Step Back, Doors Closing

An Analysis of Need for Improved Metro Transit Access in Washington, DC

INTRODUCTION

Access to reliable public transportation is one of the most important factors in determining the equitability of a city and its opportunities for social mobility. Despite this, the existing Metro train network, Washington DC's (Figure 1) primary method of rapid public transportation, is quite inequitable in the areas it serves (Figure 2), often not reaching those neighborhoods that need it most. While there are widespread bus routes throughout the entire city, because such transit is far slower, less reliable, and more infrequent, access to Metro trains offers a stark look into inequitable access to rapid transit.

It has already been studied that the Metro system is in need of significant upgrades all around and has suffered from drops in recent ridership (Finlan, 2018), and that the density of the city and the surrounding suburbs has increased significantly since 1970 (Rowlands, 2019). Despite this, not much emphasis has been placed on analyzing the expansion of Metro from a social justice perspective. Because of this, I will perform a suitability assessment to determine the areas in the District of Columbia most in need of improved access to metro service from a perspective of equitability, using six factors that approximate the diversity and inequality of the city. These parameters will help create a determination about where within the city is most in need of improved access to the Metro.

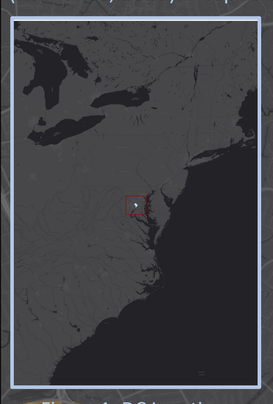

Figure 1: DC Location.

Figure 2: Existing Metro Lines.

METHODS

Using data publicly available from Opendata.dc.gov, I created a weighted suitability analysis on ArcMap 10.7.1 using six characteristics, all of which together help create an accurate assessment of a community's need for improved access to public transportation. A rank of 1-5 for each census block of the city was determined for each of the following six criteria: the distance from existing Metro, population density, average household income, poverty rate, unemployment rate, and percent spending more than 30% of household income on housing; Figures 3-8. To create the final weighted assessment that best reflects the difference in importance of the various criteria, the distance from existing Metro station scores were multiplied by 3, both the population density and average income scores were multiplied by 2, and the three remaining criteria were unchanged. These values were then added together, creating a combined score of 10 to 50 for each census block in the city.

To calculate distance, I first used the merge tool to combine layers of Metro and streetcar stations. I then manually selected blocks from the census block layer with centroids around predetermined intervals (.25,.5,.75,1 miles) and ranked these in a new attribute field of the census block layer. For population density, I used data from the census block layer, which I classified by quintile, and manually ranked using select by attribute into a new field. For income, poverty, unemployment, and rent, I first noted the quintile boundaries of the data set, then manually ranked them through selection by attribute in a separate field of each of their attribute tables. Because these layers were all separate and used the larger census tracts, I then joined each of these layers to the census block layer individually using a spatial join, averaging any values that might overlap within census blocks. This gave me the rankings for each of the parameters to the specific level of each census block. From there, I created a new field in the census block attribute table and entered the weighted summation equation to create the weighted analysis. I then added on top the the railroads layer, which completed the analysis (Figure 9).

DATA SOURCES

- Finlan, E. (2018). Metro's ridership crisis in focus: The Orange Line. DC Policy Center.
- Rowlands, D. W. (2019). How the D.C. area's population density has changed since 1970. DC Policy Center.

Map created by Daniel Meakem
Completed May 5, 2020
ENV 107: Introduction to GIS
Projection used throughout:
Maryland State Plane NAD83 Meters

REFERENCES

- Metro Stations in DC, June 2019, DCGIS Open Data
- DC Street Car Stops, June 2019, DCGIS Open Data
- Census Blocks, Feb. 2020, DCGIS Open Data
- ACS 2018 Median Household Income Variables Tract, January 2020, DCGIS Open Data
- ACS 2018 Housing Costs Variables Tract, January 2020, DCGIS Open Data
- ACS 2018 Employment Status Variables Tract, January 2020, DCGIS Open Data
- ACS 2018 Poverty Status Variables Tract, March 2020, DCGIS Open Data
- Metro Lines Regional, September 2019, DCGIS Open Data
- Railroads, February 2020, DCGIS Open Data

RESULTS

The results of the analysis (Figure 9) show a clear trend that while there are areas throughout the city in need of improved Metro service, the overwhelming majority of these areas are in the eastern and southern neighborhoods of the city. While somewhat equal access to Metro stations in all directions can be seen (Figure 3), fanning out from the well-connected center, the inequities in the demographics of populations around the city create enormous disparities in need for increased Metro service (Figure 4-8). Several key areas are highlighted by the black circles on Figure 9, with suggested corridors for future Metro lines to serve these neighborhoods identified:

1. BRIGHTWOOD

Brightwood has the highest average need for Metro service in the western half of the city, due largely to its distance from existing Metro lines. Both 16th Street and Georgia Avenue NW provide north-south arteries through the neighborhood that would be well-suited to connect Brightwood to the downtown area to its south.

2. BROOKLAND

Brookland suffers primarily from its distance from existing Metro lines. Despite this, two Amtrak and Maryland Area Regional Commuter train lines bisect the neighborhood, which would provide extremely suitable corridors for future metro expansions.

3. & 4. CENTRAL AND SOUTHERN ANACOSTIA

These neighborhoods in the far southeast are in particular need of improved access to Metro due largely to their severe poverty and distance from existing metro lines. However, both are near existing and abandoned freight railroad rights of way, along which Metro trains or streetcars could feasibly be built.

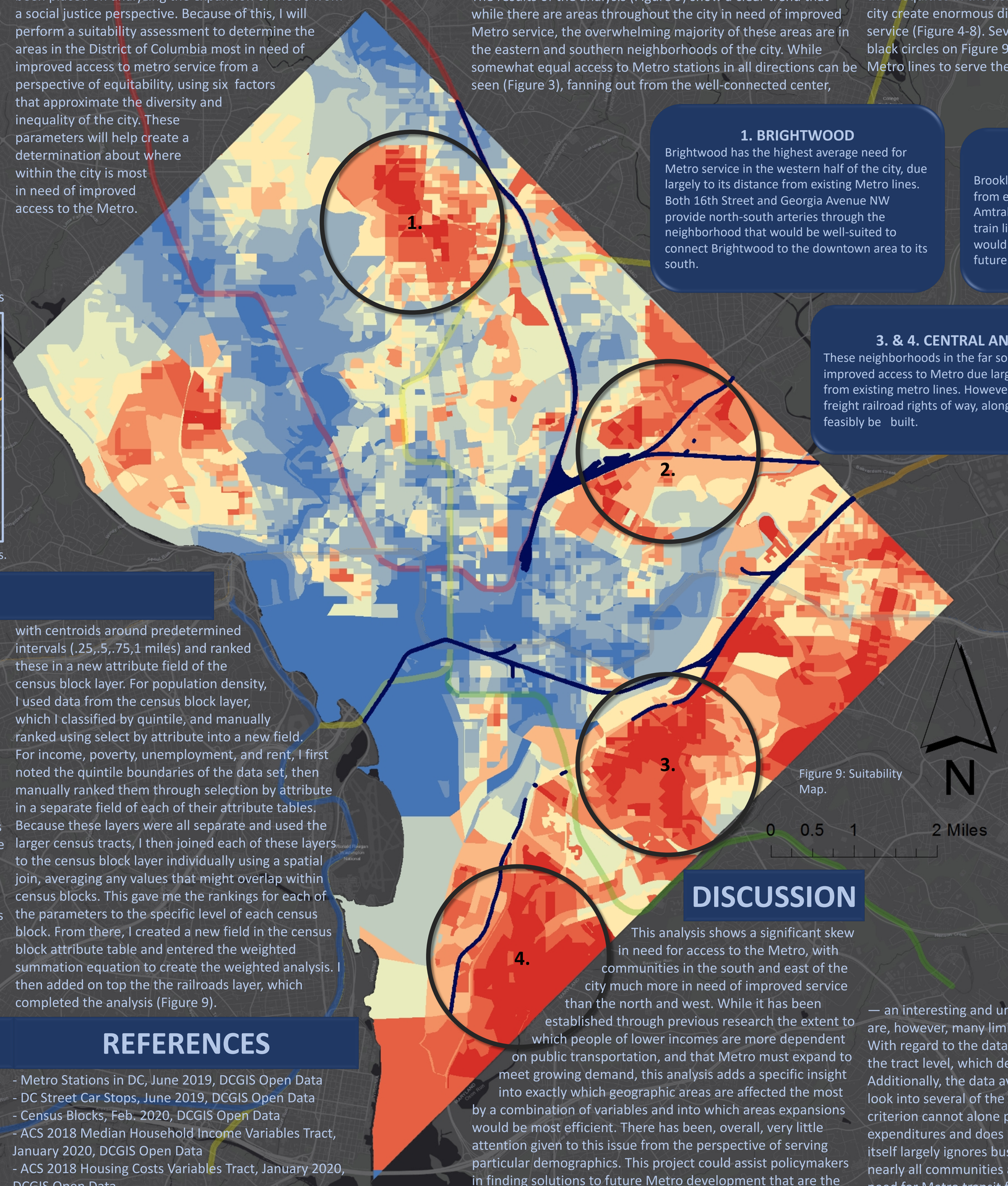

Figure 9: Suitability Map.

Legend

Non-Metro Railroads

Cumulative Weighted Score of all 6 Parameters

- 0 - 16
- 17 - 20
- 21 - 23
- 24 - 26
- 27 - 28
- 29 - 30
- 31 - 32
- 33 - 34
- 35 - 38
- 39 - 50

Existing Metro Lines

By Line Color

- Blue
- Green
- Orange
- Red
- Silver
- Yellow

DISCUSSION

This analysis shows a significant skew in need for access to the Metro, with communities in the south and east of the city much more in need of improved service than the north and west. While it has been established through previous research the extent to which people of lower incomes are more dependent on public transportation, and that Metro must expand to meet growing demand, this analysis adds a specific insight into exactly which geographic areas are affected the most by a combination of variables and into which areas expansions would be most efficient. There has been, overall, very little attention given to this issue from the perspective of serving particular demographics. This project could assist policymakers in finding solutions to future Metro development that are the most socially equitable and provide access most efficiently to those who disproportionately need it.

The results of this analysis are somewhat predictable given that the areas with the greatest need for Metro service correspond largely to areas suffering the most from poverty in general, though clearly visualizing these disparities makes even starker the inequities in the present system. One result I found surprising was the extent of areas with large need of Metro service in the affluent northern and western portions of the city — an interesting and unexpected result of the analysis. There are, however, many limitations to the data and the analysis. With regard to the data, several criteria were accessible only at the tract level, which decreased the accuracy of the analysis. Additionally, the data available cannot present a comprehensive look into several of the factors; for example the housing criterion cannot alone provide a full picture of households' expenditures and does not factor in homeowners. The analysis itself largely ignores buses, which serve a significant role in nearly all communities around the city. Secondly, it ignores the need for Metro transit from those outside the city limits of Washington, DC in both Maryland and Virginia, where significant portions of Metro riders reside. Thirdly, the analysis focuses mostly on places of residence, giving no consideration to places with high concentrations of jobs, areas that also must have effective Metro service for improvements in service to be relevant. Future analyses could pick up from this, incorporating these elements into a more comprehensive look at the best locations for improved Metro service.

DISTANCE FROM EXISTING TRANSIT

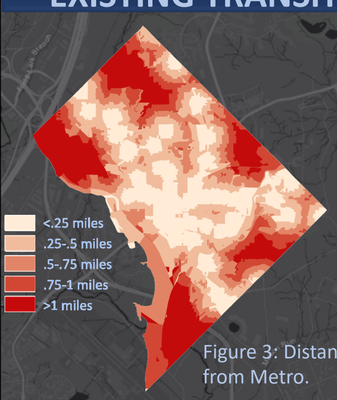

Figure 3: Distance from Metro.

POPULATION DENSITY

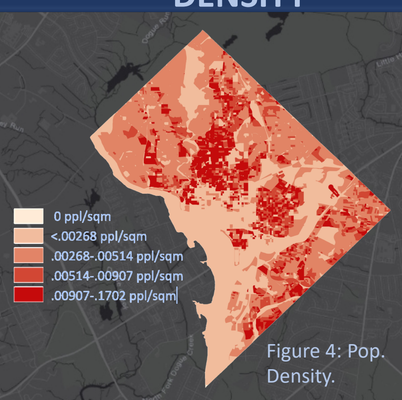

Figure 4: Pop. Density.

AVG. HOUSEHOLD INCOME

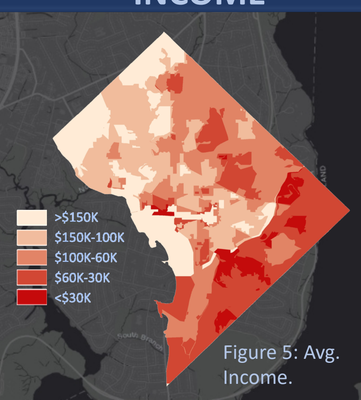

Figure 5: Avg. Income.

Legend

Figures 3-8

Weighted Score

- 1
- 2
- 3
- 4
- 5

AVERAGE UNEMPLOYMENT

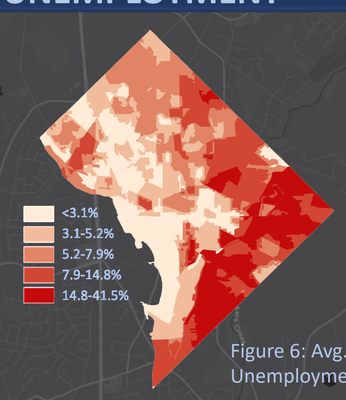

Figure 6: Avg. Unemployment.

PCT. EXCESS HOUSING COSTS

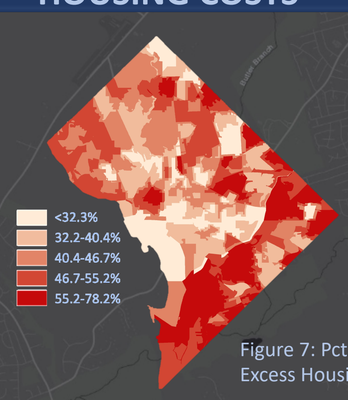

Figure 7: Pct. Excess Housing.

PERCENT IN POVERTY

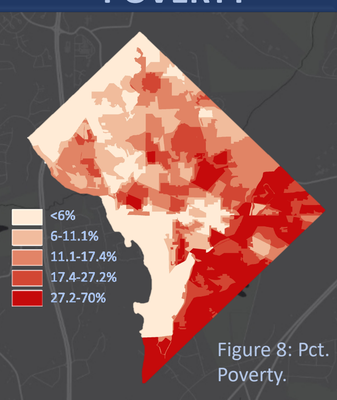

Figure 8: Pct. Poverty.