

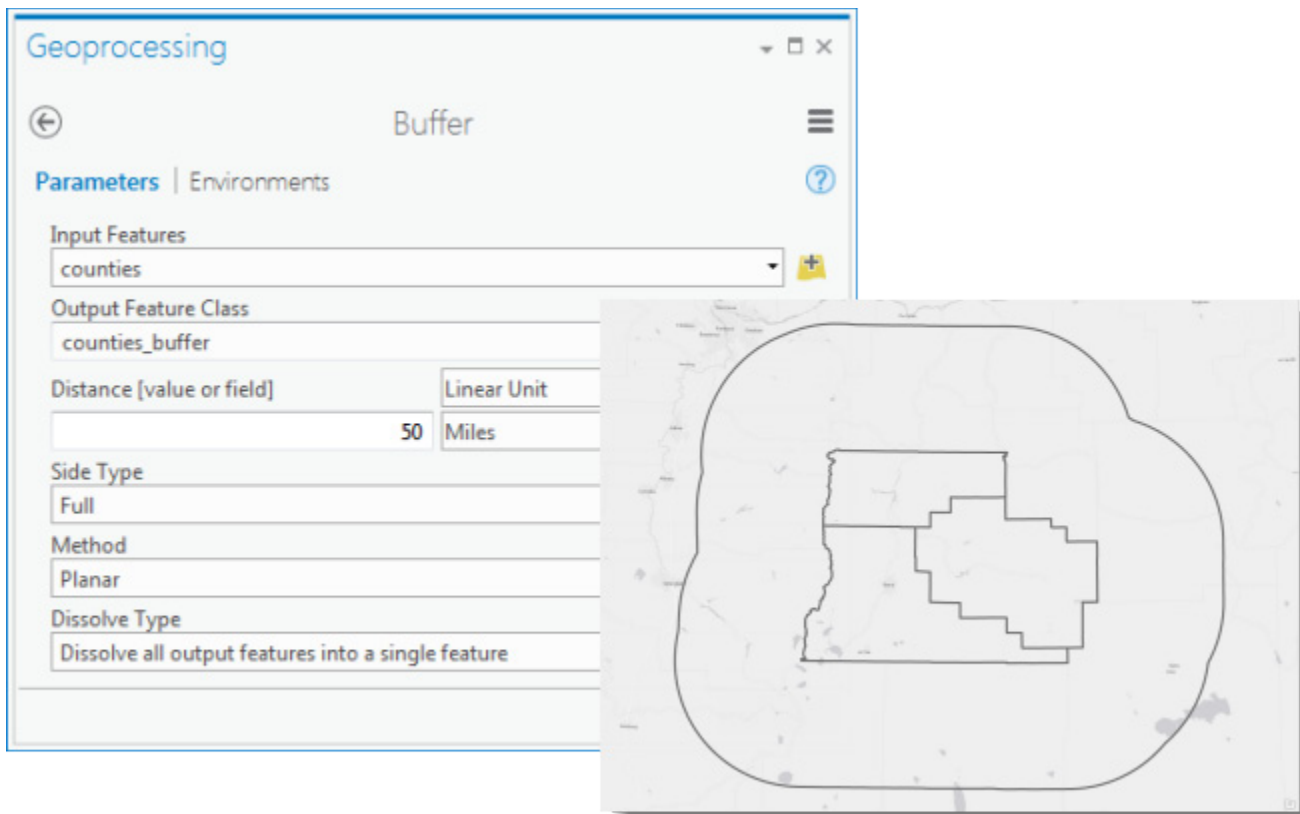
Where are the best locations for a golf resort?

An Esri Case Study Workflow using ArcGIS Pro

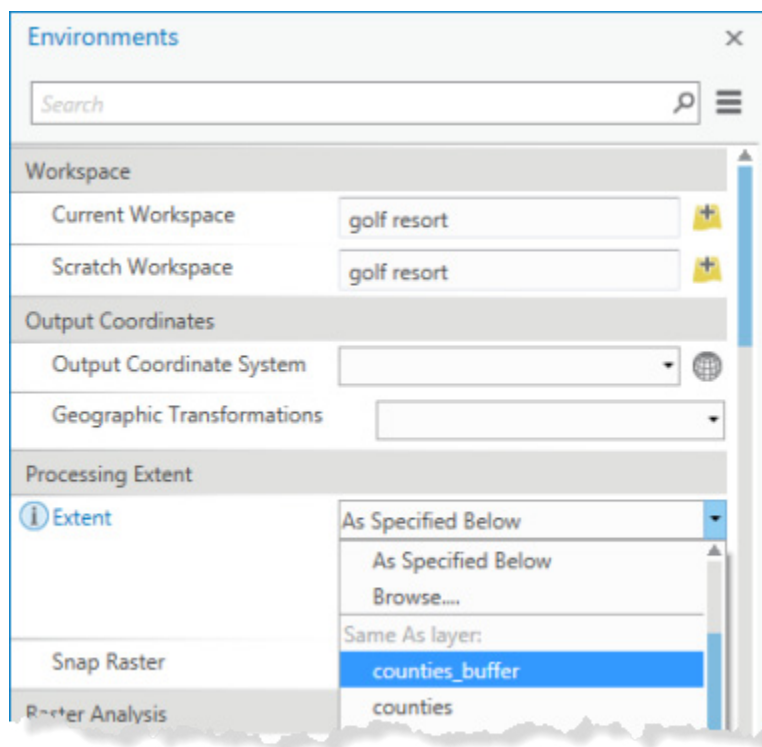
This workflow provides the steps necessary to complete the spatial analysis presented in the hypothetical case study “Where are the best locations for a golf resort?” A Spatial Analyst license is required to complete the workflow.

Set up the processing environment

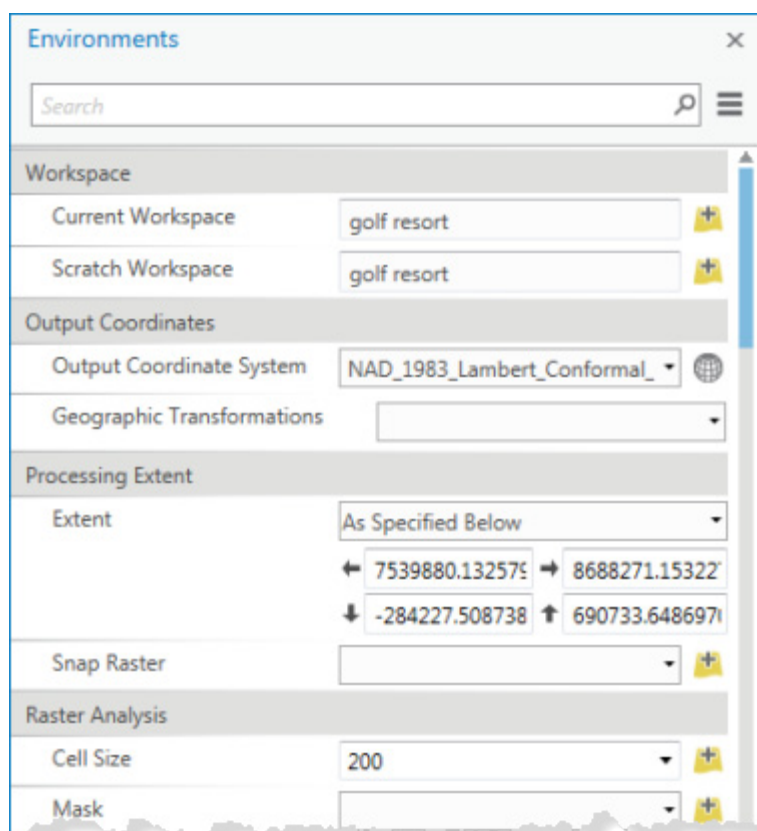
Create the 50-mile buffer around the three target counties. For Dissolve Type, specify Dissolve all output features into a single feature.



Open the Environments window in the Analysis ribbon tab and set the Processing Extent to the buffer layer, `counties_buffer`.



Then set the Output Coordinate System to be the same as the `land_cover` layer. The measurement units for this coordinate system are feet. Set the Cell Size to 200 (feet). Each cell in the raster layers you create will equal about an acre, which is appropriate for this scale of analysis (the regions that will be created are 1,500 acres in size). These steps aren't required since ArcGIS will automatically do all the transformations between coordinate systems and will use a default cell size, but making these settings explicit will make it easier to keep track of which coordinate system and which measurement units you are working with as you progress through the workflow. Your environment settings should look something like this (the Processing Extent coordinates may vary slightly).



Create the criteria layers

Now you can start processing the source layers to create the layers corresponding to each criteria.

Landscape variety

Reclassify the land cover layer into 5 categories, per the table below.

Open Water	1
Deciduous Forest	2
Evergreen Forest	2
Mixed Forest	2
Shrub/Scrub	3
Herbaceous	3
Hay/Pasture	4
Cultivated Crops	4
Woody Wetlands	5
Emergent Herbaceous Wetlands	5
All Other Categories	NODATA

The screenshot shows the 'Reclassify' tool in the ArcGIS Geoprocessing environment. The 'Input raster' is set to 'land_cover'. The 'Reclass field' is set to 'LAND_COVER'. The 'Reclassification' table is visible, showing the mapping of old values to new values. The 'Output raster' is set to 'land_cover_reclassify'. The 'Change missing values to NoData' checkbox is unchecked. The 'Run' button is at the bottom right.

Geoprocessing

Reclassify

Parameters | Environments

Input raster
land_cover

Reclass field
LAND_COVER

Reclassification

Value	New
Developed, Medium Intensity	NODATA
Developed, High Intensity	NODATA
Barren Land	NODATA
Deciduous Forest	2
Evergreen Forest	2
Mixed Forest	2
Shrub/Scrub	3
Herbaceous	3
Hay/Pasture	4
Cultivated Crops	4
Woody Wetlands	5
Emergent Herbaceous Wetlands	5
NODATA	NODATA

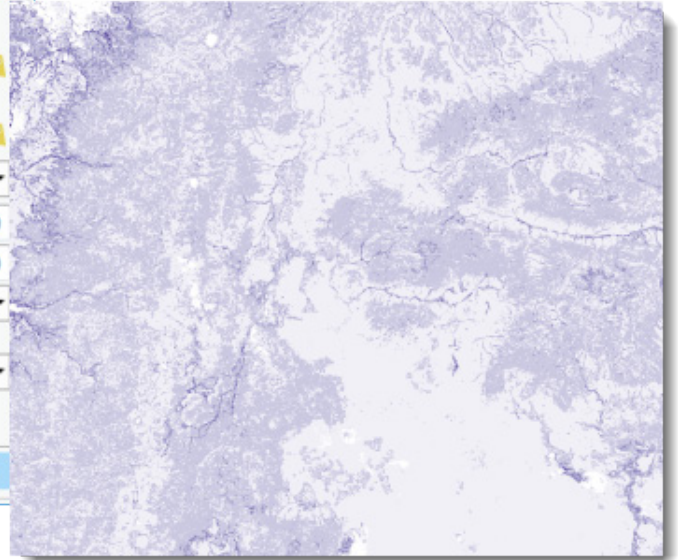
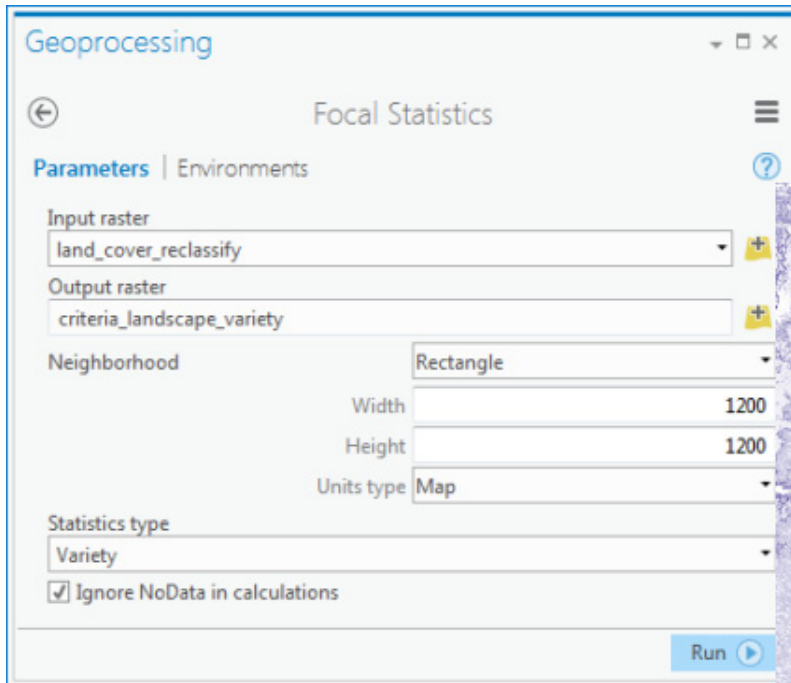
Unique Classify

Output raster
land_cover_reclassify

☐ Change missing values to NoData

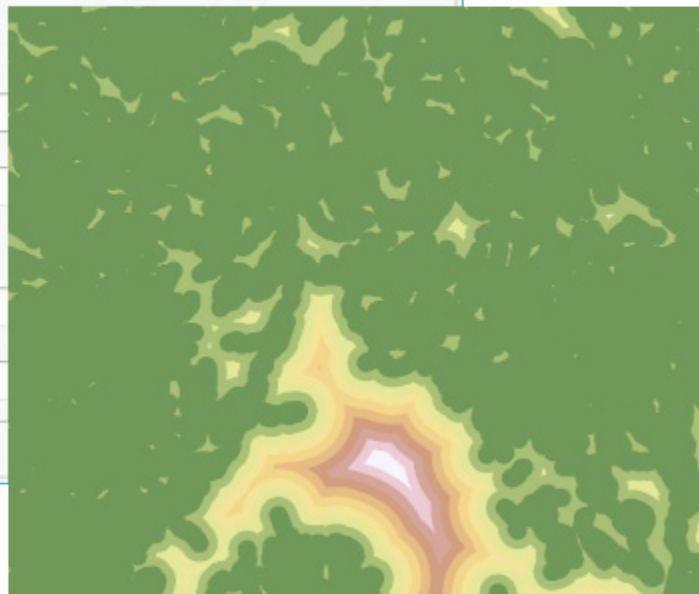
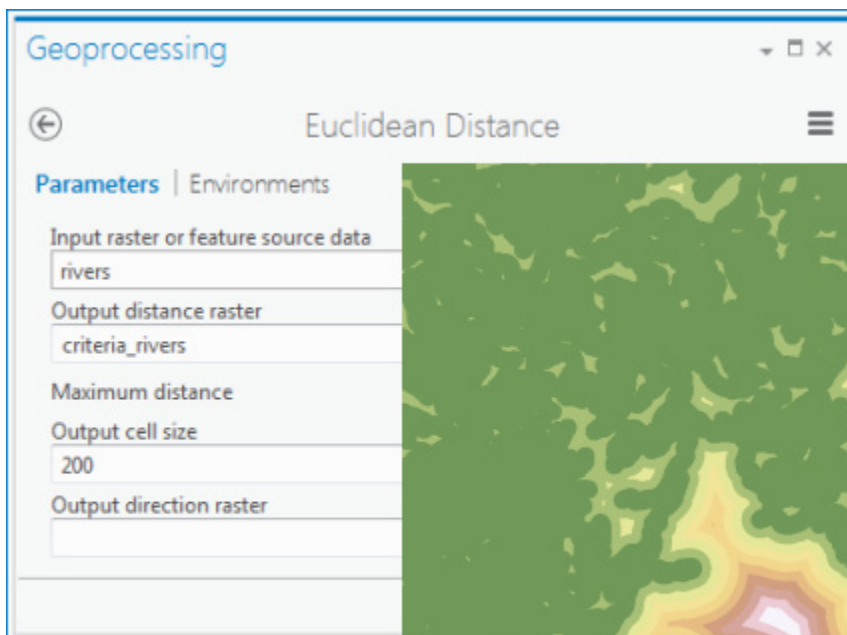
Run

Now run the Focal Statistics tool with the reclassified land cover layer. Specify a Neighborhood of 1200 x 1200 Map units (feet), and Variety as the statistic to calculate.



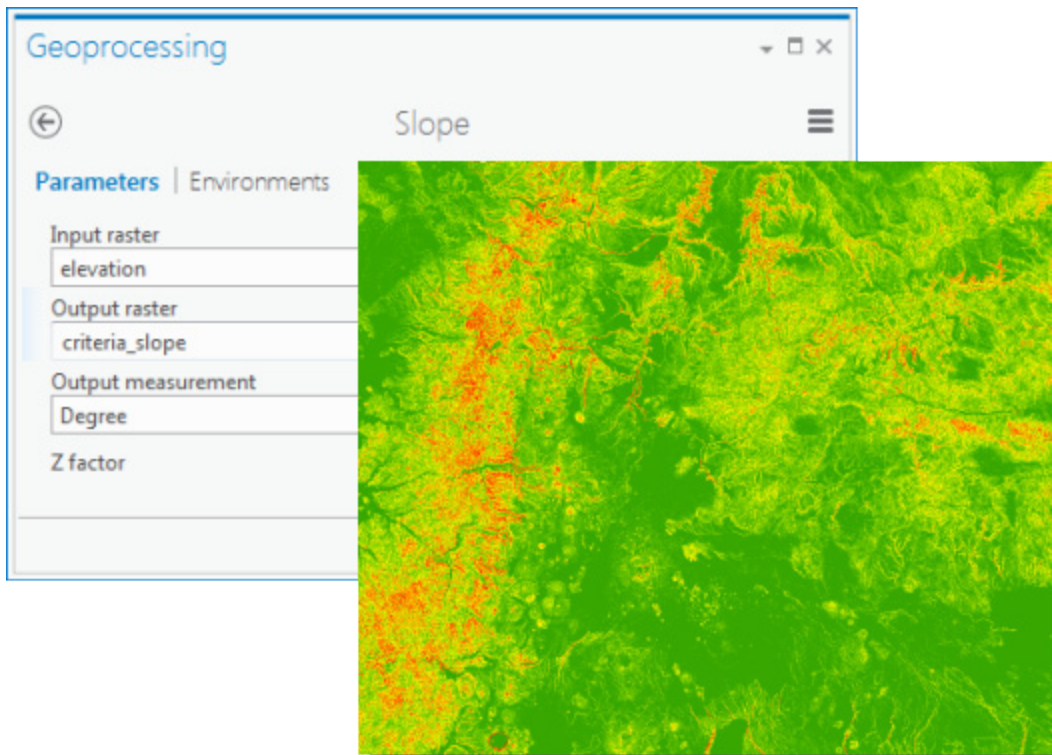
Distance from rivers

Run the Euclidean Distance tool with the rivers layer to create the distance from rivers surface.



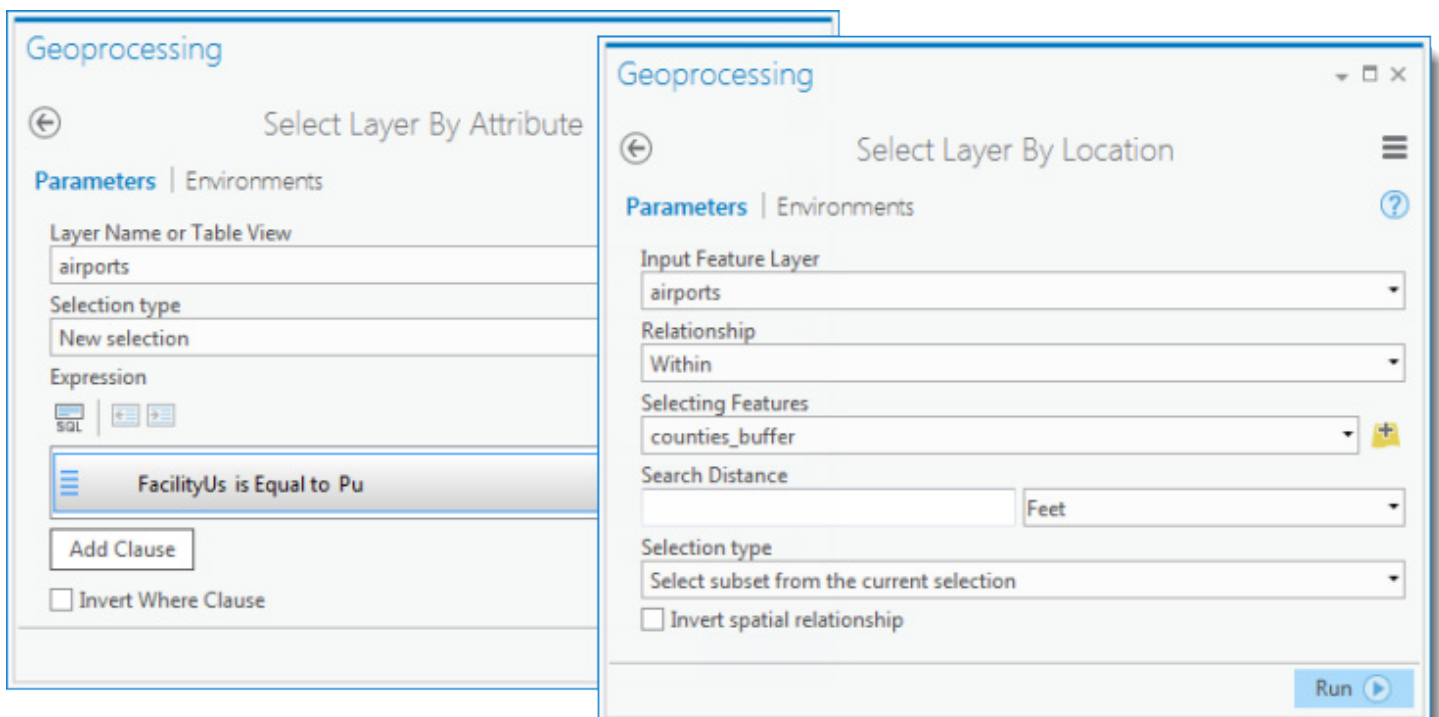
Slope

Run the Slope tool, using the Elevation layer as input. Use the default Output measurement (degrees) and Z factor (1).



Distance from airports

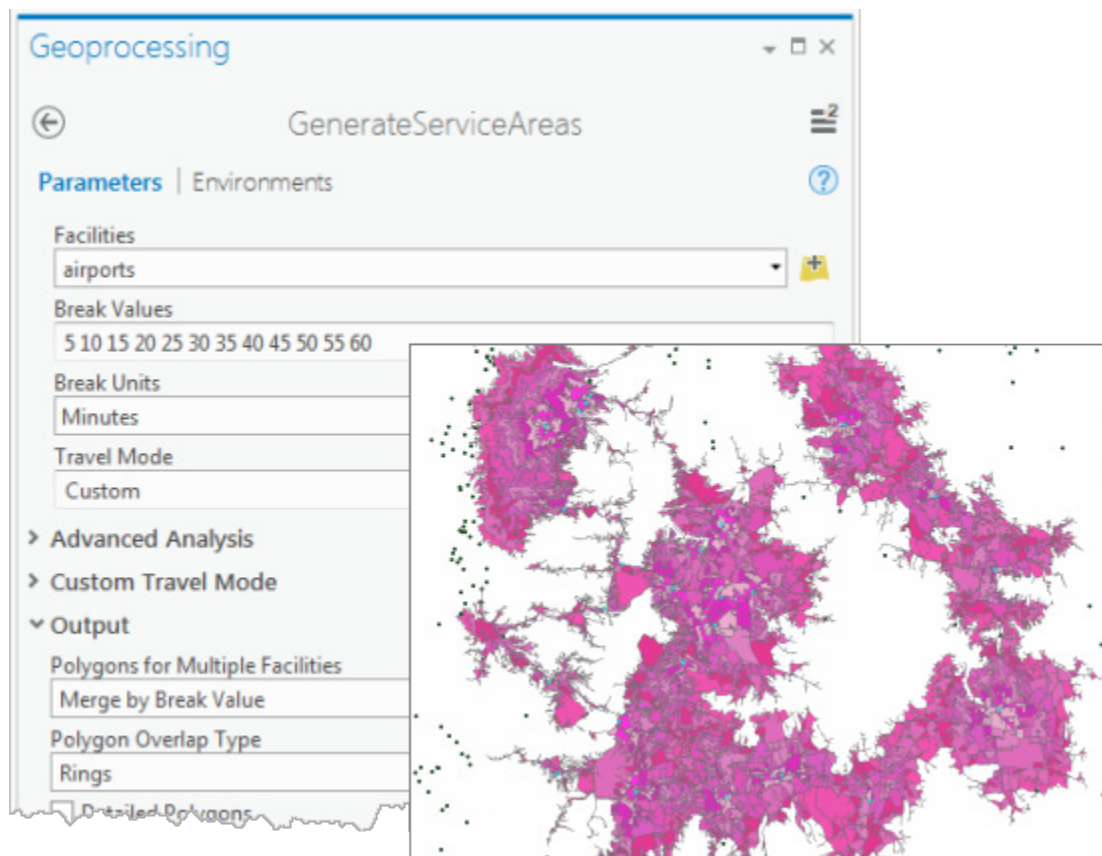
Use Select Layer By Attribute to select the public airports (FacilityUs is Pu). Then use Select Layer By Location to select the subset of these that are within the 50-mile county buffer.



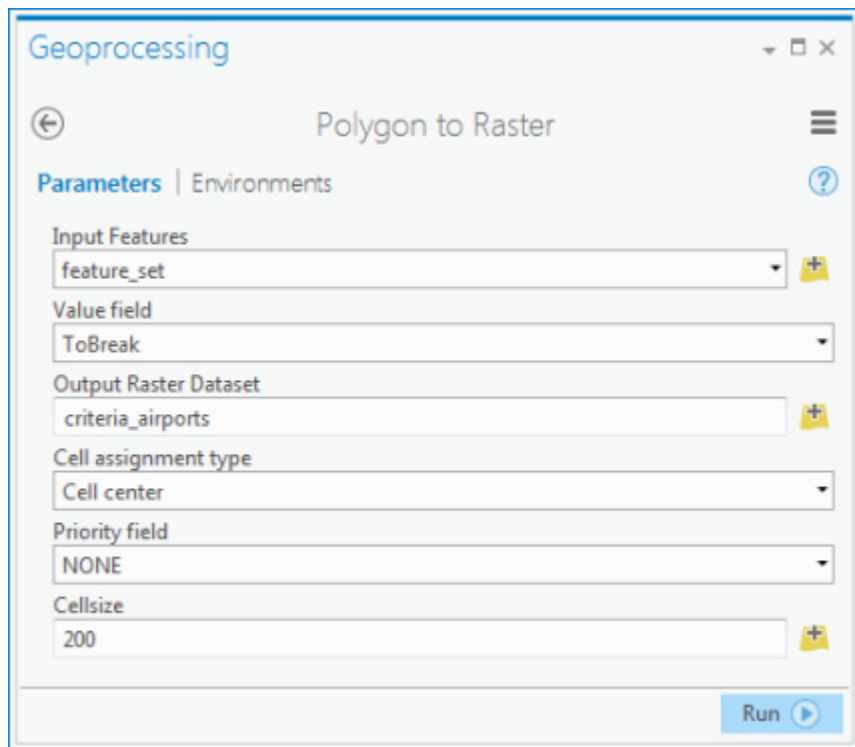
There should be 25 features selected. Next create the service areas around the selected airports. Open the GenerateServiceAreas tool by searching for it in the Geoprocessing pane (note that this Ready-To-Use tool consumes ArcGIS credits).

In the Generate Service Areas dialog, set the Facilities to airports and specify break values up to 60 minutes, in 5-minute increments. In the Output section of the dialog, under Polygons for Multiple Facilities, specify Merge by Break Value.

(The online street network dataset used by Generate Service Areas is updated twice a year. Changes in the street network data may result in slightly different service areas than shown here.)

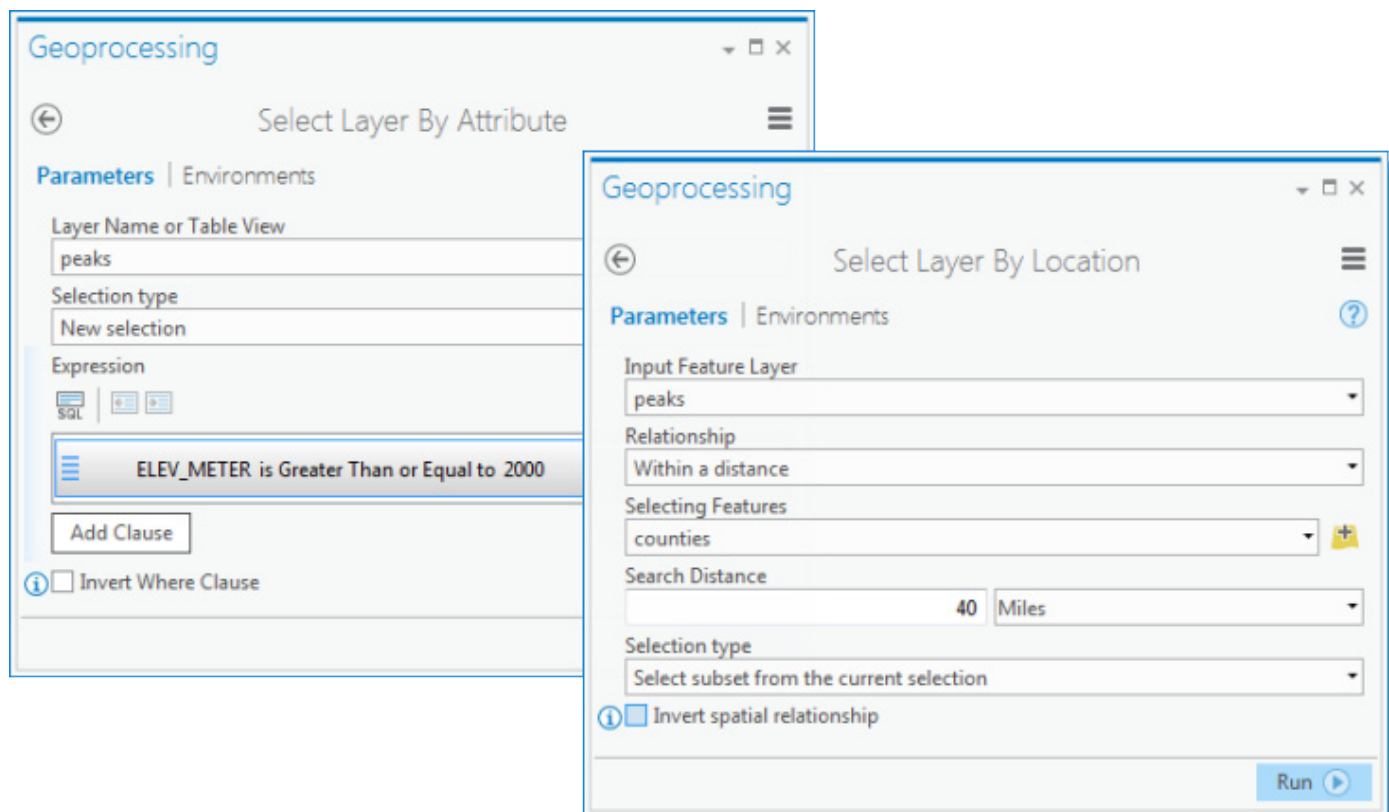


Finally, use Polygon to Raster to convert the service areas feature layer (named feature_set) to a raster layer. Set the Value field to ToBreak.

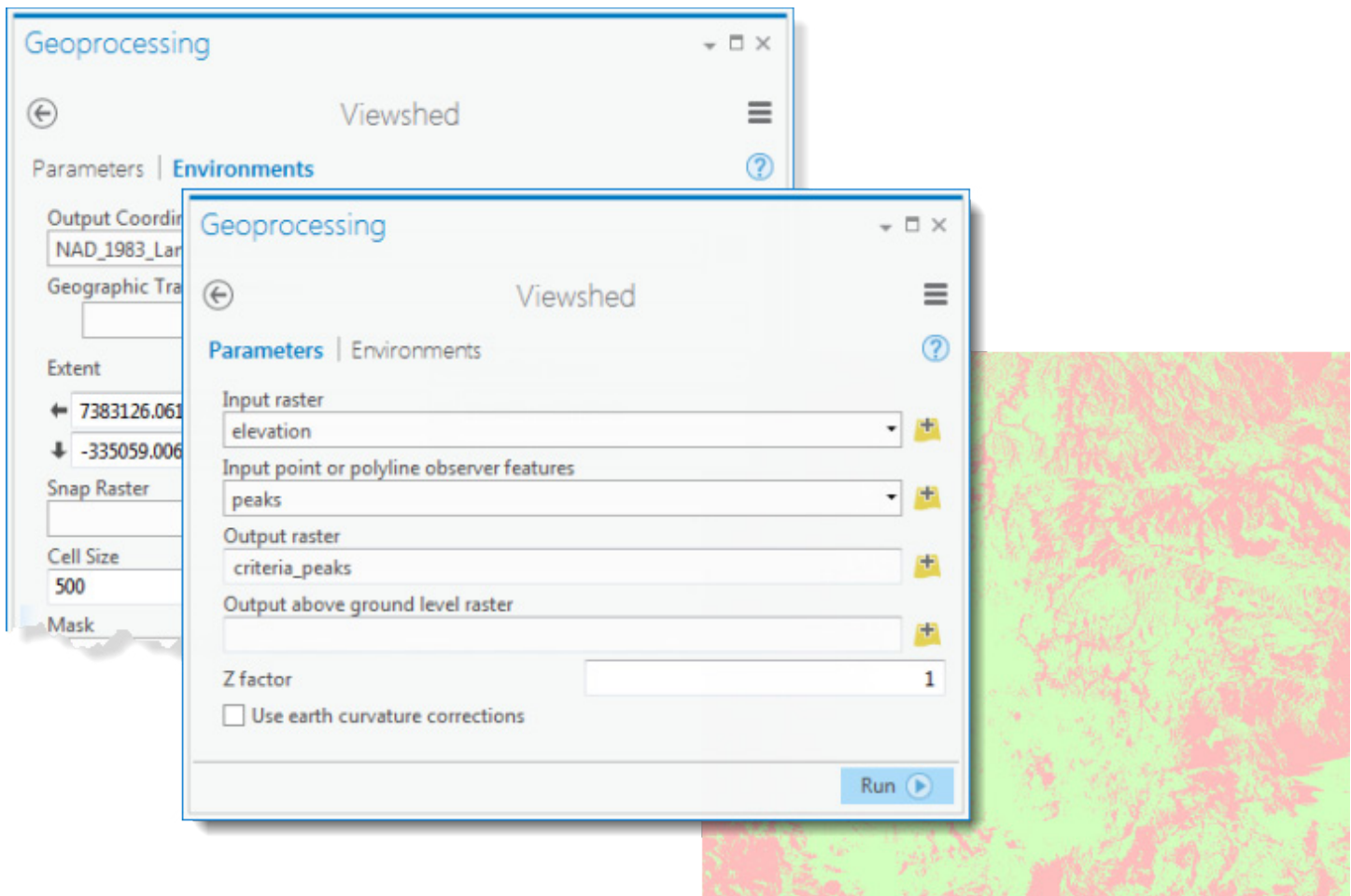


View of mountain peaks

Use Select Layer By Attribute followed by Select Layer By Location to select the peaks that are greater than or equal to 2000 meters elevation and are within 40 miles of the county borders (remember to set the Selection Type to Select subset from the current selection in the Select Layer By Location dialog).



There should be 97 features selected. Now use the Viewshed tool (in the Spatial Analyst toolset) with the elevation surface and the selected mountain peaks to create the surface of areas that have a view of at least one of the peaks. Creating a viewshed can take a while, since figuring out which peaks are visible from each cell is pretty complex. To speed things up for this workflow, you can reduce the number of cells by setting the cell size for the output layer to 500 (feet). By setting the cell size in the tool dialog (on the Environments tab) it will apply only to this layer—subsequent rasters that are created will continue to use the 200-foot cell size. Once you've specified the settings on both the Environments and Parameters tabs, click Run.

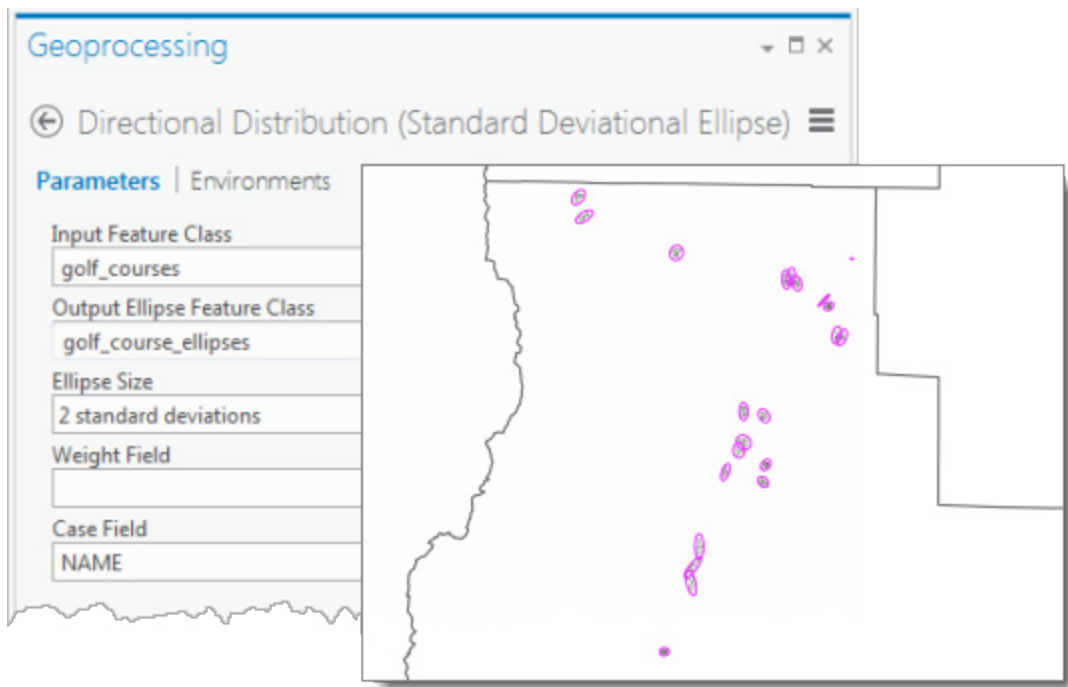


Create the suitability surface

The next part of the analysis involves creating suitability layers for each of the criteria—using a scale of 5 (most suitable) to 1 (least suitable)—and then combining the suitability layers to create the overall suitability surface.

Calculate statistics for distance from rivers and distance from airports

In the case study, the GIS analysts used existing golf courses to calculate statistics for distance from rivers and airports. They believed that evaluating existing conditions would help them refine the suitability criteria for the proposed course. To calculate the statistics, first use the Directional Distribution tool to create ellipses around the existing golf courses. Set the Ellipse Size to 2 standard deviations and the Case Field to Name (so an ellipse will be created for each golf course). You may get a warning about the spatial reference of the input layer and another warning that there are too few features for one of the ellipses—you can ignore these for this analysis.



Then use the Zonal Statistics as Table tool with the distance from rivers layer (criteria_rivers) to calculate the mean distance from a river for the area within each ellipse (your results may vary slightly).

	OBJECTID	NAME	ZONE_CODE	COUNT	AREA	MIN	MAX	RANGE	MEAN
1	1	ASPEN LAKES GOLF COURSE	1	945	37800000	3605.55127	9929.75293	6324.20166	6564.6575
2	2	AWBREY GLEN GOLF COURSE	2	753	30120000	0	5517.245605	5517.245605	2549.89546
3	3	BEND GOLF & COUNTRY CLUB	3	505	20200000	4939.635742	9097.251953	4157.616211	7089.22330
4	4	BIG MEADOW GOLF COURSE	4	863	34520000	5122.499512	8768.124023	3645.624512	7007.71100
5	5	BROKEN TOP GOLF CLUB	5	1021	40840000	3224.903076	9055.384766	5830.481689	6306.6280
6	6	CROSSWATER GOLF COURSE	6	1143	45720000	0	4204.759277	4204.759277	1551.8970
7	7	EAGLE CREST CHALLENGE COURSE	7	771	29240000	721.110229	4866.200051	4145.099731	3033.43

Now run Zonal Statistics as Table again, using the ellipses and the distance from airports layer (criteria_airports).

Create the suitability layers

The landscape variety layer (criteria_landscape_variety) already has values of 5 to 1 (with 5 being best), so it is ready to go. The other criteria layers will need to be reclassified to use a scale of 5 to 1.

criteria_peaks

First up is the layer representing views of peaks (criteria_peaks). The table shows the existing values in the left column and the corresponding suitability values in the right column. For the End value, specify the highest value in the layer (the highest value in your layer may be slightly different—check the layer's attribute table to find the highest value).

1-71	5
0	1

The screenshot shows the 'Reclassify' tool in the Geoprocessing environment. The 'Input raster' is set to 'criteria_peaks'. The 'Reclass field' is set to 'Value'. The 'Reclassification' table is as follows:

Start	End	New
0	0	1
1	71	5
NODATA	NODATA	NODATA

Below the table, there are buttons for 'Unique', 'Classify', and 'Run'. The 'Output raster' is set to 'suitability_peaks'. There is a checkbox for 'Change missing values to NoData' which is currently unchecked.

Now reclassify the rest of the layers, using the tables below as a guide. For the highest value range, make sure to specify the End value that conforms to the highest value in the layer. For example, for slope, the highest range should have a Start value of 30 and an End value of 35.115326 (although your highest value may differ slightly).

criteria_slope

0-3	5
3-5	4
5-7	3
7-15	2
15-30	1
>30	No Data

criteria_rivers

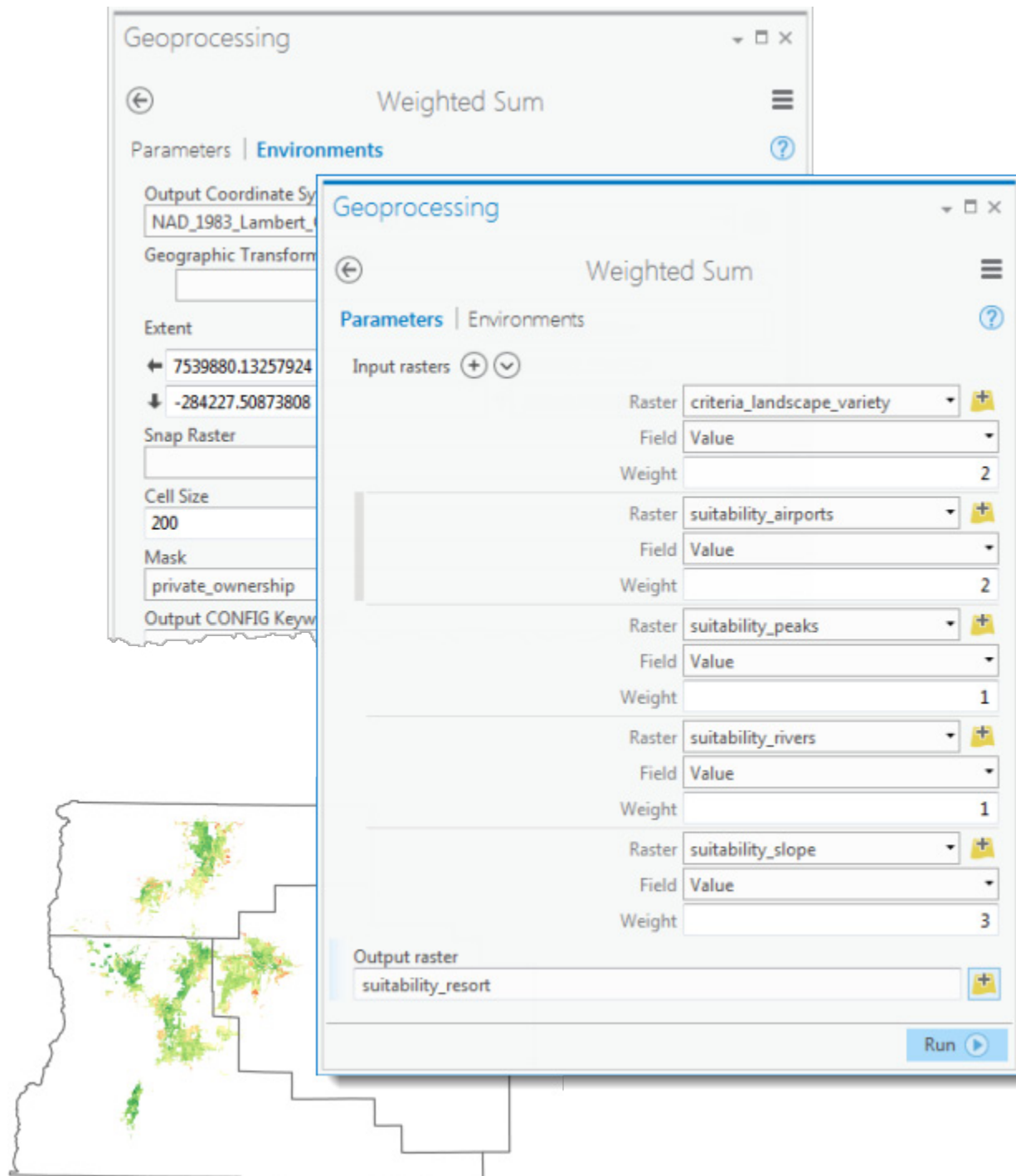
0-5280	5
5280-10560	3
>10560	1

criteria_airports

5-15	5
15-20	3
0-5	1
>20	No Data

Combine the suitability layers to create the suitability surface

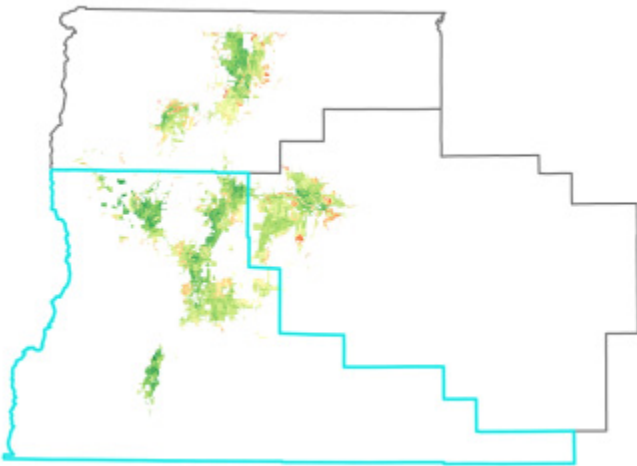
Combine the suitability layers using Weighted Sum to create the suitability surface for the three-county area. On the Environments tab, specify the private_ownership layer as the Mask so that any areas that are on public land will be excluded. On the Parameters tab, add the suitability layers and assign them weight values as shown in the dialog below.



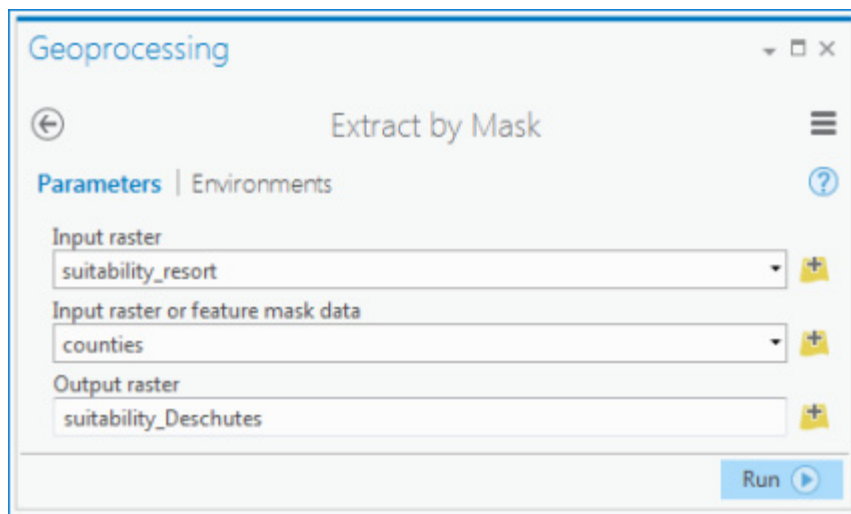
Verify the model with the existing golf courses

In the case study, the GIS analysts created regions to compare to the existing golf courses, in order to fine tune their analysis. This section shows you how to create and symbolize the features they used for the visual analysis.

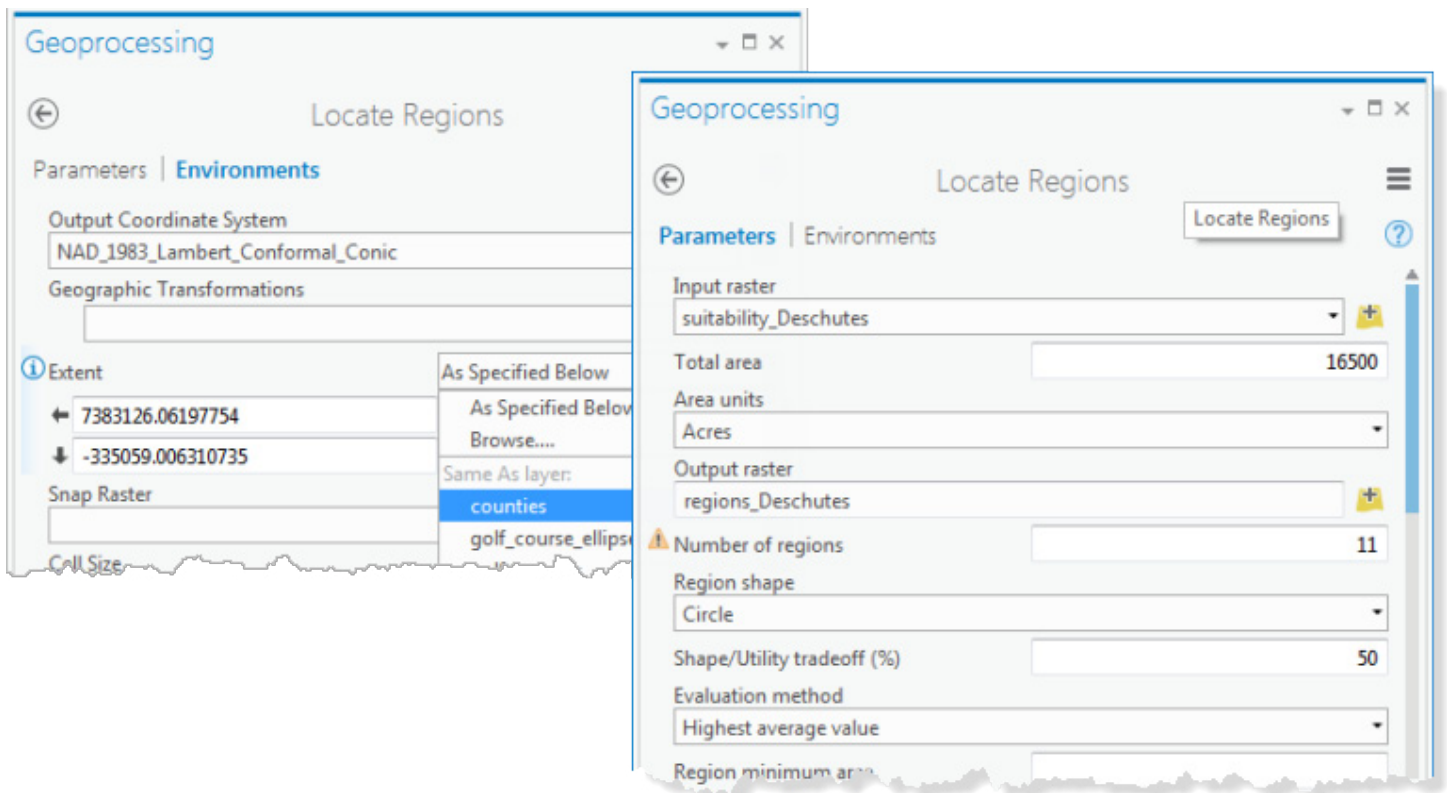
Extract the portion of the suitability surface within Deschutes county. This will ensure that when you run the Locate Regions tool, regions will be created only within this area. First, select Deschutes county using whichever method you prefer (there are at least three).



Then run Extract by Mask.



Now use the Locate Regions tool to identify the suitable areas. Locate Regions has a threshold on the minimum size of a region versus the overall area of the input raster (the suitability surface). To ensure the region size (1,500 acres, in this case) is above the threshold, reduce the processing extent. Setting it to the counties layer (on the Environments tab of the geoprocessing tool) will accomplish this. On the Parameters tab, set the input raster to be the suitability surface for Deschutes county. You want to create 11 regions, each 1500 acres in size (the size of the proposed resort). In Locate Regions you don't specify the region size explicitly. Instead, you specify the number of regions to create and the total area the regions will comprise. Set the Area units to acres, specify 11 for the Number of regions, and 16500 for the Total area ($11 \times 1500 = 16,500$). Use the default settings for the rest of the parameters.



To make it easier to see the regions, remove the symbol for value 0 (which is the rest of the suitability surface that was not chosen for a region).



In the case study, the analysts displayed the regions on top of the land cover layer to do a visual analysis. To easily see the land cover types within each region, convert the regions to polygons and display the polygon outlines. First, select the regions with Value greater than 0, then run Raster to Polygon. (You will end up with more than 11 polygons, because any diagonal cells at the edge of a region will become separate polygons, although they will still be identified as part of the region. This is not an issue for the visual analysis). Change the symbology to No Fill and specify a thick line for the outline.

Modify the input layers and run the analysis for the two target counties

To run the final analysis for the two target counties you'll use some of the same tools you used earlier.

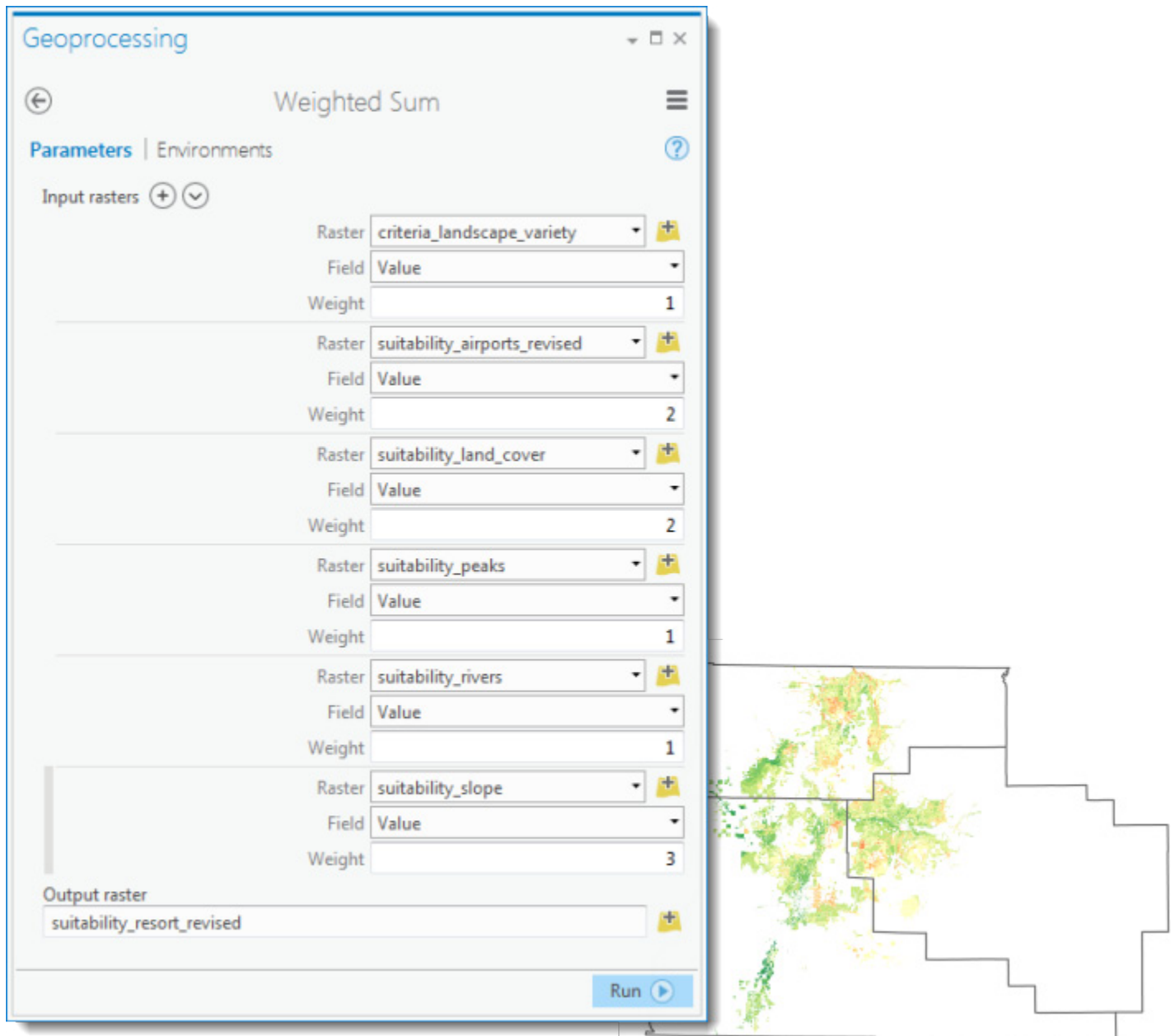
Reclassify the criteria_airports layer using the revised values, to create a new suitability layer (suitability_airports_revised).

10-20 min	5
20 – 35 min	3
5-10 min	1
0-5 min	No Data
>35 min	No Data

Create the new suitability_landcover layer by reclassifying the land_cover layer using the values in the table below.

Deciduous Forest	5
Evergreen Forest	5
Mixed Forest	5
Shrub/Scrub	3
Herbaceous	3
Hay/Pasture	3
Cultivated Crops	1
Woody Wetlands	1
Emergent Herbaceous Wetlands	1
All Other Categories	No Data

Use Weighted Sum to create the revised suitability layer (suitability_resort_revised), specifying the weight values shown in the dialog below. Remember to specify the private_ownership layer as the Mask on the Environments tab.



Select the two target counties (Jefferson and Crook), and use Extract by Mask to extract the portion of the revised suitability layer within those counties.

Finally, run Locate Regions to create the potential resort sites. Remember to set the counties layer as the Extent on the Environments tab, once again. On the Parameters tab specify the Input raster and set the units to Acres. This time, specify 7 regions, each 1500 acres in size.

Set the Region shape to Ellipse, and set the Shape/Utility Tradeoff to 40%. This gives a slight preference to suitability over shape—that is, a region can be slightly less elliptical if that results in a higher overall suitability value for the region.

Then, at the very bottom of the dialog, set the Region Selection Method to Sequential. This will rate the regions from most to least suitable, which is what you want since only one site will be selected. (The default setting of Combinatorial will create the set of regions that have the highest combined suitability. You'd use this method if, for example, you were finding the best locations for several habitat conservation areas.)

Once the regions are created you can change the symbology to use a green to red scheme to make it easier to see how each region is rated, from most suitable (a value of 1) to least suitable (a value of 7). Your final results may differ slightly given the values in your criteria and suitability layers.

