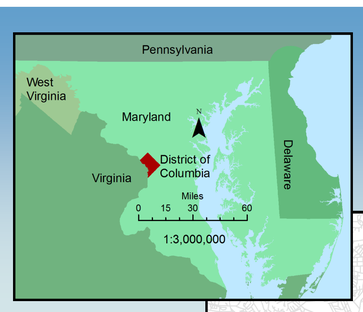
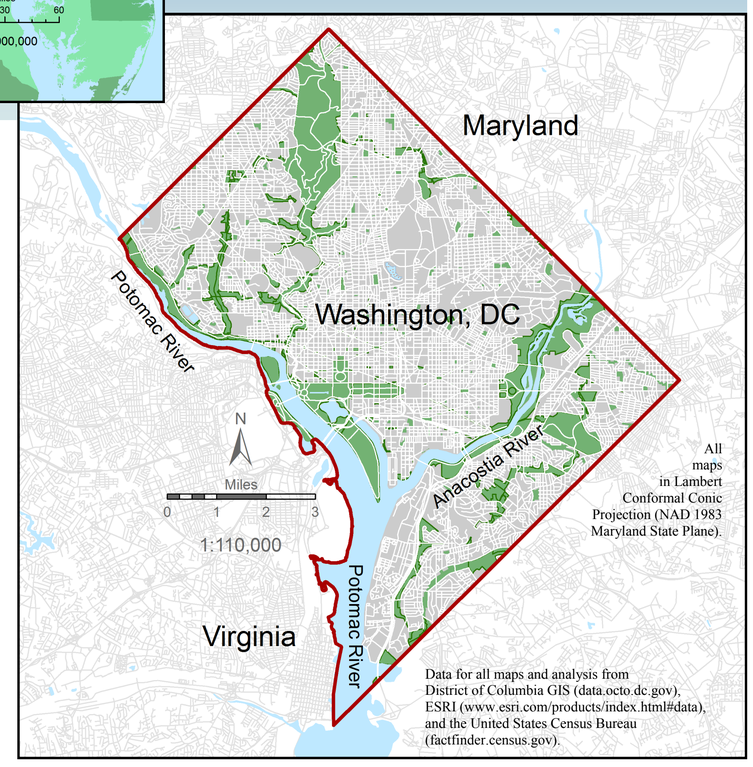
Walking the Network

A Novel Methodology for Measuring Walkability Using Distance to Destinations Along a Network



Case Study Location: Washington, D.C.



Method

1. Choose walking destinations to be factors in the analysis. Determine relevant walking distances, and assign relative weights to the factors.
I use 18 destination types, with relevant distances of either 400 or 800 meters (approximately one quarter and one half mile). See table in lower left.

2. Create a network dataset in ArcCatalog.
My network is based on street centerlines from District of Columbia GIS, but the method could easily use a dataset of walkways or sidewalk connectivity.

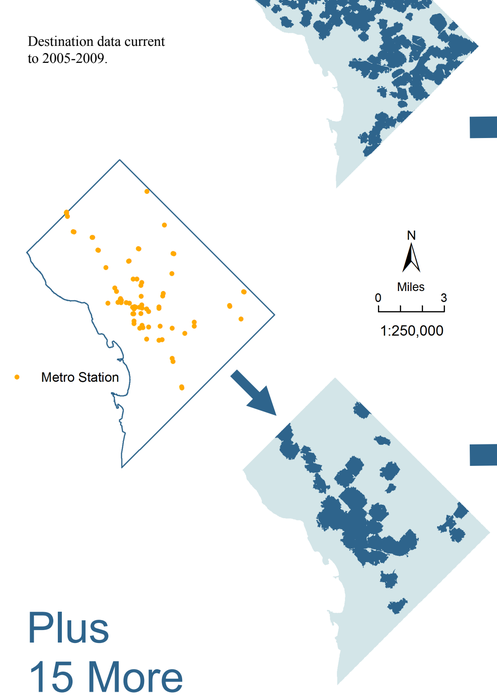
3. Obtain point datasets for all destination types. For polygon datasets, convert features to points by either centroid or vertices, or manually.
My community garden points are based on centroids. Neighborhood parks, which can be larger, use polygon vertices as points.

4. Generate network distance buffers around points for each factor.
Use Network Analyst in ArcGIS to calculate service areas. Load destination data points as the facilities, and use the relevant distance as the default break. Choose the "merge by break value" option in polygon generation to produce one multi-part polygon for each destination factor.

5. Convert network distance buffer features to raster with Spatial Analyst.
I use the District of Columbia polygon as my study area and my raster analysis mask. My raster grid cell size is 5 meters.

6. Add up rasters to create a raster surface by walkability score.
Using the Raster Calculator in Spatial Analyst, multiply each factor's input raster by the assigned weight for that factor and sum the results.

Points...



...become Raster Areas by Network Distance...

Data source for destination points: District of Columbia GIS (data.octo.dc.gov).

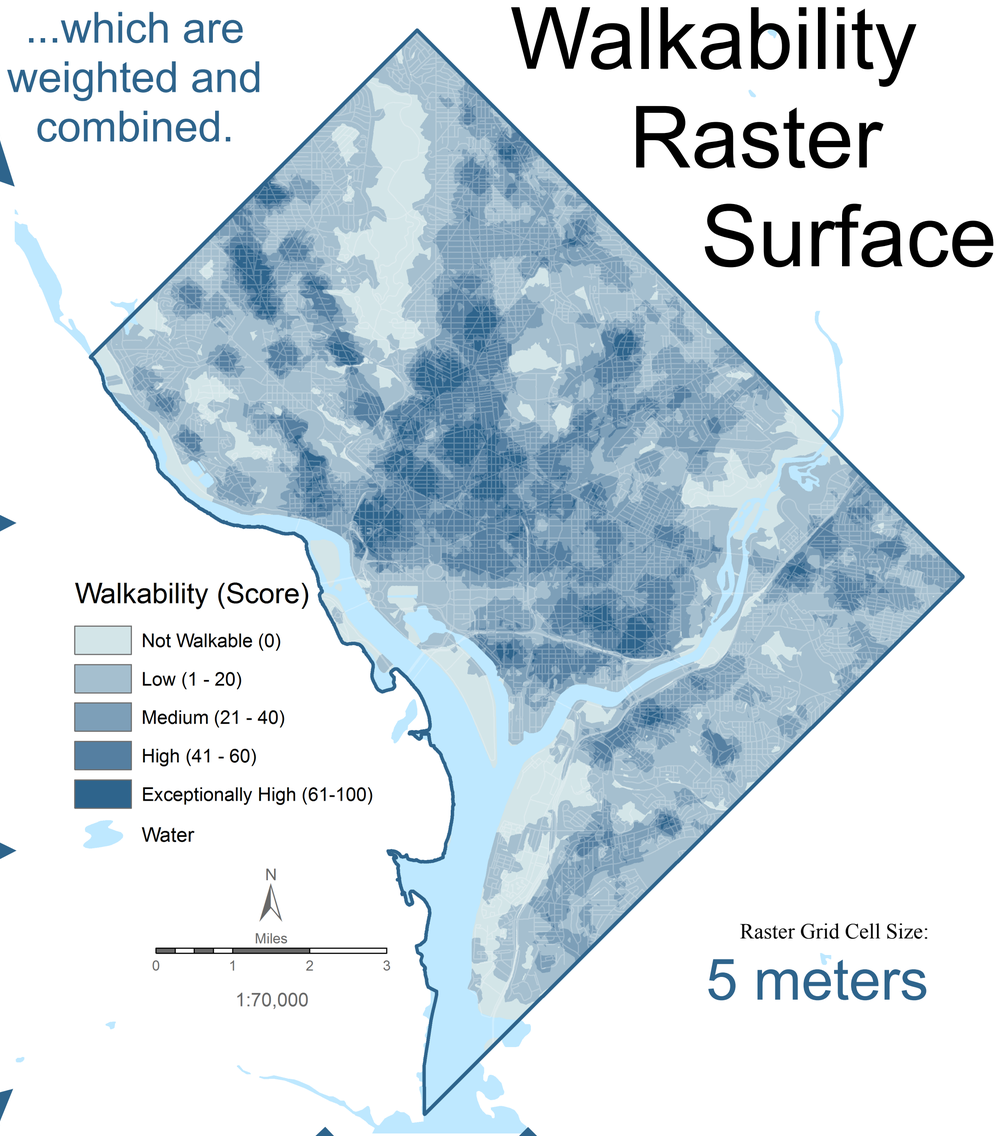
Destination data current to 2005-2009.

...which are weighted and combined.

Plus 15 More Destinations...

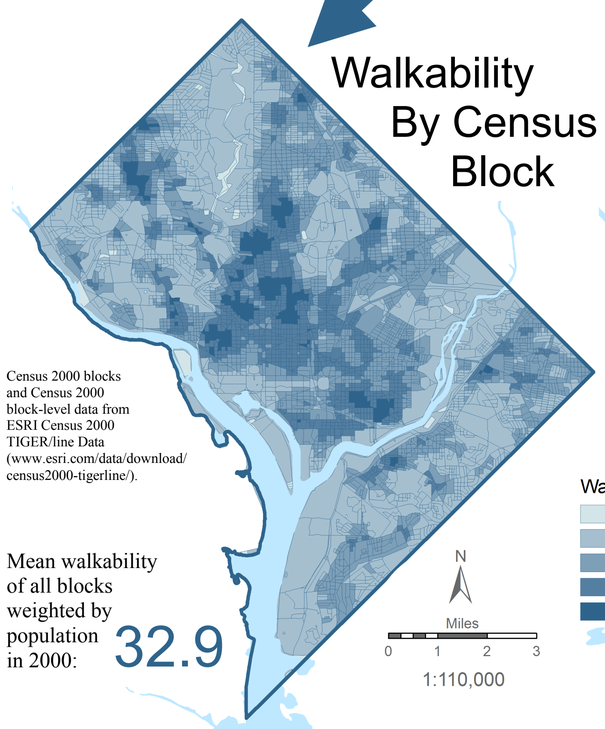
Destination	Distance (meters)	Weight
Food		
Grocery Stores (mapped above)	400	12
Community Gardens	400	2
Neighborhood Amenities and Services		
Shopping	400	12
Restaurants	400	5
Theaters	400	5
Libraries	400	5
Post Offices	400	4
Banks	400	4
Medical Care	400	4
Commuting Destinations		
Elementary Schools	400	4
Middle Schools	800	4
High Schools	800	4
Universities	800	4
Work Places	800	4
Recreation		
Neighborhood Parks (mapped above)	400	9
Recreation Facilities	400	3
Transportation		
Bus Stops	400	3
Metro Stations (mapped above)	800	12
	Total Weight	**100**

Walkability Raster Surface



Raster Grid Cell Size: **5 meters**

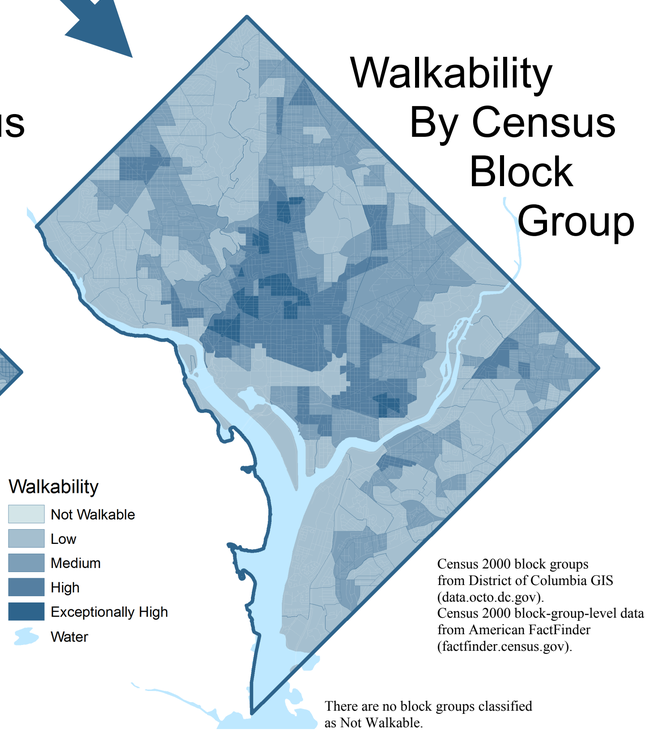
Walkability By Census Block



Mean walkability of all blocks weighted by population in 2000: **32.9**

Census 2000 **Blocks** by Walkability	Percent of Total Population in 2000	Concentration of Elderly Population in 2000	Concentration of White Population in 2000
Not Walkable	0.1	1.38	2.57
Low	28.6	1.10	0.99
Medium	38.2	1.03	0.83
High	24.5	0.94	1.13
Exceptionally High	8.6	0.68	1.42
All Blocks	100	1.00	1.00

Walkability By Census Block Group



Census 2000 **Block Groups** by Walkability	Percent of Total Population in 2000	Concentration of Population in Poverty in 2000	Average Household Median Income (in 1999 dollars)
Low	30.8	1.02	57,401
Medium	38.0	0.95	45,746
High	25.7	1.04	41,768
Exceptionally High	5.5	1.05	40,702
All Block Groups	100	1.00	47,868

Analysis

The walkability raster surface can be used in a wide range of analyses. In this case study, I aggregate walkability by Census block and Census block group using Zonal Statistics in Spatial Analyst. In the maps in the lower center, the walkability score for each block or block group is the mean walkability score of raster cells within its area.

With walkability scores by Census areas, one can compare walkability to demographics or any other Census dataset. Census blocks have the advantage of a greater level of spatial detail, but only the basic population counts in Census Summary File 1 are available for the block level. Walkability by block group or larger area is necessary for analysis of the more detailed data in Summary File 3, now the American Community Survey.

The charts below demonstrate the kinds of statistical analysis that are possible. I use counts and areas from Census 2000, although the same analysis will be possible with Census 2010 or the American Community Survey.

Concentrations are calculated for each walkability class of blocks or block groups as follows: the percentage of that population found in blocks or block groups of that class is divided by the expected value based on the percentage of the total population found in that class. Concentrations of more than 1 mean that the population is more likely to be found in that walkability class. Concentrations of less than 1 mean they are less likely, and concentrations of exactly 1 mean that their distribution is the same as the general population.

Elderly, defined as age sixty-five and up, are concentrated in low walkability blocks. Whites, the largest minority in this Black-majority city, are concentrated at both ends of the spectrum. Concentrations of poverty are all quite close to 1, indicating a weak correlation with walkability. Household median income, expressed as the mean average of the medians for block groups in that walkability class, seems to show a strong inverse correlation with walkability.

Advantages

Most existing measures of walkability use straight-line distances for ease of calculation, combined with indirect measures of network connectivity such a street node density. My method incorporates a direct measure of connectivity by using network distance, but saves computation time by calculating distances around a discrete number of destinations rather than distances out from many possible origin points.

My method can also be extended to include other travel cost factors in the network. In addition to distance, travel costs could include topography or the quality of the walking environment.

The output raster is versatile. It can be used for visualization, or added as an attribute to points, such as addresses, or to areas, such as Census blocks, for statistical analysis.

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for UEP 232, December 2010

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