GEG 410 Geographic Information Systems II
Lab 2: Raster Analysis
Due: Tuesday, September 24, 2024, 11:59 pm

Lab Description

Land suitability analysis aims to evaluate the land's capability for specific uses based on certain conditions. When you analyze land suitability for housing, you may consider the slope, aspect, and certain land use type as your criteria of evaluation, i.e., how suitable a land area is. This lab will practice raster map algebra. Simple suitability models will be applied, while more complex models could be designed with additional analysis.

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Task 1: Suitability for PG County, MD

For this task, we will use the following suitability model:

$$Suitability = int(w_1 * Reclassified\ Slope + w_2 * Reclassified\ Aspect) * Reclassified\ Land\ Use$$

Where, w_1 and w_2 are weight parameters for slope and aspect only. We define that w_1 and w_2 must be between 0 and 1 (inclusive) and add up to 1.

Let's assume that $\boldsymbol{w_1}$**=0.5** and $\boldsymbol{w_2}$**=0.5**.

1.1 Prepare data

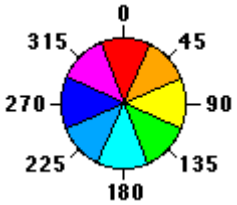
1. Download the zipped data folder from Blackboard and unzip it in your local drive. Add 2 raster datasets to your ArcGIS Pro project:

- **PG_DEM**: the DEM raster dataset for Prince George's County, MD, using UTM 18N coordinate system with a spatial resolution of 30 meters
- **PG_LandUse**: the land use map for Prince George's County, MD, also using UTM 18N coordinate system with a spatial resolution of 30 meters

1.2 Calculate slope and aspect from DEM

The **Slope** tool identifies the steepness at each cell of a raster surface. The lower the slope value, the flatter the terrain; the higher the slope value, the steeper the terrain. More information: https://pro.arcgis.com/en/pro-app/latest/tool-reference/spatial-analyst/how-slope-works.htm

The **Aspect** tool identifies the direction the downhill slope faces. The values of each cell in the output raster indicate the compass direction the surface faces at that location. It is measured clockwise in degrees from 0 (due north) to 360 (again due north), coming full circle. Flat areas having no downslope direction are given a value of -1. More information: https://pro.arcgis.com/en/pro-app/latest/tool-reference/spatial-analyst/how-aspect-works.htm



2. In the **Analysis** menu, click **Tools** to turn on the **Geoprocessing** pane (on the right).

3. Search for the **Slope** tool in the search box. Specify the **Input raster** to be **PG_DEM**, and specify the **Output raster** file path and name, e.g., **PG_Slope.tif**. Leave the rest as default.

4. Search for the **Aspect** tool in the search box. Specify the **Input raster** to be **PG_DEM**, and specify the **Output raster** file path and name, e.g., **PG_Aspect.tif**. Leave the rest as default.

1.3 Reclassify rasters

In many cases, we do not use the raw values (e.g., slope, aspect, and land use) directly – we need to pre-evaluate the values. Usually, we convert (also called Reclassify) the values into a rank. For example, the following table is how we reclassify the Slope values:

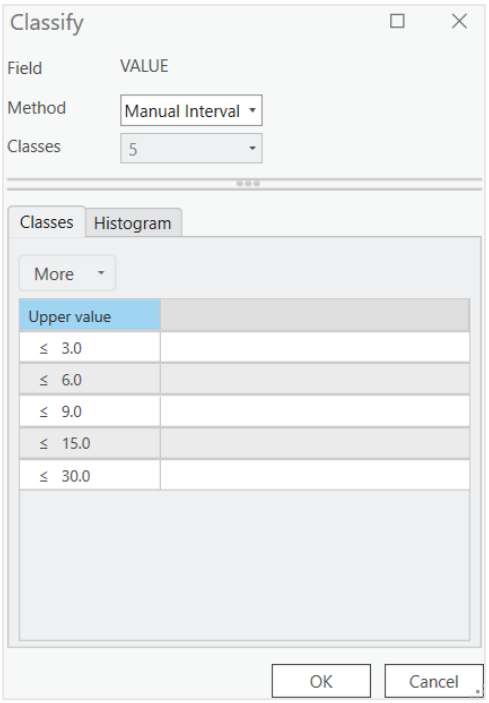
Table 1. Slope reclassification table.

Old slope value (degree)	New slope value (rank)
0 to 3	5
3 to 6	4
6 to 9	3
9 to 15	2
15 to 30	1

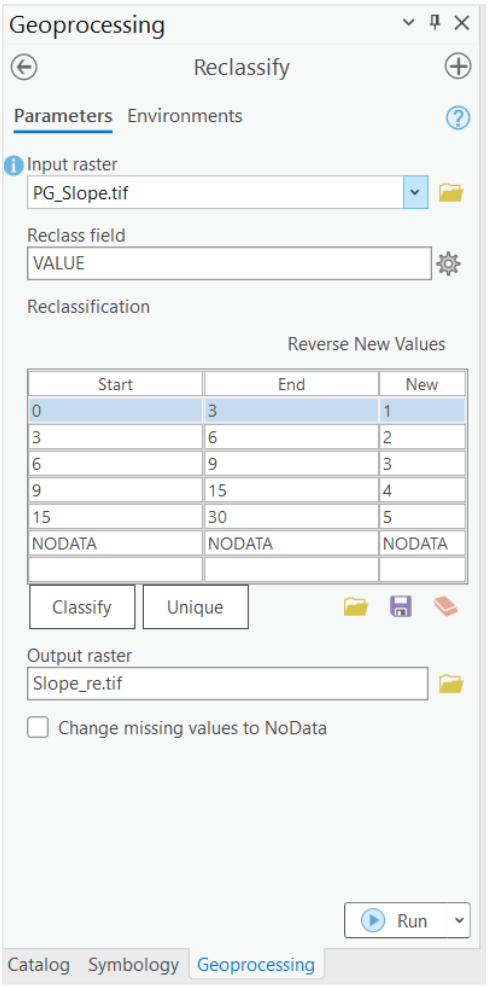
The column "Old slope value" has the slopes you calculated from the DEM raster dataset, and the "New slope value" is the rank you give to the old value. For example, the first row means that slopes between 0 and 3 degrees are given ranks 5, which is the highest value because you may prefer building houses on a flat surface. In fact, the new values can be considered how suitable a slope is for housing.

5. In the **Geoprocessing** pane, search for the **Reclassify** tool.

6. In the **Reclassify** tool, specify the **Input raster** to be **PG_Slope**. Click the **Classify** button under the reclassification table, and specify the classification schemes based on Table 1:



7. Click **OK** in the **Classify** dialog. Specify the **Output raster** file path and name, e.g., **Slope_re.tif**. Finally, click **Run**.



8. Repeat to use the Reclassify tool to reclassify the aspect based on the table below.

Table 2. Aspect reclassification table.

Old aspect value (degree)	New aspect value (rank)
-1 to 0 (Flat)	5
0 to 45 (North)	1
45 to 135 (East)	3
135 to 225 (South)	5
225 to 315 (West)	3
315 to 360 (North)	1

9. Repeat to use the Reclassify tool to reclassify the land use values based on the table below.

Table 3. Land use reclassification table.

Old land use code value	New land value (rank)
21, 31, 52, 71	1
All others	0

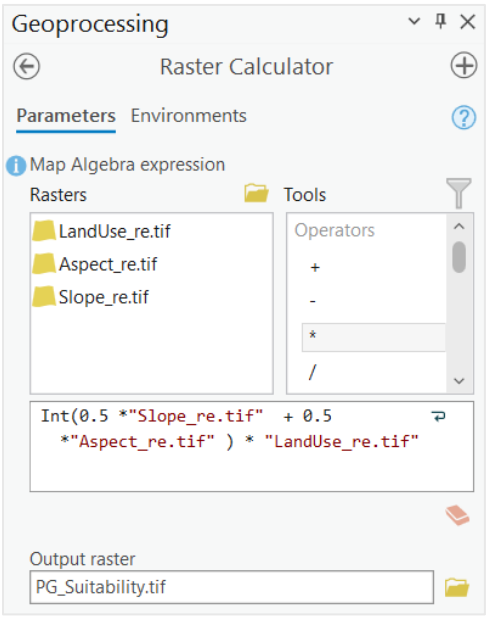
Note: the old land use values – 21 (Developed, open space), 31 (Bare land), 52 (Shrub/scrub), and 71 (Herbaceous).

*Hint: for the **PG_LandUse** dataset, which has discrete values, you can use the **Unique** button in the **Reclassify** tool. Please pay attention that ArcGIS Pro sometimes has a tiny bug that the new values you type in the reclassification table may be lost. So please make sure your old values and new values are correct before running the Reclassify tool.*

1.4 Run the suitability model

10. In the **Geoprocessing** pane, search for the **Raster Calculator** tool.

11. Follow the screenshot below to complete the Map Algebra expression box based on the suitability model equation (that we saw at the beginning of the task).

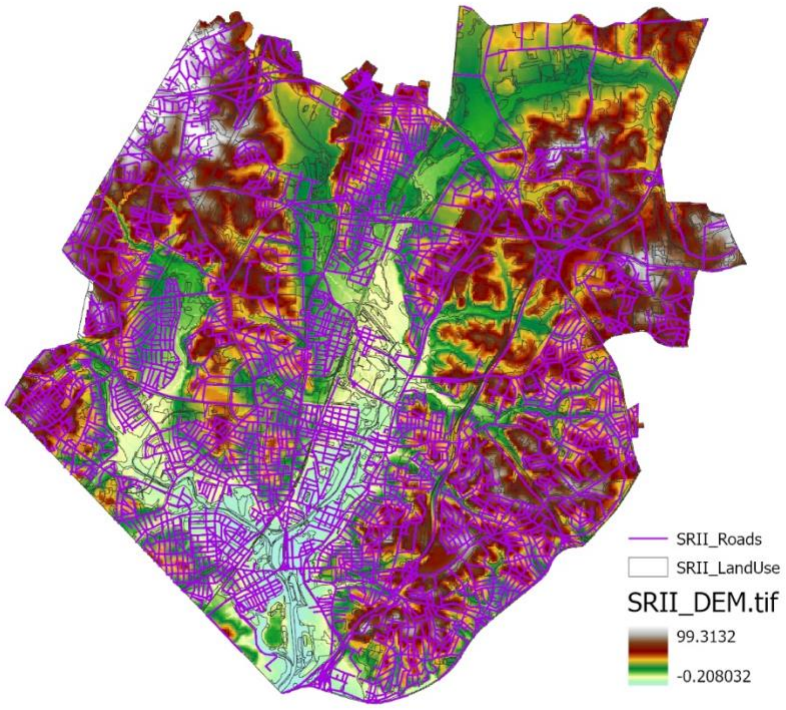


Assignment
Make a map for the final suitability rankings.

Task 2: Suitability for Sub Region II, PG County, MD

In the data folder, there are 3 datasets for **Sub Region II, PG County, MD**, which represent another situation of data collection:

- **SRII_DEM.tif**: the DEM dataset for Sub Region II, using NAD 1983 UTM Zone 18N with a spatial resolution of 30 meter
- **SRII_LandUse.shp**: the land use map of Sub Region II, in a polygon shapefile format, using NAD 1983 UTM Zone 18N (the LU_CODE column represents the land use type codes)
- **SRII_Roads.shp**: the roads in Sub Region II, in a line shapefile format, using NAD 1983 UTM Zone 18N



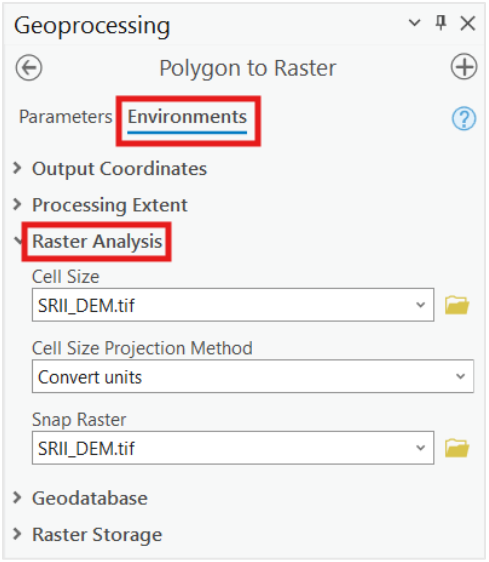
2.1 Convert polygon to raster

Since we will perform raster analysis to evaluate the suitability for building houses in the region, the polygon shapefile of land use should be converted to raster first.

1. In the **Geoprocessing** pane, search for the **Polygon to Raster** tool.

2. Use **SRII_LandUse** as the **Input Features** and **LU_CODE** as the **Value field**.

3. Go to the **Environments** tab (right under the Polygon to Raster title), and in the **Raster Analysis** group, set the **Cell Size** to be the same as **SRII_DEM** and the **Snap Raster** to be **SRII_DEM** as well.



Note: setting the environments will make your output raster the same spatial extent as the DEM and the output cells will also have the same size and locations as the DEM layer.

Assignment
Make a map of the land use raster.

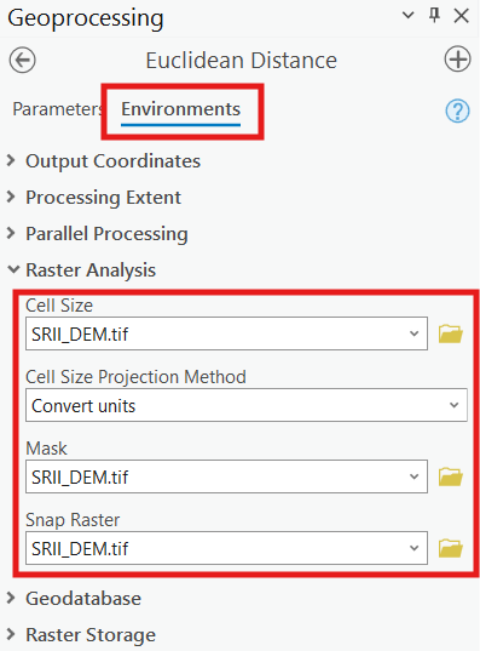
2.2 Calculate the Euclidean distances to the roads

The distance to roads is also one of the criteria of evaluation on how suitable the land is for building houses. Here we will create a raster to represent the distances to roads.

4. In the **Geoprocessing** pane, search for the **Euclidean Distance** tool.

5. Use the **SRII_Roads** as the **Input raster or feature source data**.

6. Similarly, we will also set the environment parameters for this operation. In the **Environment** tab, expand the **Raster Analysis** group, and set the **Cell Size**, **Mask**, and **Snap Raster** parameters to **SRII_DEM**.



Assignment
Make a map of the distance to roads raster.

2.3 Suitability modeling

Similar to Task 1, we will perform a suitability analysis using the raster datasets that we just created. A guideline for the steps is provided below (but without details).

7. Calculate the **Slope** and **Aspect** from the **SRII_DEM**.

8. **Reclassify** the slope, aspect, distance to roads, and land use based on the tables below:

Table 4. Reclassification slope table for Sub Region II.

Old slope value (degree)	New slope value (rank)
0 to 5	3
5 to 15	2
15 to 90	1

Table 5. Reclassification aspect table for Sub Region II.

Old aspect value (degree)	New aspect value (rank)
-1 to 45	1
45 to 135	2
135 to 225	3
225 to 315	2
315 to 360	1

Table 6. Reclassification land use code table for Sub Region II.

Old land use code value	New land value (rank)
18 (Open urban land)	1
73 (Bare ground)	1
All others	0

Table 7. Reclassification distance to roads table for Sub Region II.

Old distance value (meter)	New aspect value (rank)
0-200	4
200-400	3
400-600	2
600-800	1
800-1000	0

Note: This classification assumes the closer the land is to roads, the more suitable for housing. The maximum distance is arbitrarily given as 1,000 meters.

Assignment
Make 4 maps of the reclassification results.

9. Once you reclassified the ranks in Table 4 to Table 7, run the following suitability model using the **Raster Calculator** tool:

$$Suitability = (Reclassified\ Slope + Reclassified\ Aspect + Reclassified\ Distance\ to\ Roads) * Reclassified\ Land\ Use$$

Assignment
Make a map for the final suitability results.

Questions

Question 1 (10 points)

Include the final suitability map that you created in Task 1. And report the areas of each suitability class.

Note: When making maps, please make a formal map layout with necessary map elements, e.g., title, legend, etc., instead of taking screenshots of the ArcGIS Pro software.

Question 2 (10 points)

In Task 1, we assumed that w_1=0.5 and w_2=0.5. Please try another scenario that w_1=0.3 and w_2=0.7. Make a suitability map and report the areas of each suitability class.

Question 3 (15 points)

Include the maps that you were asked to create when you were doing Task 2 (highlighted in yellow). There should be 6 maps: land use map, distance to roads map, reclassified slope map, reclassified aspect map, reclassified distance to roads map, and reclassified land use map.

Question 4 (15 points)

Include the final suitability map for Task 2, and report the areas of each suitability class.

What to submit by Tuesday, September 24, 2024, 11:59 pm

- A report doc (Word, PDF, etc.) that has your answers to all the questions.