Geospatial Analysis of Crawford Creek Subdivision

Community Garden Opportunities

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Course:

GEOG 883

I. Introduction

The need for this project was identified in the early months of 2020 as the Coronavirus Pandemic began to fully stress the supply chains of the United States. Supply chain stress resulted in mass shortages of everyday items including edible produce. Of all the items in short supply edible produce was the most avoidable. In order to decrease the risk of further food shortages for residents in subdivisions a geospatial analysis of the Crawford Creek subdivision in Columbia County, Georgia was performed.

This project will optimize the process of identifying medium-height vegetation areas on relatively flat ground to increase the food independence of subdivisions across the country via community gardens. Community gardens are a welcoming environment for immigrants and refugees by providing a welcoming environment in which they can interact with extant social groups (Agustina & Beilin, 2012).

Marginal, scrub areas of medium-height vegetation between houses are prime real-estate for community garden cultivation much akin to British Victory Gardens of the 20th Century (Ginn, 2012). Community gardening will assist in the overall health and wellness of the community during times of supply chain pressure (Heim & Katherine Baeur, 2011). The subdivision lies in the Central Savannah River Area (CSRA) in the piedmont between the Appalachian Mountains and the coastal plains of the U.S. East coast.

Illustration 1: Crawford Creek Subdivision

II. Data Sets

National Aerial Imagery Program

- NAIP Geo-rectified Images from the USGS Earth Explorer (https://earthexplorer.usgs.gov/):
- m_3308231_se_17_060_20191011.tif
    - Sensor Type: Leica Geosystem Digital Sensor
    - Horizontal Datum: NAD 83/UTM Zone 17N
    - Horizontal Datum: NAD 83/UTM Zone 17N
    - Date of Acquisition: 11 October 2019
    - Resolution: 0.6m
- m_3308231_sw_17_060_20191109.tif
    - Sensor Type: Leica Geosystem Digital Sensor
    - Horizontal Datum: NAD 83/UTM Zone 17N
    - Horizontal Datum: NAD 83/UTM Zone 17N
    - Date of Acquisition: 11 October 2019
    - Resolution: 0.6m

Landsat 8

- Landsat 8 Images from the USGS Earth Explorer (https://earthexplorer.usgs.gov/):
- LC0801803720200904_20200917_01_T1_ANG.tif
    - Sensor Type: MSI+
    - Horizontal Datum: WGS 84/UTM Zone 17
    - Date of Acquisition: 20 Sep 2020

USGS 1/3 Arc Second DEM

- USGS_13_n34w083.tif
    - Sensor Type: LiDAR
    - Horizontal Datum: D North American 1983 (NAD 83)
    - Spheroid: GRS 1980
    - Resolution: approximately 3m N/S

III. Methodology

The data exploited via ArcGIS Pro:

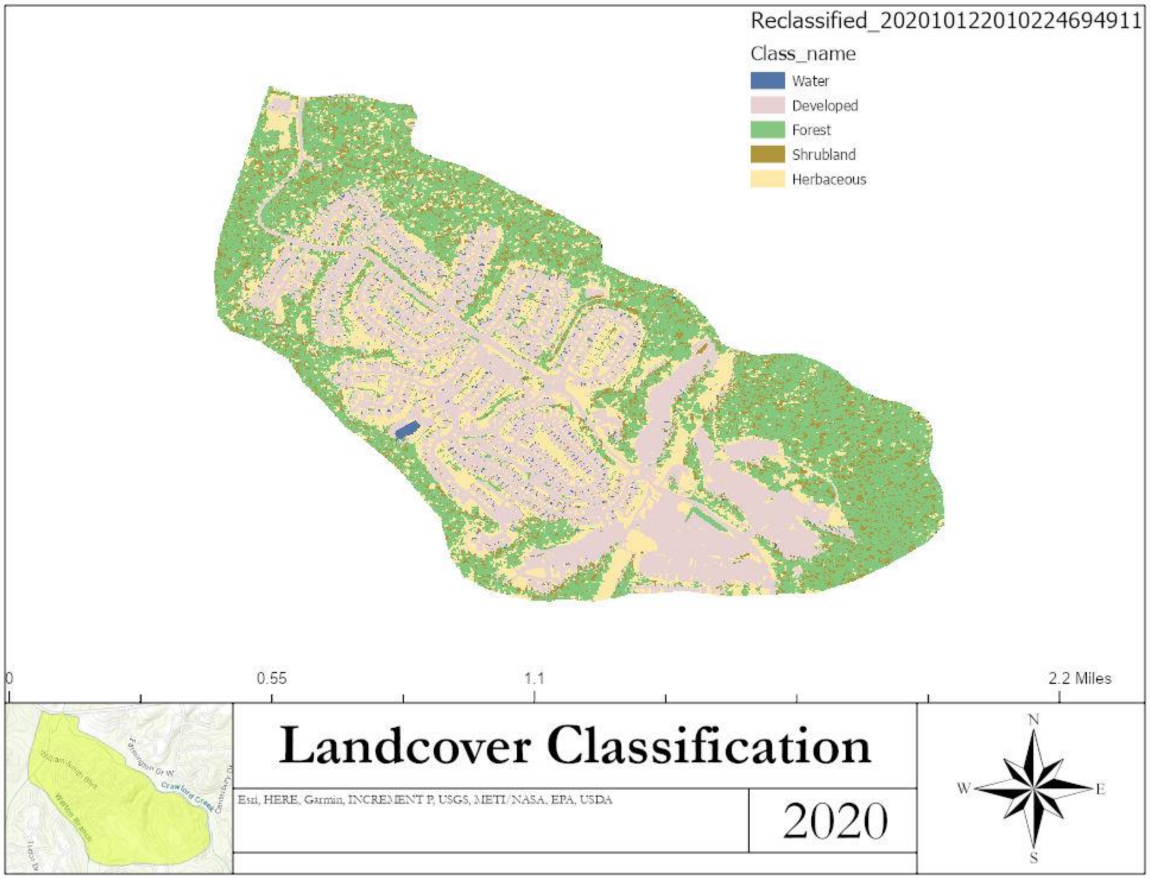
- Preprocess:
  - Generate composite images:
    - Create composite images: NAIP & Landsat Imagery
  - Project into common coordinate system:
    - As needed
- Process:
  - Calculate NDVI, NDWI, NDMI, NDTI:
    - Using DEM, Landsat, and NAIP
  - Unsupervised Landcover Classification Using DEM, Landsat, and NAIP:
    - Buildings
    - Roads
    - Low-vegetation (lawns)
    - Medium-vegetation (marginal land)
    - Tall-vegetation (trees)
    - Water
    - Test Data Accuracy
  - Slope Analysis Using DEM
  - Aspect Analysis
  - Hill-shade map relief
  - Elevation

Workflow:

Unsupervised Classification Process:

- The Unsupervised Landcover Classification process was carried out via AcrGIS Pro
- After deriving a composite Multispectral NAIP image, an image-object based classification of 50 categories was generated and trained
- Five categories were created: Water, Developed, Forest, Shrublands, and Herbaceous
- The five categories were generated with common features found in the National Landcover Database
- Herbaceous and Shrublands layers were identified as suitable locations for agricultural production
- The data generated from the Unsupervised Landcover Classification Process was tested with Accuracy Points

Figure 1. Unsupervised Image-Object Based Land Classification:



Data Test Results

The data returned from the Unsupervised Landcover Image-Object Classification was tested using a common sampling methodology of 100 randomly generated accuracy points (Congalton, 1991). The points were then gone over manually to ascertain if in fact the attributes of the landcover classification accurately reflected the underlying image. Literal image interpretation was utilized to ascertain the underlying image.

The test results revealed a total accuracy of approximately 64%.

Table 1.

Class Value	Water	Developed	Forest	Shrublands	Herbaceous	Total	Users Accuracy	Kappa
Water	0	8	1	0	1	10	0.00%	0.00%
Developed	0	28	0	1	3	32	87.50%	0.00%
Forest	0	0	32	0	4	36	88.89%	0.00%
Shrublands	0	1	7	2	0	10	20.00%	0.00%
Herbaceous	0	0	3	0	20	23	86.96%	0.00%
Total	0	37	43	3	28	111	0.00%	0.00%
Producers Accuracy	0.00%	75.68%	74.42%	66.67%	71.43%	0.00%	73.87%	0.00%
Kappa	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	63.89%

In Table 1 six categories from the National Landcover Database are identified from the Unsupervised Landcover Classification in ArcGIS Pro. No accuracy test points fell in the Water category. Due to the lack of test points in landing in Water the overall accuracy is decreased to approximately 64%. By removing the Water category we can see that the overall accuracy increases significantly. The unique classification categories are quite successful for Developed, Forest, and Herbaceous categories. This accuracy is due to the inherently clearly defined spatial characteristics. The Image-Object Classification more readily breaks out tall from short but struggles with detecting and classifying items in between; such as the shrublands.

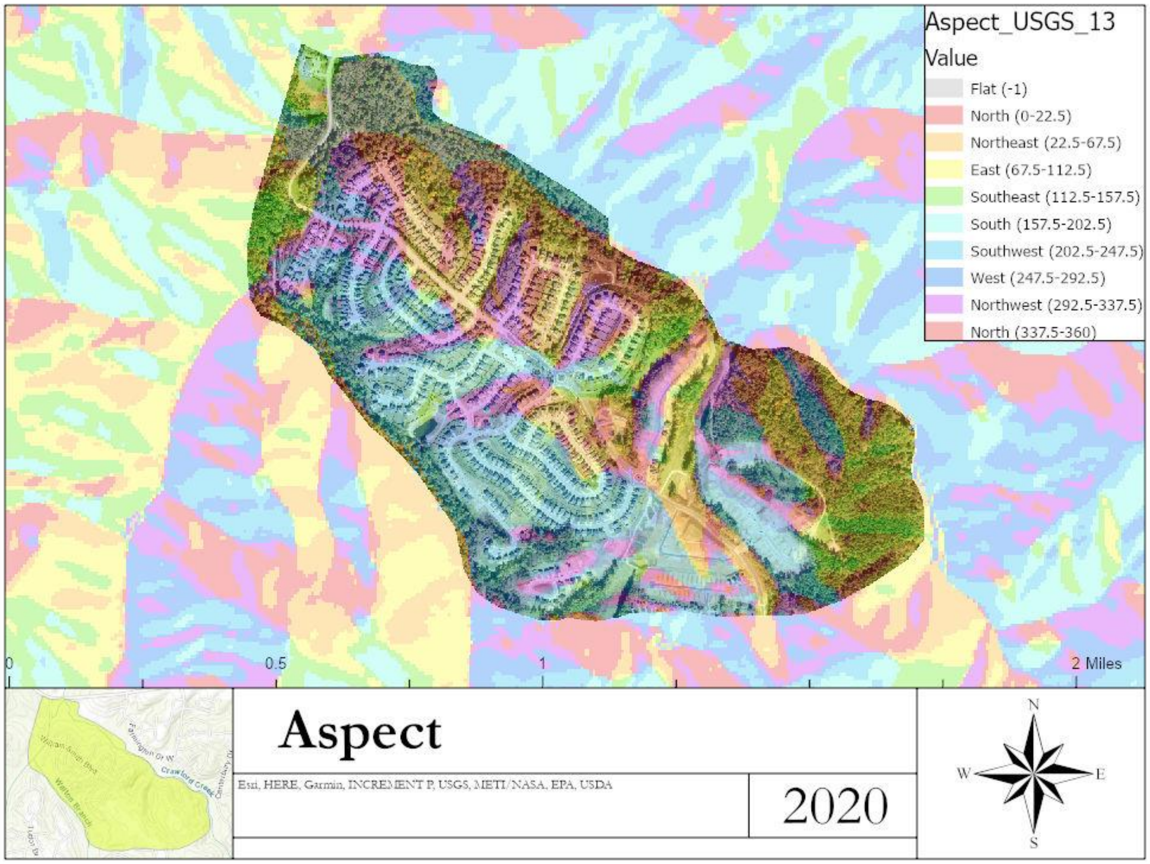
Consequently, Shrublands suffered the worse accuracy of the four actually tested categories.

The Developed category barely edged out Forest as the most accurate class.

The two most ideal candidates for cultivation were the Shrublands and Herbaceous areas due to their medium and low vegetation. It should be remembered that the height of the vegetation at these levels is decidedly new growth performed at the end of residential development and home construction. Consequently, their height roughly reflects the fact that the land slope and even aspects of home plots have optimized in some way which assists in ideal cultivation qualities.

Ideal cultivation characteristics include a South-facing aspect, low-hillshade, and slope less than 10 degrees.

Figure 2. Aspect Map:



Aspect

The aspect map reveals the cardinal direction towards which each face of the subdivision is oriented. Color-coded, it provides an ideal medium through which to convey North-facing slopes to avoid and South-facing slopes to seek out. In this analysis of the aspects of Crawford Creek subdivision, South-facing slopes will be part of our site selection for agricultural production.

This Aspect Map was created by acquiring a 1/3 Arc Second Digital Elevation Model from the USGS and running an aspect analysis in ArcGIS Pro.

Figure 3. Slope Map:

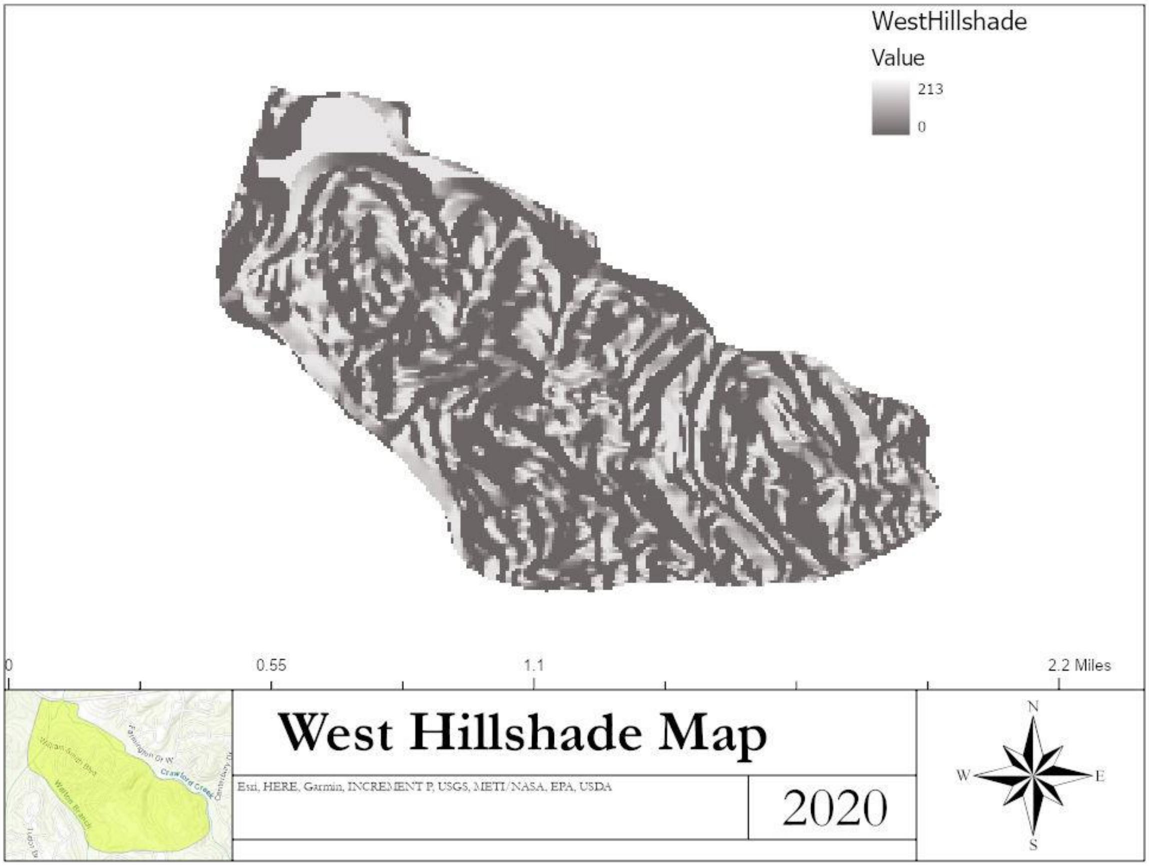
Slope

Slope information is key to understanding where and where not it is viable to plant food crops in a subdivision. Too much slope with cause rainfall to dislodge crops and retain little moisture. The piedmont between the Coastal Plains and the Appalachian Mountains provide a nice mix of undulating hills, creeks, and flat areas.

In this Slope Map of Crawford Creek subdivision, the steepest sloping areas are on the North Eastern faces of the development. This area retains its original tall forest vegetation in the form of mostly coniferous pines which are very prevalent in Georgia.

This Slope Map was generated using a 1/3 Arc Second Digital Elevation Model from the USGS and running a slope analysis in ArcGIS Pro.

Figure 4. West Hillshade Map:



Hillshade

Hillshade is useful in determining from what solar azimuth offers a certain area greatest coverage. This projection is simulating the sun facing West, resulting in a Western Hillshade.

This Hillshade was generated in ArcGIS Pro by selecting the Hillshade analysis and making the azimuth 270 degrees.

Figure 5. NDVI Green Map

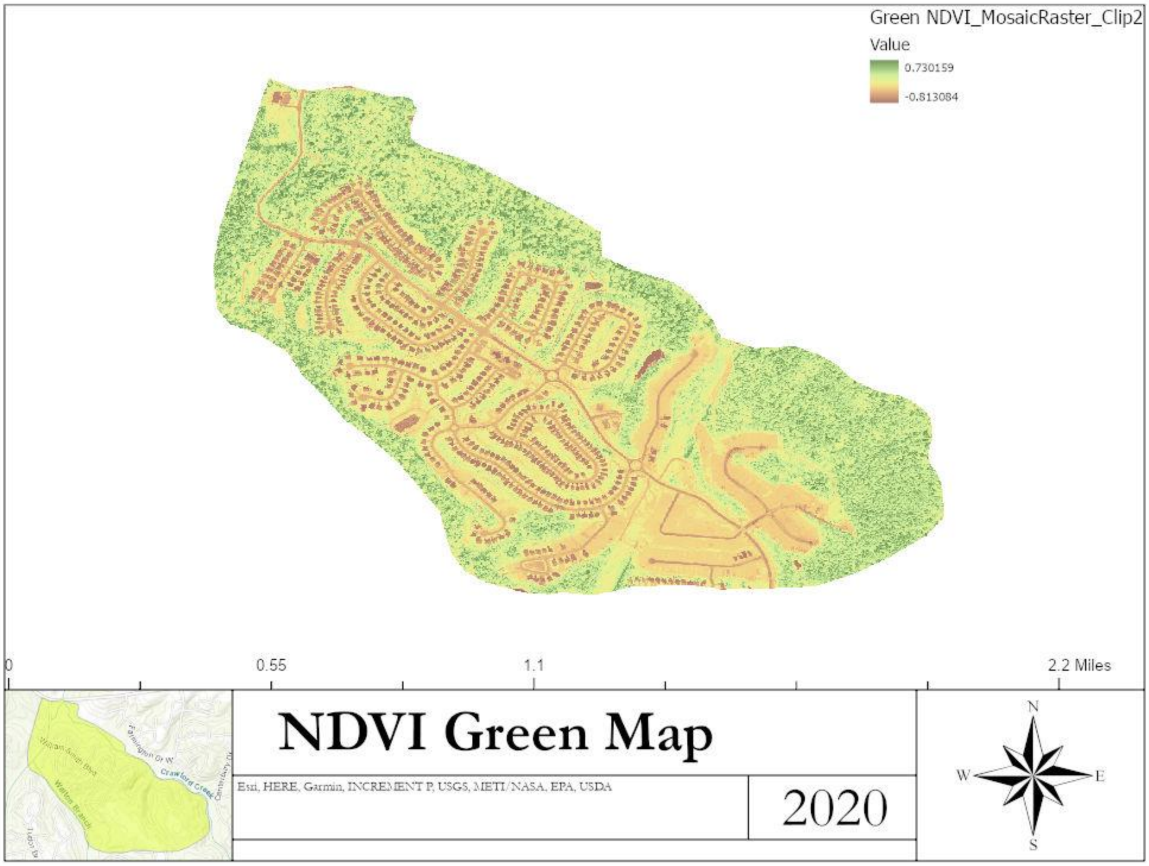
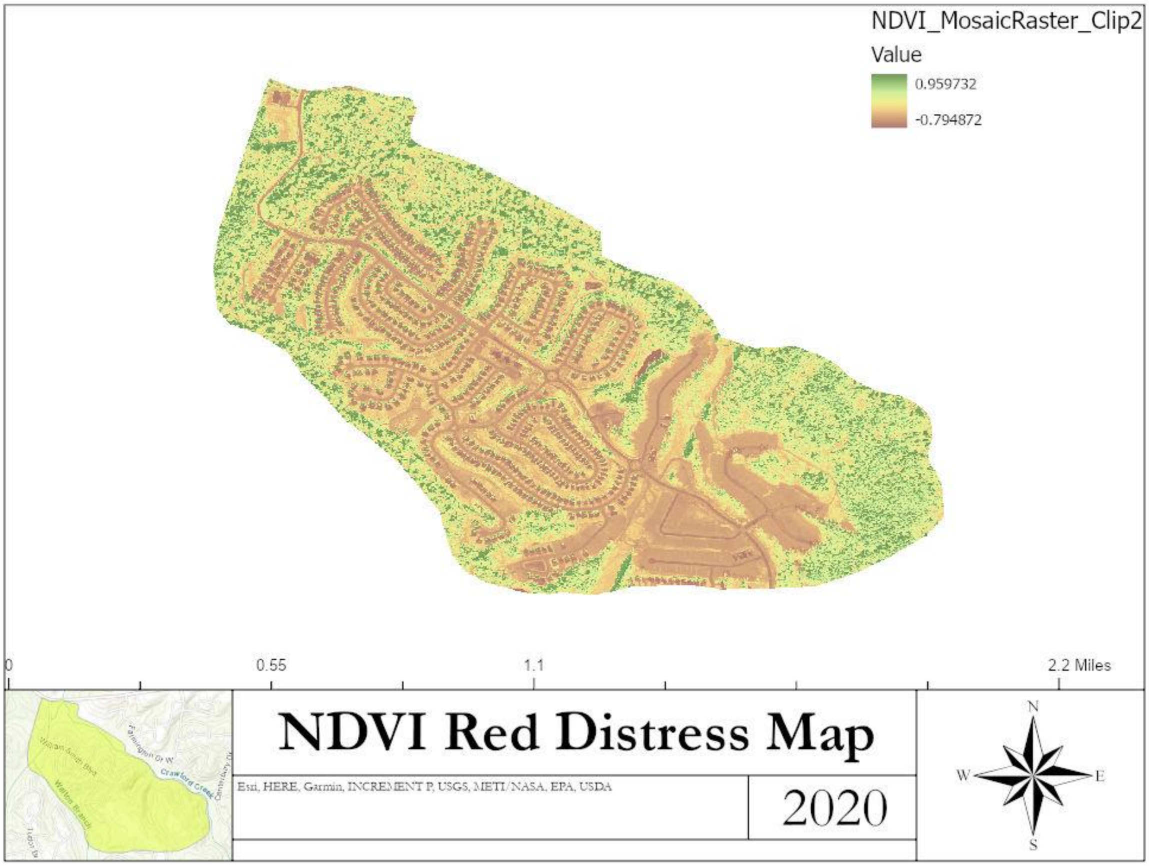


Figure 6. NDVI Red Distress Map:



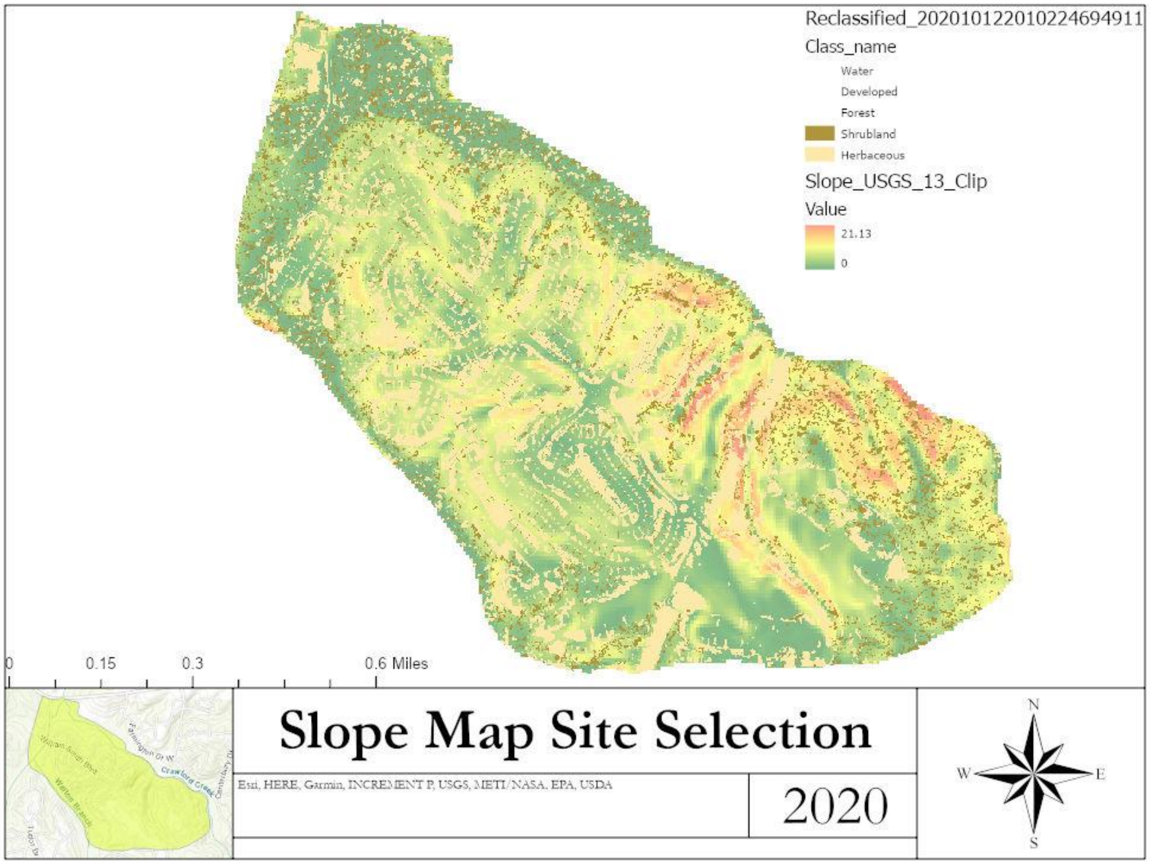
NDVI

The NDVI Green and Red maps illustrate healthy foliage versus distressed foliage. These two examples of NDVI reveal the barren grounds of developing residential neighborhoods contrasting neatly with the mature vegetation of the surrounding area.

In Figure 5, slightly greater emphasis has been added in the process to bring out healthy vegetation. Conversely, In Figure 6, the vegetation is analyzed with a Red spectrum color process. As vegetation shrivels up and dies, the chlorophyl from leaves depart the vegetation. This leaves them with a dirty, brown-red color.

Both of these NDVI maps were made in ArcGIS Pro.

Figure 7. Slope Site Selection Map:

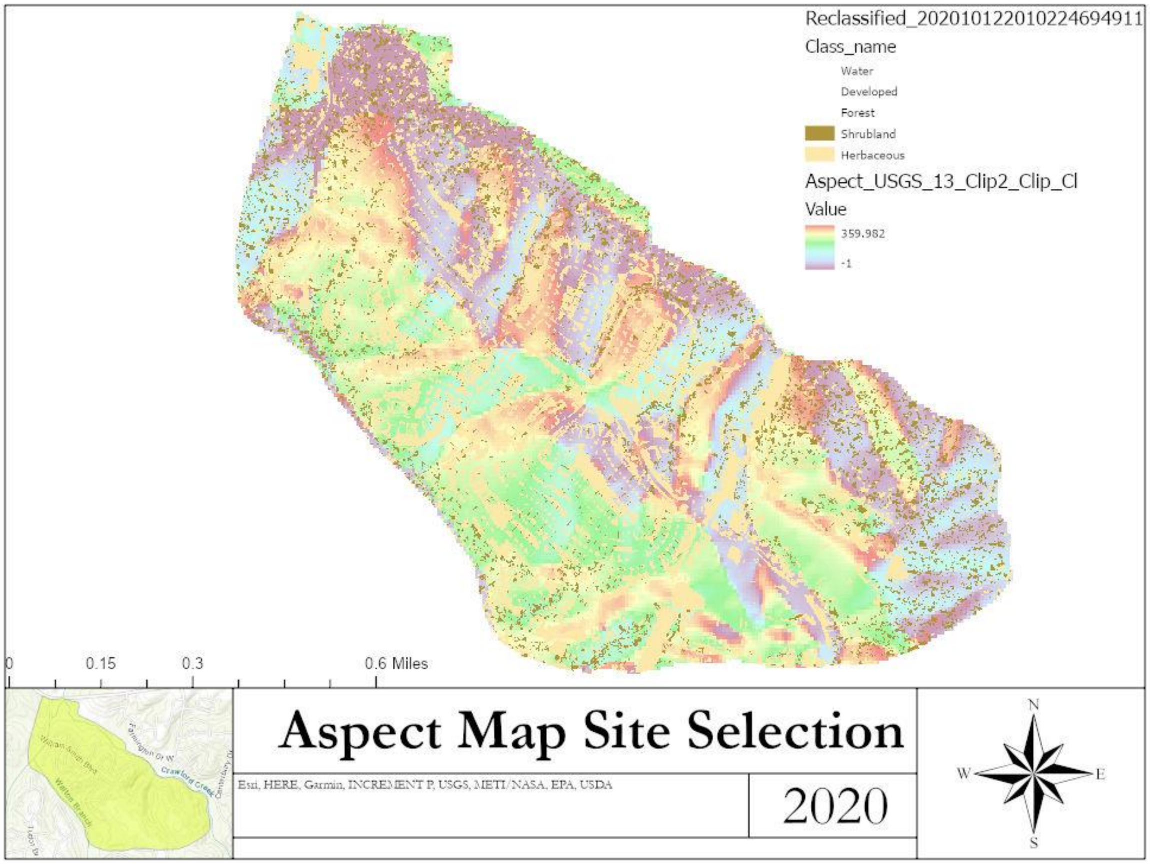


In Figure 7, the Water, Developed, and Forest layers have been removed from the Unsupervised Image-Object Based Land Classification leaving only the Shrubland and Herbaceous categories. These Low to Medium levels of Vegetation would be far better suited than the Forest or Developed classifications for food production. Slope analysis of the subdivision indicates the North side possesses the most unsuitable slope for cultivation.

The Shrubland and Herbaceous classified overlays above indicate the ideal sites for cultivation.

This product was created in ArcGIS Pro by running the Slope function.

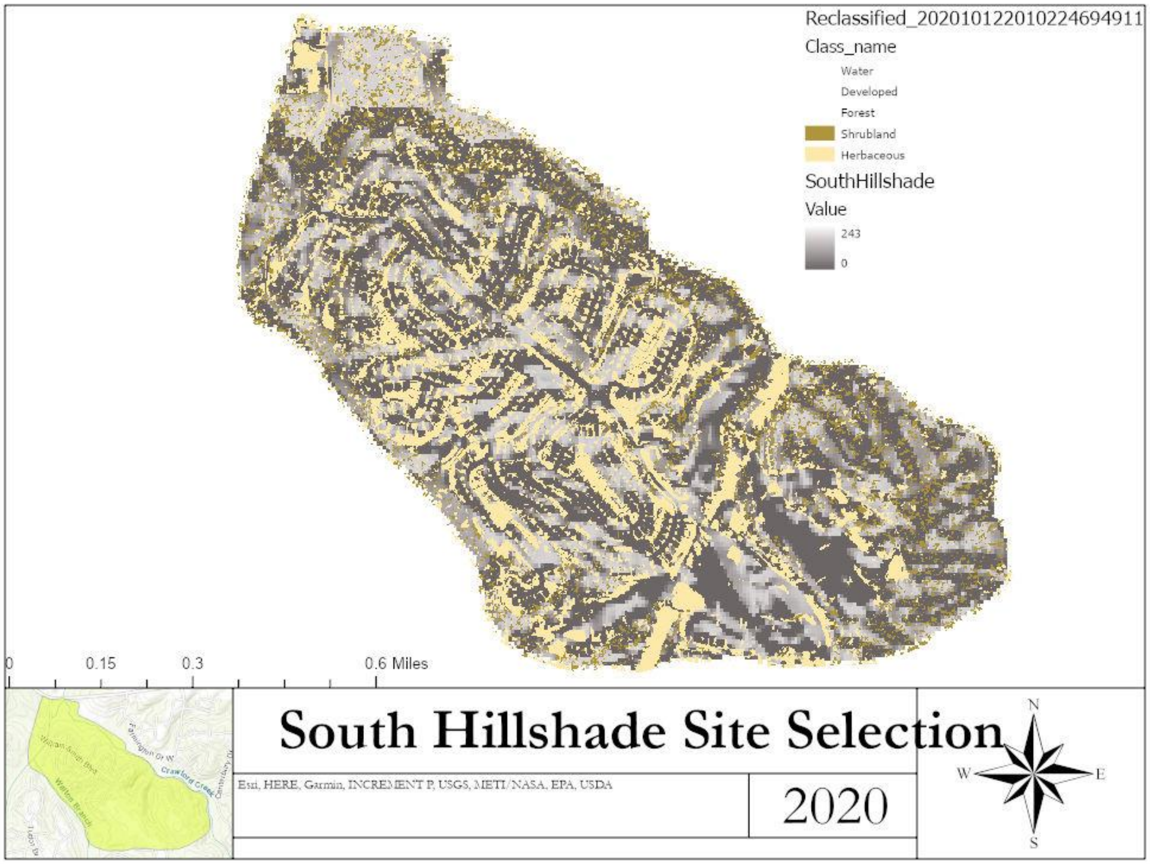
Figure 8. Aspect Site Selection Map:



In Figure 8, an Aspect Map is laid over with only the Shrubland and herbaceous classifications on it since the Unsupervised Image-Object Based Land Classification tool identified them. Gardening on the South slopes is identified as falling between the green and light blue bands of the key.

This product was created in ArcGIS Pro by running the Aspect function.

Figure 9. South Hillshade Site Selection Map:



In Figure 9, the shadows from a northerly sun have smothered the subdivision in shadow. Only the careful gardener will be able to grow anything in the cold winter months here. Although Georgia does not get much snow, gardening does not need to be completely out of the shade because some plants like it. In fact, plants have been known to completely die under the hot sun; scorched by powerful rays. There being no hope of success if the water was not kept up due to transpiration.

This product was created in ArcGIS Pro by running the Hillshade function.

IV. Conclusions

Site Selection

Site selection was based on known successful gardening techniques. When possible; plant on South-facing slopes, do not plant in shadows, and you cannot garden on a vertical face. These criteria were satisfied by the Aspect, Hillshade, and Slope Maps.

The exact areas to utilize for gardening have been clearly defined. However, actual plant selection should be guided by USDA zones. In this case the Augusta, Georgia area falls in zone 7b but can easily handle the hardier plants recommended for 8a due to its proximity to the border.

Self-Assessment

This project roughly illustrates the techniques and elements of a successful site to produce foodstuffs. Inaccuracies in the Unsupervised Landcover Classification could be remedied by creating more categories to classify. This would all be adversely challenged though by unwilling participation.

Although this study focuses on the usefulness of certain ground cover classifications, there will be no replacement or overlay which can replicate the actual joy of gardening. https://arcg.is/00jbiO

Works Cited

Agustina, I., & Beilin, R. (2012). Community Gardens: Space for Interactions and Adaptations. *Procedia Social and Behavioral Sciences*, 439-448.

Congalton, R. G. (1991). *A Review of Assessing the Accuracy of Classifications of Remotely Sensed Data.* Berkley: University of California, Berkley.

Ginn, F. (2012). Dig for Victory! New Histories of Wartime Gardening in Britain. *Journal of Historical Geography*, 294-305.

Heim, S., & Katherine Baeur, J. S. (2011). Can a Community-based Intervention Improve the Home Food Environment? Parental Perspectives of the Influence of the Delicious and Nutritious Garden. *Journal of Nutrition Education and Behavior*.