The Effect of Rising Sea Levels in

Miami-dade County, FL

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December 2016

GIS

Problem

Florida has been under investigation by many geologists because many people fear that parts of the state will be underwater in the near future. Miami-dade county will be investigated to demonstrate the effects of sea level rise along the coast of Florida because “global warming is [not] a hoax invented by the Chinese.”

Goal

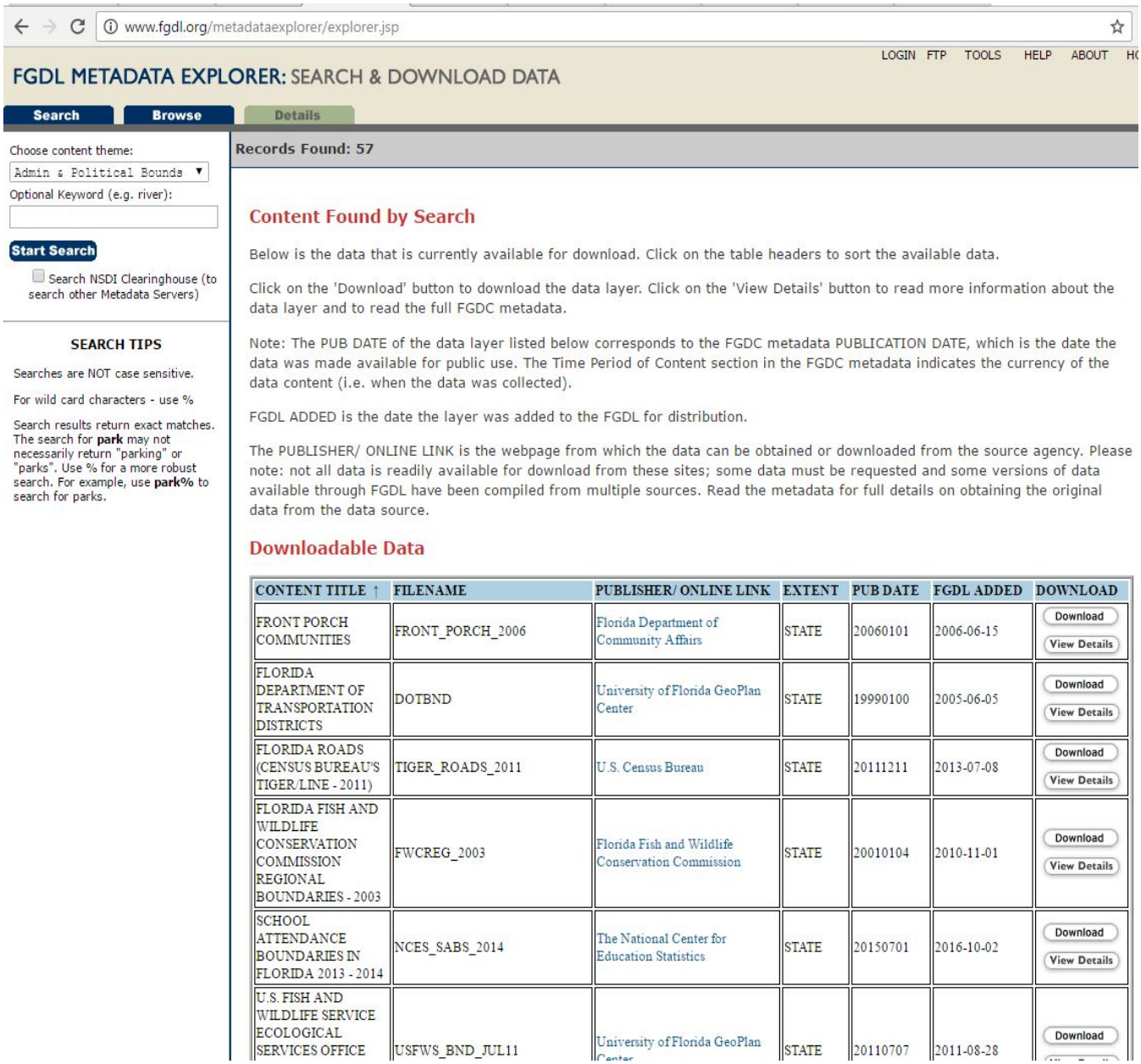
The goal for this to project is to use GIS techniques learned throughout the semester to create maps of Miami-dade county that represent the effects of different sea level changes. The maps will incorporate DEM raster files to represent an elevation model. Miami, FL will be the focus point during this project because it is one of the most populated cities in the state.

Data sources

Geographic coordinate system: NAD 1983 HARN

Florida Geographic Data Library- http://www.fgdl.org

1. Florida county boundaries – shp. file
2. Florida urban areas- shp. file
3. Florida shoreline – shp. file
4. Florida cities – shp. file



www.fgdl.org/metadataexplorer/explorer.jsp

LOGIN FTP TOOLS HELP ABOUT

FGDL METADATA EXPLORER: SEARCH & DOWNLOAD DATA

Search | Browse | Details

Choose content theme: Admin & Political Bounds

Optional Keyword (e.g. river):

Start Search

Search NSDI Clearinghouse (to search other Metadata Servers)

SEARCH TIPS

Searches are NOT case sensitive.

For wild card characters - use %

Search results return exact matches. The search for **park** may not necessarily return "parking" or "parks". Use % for a more robust search. For example, use **park%** to search for parks.

Records Found: 57

Content Found by Search

Below is the data that is currently available for download. Click on the table headers to sort the available data.

Click on the 'Download' button to download the data layer. Click on the 'View Details' button to read more information about the data layer and to read the full FGDC metadata.

Note: The PUB DATE of the data layer listed below corresponds to the FGDC metadata PUBLICATION DATE, which is the date the data was made available for public use. The Time Period of Content section in the FGDC metadata indicates the currency of the data content (i.e. when the data was collected).

FGDL ADDED is the date the layer was added to the FGDL for distribution.

The PUBLISHER/ ONLINE LINK is the webpage from which the data can be obtained or downloaded from the source agency. Please note: not all data is readily available for download from these sites; some data must be requested and some versions of data available through FGDL have been compiled from multiple sources. Read the metadata for full details on obtaining the original data from the data source.

Downloadable Data

CONTENT TITLE ↑	FILENAME	PUBLISHER/ ONLINE LINK	EXTENT	PUB DATE	FGDL ADDED	DOWNLOAD
FRONT PORCH COMMUNITIES	FRONT_PORCH_2006	Florida Department of Community Affairs	STATE	20060101	2006-06-15	Download / View Details
FLORIDA DEPARTMENT OF TRANSPORTATION DISTRICTS	DOTBND	University of Florida GeoPlan Center	STATE	19990100	2005-06-05	Download / View Details
FLORIDA ROADS (CENSUS BUREAU'S TIGER/LINE - 2011)	TIGER_ROADS_2011	U.S. Census Bureau	STATE	20111211	2013-07-08	Download / View Details
FLORIDA FISH AND WILDLIFE CONSERVATION COMMISSION REGIONAL BOUNDARIES - 2003	FWCREG_2003	Florida Fish and Wildlife Conservation Commission	STATE	20010104	2010-11-01	Download / View Details
SCHOOL ATTENDANCE BOUNDARIES IN FLORIDA 2013 - 2014	NCES_SABS_2014	The National Center for Education Statistics	STATE	20150701	2016-10-02	Download / View Details
U.S. FISH AND WILDLIFE SERVICE ECOLOGICAL SERVICES OFFICE	USFWS_BND_JUL11	University of Florida GeoPlan Center	STATE	20110707	2011-08-28	Download

Figure 1 – FGDL Database used to download the shp. files above

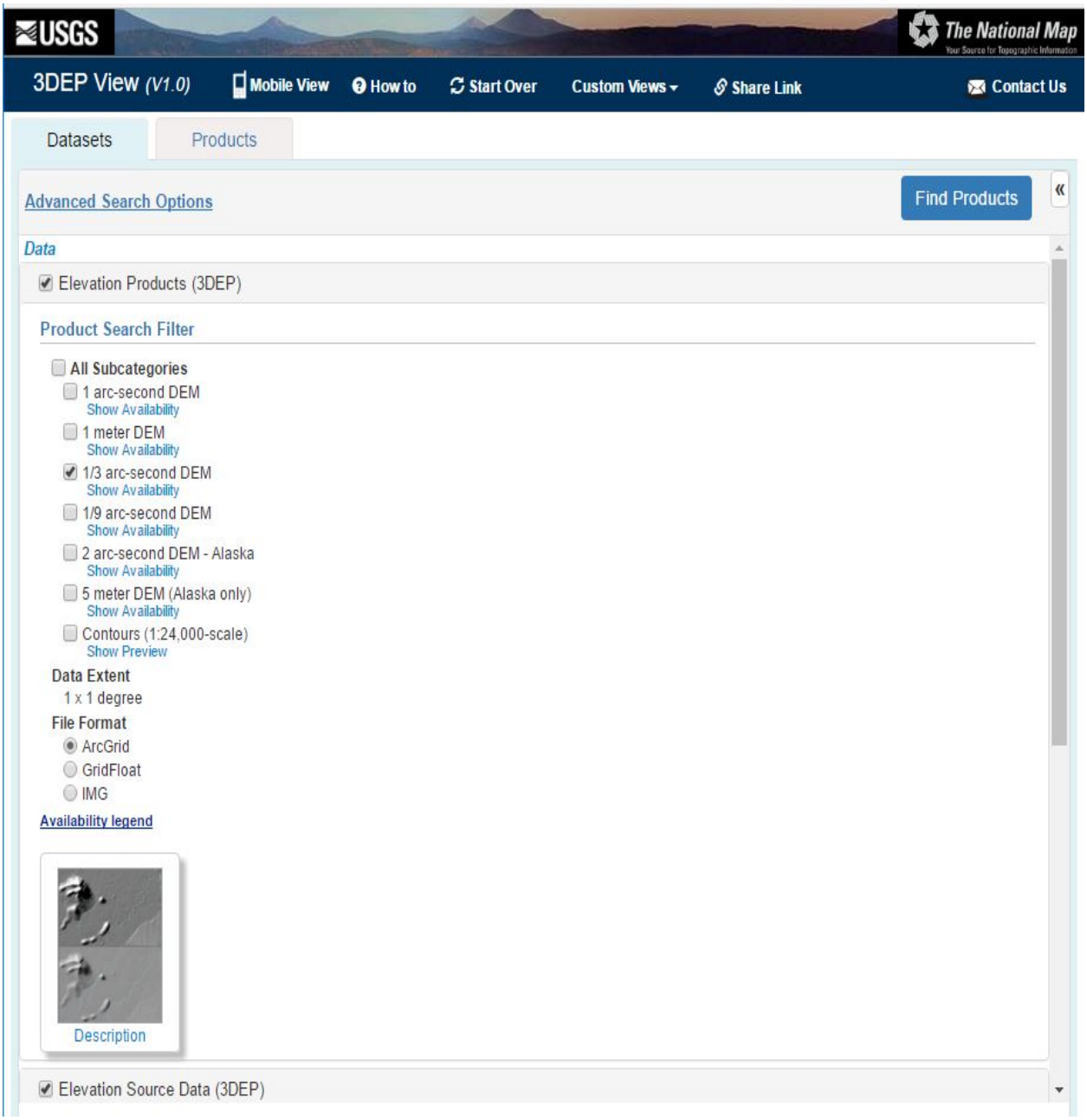


Figure 2- USGS database where DEM file was downloaded from

USGS 3D Elevation Program - http://nationalmap.gov/3DEP/index.html

1. 1/3 arc second DEMs

Methods

The first step that I did was import the county file to ArcMap. This file was downloaded from the FGDL database. The county file had a geographic coordinate system of 1983 HARN.

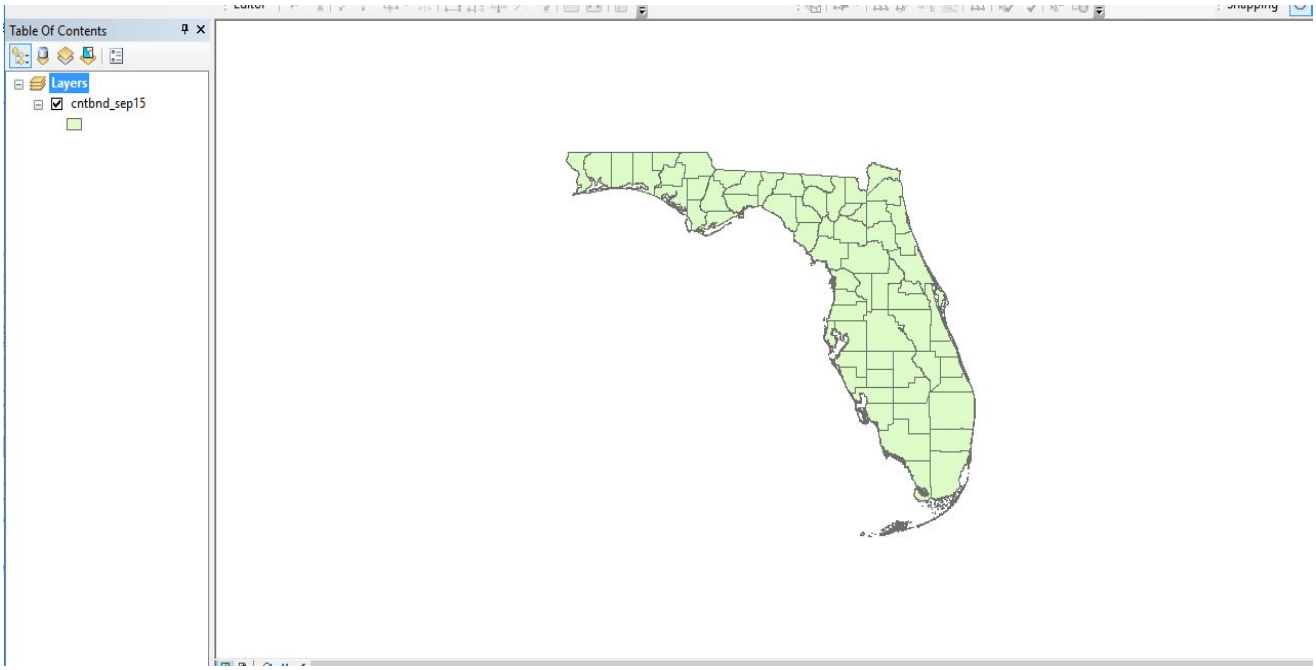


Figure 3- State of Florida with county boundaries

The next step was just to turn on the labels for all the counties. I could not take a screenshot of it but in order to do this, I right clicked the file in the TOC and checked label features. To check that the counties are labeled, I opened the properties-labels tab and made sure the label field was “Name”. It had to be this field because based on the attribute table shown below, this field name includes all the counties.

Table

cntbnd_sep15

FID	Shape	OBJECTID	TIGERNAME	NAME	FGDLCODE	FIPS	DESCRIPT	FGDLAQDATE	COASTAL	AUTOID
0	Polygon	7	Broward	BROWARD	C06	011	BROWARD	9/24/2015	Y	7
1	Polygon	8	Palm Beach	PALMBEACH	C50	099	PALMBEACH	9/24/2015	Y	8
2	Polygon	1	Hernando	HERNANDO	C27	053	HERNANDO	9/24/2015	Y	1
3	Polygon	2	Wakulla	WAKULLA	C65	129	WAKULLA	9/24/2015	Y	2
4	Polygon	9	Gilchrist	GILCHRIST	C21	041	GILCHRIST	9/24/2015	N	9
5	Polygon	10	Miami-Dade	MIAMI-DADE	C13	086	MIAMI-DADE	9/24/2015	Y	10
6	Polygon	11	Highlands	HIGHLANDS	C28	055	HIGHLANDS	9/24/2015	N	11
7	Polygon	12	Citrus	CITRUS	C09	017	CITRUS	9/24/2015	Y	12
8	Polygon	13	Okeechobee	OKEECHOBEE	C47	093	OKEECHOBEE	9/24/2015	N	13
9	Polygon	22	Pasco	PASCO	C51	101	PASCO	9/24/2015	Y	22
10	Polygon	14	St. Johns	STJOHNS	C55	109	STJOHNS	9/24/2015	Y	14
11	Polygon	23	Sumter	SUMTER	C60	119	SUMTER	9/24/2015	N	23
12	Polygon	3	Walton	WALTON	C66	131	WALTON	9/24/2015	Y	3
13	Polygon	4	Volusia	VOLUSIA	C64	127	VOLUSIA	9/24/2015	Y	4
14	Polygon	15	DeSoto	DESOTO	C14	027	DESOTO	9/24/2015	N	15

Figure 4- Attribute table of the county boundaries shp file

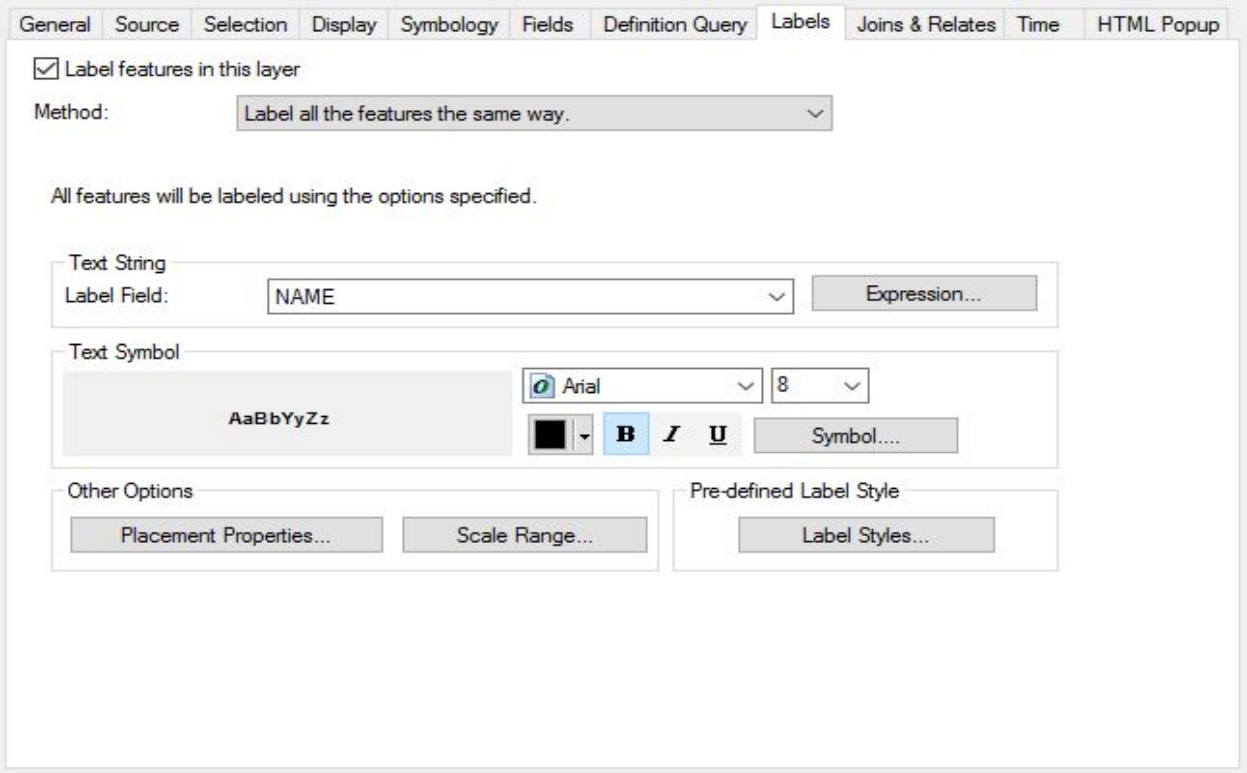


Figure 5- Properties > Labels for the county boundaries shp file

The figure below shows the result of adding labels for all the counties for the state of Florida.

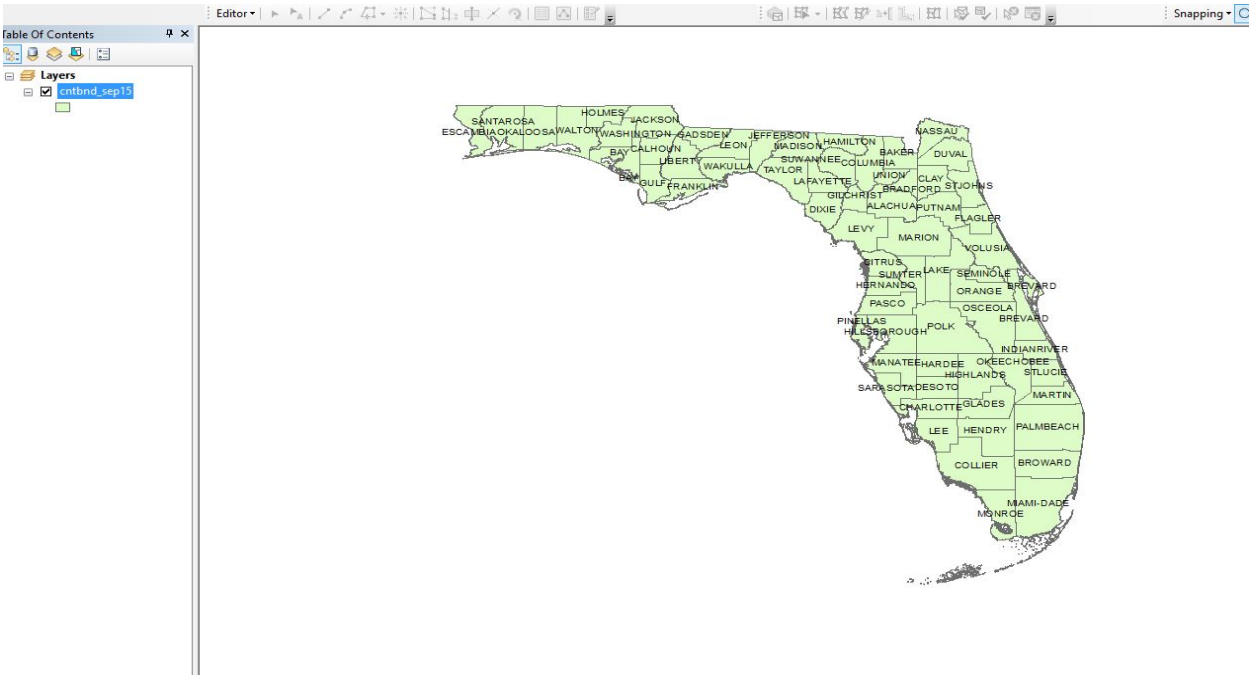


Figure 6- County labels for the state of Florida

Next, I imported the urban areas (2010) shp. file to show what areas in Florida are the most populated. I highlighted the urban area on the coast of Florida because this is where Miami and part of Miami-dade is included. I turned on the labels for this file using similar instructions as mentioned above.

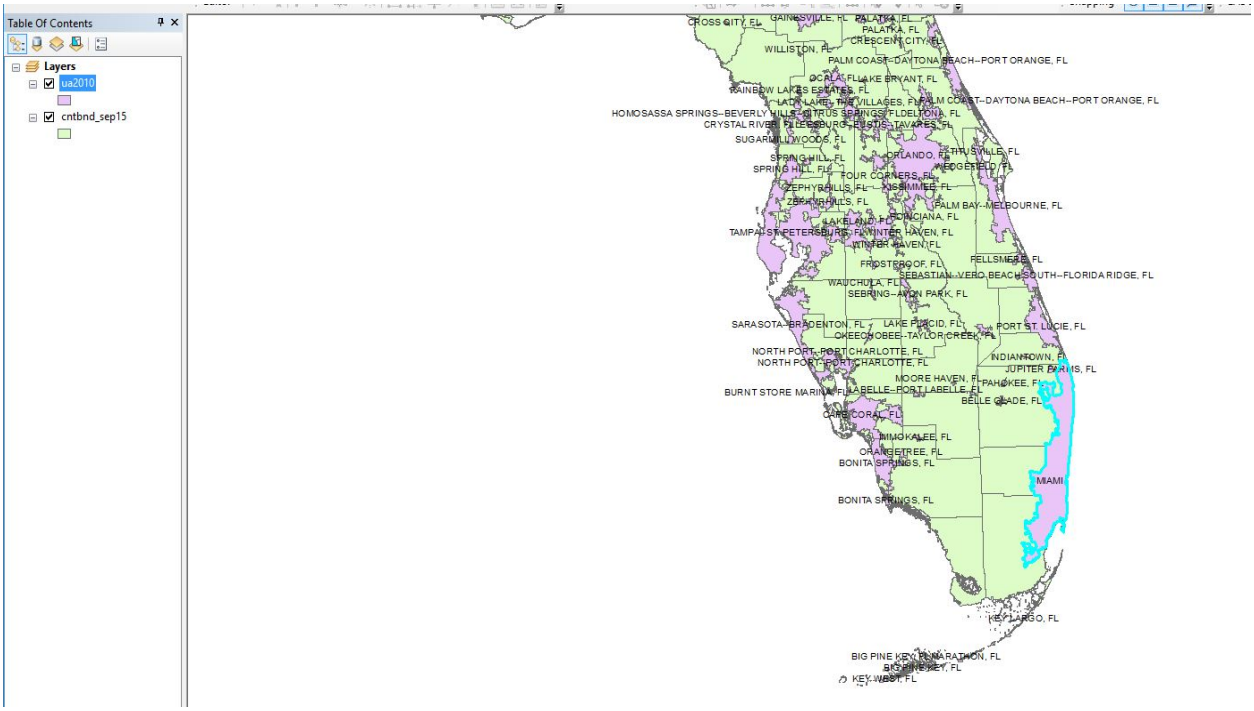


Figure 7- Florida urban areas with Miami highlighted

The next step was to just import the shoreline shp. file. The reason I used this file is because this can help demonstrate the effect of when I create the maps using the sea level changes.

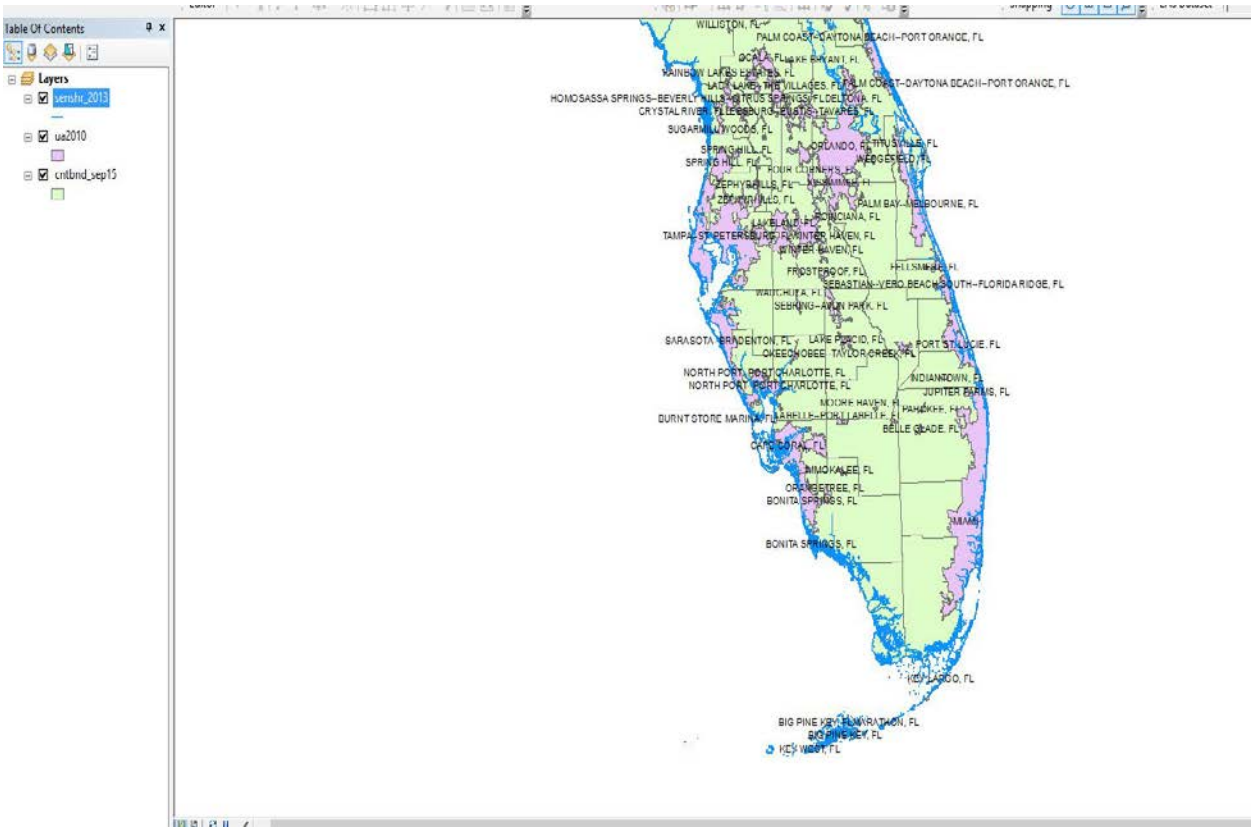


Figure 8- Florida shoreline incorporated with the urbanized areas

With the labels turned off for the urban areas, I then imported the cities shp. file. I found Miami in the attribute table and exported the data so it can just be one point on the map.

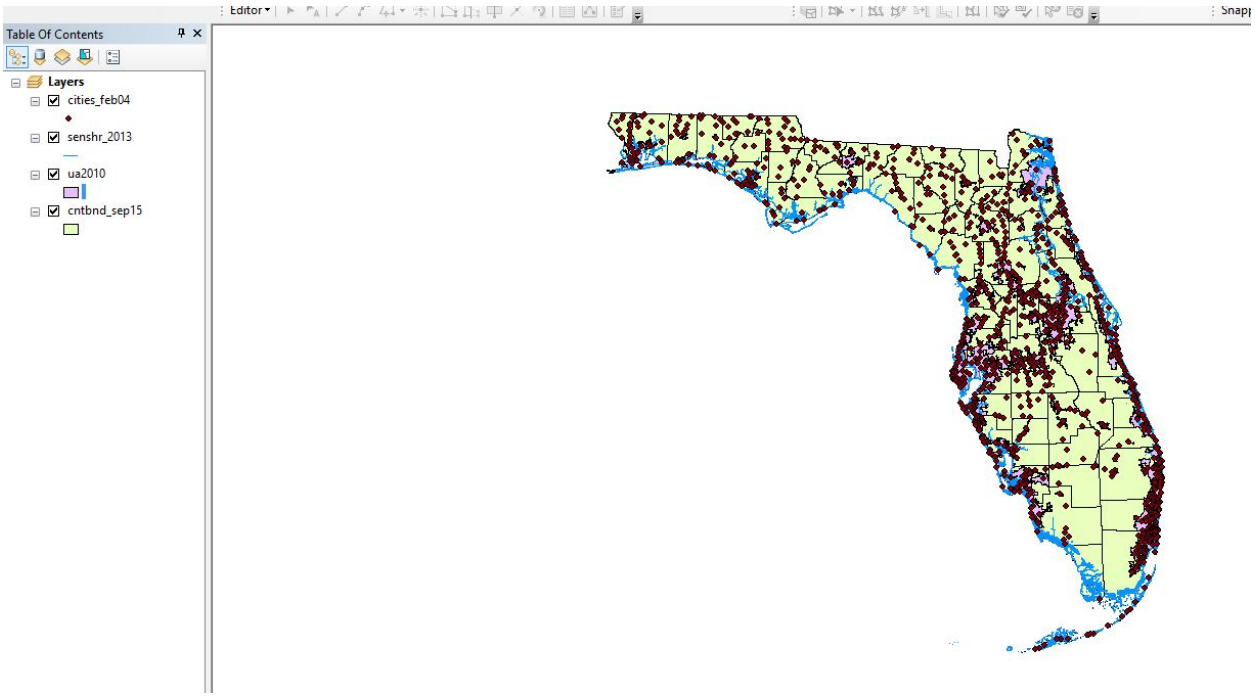


Figure 9-The state of florida with the shoreline, urban areas, and the new cities shp file.

Table

cities_feb04

FID	Shape	OBJECTID	CITIESX020	FEATURE	NAME	POP_RANGE	POP_2000	FIPS55	COUN
379	Point	1044	34672	COUNTY SEAT	MIAMI	250,000 - 499,999	362470	45000	MIAMI-DADE
374	Point	1039	34664	POPULATED PLACE	MIAMI BEACH	50,000 - 99,999	87933	45025	MIAMI-DADE
333	Point	998	34607	POPULATED PLACE	MIAMI GARDENS	UNDETERMINED	-99999	45050	BROWARD
345	Point	1010	34626	POPULATED PLACE	MIAMI GARDENS	UNDETERMINED	-99999	45060	MIAMI-DADE
357	Point	1022	34640	POPULATED PLACE	MIAMI LAKES	UNDETERMINED	-99999	45100	MIAMI-DADE
362	Point	1027	34647	POPULATED PLACE	MIAMI SHORES	10,000 - 49,999	10380	45175	MIAMI-DADE
375	Point	1040	34665	POPULATED PLACE	MIAMI SPRINGS	10,000 - 49,999	13712	45200	MIAMI-DADE
1000	Point	338	32871	POPULATED PLACE	MICANOPY	0 - 9,999	653	45225	ALACHUA C
156	Point	600	33838	POPULATED PLACE	MICCO	UNDETERMINED	-99999	45275	BREVARD C
712	Point	50	32050	POPULATED PLACE	MICCOSUKEE	UNDETERMINED	-99999	45300	LEON COUN
1095	Point	433	33292	POPULATED PLACE	MID FLORIDA LAKES	UNDETERMINED	-99999	45385	LAKE COUN
771	Point	109	32223	POPULATED PLACE	MIDDLEBURG	UNDETERMINED	-99999	45350	CLAY COUN
783	Point	121	32241	POPULATED PLACE	MIDWAY	0 - 9,999	1446	45425	GADSDEN C
816	Point	154	32321	POPULATED PLACE	MILLIGAN	UNDETERMINED	-99999	45600	OKALOOSA

0 (1 out of 1116 Selected)

cities_feb04

Figure 10- The city of Miami highlighted in the cities attribute file

The outcome of exporting Miami from the cities shp file can be seen below. I symbolized the point with a red triangle.

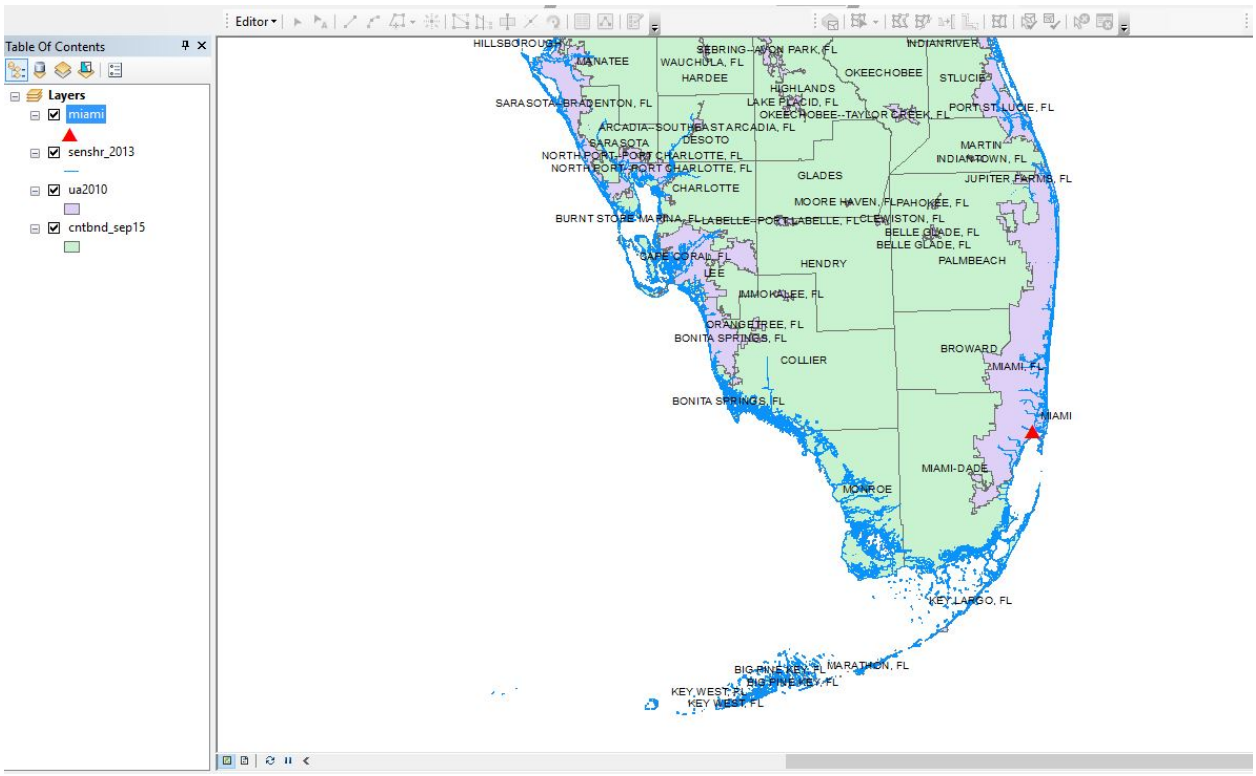


Figure 11- The city of Miami relative to the state of Florida

Using the two elevation rasters that I downloaded online, I imported them into the same file. I turned off the urban areas and kept the labels for the counties on. The two quadrangles of the DEMs are basically stitched right next to each other but as I mentioned before, my focus is in Miam-dade county and Miami, FL.

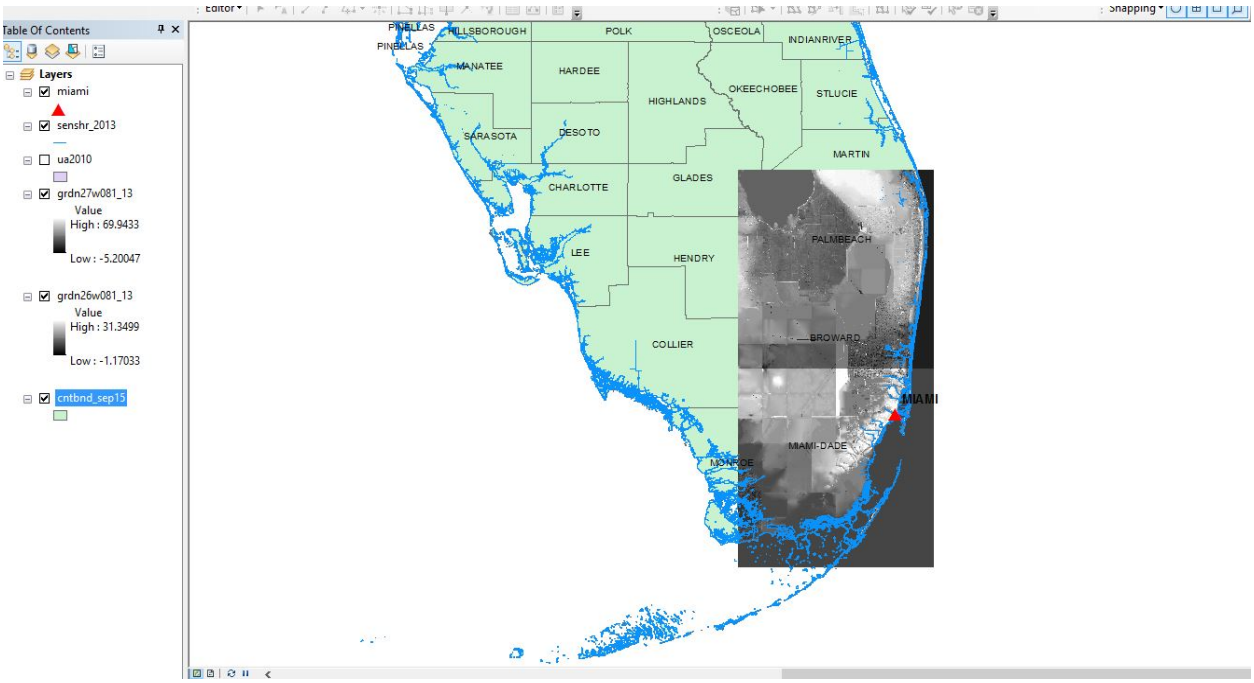


Figure 12- The two DEM rasters downloaded online relative to the state of Florida

With a hollow color for the county boundaries, the labels and outlines can still be seen on the DEM. The reason to why I only used the bottom DEM is because of my focus area. The zoomed in area can be seen below.

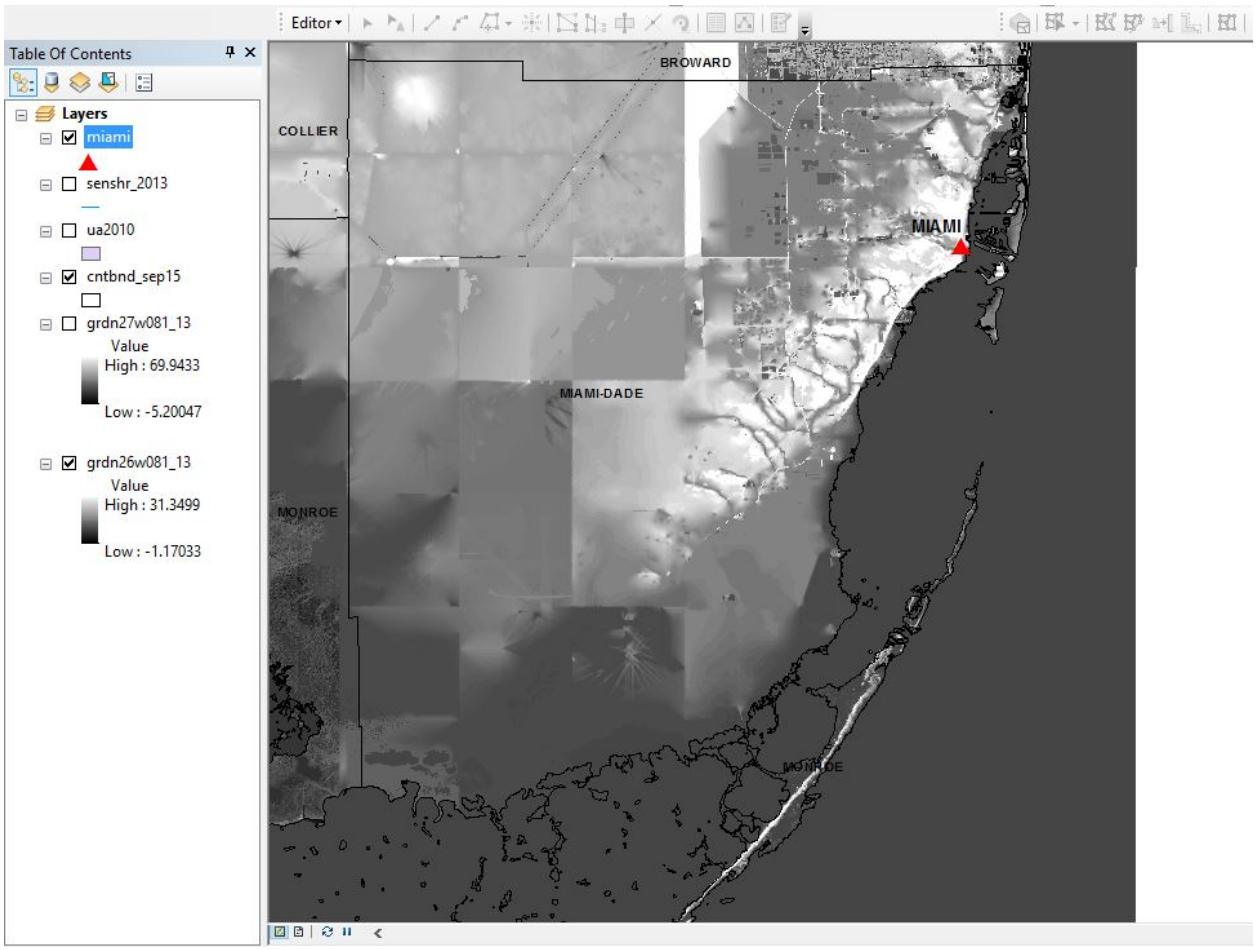


Figure 13- DEM that includes Miami-dade and the city of Miami

After zooming in my focus area, I decided to create a hillshade to show topography in the map. The steps I did to create it can be see below and the result is to left of it. It can also be seen that the shoreline can be correlated with the hill shade.

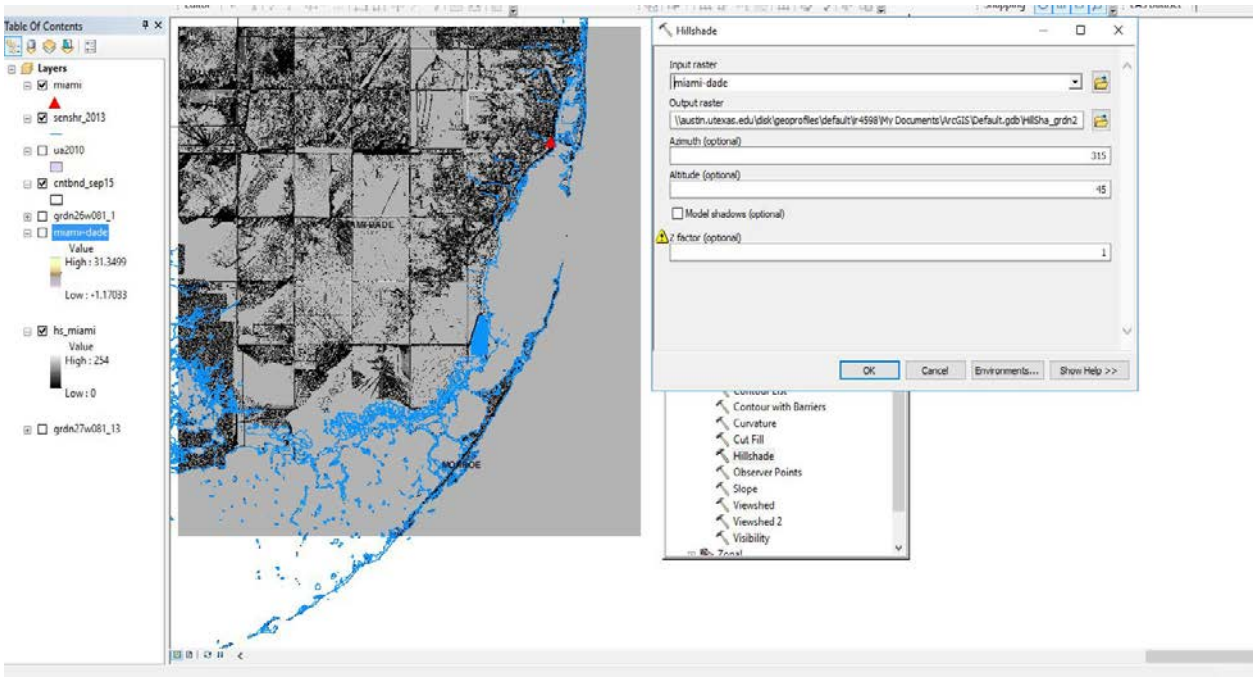


Figure 14- The creation and the result of the hillshade

After creating the hillshade, I symbolized my “Miami-dade” DEM with an inverted Elevation #2 color scheme. The purple color represent low sea level and greenish-blue is correlated with high elevations. I also made sue that my hillshade is below the DEM file in the TOC as I added a 40% transparency.

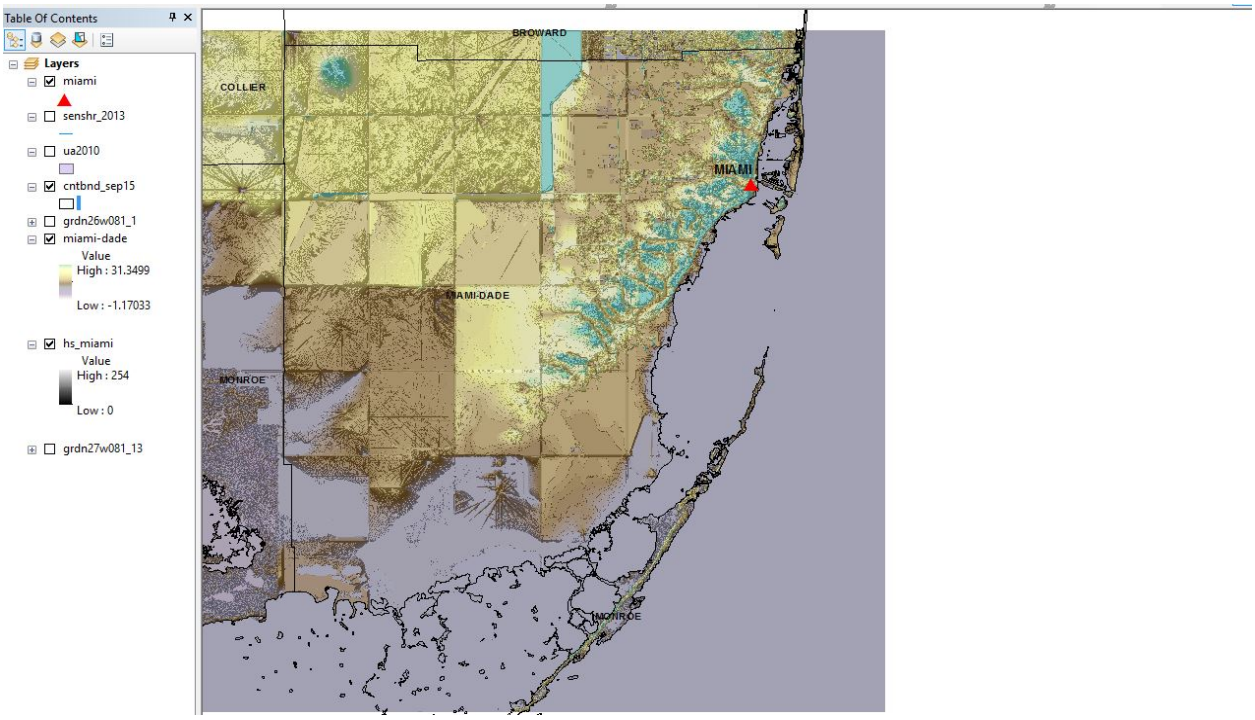


Figure 15- The Elevation #2 color scheme for the DEM file

To better represent the color scheme, I adjusted the n value to 1.5. The result can be seen below.

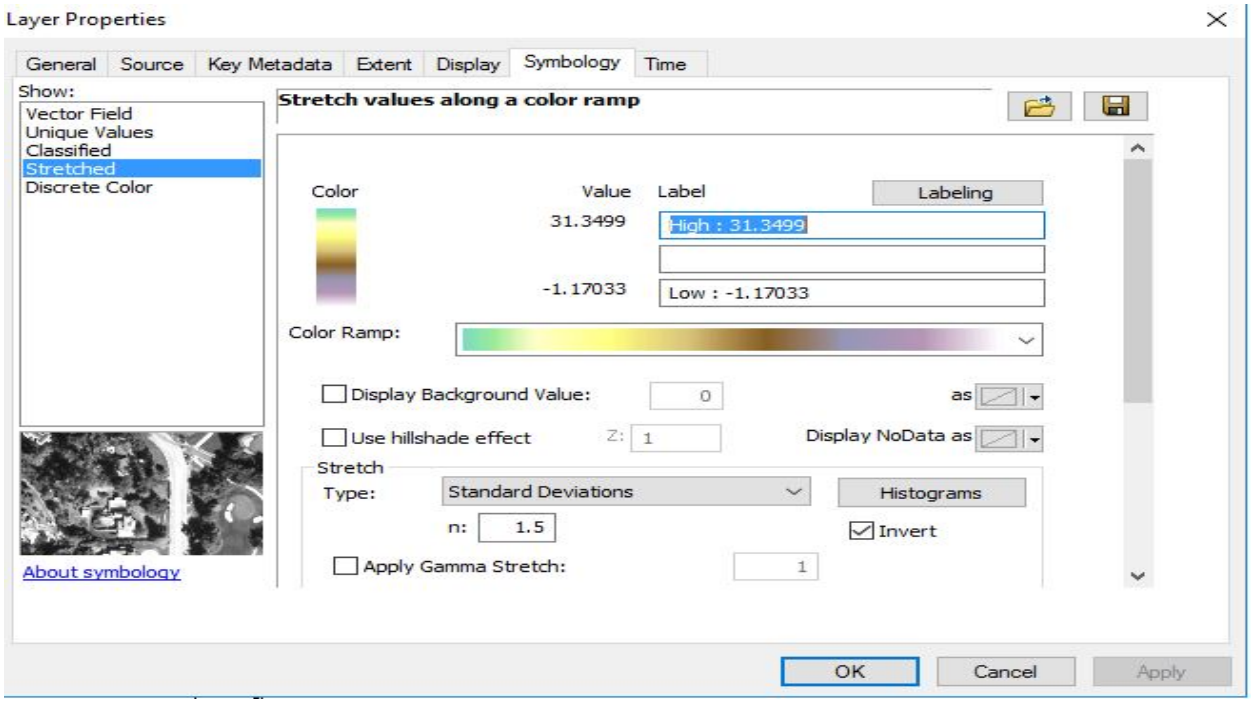


Figure 16- Properties > Symbology adjust to n=1.5

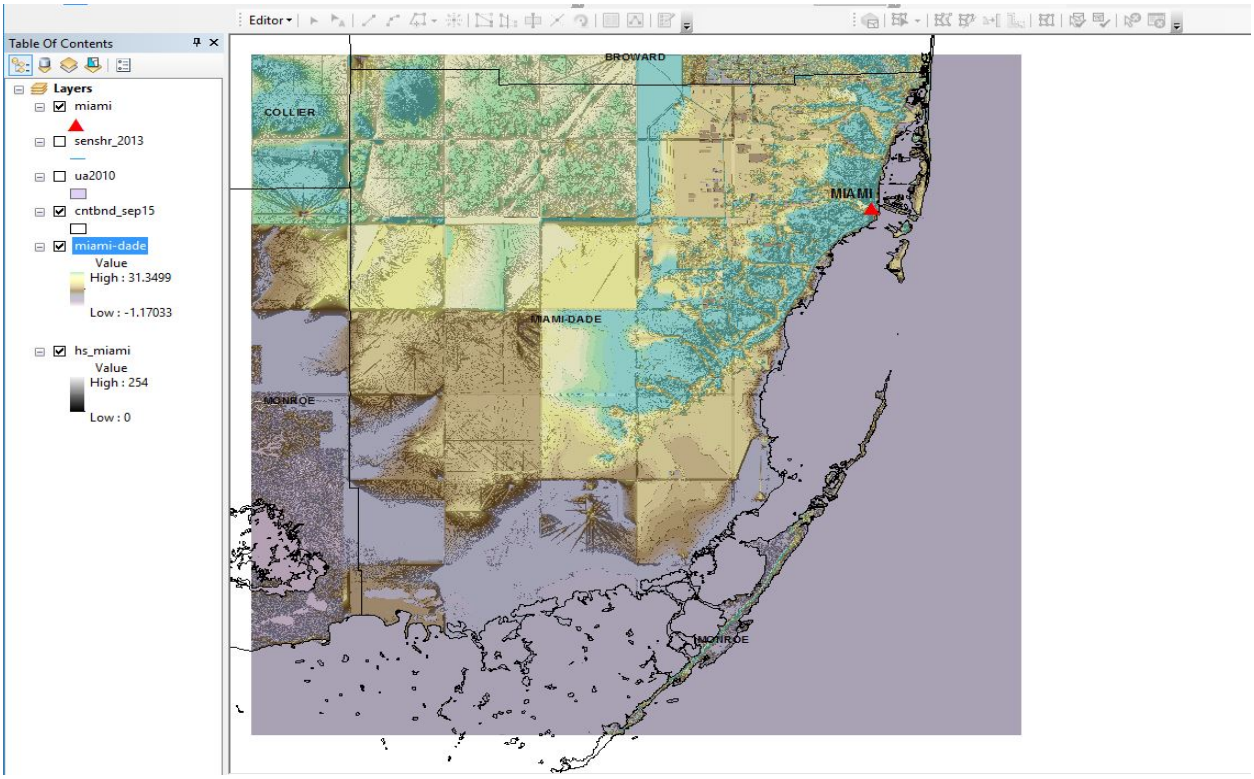


Figure 17 – The result of adjusting the n-value.

To show the areas below sea level (water), I used the following conditional statement with raster calculator tool (Arc Toolbox > Spatial Analyst >Map algebra > Raster Calculator):

Con("Miami-dade" <= 0,1).

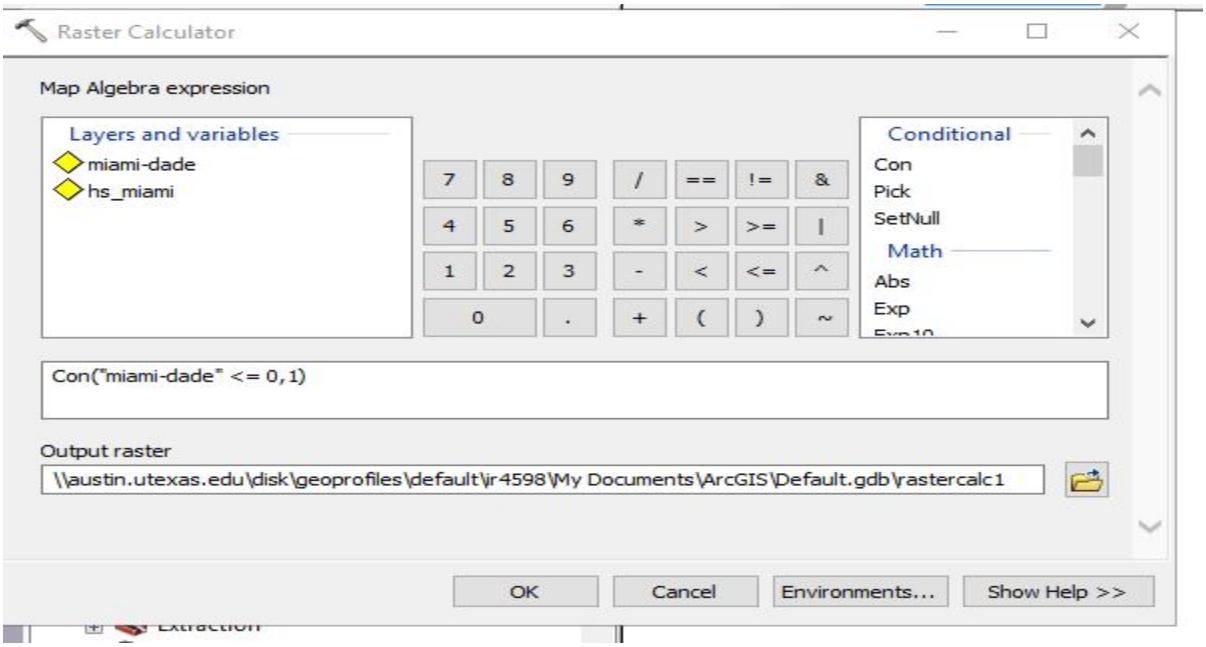


Figure 18- The conditional statement that is representative of areas below sea level

As you can see in the figure below, some areas in the southwest side of Florida are below sea level when in reality land might actually be present. However, this can be due to topography of the area when the data was gathered, for example tides can affect this.

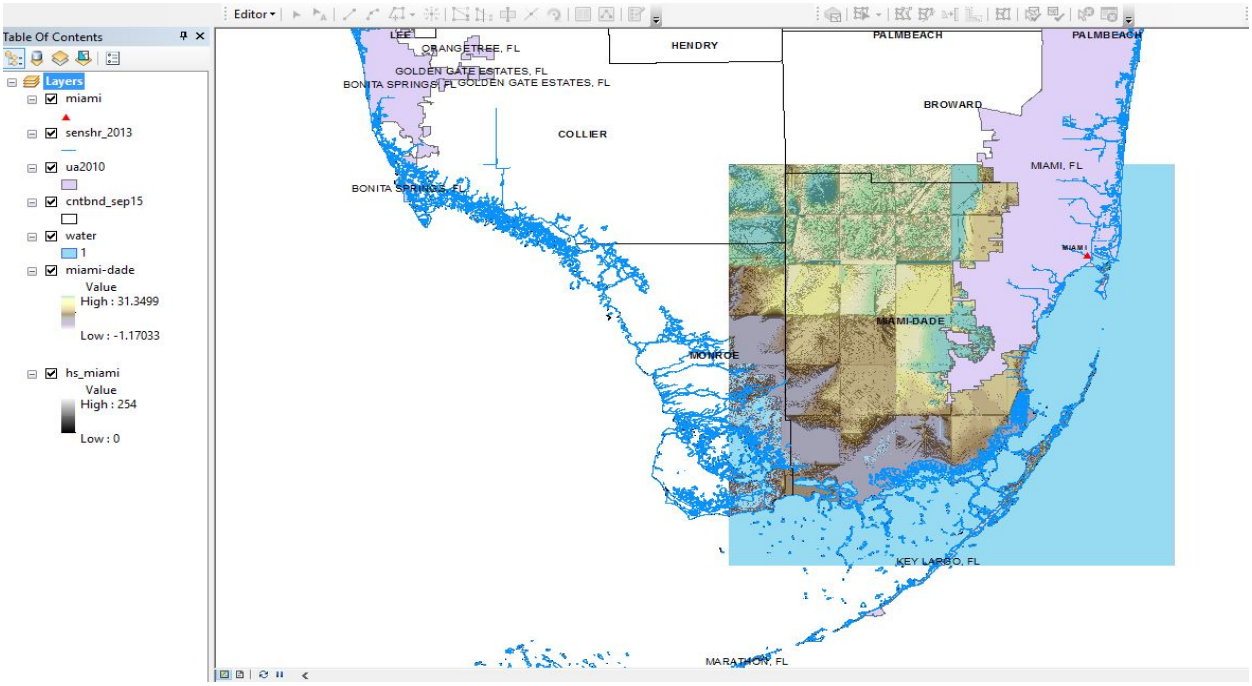


Figure 19- The result of the conditional statement with all other shp files.

I thought I was wrong in my part so I decided to find the DEM raster to the west of the one I am investigating and created a new mosaic. The result is shown below and it can be said that there is no difference. It is safe to say that the “error” is not on my end. However, this is something that can definitely be investigated in the future.

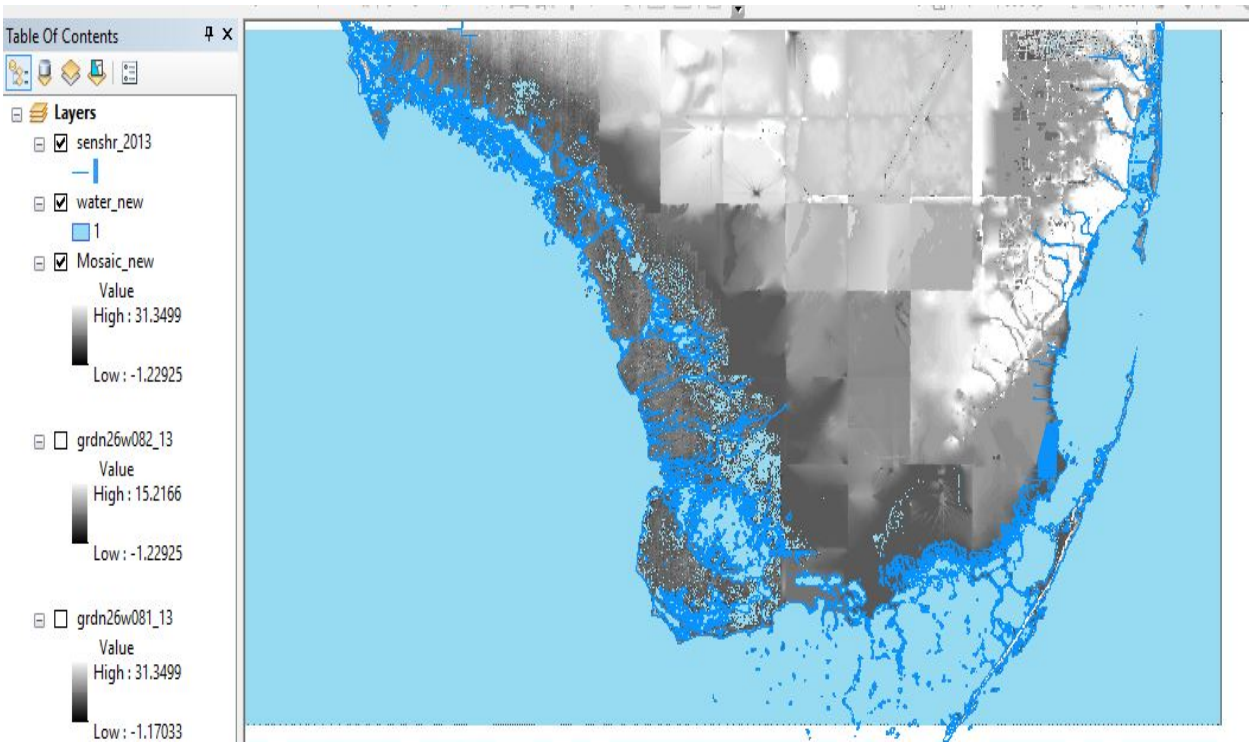


Figure 20- A screenshot of the mosaic that pieced two DEM rasters. Blue color is below sea level

To make things look prettier, I decided to clip all the features in the DEM file. The downloaded file came with a shp file which help clip the shoreline, urban areas, and counties. The shp file can be seen below.

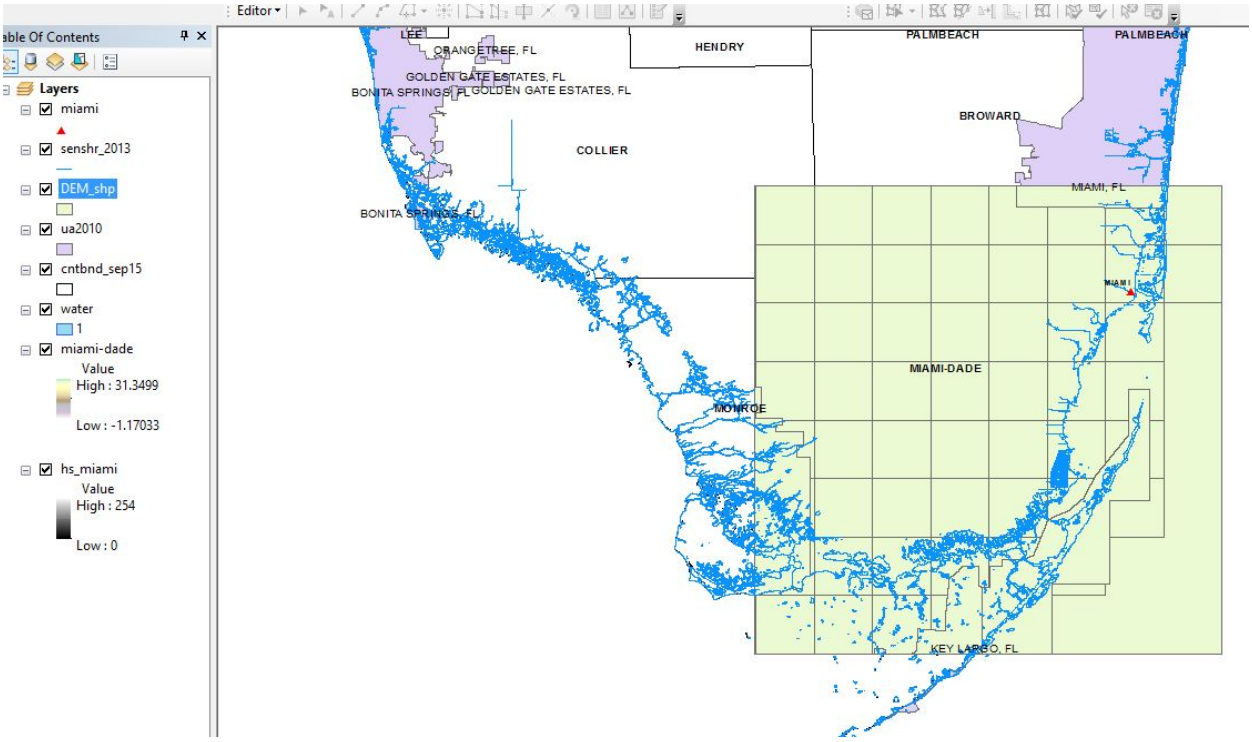


Figure 21- The DEM shp file that is used to clip the features

Using the clip tool to clip the three features inside the DEM shp file, the figure below shows the end result.

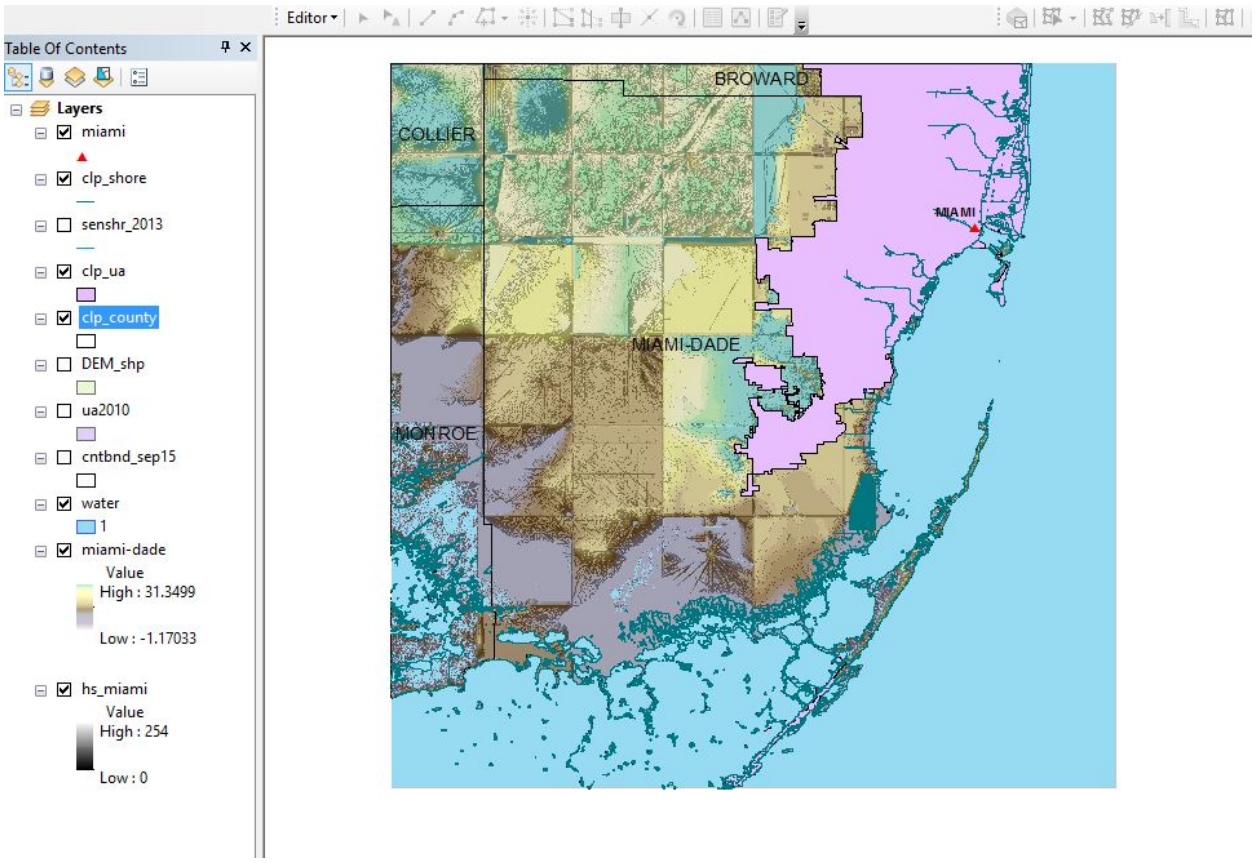


Figure 22- The clipped map inside the DEM raster

In order to display sea level rise, the raster calculator was used. For example, the equation for a 1 m sea level rise can be seen below. This just means that another raster will be made and all the areas that are 1m or less in elevation will be wiped out. .

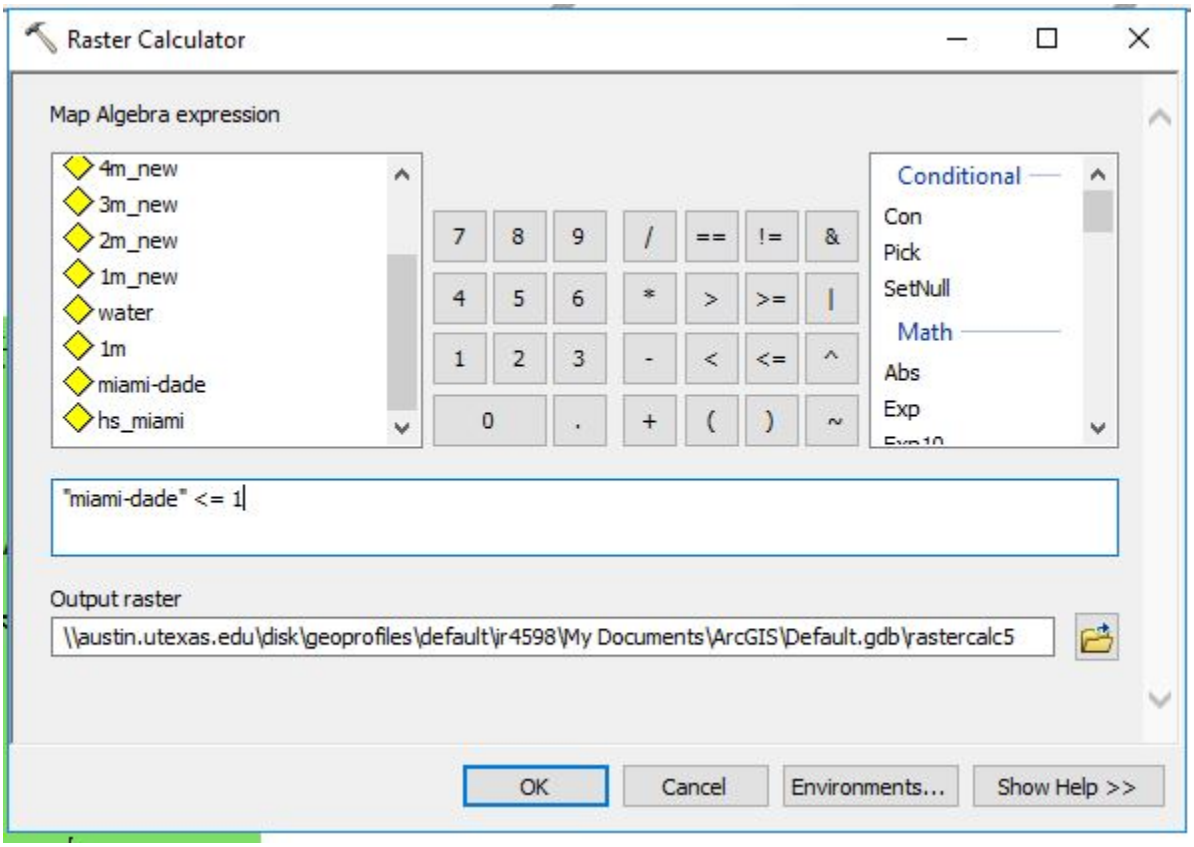


Figure 23- The equation in "raster calculator" for a 1m sea level rise

The figure below shows how Miami-dade would look after a 1m sea level rise. The same process was done for the rest of the sea level changes.

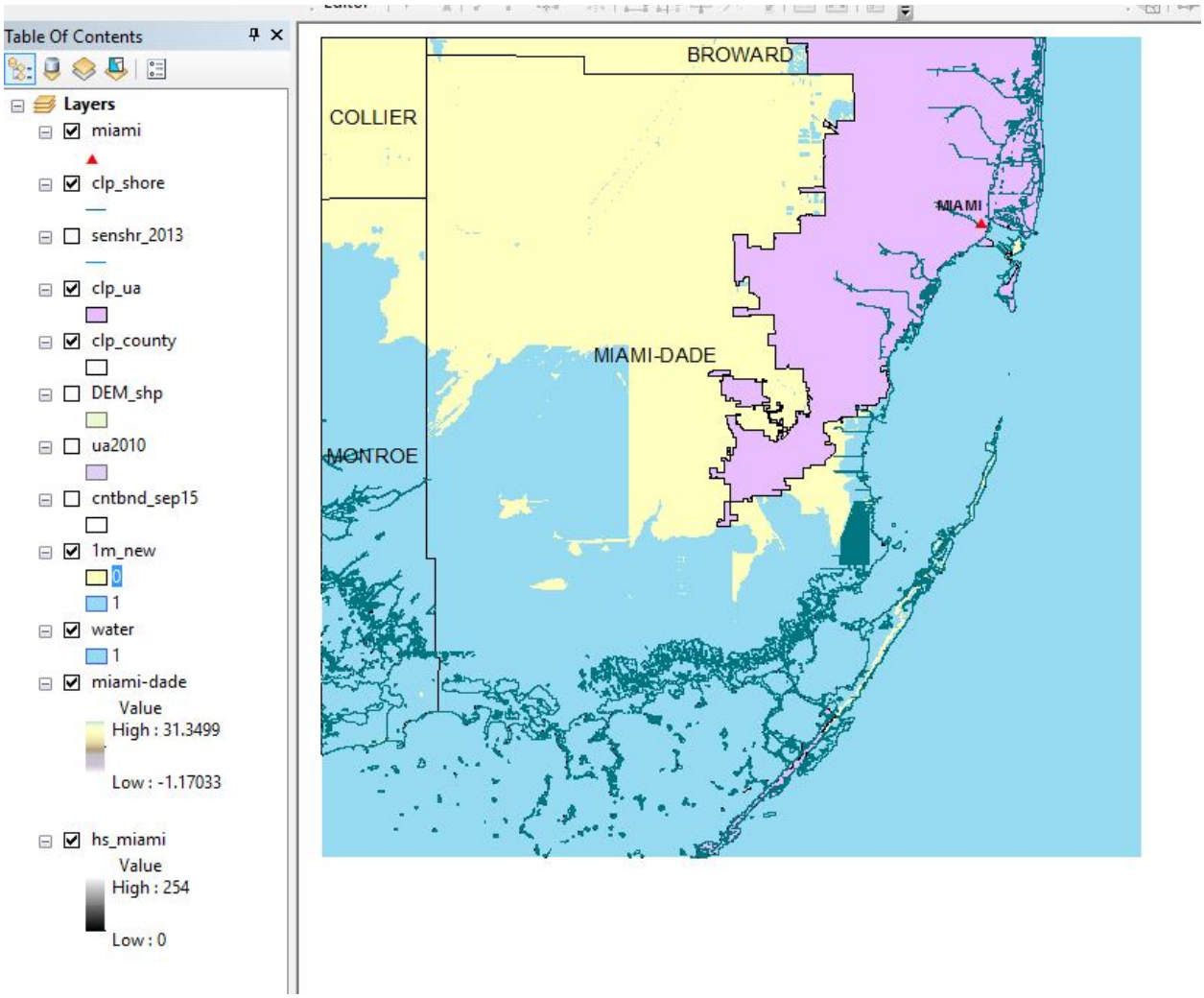
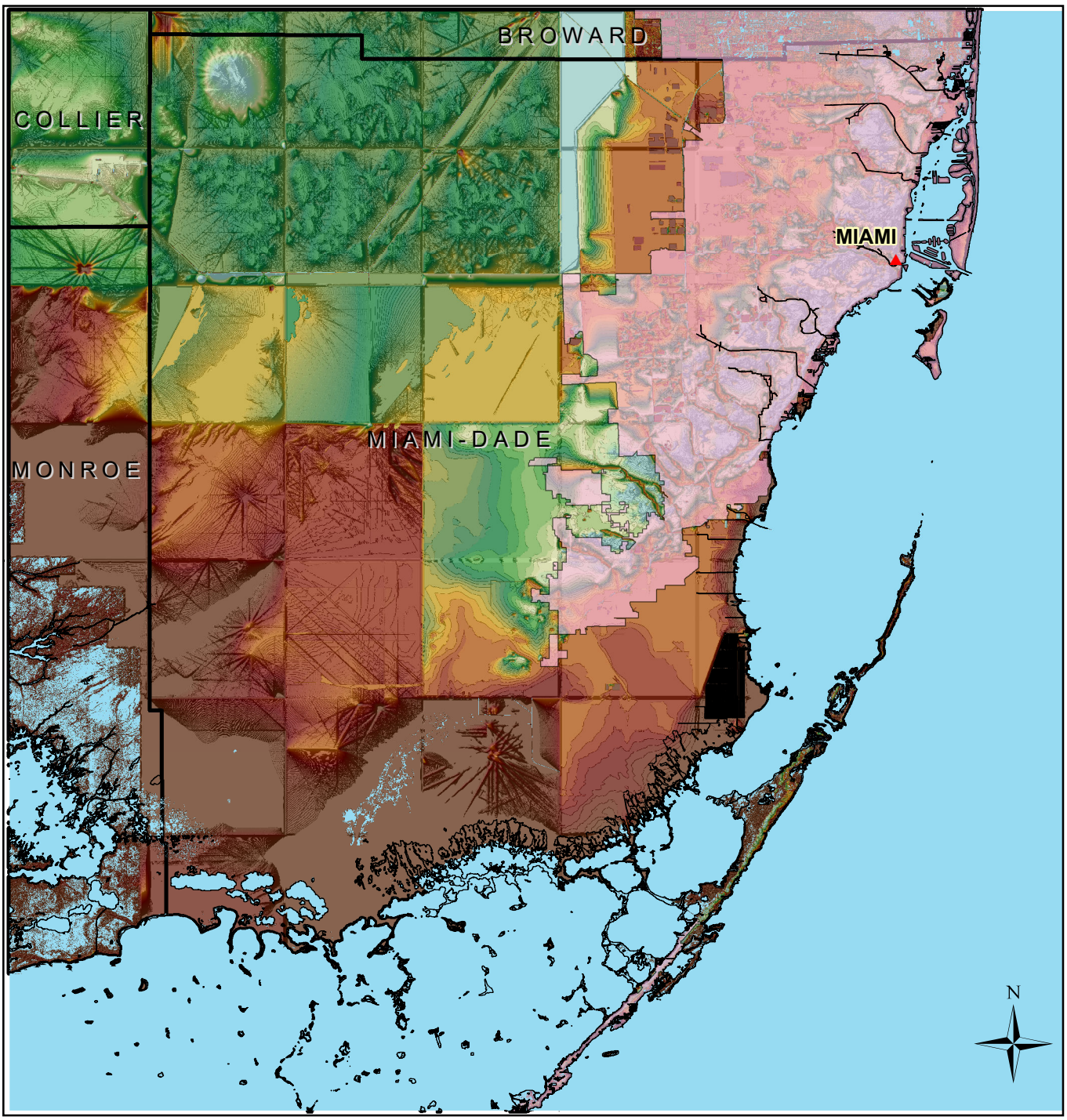


Figure 24- Screenshot of the result of a 1m sea level rise

The following images represent the final maps of the various seal level rises. The shoreline in the final maps represents to what we see today.

Izaak Ruiz
Dec. 05, 2016

Present Day Sea Level of Miami-dade County, Florida



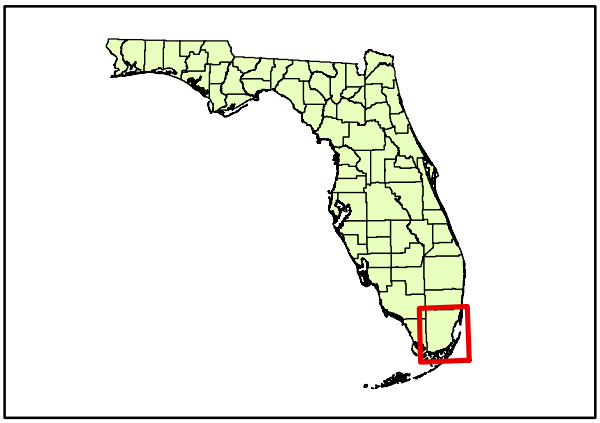
Explanation

- Shoreline
- Urban area
- Below sea level
- County boundary

NAD 1983 HARN

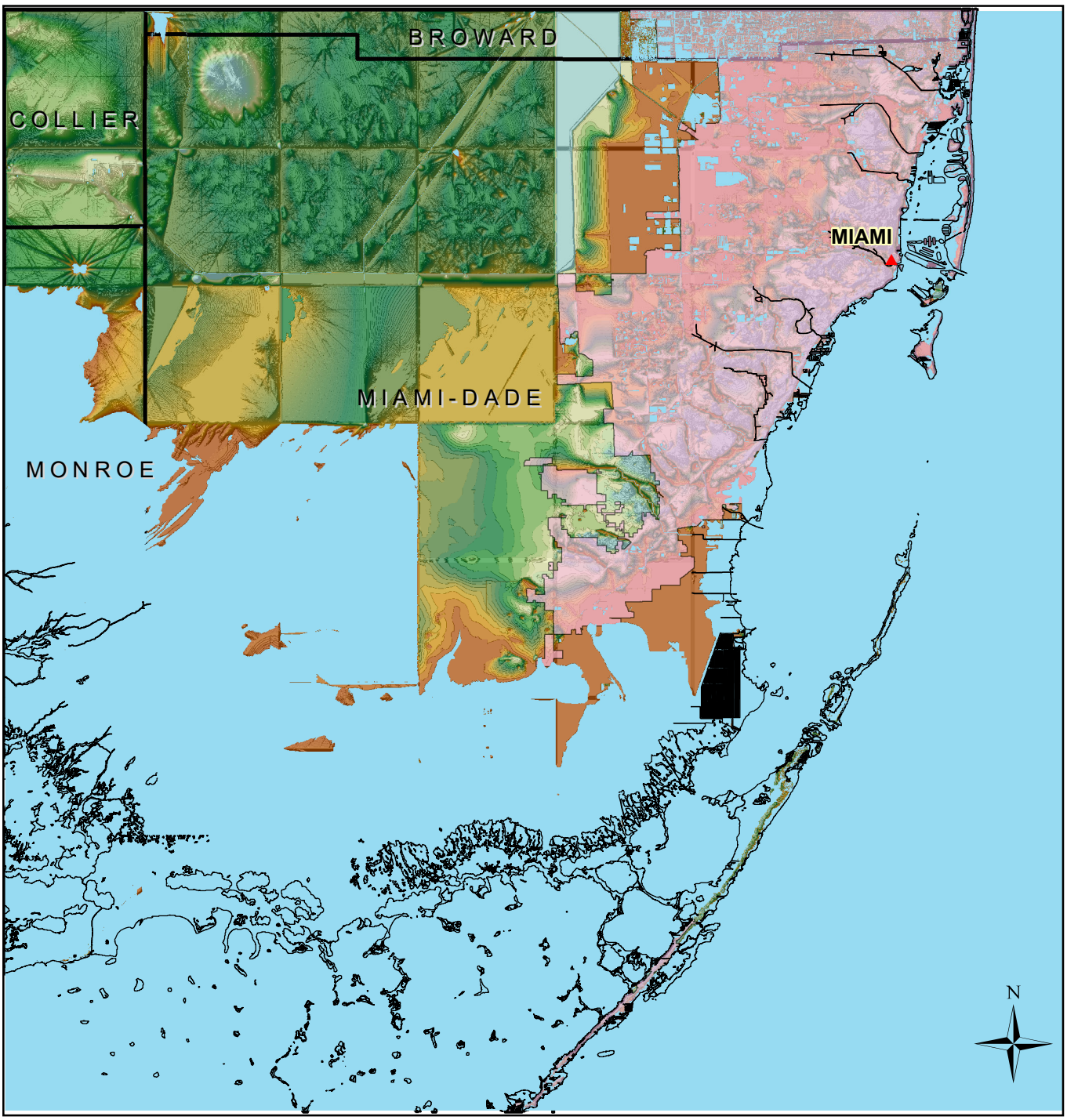
0 12.5 25 50 Kilometers

1:600,000



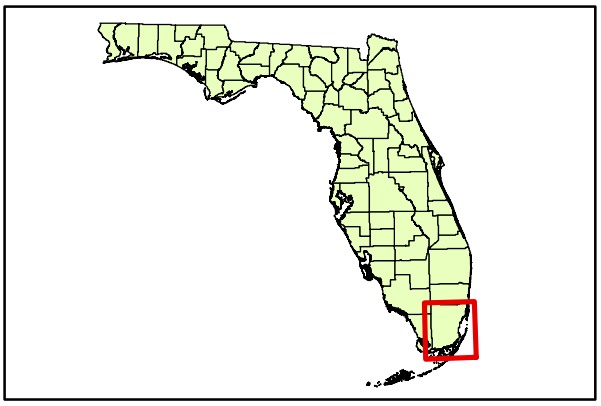
Izaak Ruiz
Dec. 05, 2016

Present Day + 1m Sea Level Rise on Miami-dade County, Florida



Explanation

- Shoreline
- Urban area
- Below sea level
- County boundary



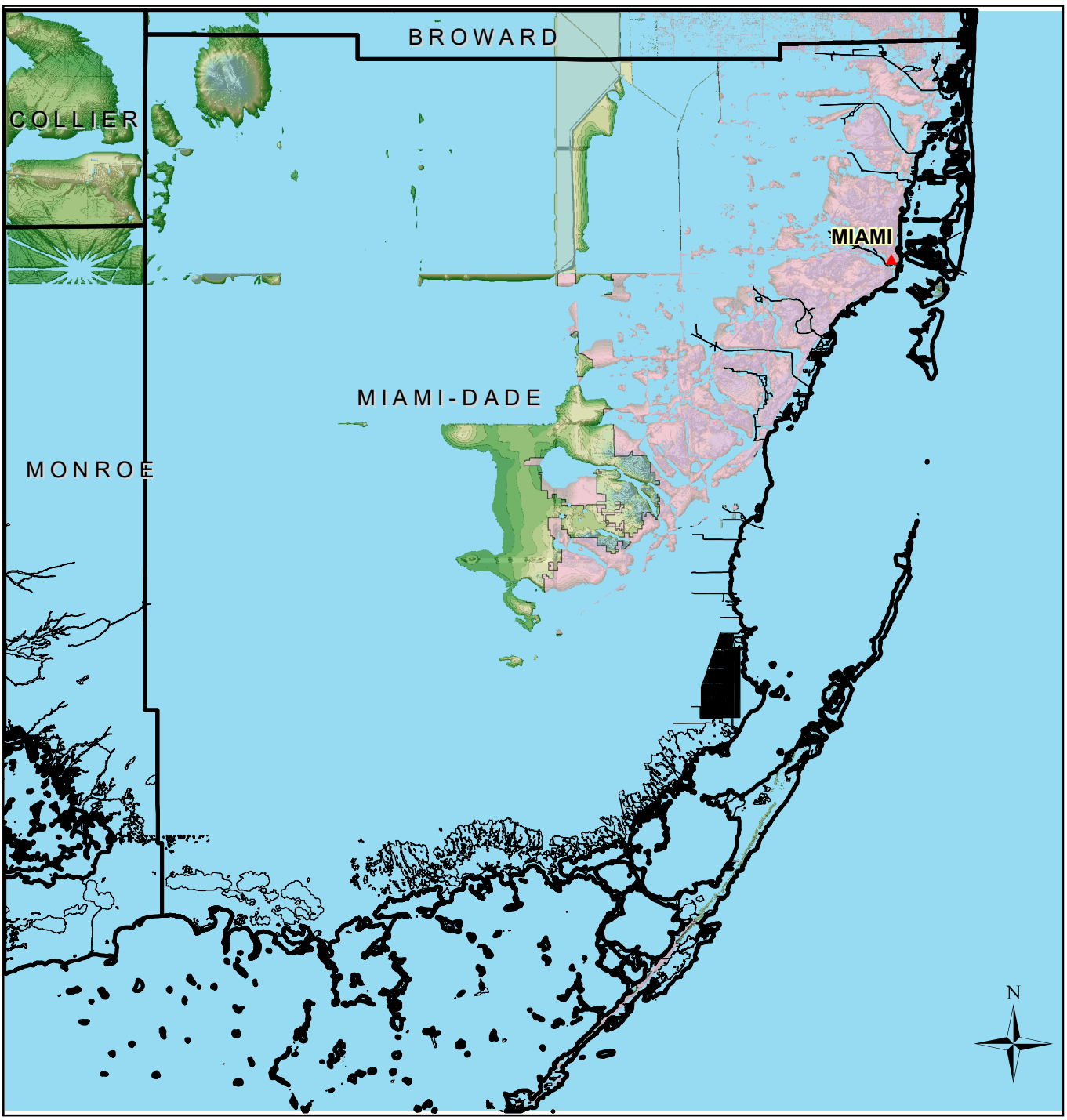
NAD 1983 HARN

0 12.5 25 50 Kilometers

1:600,000

Izaak Ruiz
Dec. 05, 2016

Present Day + 2m Sea Level Rise on Miami-dade County, Florida



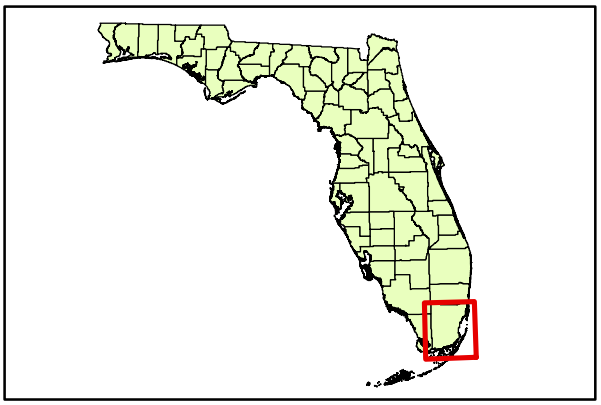
Explanation

- Shoreline
- Below sea level
- Urban area
- County boundary

NAD 1983 HARN

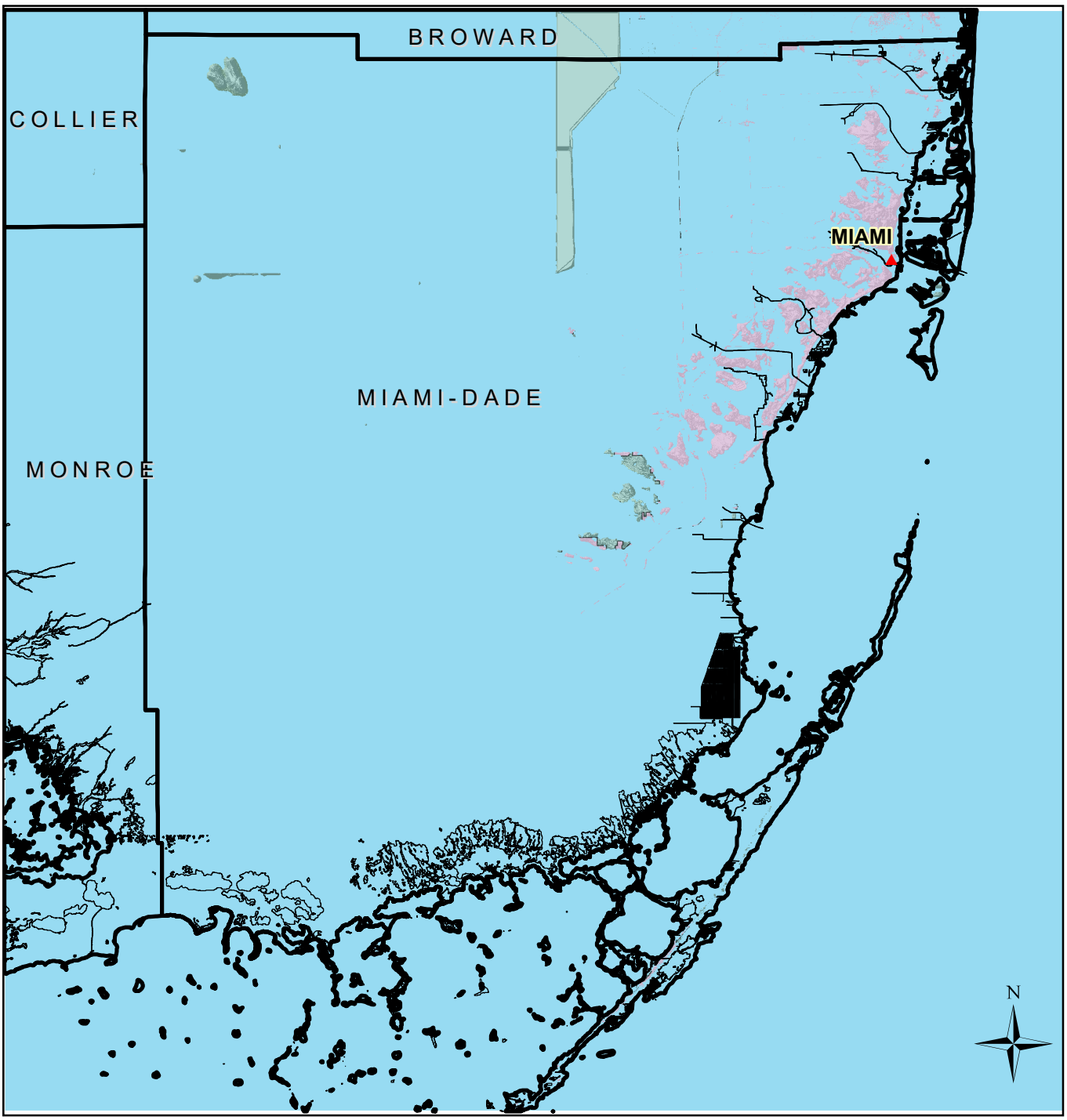
0 12.5 25 50 Kilometers

1:600,000



Izaak Ruiz
Dec. 05, 2016

Present Day + 3m Sea Level Rise on Miami-dade County, Florida



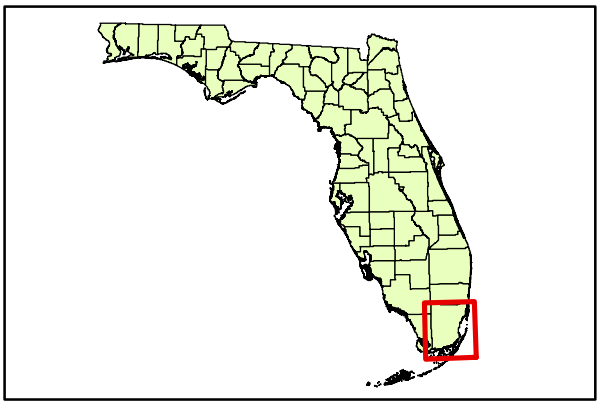
Explanation

- Shoreline
- Below sea level
- Urban area
- County boundary

NAD 1983 HARN

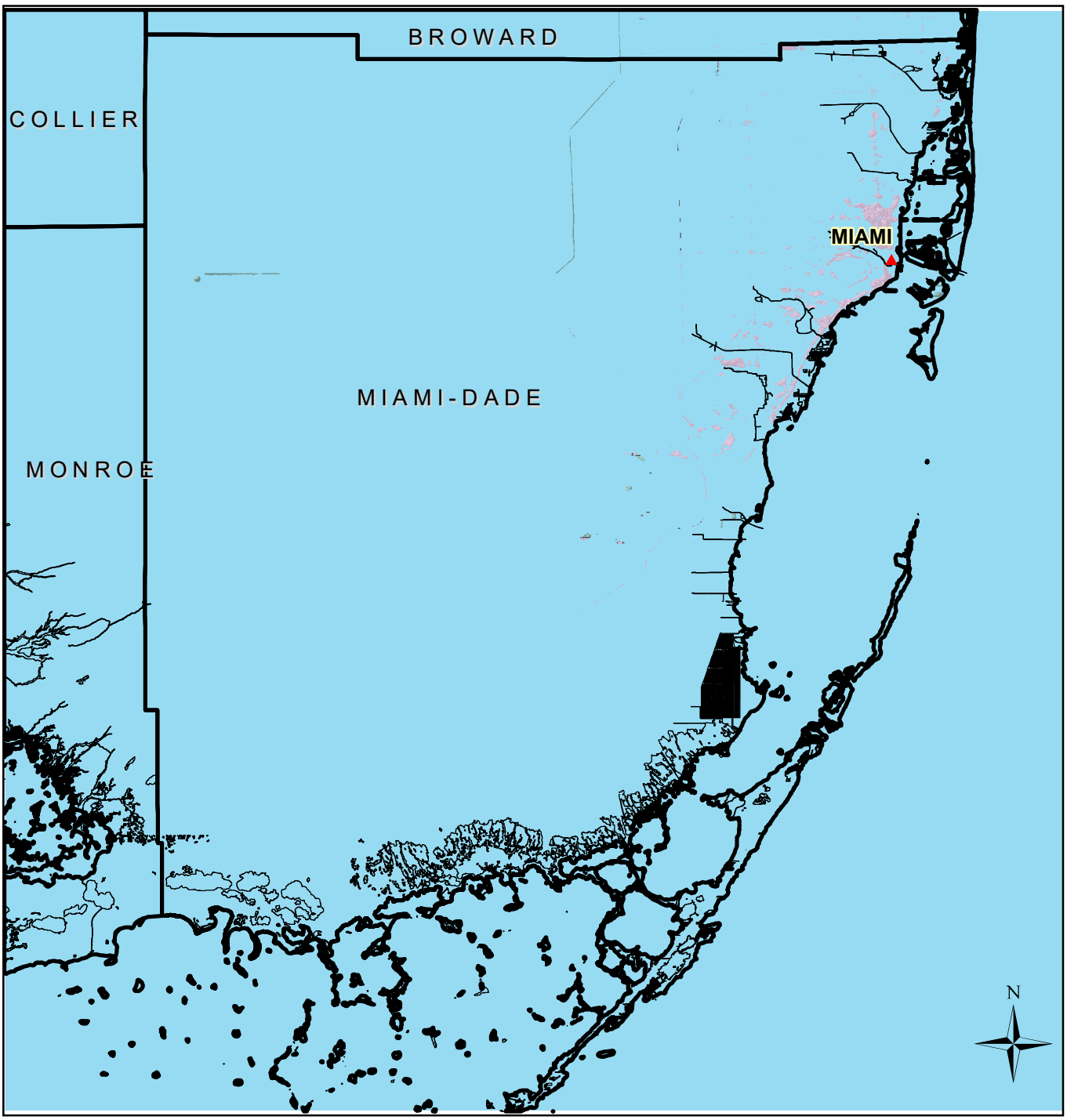
0 12.5 25 50 Kilometers

1:600,000



Izaak Ruiz
Dec. 05, 2016

Present Day + 4m Sea Level Rise on Miami-dade County, Florida



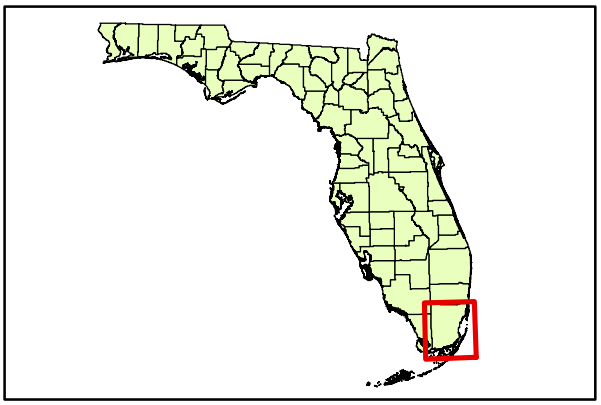
Explanation

- Shoreline
- Below sea level
- Urban area
- County boundary

NAD 1983 HARN

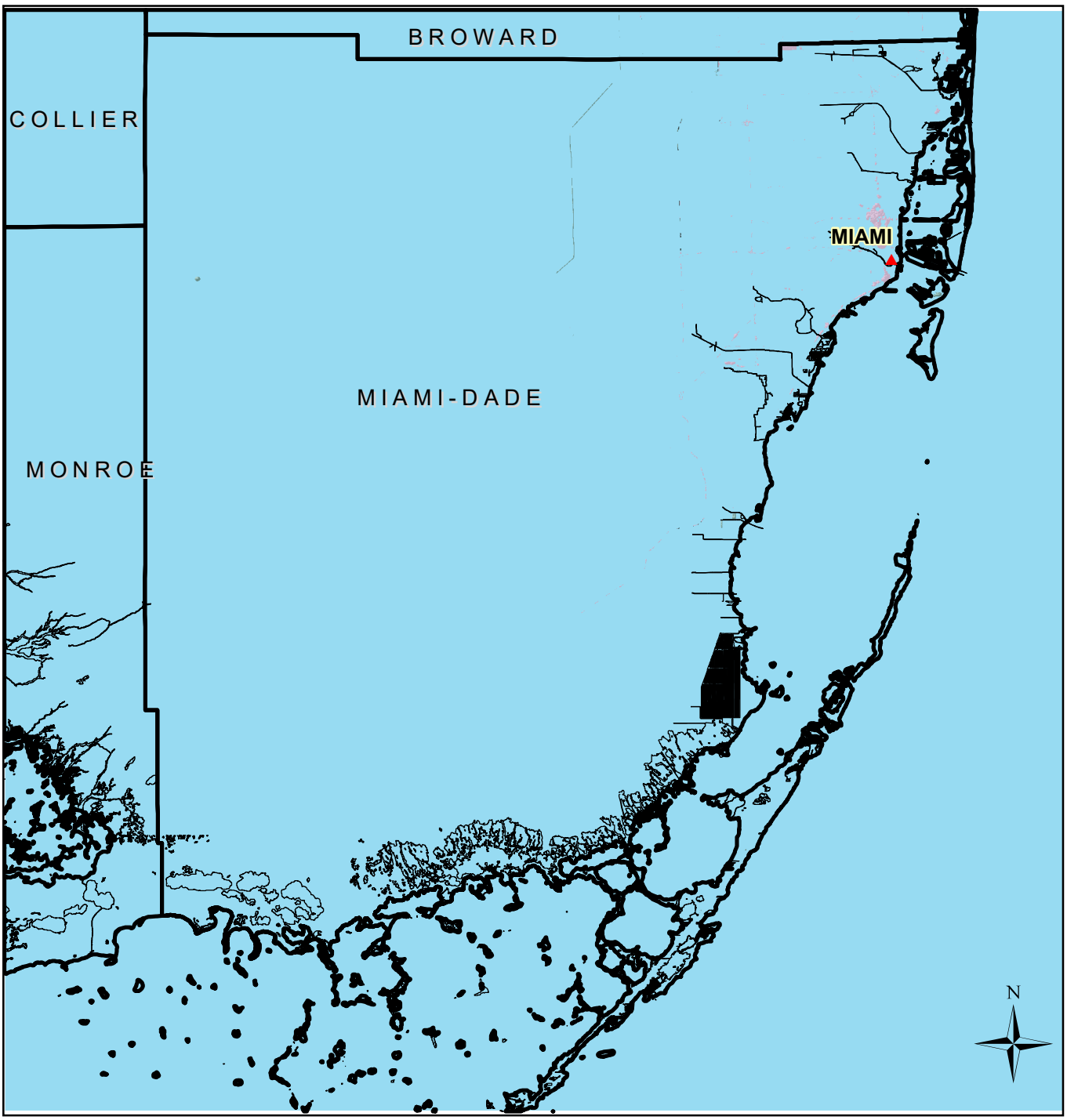
0 12.5 25 50 Kilometers

1:600,000



Izaak Ruiz
Dec. 05, 2016

Present Day + 5m Sea Level Rise on Miami-dade County, Florida



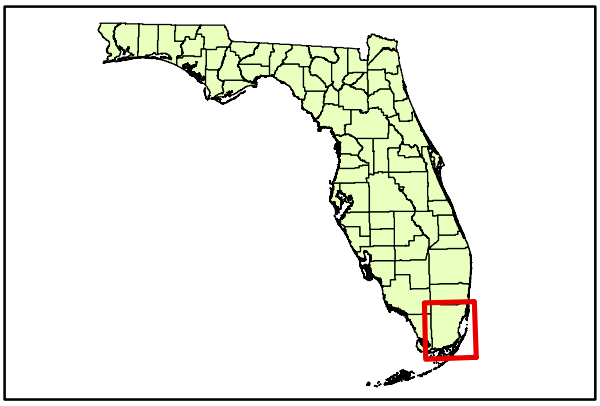
Explanation

- Shoreline
- Below sea level
- Urban area
- County boundary

NAD 1983 HARN

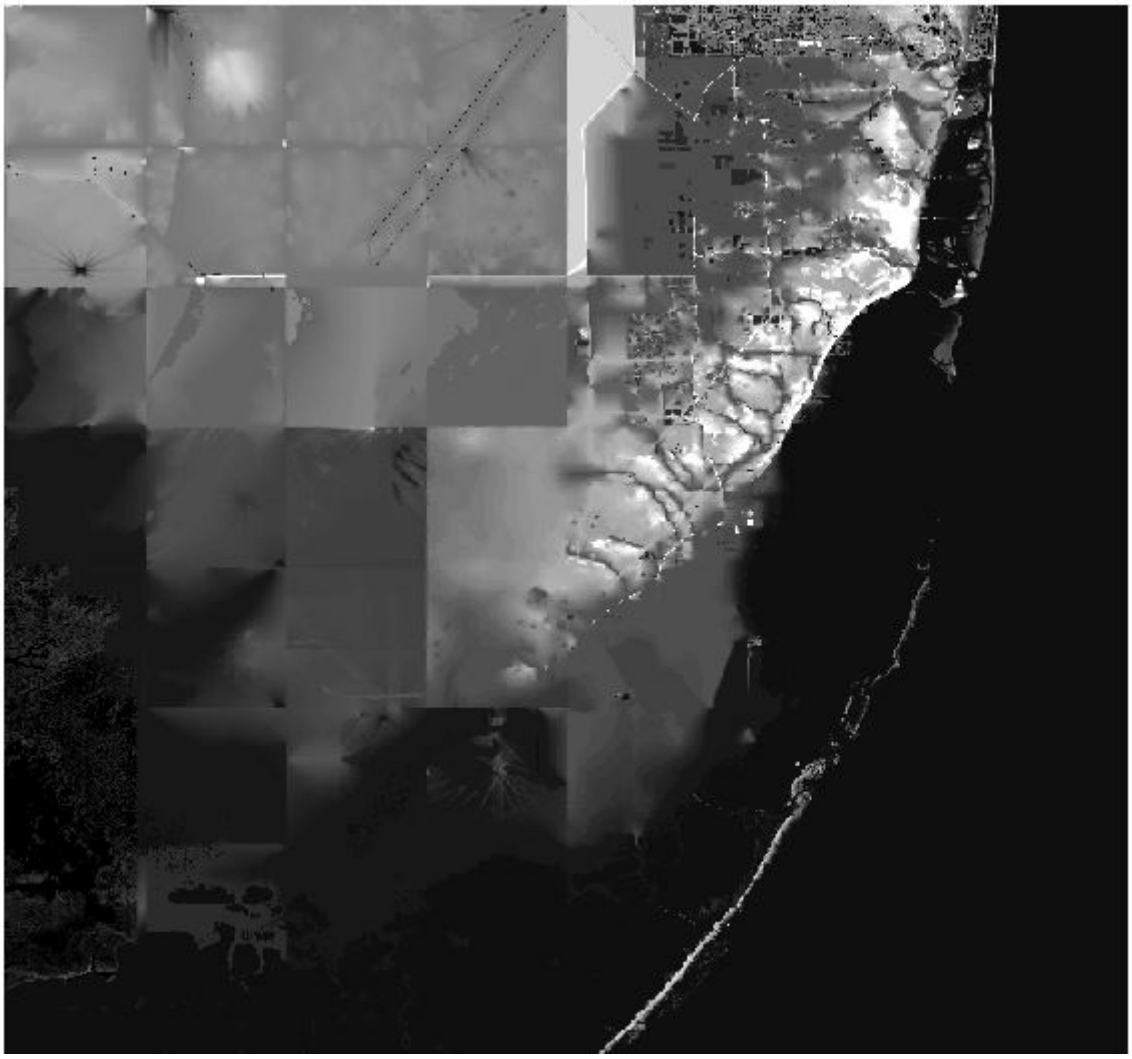
0 12.5 25 50 Kilometers

1:600,000

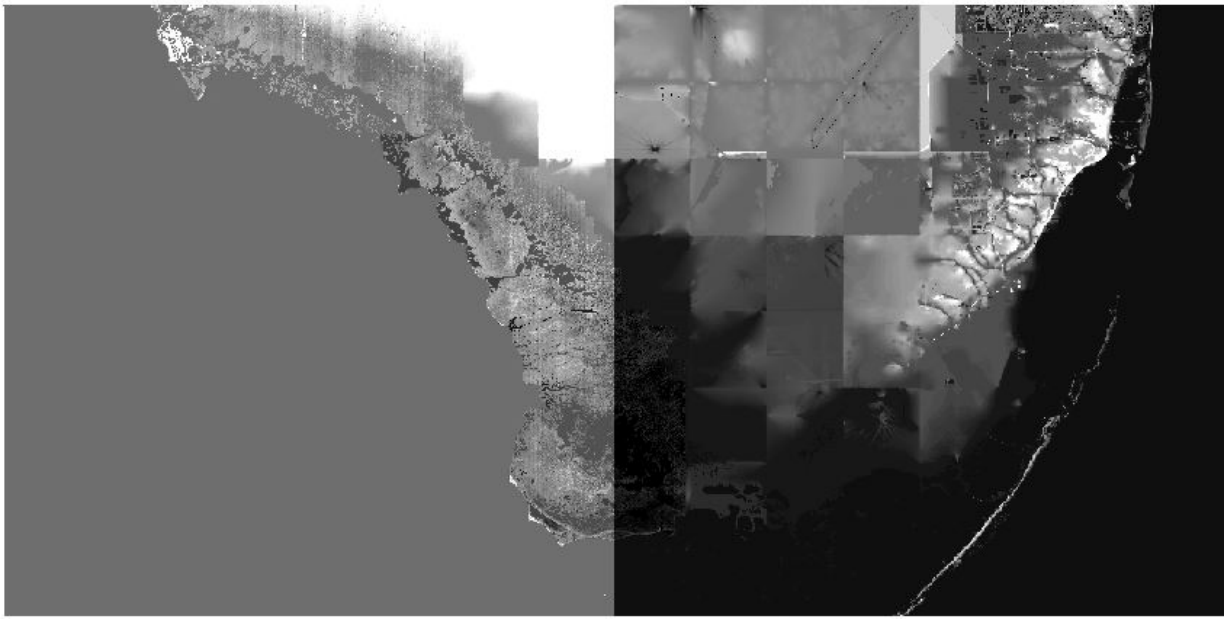


Limitations

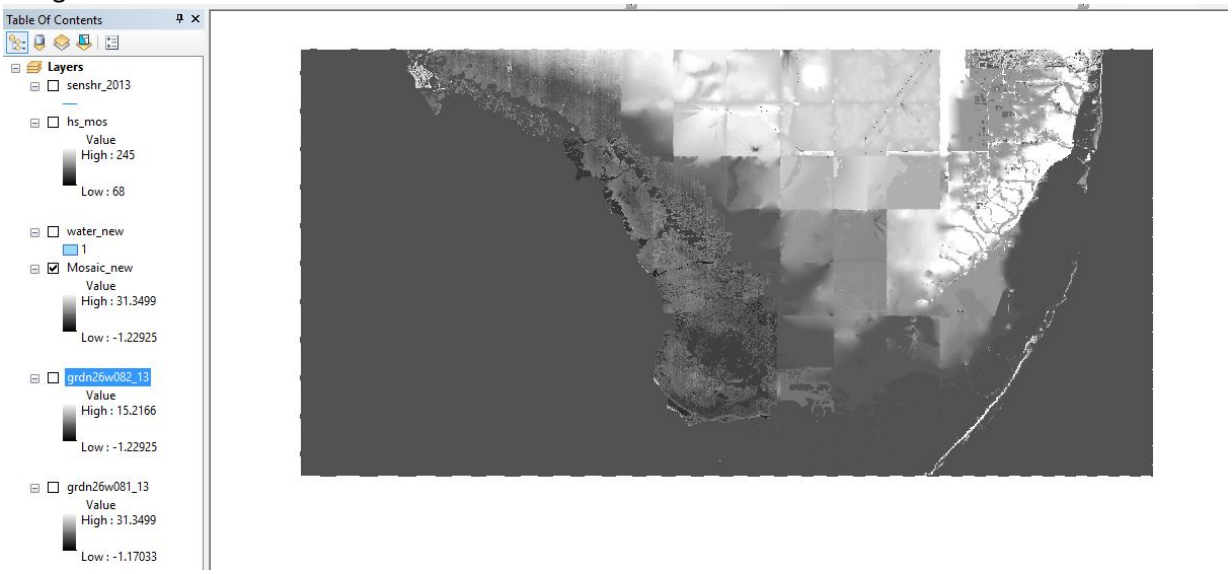
When I imported the DEM file that included Miami-dade county and the city of Miami from the National Map website into ArcMap, I noticed that it did not show a smooth surface. You can see what I mean below.



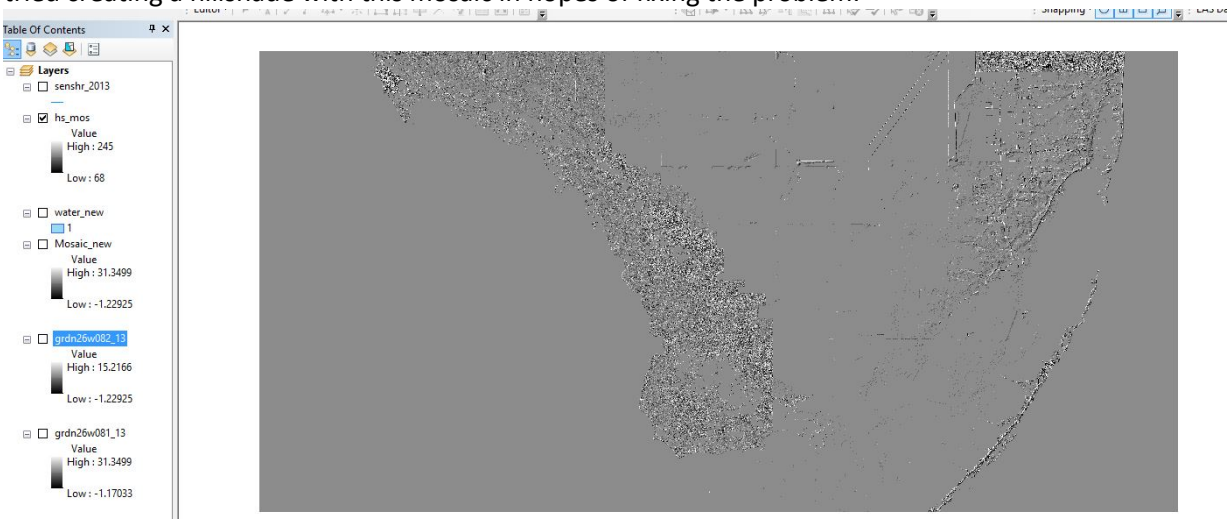
You can see that there are individual tiles within the raster. I found this to be very weird so I decided to try fixing this. I downloaded another DEM file to the west of the one above. The image below shows both rasters.



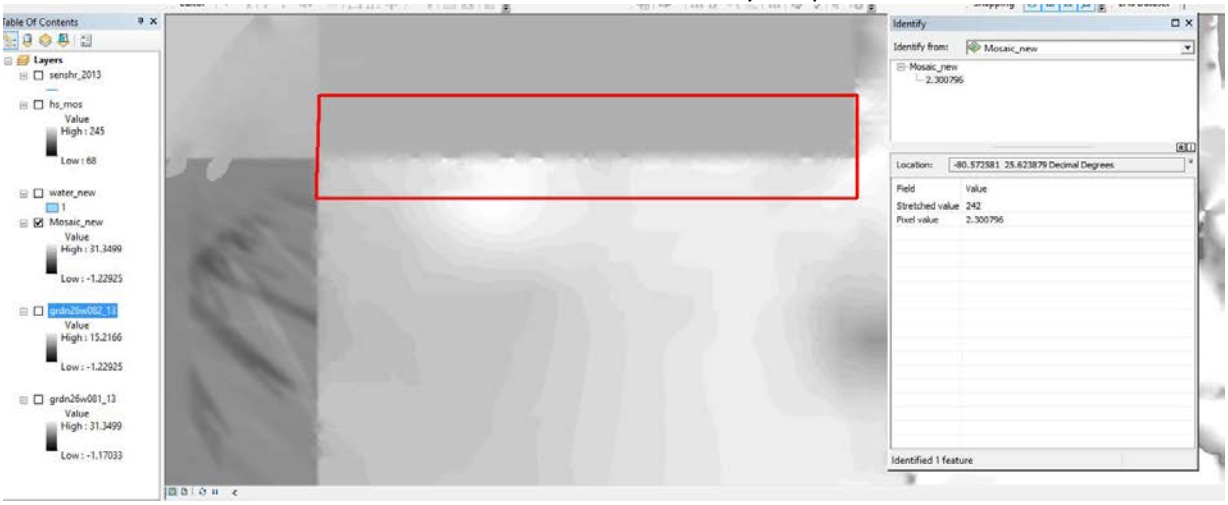
The West DEM shows a better surface so I then decided to make a mosaic out of these two rasters using the mosaic to new raster tool. The result can be seen below.



As you can see that the problem was not fixed. You can still see individual tiles on the East DEM. I then tried creating a hillshade with this mosaic in hopes of fixing the problem.



The hillshade above looks a little better but if you take a close look at it, you can still see the outlines of the tiles. At this point I concluded that error came from the file itself. The experts that gather this data did not create a consistent DEM across the lateral extents. You can see that the tiles outlined in the image below shows a significant color difference. Using the identify tool, I found boundaries like the one below with a difference of 1 m across. This data is definitely not perfect.



Based on the limitations mentioned above, the equations used to show the sea level rises is not precise because areas show dramatic changes of elevation. These areas are along the tile boundaries and represent discrepancies in the DEM data.

Conclusion

With the use of the different tools in ArcMap, I was able to draw conclusions from the raw data downloaded online from their specific sources. I was able to show the present day sea level of Miami-dade county with one meter increments of sea level rises all the way up to 5 meters total.

Based on the six hazard maps that I created using one DEM and several shp files, I concluded that the Southern tip of Florida is deeply in trouble with rising sea level. The mean rise in sea level is between 0-3 mm/yr. (Source: https://tidesandcurrents.noaa.gov/sltrends/sltrends.html) which means there is a lot of time to investigate this phenomenon more. However, with almost 2 meters of sea level rise the entire county of Miami-dade will be wiped out. What I found extraordinary was that the urban areas around Miami took longer to "drown" even though it basically lies on the coast. Another thing that I found interesting was that the islands off the southeast coast of Florida was still afloat after 1 meter of sea level rise even though part of Miami-dade was wiped out. Overall the sea level rise of at least 1 m on Miami-dade county is definitely not something we would like to experience. People living in the affected areas would have to relocate and the amount of people that actually get affected by the sea level rises can be something to investigate in the future. My data might not be perfect because of the DEM raster but it almost correlates perfectly with projections of the same area that I found online (Source- Data basin: https://databasin.org/datasets/dd54d301894f4322a7a30832572c4a7e).