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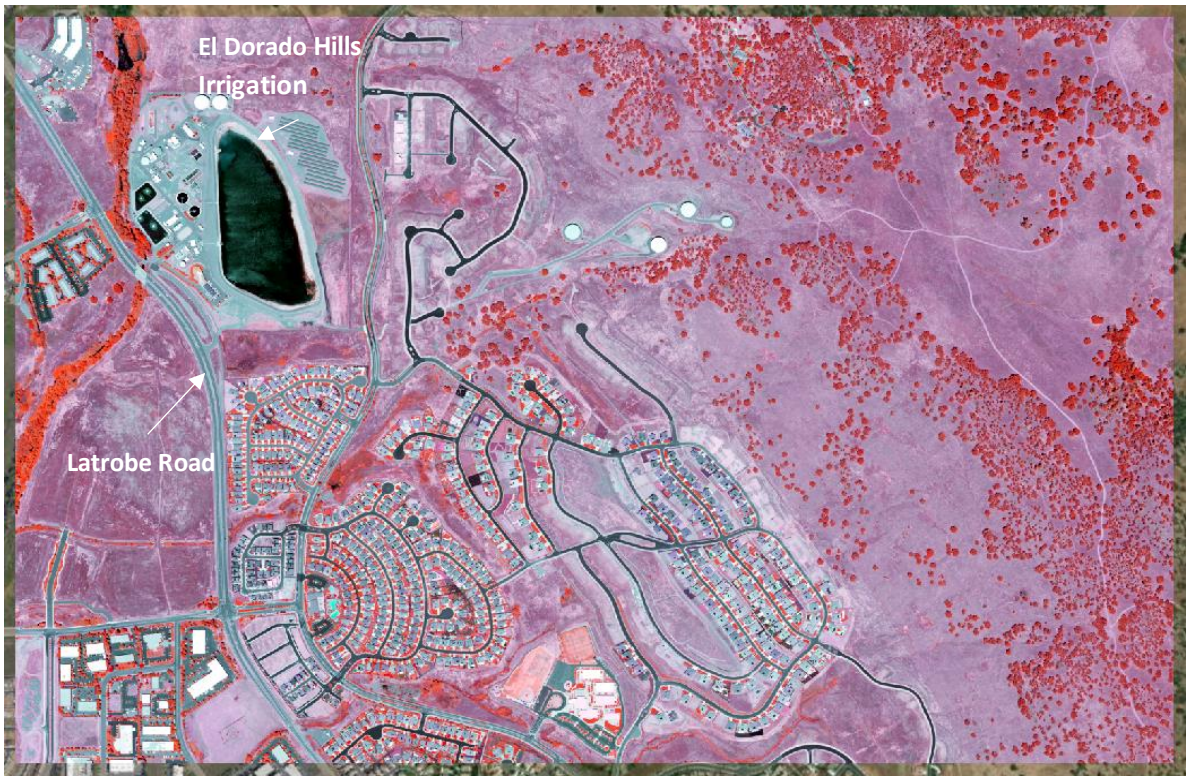
GEOG 342
Spring 2021

Supervised Classification Analysis & Multi-Date Comparison

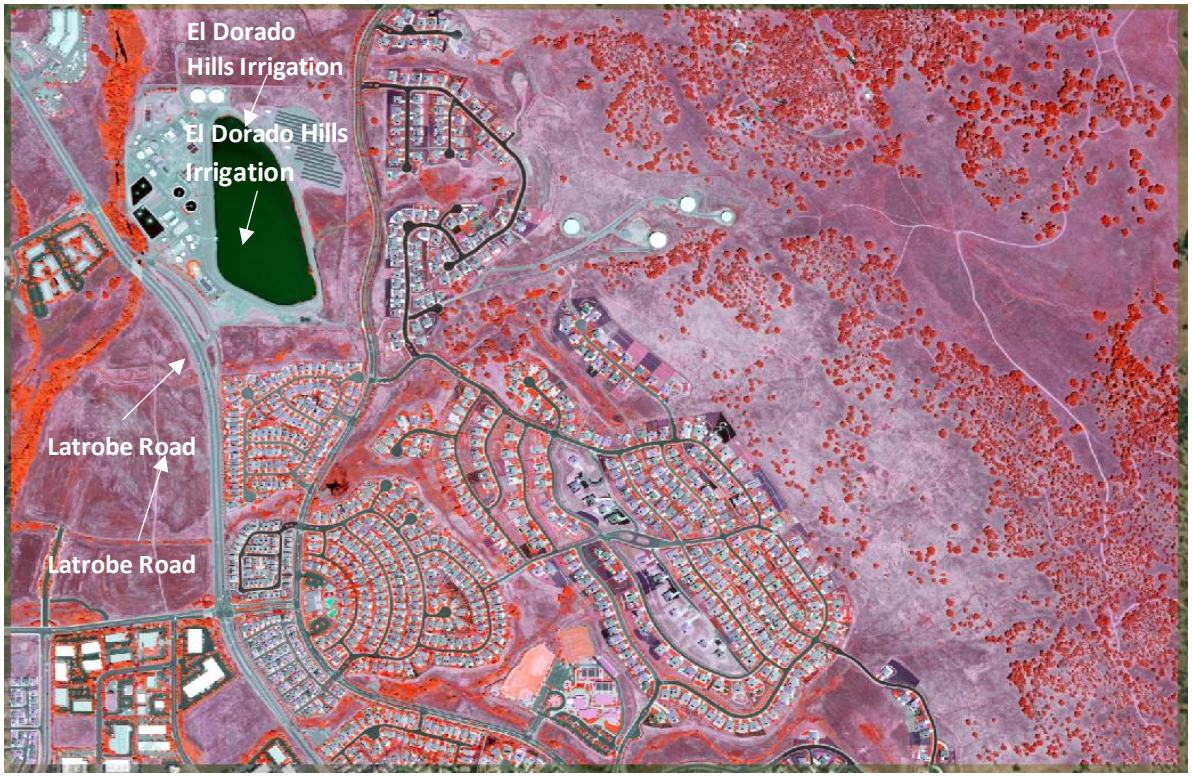
Since I really enjoyed the Classification section of this course, I wanted to perform my own classifications of an area that is familiar to me. I currently work in El Dorado Hills, CA and I noticed how a section of residential development borders right up against grassland and barren land, with sprawling deciduous tree growth in the hills above. What intrigued me to use this area for my classification project was the growth of new residential development extending from the neighborhood into the grasslands and barren area. With that in mind, I decided to use data from two different years to compare the growing development and how that affected the surrounding land classification. Along with performing the initial supervised classifications of 2016 and 2020 NAIP imagery, I conducted reclassifications on both, an Accuracy Assessment of the 2020 image, and a zonal statistics comparison between both finalized classifications.

I began this project by collecting the data through the ArcGIS Online Portal and ended up using NAIP CIR imagery of California provided by the California Department of Fish and Wildlife. I was able to locate multiple years and decided that imagery from 2016 and 2020 would show a significant change of classification and growth of developed areas. I then imported both data sets into the project to their own maps. Both images have a 60-centementer resolution and the bands for each were updated to Red: Band_4, Green: Band_2, and Blue: Band_1. This drastically increased the visibility of healthy foliage, seen as the bright orange and reds, throughout the area. Both images appear to have been collected during the summer months as the grasslands surrounding the developed areas are dry and brown in most sections, excluding residential grass or sports fields. I then exported both images set to the extent of the study area as .tif images to their respective maps.

2016 NAIP CIR Image

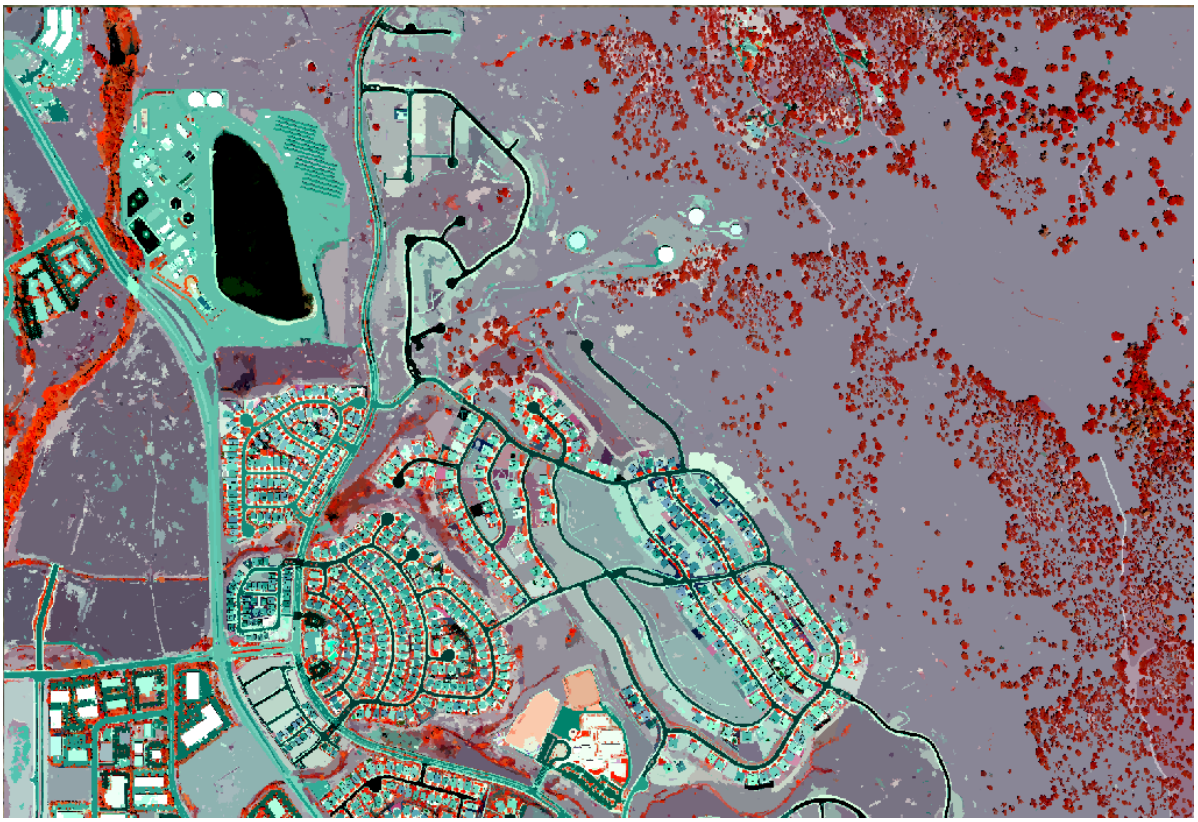


2020 NAIP CIR Image

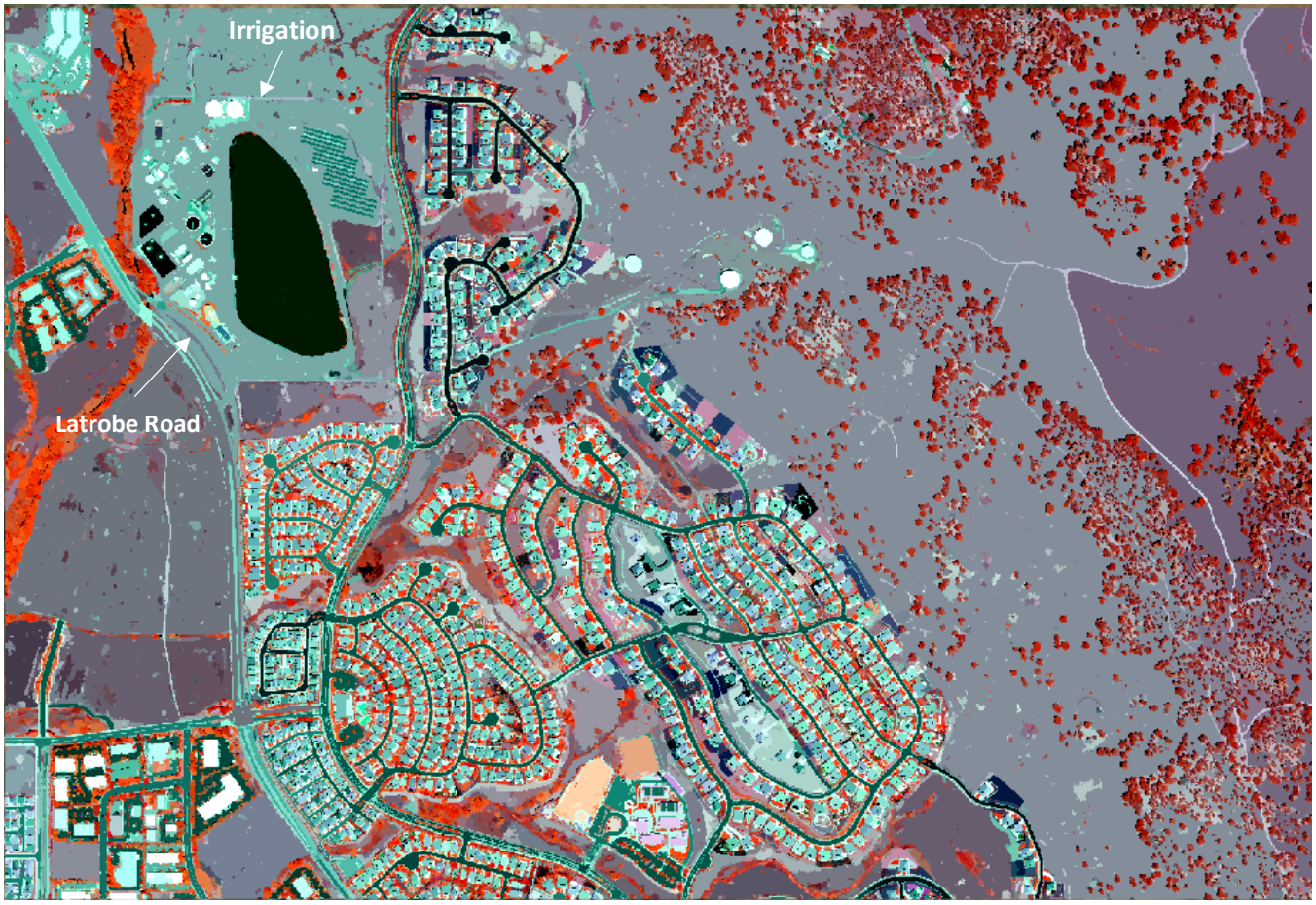


I then proceeded to segment each of the images with the default segmentation settings as we had done in the Classification assignment in class.

2016 Segmented Image



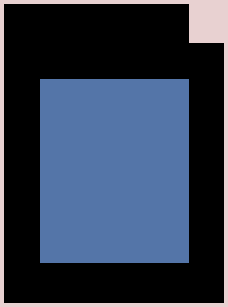
2020 Segmented Image



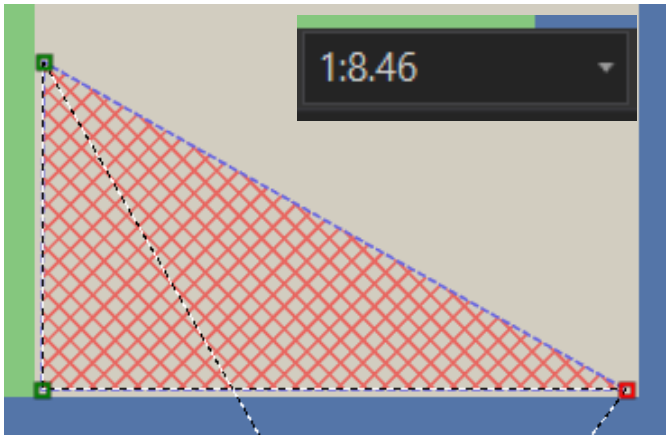
Once I had completed the segmentation of both images, I set the band colors as follows; Red: Band_1, Green: Band_2, Blue: Band_3. This provided a greater contrast between developed areas, grassland, and barren sections but kept the bright red coloring of healthy foliage. I then began the Classification Wizard and chose the Supervised classification method for each map and selected the default NLCD2011 classification schema for both. I removed the Wetlands, Planted/Cultivated, and Shrubland classes as they did not apply to my study area. I used the Deciduous class for forest but later merged it into the general Forest class. As an additional challenge, I created a Shadow class to capture shadows created from foliage and buildings. For each of the classes, I used the segment picker to select fifteen training samples across a wide variation of segment sections representing the same class.

Once the classes were trained from the training samples using the Classification Wizard defaults, the initial classifications of the images were completed, and the Deciduous class was merged into the general Forest class. I then moved into the first Reclassification for each of the maps. In my initial review of each of the classified images, I noticed a few things that would require most of my focus during the reclassifications. There were multiple areas that had a certain classification within another, often both being the incorrect classification, such as solar panels being classified as Shadow or Water. The drier climates in both images made it difficult to disinguish between Barren and Herbaceous. Plots that were in the beginning stages of development with limited construction completed would require a lot of focus to reclass from "Barren" to "Developed."

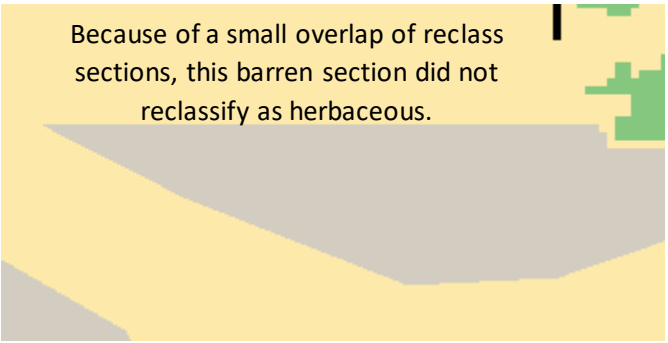
There were also areas that had incorrect classifications that were in very close proximity to each other which required me to zoom in to an incredibly small scale to correct them, which was very time consuming. As I continued to reclassify sections, I noticed my computer began to take a longer time to process the reclasses and I had to pause between them which slowed my progress.



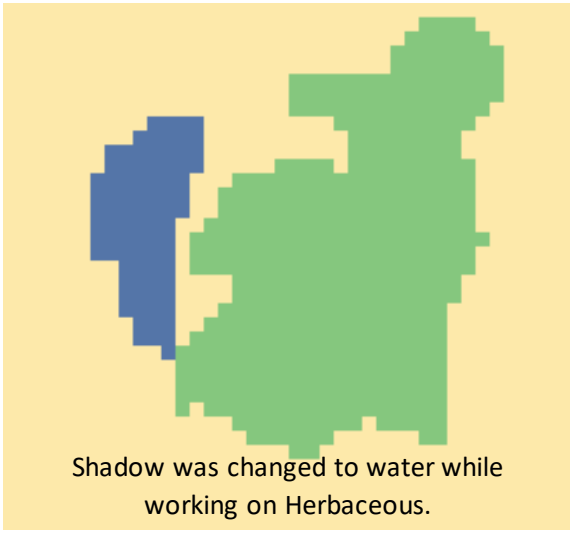
A solar panel was classified as both Shadow and Water instead of Developed.



As the reclassification process progressed, I noticed two issues that would set me back and require more attention. The first was that once I had reached approximately thirty to forty individual reclasses within a session, the reclass tool began to change the "New Class" selection to a different class than what I had originally selected. An example was that when I was reclassifying some shadows to Herbaceous in a section of trees, the "New Class" selection remained Herbaceous, but the updated class was changed to Water instead. At times, I did not notice this until I had completed a section at a larger scale and then focused in on the reclassed area. The other major issue I ran into was that if any part of an area had touched or had been overlapped from a previous reclass within the same session, the section I was trying to reclass would not reclassify.



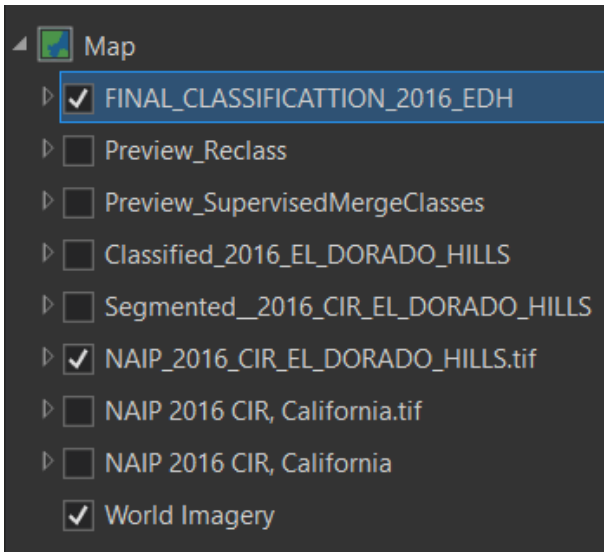
Because of a small overlap of reclass sections, this barren section did not reclassify as herbaceous.

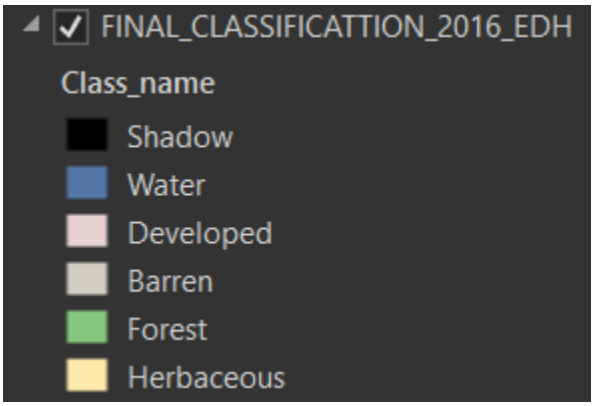


Shadow was changed to water while working on Herbaceous.

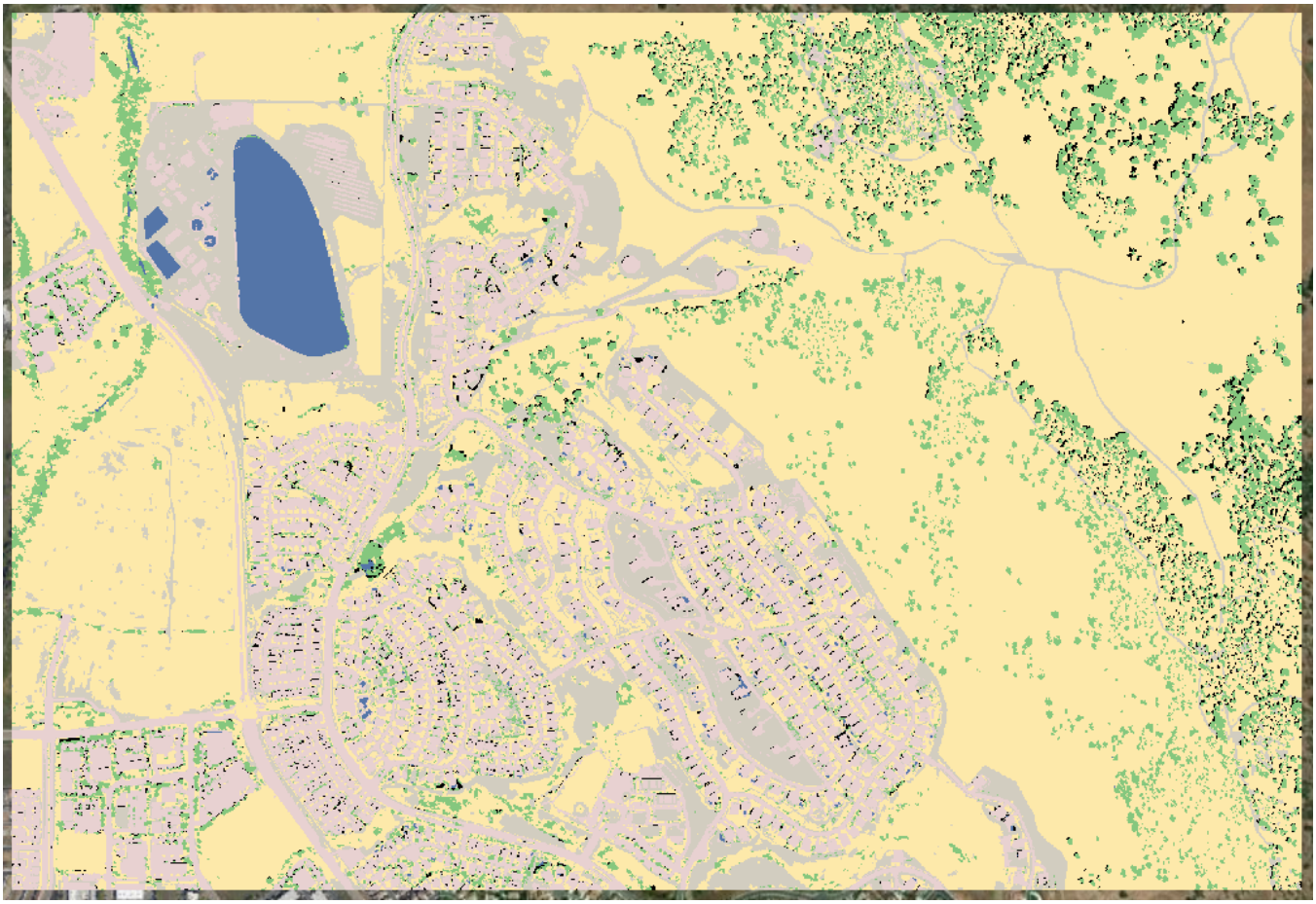
Although it took a significant amount of time to process, I developed a set of resolution methods that proved successful in reversing or correcting most of the issues with the initial classifications and follow-up reclassification sessions. For larger areas that had been incorrectly classified by technical or human error, I reverted to an older classification to start over from. I only did this a few times because some had significant amounts of reclasses done in them which could have reversed some reclasses that I did not want to change. I limited reclassification sessions to roughly twenty areas or features to avoid the "New Class" issue and to prevent slower computer performance. I focused on one class, area, and feature per session such as solar panels, artificial grass, bark, etc. In areas that were too small to be of significant value, I left as is to focus on the larger areas. In all, I performed one reclassification on the 2016 image and six on the 2020 image, with the possibility for more on both. Below are the finalized classifications for each of the images.

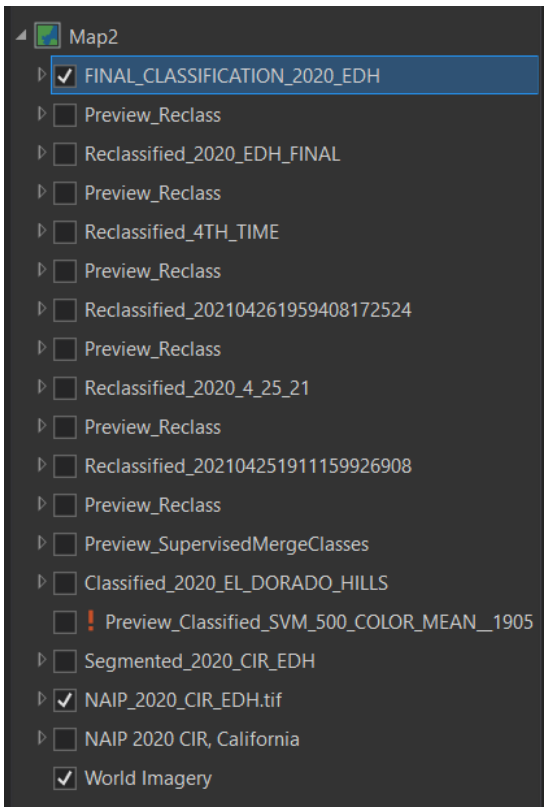
2016 Finalized Classification

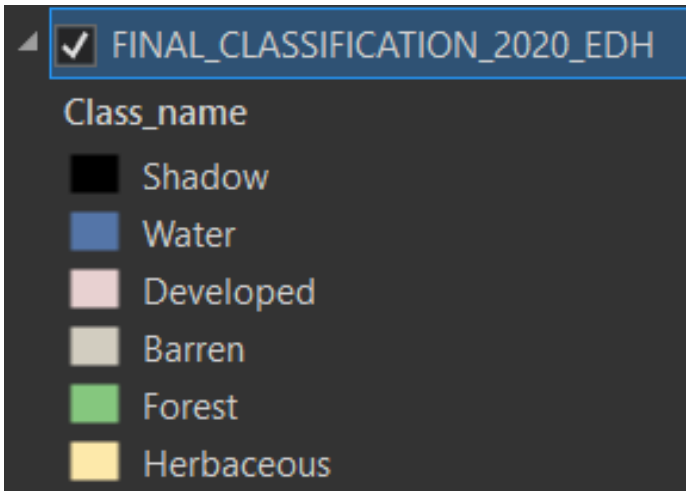




2020 Finalized Classification







I felt confident in my reclassifications of the 2020 imagery, so I then completed an Accuracy Assessment on the finalized image. Just like I did for the beginning training sessions, I selected fifteen training samples for each class. The overall results of the assessment were surprisingly better than what I had expected. The Water class was the most accurate for both the Producer's and User's accuracy (97.28% and 100% respectively). The Producer's and User's accuracy for the Shadow class (60% and 50% respectively) were much lower than I had expected, especially since I had spent a significant amount of time and portion of the reclassifications to correcting this class. Both the Forest and Herbaceous classes scored 89% and above in the Producer's and User's accuracies. The final Kappa percentage of 82.31% was higher than I had expected as well.

Shadow
Water
Developed
Barren
Forest
Herbaceous

ConfusionMatrix_Accu...essment_Results

Field: Add Calculate Selection: Select By Attributes Zoom To Switch Clear Delete Copy

OBJECTID *	ClassValue	C_0	C_10	C_20	C_30	C_40	C_70	Total	U_Accuracy	Kappa
1	C_0	6	0	0	0	0	6	12	0.5	0
2	C_10	0	107	0	0	0	0	107	1	0
3	C_20	2	1	13	5	0	2	23	0.565217	0
4	C_30	0	1	2	33	0	27	63	0.52381	0
5	C_40	0	0	0	0	9	0	9	1	0
6	C_70	2	1	0	2	1	298	304	0.980263	0
7	Total	10	110	15	40	10	333	518	0	0
8	P_Accuracy	0.6	0.972727	0.866667	0.825	0.9	0.894895	0	0.899614	0
9	Kappa	0	0	0	0	0	0	0	0	0.823077

After I had completed the Accuracy Assessment of the 2020 imagery, I wanted to perform a zonal statistics comparison between the 2016 and 2020 imagery. With the tutorial provided by Professor Jennings, I completed the Zonal Statistics to Table tool for each of the images and exported them as Excel sheets to perform some calculations. I converted the squared meter area of each table to acres for an easier to read number. I then calculated the percentage difference between the two years.

Zonal Statistics 2016				
Class_name	ZONE_CODE	COUNT	AREA	ACRES
Shadow	1	316155	113815.8	28.12445326
Water	2	369198	132911.28	32.84304184
Developed	3	2069893	745161.48	184.1331275
Barren	4	4990249	1796489.64	443.9215725
Forest	5	1985400	714744	176.6168161
Herbaceous	6	14961481	5386133.16	1330.940435

Zonal Statistics 2020					
Class_name	ZONE_CODE	COUNT	AREA	ACRES	Percentage Difference to 2016
Shadow	1	379397	136582.92	33.75032245	20%
Water	2	441543	158955.48	39.27869389	20%
Developed	3	4024199	1448711.64	357.9838898	94%
Barren	4	3503023	1261088.28	311.6212194	-30%
Forest	5	2052640	738950.4	182.5983386	3%
Herbaceous	6	14301698	5148611.28	1272.24759	-4%

The 2020 Shadow class had a 20% growth over 2016, which I attribute to foliage growth and building development over the four years. With the water level being higher in the El Dorado Hills Irrigation reservoir, and with more pools in the newer residential area, the Water class had a 20% increase as well. The Developed class saw the greatest increase with a 94% growth from 2016 to 2020. I would say that this can be attributed to the continued development of previously Barren and Herbaceous areas. The Barren class saw a 30% decline between the four years, mostly attributed to the expansion of the residential area or being overtaken by grass. The Forest class only saw a 3% increase over the four years, which I would say is due to the limited expansion of trees into the new residential area and the slight tree growth over time. The Herbaceous class had a 4% decline surprisingly; I would say because of the offset of Developed expansion but also the growth of Herbaceous into previously Barren areas. I would also take into consideration that there is of course Producer's error, through the misclassifying of pixels during the reclassification process, that could have also contributed to the percentage differences between the classes.

This project allowed me the opportunity to test my abilities as well as challenge myself with my add-ons. I really enjoyed learning and performing classifications in this course and throughout this project. Although it was very time-consuming to do the multiple reclassifications to get a better outcome in the final classifications and the Accuracy Assessment of the 2020 imagery, I have gained a greater appreciation for the overall process and the attention to detail necessary to complete them. I hope this project provided a truthful representation of the Classification processes, struggles, and resolutions so that it can serve as an example to those who also want to see how analyzing the differences between results could be used in GIS.

Data used for the project:

- **California Department of Fish and Wildlife 2016 NAIP raster from ArcGIS Online Portal.** https://map.dfg.ca.gov/arcgis/services/Base_Remote_Sensing/NAIP_2016_CIR/ImageServer
- **California Department of Fish and Wildlife 2020 NAIP raster from ArcGIS Online Portal.** https://map.dfg.ca.gov/arcgis/services/Base_Remote_Sensing/NAIP_2020_CIR/ImageServer
- **Professor Jennings' Image Classification Wizard Document provided during the course.**