Mapping for Healthier Communities: Using GIS Technology as a Tool for Addressing Food Security

by

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ABSTRACT

At first glance, trends in increased hunger and obesity in the United States (US) would seem to represent the result of different causal mechanisms. The United States Department of Agriculture (USDA) reported that nearly 50 million Americans had experienced hunger in 2009. A year later, the Centers for Disease Control and Prevention published a report showing that 68% of the US population was either overweight or obese. Researchers have found that these contrasting trends are actually interrelated. Being so, it is imperative that communities and individuals experiencing problems with food security are provided better access to healthy food options.

In response to the need to increase healthy food access, many farmers markets in the US have received funding from the USDA to accept vouchers from federal food security programs, such as the Supplemental Nutrition Assistance Program (SNAP). In Downtown Phoenix, Arizona, one organization accepting vouchers from several programs is the Phoenix Public Market. However, the mere existence of these programs is not enough to establish food security within a community: characteristics of the population and food environments must also be considered. To examine issues of food security and public health, this thesis utilizes geographical information systems (GIS)

technology as a tool to analyze specific environments in order to inform program effectiveness and future funding opportunities.

Utilizing methods from community-based participatory research (CBPR) and GIS, a mapping project was conducted in partnership with the Market to answer three questions: (1) what is the demographic makeup of the surrounding community? (2) What retailers around the Market also accept food security vouchers? And (3) where are food security offices (SNAP and WIC) located within the area? Both in terms of demographic characteristics and the surrounding food environment, the project results illustrate that the Market is embedded within a population of need, and an area where it could greatly influence community food security.

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CHAPTER 1

INTRODUCTION

In 2009, the United States Department of Agriculture (USDA) reported that nearly 50 million people in the United States had experienced hunger – a statistic that has been growing slightly each year (Nord et al. 2010). Around the same time, the Centers for Disease Control and Prevention (CDC) also published a report showing that 68% of the US population was either overweight or obese[1], with higher percentages associated with minority groups (Flegal et al. 2010). At first glance, one may assume that issues of hunger and obesity are the result of different causal mechanisms. However, researchers have found that these seemingly contradictory trends are actually interrelated within the global food system (Patel 2007; Elinder 2005).

Raj Patel (2007) analyzed how economic and political characteristics of the global food system exacerbate both hunger and obesity. From transnational corporations to foreign policy, Patel compared the global trade of food to that of a bottleneck: while the population of producers and consumers remains close in size, food traded on a global scale passes through only a small number of corporations. Strengthened by international trade agreements, these

[1] The term "obesity" will be used to describe the health condition of anyone significantly above his or her ideal healthy weight.

corporations represent a concentration of power within the global food system, and create an environment that hinders food sovereignty: the right of individuals and communities to decide and access appropriate food sources autonomously (Land Research Action Network 2007).

Yet, what role does food sovereignty play in the manifestation of hunger and obesity? According to Patel, "Overweight and hungry people are linked through the chains of production that bring food from fields to our plate (1)." In other words, the economics and politics controlling how food is grown, processed, and transported directly affect food access and availability. Since prices are also derived from the global food system, the financial and geographical characteristics of food sources also influence our ability to access it (Patel 2007; Winne et al. 2000). It is at this point where food sovereignty is inextricably linked to food security: a status where "all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life (FAO 1996)."

If food sovereignty within global trade influences trends in food security, what can be done to address these issues at the local level? With food production as the common thread, social movements focused on food sovereignty have advocated for a decentralization of power by

shifting food production from global to local sources (La Via Campesina 2011).

In the US specifically, farmers markets have provided an avenue to address food sovereignty and food security considerations, because they invest in local economies and provide access to healthy food sources. While farmers markets have been criticized for being accessible only to the wealthy elite (Alkon 2007), many farmers markets throughout the US have received funding from the USDA to collaborate with federal and state food security programs. These programs, also known as "Nutrition Assistance Programs," improve access to nutritious food sources through voucher programs implemented in partnership with local and regional businesses (USDA 2011c). While the USDA oversees numerous programs and initiatives geared towards increasing food security, there are three programs that have become aligned with farmers markets specifically: the Supplemental Nutrition Assistance Program (SNAP), previously known as the Food Stamp Program; Women, Infants, and Children (WIC); and the Farmers Market Nutrition Program (FMNP).

To receive financial assistance, each of the food security programs has its own eligibility requirements. Currently, eligibility requirements for SNAP assistance are based on household resources and income, but employment, age, disability, and immigration status

could also be considered during the application process (USDA 2011b). Through the WIC program, assistance is provided to women and children at "nutritional risk," with additional requirements for age (up to the fifth birthday for children), as well as pregnancy status (women who are either currently pregnant or postpartum) and those who meet the SNAP income requirement (USDA 2011d). The Farmers Market Nutrition Program (FMNP) also provides additional assistance to those qualifying for WIC, as well as seniors, to access fresh, local food sources (USDA 2011a).

By providing financial support to improve access to fresh and local food sources, these federal programs have become a seminal instrument for addressing food security needs and promoting food sovereignty goals within local communities (Winne et al. 2000). This shift from global to local chains of food production not only addresses issues of social justice, but also overall sustainability within the food system, and the potential impact on hunger and obesity (Patel 2007).

For residents of Arizona, investment in local food production is visible in a multitude of communities and farmers markets throughout the state. As of 2008, there were 73 farmers markets in operation within 14 counties. However, only 37 of these 73 markets accepted vouchers from WIC/FMNP, and only 16 of the 37 accepted vouchers from SNAP (Community Food Connections 2008). Additionally, only 5

out of the 9 farmers markets located in the metropolitan area accepted vouchers from all three programs (Community Food Connections 2008).

In the Downtown area of Phoenix, a non-profit organization has created a farmers market to improve the food security needs of its surrounding residents: the Phoenix Public Market. As a program of Community Food Connections – a 501c3 organization based in Phoenix – the Market has been in operation since 2008, and accepts vouchers from SNAP, WIC, and FMNP programs. Its mission aims to bring together local food producers and consumers by "creating opportunities and venues for farmers, increasing access to healthy food and providing educational outreach (Phoenix Public Market 2011)."

While eight other markets exist within the Phoenix city limits, the Market is the sole market located within the Downtown area. Located on Pierce Street and Central Avenue, the Market is adjacent to Arizona State University's Downtown campus, as well as a hotel built in the 1920s that was converted into public housing for seniors and disabled residents in the 1980s: the Westward Ho (Yuan 2003). The Market also has direct access to public transportation, including the Valley Metro LightRail and bus systems (Valley Metro 2011).

To guide the food security outreach efforts of the Market, a collaborative research project was conducted to examine the

populations within Downtown Phoenix that could benefit from its location. To target the populations that would benefit the most, key variables within demographic and food environments were analyzed. Geographical information systems (GIS) technology was used as a tool to develop a better understanding these environments within the Downtown Phoenix area.

The Market expressed an interest in researching three questions using GIS mapping technology: (1) what is the demographic makeup of the surrounding community? (2) What retailers around the Market also accept food security vouchers? And (3) where are food security offices (SNAP and WIC) located within the area? These questions are examined by mapping four sets of variables: (1) income per capita, (2) the population density of minority groups, (3) the locations of SNAP retailers, and (4) the locations of SNAP and WIC offices.

Since the nature of this project was collaborative, the research conducted with the Market followed a community-based participatory framework. While studying food security and GIS technology served as the original research interests, the aims of the project were driven by the Market's need for research that could inform its efforts to serve the food security needs in Downtown Phoenix. Throughout the community-based participatory research (CBPR) process, feedback was continuously sought to clarify and confirm the planning of the project,

and the mapping objectives. After the maps were created and analyzed, recommendations were generated for the Market to address future needs of the project.

CHAPTER 2

FOOD SECURITY REVIEW

> *Securing adequate food is one of the oldest problems confronting political institutions* (Hopkins and Puchala 1978, 581).

The relevance and timeliness of a project addressing issues of food security is evident by the growing number of Americans experiencing hunger (Nord et al. 2010), compounded also by the growing rate of obesity in the same population (Flegal et al. 2010). As a reflection of these trends, in the past decade there has been renewed interest in the study of food and understanding the multitude of ways it impacts our daily lives. Recent films, such as "Food, Inc" (Kenner 2008) and "Super Size Me" (Spurlock 2004), have brought public attention to the system in which we grow, harvest, process, distribute, and market food. In addition to films, food has become the interest of scholars and activists (Gottlieb and Fisher 1996; Kingsolver 2007; Patel 2007; Winne et al. 2000); non-profit organizations, such as La Via Campesina, Feeding America, and St. Mary's Food Bank; and political figures, such as First Lady Michelle Obama with her "Let's Move" campaign (Let's Move 2011). Greater context is needed, however, of the underlying issues within food security that prompt its current popularity. How food security is defined and measured

provides the basis of the modern discourse, and determines the strategies followed by various disciplines and groups to address it.

Within Arizona specifically, statistics and statewide initiatives have set the stage for understanding food security and health issues more comprehensively. Compared to the nationwide statistics, 19.8% of sampled residents in Arizona experienced hunger in 2009 (Nord et al. 2010), while 25.5% of the population was considered obese (CDC 2011). In an effort to address hunger and obesity in Arizona, several projects and initiatives have been developed by organizations that focus on food security and public health, such as St. Luke's Health Initiatives (2011), Arizona Indicators (2011), and Healthy Arizona 2010 (2011).

Defining Food Security

The discourse on food security provides a better understanding of what food and health organizations aim to achieve not only in Phoenix, but Arizona and the US more broadly. The definition, context and scope of food security have been transformed by discourse over the past several decades, reflecting a more comprehensive understanding of structural and systemic issues.

The origin of food security discourse can be traced back to the 1970s, when it was first acknowledged as a global issue. During the

1974 World Food Conference, attendees proposed an increase in food production as a solution to rising global malnutrition (Anderson and Cook 1999). Responses to this call to action included agricultural movements, such as the Green Revolution, which influenced several developing nations to adopt new technologies that would produce higher yields of crops (Conway 1999).

While technologies in genetic modification and pest control allowed for increased yields of crops on a global scale, low-income populations around the world were still experiencing high rates of malnutrition and starvation (Anderson and Cook 1999). Since the issue remained unresolved, a shift occurred in the definition of food security to highlight a rights-based approach to the relationship between people and food. Amartya Sen (1981) first introduced the concept as four entitlements: buying food, growing food, working for food, and being given food by others. The entitlement approach shifted the emphasis from an issue of quantity to an issue of human rights and the ability of populations to acquire food (Devereux 2001).

While much of the research on food availability and access has examined individual and household variables (Allen 1999), the discourse has recently extended yet again to gather knowledge regarding implications at the community level (USDA 2011c; Winne et al. 2000). Also known as community food security (CFS), this

expanded framework has been developed by scholars and non-profit organizations alike. The Community Food Security Coalition (2010) has served as a leading voice in the definition and measurement of CFS, and has actively advocated for the promotion of food security issues within the US. Led by scholars in the field, such as Mark Winne and Robert Gottlieb, the Coalition has published much research on best practices of CFS.

In addition to scholars in the field, government agencies have also conducted research on CFS. The USDA in particular has created special reports and resources made available on its website, including strategies and programs that help contribute to CFS goals (USDA 2011c). Current strategies contributing to the CFS goals include farmers markets, community-supported agriculture, and farm-to-school initiatives. The agency has also published its own toolkit, which allows individuals or communities to measure various aspects of CFS including demographic characteristics, food availability/accessibility, and modes of food production (Cohen 2002).

The definition of CFS was first framed as the ability of "all persons in a community having access to culturally acceptable, nutritionally adequate food through local non-emergency sources at all times (Winne et al. 2000)." This definition not only addressed previous variables of food availability and access, but also acknowledged a third,

important component adopted in food security discourse: utilization. "Effective utilization" was also recognized at the 1996 World Food Summit as a key component within the Rome Declaration on World Food Security (FAO 1996). In both cases, utilization became an important component to understanding CFS, because it addressed cultural aspects (acceptance), biological processes (digestion), and technical methods (preparation) of the relationship between people and food (Barrett 2010).

Further developments of the CFS definition have included components of sustainability and social justice as well. For instance, Hamm and Bellows (2003) defined CFS as "a situation in which all community residents obtain a safe, culturally acceptable, nutritionally adequate diet through a sustainable food system that maximizes community self-reliance and social justice (p. 37)." In this definition, the authors acknowledge the presence of systemic and structural factors impacting CFS through social and community-based variables. Systemic and structural factors indicate another key difference between food security and CFS definitions: while food security acknowledges an individual's human right to food, CFS also acknowledges an individual's human rights, but its analysis encompasses the larger context of the food system.

Further, the definition provided by Hamm and Bellows (2003) above provides an illustration of how CFS could be intertwined with health disparities research. For example, the utilization of CBPR, a common methodology used in health disparities research, parallels the community self-reliance and social justice aims of CFS. Another similarity between CFS and health disparities research includes the focus on the importance of nutritionally adequate diets (Morland et al. 2002). For example, Vásquez et al. (2007) conducted a CBPR study with youth in San Francisco that examined the availability of food options at "corner stores" within a low-income neighborhood. Their study found poor access to quality food in the area, which prompted media coverage and a new community food policy within the neighborhood to improve access to healthy food options.

Another trend within both food security (individual or community) and public health research has been the utilization of GIS mapping technology. As will be later discussed, researchers have utilized this technology as a way to visually and spatially interpret information on food and health environments. From issues regarding obesity (Frank et al. 2004; Gorden-Larsen et al. 2006; Sage et al. 2010), to the study of trends in epidemiology (Clarke et al. 1996; Jarup 2004; Poulstrup and Hansen 2004), GIS technology has proven itself to be an innovative tool for researching the interplay between people and food.

It is with the application of mapping technology that the structural and systemic concepts within CFS can be better visualized and also measured.

Measuring Food Security

How the discourse and research has defined food security has also had an impact on the way it is measured. Much like how it was defined, measuring food security has often relied on individual and household units of measure. For example, federal programs, such as SNAP, WIC, and FMNP, use individual and household level characteristics like income, age, or immigration status as part of the application process. Collecting data at this level has been beneficial for federal program effectiveness and observing large-scale trends, but these methods do not capture some of the structural or systemic issues within CFS (Allen 1999).

Despite advancements in the conceptualization of food security, there are still some unresolved practical issues. One such issue has been the lack of adequate indicators of food access failures (Webb et al. 2006). In other words, it is fairly simple to measure failures in food availability (i.e. production rates, land use) and utilization (i.e. malnutrition, starvation), but measuring access failure requires knowledge of environmental factors that may influence the behaviors

of individuals and households (Barrett 2010; Haddad and Kennedy 1994; Webb et al. 2006). The ways in which individuals and households access food are encouraged or hindered by a multiple factors, including social, economic, political, and/or geographical variables.

The lack of standard indicators of access failures is one reason why researchers and federal agencies have most often measured individual and household level characteristics of food security (Bickel et al. 2000; von Braun et al. 1992; Hamelin et al. 2008). The problem, however, is that individual and household perceptions of food security differ from the systems approach that is utilized in CFS and public health research. Although one could survey each household in a community, this method would not completely capture the structural or systemic processes within "farm-to-table" systems (Winne et al. 2000).

In an attempt to simultaneously address the need for measurement and the discrepancies within its standardization, several researchers have developed a range of general indicators or characteristics that contribute to the CFS framework (Bellows and Hamm 2003; Korf and Bauer 2002). Winne et al. (2000), in collaboration with the Community Food Security Coalition, produced an assessment kit that outlined eight key components of the CFS

framework. These components include: (1) focusing on low-income communities; (2) addressing a broad range of problems; (3) synthesizing many disparate fields; (4) developing strategies that unite rural and urban areas; (5) producing solutions that are integrative and holistic with multiple benefits; (6) incorporating a planning process; (7) embracing a systems approach; and (8) emphasizing coordination between community institutions (Winne et al. 2000).

How components of CFS are measured is complemented by another trend in CFS research: community food assessments. The process of community food assessments includes four stages: (1) organizing key and disenfranchised stakeholders (Ashman et al. 1993; Biehler et al. 1999; Harris 2007; McCullum et al. 2004), (2) planning the goals and scope of the assessment (Born et al. 2005; Pothukuchi 2004; Pothukuchi and Kaufman 2000), (3) data collection and analysis on the proposed questions or indicators (Cohen 2002; Pothukuchi et al. 2002; Winne et al. 2000), and (4) transforming research findings into advocacy for change (Harper et al. 2009; Southern Sustainable Agricultural Working Group 2005). It is within these stages that the assessment of CFS is again parallel to the CBPR process. This is because both approaches reinforce the discovery of community-identified needs, and the pursuit of policies or interventions that address these needs through research.

One method that has recently gained popularity in the assessment of CFS is GIS technology. While the USDA has used survey methods to measure individual household food security, the use of GIS has given researchers the opportunity to operationalize some of the components included in the definition and assessment of CFS. This is because GIS technology can be used to analyze and represent community level issues and systems, which are not captured in household surveys.

Application of GIS technology has been used for various topics within food security and public health. Algert et al. (2006) applied mapping methods to analyze the prevalence and use of emergency food assistance and access to healthy food options in Los Angeles. In Canada, Bertrand et al. (2008) examined the mobility potential of residents in Montréal and its influence on accessibility to fruits and vegetables. Although a majority of these studies are based in urban environments, some food security research has also examined rural environments and the existence of "food deserts" through GIS technology (Bustillos et al. 2009; McEntee and Agyemen 2010; Smith and Morton 2009).

Though GIS technology can be used as a tool for analyzing and representing a systems approach to CFS and public health, some researchers have criticized its use as a way of simply "counting grocery

stores." Rather than just counting the number of grocery stores, the technology can be used to understand the relationships between multiple variables within community level environments. The mapping project with the Market illustrates this extension of the applicability of GIS technology in understanding food security and public health in Downtown Phoenix.

CHAPTER 3

THE VALUE OF GIS RESEARCH

GIS technology has recently become a popular problem solving and analytical tool for researchers and organizations that wish to understand systemic and structural variables within specified environments (Clarke et al. 1996; Kistemann et al. 2002). While the technology itself has been in development since the 1980s (Jankowski 1995), the value of GIS research today is in its ability to expand traditional research methods, and provide compelling visual evidence for the decision-making process (Carver et al. 1995; Jankowski and Nyerges 2001; Lobao and Murray 2005; McCall 2003; Sieber 2006).

Because GIS involves the "automating, managing, and analyzing a variety of spatial data (Jankowski 1995, 251)," it is more often defined by what tasks it can complete, rather than what the technology actually is (Clarke et al. 1996). To be able to complete a GIS research project, investigators first must have the related hardware, software, and skills necessary to use it appropriately, and the institutional arrangements to share data and expertise (Jankowski 2009). However, though the GIS process requires a combination of all of these components, spatially referenced data about the target issue and/or environment serve as the foundation of the research, and must be secured before any analysis can begin.

In order to conduct spatial analysis in GIS, two characteristics of the data are required: (1) data must have a location- or coordinate-based reference, and (2) data must represent attributes "containing the factual information (Kistemann et al. 2002, 170)." For example, spatial analysis of obesity rates and activity levels within certain neighborhoods would require both the obesity statistics and geographical information (Frank et al. 2004; Gorden-Larsen et al. 2006). For the purpose of GIS research, the two characteristics cannot stand alone, but instead complement each other to generate geographical relationships within the data.

As in any type of research methodology, the quality of the data used for a GIS research project determines the quality of the analysis and results. By using faulty data, investigators run the risk of illustrating inaccurate conditions, or could make users assume the legitimacy of "cause-and-effect relationships in the real world (O'Looney 2000, 31)." This is true, especially within statistical aggregation, where the representation of spatial data could be skewed as a result of how it is organized (Current and Schilling 1990; Indulska and Orlowska 2002; Vine et al. 1997).

While GIS technology is often thought of as "a simple extension of statistical analyses (Ricketts 2003, 3)," it actually encompasses additional functions. Throughout the GIS process, spatially referenced

data are operated through several functions to "collect, store, manipulate, analyze, and display information" (Jankowski 2009, 1966; Nyerges 1993). This broad range of functional properties has led some researchers to begin approaching GIS as its own science, rather than a methodological tool (Goodchild 2000; Kistemann et al. 2002). Wright et al. (1997) recognize that GIS may find itself on a spectrum of three positions: (1) as a tool for research; (2) as a "toolmaker"; and (3) as a science of geographical and environmental concepts. Respectively, GIS could be thought of as a research method, a technology that could be further developed by geographers and other social scientists, or "a subset of geographical science (Wright et al. 1997, 356)."

Within public health research specifically, GIS technology has been used as a tool to visualize relationships, conduct exploratory data analyses, and build explanatory models (Carr et al. 2005; Carver et al. 1995; Franco et al. 2008; Galvez et al. 2007; Gatrell and Bailey 1995; Poulstrup and Hansen 2004). While the function of visualization may seem obvious, it serves as the foundation for analyzing and interpreting spatial data, as well as an opportunity to generate patterns over time (Jarup 2004). Additionally, the visualization function allows for more traditional research methods, like statistical analysis, to be applied and interpreted in new ways. Gregory (2008) utilized GIS technology to expand historical research of infant

mortality rates in England and Wales from 1851 to 1911. In this study, the statistical information was matched with spatial references to examine the historical importance of urban and rural environments, and their influence on infant mortality rates during that time period.

Exploratory data analysis, a second function of GIS research, refers to spatial data that can be mapped in order to investigate the hypothetical relationships between variables. The resulting maps from exploratory data analyses are often used to develop potential hypotheses and future research objectives (Carr et al. 2005; Clarke et al. 1996; McLafferty 2003). Studying archeological fieldwork sites, the role of GIS served as an exploratory sampling method for Carver et al. (1995) to identify "areas of interest, active process areas and areas of uncertain data quality (p. 168)." In this case, the exploratory process not only aided in the identification of preferred study areas, but also illustrated potential areas where data quality could be improved. Lobao and Murray (2005) also used this exploratory function to address disparities between perceptions and observed behaviors within the homeless shelter system in Columbus, Ohio.

Finally, the last function that has been used particularly in public health research involves model building. The purpose of using GIS technology to build models is to test complex multivariate hypotheses by illustrating statistical scenarios or predictions (Clarke

et al. 1996; Miller and Wentz 2003). This function may work in tandem with the exploratory function of mapping spatial data if new questions arise from that process. For example, if Lobao and Murray (2005) found a need to improve the homeless shelter system in Columbus, Ohio, they could have adapted their findings on observed behaviors to develop scenarios where services could be provided more effectively.

Especially in public health research, the modeling function within GIS provides investigators with the tools to map out specific phenomena, such as the spread of disease or environmental hazards that can potentially lead to development of interventions, or serve as the basis for policy changes (Jarup 2004; Lefer et al. 2008; Mantaay 2002; Vine et al. 1997). Poulstrup and Hansen (2004) used dispersion modeling to explore communities and their potential exposure to airborne dioxin. The results of their study, however, illustrated some of the constraints with the modeling approach, such as the impact of uncertain environmental variables, as well as the assumption that populations remain static over time in these specific environments. While these are limitations to the GIS modeling process, they do not disprove that chemicals, like dioxin, could represent environmental hazards within a community. To retain the validity of the GIS

research, investigators must account for limitations within the data analysis, or develop procedures for measuring such discrepancies.

The functions and results of GIS research and spatial analysis do not operate solely as exercises in methodological practice: the generation of new knowledge also informs the decision-making process (Jankowski 2009). After all, the value of GIS is not only in its ability to expand the scope of traditional research, but also in its use of that research to better inform communities and decision-makers (Sieber 2006). In order to promote equity within the mapping process, a call for the democratization of GIS has been made to ensure that the decisions made based upon the research benefit all those who are affected by it.

The Democratization of GIS Technology

While GIS serves as a methodological tool for research, its value is also able to inform decision-making processes. Historically, this has placed the technology in municipal or government agencies, where public policy and services are administered (Ghose 2001; O'Looney 2000). Being so, GIS has often been regarded as inaccessible to the public for two reasons: cost and expertise (Sieber 2003; Worrall 1994). Not only can the hardware and software components price into the thousands of dollars, but also the technicality of handling data and

software tools requires extensive training and understanding of spatial systems. Without a way to circumvent the cost and learning curve barriers, the public's ability to engage in GIS research is limited.

Expertise and financial barriers to the use of GIS technology have introduced a call for its democratization, which would provide the public with improved access to the technology and decision-making process. This new conception of GIS is most commonly referred to as public participation GIS (PPGIS). PPGIS was first conceptualized as a way to include the public in GIS research and decision-making "with the goals of improving the transparency of and influencing government policy (Sieber 2006, 492)." Drew (2003) examined the need for transparency in the PPGIS process, but also the limitations of its evaluation. To clarify what transparency could entail, she introduced a framework of seven key concepts: "clarity, accessibility, integration with other decisions, logic and rationale, accountability, truth and accuracy, and openness (Drew 2003, 74)."

The democratization of GIS is also important to influence governmental policy, because: (1) the decision-making process should involve the voices of those affected by it (Jankowski 2009; Smith 1982); and (2) access to information and tools that generate greater knowledge, in turn, directly influence community empowerment (Ghose 2001; McCall 2003; O'Connor 2009; Robinson 2010; Sieber

2003; Sieber 2006). Much of the PPGIS literature has included discussions of the relationship between GIS and local empowerment, and how the two operate within the research setting.

Ghose (2001) presented the strengths and limitations of PPGIS empowerment projects by examining a university/community partnership in Milwaukee, Wisconsin. In the study, residents of Metcalfe Park were trained in GIS technology to address municipal housing policies and environmental concerns. Evaluation of the project showed success in several formats: (1) residents with no prior computer experience were able to operate GIS technology; (2) the project established a model for neighborhood planning by neighborhood residents; and (3) a reciprocal relationship of knowledge generation was formed between the university and the neighborhood residents. However, sustainability of the GIS project within the neighborhood failed, because "the complexity of the GIS proved to be too difficult to master (Ghose 2001,156)."

As Ghose (2001) illustrated, while the ideals of PPGIS contribute to a more democratic process of decision-making, the fact remains that technical expertise is still needed to assert credibility of the results. Sieber (2003) equates this to a "tension" within the concept: as expertise is needed to operate GIS, PPGIS requires a diffusion of the technology to organizations and communities in need,

"or the adoption will fail to reach its empowering potential (p. 55)." One solution that has been presented to issue in PPGIS is the partnership between universities and community organizations (Barnt 1998; Leitner et al. 2000; Sawicki and Craig 1996). However, instead of training community members in GIS and spatial concepts, students and faculty members operate the technology, which is reciprocated by community-embedded knowledge and identified needs (Ghose 2001; Robinson 2010).

An additional concern for PPGIS projects is that they are not "implemented in a void (Sieber 2006, 494)." In other words, the data, users, procedures, and results operate within social, political, and economic contexts (Ghose 2001; Jankwoski 1995). These contexts could hinder the GIS process beyond financial and technical barriers, and counter the democratic proclivity of PPGIS. It is especially concerning for populations that may be marginalized within sociopolitical spheres, or within the GIS process itself. Craig and Elwood (1998) illustrated that marginalization could represent an inability of non-GIS users to express their opinions within the GIS process.

The use of web-based GIS technology has introduced a potential avenue through financial and technical barriers (Kingston et al. 2000; Kingston 2007). By accessing GIS software over the Internet, more

users could potentially engage in the mapping process (Wong and Chua 2001). However, increased accessibility for those who may not be trained in GIS could cause concern for accurate, rigorous research. To address this, web-based applications could be developed in such a way to "hide the complexity of GIS behind friendly, easy-to-use graphical user interfaces (Carver et al. 2001, 918)." Therefore, the need for extensive expertise in GIS technology could be circumvented and made more accessible to the public. More than just the software, the Internet has provided a way for increased access to spatial and statistical data sources as well (Carver et al. 2001; Kistemann et al. 2002; Mantaay 2002).

Case Study: San Francisco Collaborative Food System Assessment

In 2005, the San Francisco Food Alliance (SFFA) conducted an assessment project that analyzed several characteristics of community food security to influence local policies and programs. The project, as a response to the 1997 Sustainability Plan for San Francisco, identified four different components of the local food system to be examined: production, distribution, consumption, and recycling (San Francisco Food Alliance 2005). The methods used for the assessment involved formal document reviews, data collection, and most importantly, GIS technology. Particularly with food production and consumption, the

San Francisco assessment serves as a case study to provide greater context to the mapping project conducted with the Market.

Production – In their assessment, the SFFA examined the frequency and distribution of school and community gardens within open spaces and neighborhoods (Figure 1). By using GIS technology, a map was generated to identify trends where gardens were located. Out of 59 total community gardens, neighborhoods such as Castro/Upper Market, Mission, and Bernal Heights showed a high number of gardens. However, more western neighborhoods, such as Outer Richmond and Outer Sunset, contained little to no gardens.

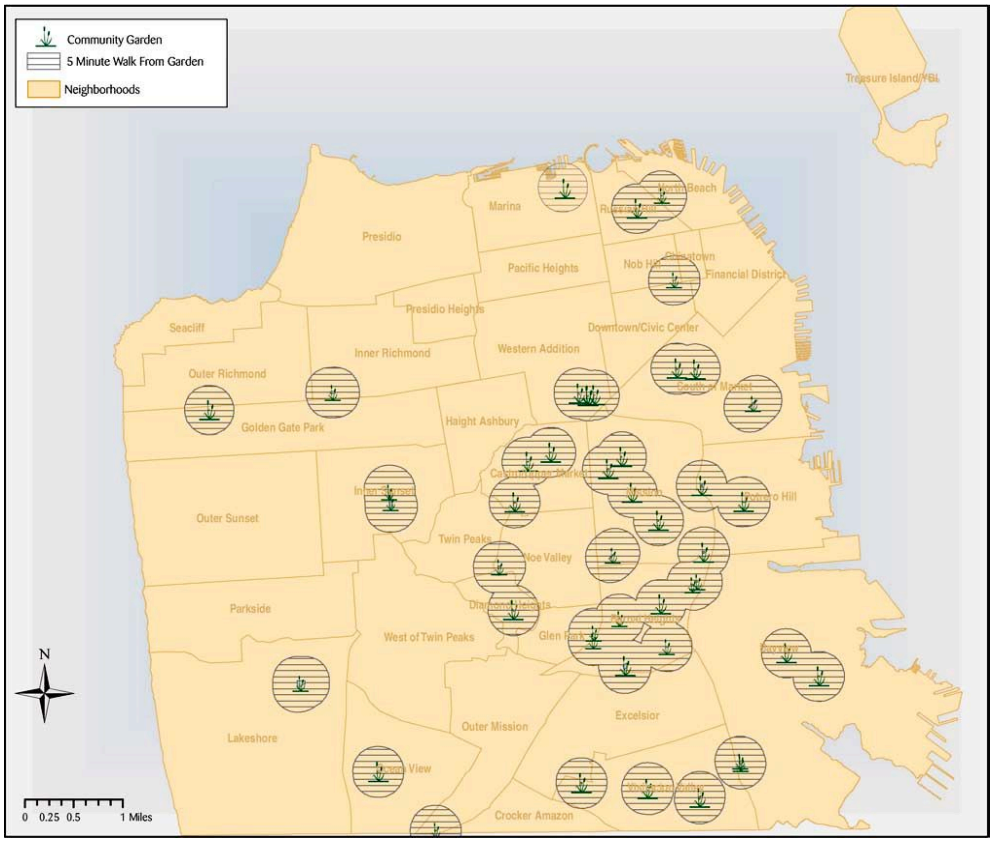

Figure 1. Distribution of community gardens in San Francisco neighborhoods.

Using GIS technology, the assessment allowed for the immediate identification of trends between social and geographical relationships. The maps show the number of community gardens in neighborhoods, but they also illustrated whether or not gardens were accessible to bordering neighborhoods by incorporating a quarter-mile buffer zone. Incorporating the zones broadened the scope of the spatial analysis, because it showed that access to the gardens was not necessarily determined by municipal boundaries – something a table with the same information could not illustrate easily. In other words,

if a garden was within a quarter-mile of a bordering neighborhood, it is possible that residents from that neighborhood could still access it.

By mapping the locations of community gardens and quarter-mile buffer zones, the SSFA assessment showed that measures of access and/or access failure could be spatially analyzed; thus, resolving a limitation of the CFS framework previously introduced by Webb et al. (2006). This portion of the assessment provides context for the mapping project conducted with the Market, because similar variables were used to understand food access within Downtown Phoenix. For example, as some of the maps will later show, demographics associated with income were combined with the locations of retailers accepting SNAP vouchers. While a buffer zone was not used for the maps, the benefit of studying the Downtown Phoenix area is that the streets comprise a grid system that is easily scaled. Thus, access and/or access failure was easily measured via street distances.

Consumption – The SSFA assessment also examined spatial trends between the location and frequency of 55 supermarkets, and the distribution of income throughout San Francisco (Figure 2). Similar to the community gardens, a quarter-mile buffer zone was incorporated to illustrate walking distance from each supermarket location. The SSFA reported that access to supermarkets in some neighborhoods were

somewhat restricted by walking distance, especially within the southeast region of the city. Additional barriers were acknowledged, such as the lack of topography information (as San Francisco is characterized by steep inclines), as well as the prevalence of violence and gang territories, which may also have an influence on accessibility.

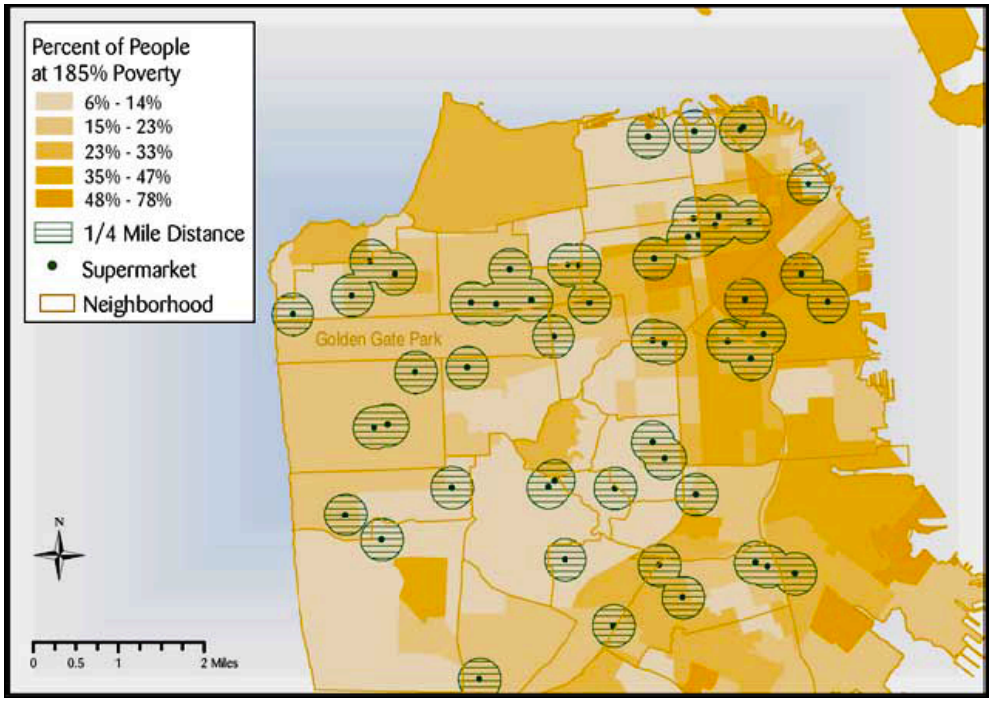

Figure 2. Distribution of supermarkets in relationship to poverty in San Francisco.

The use of this map in the SSFA assessment provides greater context to the mapping project with the Market, in that it examined the distribution of supermarket locations in relationship to poverty. This spatial relationship is important, because it addresses a criticism that GIS technology is only capable of "counting grocery stores." Clearly, combining the supermarket locations with income distribution

provided a more rigorous analysis of CFS in San Francisco. Incorporating the quarter-mile buffer zone served as an additional feature that illustrated the barriers to food access that some neighborhoods experienced. Similarly, as proceeding maps will show, the benefit of mapping spatial relationships between retailers and demographics is that avenues and barriers to food access can be better visualized. The mapping project with the Market demonstrates a similar benefit within GIS research, because the technology was used as a tool to generate spatial relationships for the increased understanding of food security and public health in Downtown Phoenix.

CHAPTER 4

THE MAPPING PROJECT

The mapping project conducted with the Phoenix Public Market illustrates how GIS mapping technology can be used as a tool in food security research. As mentioned previously, the Market expressed an interest in researching three questions: (1) what is the demographic makeup of the surrounding community? (2) What retailers around the Market also accept food security vouchers? And (3) where are food security offices (SNAP and WIC) located within the area? Using GIS to map these three questions, the Market will be able to visually assess the surrounding community in order to better serve its mission to "increase access to fresh, healthy foods in an underserved area (Phoenix Public Market 2011)."

To create the maps of the surrounding community, data were extracted using resources from Arizona State University, as well as field research. Three demographic characteristics were chosen to study: (1) income per capita, and the population densities of (2) African American and (3) Hispanic residents. These characteristics were then mapped alongside available SNAP retailers, and the locations of SNAP offices and WIC clinics. Income per capita was particularly important to map, because it serves as a determining factor to receive federal food security assistance.

Also examined were the population densities of African American and Hispanic residents within Downtown Phoenix. These layers of information were joined with the plotting of specific SNAP retailers and SNAP offices/WIC clinics. Population densities for these two minority groups were chosen for the study, because of their high risk for obesity (Flegal et al. 2010).

It is important to note that this mapping project introduces a praxis component to understanding community food security in Downtown Phoenix. Through the combination of both theoretical and practical discussions, a more informative perspective is also gained on the value of GIS research in two ways. First, the methods used during this mapping project followed a CBPR process. Research began with questions of interest to the Market, and was guided from that moment by constant feedback. It is here where the similarities between PPGIS and CBPR methodologies can be identified: both prioritize community participation towards identification of research goals.

Second, by addressing a community-identified need, the maps will serve as a resource for the Market, and its mission to serve the residents of Downtown Phoenix. Not only will the maps be able to inform the Market's strategic planning exercises, but they will also provide support for future funding by justifying their role within a community of need.

Gathering information and conducting analysis within the Downtown Phoenix area was additionally important to the Market for two reasons: improved outreach efforts, and benefits to the surrounding community.

Improved Outreach – First, the Market accepts food security vouchers at their Urban Grocery and Open Air Market from SNAP, WIC, and FMNP. Within both components of the Market, those who qualify for SNAP can use vouchers (food stamps) to purchase accepted food items. For the Open Air Market specifically, customers can also use vouchers from both WIC and FMNP. The Open Air Market serves as the weekly farmers market in a parking lot next to the Urban Grocery. By accepting vouchers from all three programs, the Market provides greater access to healthy, local food options for the surrounding community. Mapping out the demographic characteristics and food security options in Downtown Phoenix served as a first step to determine the potential areas where outreach efforts could be made to raise awareness about the Market. Such efforts are important for the Market to serve the Downtown Phoenix community, because without knowing where populations of need may exist, it would be difficult to strategically plan where efforts would be best served.

Community Benefits – Second, as the Market will be supplied with a better understanding of population and food options in Downtown Phoenix, their improved outreach efforts benefit the surrounding community as a result. Multiple food retailers that accept vouchers from food security programs surround the Market within a 30 square mile area. Small, family-owned grocery stores, convenience stores, and even liquor stores make up some of the available options for neighborhood residents. As the maps show, an overwhelming majority of residents within the project area were considered low-income. Therefore, the Market is positioned in an area where their mission is best served, and the surrounding residents would benefit of better access to local, healthy food.

Methods

To identify and develop the research questions, a basic interview and needs assessment was conducted with Cindy Gentry, executive director of Community Food Connections. Gentry was chosen to participate in the assessment, because the Market is a project funded by Community Food Connections; therefore, her leadership extends to the operations and partnerships of the Market. Through several meetings, Gentry explained the mission of the Market, and its history within the Downtown Phoenix area. Expressing an interest in the

potential benefits of using GIS technology to understand community food security, Gentry introduced a series of research questions based on needs of the organization, as well as the community at large. Developing these questions was crucial to the CBPR process, because the first step asks the community to "define a problem that they seek to resolve (Greenwood and Levin 2007, 4)." In this case, "community" was defined as those who work for the Market (employees and/or volunteers that manage its operation), as well as the residents of Downtown Phoenix who may benefit from their services and products.

Gentry's questions identified a need for more information on four types of data: demographics, health indicators, food security retailers, and food security offices and clinics. Gentry explained that these data would allow the Market to develop outreach efforts to those qualifying for federal food security programs, as well as gain a better understanding of the surrounding community and the food options available to the area residents.

At this point in the CBPR process, an informational feedback loop was initiated to allow the Market a constant presence in shaping the progress of the research objectives and goals. When necessary, additional meetings were held with Gentry in order to answer questions and resolve issues within the project. Additional meetings not only allowed her to approve new ideas or changes to the research,

but Gentry was also able to provide expertise with different portions of the project. For example, some data proved to be difficult to obtain, so Gentry shared professional contacts that could speed up the data acquisition process.

After the data was acquired and the maps created, the next step taken with the Market was to develop recommendations from the results. This forms another important step in the CBPR process, as all participants have the chance to provide feedback, as well as determine the course of action based on the results. While recommendations are provided based on the results of the maps, this step of the CBPR process is still in progress. However, once the maps are reviewed, a discussion will be held on how the Market can further develop the information, and implement an outreach campaign to increase community food security in Downtown Phoenix.

The final mapping project will be presented to the Market to continue the discussion on how the research will be replicated and/or expanded for future studies. Because the project evolved within a timeframe of approximately four months, the resulting maps were considered to be the first step within an extended research process. For example, there were some environmental factors that were not included in the research that would provide further understanding of the Downtown Phoenix community. (e.g. Is the Market an economically

viable option for residents? How does public transportation influence its geographic viability?) In other words, incorporating as many environmental factors as possible requires further data and analyses to create a more complete outlook of the surrounding community. Contributing to further sustainability of the project, the Market will be given full ownership of all of the necessary documents and data sources for use in future studies.

Data Acquisition

In order to map the demographic and food environments within the Downtown Phoenix area, data were accessed from a GIS repository available from Arizona State University (ASU), as well as field research. Table 1 lists general information about the data files obtained or created for the mapping project.

Table 1. List of GIS data files and locations.

Data	Location and/or Folder	File Name
Income	ASU repository – Census, 2000, Income	MaricopaIncome2000
Race/ethnicity	ASU repository – Census, 2000, Ethnicity	MaricopaEthnicity2000
Arterial streets	ASU repository – Arizona, Transportation	MaricopaArterials
General streets (geocoding)	ASU repository – Arizona Geocodable	Azstreetsdd
SNAP Retailers	USDA	Retailer
SNAP Offices	Arizona Department of Economic Security website	N/A – Compiled data using Microsoft Excel
WIC Clinics	Arizona Department of Health Services website	N/A – Compiled data using Microsoft Excel

Data obtained from ASU were accessed from an online GIS repository via the library (http://lib.asu.edu/gis/repository). This repository included files from the US Census Bureau (Income, Race/Ethnicity), as well as from Maricopa County (Arterial streets, General streets). From the US Census Bureau, files for Income and Race/ethnicity were from the 2000 Census report, and were representative of Maricopa County. These Census files were placed under two separate folders within the repository: one titled "Income", and the other titled "Ethnicity". The specific files included in the mapping process were "MaricopaIncome2000" and "MaricopaEthnicity2000", respectively.

Field data were collected manually by compiling addresses for SNAP retailers, as well as SNAP offices/WIC clinics. For the SNAP retailers, the USDA's website was used to download a specific data layer of retailers in Arizona (USDA 2011b). Locations of SNAP offices were acquired through the website for the Arizona Department of Economic Security (https://app.azdes.gov/faa/AllZipsServByEachSite.asp). Finally, the addresses of WIC clinics were taken from the Arizona Department of Health Services website (http://clinicsearch.azbnp.gov/).

GIS data for arterial streets in Maricopa County were also acquired from the ASU repository under the "Transportation" folder,

using the "MaricopaArterials" file. Arterial streets demonstrated a clearer representation of Census tract boundaries, and provided context for the size of the project area. Within Downtown Phoenix specifically, Census tract boundaries most often fall on the major, arterial streets, and these streets create a transportation grid for the entire city. In Downtown Phoenix, most of the Census tracts around the Market represent approximately one square mile of area.

GIS data for roads were also included, because they allowed for specific addresses to be geocoded. In order to map the specific locations of SNAP offices and WIC clinics, addresses and zip codes were compiled from SNAP and WIC websites into a table in Microsoft Excel, and then imported into the ArcGIS software. Once the table was included as a layer of data, a geocoding function within ArcMap automatically took the data within the Excel table, and plotted the SNAP offices and WIC clinics in reference to a data layer comprising all roads within Arizona (Azstreetsdd).

Mapping

ArcGIS software served as the primary method of organizing, mapping, analyzing, and displaying all the data. Microsoft Excel was also used to create the tables for geocoding addresses within ArcGIS. To organize and process the data, two components of the ArcGIS

software were used: ArcCatalog and ArcMap. ArcCatalog organized the data so that it could be represented within ArcMap, and ArcMap served as a tool to manipulate and display the data. Using the components of ArcGIS, as well as Microsoft Excel, allowed for the visualization of several different maps, as well as the creation of new data sources to be used by the Market. The mapping process involved several steps, including (1) the creation of separate layers of Census tract data; (2) the manipulation and illustration of varying quantities within each Census tract; and (3) the geocoding and plotting of addresses for the SNAP retailers, as well as SNAP offices and WIC clinics.

The project area included approximately a 30 square mile area around the Market. This area included Census tracts to the south of Indian School Road, the north of Broadway Road, the west of 24th Street, and the east of 27th Avenue. However, the southwest corner of the project area extended to 35th Avenue, due to the size and boundaries of that particular Census tract. These tracts were selected to incorporate a wider range of distribution for income per capita, as well as population density for minority residents. Furthermore, as most of the tracts measured approximately 1 square mile, no buffer zones were needed to illustrate traveling distance, like within the San Francisco case study. The project area for the Market includes a travel

distance of approximately five miles between the western and eastern perimeters, and approximately six miles between the northern and southern perimeters.

Creating Separate Layers – Data files for income and race/ethnicity distributions originally included all Census tracts within Maricopa County. To focus on the project's geographic section within Downtown Phoenix, it was important to select the specific tracts to be used to create boundaries for the area. Using the Selection tool in ArcMap, the necessary tracts were selected around the Market and made into a separate data layer so that only data from these tracts would be visible. The Selection tool was especially important for the race/ethnicity data layer, because each Census tract simultaneously represents all racial/ethnic groups as reported in the US Census. Thus, separate layers had to be created to delineate the population densities between the two minority groups chosen.

Illustrating Varying Quantities – Once separate data layers for the project area were created for income and race/ethnicity, the different ranges within these layers were depicted using the Layer Properties menu. For example, variances between income levels were illustrated by changing the symbology output with a gradient color scale to

associate each scale segment with a different color. In GIS terminology, this type of data representation is commonly referred to as a choropleth map.

With income specifically, it was also important to accommodate for differences in population density for each tract. To address these differences more efficiently, income levels were generated per capita to show the average annual income per person without creating additional maps to show population density. Using the Label menu for the income data layer also allowed for the population density to be included within each tract.

To show comparisons of income levels between the project area and all of Maricopa County, the possible range of income for the project area was normalized to the range for the entire county. This feature allowed income per capita within Downtown Phoenix to be representative of the potential range within Maricopa County, without including the entire county in the map display. This was accomplished within ArcMap by importing the original MaricopaIncome2000 data layer as a reference for the area selected around the Market. Thus, the ranges for income per capita represented in the maps fell within the scale of income per capita for the entire county.

For the population density of African American and Hispanic residents, it is important to note that the ranges selected do not align

categorically. This is because the total African American population was much smaller than the total reported for the Hispanic population. The highest reported population density of African Americans ranged from 504 to 840 residents, compared to the lowest range for the Hispanic population, which fell between 180 and 757 residents. If ranges for the two minority groups were normalized to reflect the same categories, the map representing the African American population would only represent the bottom two ranges. In order to create visual differences between the tracts in both maps, it was decided that the ranges would be not be normalized, and instead, be determined by the natural breaks calculated by the ArcMap software.

Geocoding and Plotting – In order to compare the income and race/ethnicity data with SNAP offices/retailers and WIC clinics, geocoding and manually plotting points on the map was necessary to visualize their specific locations. It was important to map these offices and clinics, because each serves as a location that provides services to those who qualify for SNAP or WIC assistance. Additionally, the Market found it would be beneficial to map the locations of SNAP offices and WIC clinics as a way to begin future outreach campaigns.

For the mapping process, Microsoft Excel tables were used to organize the addresses and zip codes for both SNAP offices and WIC

clinics. Once the addresses and zip codes were compiled and checked for accuracy, the table was imported as a layer file into ArcMap. To place the points on the map, a geocoding function within the ArcMap software was used to match the SNAP/WIC addresses and zip codes within the table to actual streets within the map. Using a similar process with the income data, the Symbology menu within ArcMap provided an opportunity to change how the SNAP/WIC locations were represented visually.

With the data for SNAP retailers, the mapping process involved manually plotting the locations of each address, and attaching factual information for the names and types of retailers. This step was completed by hand, because the data layer for SNAP retailers was originally acquired from the USDA website (USDA 2011c), and could not be edited further to reflect the names and/or types of retailers for each location. Using the Editing toolbar, a new data layer of SNAP retailers was created by manually plotting the specific points of retailers over the existing locations provided within the USDA layer. When a new point was added over an existing SNAP retailer location, information reflecting the name and type of each retailer was added. Once all of the locations were plotted, the original USDA data layer was removed, leaving the newly added SNAP retailers available for analysis. Symbology was again used to differentiate the types of SNAP

retailers, representing each category with a different color and/or shape.

CHAPTER 5

RESULTS

Due to the number of variables represented in the data layers, numerous maps were created to better understand the population surrounding the Market. The base layers of the maps represented demographic data, such as income per capita, the population densities of African American and Hispanic residents, as well as SNAP retailers and SNAP offices/WIC clinics.

The ArcGIS software allowed for a multitude of data combinations that illustrated not only the demographic makeup of the Downtown Phoenix area, but also the presence or absence of certain categories of food retailers. Most importantly, the maps addressed the three questions provided by the Market: (1) what is the demographic makeup of the surrounding community? (2) What retailers around the Market also accept food security vouchers? And (3) where are food security offices (SNAP and WIC) located within the area?

Definitions

During the mapping process, it became apparent that SNAP retailers in the Downtown Phoenix area needed further definition and analysis. Table 1 illustrates five categories of SNAP retailers that were mapped with their corresponding definitions. The categories

included convenience stores, major and small grocery stores, and liquor stores. In regards to liquor stores, it is important to note that SNAP vouchers cannot be used towards the purchase of liquor. However, it is important to include liquor stores in the analysis, because they also sell food items that can be purchased with SNAP vouchers.

Table 2. Definitions of SNAP Retailers within Downtown Phoenix.

Category	Definition
Convenience	A retail location that provides on-the-go or pre-packaged food and beverages, normally connected to another type of service, like a gas station. (i.e. Circle K, 7-Eleven)
Grocery – Major	A retail location that is associated with a state, regional, or national chain that provides a wide variety of food and beverage options. (i.e. Safeway, Basha's)
Grocery – Small	A retail location that operates as a small, sometimes family-owned business that is not associated with a state, regional, or national company chain. May also include ethnic grocery stores that supply specific types of food and beverage options.
Liquor	A small retail location that provides an assortment of alcoholic beverages: beer, wine, liquor, etc. May also contain similar food and beverage options to Convenience stores.

Income

The first set of maps created for the Market illustrated trends in income per capita within the surrounding area (Figure 3). While varying levels of income were illustrated in the project area, the highest annual income represented a range between $23,665 and $34,098 per person. Within the Census tract that the Market is

located, the average annual income for residents in 2000 was between $15,113 and $23,664. The area to the southwest and southeast of the Market represented up to $15,113 for average annual income per capita. To the north, two tracts near the Market illustrated the highest range of annual income per capita between $23,665 and $34,098.

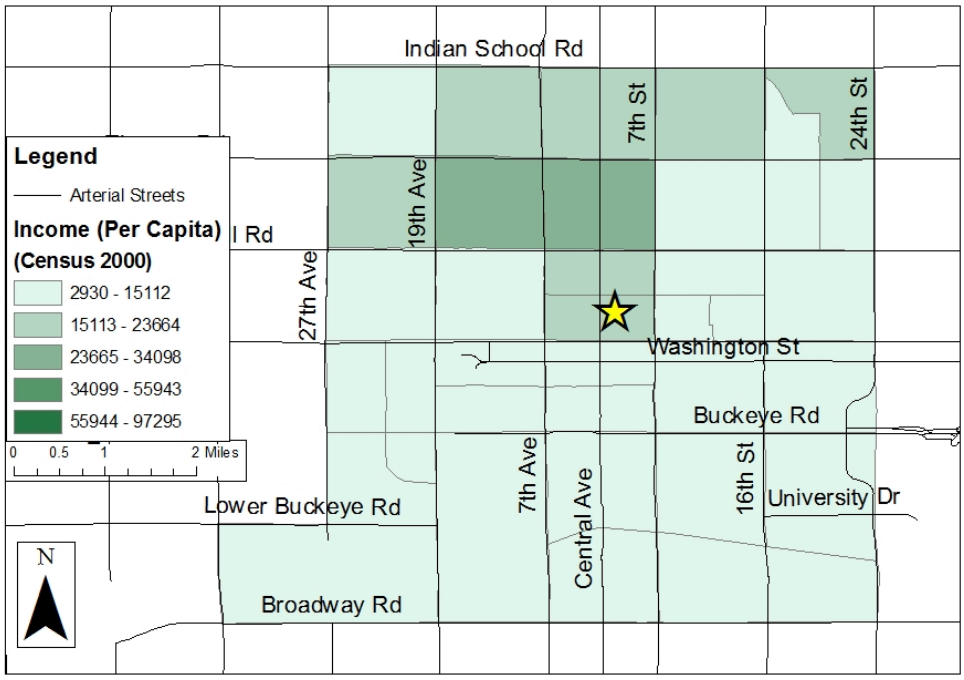

Figure 3. Distribution of income per capita within Downtown Phoenix (2000).

Overall, the map illustrates that the Market is located within an area characterized by low-income. The Census tracts represented by the lightest shade of green also indicate income that is below the poverty threshold, an economic indicator also determined by the US Census Bureau. The poverty threshold for 2000 was reported at

$8,794 for individuals and $13,738 for households with three individuals (US Census Bureau 2010). It is important that the threshold for 2000 is referenced, because the distribution of income in the maps also represents Census data from 2000. Further illustrations of trends in income per capita are featured in the analysis of SNAP retailers.

Race / Ethnicity

Two maps were created to represent trends in race/ethnicity of minority populations residing around the Market. The first map illustrated the population of African Americans in 2000 (Figure 4). Between 122 and 287 African Americans resided within the Market's specific Census tract. At the very northern section of the project area, the population of African Americans ranged between 288 and 503. However, to the east, south, and west of the Market, the population density for each tract indicated a wide range from 3 to 55 residents up to 504 to 840 residents.

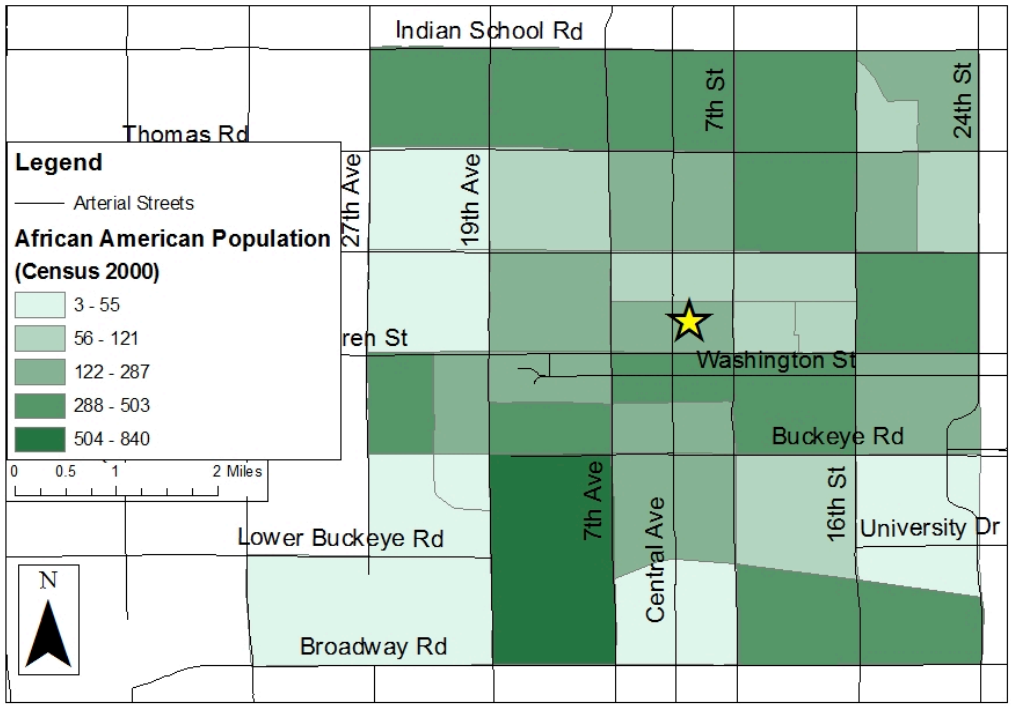

Figure 4. Distribution of the African American population within Downtown Phoenix (2000).

The second map for race/ethnicity illustrated the population density of Hispanic residents for 2000 (Figure 5). In the same Census tract as the Market, the lowest range of population density was represented at 180 to 757 residents. However, both of the tracts to the west and east of the Market represented much higher ranges: 3220 to 5495 residents in the western tract, and 2260 to 3219 residents in the eastern tract. South to the Market's location, the Hispanic population between Washington Street and Broadway Road generally ranged within the middle three categories, inclusive of 758 to 3,219 residents. A few exceptions within the southern area represent population ranges between 180 and 757 Hispanic residents.

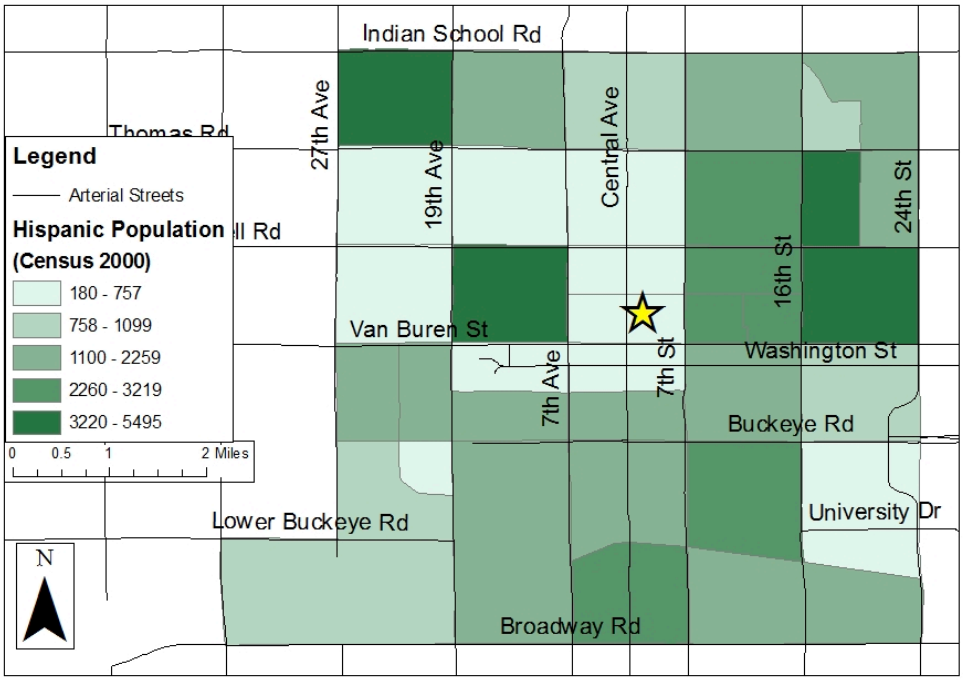

Figure 5. Distribution of the Hispanic population within Downtown Phoenix (2000).

SNAP Retailers

The next set of maps created for the Market illustrated the specific locations of retailers that accept SNAP vouchers. To compare retailers alongside Census data, income per capita, and the population density of African American and Hispanic resident served as base layers underneath the locations of SNAP retailers. This provided an opportunity to see if trends in income or race/ethnicity held any spatial relationship with the locations of SNAP retailers.

Additionally, the type of SNAP retailer was represented by creating separate layers and symbology for each of the four categories defined above: convenience stores, major and small grocery stores, and liquor stores. Each category was mapped in relationship to income per capita and the population densities of African American and Hispanic residents. However, similar trends were observed in both minority groups. Thus, for organizational purposes only the analyses for the Hispanic population are described in this section. Maps showing the trends for the African American population are included in the Appendix.

Income – The first subset of maps within this section illustrated the distribution of annual income per capita in relation to the location of SNAP retailers. The Market serves as one of these retailers, and is

located within a Census tract that represents an annual income per capita range between $15,113 and $23,664. Figure 6 shows the distribution of convenience stores layered over income per capita. The overwhelming majority of these retailers are found on arterial streets, or in the intersection of arterial streets. A trend in ownership was discovered within the convenience store locations. Out of the 109 convenience stores, Circle K accounted for the highest rate of ownership with about 21% of the retailer locations.

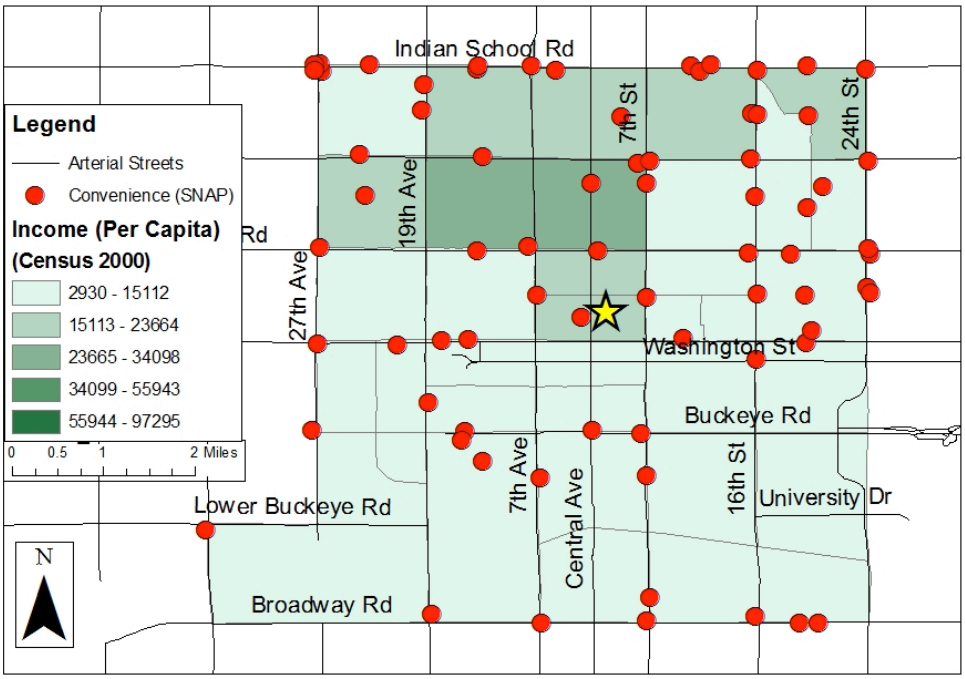

Figure 6. Distribution of convenience stores (SNAP) and income per capita within Downtown Phoenix.

Figure 7 shows the spatial relationship between annual income per capita, small and major grocery stores, and liquor stores. This is perhaps the most striking of all the maps, because it depicts a visual

correlation between income per capita and the presence or absence of major grocery stores. Of all the grocery stores mapped, only six locations were considered major stores, and the rest were considered small, family-owned, or ethnic stores. Five of the six were found within or on the periphery of Census tracts representing higher income per capita, ranging from $15,113 to $34,098. The small grocery stores were most commonly located proximal to the lowest category of income per capita, from $2,930 to $15,112.

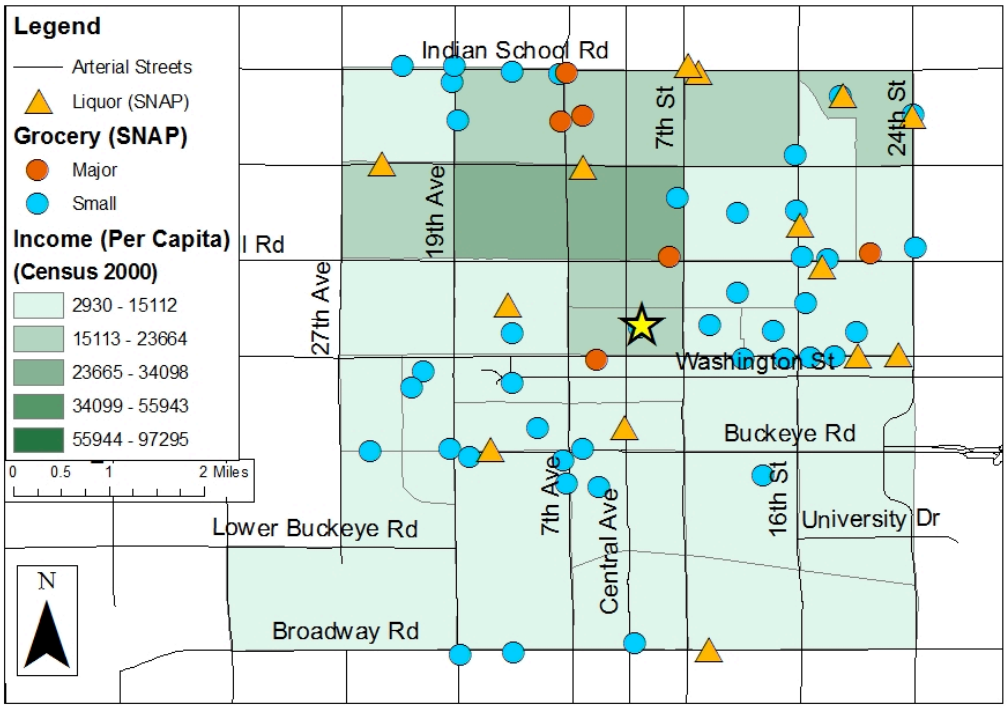

Figure 7. Distribution of grocery and liquor stores (SNAP), and income per capita within Downtown Phoenix.

Figure 7 also illustrates income per capita in relation to location of liquor stores. As the map shows, liquor stores were more commonly

present in Census tracts representing the lower two income per capita ranges.

Hispanic Population – The final subset of maps examined the spatial relationship between the location of SNAP retailers and the population density of Hispanic residents in Downtown Phoenix. Figure 8 illustrates the location of major and small grocery stores, as well as the location of liquor stores. As the map shows, the placement of major grocery stores were more likely to fall within Census tracts representing lower population ranges for Hispanic residents. Two out of the six stores fell within tracts reporting between 180 and 757 Hispanic residents. The other four were located within two categories ranging from 758 to 2259 total Hispanic residents.

Figure 8 also shows that small grocery stores tended to fall within Census tracts that represented a higher population density of Hispanic residents. Small clusters of these stores are located within tracts representing between 1100 and 5495 Hispanic residents. As small grocery stores were plotted, a relationship was found between the names of the stores and the population density of Hispanic residents. For tracts reporting higher population ranges, the names of some of the stores tended to be in Spanish, using words like "mercado" or "carniceria" in the title.

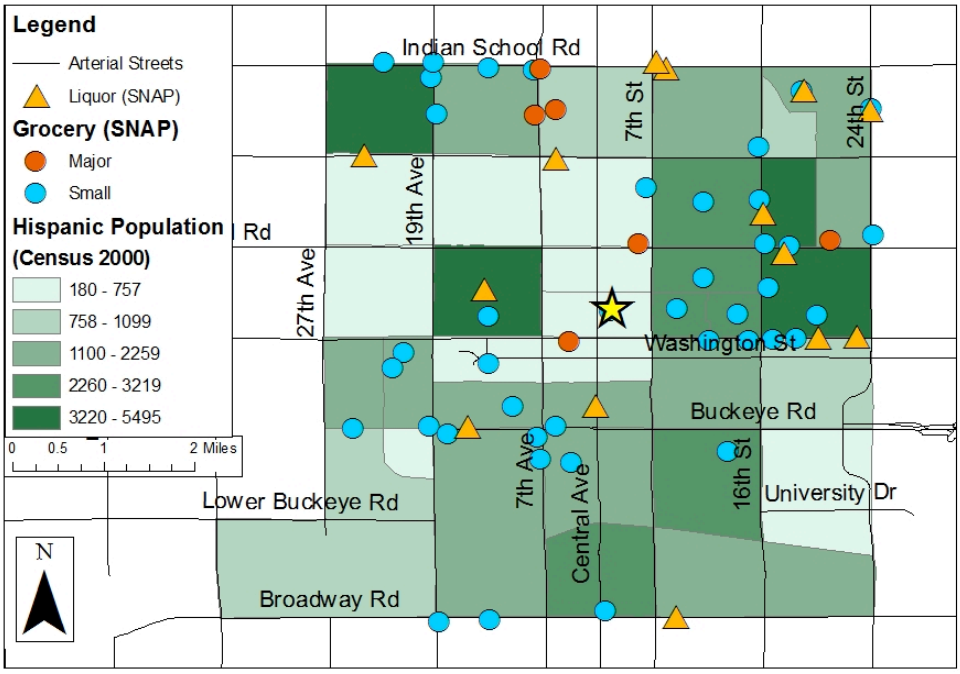

Figure 8. Distribution of grocery and liquor stores (SNAP), and the Hispanic population within Downtown Phoenix.

Finally, Figure 8 also illustrated the relationship between the Hispanic population and the presence of liquor stores. As the map indicates, the locations of liquor stores were more likely to be within or proximal to Census tracts representing higher population densities, which ranged from 1100 to 2259 Hispanic residents.

SNAP Offices / WIC Clinics

The final set of maps created for the Market examined the distribution of demographic characteristics in relationship to locations of SNAP offices and WIC clinics.

Income – Figure 9 illustrates the locations of SNAP offices and WIC clinics, as well as the distribution of annual income per capita. This map illustrates that only one SNAP office it is included within the project area. This office is located within a Census tract representing the lowest income per capita range ($2,930 to $15,112). Two WIC clinics were also included in the project area, and were similarly located in the same income per capita range.

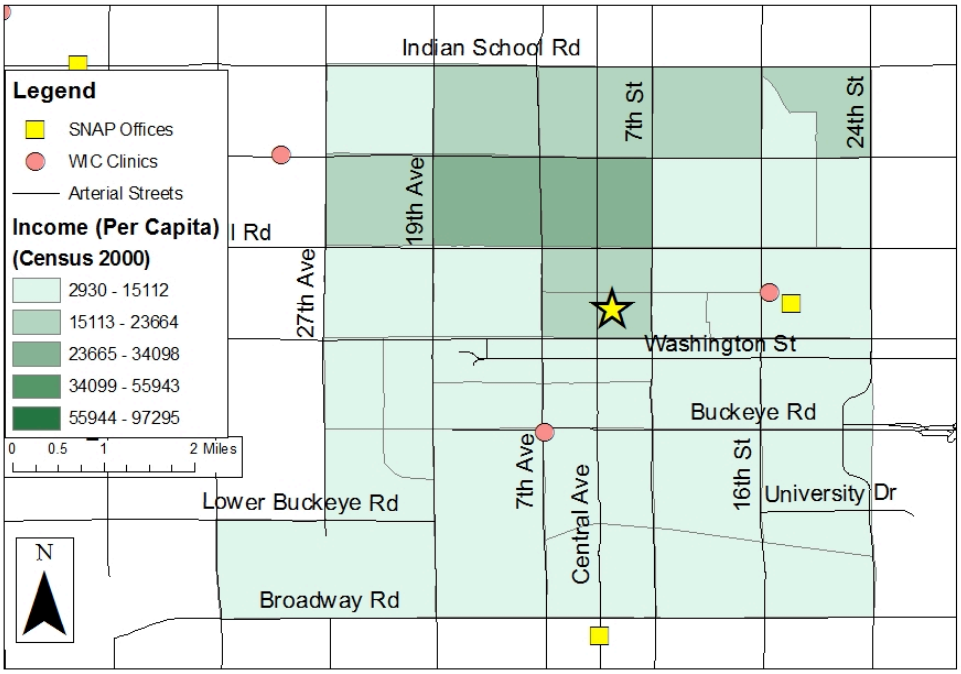

Figure 9. Distribution of SNAP offices/WIC clinics and income per capita within Downtown Phoenix.

Hispanic Population – Figure 10 illustrates the locations of SNAP offices and WIC clinics in relationship to the population density of Hispanic residents. The only SNAP office in the project area is located within a Census tract representing a population range between 3220 to

5495 Hispanic residents. For the two WIC clinics in the project area, one location fell within a tract reporting 1100 to 2259 Hispanic residents, while the other was located within a tract reporting 3220 to 5495 residents.

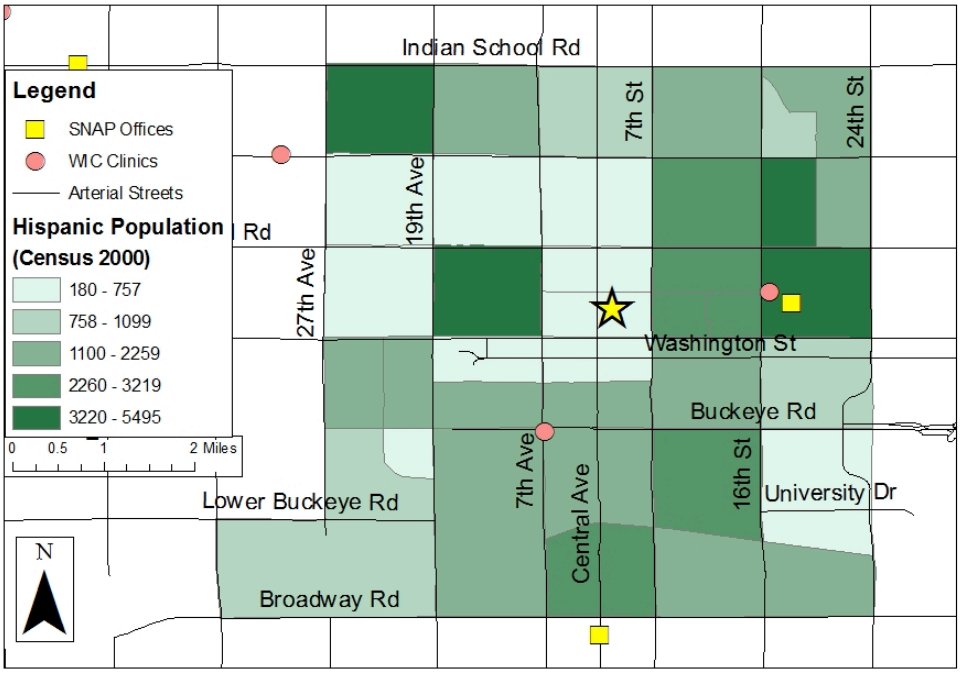

Figure 10. Distribution of SNAP offices/WIC clinics and the Hispanic population within Downtown Phoenix.

CHAPTER 6

DISCUSSION

With greater knowledge of the surrounding community, the Market will be able to identify areas of need where food security outreach efforts could best be implemented. As the maps illustrate, the Market is located in an area characterized by low-income populations that could potentially qualify for food security assistance. Race/ethnicity data, as well as the distribution of food retailers, also illustrate characteristics of the Downtown Phoenix community, and provide the Market with greater context of their role within the environment. The Market will be able to further develop their strategic planning efforts with these maps, and raise awareness of their location and service to Downtown Phoenix.

The creation of these maps not only illustrate the importance of the Market, but also serve as an example of the potential applicability of CBPR and PPGIS methods in food security research. Creating the partnership between Arizona State University and the local community further emphasizes the reciprocal relationship possible between these two parties. As the project introduced access to GIS technology and data, the Market was able to contribute the purpose for conducting research, and knowledge of the networks and history of food security in the area.

To gain more knowledge about food security in Downtown Phoenix, GIS was successfully applied as a research tool to understand the demographic and food environments in which populations of need exist, as well as the type of food options they can access on a daily basis. While the mapping of specific food retailers may not imply actual usage of these locations, the GIS process allowed for the generation of greater knowledge of potential areas for intervention. Furthermore, mapping methods provided a way to better inform the mission and vision of the Market, and expanded the application of GIS technology beyond "counting grocery stores," and towards a tool to assess and improve program effectiveness and support future funding applications.

The Market's ability to serve populations qualifying for food security assistance is part of a greater context and shift towards valuing local and regional food systems. By providing farmers markets with funding to support food security vouchers, the USDA has played a key role in this shift, making fresh, local food more accessible to populations in need. It is within food security programs, such as SNAP, WIC, and FMNP, that economic barriers to healthy and local food options can be overcome by providing low-income individuals and households with financial assistance.

The shift towards local food production also ties food security issues to the broader goals of the food sovereignty movement. Because transnational corporations and trade agreements influence the trajectories of food on a global scale (Patel 2007), decisions are being made at that same scale on how food is grown, processed, and distributed. Moving the locus of food production to local and regional environments allows organizations like the Market to directly influence the availability of healthy food options that can contribute to greater community food security.

It is at this point where CBPR and PPGIS methods have the potential to change the food security status quo: by shifting the decision-making process from global-scale powers to local communities and neighborhoods. As a result, current trends in hunger (Nord et al. 2010) and obesity (Flegal et al. 2010) can be addressed through the use of GIS technology for community empowerment to address issues of food security and public health.

Recommendations to the Market

In the final stage of the CBPR process, the results of the mapping project will be shared with the Market in order to generate recommendations for the future. Based on the original research

questions, the following recommendations will be presented to the Market.

The first recommendation was to utilize the maps to support future funding applications, such as grants and/or donor support. The maps illustrated that low-income populations characterized the area surrounding the Market. These data justify its location as appropriate to fulfill their mission to "increase access to fresh, healthy foods in an underserved area (Phoenix Public Market 2011)." The maps also showed that major grocery store retailers that accepted SNAP vouchers are scarce within tracts reporting higher minority populations. This could provide an opportunity for the Market to focus on the food security needs of minority populations specifically.

Recommendations also included next steps for outreach efforts to be made within the Downtown Phoenix community. As the final set of maps indicated, the locations of SNAP offices and WIC clinics were identified within tracts reporting low-income and higher minority residents. Thus, these locations should be included as part of the initial outreach process, because SNAP offices and WIC clinics could provide guidance and links to identify important areas for intervention. Additional community focal points to be considered in the Market's outreach efforts include schools, places of worship, and other health clinics.

The final recommendation was to maintain a partnership with ASU to continue this type of analytical efforts. A number of graduate students at ASU have interests in food security research and GIS technology, which may benefit the future research needs of the Market. In doing so, the university-community partnership would be further sustained, and would allow the Market to continue exploring their role within Downtown Phoenix.

Future Research

Food Sources and Public Transportation – As a recommendation to the Market, further research should be conducted to fully understand the demographic and food environments within Downtown Phoenix. While the mapping of SNAP retailers illustrated available food options for those qualifying for assistance, it is important to recognize that these are not the only locations where food is obtained. Further research within the project area should include the availability of additional food sources, such as fast food, restaurants, and emergency food providers. Public transportation routes should also be explored in future research, which would illustrate the influence of mobility on food access. This would be particularly informative, since the southern portion of the project area does not have access to the Light Rail, and instead utilizes the Valley Metro bus system.

Race/Ethnicity – To evaluate shifts in the characteristics of the Downtown Phoenix population, the analysis conducted in this project should be replicated using the 2010 Census data. Compared to the 2000 data used for this project, trends could also be analyzed between the two years, and the Market would be supplied with a more accurate depiction of the project area.

Further research should also examine the spatial relationship between population densities of minority groups and the proximity and number of SNAP retailers. As some of the maps illustrated, some types of retailers, such as liquor stores and small grocery stores, tended to be in closer proximity to Census tracts reporting higher minority populations. For liquor stores, future research should include other SNAP retailers that also sell liquor, such as the grocery and convenience stores. Future analysis of race/ethnicity distribution could also examine the relationship between minority populations and the locations and utilization of SNAP offices and WIC clinics.

Economic Viability – One final consideration for future research would be to examine the economic viability of the Market in comparison to other SNAP retailers. It would be important to know this information, because geographic barriers between populations and the Market are

not the only hindrances that could affect its utilization as a food source. The prices of food options at the Market would have to compare to other retailers. In order to examine this information through GIS, a random sample could be collected from all of the SNAP retailers within the project area. Researcher(s) can conduct price surveys of each item of a basic "food basket" including a list of the most common food items (e.g., milk, bread, cheese, chicken, and tuna) from each retailer within the sample. These data could also be mapped when combined with geographic references, allowing for spatial analyses examining the relationships between prices of entire food baskets, or specific items within the list. Furthermore, the use of mixed methods, such as interviews or focus groups, could provide qualitative analysis of the Market's viability.

Limitations

During the data acquisition process, two sources of information were not available within the timeframe: 2010 US Census data, and data for health indicators within Downtown Phoenix. Due to the fact that this project was conducted prior to the release of the 2010 Census report, data used to create the maps represents demographics reported in 2000. Once the 2010 data are published, the analyses could be

easily repeated by adding the new data to the mapping file, keeping all other layers of data intact.

Access to data for obesity, diabetes, and heart disease was not obtained within the timeframe, due to regulatory barriers common in government management of data. Although government agencies compile and manage data efficiently and effectively, the data are managed by multiple agencies. Thus, the navigation between departments and various offices can prove to be a cumbersome process. Following the feedback loop method within CBPR, a discussion was held with the Market to reprioritize the data needed for the project. It was recommended that both the 2010 Census and health indicator data be considered for future research projects.

The use of 2010 Census data would update the current maps for greater accuracy, and better inform the Market's strategic planning efforts. Health indicators could complement spatial analysis regarding income levels and minority populations, as well the proximity and presence of different types of SNAP retailers. In doing so, the Market would be able to examine additional variables within the surrounding community, and develop more informative strategies to address issues of food security and public health.

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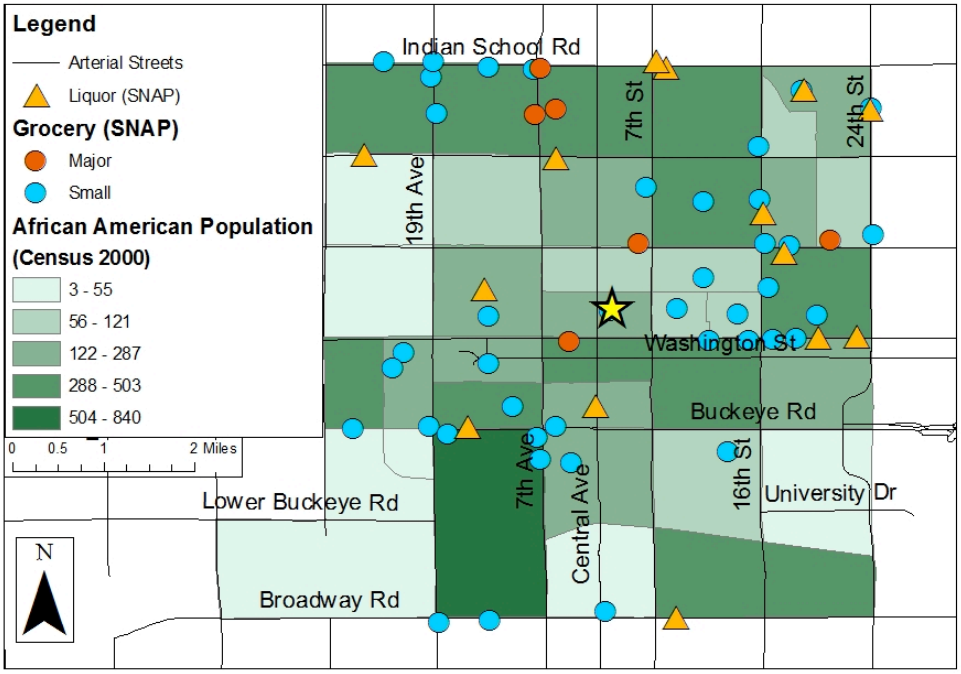
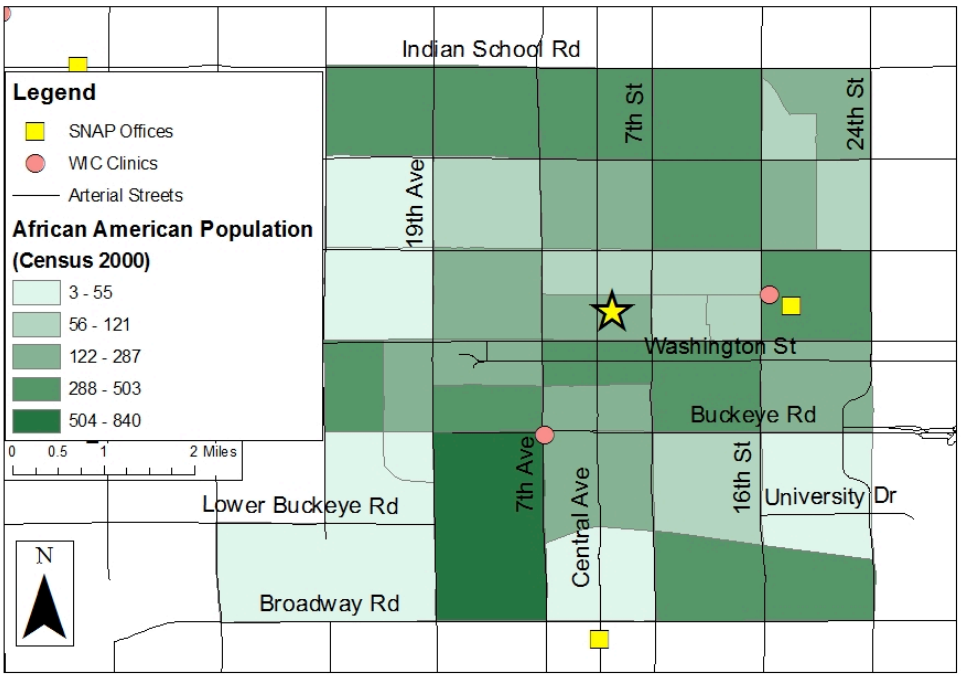
APPENDIX A

ADDITIONAL MAPS



Distribution of grocery and liquor stores (SNAP), and the African American population within Downtown Phoenix.



Distribution of SNAP offices/WIC clinics and the African American population within Downtown Phoenix.

BIOGRAPHICAL SKETCH

I was born and grew up in West Virginia – a state increasingly known for its high rates of obesity and systemic poverty. Seeing these issues double as regional stereotypes, I decided to pursue research in the field of food sovereignty as an avenue for community empowerment and social justice. This research, thus, finds its genesis in the foothills of the Appalachian Mountains, and is written for communities and organizations wishing to better understand the food environments in which they live.

Brooke Rawson, 2011