

“Out of the frying pan and into the fire? Urbanization and Sustainable Food Systems in Accra, Ghana”

Author: Anna Carla Lopez-Carr

Affiliation: San Diego State University, Department of Geography

Abstract: Swelling urban populations over the past twenty years have accompanied unprecedented growth in the number of undernourished urban households. This study integrates survey and remote sensing data to map the distribution of food insecurity in Accra, Ghana and to determine significant predictor variables associated with emergent geographic patterns. The results suggest that food spaces play a critical role in building not just sustainable cities but also sustainable *neighborhoods*. With all the world’s net population growth occurring in the poorest cities in the coming decades, tailoring food programs accordingly might represent a successful component of more nuanced and effective urban development policies.

** Anna Lopez-Carr’s paper was awarded an Honorable Mention in the “Places We Live” research paper competition held by the International Housing Coalition (IHC), USAID, The World Bank, Cities Alliance, and the Woodrow Wilson Center’s Comparative Urban Studies Program (CUSP).*

Introduction

Global hunger afflicts nearly one billion of our Earth's population (FAO, 2009). In addressing this vast problem, hunger, famine, and food security scholars target rural communities reliant on subsistence farming or agriculture-related livelihoods (Kracht and Schultz, 1999). Following this body of literature, poverty and failing agricultural systems, poor governance, ailing economies, conflict, and natural disasters are recurrent themes. While the majority of people facing acute hunger and poverty are indeed rural, the current research focus on this population belies unprecedented urbanization unfolding across the global south. For the first time in history, most humans live in cities. Nearly all of the world's urbanization is occurring in developing countries. The vast majority of *that* growth is in the world's poorest cities and the share of urbanization attributed to the world's poorest is accelerating. The urban hungry can no longer be discounted.

What proportion of the world's food insecure is urban? And how vulnerable to hunger are they? We simply don't know. Research addressing *urban* food security is confined almost entirely to the North American continent. And yet a stroll through any African or Asian city would immediately convince any reasonably sentient observer of the urgency of urban poverty, disease, and food insecurity. This exploratory research on food security in urban West Africa responds to the paucity of studies on urban food security. This paper seeks to identify the influencing factors of urban food insecurity, and whether they can be differentiated in their "urban-ness" from variables traditionally discussed in the (predominantly rural) food security literature.

A review of the literature reveals the complexity threading through extant food security measures and conceptual frameworks. Understanding how diverse variables

interact with each other from both a supply *and* demand food security perspective requires ponderous data and computing power. But the review of the literature also reveals a conspicuous absence of frameworks and measurements specifically designed for urban communities in developing countries. The discrete, underlying assumption is that urban dwellers are simply better off in terms of health and nutrition than their rural counterparts. The pervading *rural bias* in the food security literature has left this question unanswered for far too long.

The conceptual framework developed for this research takes into account the characteristics of an urban environment: a high degree of economic informality; reliance on a system of monetary exchange for food; the need to navigate crowded and busy urban spaces to reach food markets; and the need for women, the primary caregivers, to balance economic livelihoods and domestic responsibilities within non-traditional social structures.

This study measured household food security using a logistic regression model derived from data in the Women's Health Survey in Accra (WHSA)¹. *Food security*, the dependent variable for this study, is defined as: *when all people, at all times, have physical, social and economic access to sufficient, safe and nutritional food that meets their dietary needs and food preferences for an active and healthy life* (FAO, 1996). A household reporting adequate amounts of food over the past twelve months was considered food secure. If a household did not consistently have sufficient amounts of foods, then it was labeled food *insecure*.

¹ The Women's Health Study of Accra (WHSA), conducted in 2003, is a population-based cross-sectional survey assessing the burden of illness in adult women residing in an urban environment. See Duda et al, 2007.

The conceptual framework suggests that in urban areas, household food access and utilization are largely managed *vis a vis* a series of constraints. These constraints, based largely on thematic clusters in the literature, are ordered in the following categories: *Socio-economic, Home Environment, Urban Neighborhood Environment, and Health and Wellness* (Lopez, 2009). Table 1 presents important predictor variables derived from the literature and contained within each conceptual rubric. A weighted combination of these variables will determine a household’s access and utilization, assuming constant food supply².

Table 1. Food Security Constraints and Relevant Predictor Variables

Socio-Economic	Home Environment	Urban Neighborhood Environment	Health and Wellness
Education	Home infrastructure	Land cover (from satellite)	Self reported overall health
Income	Crowding	Food market availability	Non-communicable disease
Ethnicity	Plumbing facilities		Communicable disease
Language	Waste collection		Caring practices
Gender			

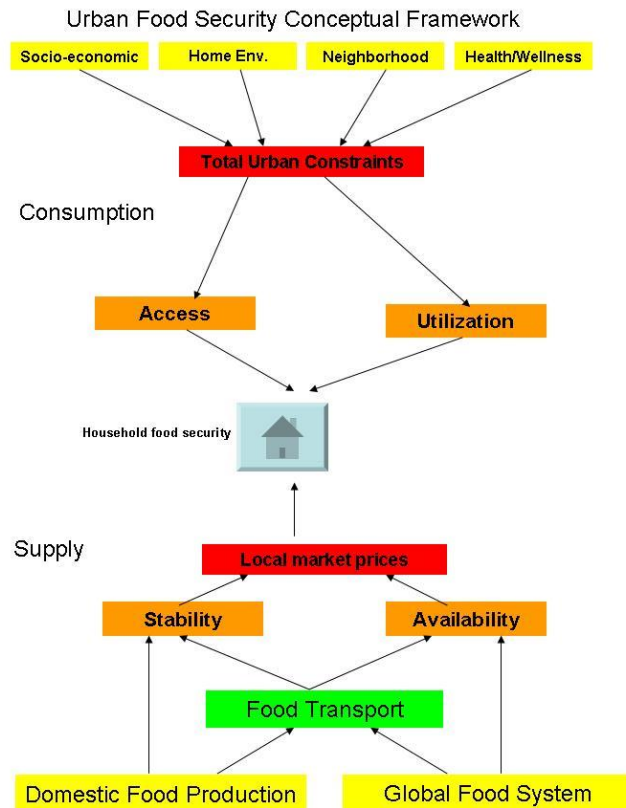
Figure 1 represents a heuristic of this conceptual framework. Urban food supply converges with household (or individual) access and utilization, given endogenous and exogenous factors. When both supply and demand intersect at the desired level, urban households become food secure. When, conversely, observed demand is less than desired demand, due to a combination of the identified constraints, households remain food

² Rarely do cities undergo famines or lack of food, making food security mostly an access and distribution issue. Under normal circumstances, even the poorest urban centers tend to act as food hubs, regardless of the food situation in rural parts of the country. Exceptions include natural and man-made disasters which may interfere with the regular supply chain.

insecure. The underlying concept is that of *unmet needs*, as developed intensively in the family planning literature (Westoff and Bankole 1996).

The goals of this paper are twofold. First, it seeks to explore the *intra-urban* differences in food security in West Africa, one of the most rapidly urbanizing areas of the world. In particular, it investigates the geographical distribution and causal factors of food insecurity in Accra, Ghana. Second, it aims to identify which urban factors most influence household food security. Satellite data and Geographic Information Systems (GIS) are coupled with survey and in-depth household interviews to explore these questions. Combining different types of data into one geo-database allows insights into the state of food security *within* urban populations in developing countries and into the underlying spatial patterns and socio-economic, environmental and spatial predictors.

Figure 1. Urban Food Security Conceptual Framework



Materials and Methods

Study Site

The study is focused on the urban area known as the Accra Metropolitan Area (AMA) (Figure 2), the most densely populated and urbanized area of the Greater Accra Region. AMA is the capital city of Ghana, a West African country located on the Gulf of Guinea near the intersection of the equator and the Prime Meridian. The city area is measured at 185 km², while the entire metro area takes up 200 km². According to the Ghana 2000 Census, AMA is currently home to circa two million people, with a growth rate of 3 percent, and a population density close to 10,000 people per square kilometer. By the year 2020, over 3 million people are expected to live in Accra (UN Population Division, 2008). Though Accra is the heart of economic and political activity in Ghana, nearly 70 percent of the city's population resides in slum-like conditions, without access to basic services such as water, sanitation, and health care (Weeks et al, 2007).

Figure 2. Accra, Ghana. (Sources, Google Earth 2008; and Digital Globe 2002)



Thirty major food markets are located within AMA, of which ten supply approximately 80 percent of the city's food needs (Lardemelle, 1996). Outside of the formal market setting, countless food traders roam the streets of Accra hawking fresh fruits and vegetables, processed foods (or *provisions*), or small snacks prepared at home. Relative ease of entry into the informal food market makes food vending a popular trade for Ghanaians living in Accra. Woman account for over 90 percent of food traders in the city and are heavily

involved in the urban food system from the farming and wholesaling of products to retailing to the urban consumer (Lardemelle, 1996). MaxMart, Koala, and Shoprite, are the three major AMA supermarkets, catering primarily to wealthy Ghanaian families or the expatriate community. The majority of people in Accra buy their food at local open-stall markets such as Makola Market and Kaneshie Market, from small retailers of dry goods, and from street vendors. While food is relatively abundant in Accra, price increases on basic staples have made it harder for low-income families to meet their food needs in terms of both quantity and quality of diet. Additionally, much of the infrastructure upon which the food system relies has become congested, outdated, or dilapidated.

Survey data show that nearly 4 percent of the population in the Greater Accra region is underweight, and that 11.5 percent, 7.5 percent, and 11.4 percent of children in the same area are underweight, stunted, and wasted respectively (GSS, 2004). Nearly 65 percent of children consume an inadequate amount of Vitamin A, and another 60 percent are lacking sufficient quantities of iodine (UNICEF, 2007). The average life expectancy for Ghanaians at birth is 59 years (UNICEF, 2007), a level not seen in the United States since the 1930s.

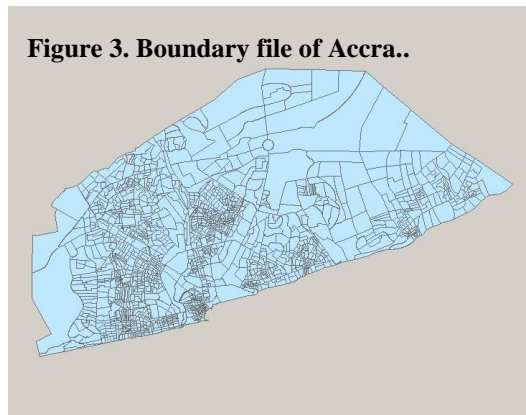
Data

Data for this analysis come from three sources: (1) GIS data; (2) population data; and (3) remote sensing data (Table 2).

Table 2. Data sources.

GIS Data	Population Data	Remote Sensing Data
Accra boundary file including all 1724 enumeration areas (EAs)	2003 Women's Health Study of Accra individual/household and EA level data	2002 Digital Globe Quickbird Satellite Imagery. 2.4m resolution
	2007 In-depth HH interviews	

A shapefile is a digital geometric representation of geographic objects and features that is compatible with GIS software. This study used a shapefile of Accra that was developed at San Diego State University in 2004 (Figure 3). All 1724



Enumeration Areas (EAs), or census blocks, of the Greater Accra Metropolitan Area identified in the Ghana 2000 Census were represented, geo-referenced, and available in digitized format in preparation for GIS analysis.

The richest source of health data for Accra comes from Harvard University's 2003 Women's Health Study of Accra, (Duda et al, 2007). Data were collected from 3,200 women aged 18 and older between April and July 2003 and provide self-report health data, data from a clinical examination and laboratory work, as well as data on the household's facilities matched to the census of 2000. To obtain a representative sample for the WHSA, EAs were first stratified into four quartiles representing different levels of socio-economic status. Household facility indicators and education were used to measure Socio-economic (SES) levels. The result was a representative sample of 200 non-contiguous, occupied EAs with an average of 959 people residing in each. Overall, a total

of 3175 Ghanaian women, age 18 and older, were interviewed with a privately conducted household survey (HHS) that included questions for self-reported illnesses, reproductive history, and health practice. The survey includes a section which is dedicated specifically to food security and the food consumption patterns of the women surveyed. While limited, information derived from this portion of the survey was used to describe both the quantity and quality of diets and made possible the extraction of a “food security” dependent variable. To maintain privacy, the location of each household in the survey is geo-referenced to the census EA-level.

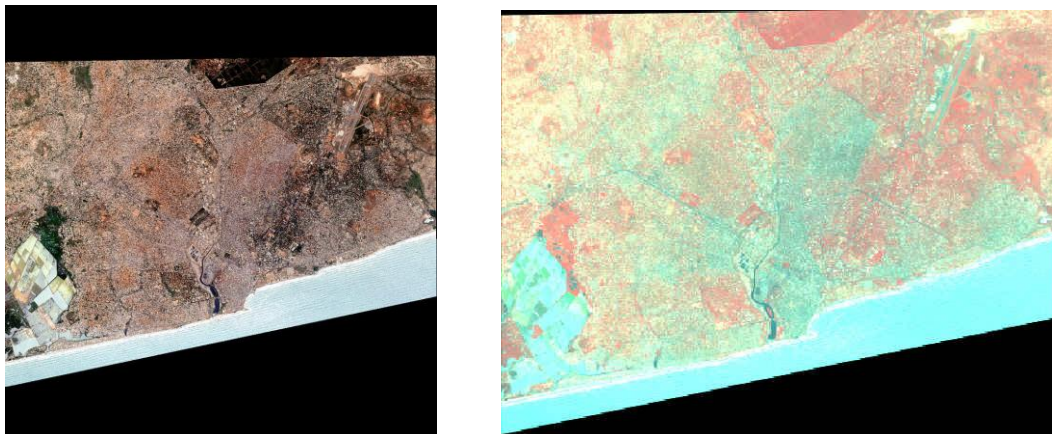
Household interviews were undertaken during the months of August, September, and October, 2007 in Accra, Ghana. A total of thirty women (approximately 10 from three different neighborhoods) were interviewed. Women were asked a suite of questions covering the four sub-categories of the conceptual model. Questions under these four categories were designed to complement information in the WHSA which lacked sufficient depth in its Food Security section. None of these areas was addressed in the WHSA and yet they are key to contextualizing the research questions. Answers were organized by neighborhood and compared for similarities or significant differences. Neighborhood level predictors were of particular interest and recorded. New information was collected from the qualitative survey which helped interpret data supplied by the quantitative survey.

An important aspect of this research was the use of urban satellite imagery to quantify compositional aspects of the urban environment. Imagery can be useful in providing information on land-cover (basic components on the ground) and land-use (industrial, residential, public space, etc). A high spatial resolution (2.4 meter) multi-

spectral (four bands—blue, green, red, and near infra-red) Digital Globe Quickbird satellite image (Figures 4 and 5) of the Accra metropolitan area (acquired on 12 April 2002 on a cloudless day) was used for the remote sensing analysis along with a 0.6 meter resolution panchromatic image taken at the same time. The multispectral image is of sufficiently high resolution that a high degree of accuracy can be obtained with a “hard” land cover classification (Strahler et al, 2006). The imagery covers 86 percent of the 1724 enumeration areas. Coverage encompasses the western portion of the city, thus limiting the remote sensing analysis for the eastern part of the city. Results for the remote sensing analysis are therefore not representative of all Accra.

In classifying the data by land cover, Ridd’s (1995) V-I-S (vegetation, impervious surface, soil) model was applied to the high resolution imagery available for Accra. Ridd (1995) devised this method for land cover fraction mapping for urban areas. His work was based on research that explained that the dominant “building blocks” or materials of

Figures 4 and 5. 2002 Quickbird imagery in true color (left) and false color (right).



urban areas are vegetation, impervious surface, and soil. By extracting the proportional presence of each of these types of surface materials, he could estimate the different types of land-use occurring within a city. An area comprised entirely of soil, for example, may

be considered a desert or non-inhabited area. However, if an area were to be composed of mostly soil *and* impervious surface, it could indicate an industrial park in a developed country or a low-income housing neighborhood in a developing country.

Vegetation, impervious surface, and bare soil were used as independent variables in this study. These remote sensing variables were tested under the Neighborhood Environment category of the conceptual model. The V-I-S components were aggregated at the EA level.

Spatial and Statistical Analysis

Data were mapped in ArcGIS 9 (ESRI, 2004) to food insecurity in proportional abundance at the EA level. Moran's I (1950) and Local Indicators of Spatial Autocorrelation (LISA) were then calculated and mapped in GeoDa 0.9.5 (Anselin, 2004) to examine patterns of spatial autocorrelation of food security. Like temporal (serial) autocorrelation (or correlation in time), *spatial* autocorrelation means that adjacent observations of the same phenomenon are correlated in (two-dimensional) space. Spatial autocorrelation has greater complexity than temporal autocorrelation because the correlation is both two-dimensional and bi-directional (Geary, 1954). It can be used to identify local clusters (regions where adjacent areas have similar values) or spatial outliers (areas distinct from their neighbors). Because the data consist of a sample of EAs and not the entirety of the units which comprise the map of Accra, a technique called Bayesian smoothing was applied to fill the "empty spaces" on the map. In other words, values were given to non-sampled EAs to assess their risk of food insecurity. Bayesian smoothing has been used extensively in disease mapping (Cressie, 1992). The algorithm

works by predicting the probability of an event occurring in a non-sampled area by manipulating the observed rates of that event in neighboring areas (Cressie, 1995). This normal or Gaussian model is heteroskedastic and spatial, with parameters that are estimated using restricted maximum likelihood. The result is a map where every areal unit has an assigned probability.

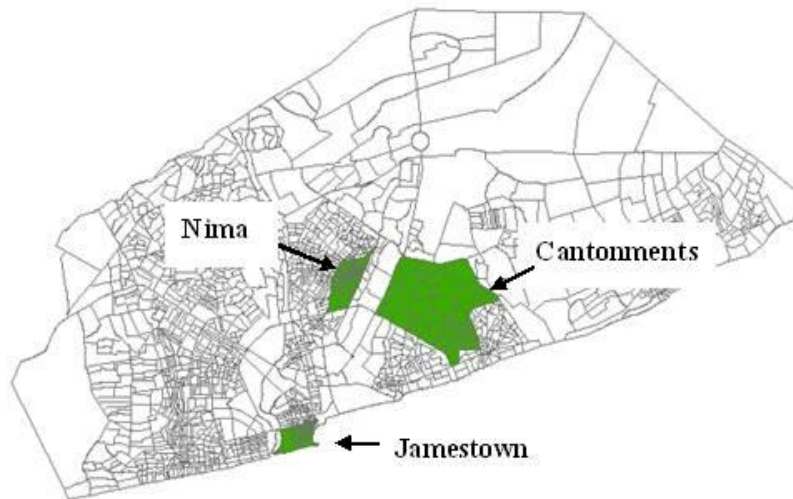
A binary logistic regression (households are either more food secure or more food insecure), was used to test the independent variables from the WHSA and from satellite data. Independent variables were assigned membership to one of the four sub-groupings of the conceptual model. The model outcome therefore provides a basis for discussing which variables are particularly important to urban households for maintaining food security and how the understanding of those variables can help inform policy.

Qualitative Analysis

Here, results are explicated from the in-depth household interviews conducted with a subset of respondents from the WHSA. It explores the factors surrounding household food security using a broader range of variables derived from the food security literature and other factors developed specifically for the intra-urban nature of this study. The interviews and qualitative data collected in this portion of the study permitted the relative validation and interpretation of quantitative household data from the statistical analysis. They also revealed surprising findings that in some cases supercede the data collected in the WHSA.

Approximately ten women were interviewed from each of three neighborhoods: Nima, Jamestown, and Cantonments (Figure 6). The neighborhoods were chosen to capture distinct geographical, neighborhood, and social experiences in Accra and to determine whether differences are reflected in a household's access to food. Nima, Jamestown, and Cantonments differ in their demographic profile, availability of food markets, and organization of social networks. Some of these factors were captured by the quantitative data set but others, such as "neighborhood experience," were not. Qualitative data collection, therefore, was necessary to capture these intangible variables, not easily measured by any standard survey. Women who participated in this study were effusive in speaking about food and nutrition since "food management" is core to their household responsibility. But it was also clear that these women had different choices and

Figures 6. Map of selected neighborhoods in Accra.



opportunities based on their neighborhood location and socio-economic standing.

Results

Spatial and Statistical Analysis

A look at these outcomes in relation to the conceptual model illuminates the underpinnings of food security in the urban environment. Over half, or 57 percent, of the respondents in the WHSA were food insecure, while 43 percent were food secure, meaning that the majority of women surveyed do not have access to the quantity and quality of foods they desire at all times. A large majority, nearly 83 percent of respondents, said that they had involuntarily skipped meals in the twelve months preceding the survey. A further look showed that nearly 70 percent of respondents skipped meals almost every month of the year. Only a small minority (12.5 percent) skipped meals only one or two months out of twelve. The descriptive statistics point toward a pattern of substantial urban food insecurity. Most respondents were food insecure, as defined by this study, and had a high frequency of skipping meals on an involuntary basis.

The percentage of food insecure households was mapped for each EA in the survey. Figure 7 shows this distribution with darker colors representing higher proportions of hungry households (white areas contain no data). Rates of food insecurity seem to be distributed randomly across space, despite the non-contiguous sampling of EAs.

Figure 7. Proportion of food insecure HH by EA.

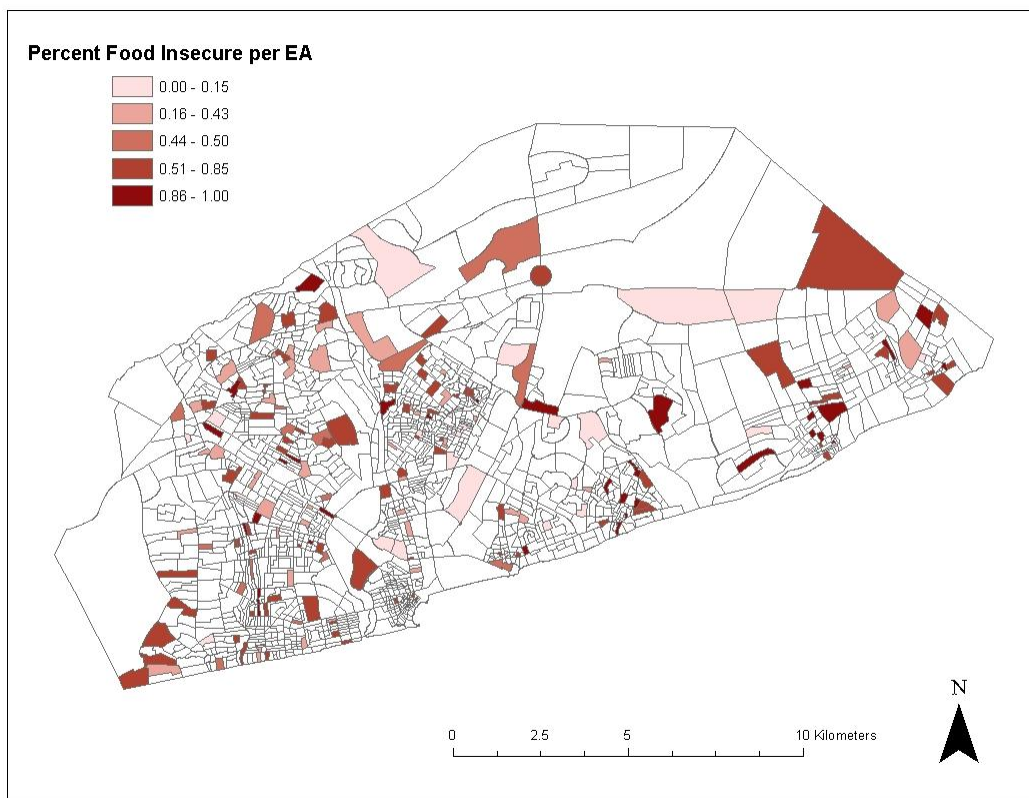
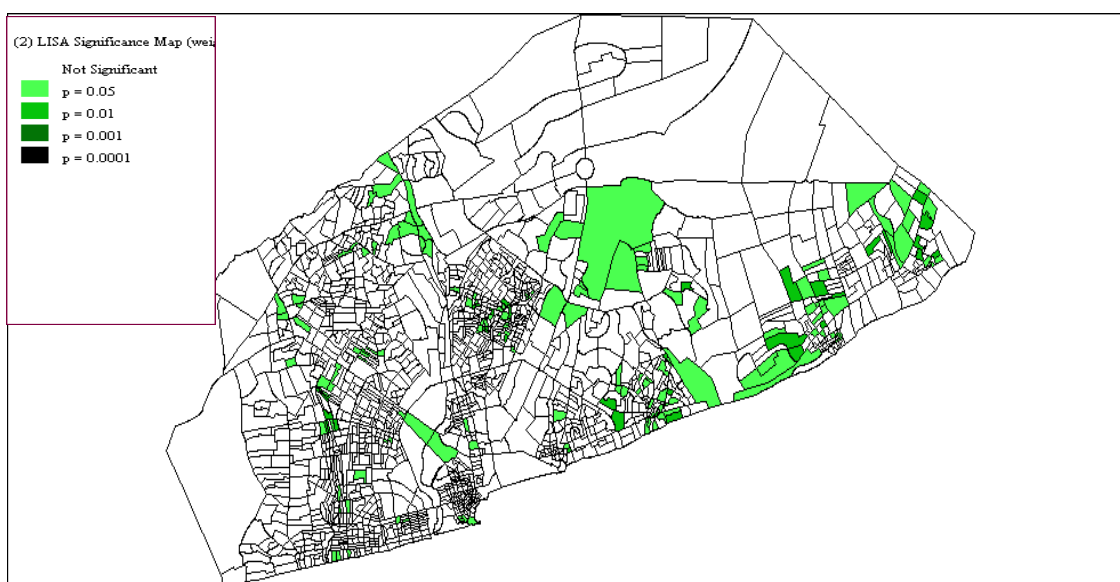


Figure 8. Local Moran's I: Rates of food insecurity per EA.



Local Moran's I for food insecurity was calculated and mapped in GeoDa (Figure 8). The map shows EAs with significant Local Moran's I statistics as different shades of green depending on the significance level (non-colored areas being insignificant). The darker the shade of green, the more significant the cluster. Figure 8 shows clusters of food insecure households in the center area of the map (corresponding to the Nima neighborhood) and around the eastern edge of the city (Tema).

Bayesian smoothing was used to estimate rates for unspecified EAs. Figure 9 shows a map developed in GeoDa 0.9.5 using its Spatial Empirical Bayes technique. A k-Nearest Neighbor weights matrix was developed for the analysis with the number of nearest neighbors at 10. It shows the estimated risk that households within an EA will be food insecure. In this case, clusters of higher risk are visible towards the eastern extreme of the map (Tema), around the south western salt ponds where a notorious slum community is located (Sodom and Gomorrah), and in various other areas scattered along the western and central parts of the city.

Figure 9. Bayesian smoothing: Probability estimates of food insecurity per EA.

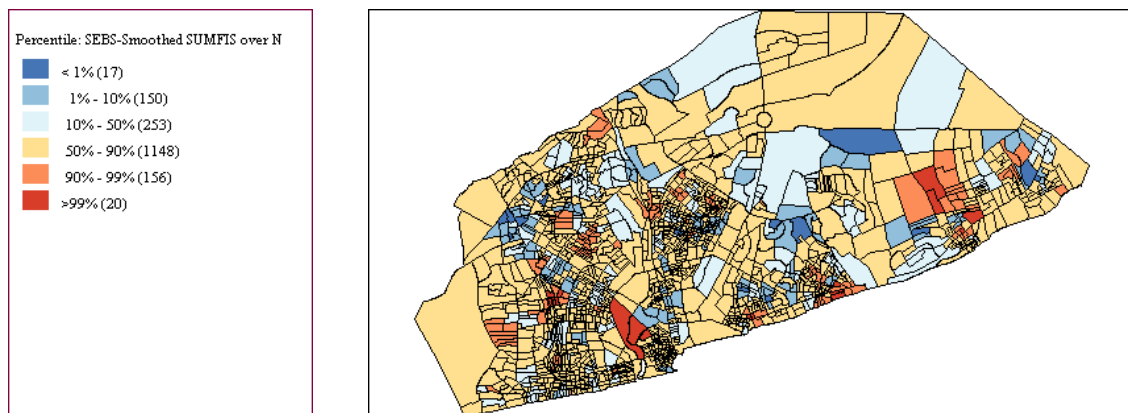


Table 4 shows the model summary for the binary logistic regression. Seven variables were statistically significant in influencing food security: *refrigerator ownership, security in housing tenure, adequate bathing facilities, solid waste collection, vegetation, breastfeeding children, and good self-reported overall health*. To the left of each variable in the table, initials indicate the sub-grouping membership from the conceptual model. The log odds of the coefficients ($\text{Exp } \beta$) reveal that households residing in vegetated neighborhoods were nearly three times more likely to be food secure than those living in “sparse” neighborhoods. The implications are important and support studies by Weeks (2003, 2007.) that show that remote sensing can be used to trace patterns of social processes on the ground. While more research is needed to understand exactly how vegetation patterns are related to household nutrition, the model suggests a positive correlation over and above the effect of household infrastructure (which is, in turn, highly related to socio-economic status.) This result indicates a first step in recognizing the validity of remote sensing data in social studies research. Those with access to adequate solid waste removal were nearly two and a half times more likely to be food secure than households without similar access. And households with access to adequate bathing facilities and a refrigerator are nearly two times and 1.7 times more likely to be food secure respectively. In regards to the health variables, households who reported good overall health and breastfeeding practices were nearly one and one-half times more likely to be food secure.

Table 4. Results of the binary logistic model for food security.

	B	S.E.	Wald	df	Sig.	Exp(B)
S.E. fridge	.517	.103	24.982	1	.000	1.677
S.E. tenure	-.217	.063	11.782	1	.001	.805
H.E. bath	.649	.118	30.242	1	.000	1.914
H.E. solidwas	.926	.148	38.911	1	.000	2.525
N.E. veg	1.066	.360	8.775	1	.003	2.905
HW breastfeed	.465	.161	8.335	1	.004	1.592
HW over_health	.429	.113	14.335	1	.000	1.535
Constant	-1.429	.237	36.459	1	.000	.239

Qualitative Analysis

Trends at the household level derived from the in-depth interviews show general consistency with the food security literature. First, the households with greater wealth, as demonstrated by the housing quality and household assets observed during the interviews, were relatively more food secure than other households. Second, households located in vegetated neighborhoods (i.e. Cantonments) were also generally better off and better educated than those household living in sparsely vegetated areas. And third, households for which food was the most important expense had near equal chances of being found in any of the three neighborhoods.

While the quantitative data did not indicate that geography or neighborhood was a significant factor in determining food security, the qualitative interviews revealed that

households have significantly different experiences accessing sufficient food for their families, depending on where they are located. This new evidence is perhaps the most important in terms of challenging the original conceptual framework. Nima, for example, held a particular advantage over James Town and Cantonments, with its daily outdoor food market which provided bountiful food resources to the neighborhood at a relatively low price. All women living in Nima indicated that this market was their primary source of food.

Neither Jamestown nor Cantonments had a central food market of its own. Women living in these neighborhoods had to travel further to reach food markets. Cantonments women, however, were equipped with more economic resources to bear the cost of transportation both in terms of time and money. Jamestown women were not. They were forced to make the trade-off between several hours of earning income and several hours of food shopping. “When I go to market,” said one woman, “I cannot work. The traffic is so terrible that it takes me all day.” The issue of “structure” vs. “agency” therefore arises and points to further research. Just how influential is the neighborhood environment in affecting household food security?

Whether these neighborhood level differences in Accra can be applied to other urban areas in developing countries is unclear since the food security literature offers little clues. These results resonate with the “food desert” literature that has examined food sources in British and American cities. Studies from this body of literature show that poor neighborhoods often lack supermarkets, farmers markets, or other sources of freshly farmed foods (Lewis et al, 2005; Pothukuchi , 2005; Pothukuchi 2004; Whelan et al,

2002). The data from Accra suggest that the idea of a “food desert” is a valid concept, but that it is not necessarily related to the socioeconomic status of a neighborhood.

In terms of health and food utilization, the interviews produced surprising results. While it is generally assumed that urban communities practice better hygiene or are more knowledgeable about food safety and hygiene issues, this study questions whether that is necessarily so. Simple practices such as washing hands or boiling drinking water were not practiced among the majority of women interviewed. The added expense of paying for potable water and latrine was often cited as a deterrent for poor families to maintain appropriate hygienic practices. Additionally, these women demonstrated very little knowledge of causal factors leading to food borne illness. Even a common illness such as typhoid was not recognized as having any association with food contamination.

Discussion and Conclusion

The variability in socio-economic status and neighborhood experience within growing urban areas suggests that policy would be fruitfully informed by disaggregated studies. People suffer food insecurity differently across neighborhoods based on local obstacles and opportunities. With food prices rising rapidly worldwide, it behooves policymakers to understand their impact on urban households. Neighborhood level policy can assist communities, in both the short and long term, weather the vicissitudes of accessing sufficient quantities of healthy, nutritious, and culturally appropriate foods.

Results demonstrate the need to add variables that are decidedly urban. Without them, it would be difficult to draw meaningful conclusions from the observed dynamics of food access and utilization within the urban environment. This study also argues for

enhanced sensitivity to place and scale, particularly in regards to neighborhood variability. Continued work at the neighborhood level within urbanizing areas of developing countries, may yield pioneering results, especially in sub-Saharan Africa whose urban areas have been largely ignored in the food security literature.

Successful future research in the area of urban food security will continue to focus on the specific variables which make urban hunger different from rural hunger. Future research might also fruitfully explore the spatial distribution of resources, food markets, and food cultures which vary across intra-urban boundaries. The integration of mixed-methods was especially useful in highlighting and explaining neighborhood variability described only superficially by the quantitative data.

Several “bigger questions” remain for which studies employing cognate methods are necessary. As developing country populations continue to urbanize, it benefits all of us to better understand how the “structure” vs. “agency” will play out in nascent urban neighborhoods. Will the neighborhood environment weigh significantly on people’s livelihoods and health? How will people’s health be affected by rapid urbanization? How will food systems, be organized across various communities? How will urbanization and changing (westernizing?) diets affect the demands we place on our global food systems and ecology? Evidently, the urban neighborhood impacts household food security in tangible and quantifiable ways that will become increasingly recognized in conceptual frameworks, future research, and policy applications.

References

1. Anselin, Luc, *GeoDa: geodata analysis software*. Urbana: University of Illinois, 2004.
2. Cressie, N., “Smoothing regional maps using empirical Bayes predictors,” *Geographical Analysis, Vol 24, p. 75 -95, 1992*.
3. Cressie, N., “Bayesian smoothing of rates in small geographic areas,” *Journal of Regional Science, Vol 35, Iss. 4, 1995*.
4. Duda, R., M. Kim, R. Darko, R. Adanu, J. Seffah, J. Anarfi, and A. Hill, “Results of the Women's Health Study of Accra: Assessment of blood pressure in urban women,” *International Journal of Cardiology, Vol. 117 p. 115, (2007)*.
5. ESRI, ArcMap Mapping Software, 2004.
6. FAO, *Rome Declaration on World Food Security and World Food Summit Plan of Action*, Rome, Italy (1996).
7. FAO, “1.02 billion people hungry: one sixth of humanity undernourished – more than ever before,” FAO, Rome, 2009.
8. Geary, R.C., *The Contiguity Ratio and Statistical Mapping*, The Incorporated Statistician, p. 115–145, <http://www.jstor.org/pss/2986645>, (1954).
9. Ghana Statistical Service (GSS), Noguchi Memorial Institute for Medical Research (NMIMR), and ORC Macro. *Ghana Demographic and Health Survey-DHS-2003*, 2004.
10. Kracht, Uwe and Manfred Schultz, *Food Security and Nutrition: The Global Challenge*, St. Martin’s Press, New York, 1999.
11. de Lardamelle, L., “The Role of Local authorities in the Food Supply and Distribution Systems in Ghana,” *Food into Cities Collection, FAO, Rome, 1996*.
12. Lewis, L.B., D. C. Sloane, L. M. Nascimento, A. L. Diamant, J. J. Guinyard, A. K. Yancey, G. Flynn, and for the REACH Coalition of the African Americans B, “African Americans' Access to Healthy Food Options in South Los Angeles Restaurants,” *Am J Public Health, Vol. 95, Iss. 4, p. 668, (2005)*.
13. Lopez, Anna Carla, *Spatial Patterns of Urban Food Security in Accra, Ghana: A Geographic Analysis of Household Hunger in an African City*, Ph.D. Dissertation, University of California, Santa Barbara and San Diego State University, 2009, 216 pages; AAT 3379488

14. Moran, P.A.P., "Notes on continuous stochastic phenomena," *Biometrika*, Vol 37, No. 1/2, June, 1950.
15. Pothukuchi, K. "Community Food Assessment: A First Step in Planning for Community Food Security," *Journal of Planning Education and Research*, Vol. 23, Iss.4, p. 356, (2004).
16. Pothukuchi, K. "Attracting Supermarkets to Inner-City Neighborhoods: Economic Development Outside the Box Economic Development Quarterly," Vol.3, p. 232, (2005).
17. Ridd, M., "Exploring a V-I-S (Vegetation-Impervious Surface-Soil) model for urban ecosystem analysis through remote sensing: Comparative anatomy of cities," *International Journal of Remote Sensing*, Vol. 16, Iss. 12, p. 2165, (1995).
18. Strahler, A.H, Woodcock, C.E, and J.A. Smith, 1986. On the Nature of Models in Remote Sensing. *Remote Sensing of the Environment* 20: 121-139.
19. UNICEF, *State of the World's Children: Child Survival*, UNICEF, 2007.
20. United Nations-POPIN, DATA, www.un.org/popin/data.html, (2008).
21. Weeks, J.R., "Using remote sensing and geographic information systems to identify underlying properties of urban environments," in *New Forms of Urbanization: conceptualizing and measuring human settlement in the twenty-first century*, edited by A.G. Champion and G. Hugo, London, Ashgate Publishing Limited, (2003).
22. Weeks, John R., A. Hill, D. Stow, A. Getis, and D. Fugate, "Can we spot a neighborhood from the air? Defining neighborhood structure in Accra, Ghana." *GeoJournal*, Vol. 69, Numbers 1-2, June, 2007.
23. Westoff, C., and A. Bankole., The Potential Demographic Significance of Unmet Need," *International Family Planning Perspectives*, Vol. 22, Iss. 1, p.16, (1996).
24. Whelan, A. N Wrigley, D Warm, E Cannings, "Life in a 'Food Desert'," *Urban Studies*, Vol. 39, No. 11, (2002).