. No spatial reference exists. Failed to execute (Reclassify), then close the model, and reopen it from

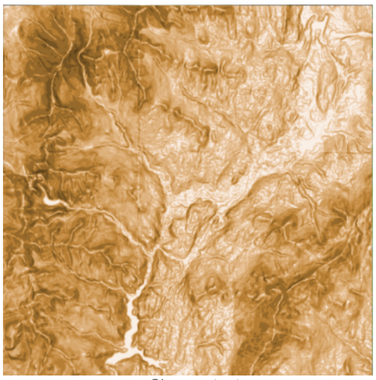
Catalog with a right-click and by selecting Edit. Then use Run (do not use Model> Run Entire Model).

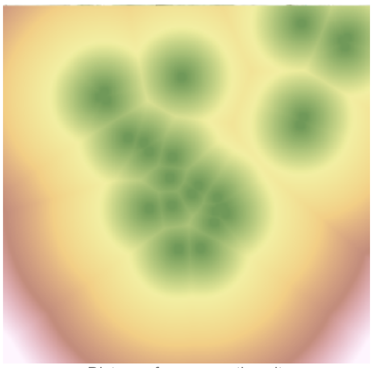
3. If the progress dialog box is open, check the check box to Close this dialog when completed successfully, then click Close. If it fails to run successfully in the future then it will stay open and show an ERROR as above.

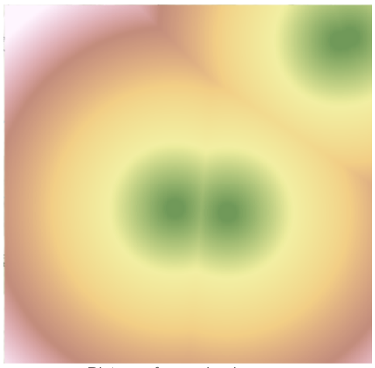


4. Examine the output layers, which should be automatically added* to your data frame using the model output names and symbolised as below (the rec_sites and schools point layers have been added here for reference). ArcGIS should automatically symbolise increasing slope from green to red, and increasing distance from orange to blue, with values shown in the table of contents.

* If the datasets are not added, right-click the model outputs to ensure Add to Display is checked on. If it is on then try turning it off and back on, and save, and possibly Rerun the Entire Model. If you still have trouble then close the model and reopen with Edit, and Rerun the Entire Model.


Slope output map


Distance from recreation sites map


Distance from schools map

Note: If they still don't appear then you can try dragging them in from your scratch.gdb in Catalog, but this uses the source data name rather than the model output name, while symbology is likely to be stretched greyscale. To address the latter problem, open each layers Symbologies … and set Symbology as follows: ***Slope****> Symbology = Classified, Natural Breaks (Jenks), 9 classes, with a green to red colour ramp;* ***Distance****> Symbology = Classify, Equal Interval, 10 classes, with an orange to blue colour ramp. The key thing is to understand the process and resulting patterns, and recognise that the underlying values are correct for use in the final analysis.*

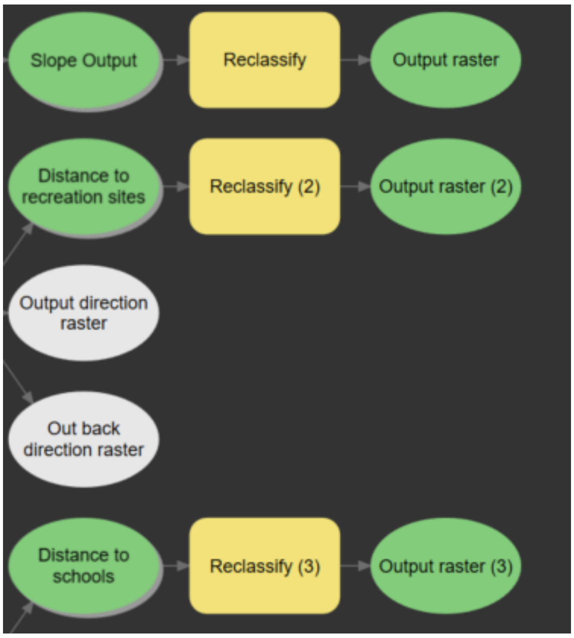
Slope > *Primary Symbology: Classify, Equal interval, Classes 11, colour scheme... Bronze??* ***Distance:*** *Primary symbology: stretch, colour ramp: green to red but like pastel.*

Reclassifying datasets

Deriving datasets such as slope and distance is the first step in building a suitability model. Each cell in your study area now has a value for each of the input criteria (slope, distance to recreation sites and schools, and land use).

The next step is to reclassify their values to a common measurement scale, giving cells an integer value ranging from 10 down to 1 where higher values indicate greater suitability, before combining them into a single output that highlights potential locations for a new school.

The next section of your model will look like the following:



Q6. Why reclassify to a common measurement scale?

Steps:

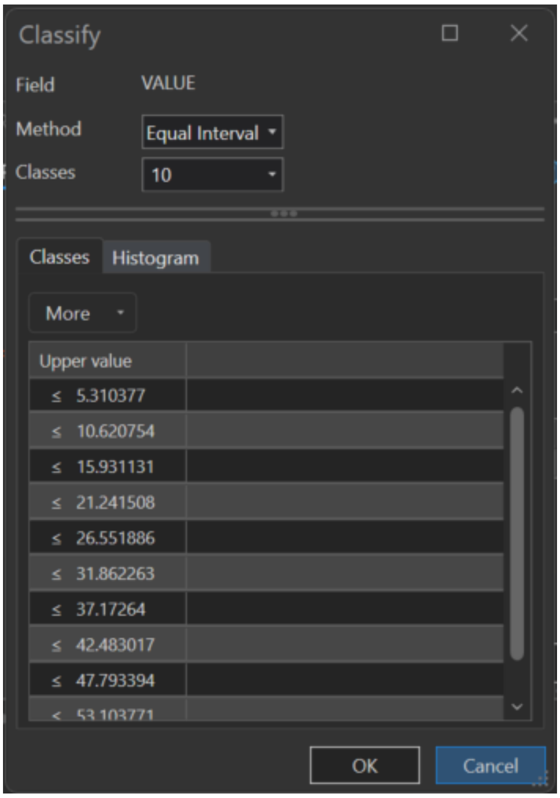
1. Search for the Reclassify (Spatial Analyst) tool and drag in to ModelBuilder in line with Slope Output. Add another Reclassify tool in line with Distance to recreation sites, and another in line with Distance to schools.
2. Connect the green 'slope output' 'Distance to recreation sites' and 'Distance to schools' outputs to the reclassify tools as the input rasters.
3. Click the Auto Layout button, then the Fit to Window button.

Reclassify slope

It is preferable that the new school site be located on relatively flat ground. You'll reclassify the slope output, assigning values of 10 to the most suitable range of slopes (i.e. those with the lowest angle of slope) down to 1 for the least suitable range of slopes (i.e. those with the steepest angle of slope).

Steps:

1. Open the orange Reclassify tool connected to the Slope Output variable.



2. Accept the default for the Reclass field parameter so the Value field will be used.
3. Click Classify.
4. Click the Method drop-down arrow and click Equal Interval.
5. Click the Classes drop-down arrow and click 10.
6. Click OK.
7. Click Reverse New Values to apply higher new values to old values of lower slope, since these areas are more suitable for building.

8. Change the Output raster name Reclass_Slop1 to Reclass_Slope.
9. Click OK.

Reclassify distance to recreation sites

The new school should be located as close as possible to recreational facilities. You will reclassify the distance to recreation sites by assigning values of 10 to the most suitable locations (i.e. areas closest to recreation sites) down to values of 1 for the least suitable locations (i.e. areas farthest from recreation sites).

Steps:

1. Open the Reclassify tool connected to the Distance to recreation sites variable.
2. Accept the default for the Reclass field parameter so the Value field will be used.
3. Click Classify.
4. Set the Method to Equal Interval and the number of Classes to 10.
5. Click OK.
6. Click Reverse New Values so that distances close to recreational facilities receive a higher new value, since these areas are deemed more suitable under this criterion.
7. Change the Output raster default name to Reclass_Recsites.

8. Click OK.

Reclassify distance to schools

The new school should be located as far from existing schools as possible to avoid encroaching on their catchment areas. You will reclassify the Distance to schools layer, assigning values of 10 to the most suitable locations (i.e. areas farthest from existing schools), and values of 1 to areas least suitable (i.e. near existing schools). By doing this, you will determine which areas are near and which areas are far from existing schools.

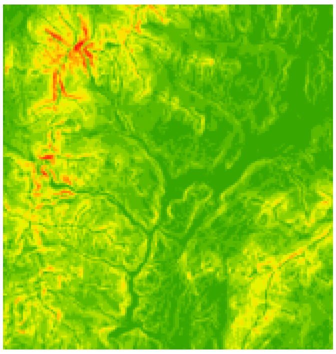
Steps:

1. Open the Reclassify tool connected to the Distance to schools variable.
2. Accept the default for the Reclass field parameter so the Value field will be used.
3. Click Classify.
4. Set the Method to Equal Interval and the number of Classes to 10.
5. Click OK. Unlike the previous two 'reclasses', you do not need to reverse the default new values, as locations farther away from existing schools are the most suitable.
6. Change the Output raster default name to Reclass_Schools.
7. Click OK.

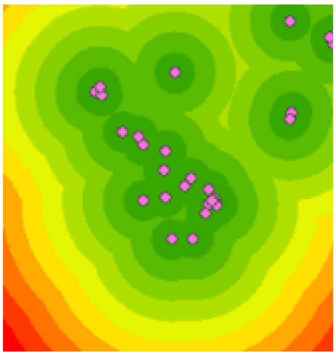
Executing Reclassify

Steps:

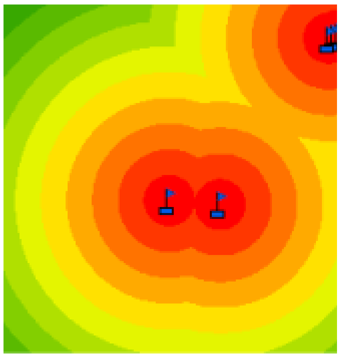
1. Right-click each of the Reclassify outputs and click Add To Display, then right-click again to Rename as Reclassed Slope, Reclassed RecSites, and Reclassed Schools.
2. Click the Run button to execute your model.
3. Examine the layers added to your data frame (if not added automatically, refer to * on page ~19-20).
4. The layers have integer values ranging from 1 to 10, which are likely to be symbolised using Unique Values and a randomised colour scheme. To aid visual interpretation of suitability based on red being least suitable and green being most suitable (as below), right-click each new layer to open its Symbology and change the Colour Scheme to a red to green colour ramp.



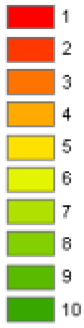
Reclassified slope



Reclassified distance to recreation sites



Reclassified distance to schools



Locations with low values (displayed in red) are less suitable than locations with high values (displayed in green).

Weighting and combining datasets

You are now ready to combine the datasets to find the most suitable locations to build a new school. If all the input datasets were equally important you could simply add them together to identify cells with the highest values. However, you have been instructed that proximity to recreational facilities is more important than distance from other schools, so you will use the Weighted Overlay tool to adjust the influence of the inputs as a percentage out of 100%. The higher the percentage value the greater the influence in the model.

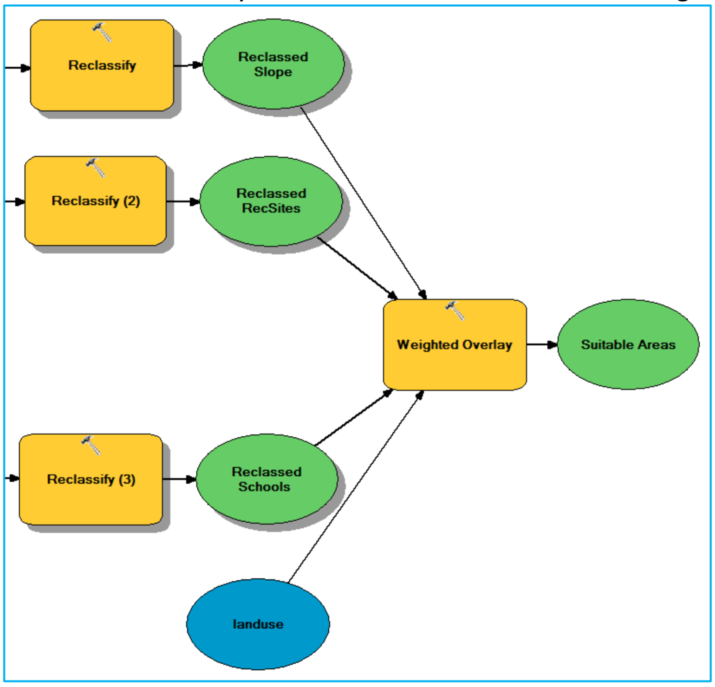
The reclassified datasets are in a common scale where higher values indicate higher suitability, while the landuse values represent a classification and will be given suitability values directly in the overlay process that follows. Cells that are completely unsuitable will be excluded by marking them as ‘restricted’ (e.g. slopes that are too steep for building, and water or wetlands).

Q7. Why weight the datasets?

You will assign the inputs the following percentages of influence:

- Reclassed distance to rec_sites: 50%
- Reclassed distance to schools: 25%
- Reclassed slope: 13%
- landuse: 12%

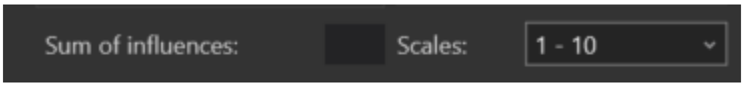
The next section of your model will look like the following:



Weighted Overlay

Steps:

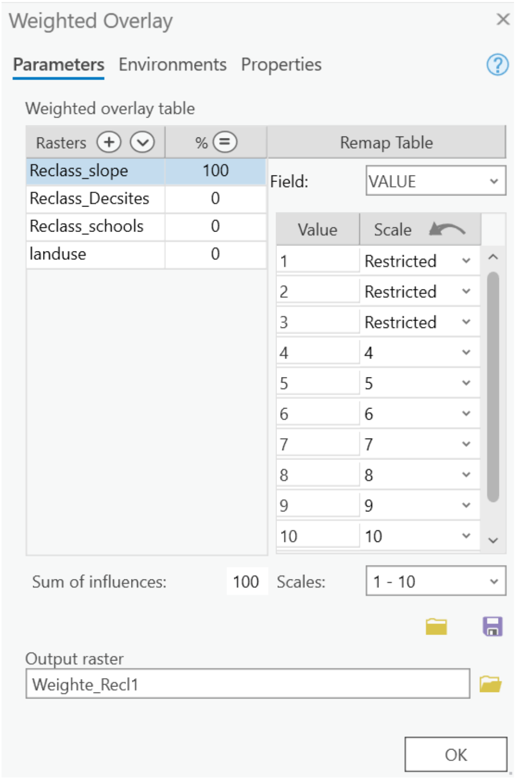
1. Search for the Weighted Overlay (Spatial Analyst) tool, and drag onto your model. Open the Weighted Overlay tool
2. The default evaluation scale is from 1 to 9 by 1. A scale of 1 to 10 was used when reclassifying datasets, so the first thing you need to do is set the scale from 1 to 10 by 1.



4. Add the reclassed Slope, Rec sites, and Schools to the Weighted Overlay tool as a weighted overlay table.

   The raster is added to the Weighted Overlay Table. The %Influence column is 100 because there is currently just one input; the Field column displays the values of the reclassified slope data; and the Scale Value column reflects these because the Evaluation scale was set to the same range of values in the input.

5. Repeat the previous step to add the blue reclassified recreation sites and schools model variables.
6. You want to exclude steep slopes from the output, even if all other conditions are ideal. You can do this by changing the reclassified slope Scale Value entries from 1 to 3 to ‘restricted’, since these values represent slopes above ~33 degrees (deemed too steep). For the Reclassed slope input, in the Scale Value column, very carefully click in the cell with a value of 1 – **DO NOT** click the arrow above this row and below Scale Value as this can scramble the other numbers and create unexpected results.
7. Click the drop-down arrow to the right of 1, scroll down and select Restricted.



8. Repeat to set the slope Scale Values of 2 and 3 to Restricted.

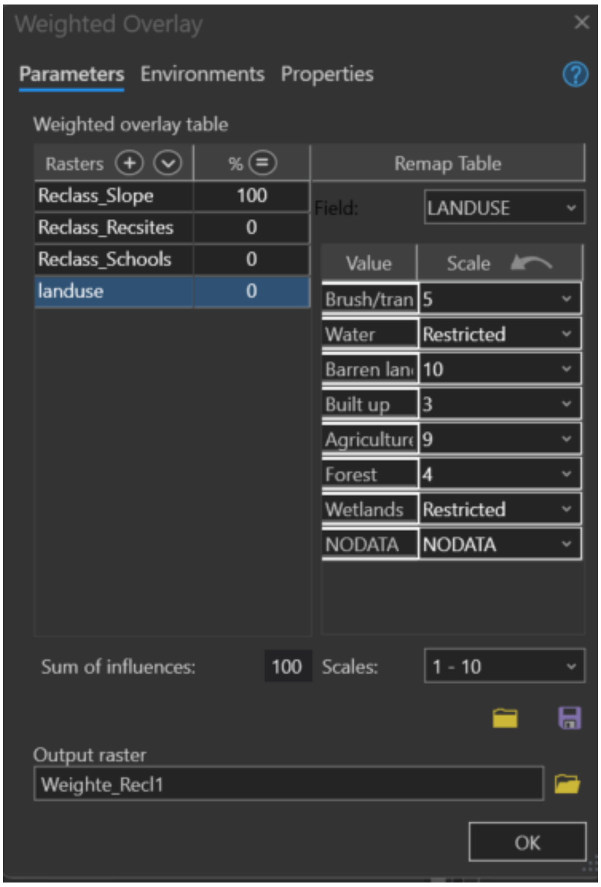
Dive-in: Setting a Scale Value to Restricted assigns a value to that cell in the output weighted overlay result that is the minimum value of the evaluation scale set minus 1 (zero in this task). If there are no inputs to the Weighted Overlay tool with cells of NoData, you could use NoData as the scale value to exclude certain values. However, if you have NoData cells in any of your inputs, it is safest to use Restricted. Potentially, a result from the Weighted Overlay tool could contain cells of NoData that have come from one or more of the inputs (NoData on any input equals NoData in the result) and restricted areas that you intentionally excluded. NoData and Restricted values should not be confused. Each serves a specific purpose. There may be areas of NoData for which you don't know the value but that are actually suitable areas. If you use NoData to exclude certain cell values and there is NoData in one or more inputs, you will not know whether a cell of NoData means the area is restricted from use or there was no input data available in that location.

9. Add the landuse layer and set the Input field to LANDUSE. You'll now set the landuse scale values to the same range used for the other inputs (i.e. 0-10), where higher values are more suitable.

10. Use the Weighted overlay table and set the Scale Values as follows:

- Brush/transitional = 5
- Barren land = 10
- Built up = 3
- Agriculture = 9
- Forest = 4

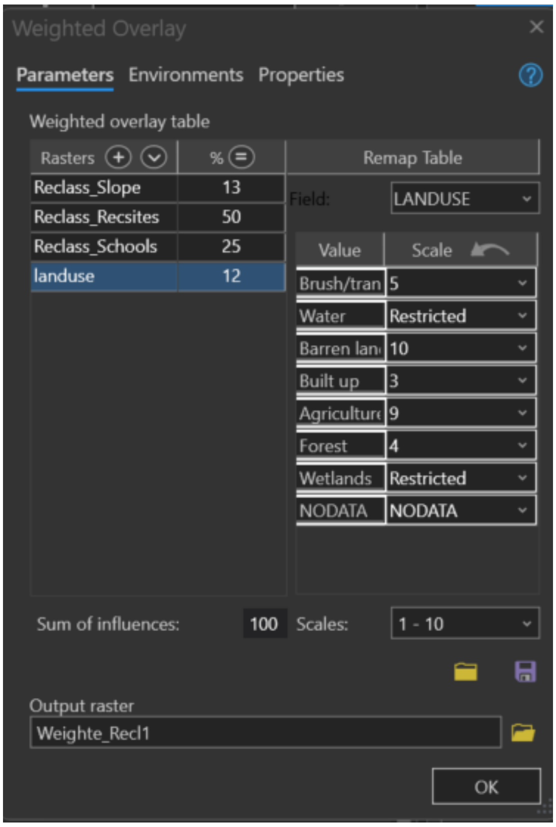
11. Water and Wetlands cannot be built on, so change them to Restricted.



12. You'll now weight each raster by assigning a percentage of influence on how much importance each should have in the final suitability map.

13. In the % Influence column, enter the following percentages for each input raster:

- Reclass Slope = 13
- Reclass Recsites = 50
- Reclass Schools = 25
- landuse = 12



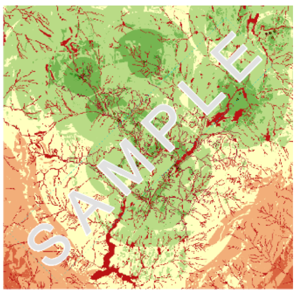
14. Accept the default for the Output raster name and click OK.

Executing Weighted Overlay

Steps:

1. In ModelBuilder click the Auto Layout button, then Fit to Window.
2. Right-click the output from the Weighted Overlay tool to Rename as Suitable Areas
3. Right-click the Suitable Areas variable and select Add To Display.
4. On the toolbar, click the Save button.
5. Run your model with Weighted Overlay.

Examine the layer added to your ArcGIS Pro display – by default it should look similar to, if not the same as, the graphic below (check the values and scale numbers match up for each layer in the weighted overlay tool). If not then try re-running the entire model, or save, close and reopen your map document and re-run. If that fails then try starting a new map document with elevation, landuse, rec_sites, and schools, then Edit… the model and run. Locations with higher values indicate more suitable sites, and the areas you marked as restricted have a value of zero.



Zoom this suitability layer to its full extent to capture and save it for your hand-in.

Once you have a working model you can easily change and re-run it to see what happens if you change the weightings (it also documents your workflow and can be used again or shared with others).

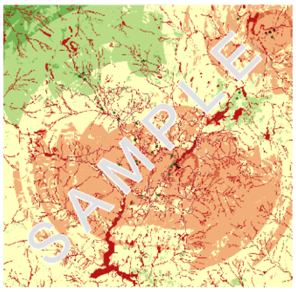
Let's say that you want to reverse the emphasis on proximity to recreation sites over distance from other schools. First, create a backup copy of your working model by right-clicking on it (i.e. the model) in your Catalog Home - Site Analysis Tools.tbx and selecting Copy, then right-click on the Site Analysis Tools.tbx and select Paste.

1. Open the yellow Weighted Overlay tool in your model and change the % Influence as follows:

- Reclassed distance to recreation sites = 25 (was 50)
- Reclassed distance to schools = 50 (was 25)
- Change the name of the Output Raster so that it doesn't over write your first output (add _v2 to its name).

2. Save the model and Run, which should just run from the point where you've made the change. The output should look similar to the graphic below.

   If you get ERROR 999999: Error executing function. The table already exists. No spatial reference exists. Failed to execute (Reclassify), then change the name of the output raster as in step 1 above and save and run.



Zoom this second suitability layer to its full extent to capture and save it for your hand-in.

Before closing your model and map document, export a graphic of your completed model for your hand-in, as a screenshot may be too low a resolution to be legible. Modelbuilder> Export> Export to Graphic>SVG (can then be converted to PNG) or PDF.

Finally

In your Learn quiz, be sure to select Finish attempt... and **'Submit all and finish'** so it is submitted for assessment.
