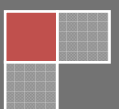


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Introduction

Food deserts are defined by the Center for Disease Control defines food deserts as “areas that lack access to affordable fruits, vegetables, whole grains, low-fat milk, and other foods that make up the full range of a healthy diet”ⁱ. Studies have been done the link limited access to healthy foods, or the presence of a food desert, to increased rates of diet-related conditions such as obesity and diabetes, all of which have increased in the US in the past ten years. This lack of access could be based on geographic isolation, insufficient grocery shopping options, limited incomes, or impaired mobility. Many people do not have cars and live in areas that are within a few miles of the closest grocery store or farmer’s market. This means they often rely on corner markets such as 7-11 for their every day shopping; stores that are not known for healthy food choices. Food deserts have long existed, but have recently garnered national attention through the 2008 Farm Bill and the more recent launch of the First Lady’s “Let’s Move” initiativeⁱⁱ, which was started with the intention of solving the challenge of childhood obesity within a generation.

The objective of this paper is twofold: to review how GIS is currently used as a tool within this topic area and to explore the applicability of GIS-based mapping procedures in determining a correlation between the location of food deserts, income, and race. I hypothesize that that food deserts will be more prevalent in census tracts with high rates of minority populations and lower incomes.

This paper is organized into six sections; a brief introduction, a review of selected literature on the subject, background of the GIS methods employed within the topic area, a review of how GIS was used in this analysis, and concluding remarks.

Literature Review

A review of literature on food deserts and public health was performed to provide background on past studies. The ideas presented by previous studies have been considered in developing a hypothesis for this analysis. Three of these literature reviews are provided below.

- A. Bitler, M., Haider, S. (2009). “An Economic View of Food Deserts in the United States”. National Poverty Center Working Paper. <http://www.npc.umich.edu/news/events/food-access/index.php>. Accessed 8/18/11.

The authors of this study used a standard economic analysis and applied it to the study of food deserts, particularly whether and why they exist in certain census tracts. The authors also take a critical stance on existing literature on food deserts. The purpose was to examine the research that has been done and the data that has been used to study this topic area. Several studies documented the existence of food deserts in local areas, but shortcomings in available data have limited researchers in their ability to convincingly document the presence or absence of food deserts on a national scale. For example, many studies the authors reviewed do not have a concrete definition of nutritious foods or do not include price information in the discussion. The conclusion of the study was that sufficient data do not exist, and those data that have been used in large-scale studies have numerous problems of inconsistency such that there is little basis to make any general statements about the causes of food deserts in the United States even the existence was confirmed.

- B. Bader, M., Neckerman, K., Purciel, M., Yousefzadeh, P. Measuring Food Access in Urban Areas; Columbia University, 2009. National Poverty Center Working Paper. http://www.npc.umich.edu/news/events/food-access/neckerman_et_al.pdf Accessed 8/16/11.

The authors of this study examine the measurement of the food environment in urban areas and highlight two categories of conceptual and methodological questions: how the relevant neighborhood is defined and how the food environment is characterized within that neighborhood. The authors use GIS data to analyze the spatial accessibility of healthy food in New York City, including a look at farmers markets and supermarkets, and conduct sensitivity analyses to incorporate variables such as vehicle ownership, crime, and public transit on access to healthy food. One conclusion from the study was that racial disparities exist with respect to access to healthy food outlets. The authors generally support past findings that neighborhoods with higher income levels and higher proportions of white residents tend to have greater access to supermarkets or large chain food stores, although poorer neighborhoods and those with higher proportions of black or Hispanic residents may have greater access to small grocery stores. The authors point out that the introduction of smaller retailers and farmers markets in densely settled areas of poverty have been successful, but lower-density neighborhoods may also be underserved. The authors also conclude that further definition of how the neighborhood is defined will be critical to the success of future studies, but also that the use of GIS has enhanced the understanding of environmental constraints of healthy eating. As for their review of existing literature, they state that greater consistency of measures and analytic strategies would make it easier to derive high-level conclusions.

- C. Rose, D., J.N. Bodor, C.M. Swalm, J.C. Rice, T.A. Farley, P.L. Hutchinson (2009). "Deserts in New Orleans? Illustrations of Urban Food Access and Implications for Policy". National Poverty Center Working Paper. <http://www.npc.umich.edu/news/events/food-access/index.php>. Accessed 8/18/11.

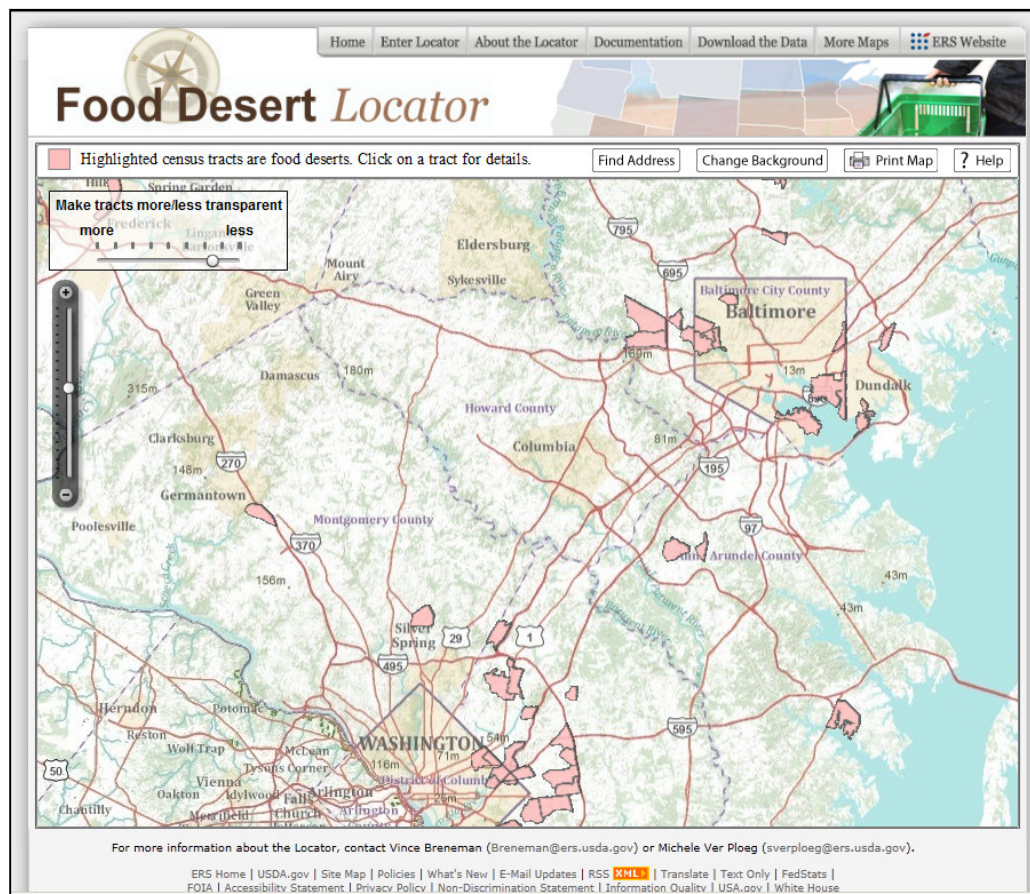
The authors of this study examine food access in post-Katrina New Orleans. The authors expand the conventional definition of food desert by also considering non-typical food outlets that were found by mapping the city and incorporating data on the availability of fruits and vegetables within each store. The purpose of the paper was threefold: to expand the basis for food desert definitions, to illustrate how the existence of food deserts is to a large degree based on the specific definitions used, and to show how information on access to food can be useful for federal food assistance policy as well as for local planning initiatives. Part of the analysis included mapping New Orleans retail food outlets in GIS and then sending a team into the field to verify locations. Census tract information was then overlaid on these areas for comparison. The paper concludes that the existence of food deserts depends on what definition is used, but that the ability to identify areas of need can be used at the local level to prioritize retail food projects or to inform food assistance policies. The paper also coins a new term, "food swamps", which the authors claim is a more useful metaphor for areas in the US in which relatively large amounts of energy-dense snack foods inundate healthy food options, therefore making a healthy choice more difficult for consumers.

GIS Methods

Online Resources

The use of GIS is an integral part of a successful analysis of the factors contributing to the presence of a food desert in a geographic region. The Food Desert Locator tool created by the USDA is a prime example of how GIS can be used to convey information. As part of an effort by the Federal Government's "Let's Move" campaign to promote healthier eating and lower rates of obesity and diet-related diseases, the USDA compiled data for the entire United States and developed the Food Desert Locator tool and corresponding data sets. This interactive tool allows users to locate food deserts, which in this case is defined as a low-income census tract where a substantial number or substantial share of residents does not have easy access to a supermarket or large grocery store. Interested parties can go online and interactively map any census tract in which they are interested. The user can then create and save maps showing food-desert census tracts by address, or within a certain county, state, or region, view statistics on selected population characteristics in food-desert census tracts, and download census-tract level data from food-desert tracts. Figure 1 shows a screen capture of the website, which includes features such as zoom, transparency level adjustment lever, address locator, satellite or topographic background options, and printing. These features are familiar to a GIS user, but are also intuitive for the non-GIS user as well.

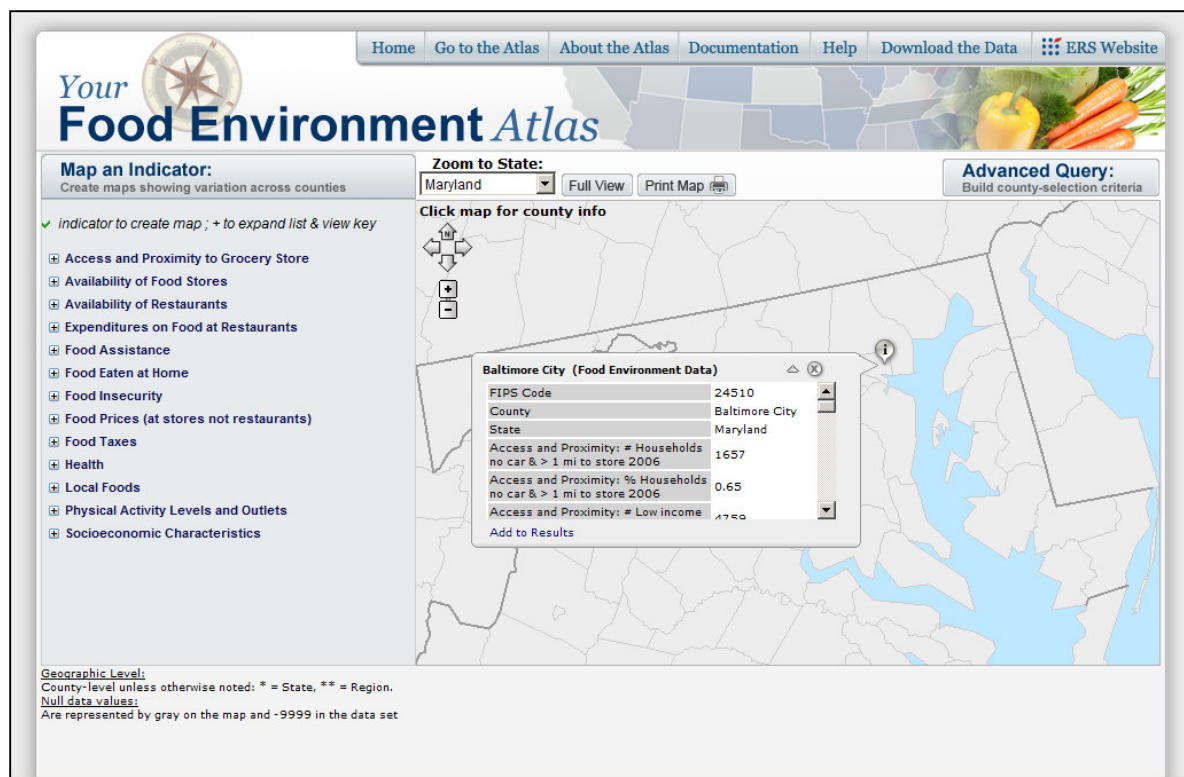
Figure 1: USDA Food Desert Locator Website



The excel file that is available as a download contains detailed population statistics on each food desert census tract, including percentage and number of people in the tract with low access to large grocery outlets, percentage and number of people who are low income and also have low access, or number of low-access households without a car. These data are not available for non-food desert census tracts, however, which limits extensive comparison. This GIS tool could be useful to urban planners, public health professionals, local food advocates, farmers looking for a potential market, and government policy makers.

The Food Environment Atlasⁱⁱⁱ is another example of how GIS is used within this field. The creation of the Atlas was a coordinated effort between the Economic Research Service, academia, the Federal Government, and the private sector. The objective is twofold: To assemble statistics on food environment indicators to stimulate research on the determinants of food choices and diet quality and to provide a spatial overview of a community's ability to access healthy food and its success in doing so. Data made available via this Atlas include statistics on obesity, diabetes, and farm-to-school programs, indicators on physical activity and recreation centers, farmers' markets, information on State-level food and nutrition assistance program participation rates, information on and State beverage and snack taxes.

Figure 2: Food Environment Atlas Website



As shown in the screen capture of the website in Figure 2, users can create maps showing the variation in a single indicator across the US, view county-specific data for the count of their choice, or do advanced queries on multiple indicators or counties. The Atlas is user-friendly and provides a font of

information with just a click of the mouse. Data within the indicator varies based on availability. Some data are at the county level, some at the state level, and others are at the regional level. No data has been made available at the census tract level or it would have been used in this analysis.

This Analysis

A map can prove much more effective in identifying correlations between data and understanding relationships between trends. This analysis used GIS to create maps and visually interpret tables of census data and data from the USDA on food deserts. A number of GIS processes were used to convert the data from tabular form into shapefiles. First, census tracts within the City of Baltimore were downloaded from the Census website as tigerline files. Next, American Fact Finder was used to find and download population and income data for these tracts in the form of an excel spreadsheet. The spreadsheet was modified so that there was a unique identifier for each tract (a GEOID or FIPS code) and all fields were readable by ArcMap. The excel files and the shapefile were then added to a new ArcMap and spatially joined based on the unique identifier. This joined file was exported as a new shapefile which could be more easily manipulated. Within the attribute table a field was added that calculated the total of the entire nonwhite population within each census tract to create a 'minority' category with which to compare the percentage of minority population within each census tract. The category was classified into five defined intervals and symbolized using a color ramp. Mean household income was mapped using a color ramp and defined intervals.

The food deserts census tract data used in this analysis were downloaded as an excel file from USDA Food Desert Locator site and then spatially joined to the original tigerline file of Baltimore City census tracts downloaded from American Fact Finder^{iv}. The results from the food desert data were then overlaid on both data sets to show any correlation. The final maps are shown in Figures 3 and 4 below.

Figure 3: Food Deserts & Racial Composition

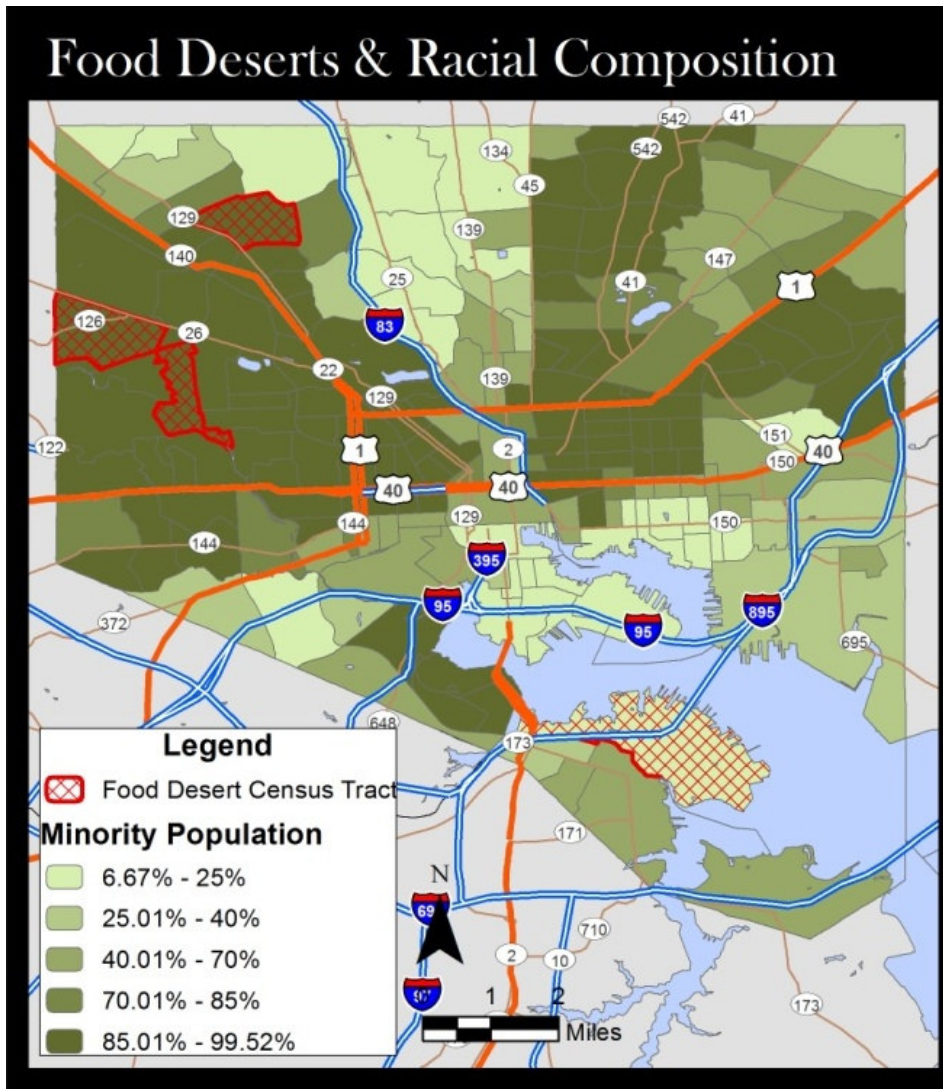
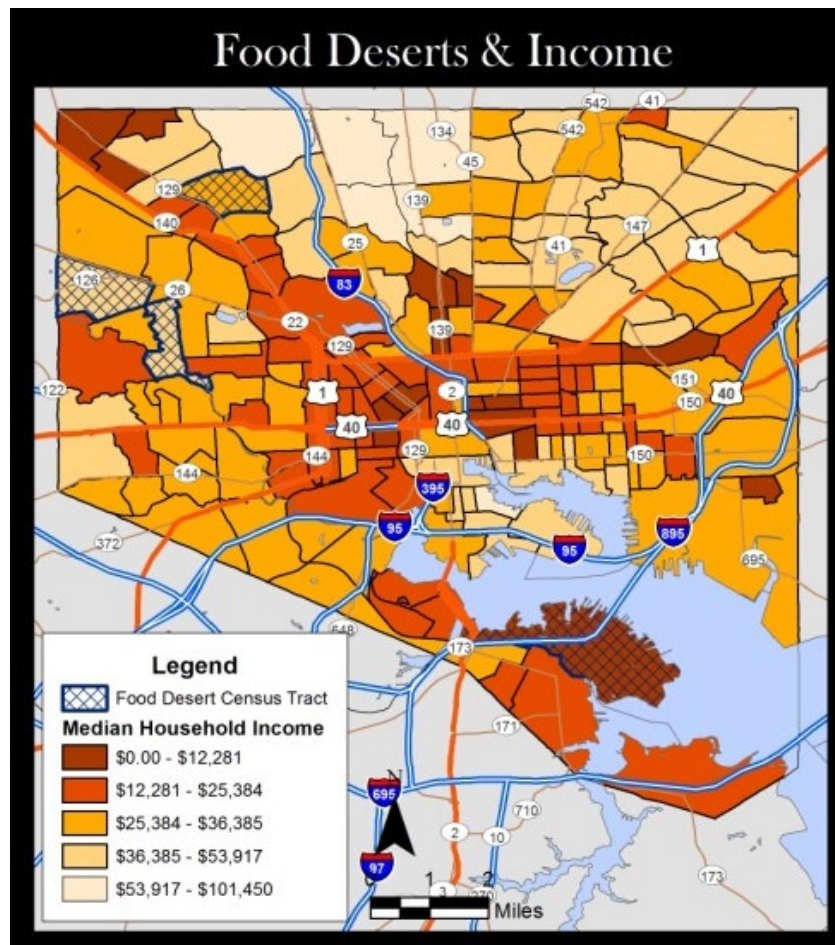


Figure 4: Food Deserts and Median Household Income



As shown in the Food Deserts and Racial Composition Map, there is some correlation between the presence of a food desert and areas of high minority population. Three of the food deserts in Baltimore City have minority populations of over 85 percent. The remaining food desert has a low minority population, but has a very low median household income, as shown in the Food Deserts and Income map. The median household income of that particular census tract is less than \$13,000 per year. The remaining three food deserts all have median household incomes between \$25,000 and \$53,000 per year. By overlaying the highway system, it is also apparent that the southernmost food desert is also relatively geographically isolated in a historically industrial area of the City, which may be a contributing factor in its designation as a food desert.

For the purpose of this analysis, health data were excluded due to the constraints of availability—all health data related to obesity and diabetes were only available at a county level. When available, the processes described in this analysis could be repeated and expanded to include any number of demographic factors with the use of GIS. Future analysis could include distance to highways, the population under 18 years of age, family size, car ownership, employment, educational attainment, access to public transportation, and vacancy rates. Cost of food and trends in where people spend the

most money on food could also be reviewed and mapped. An expansion of the analysis may prove valuable to include more of Maryland to identify any trends within the region.

Conclusions

Over the past decade, the United States has seen an increase in obesity and diet-related diseases. This analysis showed that GIS can be a very useful tool when looking at geographic and demographic influences on the access to healthy food. The framework was laid for a complete analysis of why food deserts exist in Baltimore City, besides the impacts of low income and race. As shown, race seems to have a stronger relationship than income with the presence of a food desert, but sufficient information does not exist to be able to support a definite conclusion. The analyses performed in this study may prove more revealing if done in a metropolitan area with a greater number of food deserts, or comparing two cities to see if there is a trend in the correlations. These findings are consistent with the literature reviewed on the topic, and this author would like to see steps taken within the field to provide a consistent set of measures and analytic strategies.

As pointed out in the literature review, challenges exist with the use of census tract boundaries for defining a food desert: using such a specific boundary ignores stores just outside the boundary and there could be substantial variation in the distance to retail food outlets within the geographic area. Zoning is also not considered in the geographic definition.

The USDA Locator identified 13.5 million people in the United States that have low access to sources of healthful food. These data and the maps developed for this report could be used by nonprofits or the City of Baltimore to understand where these people are living and locate the areas they want to target for food assistance or transportation support. The data could also be used as a basis on which to build a stronger database through a field survey of the food outlets in the highlighted areas.

Improving access to healthier foods is a first step to helping people make better nutritional choices, but it is not the only action that will bring change. Diet is a personal choice and it can be very difficult to change old habits without the proper educational and marketing efforts. Through GIS, high needs areas could be mapped and extra efforts could be made in those areas identified as high risk for diet-related diseases and with barriers to accessing a food store with adequate healthy options. Public health officials can use these maps to support broader efforts at reducing obesity and other diseases.

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ⁱ <http://www.cdc.gov/Features/FoodDeserts/>

ⁱⁱ <http://www.letsmove.gov/>

ⁱⁱⁱ <http://maps.ers.usda.gov/FoodAtlas/foodenv5.aspx>

^{iv} <http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml>