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Glaciers of Mt. Baker

Introduction:

Mt. Baker is located in Mt. Baker National for in the North West part of Washington. There are about 10 large glaciers and 5 smaller ones that sit on top of the mountain. Coleman Glacier is the largest of them all while Boulder is the most dramatic of the group. The glaciers as a whole retreated dramatically from about 1890 to about the mid 1900's and then spend a couple of decades actually advancing. Since then they have been in a period of retreat and have been rapidly getting smaller as time goes on. I thought this to be a good project because glaciers are great "canaries in a coal mine" in regards to climate change. They have been studied quite extensively and not only do their size give us a plethora of information to examine climate change but they contain layers upon layers of ice that go back thousands of years giving us a timeline of history. In thinking of a project, I wanted to do something relating to climate change and found in the LULC classification systems that perennial ice was in class of its own. In finding this out I wanted to determine an area of interest and classify and quantify an area that changed over time with regards to this class, in which I had to first find available data.

Objective:

In order to show an area of great change I did a little research on glaciers throughout the country. Basically, I just looked for a list of glaciers and read a little about which have had the most melt since the industrial revolution. Specifically which ones that have had the most dramatic change in recent years so the data I look for will be most up to date and relevant. Mt. Baker was one such area with glaciers that have gone through a lot of change. My objective was to gather land use land cover data

from two different time periods, clip the area of interest, reclassify them to the classes I want, and identify and quantify the areas of change.

Methods:

The data I acquired was from the USGS Earth Explorer interface online. I got both land cover imagery from 1992 and 2006. The 1992 data consisted of the whole state of Washington, while the 2006 data was of the whole USA mainland. They were recorded in different times of the year with only two months difference between them. The raster format (.tif) consisted of a 30m pixel size and was of a Level 1 classification system resampled to the Nearest Neighbor.

For each of the years I had to clip using the ArcMap clipping tool in order to narrow down the area I was to use. I used the geocoding toolbar to input Mt. Baker and changed my online reference to the North American areas of interest. This then flashed a dot over the mountain top. I then made ArcMap make a permanent point over the area and used it to zoom in on the area. In the clipping tool the top and bottom y and left and right x coordinates were need in order to clip. These coordinates were obtained from the bottom right of the status bar in which I just simply hand wrote the corresponding numbers.

Once I had my area the next thing to do was to match up the classification systems. The 1992 land cover data had an older Anderson classification system and had a slightly different color as well as a different value for perennial ice. One this was done I first used ERDAS Imagine to reclassify the data. This came with moderate success and I was able to find what values represented perennial ice visually. The swipe utility was the best way in order to visualize this. In the viewer panel I could layer the reclassified image over the original image in one and also layer the two years on top of one another. After getting a good idea of what I was to look for I switched over to ArcGIS.

Here I simply went into the symbology of the layer and chose the value that represented perennial ice to be one color and all other another. Then to get the histogram of values correct I did a

proper reclassification in the spatial analyst tools where I made the perennial ice its own original value and all other considered to be no data. I also did the inverse process just in case I needed them to be in that format for when I do a comparative analysis.

The analysis I did was with the Raster calculator tool in the map algebra section of the spatial analyst tools. Here I had to make a query of my output raster. The equation looked like outRast = "1992rc" – "2006rc" and is basically saying I want an output raster that takes the values of the 2006 reclassified data and subtracts them from the 1992 reclassified data. This then produced a stretched values color map. From here I simply exported the raster data as an IMAGINE format.

From this map in ERDAS Imagine I used the unsupervised classification utility and could through visual inspection find which values were representative of the ice melt. This then made it easy to change the color symbology and create a layer map of just the ice melt. Here it could be thrown over the original 1992 land cover layer and upon visual inspection matched up perfectly. In all the unsupervised reclassifications I used 20 different classes. 10 classes were not enough to show enough detail of the perennial ice and more than 20 just got too unnecessarily complicated.

Discussion/Conclusion:

The last thing I did was to quantify the areas of ice melt. To do this I just calculated the area of a pixel, which was just a 30m x 30m area. This came out to be 900m^2 for each pixel. Then I went into the attributes table for each of the reclassified systems (histogram) and took the number of pixels for each. I simply multiplied the number of pixels by the pixel area for each land cover layer. Then subtracted the 2006 number from the 1992 number and it results in your total ice melt in m^2. For visual purposes I calculated the numbers into miles. In the end the glaciers of Mt. Baker had approximately a 37% decrease in perennial ice. In 1992 Mt. Baker had about 29 square miles of ice and in 2006 it went down to almost 19 square miles.

There are many considerations I while thinking about the results when analyzing the data. I wonder how accurate these sensors are in determining the difference between seasonal snowfall and perennial ice. Does the time of year affect this? Can it determine the thickness of the ice? Also when doing the reclassification, I felt it could not be perfectly accurate and a lot of human judgment was used in the process. When doing the research, it is well know that a lot of glaciers throughout the world today are either non-existent or are melting fast, but when comparing the years of land cover for a lot of other glaciers in the country, it showed, many times, an increase in perennial ice. Maybe the fact that these layers were captured at different times of the year, or maybe even issues with how the glaciers were classified, had something to do with these findings. They did represent lakes and ponds as residential areas in the legend. Whatever the case, this project allowed me to use programs that I had never used before and it was a great experience. Even with all the questions I felt my project came up with some pretty reliable findings and I wonder if findings match up with any professional research done in the area.

References:

ArcGIS
ERDAS Imagine
Google maps
USGS
URI

Appendices: