

# **GIS Certificate Capstone Interactive Map: Comparison of Food Access Areas in Urban Communities in the United States**

*University of Wisconsin-Madison Department of Geography  
University of Wisconsin-Kaufman Food Systems Laboratory*

*Jonathan Y. Fok*  
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**ABSTRACT**

The objective of the interactive map is to identify and compare food access areas by different sustainable transportation mode choices for different urban communities in the United States. As communities across the United States continue to experience land use changes and growth, the challenges to address population public health concerns become more complex. The ability to address food accessibility in combination with the promotion sustainable transportation mode choices provide opportunities for local communities to address underserved areas. The target users for the interactive would have an interest in community development. Examples of potential target users would range from researchers from the United States Department of Agriculture to local non-profit organizations. The use scenario for the interactive would provide the user the opportunity to identify service areas for different mode choices for different retail food market types for three urban communities in the United States: Seattle, WA, Chicago, IL and Boston, MA.

The oversight of the project was with Professor Alfonso Morales with the Kaufman Food Systems Laboratory in the University of Wisconsin (UW)-Madison Department of Urban and Regional Planning and Professor Qunying Huang in the UW-Madison Department of Geography.

## **I) INTRODUCTION**

The use of various GIS tools provides guidance for communities to understand the impact of changes in the community development and the impact on quality of life standards. As communities continue to become more complex, one of the bigger challenges that communities continue to face is the ability to provide healthy, affordable food options for households. The purpose of the interactive map is to show the application of GIS in comparing food access areas by different transportation mode choices in urban communities in the United States. The target users for the interactive consist of different disciplines ranging from the researchers at the US Food Nutrition Services to local non-profit organizations. The user will be able to engage in the interactive by selecting between retail market locations and transportation mode choice service areas for three urban communities in the United States: Seattle, WA, Chicago, IL and Boston, MA. The combination of both the retail food market locations and the transportation mode choices would provide context as how retail food market locations are served by different mode choices.

## **II) BACKGROUND**

The initiative to address quality of life improvements in communities in the United States began in 2010 as a part of the Healthy Food Financing Initiative (HFFI) launched by the administration of President Obama. The objective of the HFFI was to help assist communities in bringing healthy food options to underserved areas across the country. These areas, known as “food deserts”, were defined by the United States Department of Agriculture (USDA) as “low-income communities without ready access to healthy and affordable food” and as of 2010 approximated nearly 23.5 million people nationwide resided in such areas (13). While the issue has been in and out of national attention since the end of the Great Depression, the revitalization of community growth has brought forth greater attention in recent years in addressing how to improve public health through food access initiatives. The result to reduce the number of underserved areas in communities has been to place food retailers with healthy and affordable food options in underserved communities to improve the well-being of the community.

To address solutions for improving food accessibility, one must evaluate the built environment, particularly the transportation infrastructure. While the course of action across the United States

has been to place food markets that have healthy and affordable food in underserved areas, the challenge becomes more complex with the consideration of mobility and accessibility constraints for residents. The predominant vehicle-oriented transportation infrastructure often presents challenges for residents in the underserved areas that are reliant on other transportation mode choices such as walking, bicycling or public transportation. The need to address alternative transportation mode choices not only provides opportunities to improve mobility and access in the community, but also provides opportunities to encourage physical activity and healthy practices that are useful for improving public health in communities.

### **III) PRESENT ASSESSMENT OF FOOD DESERTS**

The main definition of food deserts has often been derived from proximity to food markets and other food markets. Since the definition inception in the early 1990's, the targeted areas over time have shifted from all residential areas to low-income, minority residential areas. The result has been an ongoing debate on whether accessibility or income is the reasoning behind poor healthy food options leading to increasing health concerns in the community.

The USDA definition of food deserts accounts for both income and accessibility from the county and census tract level. There are two parameters that the USDA uses to define low-income, low-access communities, or food deserts:

- 1) Areas that have a poverty rate of twenty percent or greater or median family income at or below eighty percent of the area median family income and
- 2) At least five hundred people and/or least thirty-three percent of the census tract population live more than one mile from a food market (or ten miles for rural areas)

While there are some concerns with the use of the definition in food accessibility research, the focus of the report will go into the ambiguity as to what the distances mean from residential areas to the nearest food market. The USDA definition mentions accessibility by the measured distance to retail food markets in an area for both urban and rural areas, but the definition does not address the influence of the built environment to travel to and from the food market. The combination of major roadway systems and a lack of alternative transportation systems can

negatively impact travel distances therefore the distances defined by the USDA do not necessarily accurately reflect the distance to a store. As a result is that an understanding of the built environment could provide more in-depth information and present more accurate analysis in the future.

#### **IV) LITERATURE REVIEW**

The efforts to address food accessibility in communities from the relationship between three components: transportation, the built environment and public health. While the focus in past studies has been only specific to two components (e.g. transportation and the built environment), more analyses have highlighted the multi-linear relationship between all three components when addressing community growth in the United States. Studies such as ones conducted by Giles-Corti et al. and the United Nations Department of Economic and Social Affairs are some of many identifying how potential public health impacts are related to the built environment and transportation mode choice activities. One of the bigger planning issues in communities, particularly in urban ones, is the development of Environmental Justice areas (EJs) which arise when certain groups of people are restricted to certain locations. These areas tend to experience negative externalities with changes in the transportation system and the built environment more than most areas, which often have been linked to greater public health concerns (14). The challenge becomes how to improve the transportation system to not only improve mobility in EJ areas but also help address accessibility issues (9). Planning agencies across the US therefore have been looking to incorporate livability into community practices hoping to alleviate physical burdens on households in EJ areas.

While sustainable transportation practices have the potential to be beneficial for communities, there are different perspectives on how impactful transportation, particularly alternative transportation mode choices, is on improving food access in communities. Low levels of food accessibility have been linked with chronic health problems such as diabetes and obesity from poor food diets because of poor access to healthy and affordable food options. The predominance of vehicle ownership in the United States has negatively impacted not only physical activity, but also locations for food markets from land use policies. A part of the food desert definition from the American Nutrition Association is that households in food deserts are required to travel more

than one mile to the nearest food market in urban communities (ten miles for rural communities) (13). The challenge becomes more complex when households do not have convenient alternative modes choices to travel and are limited to where to purchase food because of food stamps. The encouragement towards participation in local farmer's markets, community gardens and urban agriculture have been identified as potential solutions to address food deserts and other food accessibility issues (1, 3, 6). These specific food market options however will not be analyzed in the project, but hopeful for future analysis as more creative opportunities to improve access health and affordable food options in communities.

## **V) METHODOLOGY**

The intention of the interactive map is to identify and compare different transportation network mode choices and the service areas for retail food markets in different urban communities across the United States. The layers for the interactive map will be an overlay of the socio-demographic characteristics for census tracts in urban communities, the locations of large grocery stores, supermarkets and hypermarkets and the service areas provided by different transportation mode choices. The scope of the interactive is to compare how alternative transportation networks provide service for people to reach retail food markets that provide healthy and affordable food options.

The first project objective is to identify a spatial relationship with levels of food accessibility across the United States. The main characteristics in identifying low food accessibility areas have often been associated with household distance to food markets and population demographics. The population demographics used in the project will be from the Food Environment Atlas dataset, which developed by the USDA to identify food accessibility indicators in the country (4). The evaluation scale is at the census tract level and is done by the percentage of total population under five low food accessibility characteristics: census tract population with low access, low-income, age demographics (children and seniors) and households with zero vehicle availability. The census tracts will be grouped into quartiles based upon each characteristic using a Principal Component Analysis (PCA), which is used to reduce large variation in the data values. The PCA will be used to highlight the trends for different census tracts with similar characteristics. Since the variation will be associated with the census tracts from each state, there

will be differences in the size of each quartile range. The project scope focuses on urban communities for the evaluation because of complexity of integrating different transportation mode choices with areas of higher population densities. While rural communities are just as important for addressing food deserts and other food accessibility concerns, rural communities present a new set of different challenges addressing transportation network improvements. The combination of high population densities and the integration of different mode choices present complex challenges are more so applicable to urban communities than rural communities.

The second objective is to identify several types of retail food markets to have a better understanding of issues associated with food accessibility issues around the United States. The second part of the interactive will be overlays of retail food markets in urban areas throughout the country. The retail food markets will be divided up into three categories: large grocery stores, supermarkets and hypermarkets. The three groups will take into consideration the availability of fresh produce and the number of amenities provided in each market. One of the main concerns with food accessibility is the produce availability and the diversity of grocery items. While smaller retail food market such as convenience stores provide residents in underserved areas access to necessities, the inconsistent amount of quality produce and the overabundance of processed food raise public health concerns. A major reason for the promotion of the Healthy Food Financing Initiative in 2010 was the concern for the over-reliance on processed foods and fast food options to ensure food security for residents (13). The overlay will be evaluated at the local level to compare retail food market locations to transportation mode choices. The shapefiles are created from the Supplemental Nutrition Assistance Program (SNAP) Retailer Data which identifies retail food markets that support SNAP. There is a future opportunity to address other food financial assistance programs such as the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC), however for the project will only be addressing SNAP for now.

The final objective is to identify how sustainable transportation practices relate to food accessibility throughout the United States. The incorporation of national and state transportation policies for sustainable infrastructure will help provide context as to incorporate sustainable practices for livability and community growth. While mobility has been a focus in addressing

how people interact within the community, there has been a shift towards accessibility-based transportation planning. The result has in a greater focus on the specific origins and destinations than the route traveled. The final set of layers will be an overlay of service areas for different alternative transportation systems (walking, bicycling, rail and bus) for three cities across the United States. Each city will have an overlay for each mode to highlight service areas where access to retail food markets is available. The service areas for each transportation mode choice are created using shapefiles from open source data provided by local transportation planning agencies and using the Network Analyst in ArcMap. The service areas for walking and bicycling were generated using a half mile buffer from large grocery store, supermarket and hypermarket locations. The service areas for the rail lines and bus routes were generated using a buffer from stations and stops that were a quarter mile walking distance to large grocery store, supermarket and hypermarket locations. The buffer sizes used are consistent with prior research done regarding food accessibility and travel behavior, particularly for public transportation services such as bus and rail.

## **VI) TARGET USERS & SCENARIO**

The use of the interactive map can be applicable for a range of different target users. All of the potential target users would have an interest in different facets of analyzing community development. The potential users for the interactive are the following: researchers from the USDA Food Nutrition Services (FNS), city planners and non-profit organizations with an interest in food assistance.

### **i) USDA Economic Research Service**

The use of the interactive map would be to provide potential context as to the relation between different socio-demographic characteristics in evaluating food accessibility. The creation of the Food Environment Atlas (FEA) assembles food environment indicators that are used to evaluate how relationships between food access and the built environment. The five main factors that are used in the FEA are population with low access, population with low access & low income, population with low access based on age demographics (children and seniors) and population with low access with no household vehicle availability.

## **ii) City Planners**

The potential use of the interactive map would be to identify the spatial relation retail market locations and the transportation network for different transportation mode choices. The changing of land uses in communities presents challenges to city planners to keep up with the demands from community growth. The particular personnel would have a familiarity with city zoning ordinances and transportation engineering practices to identify the relationship between the transportation networks and the types of land uses that are within the service areas.

## **iii) Non-Profit Organizations**

The interactive map would provide information for non-profit organizations about the retail food markets in their respective community. The user would be seeking the information to guide people with food insecurity or residents in underserved food access areas potential locations to shop for healthy and affordable food options that work with SNAP. A similar purpose for using the interactive would be for interested citizens to know where specific types of retail food markets are relevant to their residence or place of interest.

## **TARGET USER SCENARIO**

The user would enter the interactive with the base layer and the census tract overlays for each urban community loaded prior to any interaction. The user would be given a legend to identify the color associated with the values and the relationship between the census tracts. The user will have two drop down menus to select from between the transportation mode choice and the retail food market type. The drop down menu for the transportation mode choice would provide the user the selection of an alternative mode choice which would be applied to all of the maps. The application of the drop down menu to all of the maps at once would give the user the opportunity to compare the service areas for each of the urban communities (Seattle, WA, Chicago, IL and Boston, MA). Should the user select a different transportation mode choice, the previous mode choice would be removed from the maps and the mode choice would be applied. The same functionality would occur if the user selected the drop down menu for the retail food markets. The user would be able to apply both drop downs to evaluate mode choice by retail food market locations and vice versa. The user could with the retail food market types hover over the points

to gather additional information about the market name, address and the type of retail food market for each of the three urban communities.

The required documents used for the interactive map are in the appendix section of the report for more information regarding the specific layers in the interactive.

## **VI) CONCLUSION**

The purpose of the interactive map is to compare different urban communities across the United States and identify how service areas for alternative transportation mode choices provide access to healthy and affordable food. With the use of various GIS tools, there are opportunities created to explore different relationships in community development, particularly in addressing public health through food access initiatives. As communities continue to grow and change, there becomes a greater emphasis on understanding the needs to best serve the community and improve public health for all. While the United States has launched federal initiatives to improve access to health and affordable food to communities, particularly underserved ones, the challenge becomes more complex with the inclusion of mobility and accessibility factors within the built environment. Therefore, addressing both the location of different retail food markets (grocery stores, supermarkets and hypermarkets) and service areas for different transportation mode choices (pedestrian, bicycle, rail and bus) can be beneficial for community growth not only for one community, but for others as well looking to improve community developments in such manners. The range of target users that would use the interactive is quite diverse and have high interest in community development. Researchers from the USDA Economic Research Services to non-profit organizations that assistance in food security and access could have potential interest in the interactive map.

Though the report only focuses on specific retail food market types for Seattle, WA, Chicago, IL and Boston, MA, there are a couple of future opportunities to look into. The first would be to increase the number of urban communities in the evaluation. Since the initial project idea was to look at food accessibility throughout the United States, a potential future initiative is to expand the number of urban communities to further investigate how different regions of the United States address food access. The second future opportunity would be to integrate urban-related

food initiatives and identify how such initiatives relate to the food access narrative in the United States. Such initiatives as community gardens, farmers markets and urban agriculture in could provide insight as to how different mode choices can provide opportunities to improve food accessibility and insecurities that lead to underserved areas.

## VI) APPENDIX

### REQUIRED DOCUMENTS

<b>Layer</b>	<b>Source</b>	<b>Symbolization</b>
Base Layer	OpenSourceMap	City Boundaries
Census Tracts with PCA Scoring Values	Food Environment Atlas (US Department of Agriculture Economic Research Service)	Polygon overlays with change in color associated with high to low food accessibility
Transportation Mode Choice Service Areas (Walking, Bicycle, Bus, Rail)	City of Seattle OpenSource Data Portal, King County GIS Data Hub, City of Chicago OpenSource Data Portal, City of Boston OpenSource Data Portal, Massachusetts Bay Transit Authority (MBTA) Public Transportation Polylines	Polygons showing the service areas for each mode of transportation based on proximity to large grocery stores, supermarkets and hypermarkets in Seattle, Chicago, Boston
Food Retail Market Locations	Supplemental Nutrition Assistance Program (SNAP) Retailer Database	Points with different colors and sizes based upon the food market retail type
<b>Function</b>	<b>Interaction Behavior</b>	<b>Operator: Operand</b>
Drop-down Menu (Transportation Mode Choice)	Allows user to select the service areas for different alternative transportation mode choices (walking, bicycling, bus and rail). Loads the service area based on the user selection	Select, Retrieve: Area Proximity
Drop-down Menu (Retail Food Markets)	Allows user to select the type of retail food market for each urban community	Select, Retrieve: Retail Market Location
Hover Popup for Retail Food Markets	Allows user to hover over retail food market point for name of the market, address and market type.	Retrieve: Retail Food Market Information

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