

# **SUPERVISED CLASSIFICATION OF SATELLITE IMAGERY OF THE YOLO BYPASS**

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**The Yolo Bypass** is a 59,000-acre engineered flood bypass that is part of the Sacramento River Flood Control Project. It is a diversion channel for the Sacramento River via the Fremont and Sacramento Weirs (the latter involving manual operation of 48 steel gates during pouring rain) and is also fed by the Colusa Basin Drain, Willow Slough, and Cache and Putah Creeks. It incorporates seasonal and permanent wetlands, as well as seasonal agricultural areas (mostly rice fields).

I became curious about the Bypass driving over it on my way to school and back to Woodland. The overlap of agriculture, wildlife habitat, and flood protection—and the variation in these through the seasons—made it a potentially rich area of interest for image classification, and I decided to make it the focus of my project.

## ACQUIRING DATA

To find satellite imagery showing seasonal change in land use and vegetation in the Yolo Bypass, I went to the USGS's Global Visualization Viewer (GLOVIS) web site at <http://glovis.usgs.gov/>. This site (Fig. 1) is designed to make it fairly easy to view images before choosing and downloading, so I was able to pick four images representative of the seasonal trends that emerged when I looked through three years' worth of monthly Landsat TM images. The images I chose were not all from the same year; my goal was to select cloud-free images that showed expected seasonal variations, with one from the 2006 flood. (Note: I needed coordinates to get to the correct path and row of imagery the first time. I got them by looking at the Yolo Bypass area in Google Earth. For subsequent images, I was able to use just the path and row information.)

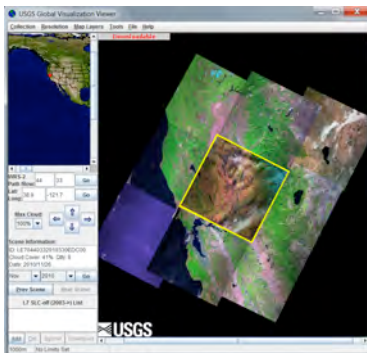


Figure 1. The GLOVIS interface

I had a couple of problems, though. Even though I had Windows 7's pop-up blocker disabled, the GLOVIS site did not recognize this, and I was unable to download anything. With a little online research, I found that the solution is to hold down the control key when navigating through the site. Next, after somewhat lengthy downloads, came the problem of opening the GLOVIS files that arrived zipped as .tar.gz files. Online research yielded mixed results here, as the recommended solutions like 7-Zip also seemed very likely to be malware vehicles. Eventually I found Microsoft's recommendation to use WinZip; I downloaded it for a free trial and was able to open the files with no further problems.

## PREPARING IMAGES

The unzipped Landsat images were sets of six single-band raster datasets that each displayed as black-and-white, not color. I poked around in the ArcGIS Toolbox until I came across Composite Bands (Data Management > Raster > Raster Processing > Composite Bands), which created a single multiple-band raster dataset (Fig 2.) from each set. (Later I found that Nate had noted this in the Project Information.)

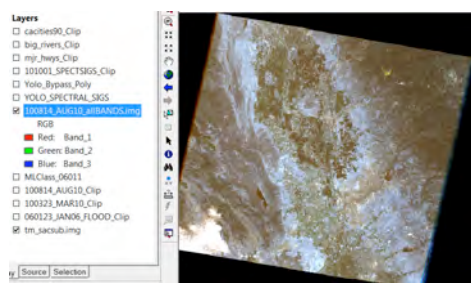


Figure 2. Single multiple-band image resulting from Composite Bands

Next I clipped the huge Landsat Tm images to focus on my area of interest. I used Clip (reached by the same path as for Composite Bands, above); this allowed me to clip the images using the north, south, east, and west coordinates (X and Y maximums and minimums) to define the area (after consulting Google Earth again). (Fig. 3)

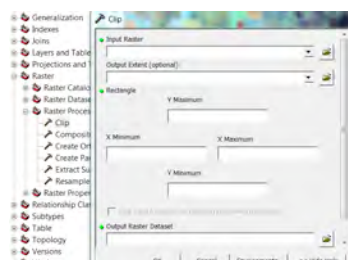


Figure 3. Clipping the image using X, Y coordinates

I then assigned the image bands to color channels in Symbology in each image's Layer Properties, using the familiar R=4, G=5, B=3 combination. (Fig. 4)

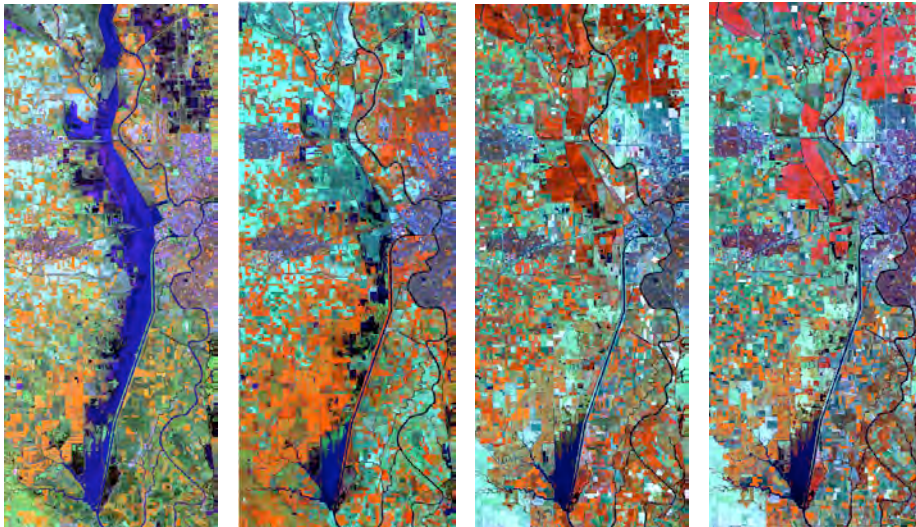


Figure 4. The four seasonal images, after assigning color channels; from left: Winter, 01/23/06 (flood event); Spring, 03/23/10; Summer, 08/14/10; Fall, 10/01/10.

Some sidetracks: I spent quite a bit of time trying to find a way to “hack” the Feature Analyst Tutorial, hoping to fool it into using my images under the names of the ones the tutorial uses, but to no avail. I also spent a while trying to find a way to batch process the images in ArcGIS (but completely forgetting about Model Builder, which I had just been introduced to in Geography 334).

## SELECTING TRAINING SITES

I had spent so much time on image preparation and detours that I was beginning to worry that using multiple images was too ambitious for the project's time constraints. Could there be an advantage in combining training sites in one polygon feature class layer and attribute table? The table would hold sites that were common to all four images (like open water features—the rivers, the Deep Water Ship Channel—that would be consistent through all seasons and all images), as well as sites that were specific to each image and that could be selected as needed using Select by Attributes. (Later I realized that using multiple layers—one for each image—with a join to bring in the common sites might have been a better way to do this.)

At this point I decided to go forward with only one image, to save time and effort in case I had to backtrack. I set up the feature class with plenty of attribute fields to allow me to differentiate the data if I were to add attributes/polygons for more

images later. (Fig. 5) I went with land cover classes that followed the scheme used in class for supervised classification using ArcGIS. I then selected the training sites for the two images—some common to both, some specific to each image. (Fig. 6)

SHAPE *	OBJ	My ID	TM DATE	L.C. Qualifier	L.C. NAME	SIG. NUM	MY NOTES	SHAPE Length	SHAPE Area
Polygon	27	1	All Images	ResCommRds	BuiltUpUrban	51	InformedEst	1594.776281	21898.466072
Polygon	49	1	06/01/23	Flooded	Water2	22	Known	4888.140242	568275.525595
Polygon	104	1	06/01/23	Orange All	AgrWetl1	11	ByColor	1124.900037	69822.821756
Polygon	109	1	06/01/23	LIaquaBlue	AgrWetl2	12	ByColor	3325.364291	634616.79317
Polygon	130	1	06/01/23	MidDcGreen	AgrWetl3	13	ByColor	1653.361727	144894.006096
Polygon	2	2	All Images	Year Round	Water1	21	Known	5984.162645	1464766.415181
Polygon	28	2	All Images	ResCommRds	BuiltUpUrban	51	InformedEst	589.951347	1709.434951
Polygon	50	2	06/01/23	Flooded	Water2	22	Known	3149.93532	561910.052623
Polygon	105	2	06/01/23	Orange All	AgrWetl1	11	ByColor	949.535508	62074.966335
Polygon	110	2	06/01/23	LIaquaBlue	AgrWetl2	12	ByColor	5142.342895	1180991.15691
Polygon	131	2	06/01/23	MidDcGreen	AgrWetl3	13	ByColor	871.164861	36979.109921
Polygon	3	3	All Images	Year Round	Water1	21	Known	1333.92378	67585.69006
Polygon	29	3	All Images	ResCommRds	BuiltUpUrban	51	InformedEst	620.902782	22991.85166
Polygon	51	3	06/01/23	Flooded	Water2	22	Known	3263.328571	416961.613619
Polygon	106	3	06/01/23	Orange All	AgrWetl1	11	ByColor	2128.910555	274579.366575
Polygon	111	3	06/01/23	LIaquaBlue	AgrWetl2	12	ByColor	1543.38964	147356.191505
Polygon	132	3	06/01/23	MidDcGreen	AgrWetl3	13	ByColor	808.868538	37534.218296
Polygon	153	3	06/01/23	LightGreen	Grassland	31	ColorGuess	1671.678447	164242.363491
Polygon	4	4	All Images	Year Round	Water1	21	Known	2247.019313	118413.408194
Polygon	31	4	All Images	ResCommRds	BuiltUpUrban	51	InformedEst	811.958884	10813.746803
Polygon	52	4	06/01/23	Flooded	Water2	22	Known	2827.117186	282743.392577
Polygon	107	4	06/01/23	Orange All	AgrWetl1	11	ByColor	8480.726298	161781.162651
Polygon	112	4	06/01/23	LIaquaBlue	AgrWetl2	12	ByColor	1721.376357	135147.897723
Polygon	133	4	06/01/23	MidDcGreen	AgrWetl3	13	ByColor	897.246289	40315.61155
Polygon	154	4	06/01/23	LightGreen	Grassland	31	ColorGuess	905.016155	35478.66828
Polygon	5	5	All Images	Year Round	Water1	21	Known	1952.848245	162978.827872

Figure 5. The attribute table for training sites

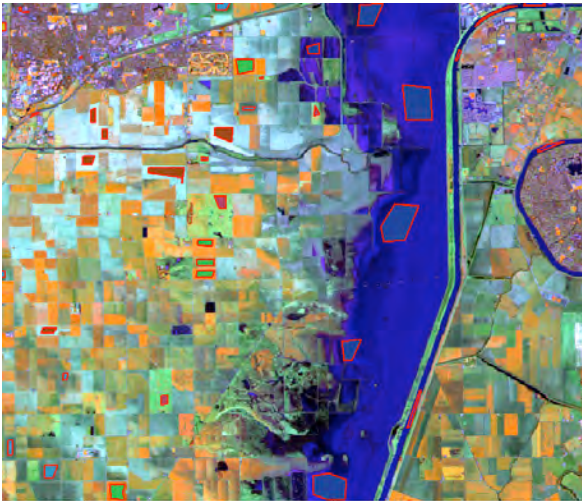


Figure 6. Training sites

## RUNNING THE CLASSIFICATION

In ArcGIS, I ran the process to create signatures (Spatial Analyst > Multivariate > Create Signatures), then used the .gsg file to run the Dendrogram routine. The dendrogram's signature evaluation showed some confusion with UrbanBuiltup and AgrWetl. (Fig. 7) I ran the Maximum Likelihood Classification and got a bad result (much like others in the class had).

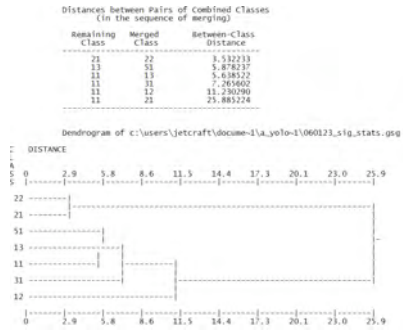


Figure 7. The first dendrogram

## REFINING THE RESULTS

In the attribute table, I deleted all records for the UrbanBuiltUp category (not really important for the Yolo Bypass area of interest), then repeated the steps above. This time, to my relief, the dendrogram looked fine (Fig. 8) and the Maximum Likelihood Classification ran successfully, with the resulting classification correlating nicely with the image. (Fig. 9 and 10)

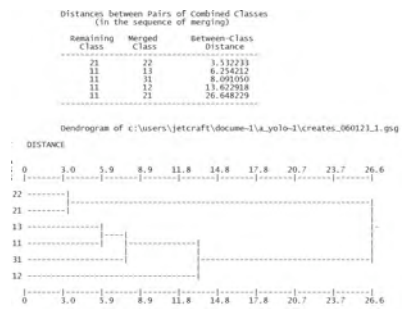


Figure 8. The second dendrogram

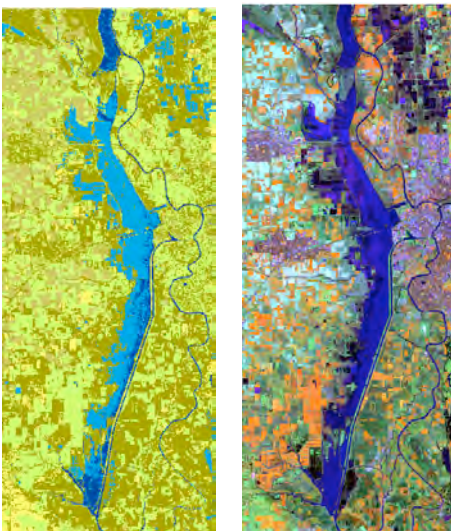


Figure 9. The results of the second classification (left), with original image

## **CONCLUSION & LEARNING OUTCOME**

Refining training sites and repeating the classification can lead to a successful outcome, even when previous results were discouragingly bad.

I spent too much time on preprocessing and exploring tangents and consequently didn't have time to process multiple images, so I switched from using multiples to just one. This reduced the scope of the project to a manageable one but left behind my original goal of examining seasonal changes.

While the Yolo Bypass offered a rich area for investigation, its ambiguity and myriad tiny fields made discrimination between land cover types difficult without having any actual field knowledge there. I had hoped to be able to distinguish the seasonal status of individual fields but, without any known areas to reference, I ended up lumping agriculture and wetlands together for training.

The project afforded me a chance to apply things learned in class, giving them context. I learned things about using ArcGIS for raster images. It was satisfying to have the classification go well after modifying the attributes. I'd enjoy more work with remote sensed images, possibly combined with actual field experience of an area.