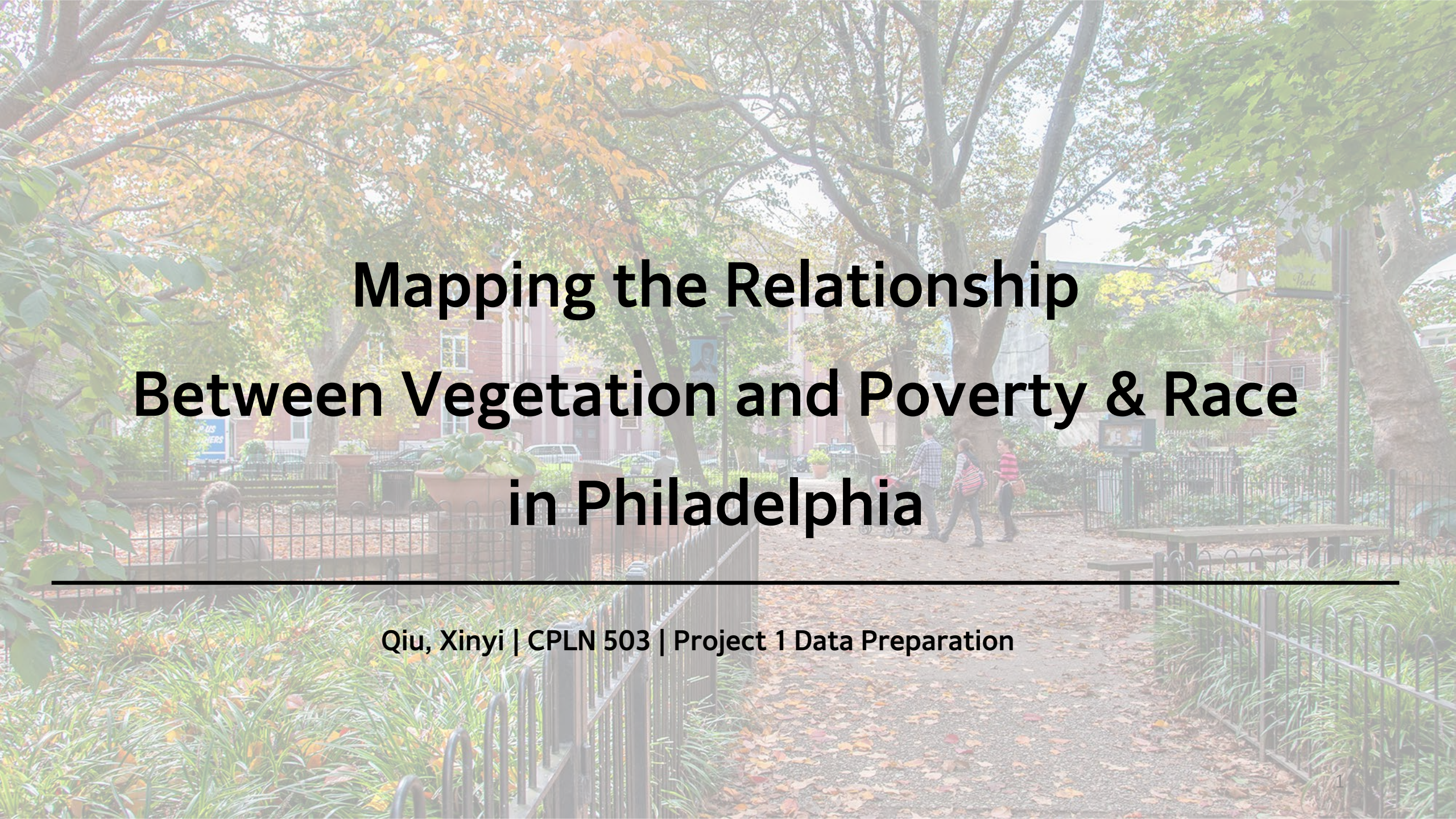


Mapping the Relationship Between Vegetation and Poverty & Race in Philadelphia

Qiu, Xinyi | CPLN 503 | Project 1 Data Preparation

CONTENTS

PROJECT INTRODUCTION

Project Background and Objectives

Background

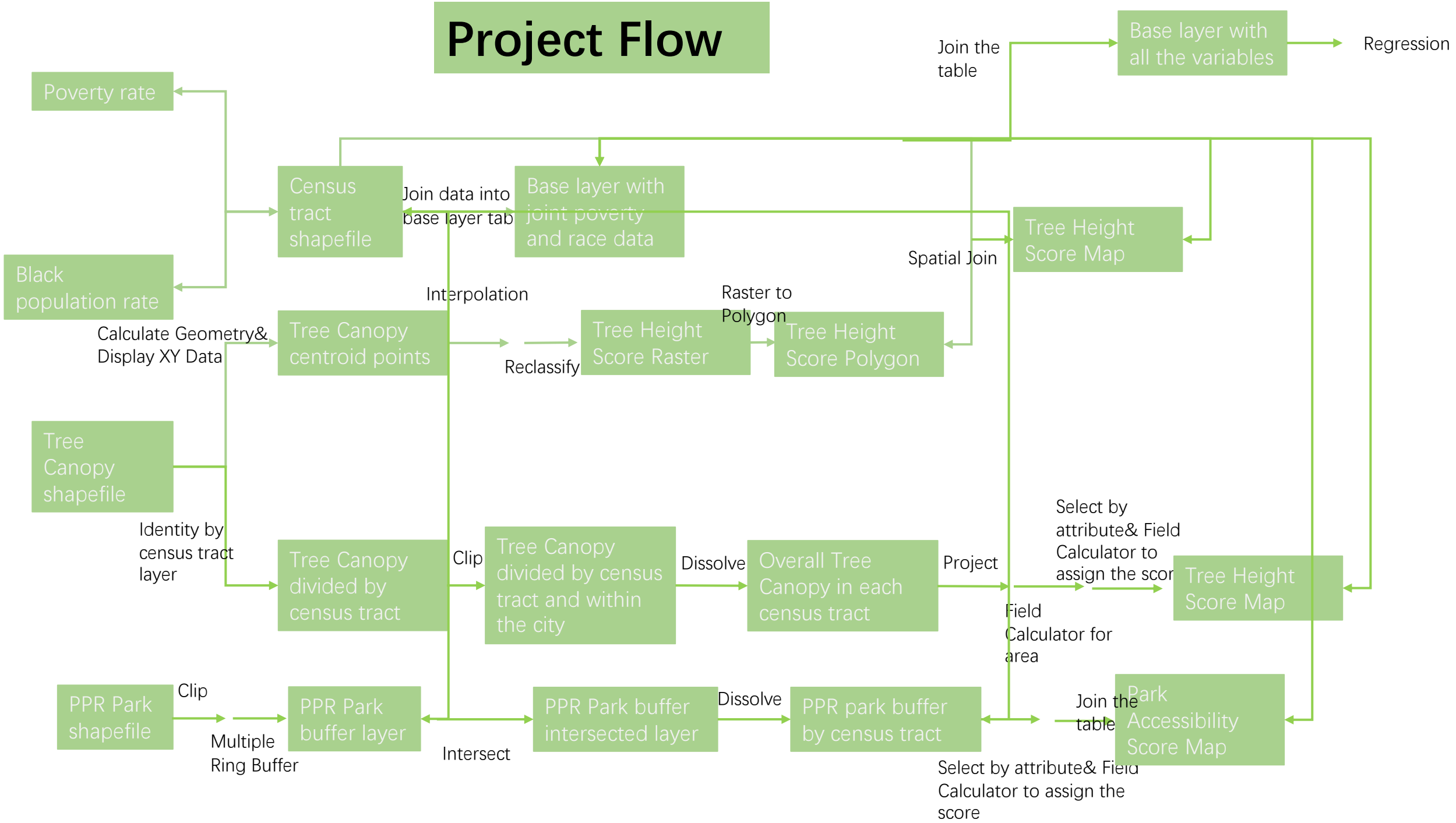
Abundant research proved that access to greenspace varies highly based on income, level of education, gender, race, age and other socioeconomic and personal characteristics differences. A common finding is that income and level of education are positively correlated with a greater accessibility to greenspace, while low-income, racial minorities and other vulnerable groups in the city have less access to vegetation.

According to the reports, this situation is happening in Philadelphia, especially the lack of trees in poor neighborhood. We need to ensure if it is true and where exactly demand for more trees.

Objectives

I. Identify the characteristics of poverty status in Philadelphia, and stress the importance on race differences;
II. Identify the characteristics of tree canopy in Philadelphia, including the area and height;
III. Explore the relationship between tree canopy and poverty in Philadelphia

Project Flow



PART I DATA PREPARATION

Project Data

Data Catalogue	Data Items	Data Source
Socioeconomic Data	Poverty Population	https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml
	White Poverty Population	
	Black Poverty Population	
	Black Population	
	White Population	
Vegetation Data	Tree Average Height	https://www.opendataphilly.org/dataset/ppr-tree-canopy
	Tree Canopy Coverage	
	Philadelphia PPR Park	https://www.opendataphilly.org/dataset/ppr-properties
Base Map	Philadelphia Census Tract Map	https://www.opendataphilly.org/dataset/census-tracts

Part I Data Preparation-Vegetation

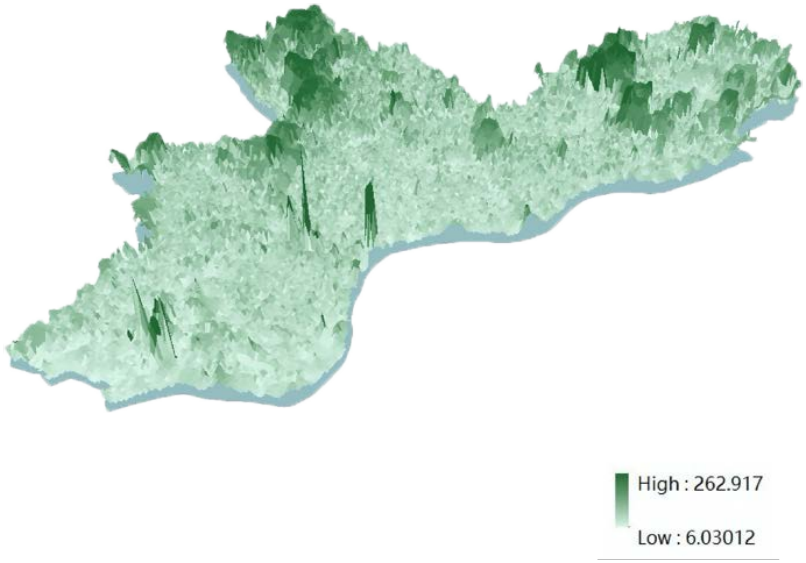
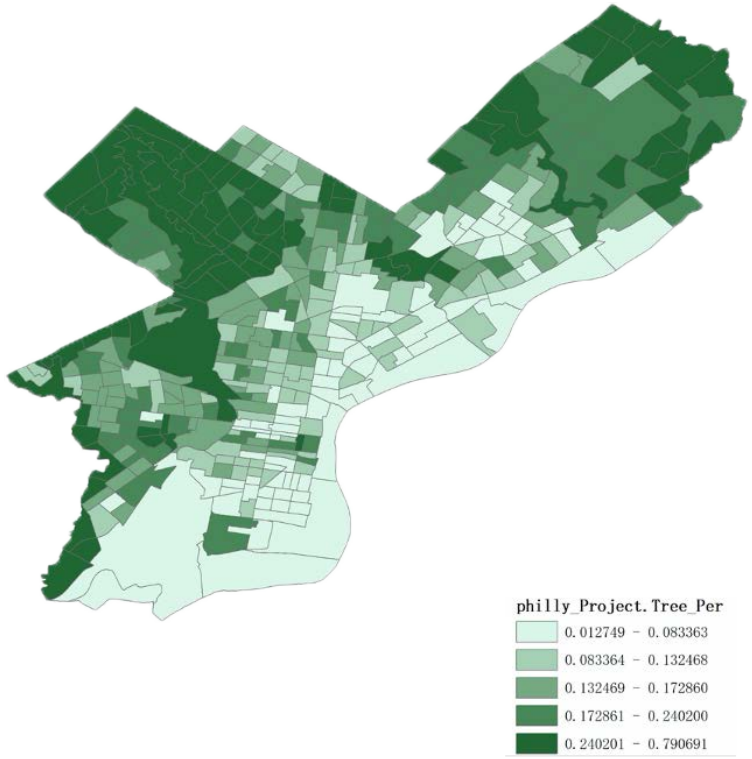


Figure 1.1 Average Tree Height in Philadelphia

Figure 1.2 Percentage of Tree Canopy Area by Census Tracts in Philadelphia



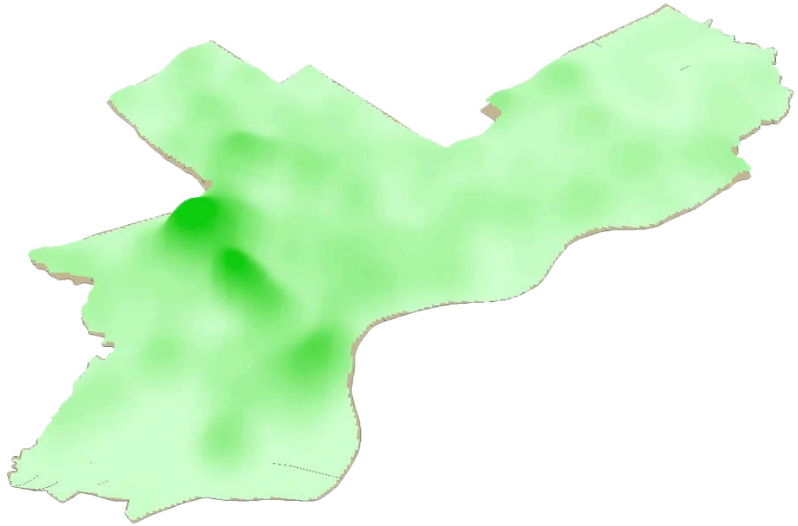


Figure 1.3 PPR Park Location in Philadelphia

Part I Data Preparation-Population & Poverty

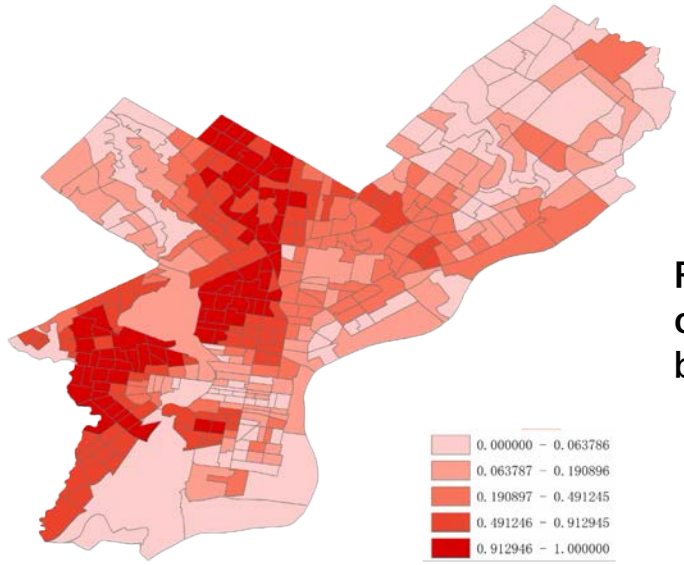


Figure 1.4 Percentage of Black Population by Census Tracts

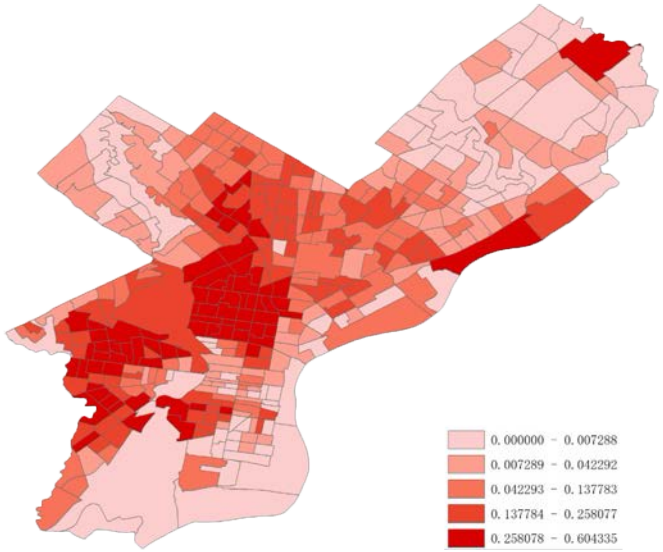


Figure 1.5 Black Population Poverty Rate by Census Tracts

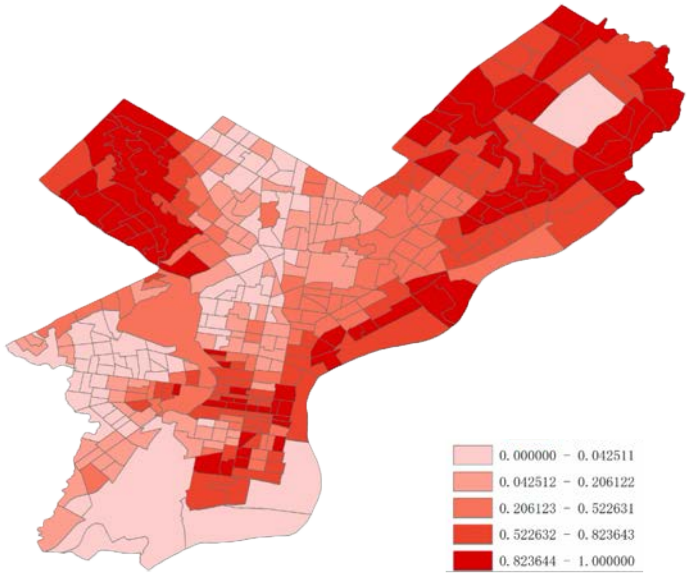


Figure 1.6 Percentage of White Population by Census Tracts

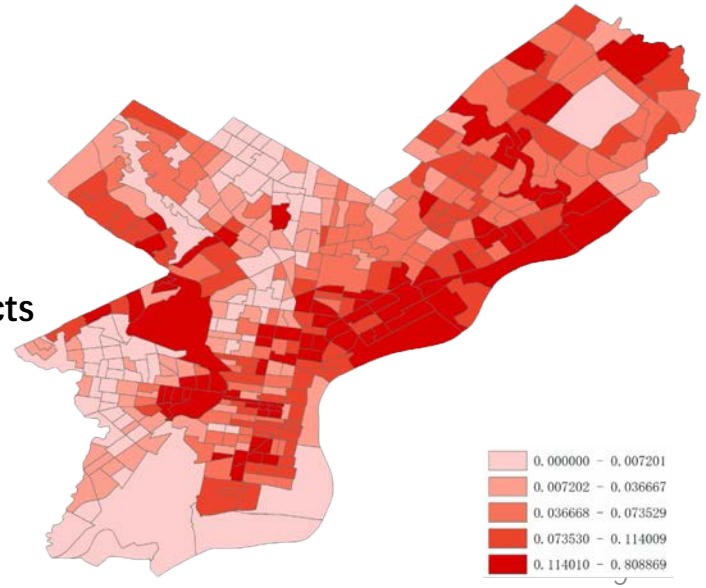
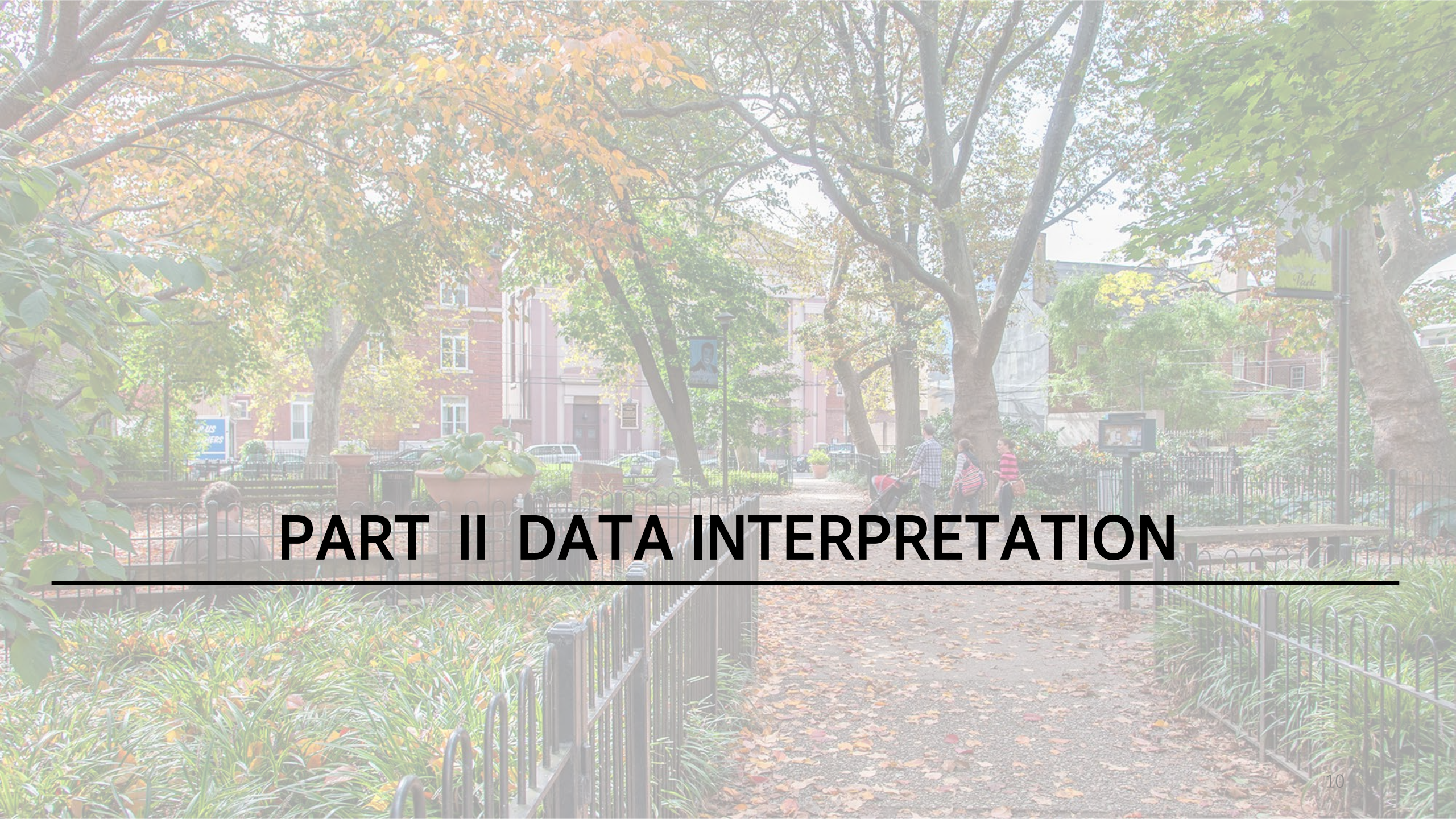


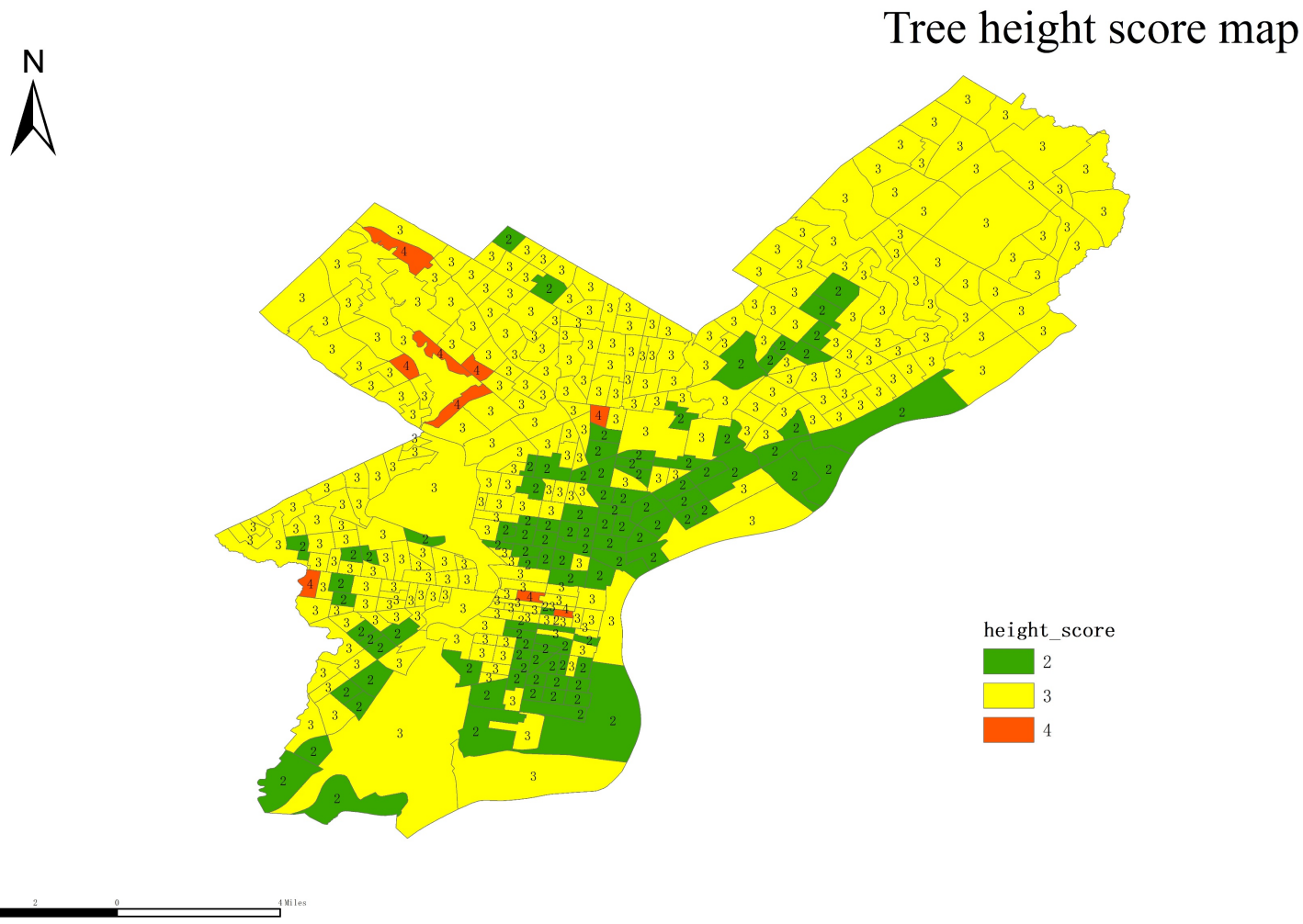
Figure 1.7 White Population Poverty Rate by Census Tracts



PART II DATA INTERPRETATION

Part II Data Interpretation-Evaluating the vegetation in Philadelphia

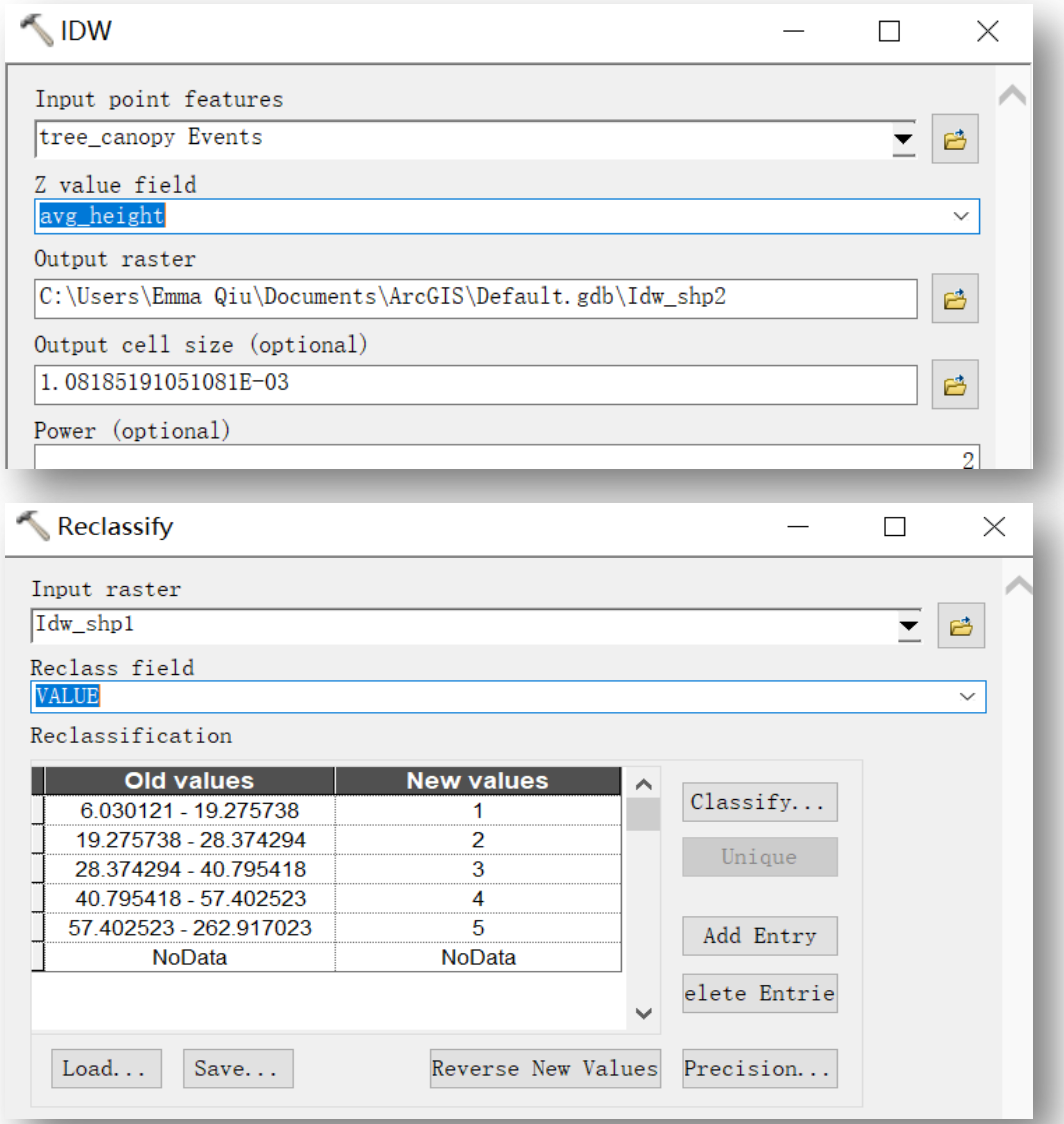
1.-Evaluating tree height

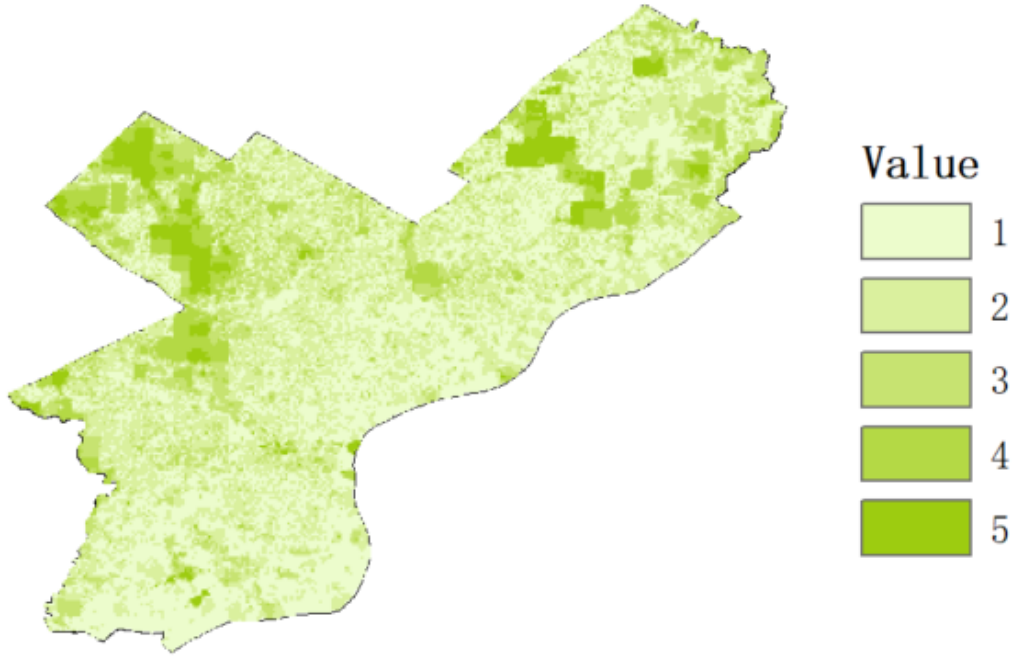


In data preparation, centroid points of each tree canopy has been displayed

Part II Data Interpretation-Evaluating the vegetation in Philadelphia

1.-Evaluating tree height

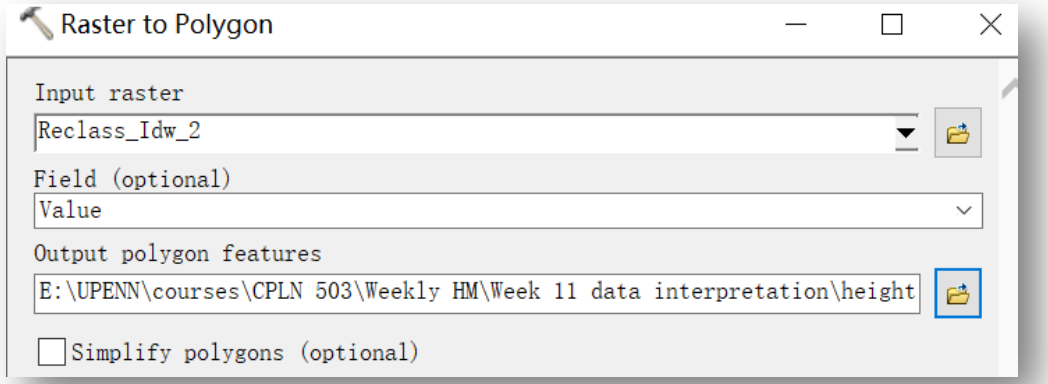


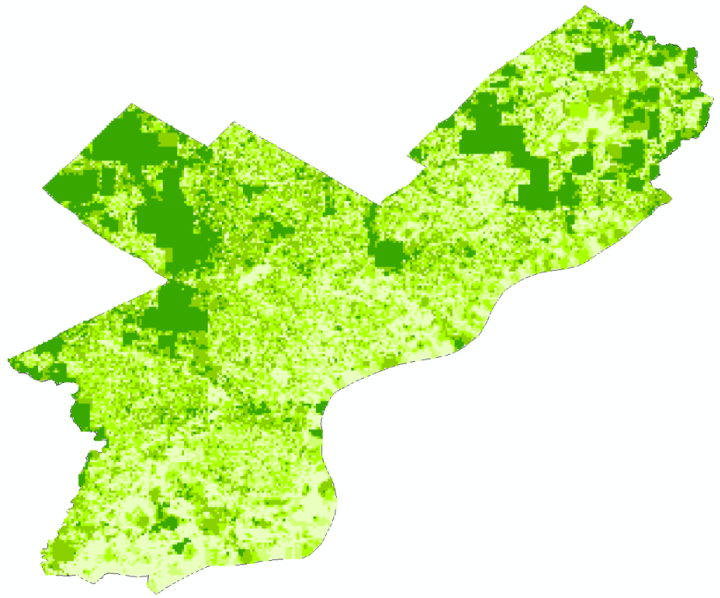


Since the centroids of tree canopy has been prepared in the data preparation report, use Spatial analyst tools-interpolation-IDW to interpolate the tree height within the city;
And then use Spatial Analyst Tools-Reclass-Reclassify to attribute the score to different classes by "Quantile" classification method

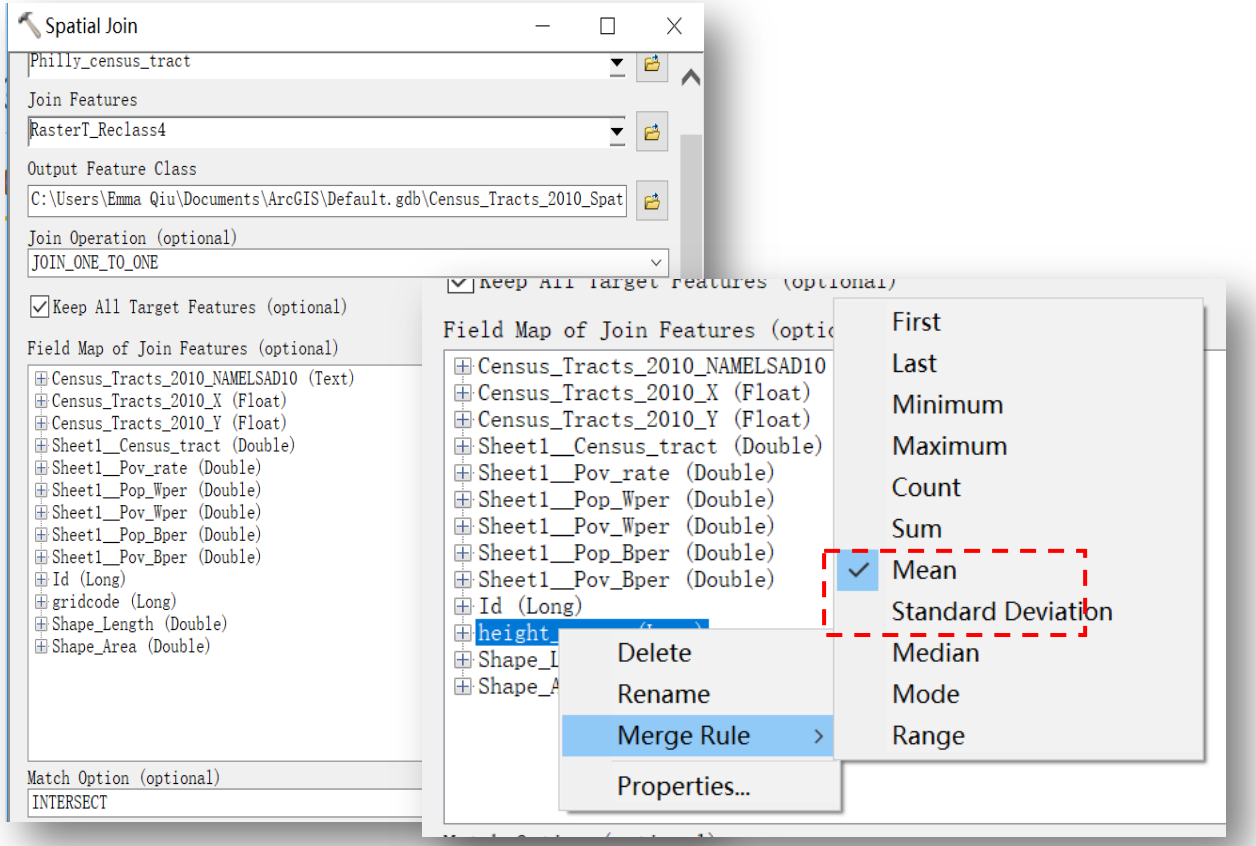
Part II Data Interpretation-Evaluating the vegetation in Philadelphia

1.-Evaluating tree height





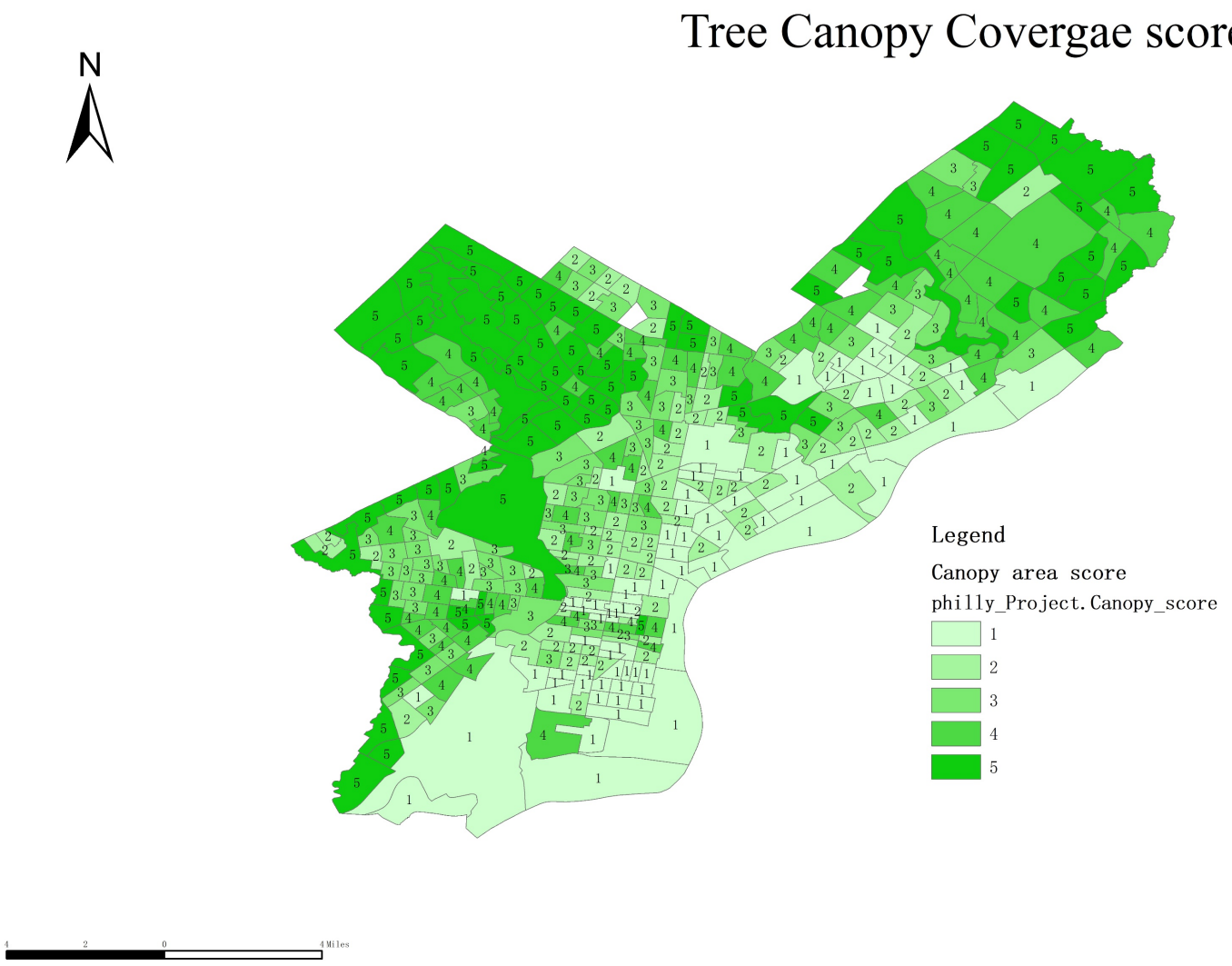
Use Conversion Tool-From Raster-Raster to Polygon to transform the IDW raster into polygon for further data interpretation



Use Analysis Tools-Overlay-Spatial join to join the reclassified interpolated tree height layer to the census tract layer. It should be noted that the merge rule must be Mean when doing the spatial join, so that we can get the average tree height score of each census tracts.

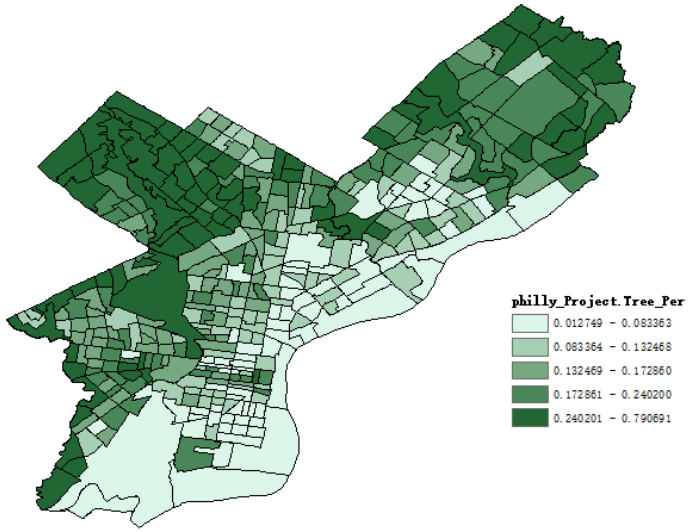
Part II Data Interpretation-Evaluating the vegetation in Philadelphia

2.-Evaluating tree canopy coverage



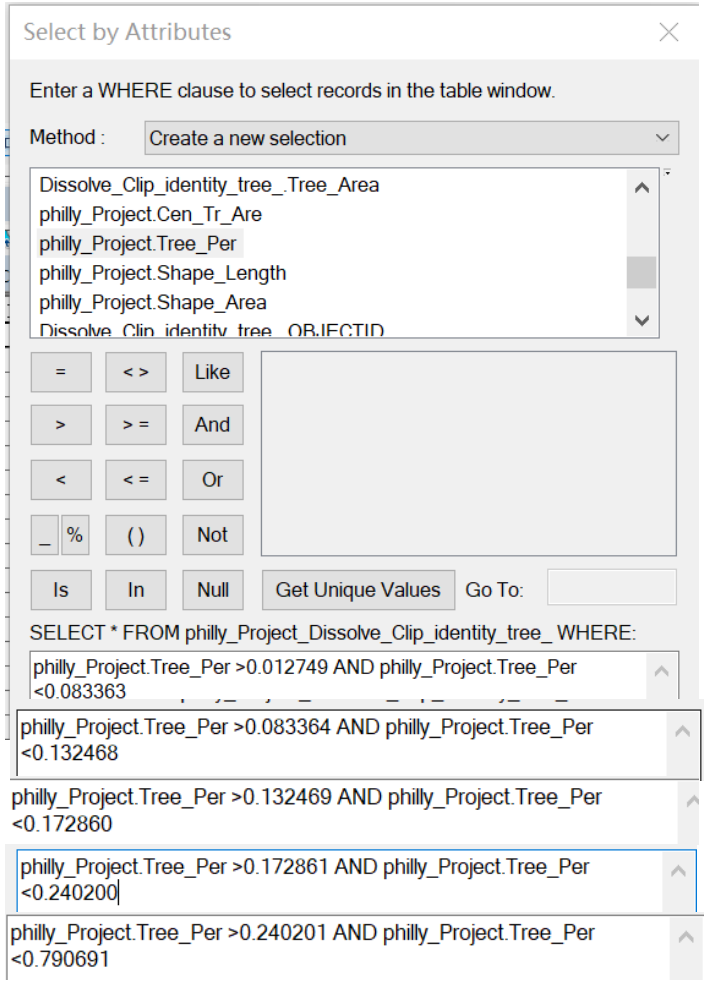
In the data preparation report, I used Identity, Dissolve, Project, Calculate Geometry and Field Calculator tools to obtain the tree canopy coverage rate map.

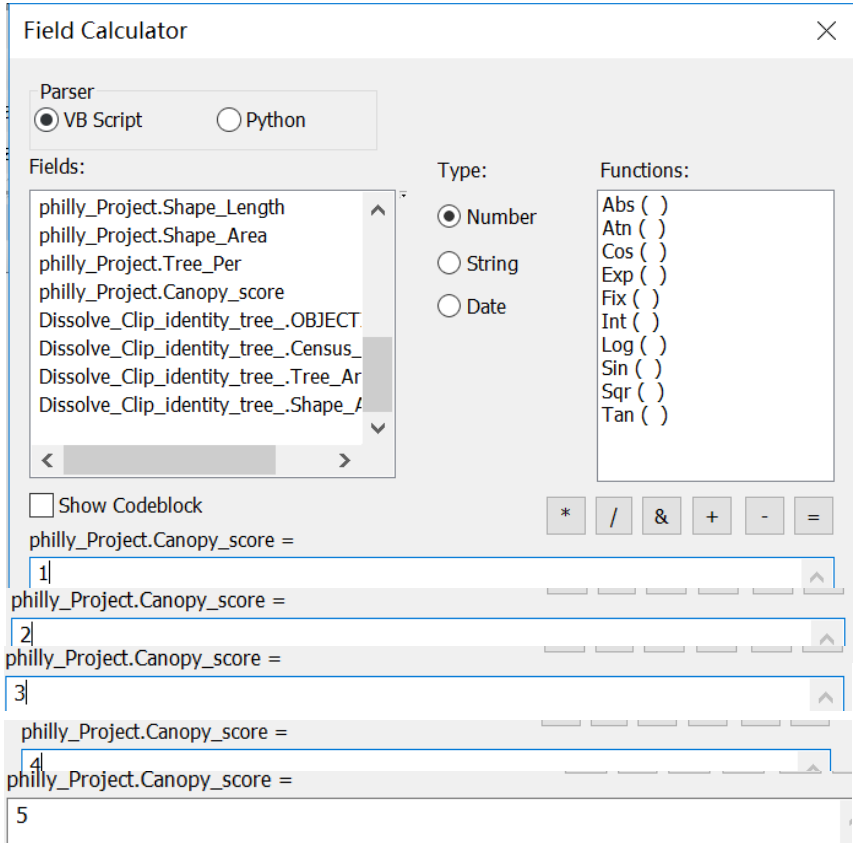
What to do next is to assign the score to different Quantile intervals.



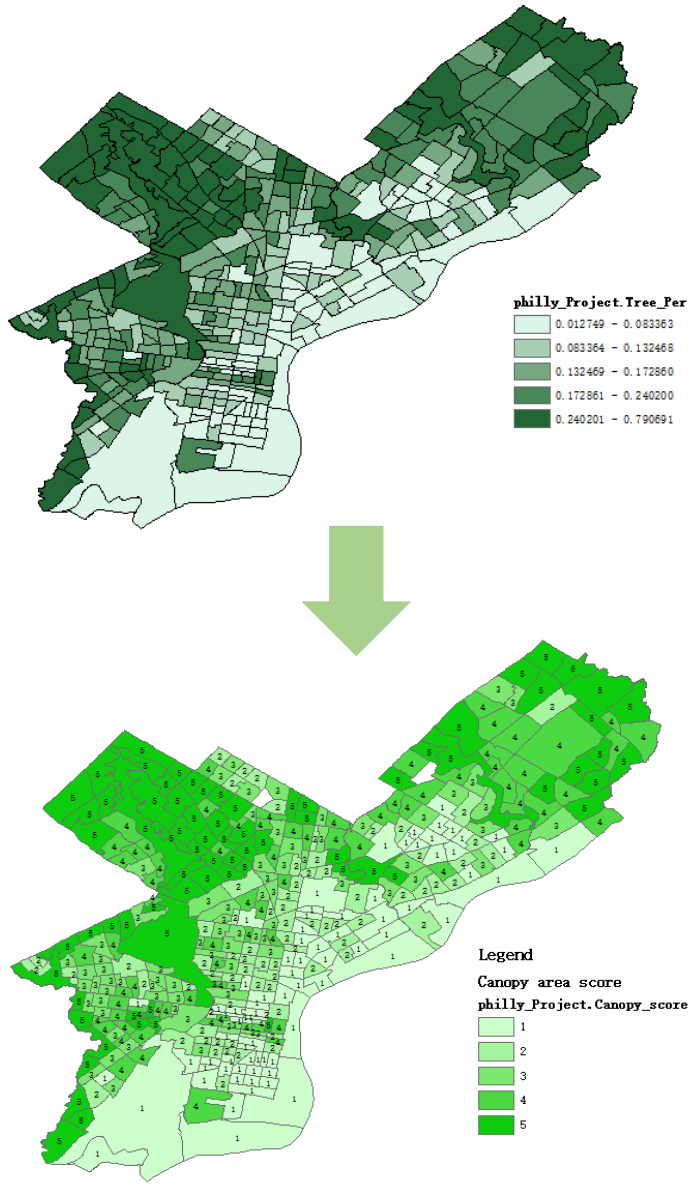
Part II Data Interpretation-Evaluating the vegetation in Philadelphia

2.-Evaluating tree canopy coverage



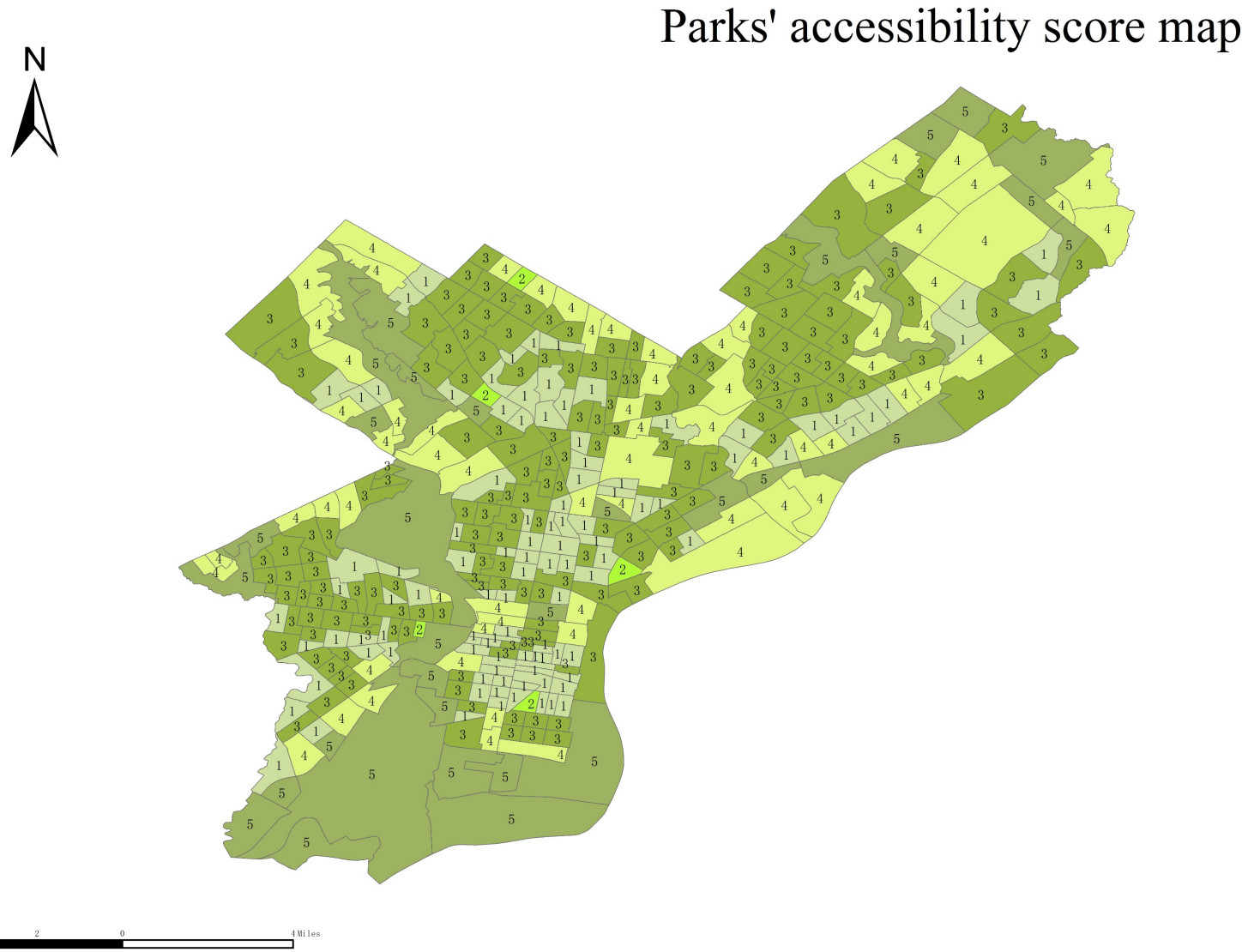


Use Select by Attributes to select census tracts in different tree canopy coverage intervals one by one and use Field Calculator to assign the score to the selected census tract from 1 to 5.



Part II Data Interpretation-Evaluating the vegetation in Philadelphia

3.-Evaluate the accessibility of parks in Philadelphia

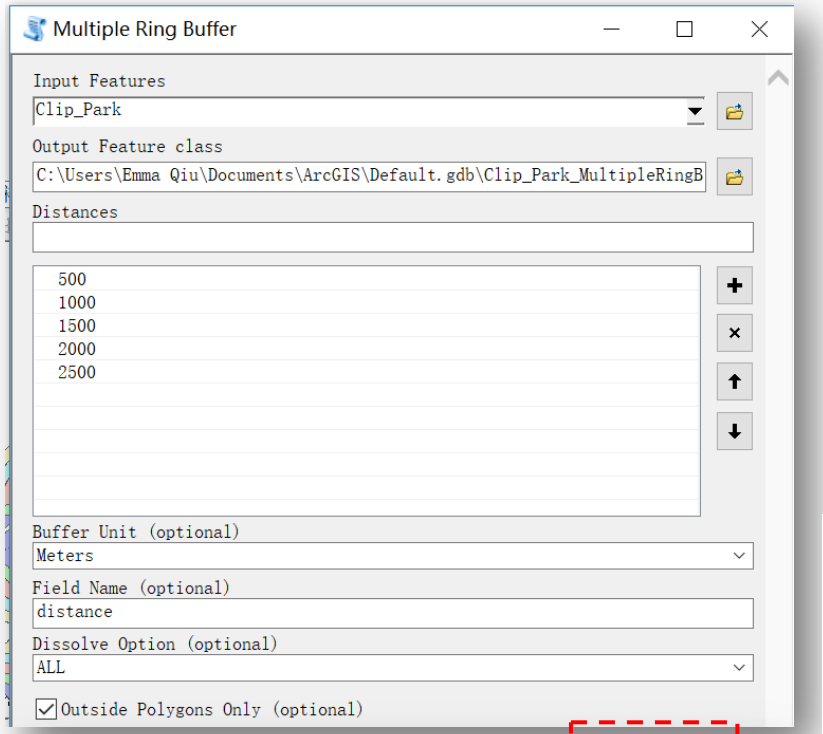


Assume that the less distance away from the park, the better living experience the residents will have. So evaluate the accessibility of parks by the distance from the boundary of the parks in Philadelphia

Part II Data Interpretation-Evaluating the vegetation in Philadelphia

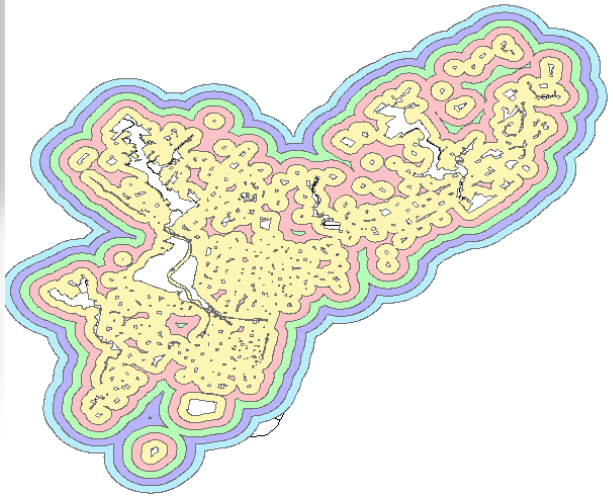
3.-Evaluate the accessibility of parks in Philadelphia

Step 1- BUFFER

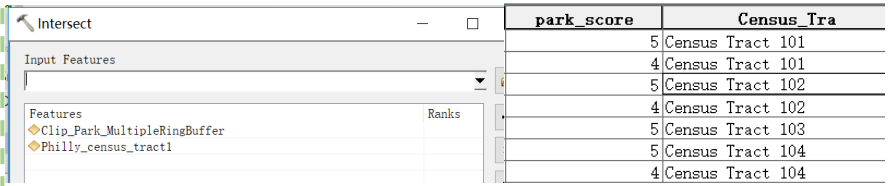


distance	Shape_Length	Shape_Area	park_score
500	2642059.415164	2733124371.494181	5
1000	1610357.85487	1159087645.56213	4
1500	949845.116341	746352431.796468	3
2000	803667.783245	660701256.93267	2
2500	763675.13451	623887484.534334	1

Use Analysis Tools-Proximity-Multiple Ring Buffer to find the areas which are 500 meters, 1000 meters, 1500 meters, 2000 meters and 2500 meters away from the park. The Multiple Ring Buffer helps to dissolve the circles by distance intervals instead of using dissolve and erase tool later when using buffer tool.

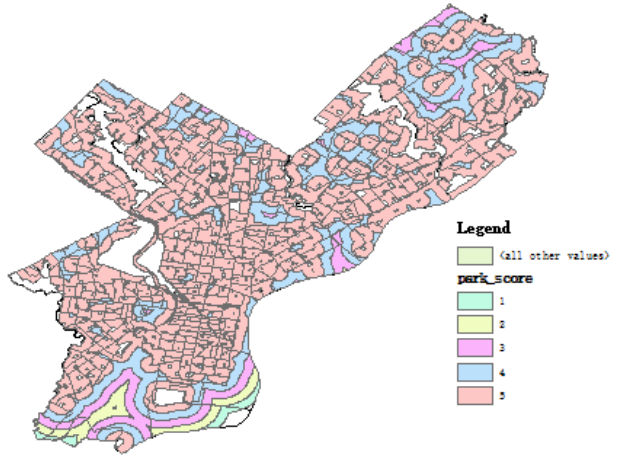


Step 2- INTERSECT



park_score	Census_Tra
5	Census Tract 101
4	Census Tract 101
5	Census Tract 102
4	Census Tract 102
5	Census Tract 103
5	Census Tract 104
4	Census Tract 104

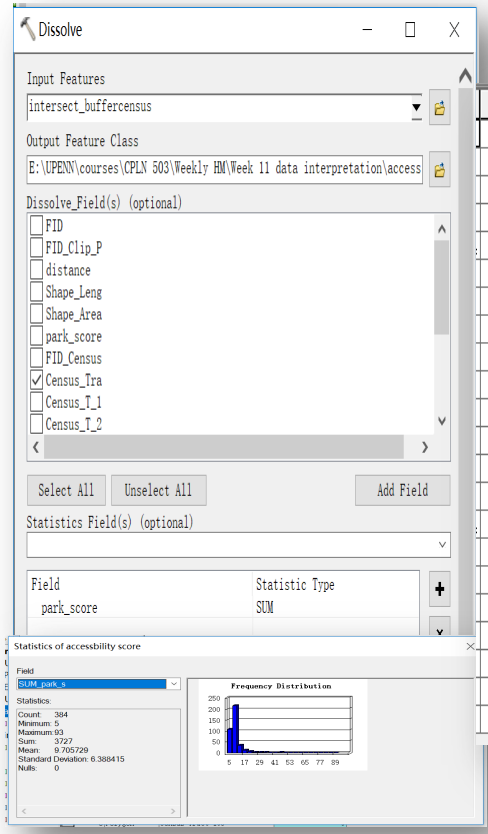
Use Analysis Tools-Overlay-Intersect, we can intersect the buffer layer with the base layer and obtain a layer with combined attributes. Besides, the buffer are divided by the census tract boundary, so that I can calculate the sum score of each census tract



Part II Data Interpretation-Evaluating the vegetation in Philadelphia

3.-Evaluate the accessibility of parks in Philadelphia

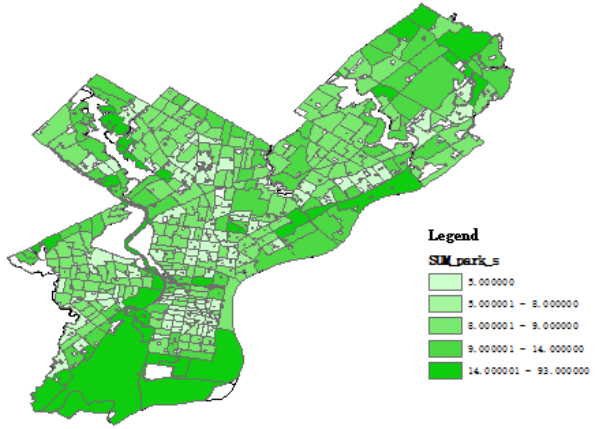
Step 3- Dissolve



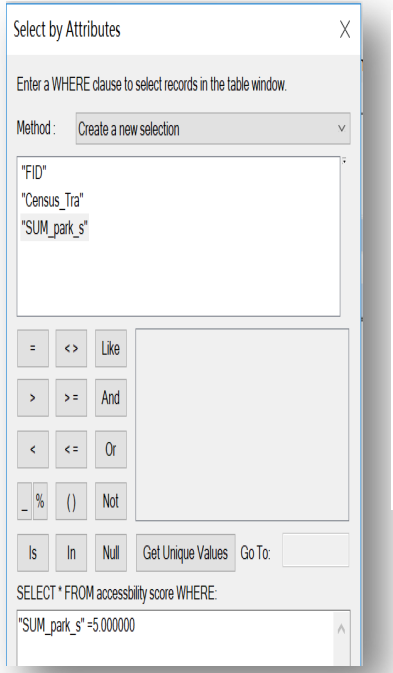
SUM_park_s	Count_SUM_park_s
5	103
7	2
8	3
9	174
10	18
12	24
13	4
14	24
15	7
17	4
18	4
19	4
21	1
22	2
23	2
24	1
27	1
29	1
30	1
36	2
45	1
93	1

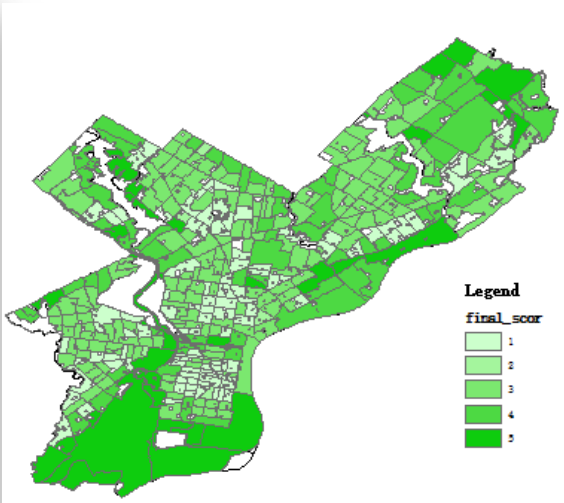
Use Data Management Tool-Generalization-Dissolve tool to dissolve the intersected layer by census tract and sum the park score by census tract.

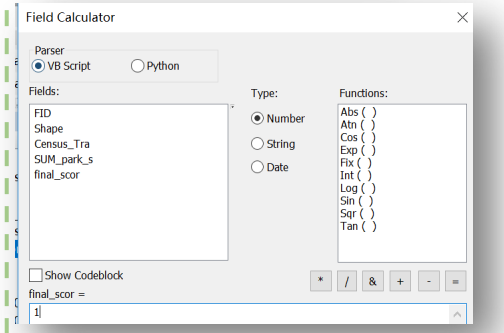
Then use Quantile classification to define five level of parks' accessibility in Philadelphia



Step 4- Select by Attributes and assign the score





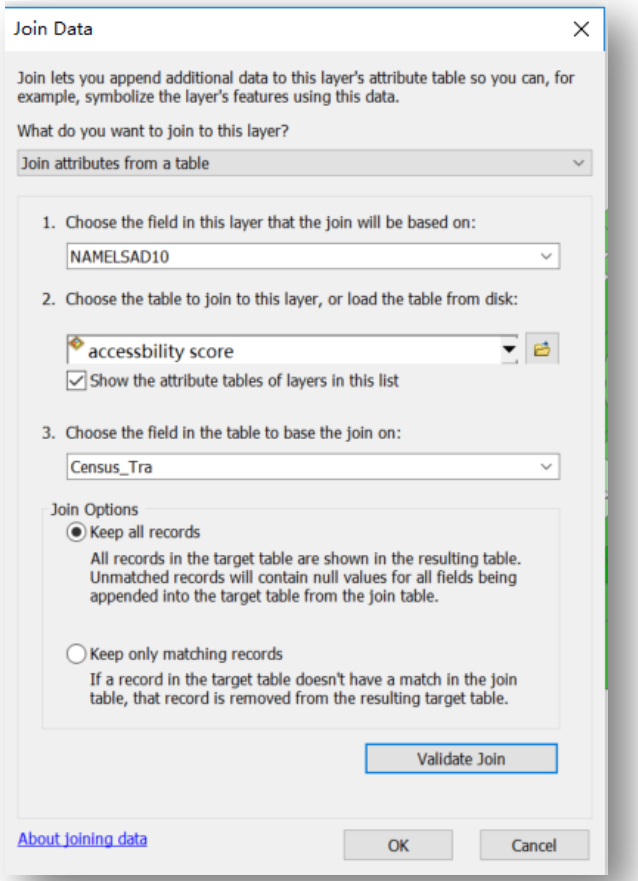


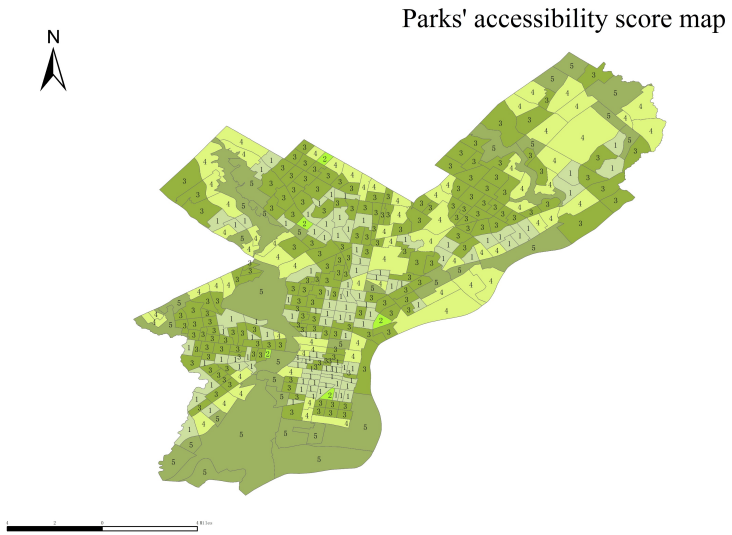
Use Select by Attributes and Field Calculator to assign the score from 1 to 5 to the sum scores' intervals.

Part II Data Interpretation-Evaluating the vegetation in Philadelphia

3.-Evaluate the accessibility of parks in Philadelphia

Step 5- Join the table and Display

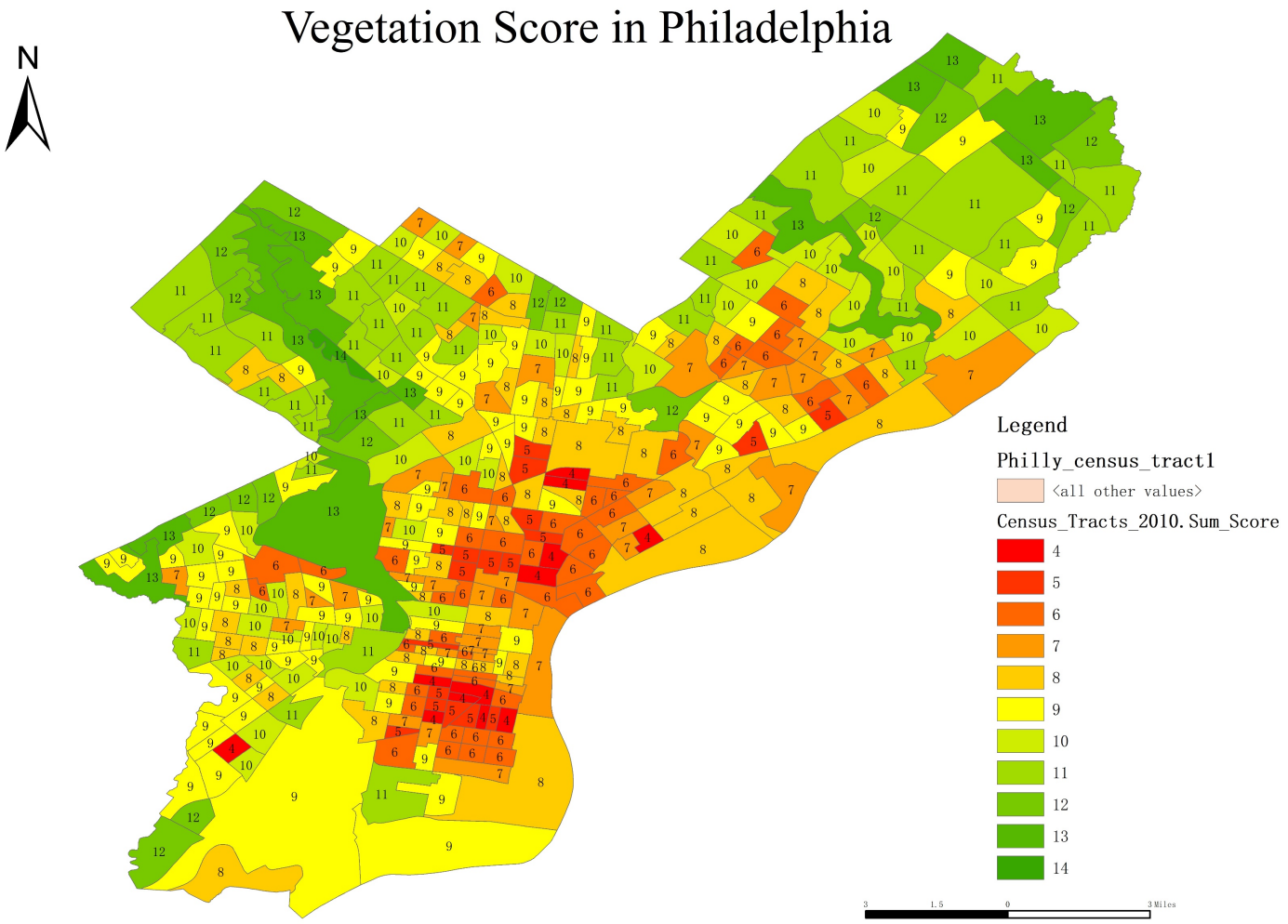




Join the table of the intersected layer with the base layer and display the distribution of parks' accessibility in the base map.

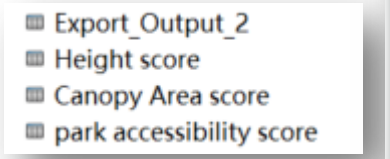
Part II Data Interpretation-Evaluating the vegetation in Philadelphia

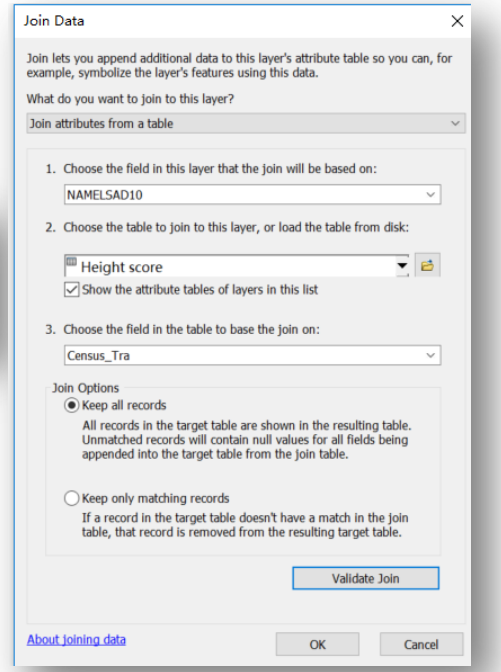
4.-Sum the total score of the vegetation



Vegetation Score= Tree Height Score+ Tree Canopy Area Score+ Park Accessibility Score

Step 1- Join the table

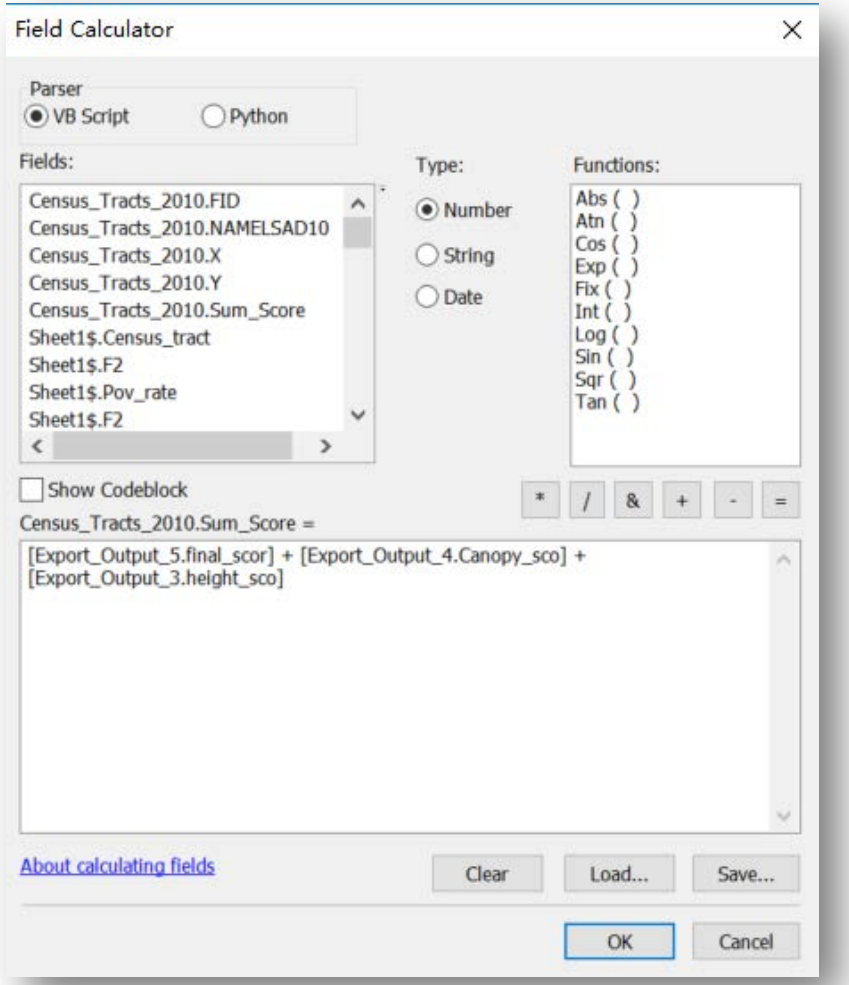


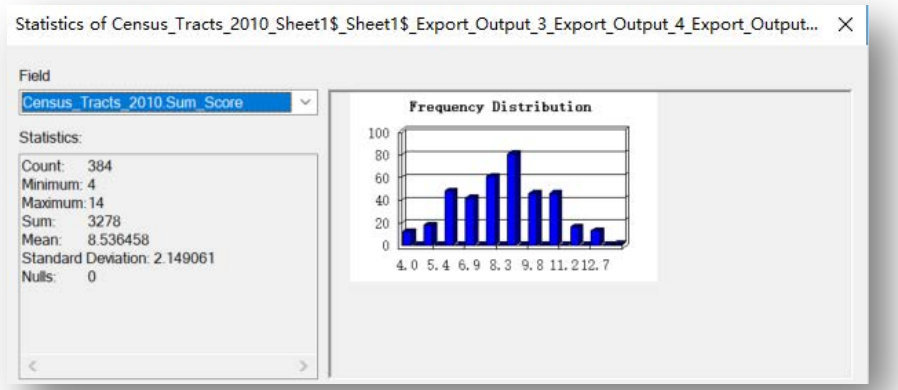


Export all the score layers' data into dbf. File, and join them into the base layer to calculate the final score later

Part II Data Interpretation-Evaluating the vegetation in Philadelphia

4.-Sum the total score of the vegetation





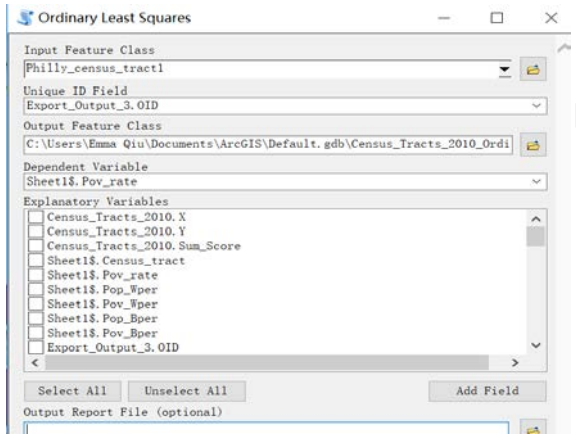
OID	Sum_Score	Count_Sum_Score
0	4	12
1	5	18
2	6	48
3	7	42
4	8	61
5	9	81
6	10	46
7	11	46
8	12	16
9	13	13
10	14	1

Step 2- Field Calculator

Use Field Calculator to calculate the total score of vegetation in Philadelphia. The Statistics shows that the minimum score is 4, and the maximum score is 14. Most census tracts are between 6 and 11 score interval.

Part II Data Interpretation- Explore the relationship

1.-examine the relationship between vegetation and poverty



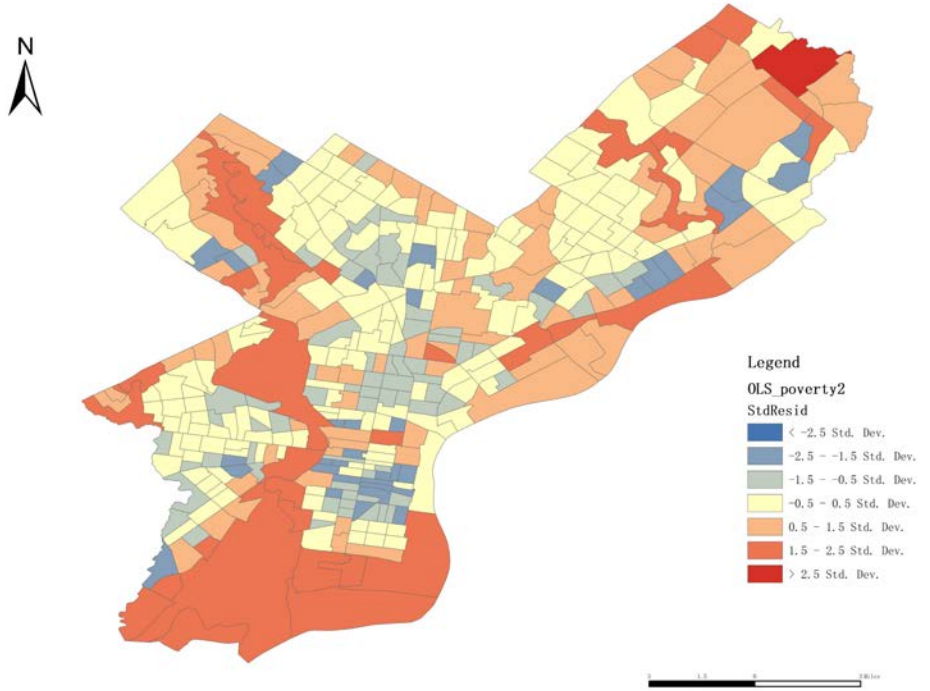
Summary of OLS Results

Variable	Coefficient [a]	StdError	t-Statistic	Probability [b]	Robust_SE	Robust_t	Robust_Pr [b]
Intercept	3.146409	0.114434	27.495321	0.000000*	0.125077	25.155781	0.000000*
EXPORT_OUTPUT_4.POV_RATE	-1.388129	0.382611	-3.628045	0.000336*	0.453509	-3.060863	0.002373*

OLS Diagnostics

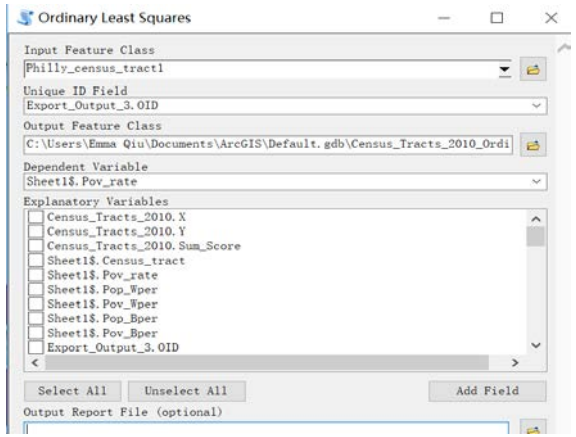
Input Features:	Philly_census_tract1	Dependent Variable:	EXPORT_OUTPUT_5.FINAL_SCOR
Number of Observations:	384	Akaike's Information Criterion (AICc) [d]:	1253.891665
Multiple R-Squared [d]:	0.033310	Adjusted R-Squared [d]:	0.030779
Joint F-Statistic [e]:	13.162707	Prob(>F), (1,382) degrees of freedom:	0.000324*
Joint Wald Statistic [e]:	9.368880	Prob(>chi-squared), (1) degrees of freedom:	0.002207*
Koenker (BP) Statistic [f]:	2.717229	Prob(>chi-squared), (1) degrees of freedom:	0.099270
Jarque-Bera Statistic [g]:	10.300461	Prob(>chi-squared), (2) degrees of freedom:	0.005798*

Use Spatial Statistics Tools- Modeling Spatial Relationships- Ordinary Least Squares to build the relationship between vegetation and poverty. Although the R-square is small, the overall model is significant according to the Joint F-Statistic. And, the poverty rate is significantly related to the vegetation. According to the summary of OLS result, when the poverty rate is higher, there is supposed to be less vegetation.



Part II Data Interpretation- Explore the relationship

2.-examine the relationship between vegetation and race

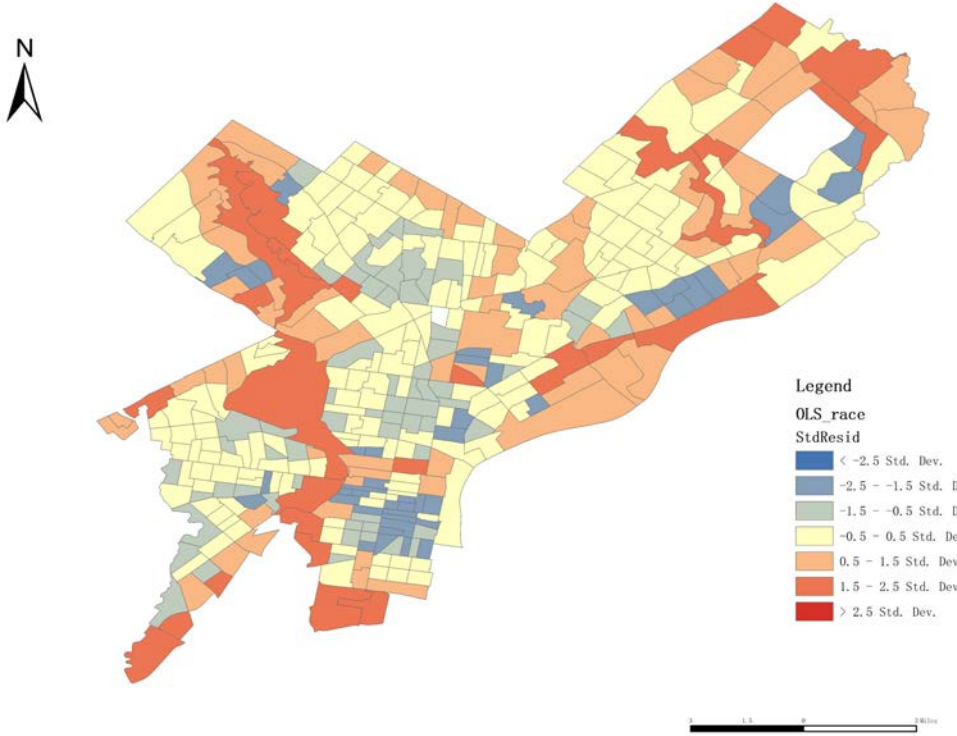


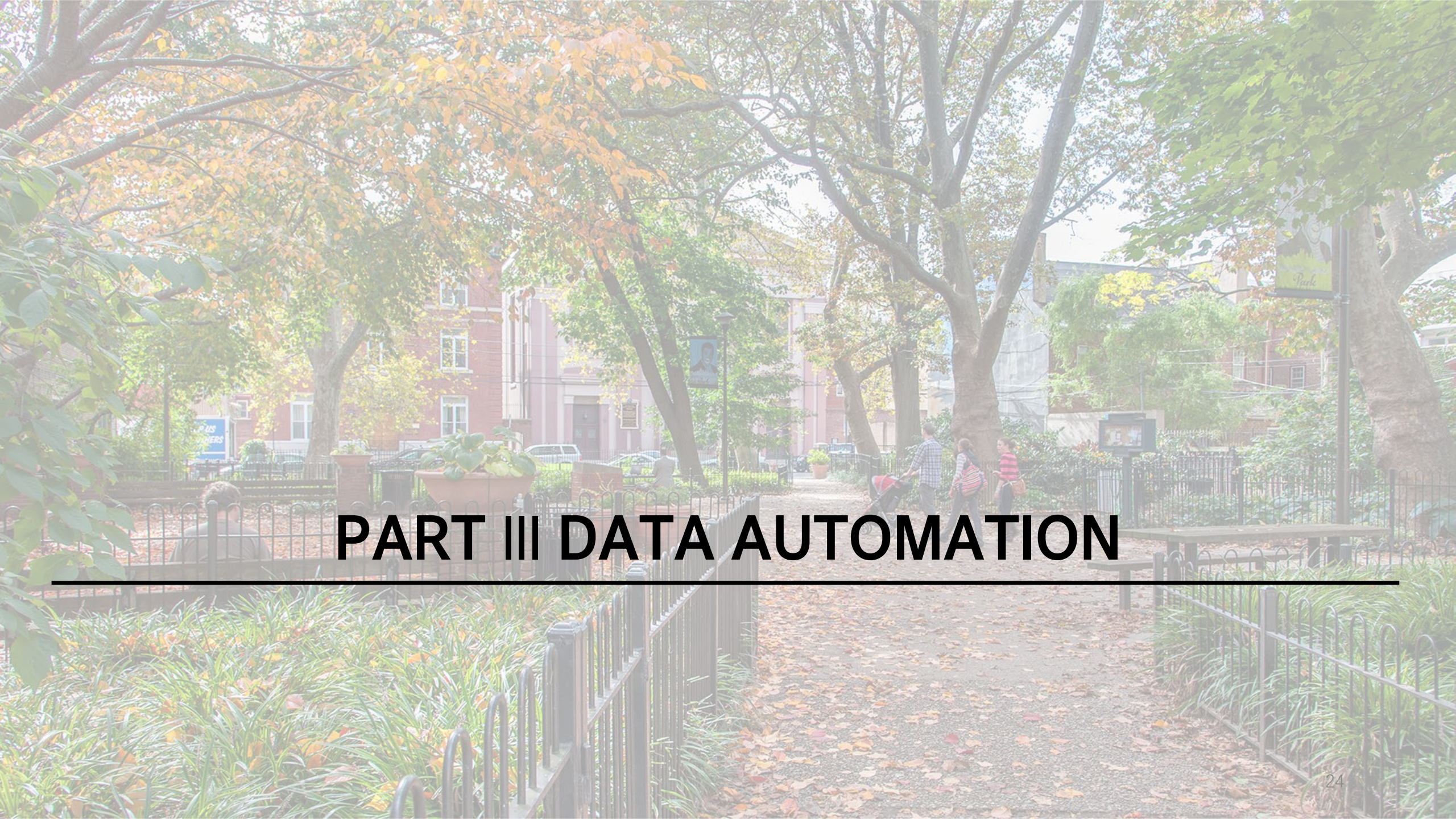
Summary of OLS Results - Model Variables

Variable	Coefficient [a]	StdError	t-Statistic	Probability [b]	Robust_SE	Robust_t	Robust_Pr [b]
Intercept	2.963465	0.099030	29.924824	0.000000*	0.101981	29.058955	0.000000*
SHEET1$.POP_	-0.430970	0.171894	-2.507183	0.012582*	0.161599	-2.666918	0.007982*

Input Features:	Philly_census_tract1	Dependent Variable:	EXPORT_OUTPUT_5.FINAL_S
Number of Observations:	377	Akaike's Information Criterion (AICc) [d]:	1225.777904
Multiple R-Squared [d]:	0.016486	Adjusted R-Squared [d]:	0.013864
Joint F-Statistic [e]:	6.285969	Prob(>F), (1,375) degrees of freedom:	0.012592*
Joint Wald Statistic [e]:	7.112450	Prob(>chi-squared), (1) degrees of freedom:	0.007655*
Koenker (BP) Statistic [f]:	6.075476	Prob(>chi-squared), (1) degrees of freedom:	0.013707*
Jarque-Bera Statistic [g]:	16.003797	Prob(>chi-squared), (2) degrees of freedom:	0.000335*

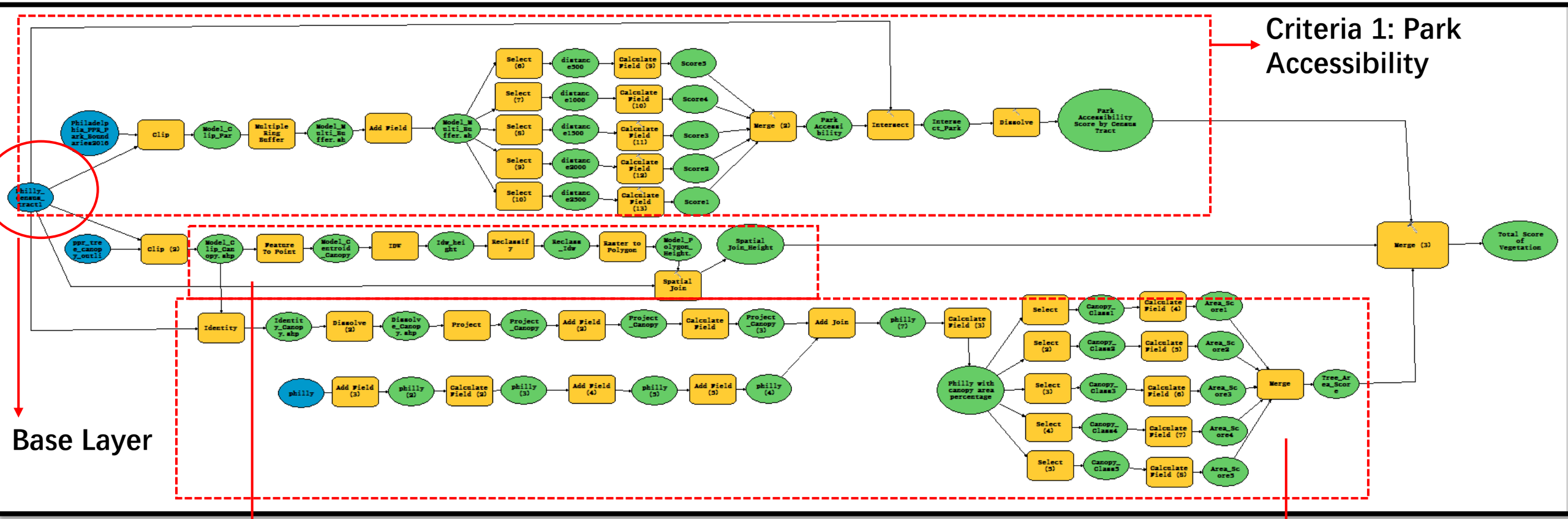
Use Spatial Statistics Tools- Modeling Spatial Relationships- Ordinary Least Squares to build the relationship between vegetation and race. Same as the previous explanation, although the R-square is small, the overall model is significant according to the Joint F-Statistic. And, the Black population percentage is significantly related to the vegetation. According to the summary of OLS result, when there are more Black race in the census tract, it is likely to have less vegetation.



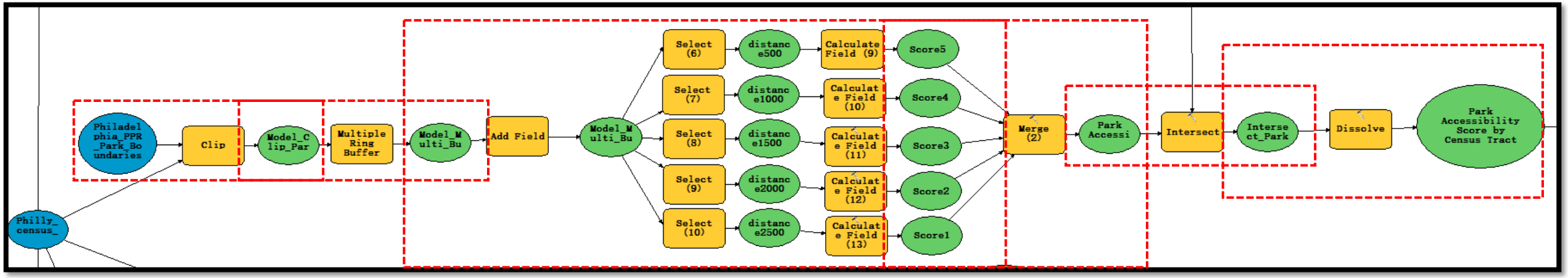


PART III DATA AUTOMATION

Overview


Criteria 1: Park Accessibility
Philadelphia_PPR_Park_Boundaries2016
Clip
Model_Clip_Par
Multiple Ring Buffer
Model_Multi_Buffer.shp
Add Field
Model_Multi_Buffer.shp
Select (6)
Select (7)
Select (8)
Select (9)
Select (10)
distance300
distance1000
distance1500
distance2000
distance2500
Calculate Field (9)
Calculate Field (10)
Calculate Field (11)
Calculate Field (12)
Calculate Field (13)
Score5
Score4
Score3
Score2
Score1
Merge (2)
Park Accessibility
Intersect
Intersect_Park
Dissolve
Park Accessibility Score by Census Tract
philly_census_tract1
ppr_tree_canopy_outl1
Clip (2)
Model_Clip_Canopy.shp
Feature To Point
Model_Centroid_Canopy
IDW
Idw_height
Reclassify
Reclass_Idw
Raster to Polygon
Model_Polygon_Height_
Spatial Join
Spatial Join_Height
Merge (3)
Total Score of Vegetation
Identity
Identity_Canopy.shp
Dissolve (2)
Dissolve_Canopy.shp
Project
Project_Canopy
Add Field (2)
Project_Canopy
Calculate Field
Project_Canopy (3)
Add Join
philly (7)
Calculate Field (3)
Philly with canopy area percentage
Select
Select (2)
Select (3)
Select (4)
Select (5)
Canopy_Class1
Canopy_Class2
Canopy_Class3
Canopy_Class4
Canopy_Class5
Calculate Field (4)
Calculate Field (5)
Calculate Field (6)
Calculate Field (7)
Calculate Field (8)
Area_Score1
Area_Score2
Area_Score3
Area_Score4
Area_Score5
Merge
Tree_Area_Score
philly
Add Field (3)
philly (2)
Calculate Field (2)
philly (3)
Add Field (4)
philly (5)
Add Field (5)
philly (4)
Base Layer
Criteria 2: Tree Height
Criteria 3:Tree Canopy Area

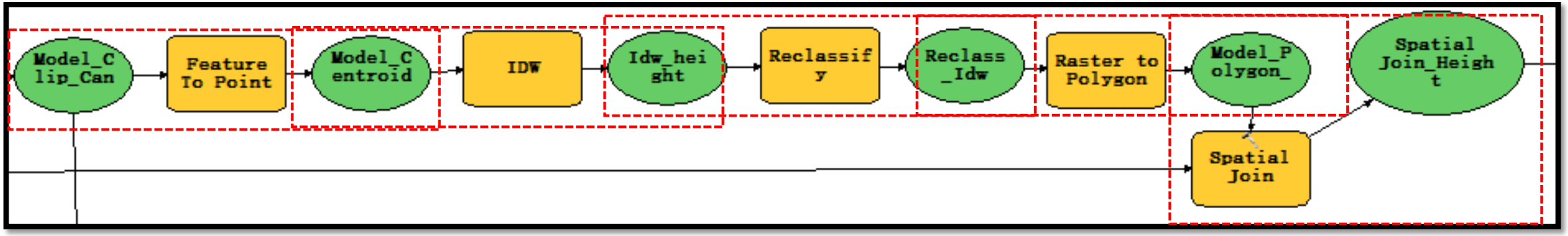
Criteria 1_ Park Accessibility



- First, clip the park within the boundaries of Philadelphia;
- Second, create multiple ring buffer;
- Third, after adding a field named “score”, use select and calculate field to assign the score from 1 to 5 to different distances;
- Fourth, merge the five buffers into one shapefile
- Fifth, intersect the merged shapefile with the base layer;
- Sixth, dissolve the park by census tracts, and sum the total score of each census tracts’ park accessibility

Distance from Park	Score
500 meters	1
1000 meters	2
1500 meters	3
2000 meters	4
2500 meters	5

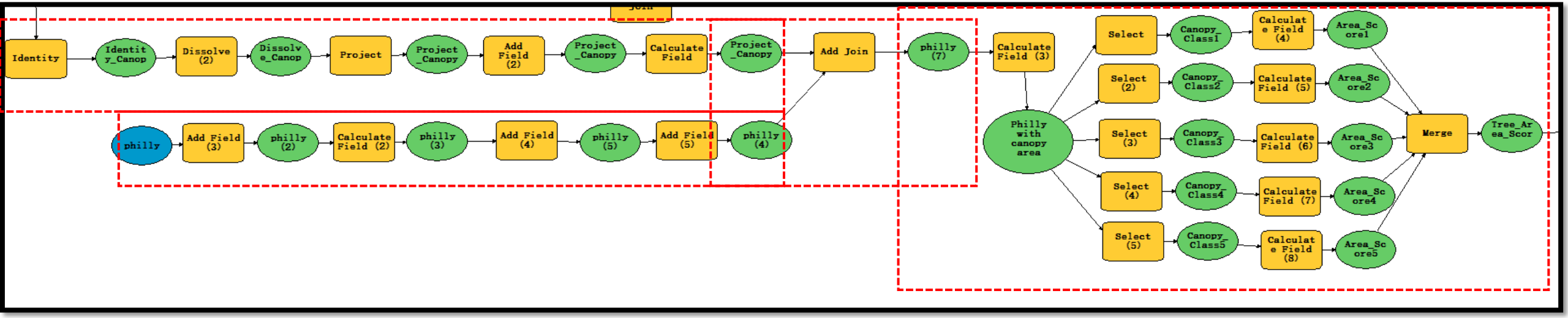
Criteria 2_ Tree Height



- After clipping the tree canopy outlines within Philadelphia, first, use feature to point to display centroid of each tree canopy;
- Second, use IDW to interpolate the tree height;
- Third, use reclassify to reclass the quantile classification to score 1 to 5;
- Fourth, transfer the raster to polygon for the further spatial join;
- Fifth, join the clipped canopy with the interpolated tree height shapefile to get the score of tree height in Philadelphia

Tree Height	Score
6.030121 – 19.275738	1
19.275738 – 28.374294	2
28.374294 – 40.795418	3
40.795418 – 57.402523	4
57.402523 – 262.917203	5

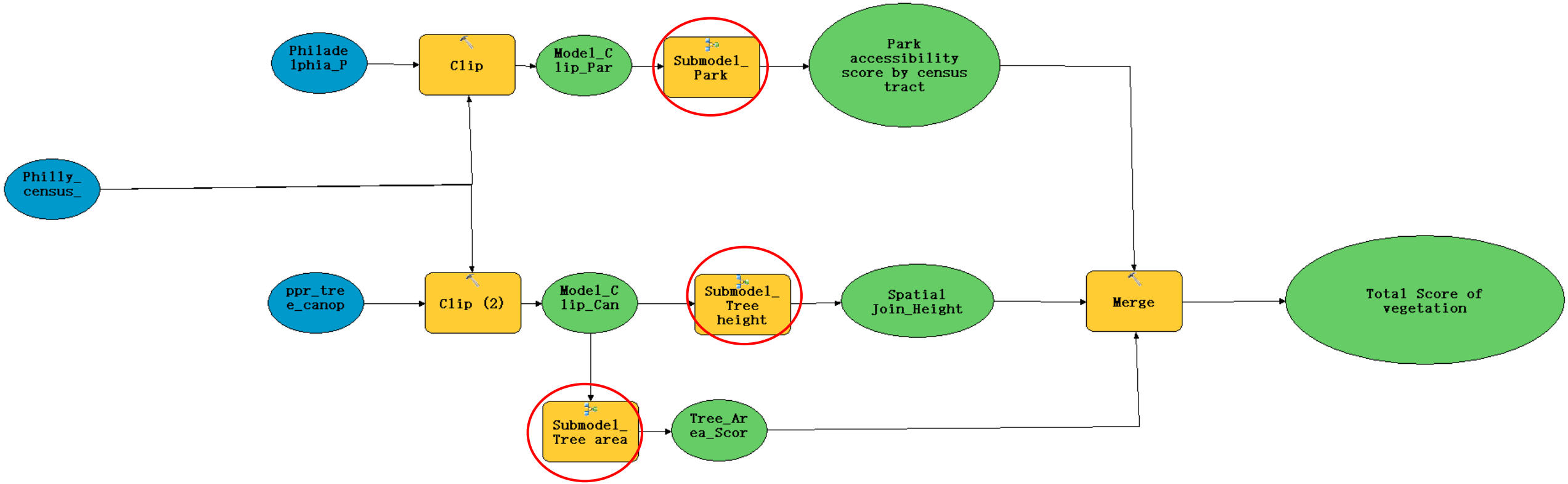
Criteria 3_ Tree Canopy Area



- Use the same base layer as the second criteria, the clipped tree canopy shapefile
- First, use identity, dissolve, project, add field and field calculator to calculate the sum area of each tree canopy in the census tracts;
- At the same time, calculate the area of each census tracts;
- Second, calculate the percentage of the area of tree canopy in different census tract;
- Third, use select and calculate field to assign the different score to different quantile level;
- Finally, merge the five score shapefiles into one, it is the tree area score shapefile.

Tree Canopy area %	Score
0.012749 – 0.083363	1
0.083364 – 0.132468	2
0.132469 – 0.172860	3
0.172861 – 0.240200	4
0.240201 – 0.790691	5

Submodel



- To make the model more clearly, create three sub models about three criteria

CONCLUSION

1. The legacy of structural racism is still influencing the living pattern in Philadelphia, where most of the Black are living in West Philadelphia, North and Upper North Philadelphia, while the White are living in the Central Philadelphia, Riverwards, Northwest Philadelphia, and Far Northeast Philadelphia.

2. Vegetation in Philadelphia is mostly in Northwest and Northeast Philadelphia, while respectively less vegetation in South Philadelphia.

3. The spatial distribution of vegetation in Philadelphia is significantly related to race and poverty. It is more likely to have less vegetation where has more Black population or higher poverty rate.