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GIS and Spatial Analysis GEOG 544
December 14, 2018
Final Project

TerraSol Community Energy: Location Analysis Study

Introduction:

TerraSol Community Energy is a proposed community-solar-farm project. A solar farm is a photovoltaic power station which supplies energy to the grid. Community solar, on the other hand, is defined as a power station which can supply energy to a number of different households—this means that people can benefit from the peace of mind of powering their house with solar energy, without having to place solar arrays on their own roofs. The thing what will make TerraSol Community Energy different from other large solar farms in the area is that we will utilize sheep to keep the vegetation from growing over the photovoltaic arrays, instead of lawnmowers and other machinery. This will appeal to people who are looking at “green” solutions to their energy supply demands.

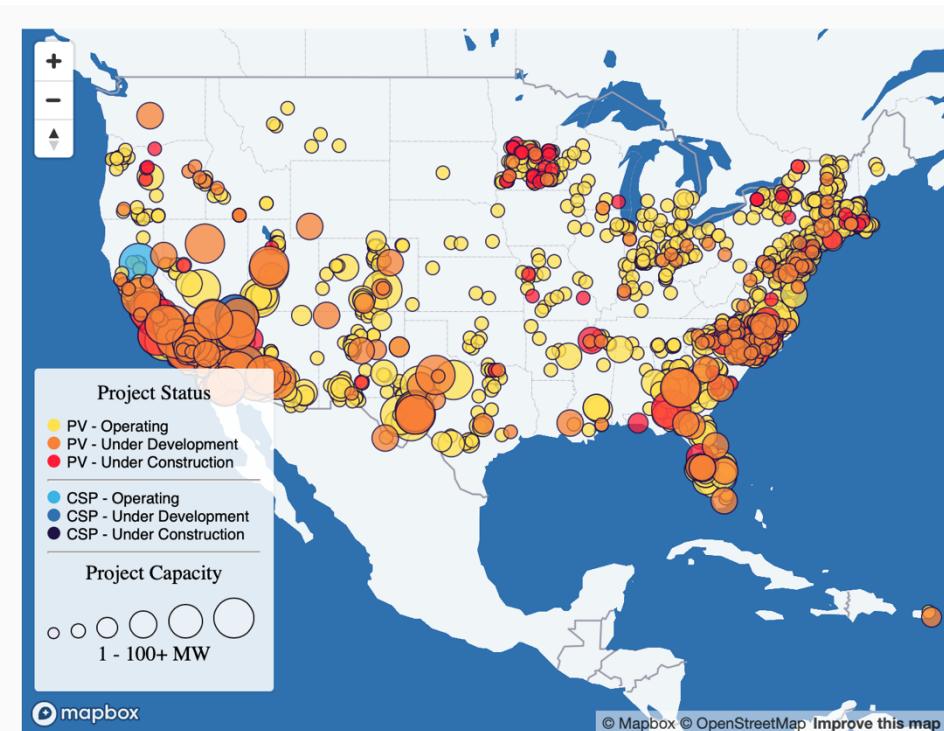


Figure 1: Map from Solar Energy Industries Association (SEIA) Showing current solar projects in the US.

This business will hire out a crew to build the solar array and will have sixteen employees to start. These employees will consist mainly of sales reps who will sell energy credits to customers who are interested in supporting this community solar project. The energy that the farm supplies will go straight to the local grid, but the customers who buy into our program will get a credit on their traditional energy bill.

Our target customers will be middle-aged, with higher educations, and disposable income. But since our customers can benefit from the community solar project from a distance away, the location of our customer base does not have to coincide exactly with the location of the solar farm. What matters is how much sun the area gets, how the area is zoned (because we are using the grounds as pasture for sheep, it must be zoned agricultural), and how large the area is. We are also looking for an area of about 100 acres, or just over 400,000 square meters so that we have room to grow.

Solar as an Economic Engine

Over 250,000 Americans work in solar - more than double the number in 2012 - at more than 9,000 companies in every U.S. state. In 2017, the solar industry generated a \$17 billion investment in the American economy.

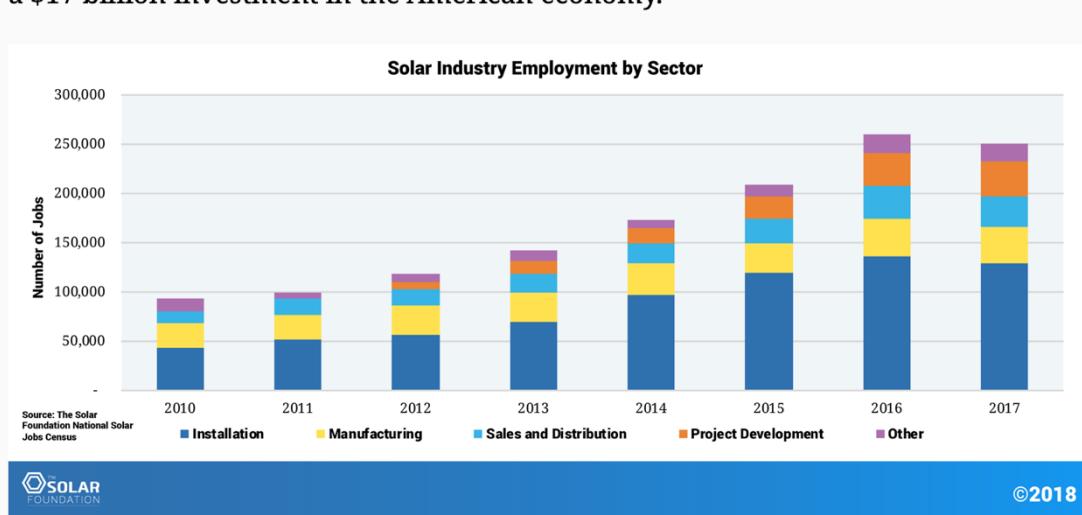


Figure 2: This graph, from the Solar Foundation National Solar Jobs Census, shows the growth of the solar industry and its impacts on jobs in the country.

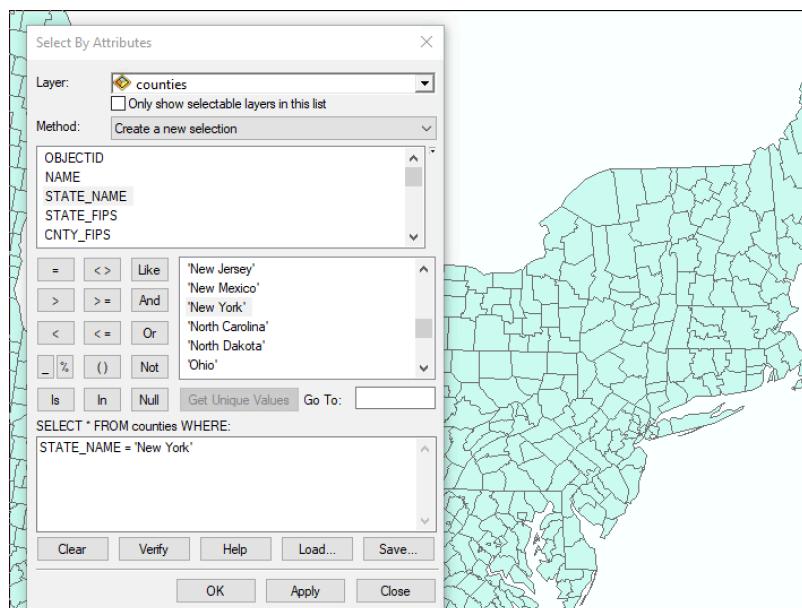
Figures 1 & 2 show how solar energy is rising in popularity all over the country. Projects are in development on the east and west coasts, and this is having an impact on the economy by boosting jobs. States such as California, Texas, Florida, and North Carolina already have many large solar stations underdevelopment. New York has many smaller stations already operational, but not many large capacity solar stations. Because of this, and because of tax incentives available in NY for solar industries, we have decided to look for an area to build in NY.

Data Collected:

- Basic shapefiles of NY including counties, roads, hydrology from ESRI class data
- A map of solar radiation received on the ground in NY from the National Renewable energy Laboratory
- Text files of personal solar arrays in the state, compost facilities, and electric vehicle charging stations from data.NY.gov
- Shape files of average precipitation across the state and zoning districts from CUIGIR
- And finally a raster image of canopy cover also from CUIGIR

Basic NY Data Processing:

To begin, I created a shapefile of NY counties from the world geodatabase in the ESRI class data. I then clipped roads and hydrology to the state.



Understanding “Greenness” by County:

Although the census data is not that important for the location of this business, for it to be successful, it needs to be installed in an area where people are already interested in the idea of green energy, ideas, and projects. To figure out good, “green” locations, I decided to look at existing personal solar arrays, areas where cities have put in large-scale composting facilities, and areas that have electric charging stations for vehicles. To create choropleth maps of these data, I needed to do some manipulations.

For the personal solar electric arrays, the list had a county field name, but because there were many solar arrays in each county (one to many), I could not use a simple join to join the table to my county shapefile. Instead, I first summarized the county field to get a count of solar arrays per county. This gave me a table of counties with field that summarized the solar data. This table, I could join to the county shapefile I had.

The screenshot shows two ArcGIS Pro windows. The left window displays a table titled "Solar_Electric_Programs_Reported_by_NYSERDA_Beginning_2018" with columns "County" and "State". The right window shows the results of a summarization process. An orange arrow points from the "Summarize" button in the left window to the "Summarize" dialog box in the right window. The dialog box has three steps: 1. Select a field to summarize (County), 2. Choose one or more summary statistics output table (F_Incentive, Total_Nameplate_kW_DC, Expected_KWh_Annual_Production, Remote_Net_Metering, Affordable_Solar, Community_Distributed_Generation, Green_Jobs_Green_New_York_Participant, Location_1 (with First checked and Last unchecked)), and 3. Specify output table (C:\Users\cnieder1\Desktop\gis\Sum_Output_2.dbf). The resulting table, "Sum_Output", is shown in the right window with columns "OID", "County", "Count_County", and "First_Loc".

OID	County	Count_County	First_Loc
0	Albany	2612	Albany, NY 12159
1	Allegany	101	Alfred Station, NY 14803
2	Bronx	1421	Bron, NY 10461
3	Broome	323	Binghamton, NY 13901
4	Cattaraugus	156	Allegany, NY 14706
5	Cayuga	293	Auburn, NY 13021
6	Chautauqua	328	Ashville, NY 14710
7	Chemung	176	Alpine, NY 14805
8	Chenango	118	Afton, NY 13720

The table for the electrical vehicle charging stations included address fields, so it was easy to geocode using ArcGIS World geolocator. The Compost data table included latitude and longitude fields, so I used the XY data to create points.

Geocode Addresses: World

Address table: Electric_Vehicle_Charging_Stations_in_New_York.csv

Address Input Fields

- Single Field
- Multiple Fields

Address or Place: Street Address

Address2: City

Address3: State

Neighborhood: ZIP

Output

- Create static snapshot of table inside new feature class
- Create dynamic feature class related to table

Output shapefile or feature class: C:\Users\cnieder1\Desktop\gis\Geocoding_Result_3.shp

Config Keyword: Advanced Geometry Options... Geocoding Options...

[About geocoding a table of addresses](#)

OK **Cancel**

Display XY Data

Table containing X and Y coordinate data can be added to the map as a layer

Use a table from the map or browse for another table: Electric_Vehicle_Charging_Stations_in_New_York

Specify the fields for the X, Y and Z coordinates:

- Field: Longitude
- Field: Latitude
- Field: <None>

Coordinate System of Input Coordinates

Description: Projected Coordinate System: Name: NAD_1983_UTM_Zone_18N

Join Data

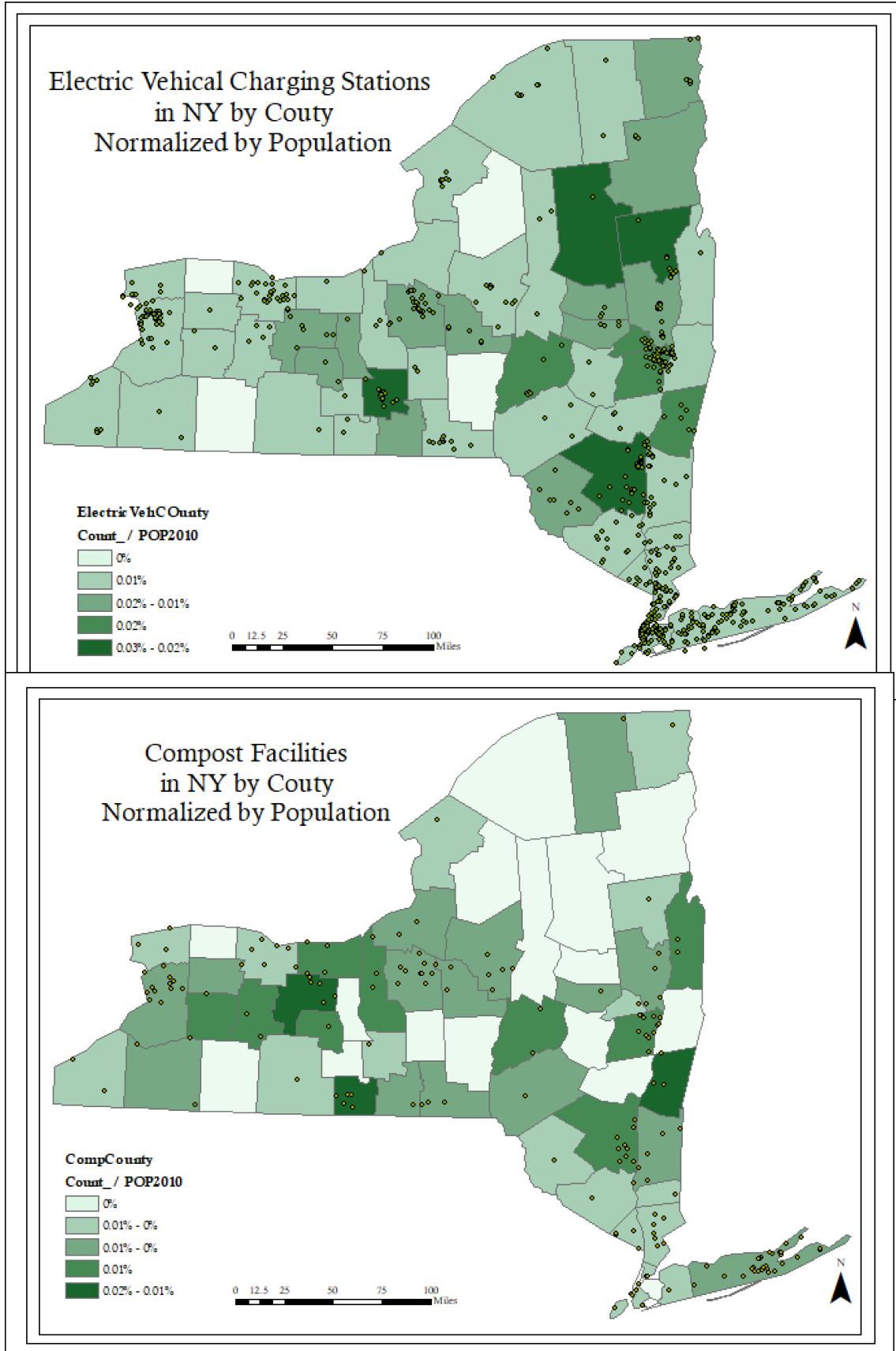
Join lets you append additional data to this layer's attribute table so you can, for example, symbolize the layer's features using this data.

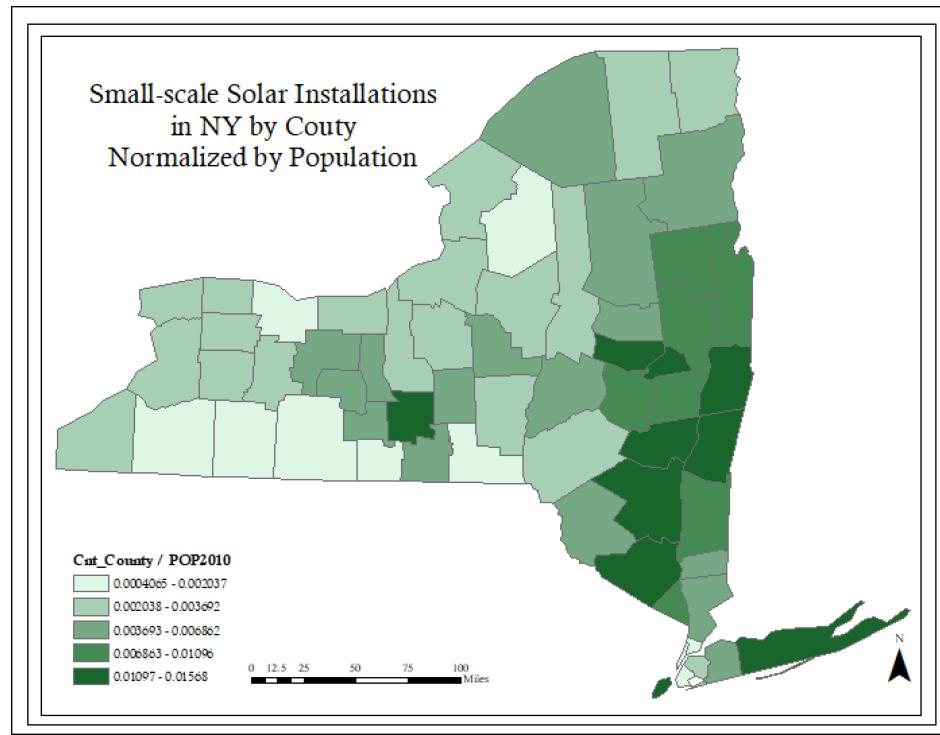
What do you want to join to this layer? Join data from another layer based on spatial location

- Choose the layer to join to this layer, or load spatial data from disk: ElectricVehic
- You are joining: Points to Polygons
Select a join feature class above. You will be given different options based on geometry types of the source feature class and the join feature class.
 - Each polygon will be given a summary of the numeric attributes of the points that fall inside it, and a count field showing how many points fall inside it.
How do you want the attributes to be summarized?
 Average Minimum Standard Deviation
 Sum Maximum Variance
 - Each polygon will be given all the attributes of the point that is closest to its boundary, and a distance field showing how close the point is (in the units of the target layer).
- Note: A point falling inside a polygon is treated as being closest to the polygon. (i.e. a distance of 0).
- The result of the join will be saved into a new layer.
Specify output shapefile or feature class for this new layer: C:\Users\cnieder1\Desktop\gis\Niederhofer_Final.gdb\Basicf

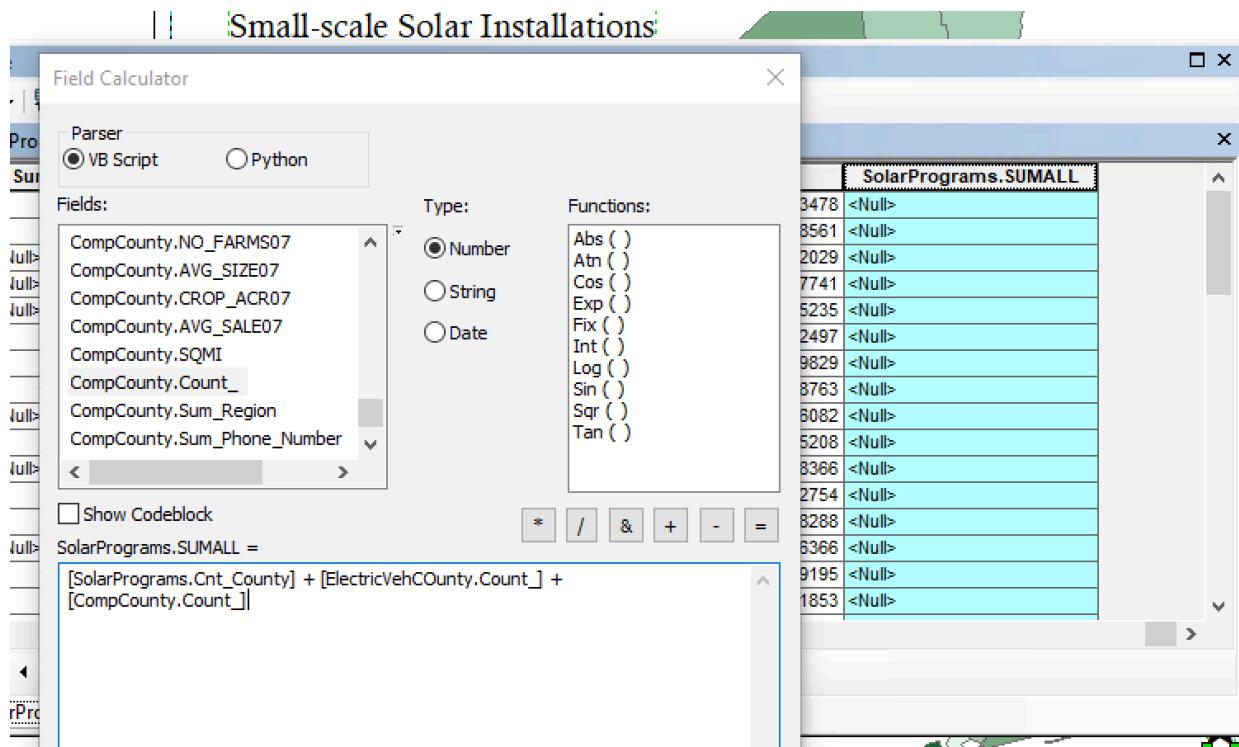
[About joining data](#)

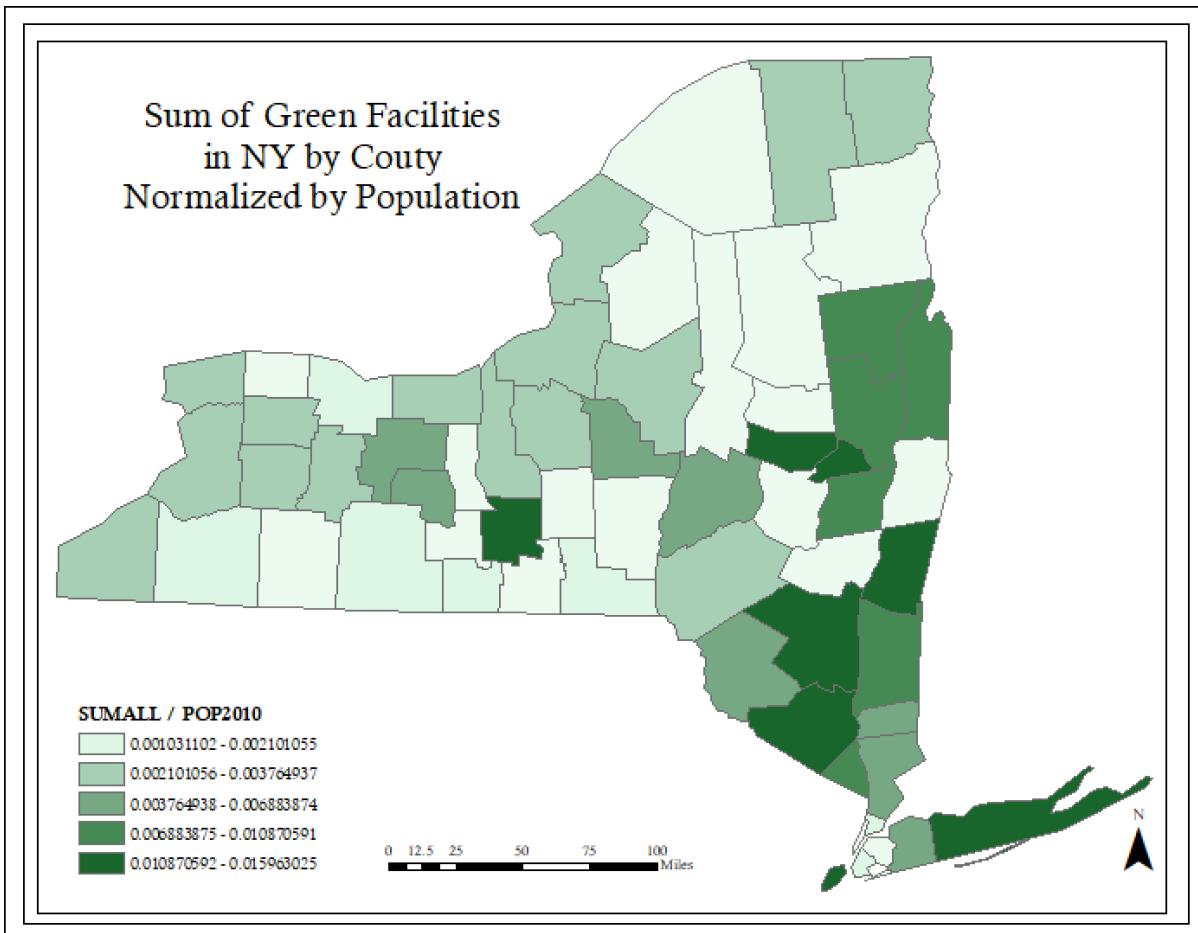
OK **Cancel**



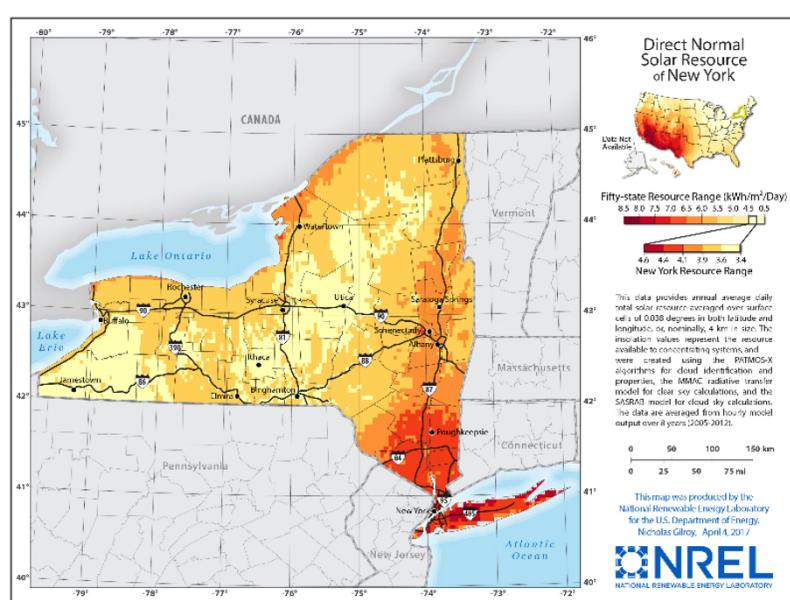


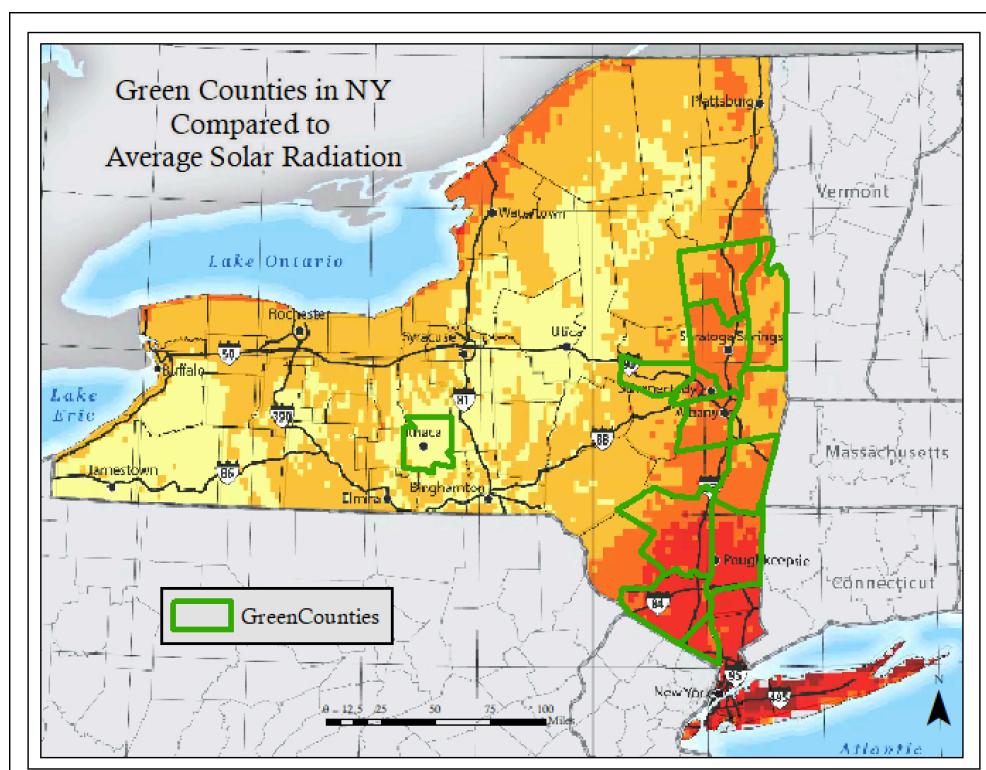
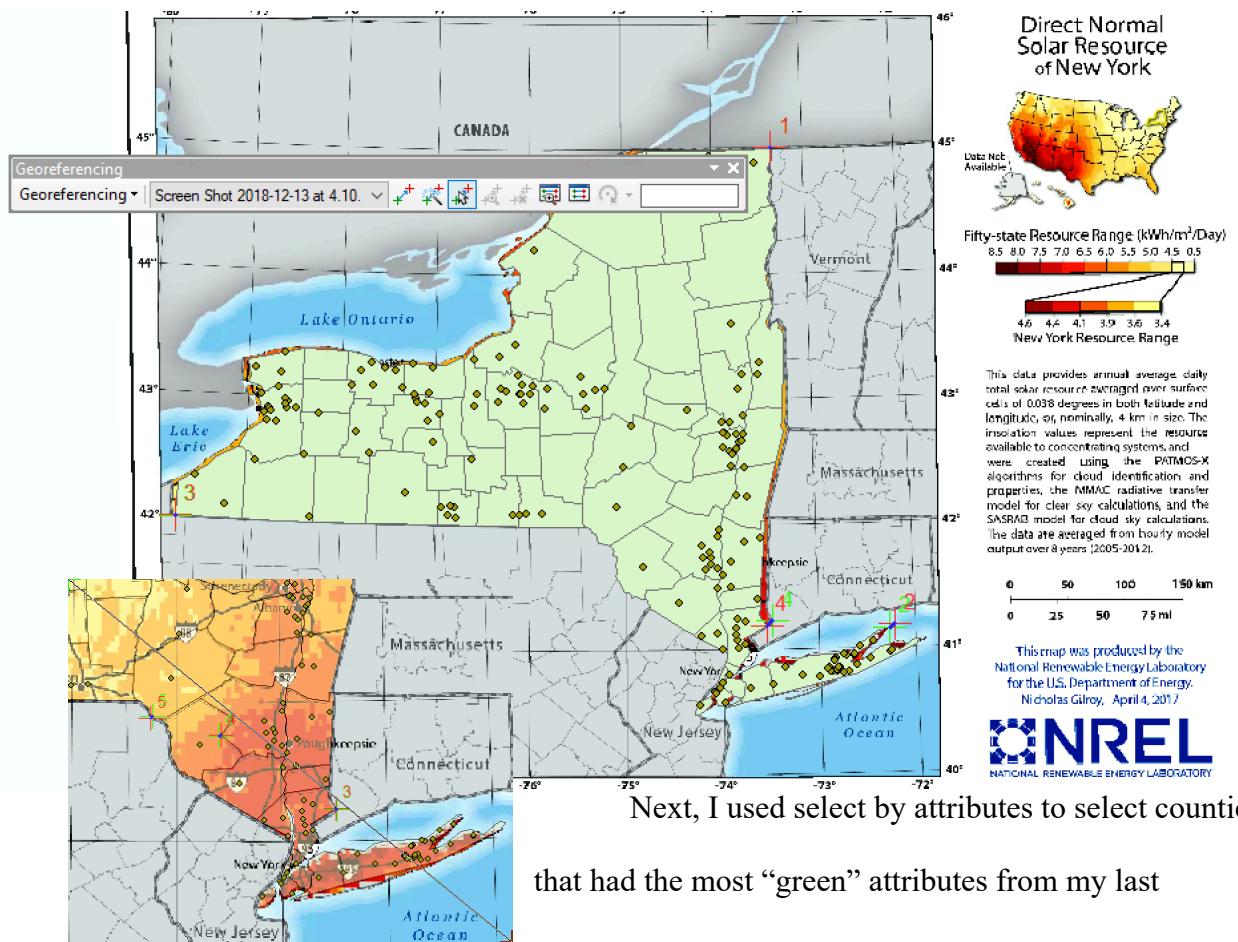
Next, I joined all three tables together and added a new field and used the field calculator to create a sum of the three types of data in each county. This gave me a look at the “greeness” of the county.

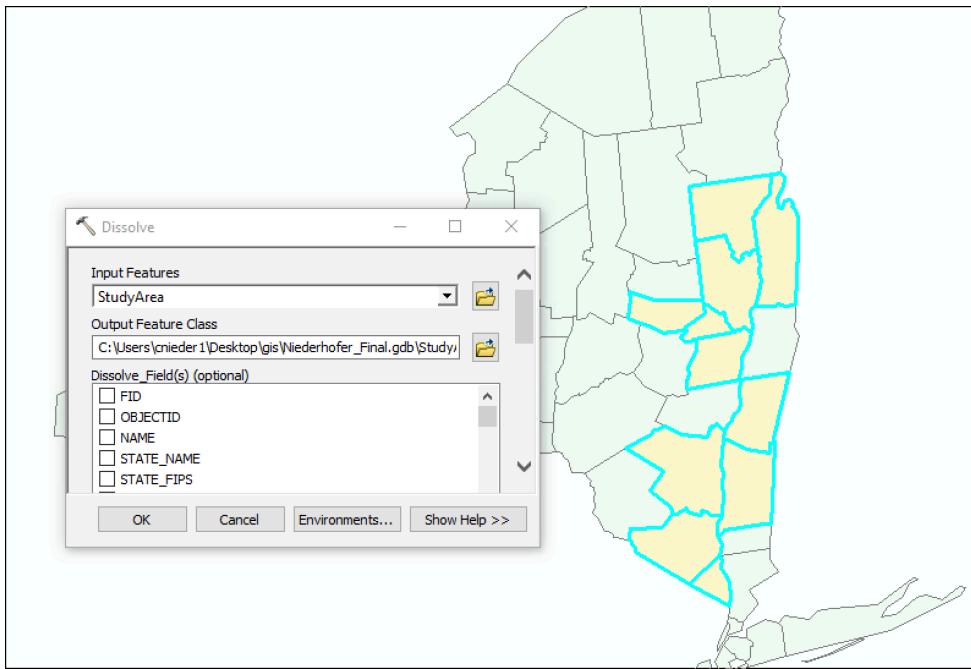




Next, I wanted to look at the solar radiation that each county receives annually. I could not find a data table showing this, but I did find a finished map from National Renewable Energy Laboratory (NREL) showing annual radiation levels for the state. I decided to use this and georeferenced it on top of the county map that I already had. This would not give me a usable attribute table, but I can use it for a visual reference.



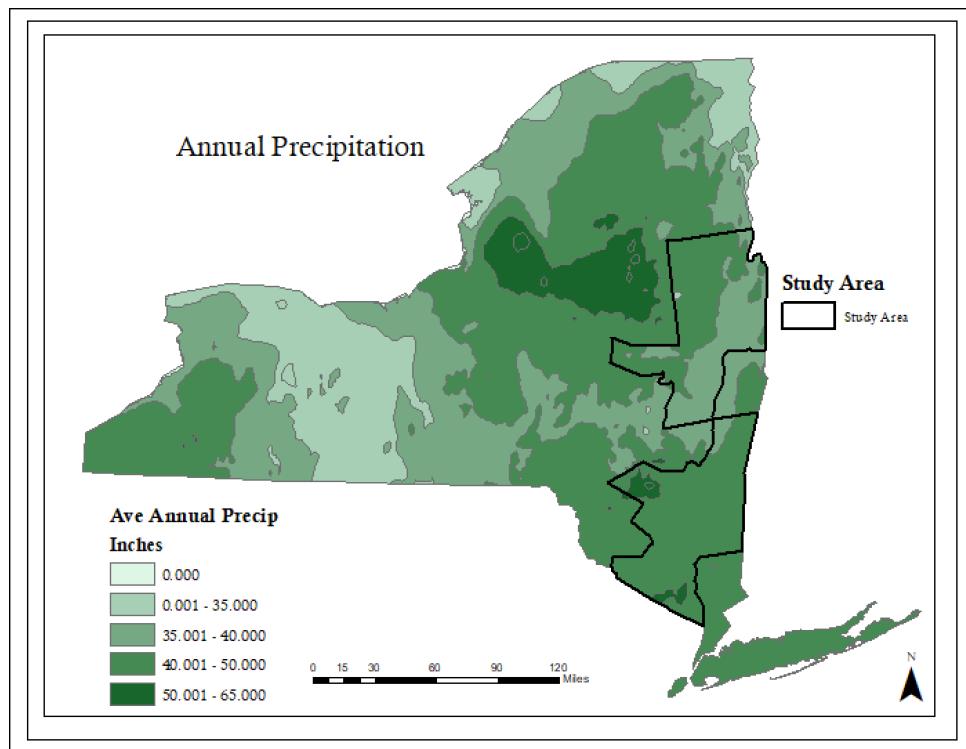




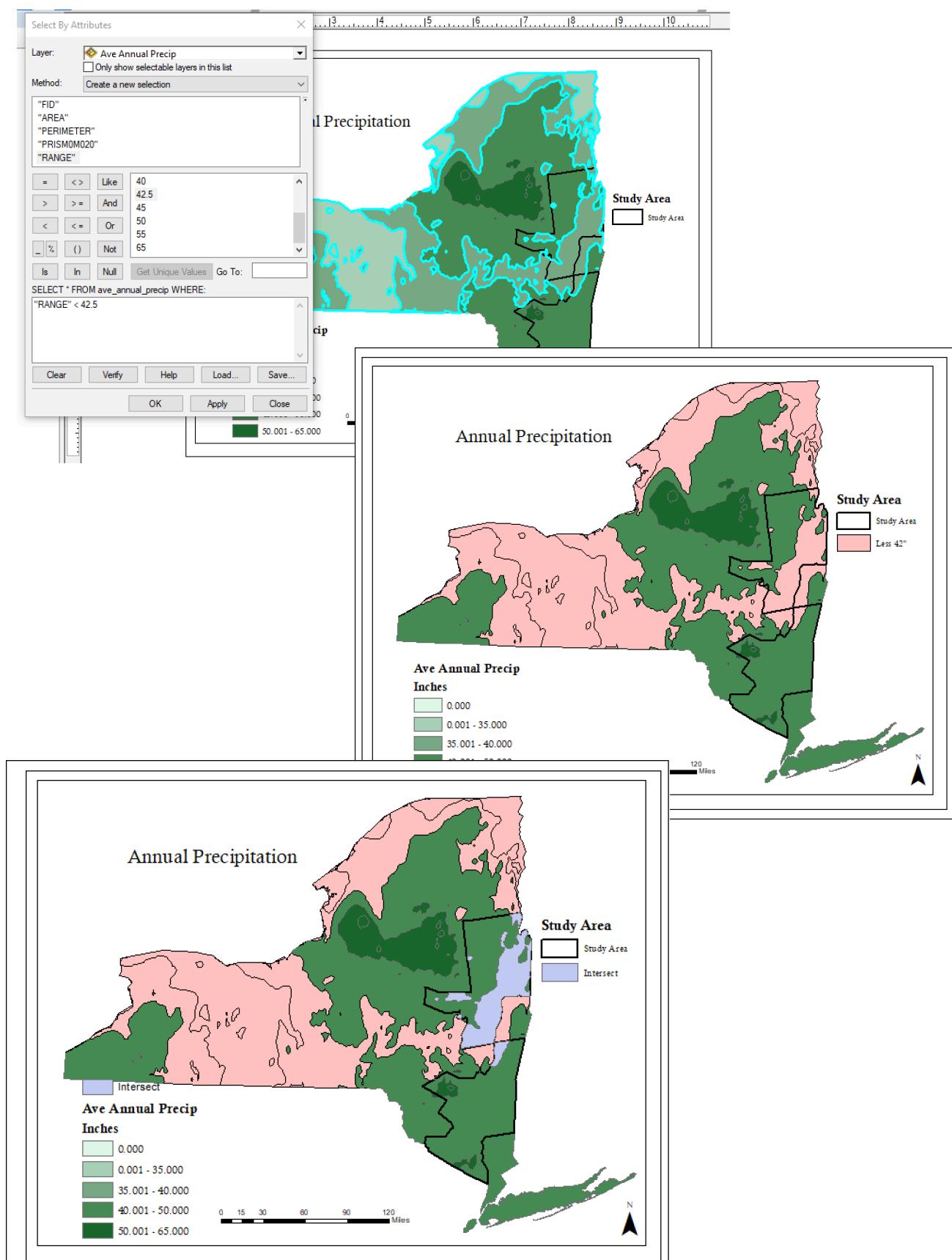
Most of the counties lined up with high radiation for the state. I used all but Tompkins county (the one in the center of the above map) as my first study area. I used the dissolve tool to get one continuous shapefile.

Next, I wanted to look at precipitation, with the thought that areas with less precipitation would have more blue skies, and less maintenance for the solar arrays.

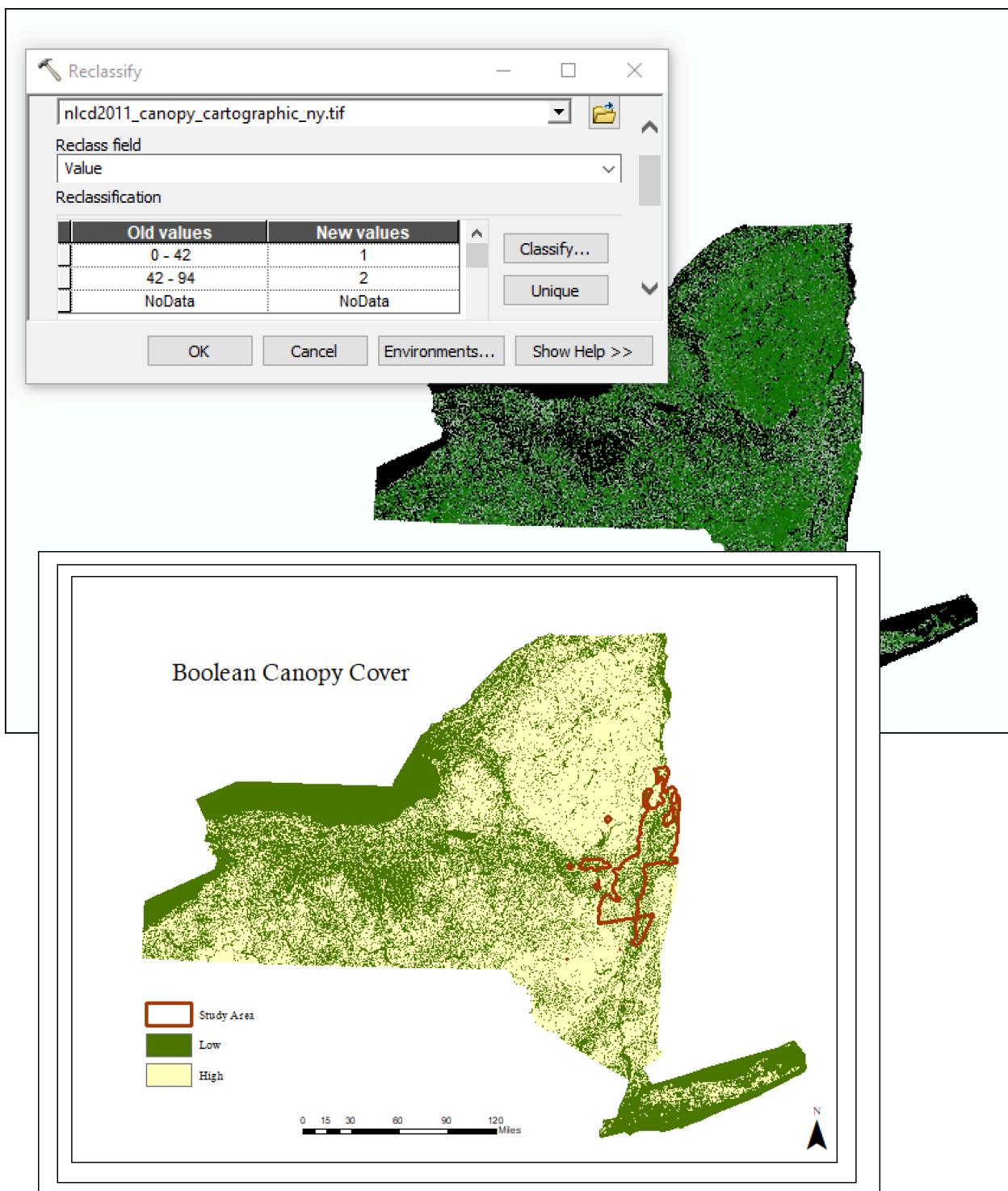
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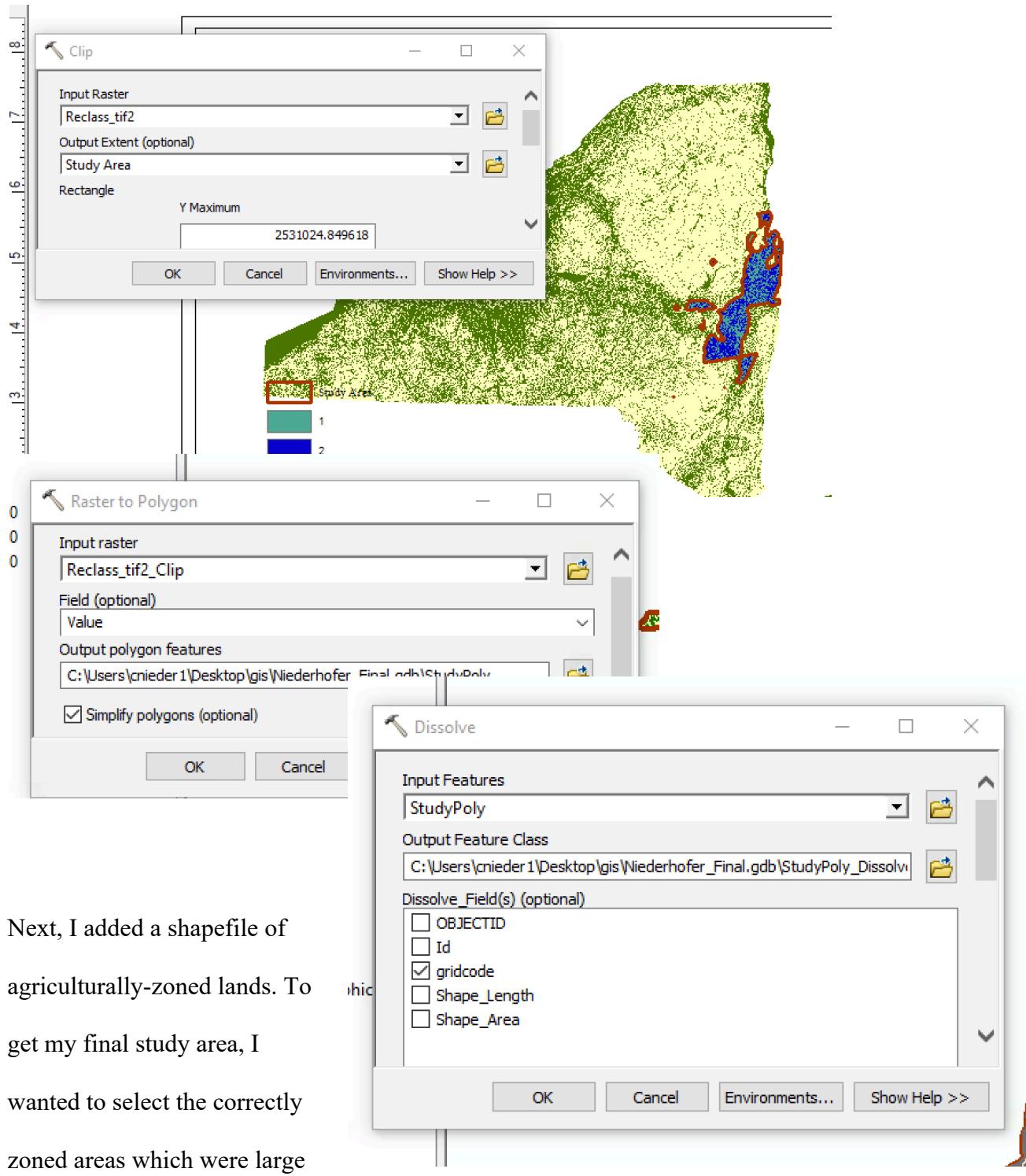


attributes to select the areas with less than 42.5 inches of precipitation a year. I then created a new shapefile of the low-precipitation areas, and intersected that with my study area to get a new, more precise location. (See next page)



For the next step, I created a Boolean raster of canopy cover to show areas where I wouldn't have to cut down a lot of trees to install my solar arrays. I then clipped my raster to the latest study area, converted this raster to a polygon, and dissolved the edges of the polygon.





I created a new field and used the Calculate geometry tool to get an area for each agricultural area within my study area.

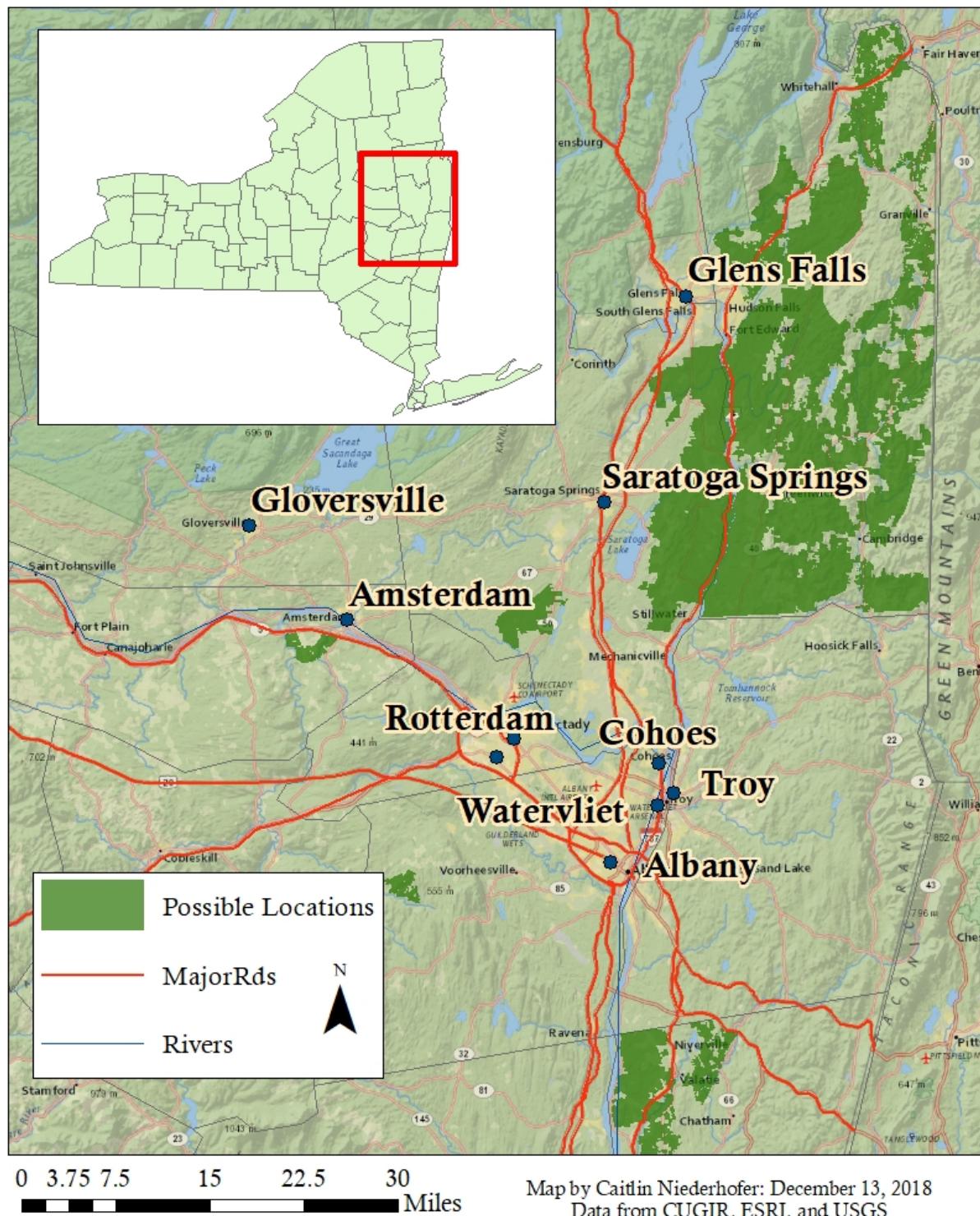
The screenshot shows a 'Table' window titled 'Final Study Area'. The table has columns: DistCode, OEadds303b, Shape_Length, Shape_Area, and Area_1. A 'Calculate Geometry' dialog box is open over the table. In the dialog, the 'Property' dropdown is set to 'Area'. Under 'Coordinate System', the 'Use coordinate system of the data frame' radio button is selected, with 'PCS: NAD 1983 UTM Zone 18N' chosen. The 'Units' dropdown is set to 'Square Meters [sq m]'. There is also a checkbox for 'Calculate selected records only' which is unchecked. At the bottom of the dialog are 'OK' and 'Cancel' buttons.

Finally, I selected just the areas of at least 100 acers.

The screenshot shows the 'Select By Attributes' dialog box. The 'Layer' dropdown is set to 'Final Study Area'. The 'Method' dropdown is set to 'Create a new selection'. In the attribute list, 'Area_1' is selected. Below the list are various comparison operators and values. The 'Where' clause in the text area is 'Area_1 > 10000000'. At the bottom are 'Clear', 'Verify', 'Help', 'Load...', 'Save...', 'OK', 'Apply', and 'Close' buttons.

Final Map:

TerraSol Community Energy: Proposed Areas



Final Proposed Area:

My final location is somewhere along the Hudson Valley North of Albany. This area has a “green minded” population, is zoned correctly, gets a high amount of solar radiation and little rain for the area, and I won’t have to cut many trees. The next step is looking at land for sale in this area.



Photo from SolarPowerPortal.co.uk

Geodatabase I created for the project:

