Wesley Street

GRY 360 Final Project

Estimating Area of Ocean Covered By Oil from Overhead Imagery

This project went through several iterations. My original concept was to use ArcMap to extract oil on the surface of the ocean, and surrounding land area to obtain either a percentage of coastline or length of coast line effected. In April 2010 the oil drilling platform Deepwater Horizon had an explosion. After this explosion, an uncapped well head leaked approximately 4.9 million barrels of oil into the Gulf of Mexico. This oil caused a major disaster for the southern coast of the United States.

After many hours of searching online for the information and visual data needed, I could not find anything that matched what I required. I then found the following picture (Fig 1). I decided to perform an extraction of oil from the following image and calculate the total area of oil on the surface of the ocean.

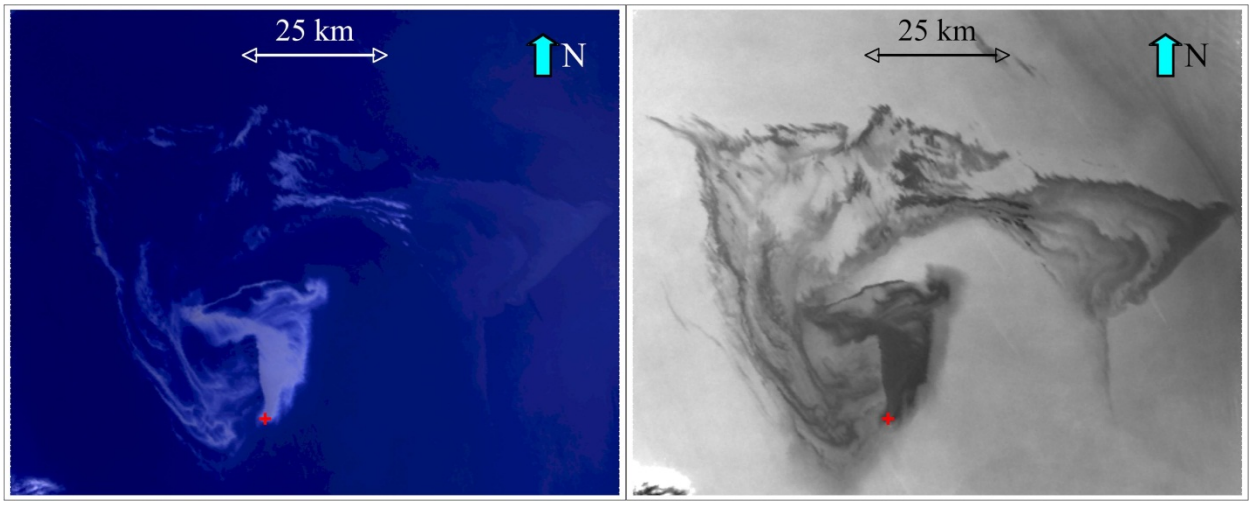

Figure 1

These images were captured by NASA's Terra satellite's Multi-angle Imaging SpectroRadiometer on May 1st, 2010 and 11:44 local time. *The image on the left is an enhanced "true color" view of the oil slick at 275 meters (902 feet) resolution from MISR's nadir (downward)-viewing camera. The image is centered on 88.26 degrees west, 29.12 degrees north, about 200 kilometers (656,168 feet) southeast of New Orleans, La. The image dimensions are about 120 kilometers (393,701 feet) in the east-west direction and 150 kilometers (492,126 feet) in the north-south direction. The red symbol indicates the approximate position of the Deepwater Horizon platform*

and the source of the oil slick. Oil is lighter than water and will float on top of the water surface, suppressing small waves and changing the way the surface reflects light. Some clouds are visible in the extreme lower left corner of the image.

The image on the right is a multiangle composite image of the oil spill, showing the ratio between the reflectances of the 26.1 degree aftward viewing (Aa) camera and the 26.1 degree forward viewing (Af) camera. The Af camera sees the reflection of sunlight from the oil more strongly than the Aa camera, so this ratio makes the oil slick appear dark gray. The uncontaminated water appears much lighter. This composite image reveals finer detail of the oil on the surface. Darker regions indicate higher concentrations of oil on the surface. This image also shows more clearly the large concentration of oil emanating from the source. Source: NASA

My original attempts involved extracting surface oil from a black and white picture (Fig 2). I thought that it would give the best results. It appears to the naked eye to give the most definition for the problem I am trying to analyze.

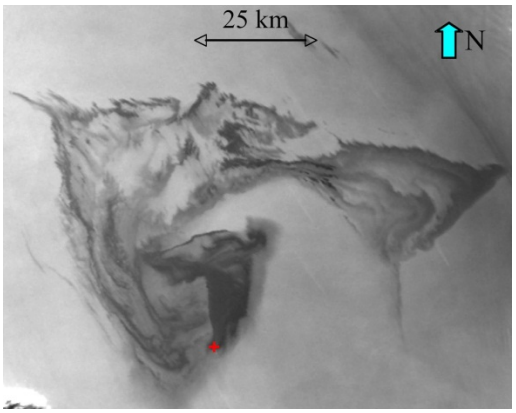

Figure 2

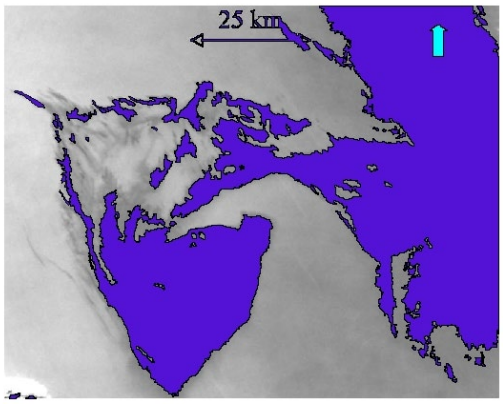

Figure 3

When I started running this in *Feature Analyst*, all the grey tones were giving the computer problems. The right hand side of the picture is darker; I believe because of the curve of the Earth, and *Feature Analyst* was extracting large chunks of the right side (Fig 3). From now on I will refer to this as “the shadow” for clarity.

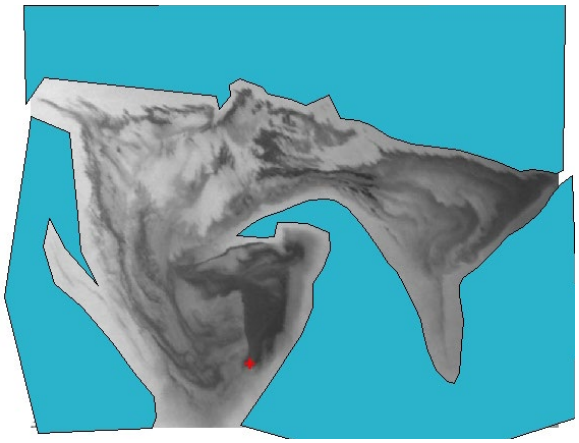

Figure 4

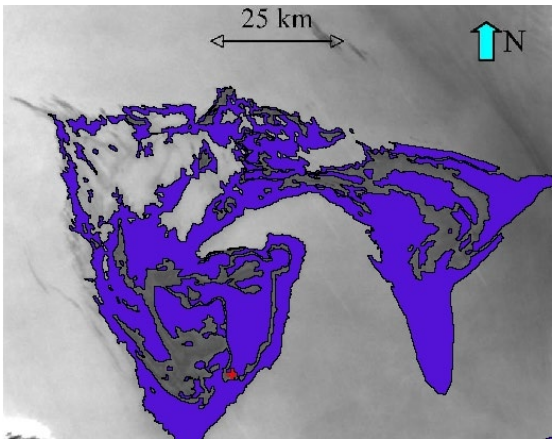

Figure 5

Next, I created a mask (Fig 4) to try and exclude certain parts of the map so that it would not try to extract the "shadow". When I did this, it also excluded several of the main concentrations of oil. I do not know why it did this, but obviously it was not correct (Fig 5).

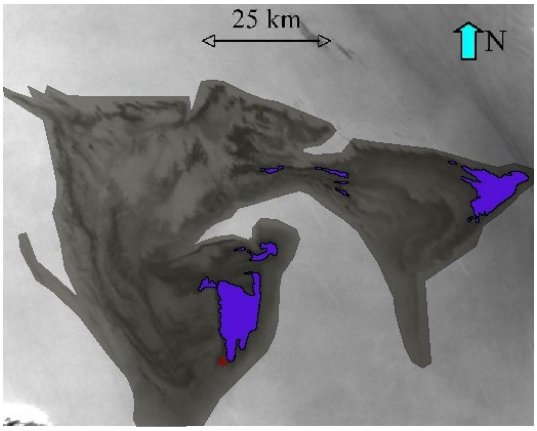

Figure 6

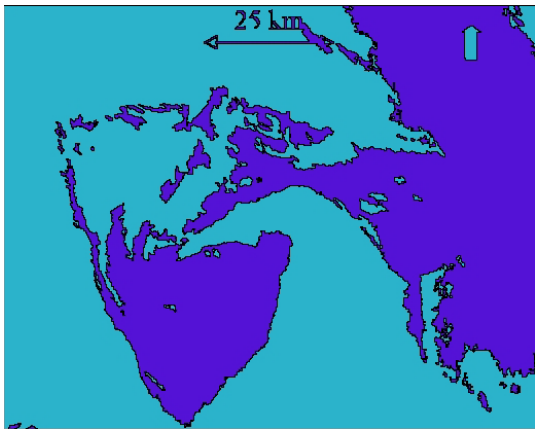

Figure 7

My third trial (Fig 6) was making a mask to only include my area of interest. It evident by the two small blue areas in that image that this was unsuccessful. For the fourth trial (Fig 7), I created a new layer and digitalized a training set of features to exclude. I then used my *Vector Tools* to create a new layer, combining my original training layer and my new exclution training layer. This attempt resulted in failure as well.

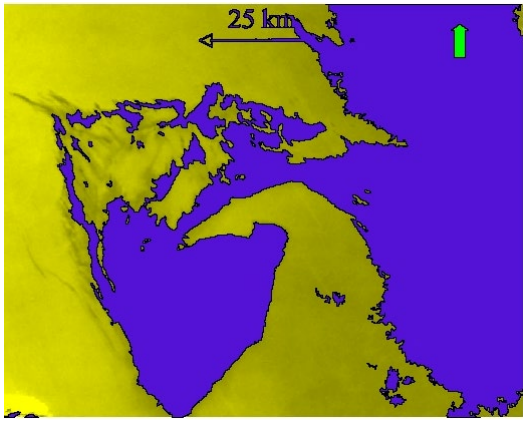

Figure 8

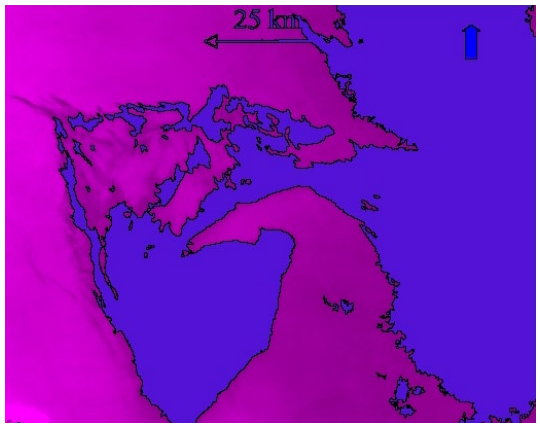

Figure 9

My next two trials involved removing a color band from the original image. In the first one (Fig 8), I turned off the blue color band and got a resultant yellow-toned image which I then used *Feature Analyst* on. Next, I tried removing the green band and ran an extraction on the magenta-toned image (Fig 9). Neither of these produced a useable result.

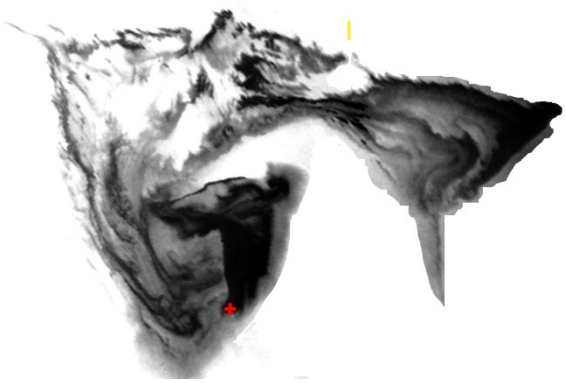

Figure 10

I then tried some image manipulation in Microsoft Office and then again in Paint. I increased the contrast and then erased some of the clutter remaining from the shadow, before reimporting the image into ArcMap. At that point, the image looked like it would work (Fig 10). I feared that lack of access to professional image editing software, detail in my image was being lost. It was very time consuming to erase pixels manualy. I had a problem where ArcMap was either extracting everything or very little. I also felt that I was doing manually what I was attempting to use *Feature Analyst* for.

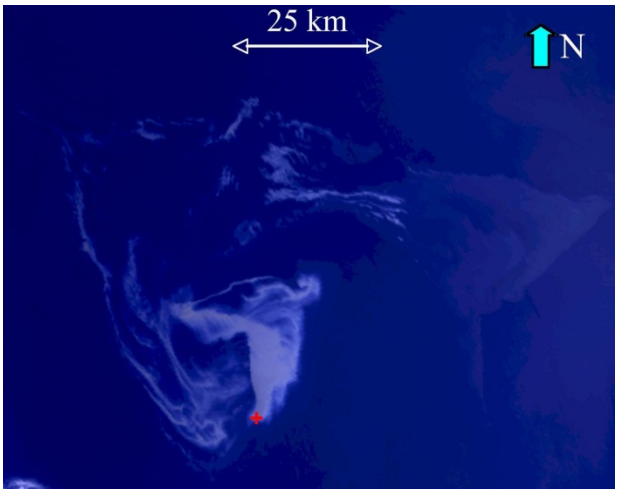

Figure 11

While people were giving their presentations in class, it was beifly mentioned that extracting from a black and white image was very difficult because of the lack of change in color, which is something *Feature Analys* relies on to preform its extractions. I was hesitiant, as I thought I might run in to the same problems that I had with the black and white image, but decided to try to blue colored image anyway (Fig 11). A little bit of the oil surface area was lost, but the main concentrations are much clearer and have a better contrast than the previous image. These sections would pose the most hazardous areas anyway. I wish there was a reference that I could obtain to tell me what the estimated concentration of oil was to cause a certain color in the returned energy. Had there been one, I could have calculated total volume of oil shown in the picture as opposed to just the total surface area of oil.

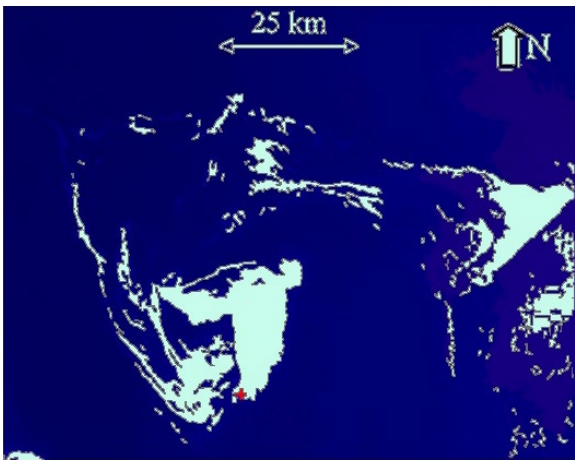

Figure 12

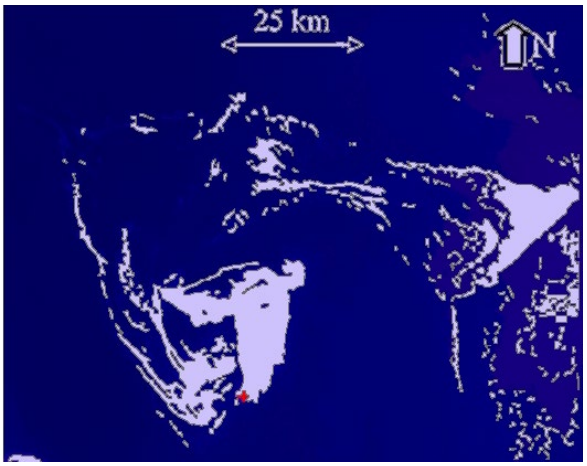

Figure 13

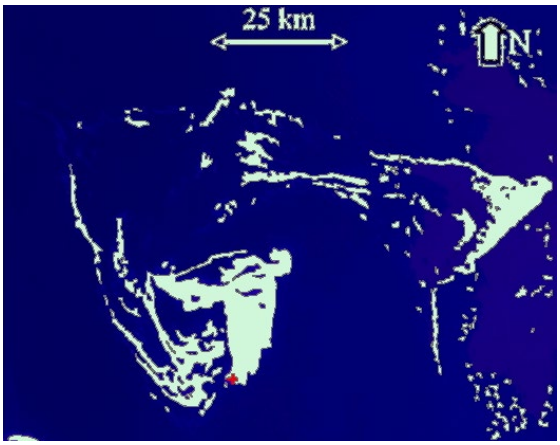

Figure 14

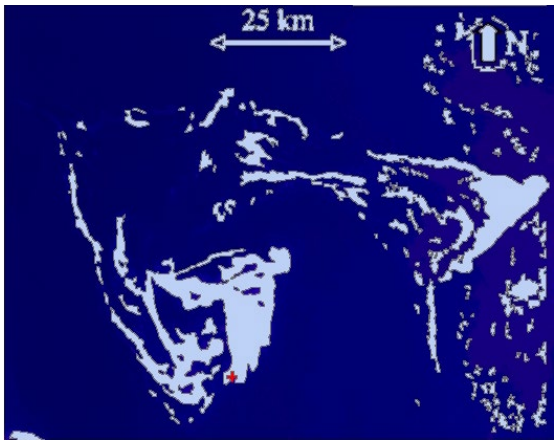

Figure 15

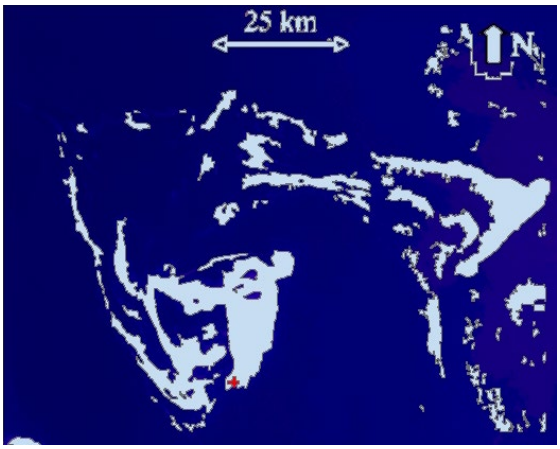

Figure 16

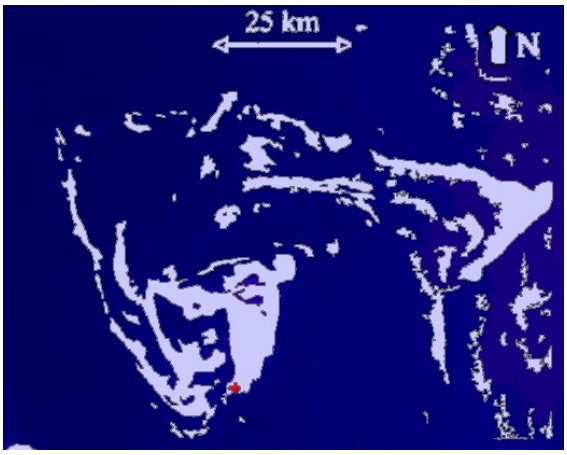

Figure 17

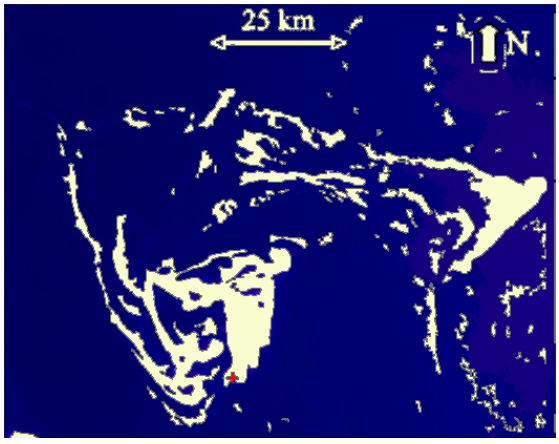

Figure 18

From my first extraction (Fig 9), I could see more promising results. I then started manipulating settings in the input representation tab. Previously, all extractions had been made with the following settings: *Image Resolution* = 3 and Manhattan *Input Representation Style* set at 5.

Figure Number	Input Representation	Setting Value	Image Resolution Value
9	Manhattan	5	3
10	Manhattan	7	3
11	Manhattan	10	3
12	Bulls Eye 2	11	3
13	Bulls Eye 2	19	3
14	Bulls Eye 2	31	3
15	Bulls Eye 4	31	3
16	Bulls Eye 4	31	2
17	Bulls Eye 4	31	1
18	Bulls Eye 4	31	3

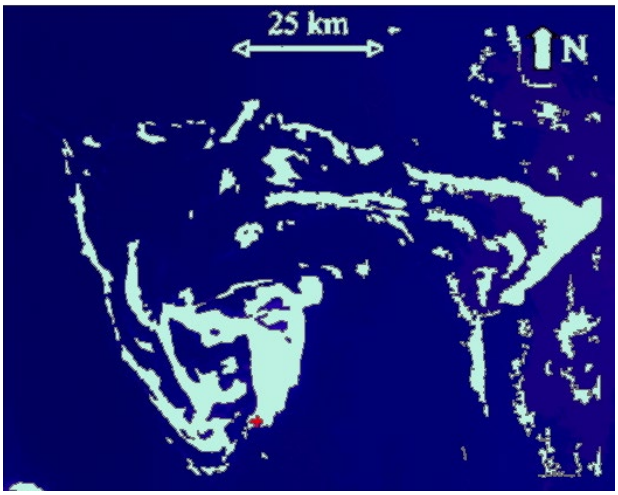

Figure 19

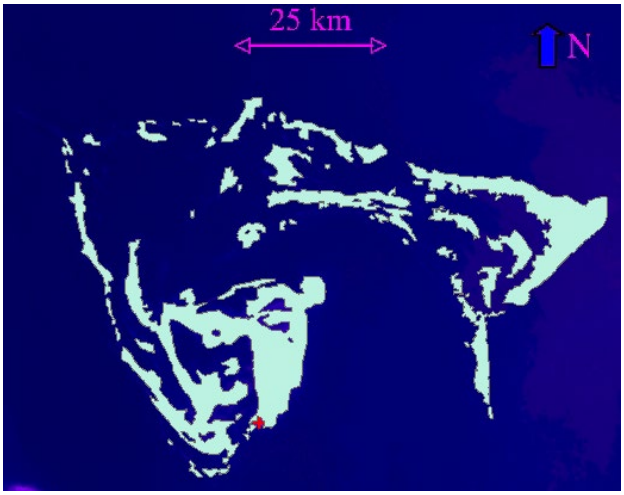

Figure 20

I was actually satisfied after completing the extraction for Figure 18; however, I accidentally turned off the green band, and noticed that it eliminated almost all of the lighter blue color at the right edge. I performed one more extraction and noticed a small change in the result, proving to be more satisfactory for my purposes (Fig 19). It caused the eastern tip of the oil mass to become more distinct. I then proceeded to eliminate the clutter and smooth the polygons (Fig 20).

When all of this was complete, I ran A*rea Calculator* on my polygons. The only problem with this however, is that with having no geographic coordinate system, there were no units attached. I then created a new layer, made a single rectangular polygon the same size as the entire image, and repeated my previous step with A*rea Calculator*. I could then obtain the percentage of the image that the extracted oil polygons covered. The oil covers 10.61% of the

image. Information given with the picture tells us that the picture is approximately 150 km buy 120 km or 18,000 km^2. 10.61% of this total is 1,910 km^2 of oil coverage in the picture.

While I found this project interesting, it was also very frustrating, attempting to figure out how to get ArcMap to do what I needed it to do. My results do differ from the information NASA attached with the image. I did do a quick polygon just around the outside of the oil and came up with a similar answer. NASA computed area is a much more time efficient way. I believe NASA's goal was to provide the total area of ocean being affected by oil, and not the total area of oil on the surface. I think by using some better image manipulation software before importing the image, this would have been accomplished more quickly and probably with more accurate results. I am thinking about taking this project further and using it in graduate school here at Missouri State when I apply for the accelerated masters in Geospatial Science.