Increasing Food Access in Baltimore, MD : Location Assessment for a New Supermarket

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Introduction

Though much progress has been made in recent years, issues of food access continue to plague the city of Baltimore, MD, particularly for households of lower socioeconomic status. Currently, the distribution of supermarkets throughout the city leaves a significant percentage of residents living in food deserts, defined as areas a quarter mile or more (roughly walking distance) from a supermarket (1). An estimated 25% of residents live in a food desert, relying on corner and convenience stores with limited selection of nutritious food such as fresh produce (2). This project seeks to identify a suitable location for a new supermarket in Baltimore that will increase access to healthy foods for households living below the poverty line.

The spatial mechanism for this project models suitability for the new supermarket as a combination of:

1. Distance from existing supermarkets
2. Population density (residents/hectare), and
3. Proportion of households living below the poverty line per block group

Critical entities in the model include population, supermarket locations, and walking radii around stores.

Methods

To identify suitable locations for a new supermarket in Baltimore, a series of three rasters were generated to capture each of the three components of the above outlined spatial mechanism. I assigned preliminary suitability scores for these conditions of interest based on rasterized datasets, displayed in Maps 1, 2, and 3. These scores were then combined using the Map Calculator function, assuming equal importance of each condition.

To simulate walking distance to existing supermarkets, data on point locations of supermarkets in Baltimore were obtained from John's Hopkins University. The Euclidean distance function was employed to rasterize and score distance categories around each store (Map 1). Scores were assigned such that areas further from existing supermarkets were designated as being more suitable for a new store

Data on population density and poverty was extracted from the 2016 American Community Survey. In this model, these data are represented at the level of block groups, rather than blocks of finer granularity, due to availability of more recent availability of block group data. Due to the fast pace of development and gentrification in the city of Baltimore, recency of data took precedence over granularity in this decision-making scenario.

For each block group with its boundary lying within Baltimore city borders, population density was represented in residents per hectare and rasterized into 30 by 30 meter cells (Map 2). The raster was then reclassified and scored such that block groups of low population density were categorized as having low suitability for a supermarket, and block groups of high population density were categorized as having high suitability. Similarly, the proportion of households living below the poverty line were mapped by block group and rasterized into cells of the same granularity, and reclassified such that block groups with a high proportion of households below the federal poverty line were given priority over those with a lower proportion (Map 3).

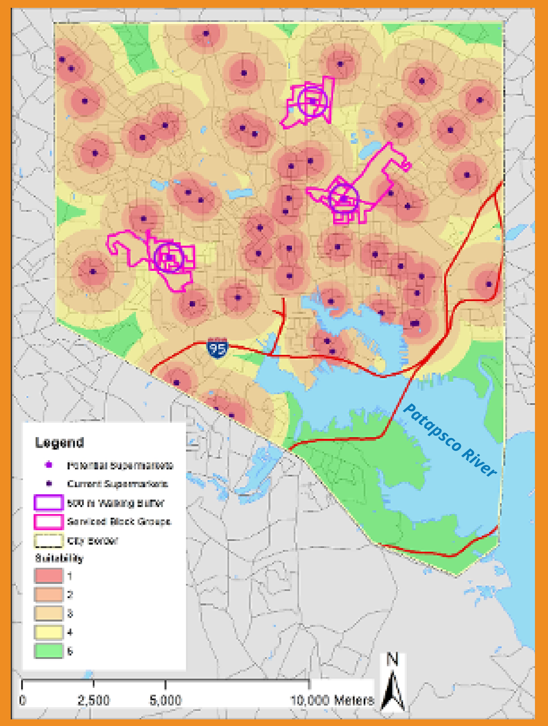
This analysis was conducted in ArcMap 10.4.1 using the NAD 1983 State Plane Maryland FIPS 1900 Projection.

Limitations

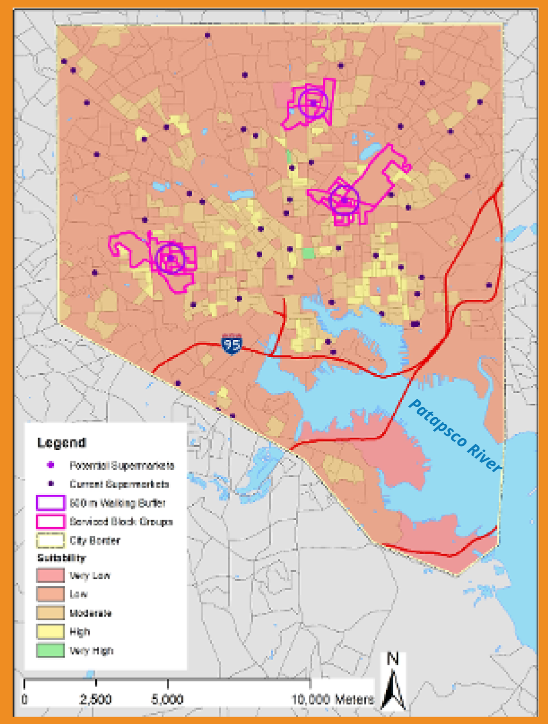
This project was subject to several limitations, including:

- Assessment of walking distance to existing supermarkets using measures of Euclidean distance, which capture walking distance "as the crow flies," did not address mediating conditions such as sidewalks, which residents encounter when traveling to the supermarket. A future simulating using measures of network distance could address this limitation.
- Rasterizing proportion of households living below the poverty line required assuming that these households were uniformly distributed across block groups. Though this may not necessarily be accurate, the ACS does not provide more granular data on residence of households below the poverty line, so making this assumption was necessary to run the model.
- Assigning equal weight to each of the three components may not account for the true relevance of each. Future models could include additional conditions to more comprehensively characterize suitability.

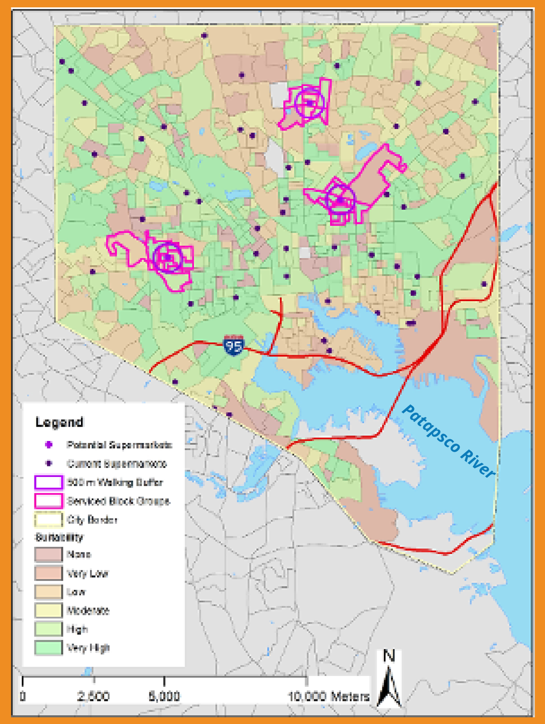
Map 1. Distance from Existing Supermarkets

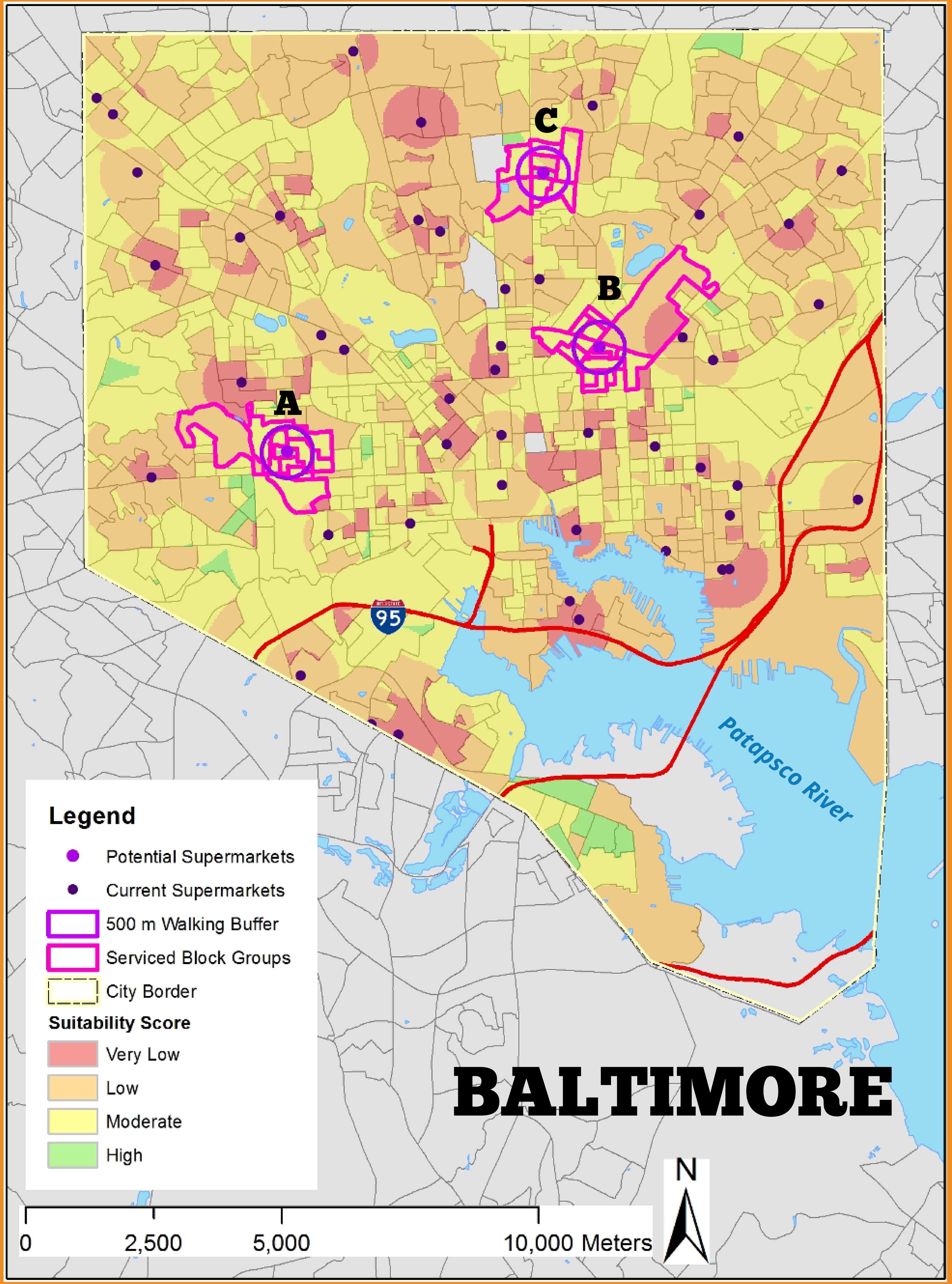


Map 2. Population Density by Block Group



Map 3. Proportion of Households Below the Poverty Line





Map 4. Combined Suitability Score for New Supermarket

Results

Using the three component model, suitability scores were used to identify three potential locations for a new supermarket in Baltimore. These proposed locations, labeled as A, B, and C on Map 4, are here compared in terms of the number of additional residents overall, and additional households below the federal poverty line, which would gain access to a supermarket should one be built at that site (Table 1, below). Currently, 307,444 Baltimore residents are served by existing supermarkets (residents served by a supermarket are defined as those living within a block group which intersects the 500m walking buffer surrounding each store). Proposed locations A, B, and C would serve an additional 22,474, 18,453, or 18,253 residents, respectively. The locations would provide access to 704, 783, or 1,111 households living below the poverty line. Each proposed location is a minimum of 1500 m from an existing store. In analyzing these factors alone, location A appears the best choice in terms of additional residents served, while location C is clearly superior in the context of increasing supermarket access to households of lower socioeconomic status. Incorporating additional data to the model on mediating conditions not addressed in this model (i.e. the impact of localized crime on perceived store safety) would be useful in differentiating the nuances of suitability between these two locations.

Table 1. Comparison of Proposed Locations by Suitability Score Component

Proposed Location	Additional Residents Served	Additional Households Below Poverty Line Served
A	22,474	704
B	18,453	783
C	18,253	1,111

Future Directions

The model could be further improved by substituting block-level in place of block group-level data, when available, in order to represent population density with finer granularity and more accurately place proposed supermarket locations. Here, it was assumed that households living below the poverty level will be less likely to own a vehicle, especially within the inner city environment where public transit may eliminate need for one. However, a raster representing household-level access to a vehicle may be useful in pinpointing areas in which it is paramount for a supermarket to be within walking distance of residences.

The choice to render the block groups containing residents served by each proposed store as those *intersecting* the 500m walking buffer, rather than the more typical *with their centroid within the walking buffer* may also be reconsidered in future models. The choice was appropriate to this model given the magnitude of gaps between existing grocery stores, and anticipated likelihood of residents to travel to a new supermarket that is closer to their home than an existing one, regardless of whether it is within the standard 500 m buffer.

Despite its limitations, the model represents several key conditions propitious to locating a supermarket site, and could be used to advise the agenda of Baltimore city planners.

References:

1. Santo,R., Palmer,A., Buczynski,A. (2015) Researching the Baltimore City Food Environment: Contributions from the Johns Hopkins Bloomberg school of Public Health.

2. Buczynski AB, Freishtat H, Buzogany S. (2015) Mapping Baltimore City's Food Environment: 2015 Report.

Data Sources:
Block Group Population Density and Households Below the Poverty Line, American Community Survey 2011-2016 via TIGER
USGS National Hydrography Dataset, HU-4 Subregion
Baltimore City Food Stores 2016, John's Hopkins University, Fall 2016
Maryland County Boundaries, Maryland GIS Data Catalog, April 2018
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