MAPPING VULNERABILITY TO SEA LEVEL RISE IN HUMBOLDT BAY

In this lab we will be mapping the impacts of sea level rise on the coastal communities around Humboldt Bay, CA. Humboldt Bay is the largest bay system between the San Francisco Bay and the Puget Sound and is critical in the economic, ecological, and social health of the larger region. In this lab we will combine a high quality land cover map of Humboldt Bay with a digital elevation model.

We will blend a hypsometric tint on the digital elevation model with a hillshade to produce a high quality map. You can then label features as you choose. You can decide to label place names, cultural landmarks, sites of historical significance, etc. There is no set number of places to label, but it should be a nice amount to get the information across.

Data: USGS National Elevation Data, Humboldt County GIS, Natural Earth
Tools: ArcGIS
Output: High Quality Print 18"x12"

DATA PREPARATION
1. First download a Digital Elevation Model from the USGS National Elevation Data. Read about the creation of the National Elevation Dataset (NED) from ASPRS https://nationalmap.gov/PERS_Jan2002_NED_highlight_article.pdf

2. Download a DEM in GeoTIFF format using the National Elevation Dataset National Map. https://viewer.nationalmap.gov/basic/. Your DEM should be in 30m resolution. Watch the following YouTube video if you have not downloaded a dataset from USGS. https://www.youtube.com/watch?v=E6sXUr8HWVk

3. Download the Humboldt County Boundary shapefile from Humboldt GIS. This will be used to clip the DEM. https://humboldtgov.org/276/GIS-Data-Download. Also download the City Boundary shapefile.

4. Download 50m rivers from Natural Earth. This will be used to add rivers to your map https://www.naturalearthdata.com/downloads/50m-physical-vectors/

5. Download the cross-blended hypsometric tint with shaded relief and water 50m raster layer from Natural Earth. This will be used as a background layer for your map. https://www.naturalearthdata.com/downloads/50m-raster-data/50m-cross-blend-hypso/

ANALYSIS STEPS
1. Create a working directory to put all the downloaded data. Open ArcMap and set the folder path to your working directory. Change the projection of the data frame to UTM 10.

2. Load the Digital Elevation Model (DEM) and the Humboldt County Boundary. **Zoom to the Humboldt County layer and create a bookmark.** Clip the DEM by the county outline. Name this layer Humboldt DEM. Add the Natural Earth Hypso Tint and place behind the Humboldt DEM. Change the color of the Humboldt DEM to the elevation #1 color range. Refer to the help section for more info on hypsometric tints. https://www.esri.com/arcgis-blog/products/product/imagery/hypsometric-tinting/

3. Open the spatial analysis toolbox and select the create hillshade tool. Use the default settings to create a greyscale shaded relief. Add the hillshade to the data frame. Refer to this video if you have not created a hillshade in ArcMap. https://www.youtube.com/watch?v=GHIY2cPQ03Q

4. You now should have three layers in your data frame: a hypsometric tint from the DEM, a greyscale hillshade, and a natural earth background layer. Now we want to create the Sea Level Rise layers from the DEM.

5. Open the Spatial Analysis toobox and select the Raster Calculator tool. For the first layer we will select all areas of 1m or less elevation. In Raster Calculator, change all values in the original raster <=1 to 1, and all other values to 0. This will create a new binary where all areas with an elevation with less than 1 meter will be coded as 1 and all other locations will be coded as 0. Name this raster 1m_rise.

6. Repeat these steps for 2,3,4, and 5 meters. In the end you will have 5 new rasters each representing a different amount of sea level inundation. In each of these raster change the 0 values to transparent and the 1 values to different levels of blue, going from darker at the 1-meter raster to lighter at the 5-meter. Overlay these in order over the DEM.

DISPLAY

1. Now that we have all our layers created, we need to display them in a visually pleasing way. We will start from the bottom and build our way up. Your order, moving from the bottom to the top, should be background, hillshade, hypsometric tint, 5m_rise, 4m_rise, 3m_rise, 2m_rise, 1m_rise, rivers, county boundary, city boundary.

2. First, set your background layer at opacity 75%. Keep the greyscale hillside as is and put the Humboldt DEM hypsometric tint at 50% opacity. This should allow the shaded relief to be visible through the hypsometric DEM to provide a nice backdrop.

3. Add each of the sea level rise layers, setting the opacity to 75%. This will create a nice gradient of of sea level inundation and provide contrast to the areas that are vulnerable to sea level rise.

4. Select the 5m_rise layer and select **zoom to layer and set a bookmark at this extent.** This will allow your map to show only the areas affected by sea level rise.

5. Add the rivers shapefile and set the line width to 3, color to light blue, and opacity to 75%. Make the country boundary line width 3 and color dark grey. Add the city boundaries and make light grey with 75% opacity. Turn the labels on for the cities and river layer to add important place names and geographic features.

6. Create a layout and add a north arrow, scale bar, and title. Export your map as a .png with CMYK color at 300DPI for printing. Your final map should look something like this.