Landslide Analysis Unit 2: Calculating and Analyzing LSI Student Exercise

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*For this assignment you will be working in pairs, or groups to generate classification schemes and calculate landslide susceptibility index (LSI) values for different regions (unless instructed otherwise by your instructor). Your final product will be a brief presentation/discussion of what classifications were used, what LSI values were the strongest, and any differences in the factors favorability of landslides between the two regions.*

# Calculating LSI

## Setting Up your Map Document

You will want to make sure that your map document uses the following projection:

Arizona (UTM Zone 12N)

Puerto Rico (UTM Zone 19N)

Since these two regions have different projections, you will need to create and work in too separate map environments!

## Factors

You will be provided with one of the following factors: elevation, slope, aspect, mean annual precipitation (MAP), lithology, or landcover. These datasets have been preprocessed to have similar extents, and pixel sizes (necessary for Unit 3). All of these data are raster datasets with the exception of the lithology dataset (vector polygons), and can be found in the AZ\_Data, or PR\_Data folders. The instructions are the same for all factors except for the lithology dataset. Lithology specific instructions have been highlighted with BLUE text. NOTE: the lithology datasets are very dense and difficult to work with. Students with exceptional GIS skills and geology background would excel most at dealing with these datasets. Lithology may be disregarded at the discretion of the instructor. The instructions also include questions to encourage further understanding. Make sure you answer the questions!

## Factor Classification and Determining Ai and AT

The first phase towards calculating LSI values is to classify your dataset. Follow the instructions below. Make sure to save all reclassified data in a file geodatabase for ease of processing. Name the geodatabase something you will remember and associated with the project.

1. Decide if you require a quantitative, or qualitative analysis.
   1. What factor were you assigned?
   2. Will this require a quantitative, or qualitative analysis? Why?
2. Come up with at least two classification schemes to test for each region (they may require different schemes!). If you are doing a quantitative classification, use natural jenks as one of the two schemes. Describe and justify why you chose the classifications that you did below. Which of the two classifications will result in the highest LSI value? Which classification will have the greatest range? Here are some helpful hints!
   1. Elevation, slope, and MAP: Think about how these factors are related to mass movements. What sort of mechanisms of slope failure (gravity, critical angle, or water content) do they influence? Use this to guide your classifications.
   2. Landcover: The dataset for Puerto Rico and Arizona were sourced differently, and therefore have different codes referring to similar things. Use the landcover code classification spreadsheets when approaching this data. Think about similar landcover types and perhaps classifying them together. Do you need a few, or many classifications? Create a new attribute field called “Class” (short integer) in the raster attribute table and in editor mode type in the class value for landcover codes you wish to lump together.
   3. Aspect: Sometimes thinking about regional geography is helpful in classifying aspect. Will slopes facing specific directions have more, or less, likelihood of failing (rainy vs rain shadow side of mountains). Consider more than 4 classifications. REMEMBER: the values for aspect are 0°-359°, so think cyclically. North is typically 315°-359° and 0°-45°, whereas south is 135°-225°.
   4. Lithology: Consider how the strength of materials might affect the likelihood of slope failure. Think about weathering rates of different materials. How does crystal, or grain size affect weathering rates? How does chemical composition (felsic vs. mafic) affect weathering rates?
3. Apply the first of at least two classification schemes by accessing the symbology tab of the raster dataset. For the lithology dataset, you should create a new integer field in the attribute table of the dataset. Using **select by attribute**, select all the lithologic units that fall under the first grouping of your classification. With the **field calculator**, assign a value of ‘1’ for the selected units. Repeat this for the next grouping, assigning a value of ‘2’. Continue until all of your groupings have been assigned an integer identifier. Make note of what each integer represents! Once the scheme has been applied, use the **feature to raster** tool to generate a raster dataset. Use the field ID of the integer identifier. Make sure to save the raster as XX\_Lithology\_Trial#, where XX represents AZ or PR depending on region, and Trial# is the classification trial number. Make note of what classification corresponds to each trial!
4. Once the classification has been applied, use the **Reclassify** tool (make sure the spatial analyst extension is turned on!). Give a single integer value to the reclassification. For instance, a classification where the first grouping is from 0-23, might be assigned an integer of 1, 23-32 a 2, and so on until all the grouping are assigned an integer. NoData values should be assigned NoData. Make note of what each integer represents for your own records! Make sure to save the reclassified raster as XX\_Factor\_Trial#, where XX represents AZ or PR depending on region, and Trial# is the classification trial number. Replace the word ‘Factor’ with the name of the actual factor (elevation, MAP, etc.). Make note of what classification corresponds to each trial! NOTE: For those working on the landcover dataset, use the **LookUp** tool instead on the class field you created in step 2 in place of the **Reclassify** tool. Those working on the lithology dataset should ignore this step.
   1. NOTE: From the **Reclassify** tool, students can explore a variety of ways to apply classifications to the raster dataset.
5. Repeat steps 3 and 4 for the second (and so on) classification schemes. When completed, you should have raster datasets representing each classification scheme for the factor(s) you were assigned.

## Calculating LSI

1. Unzip the LSI\_Calculation folder to a location specified by your instructor, or to the folder all of the project data is being stored in. If this has been done for you by your instructor, skip this step.
2. From the catalog in ArcMap, navigate to the LSI Calculation toolbox.
3. Expand the toolbox and make sure there is a script called “LSI”.
4. Right click the script and select “Edit”.
   1. Look through the annotated script to understand how the tool works.
   2. Draw a schematic workflow of the input/output datasets and processes involved in the tool below. Essentially create a visual representation of what the tool is accomplishing.
5. To calculate the LSI for each class in your reclassified raster(s) double click the script in the toolbox. Make sure the workspace you select has enough space. Save the output as XX\_LSI\_Factor\_#, where XX is the region, Factor is a four-letter abbreviation of the factor used, and # is the trial number. The tool may take some time to process depending on computer hardware, but when complete should output a raster into the workspace folder with the given name. The LSI values are 1,000x their actual value because of how the code works, so keep this in mind!
   1. You may want to apply some new color scheme if the auto-generated color scheme is not to your liking.
6. How we want to match the predicted LSI to each class. To do this, we use the **Combine** tool. Input your reclassified raster from step 4 in the prior section as well as your output LSI from step 5 above. Save the raster as XX\_LSI\_FactorC#, where XX represents the region, Factor is a four-letter abbreviation of the factor used, and # is the trial number. The C represents ‘combined’. The ouput raster will spatially join the classified regions to their respective LSI values.
7. For each classification scheme (and region if applicable), generate a table of LSImin, LSImax, LSIrange, and LSIst.dev, much like the statewide Arizona LSI data you previewed before. Make sure to give the actual LSI value and not the value x 1,000!
8. In your pair/group, discuss the implications of your results, and what they mean in regards to the favorability of areas for slope failure. Take notes of key points below:
9. In addition to the tables you have created in excel, generate maps/images of each factor with a legend, north arrow, title, and scale bar.

# Presenting Your Results

As a final summative assessment for this unit, your group will create a brief presentation to present to the class. Your presentation should include the following elements:

1. A title that reflects what factor and region(s) your group was responsible for.
2. Group members’ names.
3. How the factor likely relates to the favorability of mass movements. What failure mechanisms might this factor influence? What predictions would you make as to the LSI value (high positive, low positive, zero, low negative, high negative)? Why?
4. What classifications did you use for the first region? Why? Justify your use of the classification scheme(s) you deployed. What is your prediction as to which classification may result in the highest LSI values?
5. What were the LSI values for each classification type? Did this match your prediction? Why or why not? Include your LSI maps and an interpretation of what the geographic distribution might mean.
6. Which classification that you used would you recommend as the best to use in the first region?
7. Parts 4-6 should be repeated for the second region (if applicable). Comment on similarities and differences between the two regions.
8. At the end of your presentation, take an opportunity (one slide) to answer some reflective questions:
   1. What surprised you the most about going through the LSI analysis?
   2. What other factors might you want to consider?
   3. What is another area you would like to conduct similar experiments for, and why?

Your grade will be based on these described, and necessary components, but will also assess your oral presentation skills. For further information, refer to the Unit 2 summative rubric.