Raster Data: SF Bay SLR

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Datasets used: *Counties_UTM, NLCD_UTM, slr_sfbay_1.41m_jdr.tif, slr_sfbay_0.0m_jdr.tif*

Tools to use: *zonal statistics, reclassify, raster math (Minus), Raster to Polygon, Extract Raster by Mask*

Learning objectives

1. Internalize the difference between rasters and vectors, both in use and in origin
2. Become familiar with the NLCD
3. Utilize and apply new simple raster-specific tools

Lab Questions:

1. **What is the resolution of the NLCD raster? SLR?**
2. **How many cells are there total in the NLCD layer? What percentage of the landscape is covered in open water vs. grassland/herbaceous vs. deciduous forest?** (percentage can be calculated outside of Arc using a calculator)
3. **What is the dominant land cover type by county (hint: some counties might share a dominant cover type)**
4. **What is the range of values in the SLR datasets, what do the areas of high values and lows mean?**
5. **How many cells are the difference? Use what you know about the size of a box to calculate the area. What is the area?**

Maps: A map with the difference between a 0.0 meter SLR scenario and a 1.4 meter SLR. Include an outline of the counties shapefile and one of the files with the NLDC data.
Tools: 2 tools with descriptions

----------Lab Starts Here------- ----------

Section I. Set up map document with data

1. DOWNLOAD AND COPY THE LAB DATA FOLDER FROM GOOGLE DRIVE TO YOUR PERSONAL FOLDER ON THE Z: DRIVE
    a. Once your files are added, you can check where they came from with the source viewer in the table of contents
    b. 

2. Start your map:
    a. File ❼ Map document properties ❼ store relative pathnames to data sources
    b. Add your data files

i. Note the raster symbol in ArcGIS vs. raster (point, line, polygon)

c. Check out the different layers – notice that they are clipped to different extents…this will influence what you can analyze…

3. SAVE YOUR MAP!!!

Section II. Zonal Statistics and NLCD in Bay Counties

4. Investigate the rasters for the lab

Q1: What is the resolution of the NLCD raster? SLR?

i. *NLCD_UTM*: layer properties -> 'Source' -> 'Cell size'

ii. Compare SLR: layer properties -> 'Source' -> 'Cell size'

iii. OR zoom in and measure

5. Open the NLCD attribute table

a. RowID, VALUE, and COUNT, refer Value to TYPE ID on the right

Q2: How many cells are there total in the NLCD layer? What percentage of the landscape is covered in open water vs. grassland/herbaceous vs. deciduous forest? (percentage can be calculated outside of Arc using a calculator)

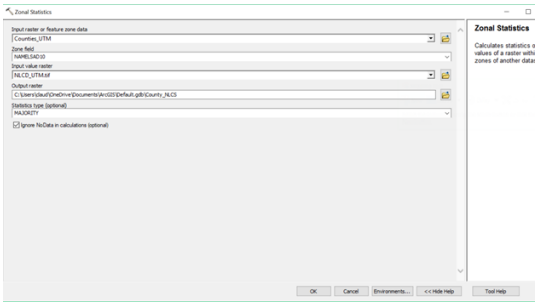
b. *Note:* NLCD data definitions can be found on the website: https://www.mrlc.gov/data/legends/national-land-cover-database-2011-nlcd2011-legend

i. 'Column Statistics' for 'COUNT to see the sum of the values

ii. Note that the column statistics only calculates statistics for highlighted values – use this to your advantage for the last part of this question!

- BUT be sure to clear your selection when you're done so you don't mess up future analyses

6. Now let's figure out the dominant cover type by county using 'Zonal Statistics'



a. This tool can be a powerful way to extract values from raster dataset. Find it 'Spatial Analyst' -> 'Zonal' -> 'Zonal Statistic'

i. Input feature: Counties_UTM

ii. Zone Field: NAMELSAD10 (This will be a field from the Counties_UTM attribute table. We will use the one for the County name to keep them counting counties

iii. Input Value Raster: NLCD_UTM.tif

iv. Set Statistics Type: Majority

b. Save it to a place you will remember and name it and then press 'OK'

if you get an error sign 'Customize' -> 'Extensions' -> and check the 'Spatial Analyst' box.

c. Now, click on the new layer and use the NLDC code to answer

Q3: What is the dominant land cover type by county (hint: some counties might share a dominant cover type)

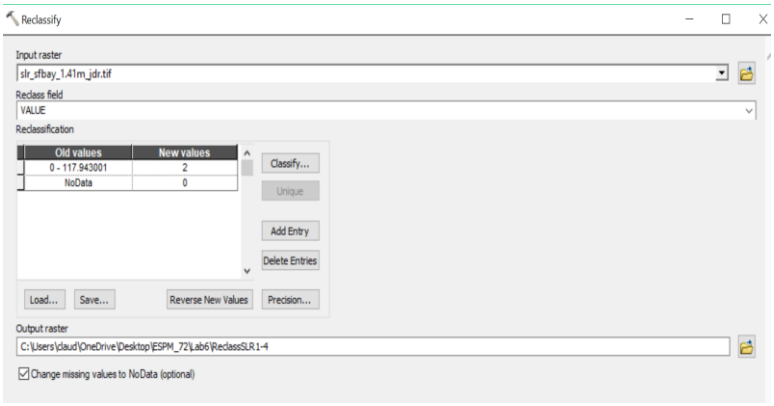
Section III. Reclassify & Raster Math

In this next section, we are interested in getting the difference in extent between the higher projection of SLR versus the lower SLR model. We will be diving into how to use 'reclassify' as a tool and raster math to do math functions on two raster layers. For this lab, we are using data from Cal-Adapt. If you are interested in reading about the data, click on the link to read about the modeling inputs and data resolution. You might notice that the layers were actually influenced by this paper for the California Energy Commission written by two Berkeley professors (cool!). The whole report is here too. Cal-Adapt is hosted by the GIF and is a great resource to keep in mind for data when exploring final projects (for this class or others).

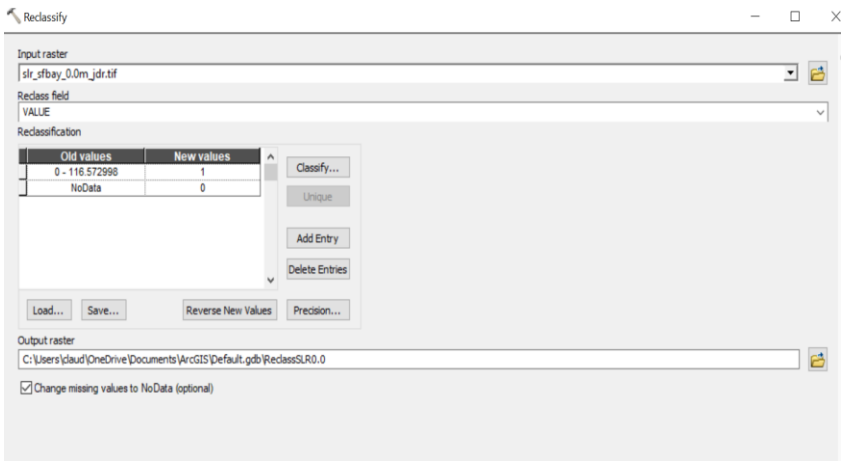
7. The two layers we will be using is the 0.0 and 1.4 meter Sea Level Rise (SLR) for the San Francisco Bay.
    a. Make sure these layers are turned on. Consider turning off the other layers (NLCD and Counties) if your computer is slow at drawing
        i. just unclick the box next to layers you aren't currently working in, no need to remove the layers we are not using
8. Change the symbology for these layers from the black and white default to a single color ramp
    a. This can help you understand the spread of values. Notice what high and low values mean.

Q4: What is the range of values in the two SLR datasets, what do the areas of high values and lows mean? (refer to metadata on Cal-Adapt if you are unsure)

9. For today's purposes, we are going to 'reclassify' both of our raster datasets to simplify the values to become a binary of the presence of SLR or absence. We are doing this to visualize the difference in an area inundated under different SLR scenarios with flooding.
10. Find the 'Reclassify' tool
    a. In toolbox, 'Spatial Analyst' -> 'Reclass' -> 'Reclassify'
11. For Input Raster: choose the slr_sfbay_1.41m_jdr.tif
    a. Reclass field: Value
    b. then click 'classify' and choose 1 class
    c. Then click on the 'new value' field and choose 2 for all of the values in the original dataset. Choose 0 for the 'NoData'
        i. This allows us to do raster math with the 0.0 m SLR raster that has a different extent

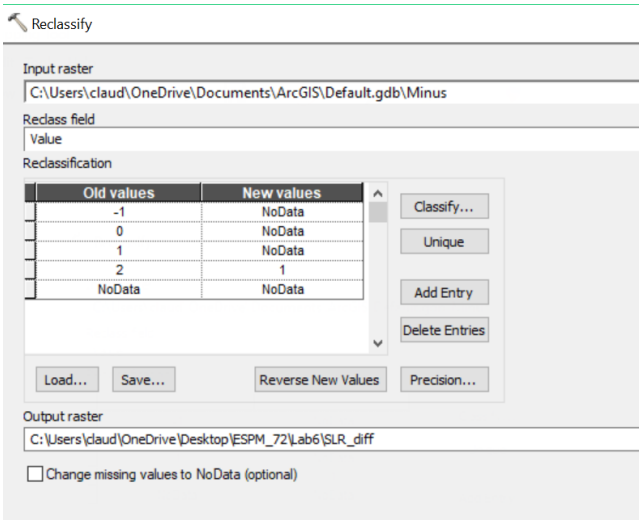


d. Save this in a place you can find
e. Click box next to 'Change missing values to NoData interval'
f. Click 'OK'
g. This tool can be a powerful way to extract values from raster dataset. Find it 'Spatial



12. Repeat the previous step of 'reclassify' with slr_sfbay_0.0m_jdr.tif
    a. **Important!** Instead of changing known values to 2, change everything except the NoData to values of 1
    b. your input should look like the image to the right

13. Next, we will use Raster Math to 'Minus' the two rasters we have created to get the difference in inundated land between the 1.4 and 0.0 meter Sea Level Rise
    a. Input raster 1: the simplified reclassified 1.4 SLR raster
    b. Input raster 2: the simplified reclassified 0.0 SLR raster
    c. Output raster: name this 'Minus'
14. Now we have an output that has four classes. Let's use 'reclassify' again to get this in a useable format: we are targeting the 1 values, think about what this means.
15. Open 'Reclassify' tool again
    a. Input: the 'Minus' layer
    b. Reclass field: Value
    c. New values: NoData (not the no spaces and capitalization) for all except the old value of 2
    d. A new value of 1 for all old values of 2
        i. Think about it, what is the old values of 2 we are limiting this raster to?
    e. name the file, save it to a navigable folder
    f. unclick the box next to 'Change missing values to NoData'
    g. click 'OK'

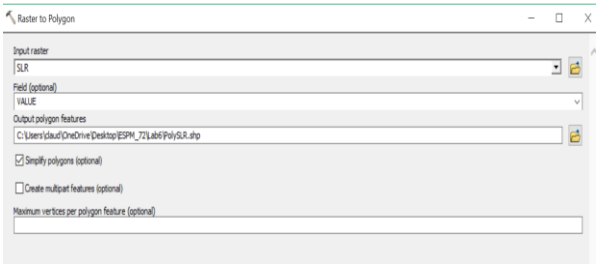


Q5: How many cells are the difference? Use what you know about the size of a box to calculate the area. What is the area?

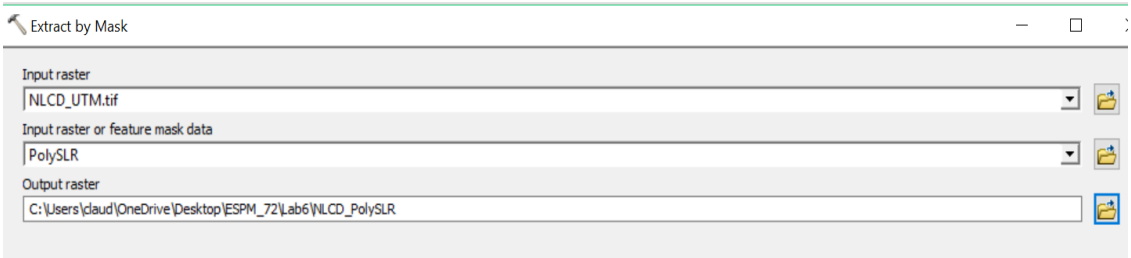
Section IV. Use differenced raster to find Land cover inundated

Now let's combine the rater we created from the difference of SLR scenarios and the NLCD to determine exactly what types of land will be inundated with water

16. There are multiple ways to get this data, but today we will be using Raster to Polygon tool to convert our Raster SLR difference extent to create a polygon we can clip our NLCD image to
    a. Navigate to Raster to polygon: In system toolbox, 'Conversion tools' -> 'From Raster' -> 'Raster to Polygon'
17. Click on Raster to Polygon tool
    a. Input raster: the SLR raster (the one that is the reclassified minus raster)
    b. Field: Value
    c. Save it to a place you can find, I named mine PolySLR
    d. Click on the box next to 'Simplify polygons (optional)'
    e. Keep other defaults and click 'OK'



18. Now we will use this created polygon as our 'Mask' to extract the values from the NLCD raster
19. Find the 'Extract by Mask' tool
    a. System toolbox: 'Spatial Analyst' -> 'Extraction' -> 'Extract by Mask'
    b. Double click on the tool
    c. Input: NLCD_UTM.tif
    d. Input raster or feature mask data: PolySLR
    e. Output: add this to a folder you are working in and name it something like NLCD_PolySLR
    f. click 'OK'



20. Examine the new file. It should have maintained the SLR extent but now have the polygons colored by the NLCD class data
21. Go to the Attribute table for the extracted NLCD

Q6: Which class seems to have the most land lost under the 1.4 meter SLR that won't be impacted at 0.0 SLR?

a. Remember to refer to what the classes of NLCD mean

Section V. Visualize your data

In this last section, you will use the skills you have gained in previous labs to make a map with the difference between a 0.0 meter SLR scenario and a 1.4 meter SLR. Include an outline of the counties shapefile and use include the NLCD dataset either in the extracted areas of the entire county. Include the standard map elements like a legend, inset map, title, author name.

- Hint: If you are working with something like the NLCD that have standard colors for each value, a way to prevent you from manually finding each color is by using the colormap button in the layer symbology.
    - For the NLDC layer, you are using in the final map, open 'layer properties' and go to symbology.
    - Click on 'Unique Values' within the panel on the left side of symbology
    - There is a file in the lab data that has a .clr extension. This is the file with the default colors for NLCD dataset that we will be adding
    - To add this, click on the 'colormap' button and find the .CLR file in your folder that corresponds to the NLCD_UTM file
    - note: this does not change the names for the legend. To do this we have to manually type in the names of the cover type that match the value number.

----------END OF LAB----------

Don't forget 2 tools descriptions in the final lab report!