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Illinois Local Food Systems: A Geospatial Analysis

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ILLINOIS LOCAL FOOD SYSTEMS: A GEOSPATIAL ANALYSIS

by

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TITLE: ILLINOIS LOCAL FOOD SYSTEM: A GEOSPATIAL ANALYSIS

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Recently, more attention has been paid to studies of local food systems that are specific to a particular place as a potential solution for providing healthy food, reducing carbon emissions, and promotion of local agriculture sustainability. In the United States, the demands of locally produced foods have increased substantially in recent years. There are several reasons for this increase, including long-distance food transportation's contribution to greenhouse gas emissions, the community food-security movement, and the increase of negative environmental problems related to large scale agriculture, etc., have contributed to the shift of attention from global food systems to local ones. Moreover, the development of local food systems would promote the local economy. Therefore, without specific knowledge and in-depth understanding of the region and various factors involved with the spatial distribution of local food systems, we may not be able to get maximum benefit. The overall objective of this research is to identify the suitable locations for local food system in Illinois. To fulfill the objective, this research applied spatial analysis techniques e.g. autocorrelation, hotspot analysis, radial basis functions, and overlay methods. On the basis of several agroecological and socioeconomic factors, the study found that counties that are most suitable for the local food systems in Illinois are Cook, Will, Kane, McHenry, DuPage, Lake, Peoria, and Winnebago. The findings of this research will help federal and state level policy makers, local food professionals, researchers, and farmers to establish sustainable local food systems.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

In Illinois, approx. 26,775,100 acres of land area is farmland, which includes some of the most fertile soils on earth (USDA, 2011). Only a few places on earth possess such an extraordinary and very productive combination of soil types, soil fertility, and climatic condition. At least 64 varieties of vegetable crops are commercially grown in Illinois because of very favorable soil and climatic conditions. Illinois is a leading producer of corn, soybeans, jack-o-lantern pumpkins, horseradish, and hydroponic peppers. The agricultural economy of Illinois is generating commodities valued at more than $9 billion a year (USDA, 2011; Illinois Ag Connection. 2009). In 2007, approx. 71,371 acres of land was used for the vegetables production, which accounted for 0.26 percent of the total farmland (USDA, 2009). The USDA reported that 1,377 farms harvested vegetables for sale whereas 1047 farms directly sold fresh vegetables to the fresh vegetables market[1].

In Illinois, most of the fruits and vegetables consumed by the consumers travel an average of 1,500 miles (IDOA, 2009). Other than locally grown fresh vegetables, state's annual expenditure for food is around $48 billion. The "Illinois Local and Organic Food and Farm Task Force" reported that if these produces could be grown in the state, local farms could generate $20 to $30 billion in economic activity, which also could generate thousands of new jobs. The Task Force emphasized that this revenue and jobs could help to build a strong local economy (IDOA, 2009). This data proves that local food system is very important for the state and local economy. In Illinois, 287 farmers' markets and 302 community supported agriculture (CSAs) are being

[1] The farmers markets, farm stand, Community Supported Agriculture (CSAs) are known as fresh vegetables market or local food market.

operated (USDA, 2010). But, most of the local food markets are concentrated around the Chicago area. Recently, the Illinois governor signed a landmark legislation in order to build strong local food systems (Illinois Stewardship Alliance, 2011). The new law is especially designed to promote the development of local food marketing mechanisms (e.g. development of farmers market). However, many researchers emphasized that local food systems are very complex, where many agroecological and socioeconomic factors are involved. Therefore, without specific knowledge and in-depth understanding of the region and various factors involved with the spatial distribution of local food systems, we may not be able to get maximum benefit from the new policy.

Thus, the main objective of this research is to identify the suitable locations for local food systems in Illinois. The research was focused on the assessment of important agroecological and socioeconomic factors that influence the suitable locations of local food systems in Illinois (e.g. farmers' markets, CSAs, fresh produce farms, etc). Based on the findings of various research studies and literature, this research selected some agroecological and socioeconomic factors as they play important role in identifying the suitable locations of local food system. The geospatial analysis was conducted on these factors. The agroecological factors studied in this research are: topography, soil, precipitation, water, crop diversity and temperature. The socioeconomic factors considered in this research are: farmers' market, vegetables harvested acres, direct farm sale, vegetables farms, income, population density, metro-nonmetro cities, and road network. However, this research only considered the fresh vegetables produced in Illinois. The other agricultural crops, such as corn, soybean are not studied in this research. The findings of this research will help farmers, agricultural professionals, extension workers, researchers, and policy planners to develop a sustainable local food system in Illinois.

CHAPTER 2

LITERATURE REVIEW

This chapter reviews relevant literature on local food systems. The review particularly focused on the definition of local food system, marketing mechanism of locally grown food, applications of GIS in the analysis of local food, and factors influences local food systems.

2.1 Definition of Local Food Systems (LFS)

Researchers have defined local food in different way from different perspective. According to the 2008 Farm Act, “the total distance that a product can be transported and still be considered a "locally or regionally produced agricultural food product" is less than 400 miles from its origin, or within the State in which it is produced”(McEntee and Agyeman, 2010). A study conducted by the Midwestern consumers and business found that consumers considered ‘local’ within a certain distance (25 or 100 miles) or within the state, while businesses were more likely to view the state or the entire Midwest region as ‘local’ boundaries (Duram and Oberholtzer, 2010).

Thus, it is clear from the several definitions that researchers and consumers perceive local food systems differently. Most definitions of local food systems use physical distance or limit. Often, they are based on a distance radius of 30, 50, 150 and 400 miles (Allen, 2010). Some researchers suggested political boundaries such as, the county while others suggested agroecological/biological delimitations such as, the watershed. However, the commonalities in all those research are, local (i.e., geographically determined) and proximity (Kremer and DeLiberty, 2011).

After reviewing an array of definitions on local food system, this research adopted the definition provided by Dr. Leslie Duram in 2010 as it appropriately depicted the nature and condition of local food system. The definition followed throughout this research is "…….. that has been produced, processed, and distributed within a particular geographic boundary or is associated with a particular region" (Duram, 2010).

2.2 Local Food Marketing Mechanisms

There are two basic types of direct marketing strategies available in the local food systems: 1) direct transaction between farmers and consumers (direct-to-consumer), and 2) direct sales by farmers to restaurants, retail stores, and institutions such as, government entities, hospitals, and schools (direct-to-retail/foodservice) (McEntee and Agyeman, 2010; Becker, 2003). Some of the examples of 'direct-to-consumer marketing mechanisms are, farmers' markets, community supported agriculture (CSAs), farm stands/on-farm sales, and "pick your own" operations. Agricultural Census (2007), defined the "direct sales to consumers" as the value of agricultural products sold directly to individuals for human consumption from roadside stands, farmers' markets, pick-your-own sites, etc. (USDA, 2010). Though there are various kinds of 'direct-to-consumer sales' are practiced, national level information is available only on farmers' market and CSA.

Farmers' Markets: A marketing mechanism of fresh vegetables that are locally grown by famers and sold directly by the famers to the consumers**.** 1n 1976, the U.S. Congress passed the Farmer-to-Consumer Direct Marketing Act which led to the development of many farmers markets in the country. Thus, the future of America's farmers' markets is bright. However, some of the factors that are stimulating the growth and awareness of farmers' markets are: strong demand for high quality fresh food, widespread concern over health and nutrition, growing interest by the farmers, and community's need to create social connections (Hamilton, 2005). In the United States, farmers' markets grew to 5,274 in 2009, a 92-percent increase from 1998. According to Feagan (2004) social interactions are the key to promote and flourish farmers' markets in the U.S. A 2006 national survey reported that people are willing to purchase fresh produce directly from the growers (USDA, 2010; Allen, 2010). In a study, Onozaka et al (2010) found that 82% of respondents buy locally grown fresh produce from these markets. They purchase local produces to support local economy.

*Community Supported Agriculture (CSA)***:** CSA is another form direct-to-consumer marketing channel. In this system, a group of people buy shares for a portion of the expected harvest of a farm. When crops are harvested, consumers can get their share of fresh vegetables at home or from the farm. According to Martinez and others (2010), the concept of CSA originated in Switzerland and Japan during the 1960s. There were only two CSA operations in the United States in 1986 (Adam, 2006). However, the number increased to 1,144 by 2005. The study conducted by Robyn Van En Center in 2010 estimated that over 1,400 CSAs are in operation in the United States (McEntee and Agyeman, 2010).

2.3 GIS Applications in Local Food Research

The application of Geographic Information Systems (GIS) in local food research is not very old. GIS has been used in a number of studies that examined access to food. Few studies have explored spatial analysis techniques for the study of local food systems (Kremer and DeLiberty, 2011). In the early studies on local food, researchers commonly used maps to present information about the study area and produces grown per geographic unit. Some studies reported that GIS technologies were not common for analysis of local food system (Wrigley et al., 2002). However, McEntee and Agyeman (2010) noted that Donkin and his co-researchers were the first to use GIS techniques in 1999 where they created maps to show the distance of food outlets over a road network. The authors also noted that the importance of GIS modeling for local food was realized very recently that could solve many problems associated with local food system research.

A recent study conducted by Pearce et al. (2007) goes beyond a presentation of relative geographic distance and performs a non-parametric Spearman's rank correlation analysis to show the access to community resources and identify the deprived areas. Burtman (2009) claims that GIS mapping on local food system has the ability to give underprivileged communities the chance to get better services that range from education and transportation to health care. Kremer and DeLiberty (2011) published a paper on local food system in Philadelphia. They argued that spatial research methods are central to understanding and evaluation of different components of local food systems. They used Philadelphia as a case study city and explored the socio-spatial structure of the current local food system. They have integrated remote sensing and GIS techniques to estimate land potential for urban food production (Kremer and DeLiberty, 2011).

2.4 Factors Influence Local Food System

Local food system is relatively a new field of research which is getting popularity among the academics, researchers, and policy makers. Researchers working in this field are investigating to learn consumer perceptions, policies, as well as marketing channels. As indicated in various studies, following variables are more influential for local food systems: (1) agro-ecological: soil fertility, species diversity, water use, precipitation, temperature, energy, etc. (2) socio-economic: direct marketing, transportation, income, consumer background, policy, etc. (Duram, 2010; Altieri, 2009; Duram, 2000; USDA, 1998; Gliessman, 1998; Rosset, 1997).

According to Mader et al. (2003), local food system ideally produces good yields with minimal impact on soil fertility. In other words, maintaining soil fertility is a contributing factor of local food system which later on provides essential nutrients for plant growth and supports a diverse and active biotic community. As reported by Gliessman (1998) and Altieri (1995), the small local farms promote biodiversity, thrive without agrochemicals, and sustain year-round yields. The management strategies in the local farms enhance the quality of the natural resources especially soil, water, and wildlife. According to USDA (1998), "small farms represent a diversity of cropping systems, biological organization, culture and traditions. They also contribute to biodiversity, a diverse rural landscape, and open space".

According to Duram (2000), various economic, political, social, and ecological structures/ factors are important for the expansion of organic farming. She noted that markets, income, labor, policy, information source, family structure, culture, ecosystem and soil health are the driving factors for organic farming.

Policy is the main pillar to promote and establish local food system. At the both Federal and state level, United States has enacted some statutes to promote local food. Some of these are: the Child Nutrition Act, the Food Stamp Acts, the National School Lunch Act, U.S. conservation program (Hardesty, 2010; Soto and Diamond, 2009; Hamilton, 2002).

CHAPTER 3

RESEARCH QUESTIONS

The research was focused on the identification and mapping of suitable locations of local food systems in Illinois. The important agroecological and socioeconomic factors that influence the location of local food system was identified and analyzed in this research. The spatial distribution of various agroecological and socioeconomic factors were analyzed using several geospatial techniques. The data for the geospatial analysis were gathered from the secondary sources. However, the overall methodology of this research was developed based on the following two research questions:

1. What factors play a major role for establishing local food systems in Illinois?
2. Which locations are suitable/potential for building local food systems in Illinois?

CHAPTER 4

MATERIALS AND METHODS

This chapter described the study area and data sets and procedures of this research.

4.1 The Study Area

Illinois is one of the most populous states in the country. The main geographic and economic features of Illinois are Chicago in the northeast, small industrial cities and great agricultural productivity in central and northern Illinois, and natural resources like coal, timber, and petroleum in the south (EPA, 2011).

Geographically, the northern part of Illinois is bordered by Wisconsin where northeastern border lies within Lake Michigan. While part of the western side is bordered by Iowa, part of the east is border by Indiana. The Wabash River flows as the eastern/southeastern border with Indiana until it enters the Ohio River. This marks the beginning of Illinois' southern border with Kentucky. The Mississippi River at the west lies as a border between Missouri and Illinois (Wikipedia, 2012).

Illinois' major agricultural products are corn, soybeans, hogs, cattle, dairy products, and wheat. In most years, Illinois is either the first or second state for the highest production of soybeans. Illinois ranks second in U.S. corn production with more than 1.5 billion bushels produce annually (USDA, 2011).

Soil and climatic diversity in Illinois provides suitable conditions for raising many different kinds of vegetables. At least 64 vegetable crops are commercially grown in Illinois. It is the leading state in the production of jack-o-lantern pumpkins, processing pumpkins, horseradish, and hydroponic peppers. With 13 million populations and its diverse ethnic residents, Illinois is a huge market for vegetable crops (IDNR, 2012).

Figure 4.1 Study area.

4.2 Data Sets and Procedure

The agroecological and socioeconomic data sets used in this research were obtained from the United States Department of Agriculture (USDA) website, "Your Food Environment Atlas" (http://www.ers.usda.gov/), Illinois Department of Agriculture, U.S. Economic Research Services, and Census Bureau. Table 1 shows the factors used in this research and the data sources. The factors considered for the study are:

Table 4.1 Agroecological and socioeconomic factors for development of local food systems (LFS) and the data sources.

Type of factors	Data Sources
Socioeconomic factors	
Population density	Local Food Atlas(USDA), Census Bureau
Poverty	Local Food Atlas(USDA), Census Bureau
Median HH Income	Local Food Atlas(USDA), Census Bureau
Urban areas	ESRI, USGS
Interstate highway	ESRI, USGS
LFS factors	
Farmers' market	Local Food Atlas(USDA), USDA Agriculture Census
Direct farm sales	Local Food Atlas(USDA), USDA Agriculture Census
Community supported agriculture (CSA)	Local Food Atlas(USDA)
Vegetables harvested acres	Local Food Atlas(USDA), USDA Agriculture Census
No of vegetables farms	Local Food Atlas(USDA), USDA Agriculture Census
Vegetables diversity	USDA Agriculture Census
Agroecological factors	
Topography	USGS,
Precipitation	NRCS
Temperature	USGS, National Elevation Data Set
Soil	USGS, Illinois Department of Natural Resources (IDNR)

4.3 Brief Description of the Factors Influencing LFS:

The important agroecological and socioeconomic factors considered and studies in this research are briefly described below:

Agroecological factors**:**

Topography**:** Illinois topography is relatively flat, however, varies from place to place. About 90% of the state is covered by gently rolling fertile plain. Northwestern part of the state is hilly. The highest point of the state is located in northwestern corner, which is very close to the Wisconsin border (mean elevation from sea level is above 600 feet) whereas the lowest point is located along the Mississippi River in Alexander County, which is 279 feet above sea level (ISGS, 2012). The central part of Illinois is known as Corn Belt whereas southern part is characterized by Shawnee hilly area.

Climate*:* The climate is very important for development of local food systems in a region. Illinois, typically experience continental climate with cold winters, warm summers, and frequent short-period fluctuations of temperature, humidity, and cloudiness. The pattern of average annual precipitation ranges from 32 to 46 inches where northeastern corner of Illinois gets less than 32 inches and the Shawnee Hills area of southern Illinois get more than 46 inches, a north-south difference of 14 inches. In general, May–August is the wettest period with little precipitation in winter months. Illinois is a water-rich state with abundant precipitation, which is the ultimate source for state water resources. The southern Illinois receive the heaviest precipitation while the northern Illinois receives the lightest (ISWS, 2012).

Soil**:** Much of Illinois is comprised of fertile flat land. About 89 percent of the state's cropland is considered prime farmland that ranked the state ‘third’ nationally in terms of total prime farmland acreage. The six major soil groups or soil orders available in Illinois are: Mollisols, Alfisols, Entisols, Inceptisols, Ultisols, and Histosols. Nearly 90 percent of state’s land is formed by the Mollisols and Alfisols. The central and northern part of Illinois is rich by Mollisols that occupied nearly 45 percent of Illinois’ land area. This dark colored soil is most fertile that develop under grass. The southern part of Illinois is rich by variety of soils. The light-colored Alfisols is existed in this region and occupied about 45 percent land. Ultisols are also available in southern Illinois and covered less than 1 percent of state's land. Entisols are recent alluvium soil that covered 7 percent land area of Southern and Western Illinois. The soils in bogs and marshes of western Illinois are Histosols which covered less than 1 percent area. Inceptisols are weakly developed soils and occupied nearly 2 percent land area of Illinois (NRCS, 2012).

Socioeconomic factors:

Population: According to 2011 estimate of the United States Census Bureau, the population of Illinois is 12,869,257 where population density is 232 people per square mile (Wiki, 2012). Though, in general, Illinois population density is low, the northeastern (Chicago and its adjoining area) and southwestern parts (Greater St. Louis area) of Illinois are highly populous. With a population of 2,695,598, Chicago is the largest city in the state. The U.S. Census Bureau currently lists seven other cities with populations of over 100,000 within Illinois. These are Aurora, Rockford, Naperville, Springfield, Peoria, Elgin, and Belleville.

Poverty*:* In 2008, more than 1.5 million people of Illinois (12.2 percent of the state's population) were living in poverty. The heavily populated urban areas of Southern Illinois are mainly poor where poverty level reached to a critical condition in three southern counties: Jackson, Alexander, Pulaski. However, the metropolitan city Chicago and its neighboring counties are the richest part of Illinois.

Urban areas: Except northeastern and southwestern part of the state, Illinois is mostly rural.

Fresh Food Markets*:* There are 3,000 farmers markets across the U.S. that offer consumers farm-fresh, affordable, convenient, and healthy products such as: fruits, vegetables, cheeses, herbs, fish, flowers, baked goods, meat and much more. In Illinois, according to the USDA (2010), there are 287 farmer markets and 302 CSAs are being operated. There are road side stand and farm stands are also selling their fresh produce.

4.4 Spatial Analysis

To identify the suitable location of local food systems, this research has used ArcGIS 10.0 and conducted spatial analysis of various agroecological and socioeconomic factors, investigated spatial patterns, and explored spatial and temporal trends. For analyzing spatial distribution of agroecological and socioeconomic factors, this research has used following geospatial techniques:

1. spatial autocorrelation,
2. hot spot analysis,
3. radial basis function,
4. mean center,
5. directional mean,
6. buffering, and
7. overly methods. Various verification

***Spatial autocorrelation*:** In this research, the spatial autocorrelation (e.g. Moran I) is used to examine spatial distribution of data including clustered, dispersed, and random. The spatial autocorrelation is the mathematical representation of the degree of similarity for data varies of an attribute (Longley and Goodchild, 2005). With this method, we can easily identify the degree of spatial factors/features and their associated data values that tend to be clustered together in space (positive spatial autocorrelation) or dispersed (negative spatial autocorrelation). The resulting number can range from +1 to -1. Moran's I index represent the data values of the variables that are spatially clustered with high values or low values. However, a Moran index of -1 value indicates that the data values are perfectly dispersed.

For classification of all the factors, natural breaks method was used. Because, natural breaks classification scheme determines the best arrangement of values into classes by iteratively comparing sums of the squared difference between observed values within each class and class means.

Radial basis functions (RBF): RBFs is a method where a series of exact interpolation techniques are performed. RBF is used to produce smooth surfaces from a large number of data points. However, the technique is inappropriate when large changes in the data series occur within short distances and the sample data is prone to measurement error or uncertainty. In this research, RBFs is used as we are not able to measure the values of the particular phenomenon in all points of the sphere, but only in some sample points. The interpolation method gives us values in such points where we have no measurements (ESRI, 2012; Longley and Goodchild, 2005).

Hot Spot: This method gives us a set of weighted features, identifies statistically significant hot spots and cold spots using the Getis-Ord Gi* statistic. Hot spot analysis has been used in this research to examine distributional pattern of various factors' (e.g. farmers market, CSAs). This method also gives us a z-score and p-value. A high z-score and small p-value for a feature indicates a spatial clustering of high values. A low negative z-score and small p-value indicates a spatial clustering of low values. The higher (or lower) the z-score, the more intense the clustering. A z-score near zero indicates no apparent spatial clustering (ESRI, 2012).

Mean Center: This method identifies the geographic center (or the center of concentration) for a set of features. The mean center is a point constructed from the average x and y values for the input feature centroids. With the projected data this tool accurately measure distances (ESRI, 2012).

Buffer: The buffering is basically creates buffer polygons around input features to a specified distance. In this research, I have created 10 miles buffer zone from the interstate highway to see the concentration of farmers' markets (ESRI, 2012).

Overlay: The Overlay toolset contains tools to overlay multiple feature classes to combine, erase, modify, or update spatial features, resulting in a new feature class (ESRI, 2012).

4.5 Local Food System Suitability Analysis

The integration of multicriteria decision analysis (MCDA) with the GIS has been considered as an advanced land suitability analysis (Malczewski, 2004; Drobne and lisec, 2009). The GIS-based MCDA is a process where both spatial and aspatial data (inputs) are used to reach to a decision (output). However, the review of literature in local food system shows that the MCDA has not been used for local food systems research though it has widely been used in other areas. Thus, in this study, GIS-based MCDA method is used to explore the selection of suitable locations for development of local food systems in Illinois. Using the MCDA method, this research has developed a suitability index though the integration of agroecological and socioeconomic factors. This research adopted the suitability index from Wang (2008) (Introduction to GIS: class lecture note), Mabin and Beattie (2005), and Saaty (1980). The detail of the suitability matrix is presented below:

Basic rules

1) <u>Suitability classes:</u>

The analysis of location suitable for local food systems is termed as "suitability analysis". The suitability analysis is conducted for 102 counties in Illinois. In the county level analysis, a range of suitability classes is used. However, the "Natural Breaks" method in ArcGIS has been used for classifications.

Table 4.2 Score and suitability class.

Score	Suitability class
1	Very low
2	Low
3	Medium
4	High
5	Very high

2) <u>Criteria used for suitability modeling</u>:

a. *Farmers' market*: No. of farmers' markets (higher number of farmers' market indicate very high suitability)
b. *Direct farm sale:* More direct sale from farm (increased direct sale from farm will indicate very high suitability)
c. *Vegetables harvested acres:* More land used for vegetable harvesting.
d. *Vegetables harvested farms:* No. of vegetables farms
e. *Vegetables diversity:* No. of vegetables produces in a farm.
f. *Pop. density:* No. of people living in a county
g. *Income: Average state income*
h. *Topography:* >500 and < 800 feet from sea level and high slope drained quickly
i. *Precipitation:* Less than 39"rainfall annually
j. *Temperature:* Less than 52^0 F annual temperature
k. *Metropolitan area:* More consumers in urban areas
l. *Interstate highway:* County has interstate highway

Note: Since availability of water is not an issue for Illinois, this study has not incorporated it under the suitability criteria. Various studies indicated that Illinois has abundant supply of both surface and ground water.

<u>3) Suitability analysis and modeling scores</u>

Here are some examples:

a) No. of farmers' markets:

No. of FMs	<1	2-3	4-8	9-14	15>
Scores	1	2	3	4	5

b) Direct farm sales ($ 000):

Sales	<94	94.1 - 306	306.1 - 700	700.1 - 1434	1434.1 >
Scores	1	2	3	4	5

c) Vegetables harvested acres:

Acres	<149	149.1 - 502	502.1 - 1180	1180.1-3872	3872.1>
Scores	1	2	3	4	5

d) No. of vegetables harvested farms:

No. of farms	<6	7 - 13	14 - 23	24 - 42	43>
Scores	1	2	3	4	5

<u>4) The criterion of weight</u>

Each layer takes a different degree of importance for the final local food suitability map. (Table 4.3.

Table 4.3 Factors, relative importance and weight.

Factors	Relative importance	Weight
1. No. of farmers' market	5	.12
2. Direct farm sale (DFS)	4	.09
3. Vegetables harvested acres	3	.07
4. Vegetables harvested farms	2	.05
5. Vegetables diversity	3	.07
6. Pop. density	5	.12
7. Income	4	.09
8. Topography	3	.07
9. Precipitation	4	.09
10. Temperature	3	.07
11. Soil	2	.05
12. Metropolitan area	4	.09
13. Interstate highway	1	.02
Sum	43	1

Note: The relative importance of factors has been decided after reviewing numerous literature on local food systems. My professional experience with "Food Works" and involvement with local farmers in Southern Illinois have given me some insights in categorizing the relative importance.

5) The rule for the final suitability analysis model for potential locations of local food systems:

Local Food Suitability Index = Weight1*No. of farmers' market score **+** Weight2* DFS score + Weight3*vegetables harvested areas score + Weight4*vegetables farms score + Weight5*vegetables diversity score +Weight6*population density score + Weight7*income score + Weight8*topography score + Weight9*precipitation score + Weight10* temperature score + Weight11* soil score + Weight12*Metro-non metro score + Weight13* Interstate highway score.

Two spatial analyses tools were used to display the county wise total weighted results, which were:

1. Spatial autocorrelation and
2. Radial Basis Functions

CHAPTER 5

RESULTS

This section presents the discussion and results of this research. The overall presentation of the results and discussion was made based on two important research questions.

Research Question 1: What Factors Play a Major Role for Establishing Local Food System in Illinois?

Many agroecological and socioeconomic factors directly or indirectly affect the local food system; some of them play a major role for building a sustainable local food system. This research conducted spatial analysis of 14 agroecological and socioeconomic factors to see how these factors influence the development of local food systems. The factor studied in this research are: topography, precipitation, temperature, water availability, soil, summer water deficit, farmers' markets (FMs), community supported agriculture (CSAs), fresh vegetables harvested areas, direct sale, vegetables diversity, income, pop. density, urban areas, and road network. For planning and developing a local food system in Illinois, following spatial analysis were carried.

Spatial Analysis

The three important components of a local food system include farmers' market, CSA, and farm stand. Farmers' markets are the engines of local food systems where the producers and the consumers converge. In general, most of the produces sold in the farmers' market come from the same or nearby neighborhood or that locality. Thus, location of farmers' market is considered as one of the most important factor that determines the suitable location of local food systems.

In Illinois, according to the USDA (2010), there are 287 farmers' markets are actively in operation. Thus, spatial distribution of 287 markets would primarily give an idea of potentials

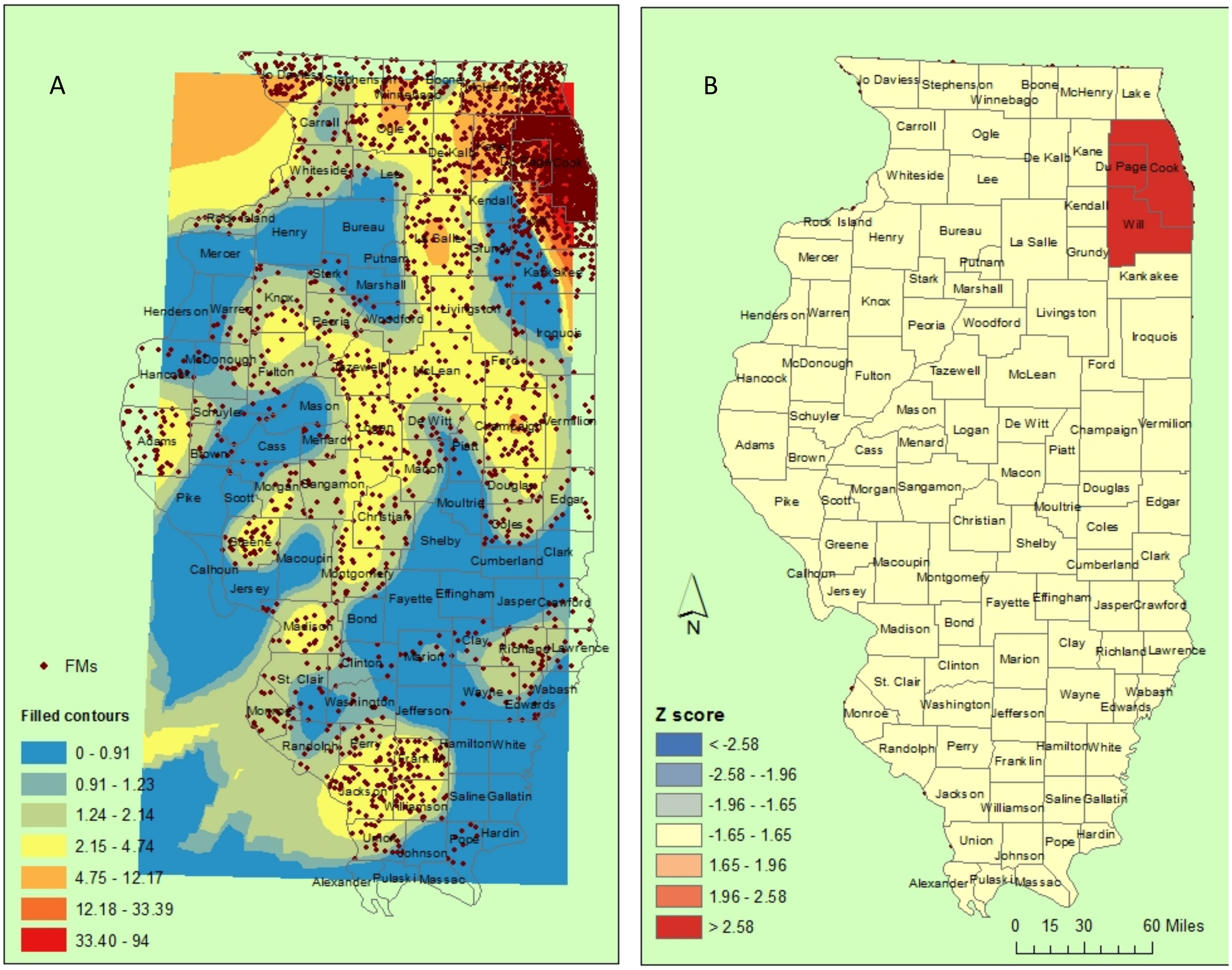

Figure 5.1 A) Farmers' market distribution pattern, B) Farmers' market hot spot analysis.

location of local food systems (LFS) in Illinois. In order to learn the spatial distribution of the farmers' market in Illinois, in this research spatial autocorrelation was performed using Global Moran's I and hotspot analysis.

Figure 5.1 A and B display the farmers' market distribution pattern and the hot spot. The spatial autocorrelation analysis shows that in Illinois, most of the farmers' markets are clustered in the northern part of the state. Other clusters have been observed in the central and southern part of the state. The Cook, Lake, Will, Kane, and Dupage counties have the highest concentration of the farmers markets.

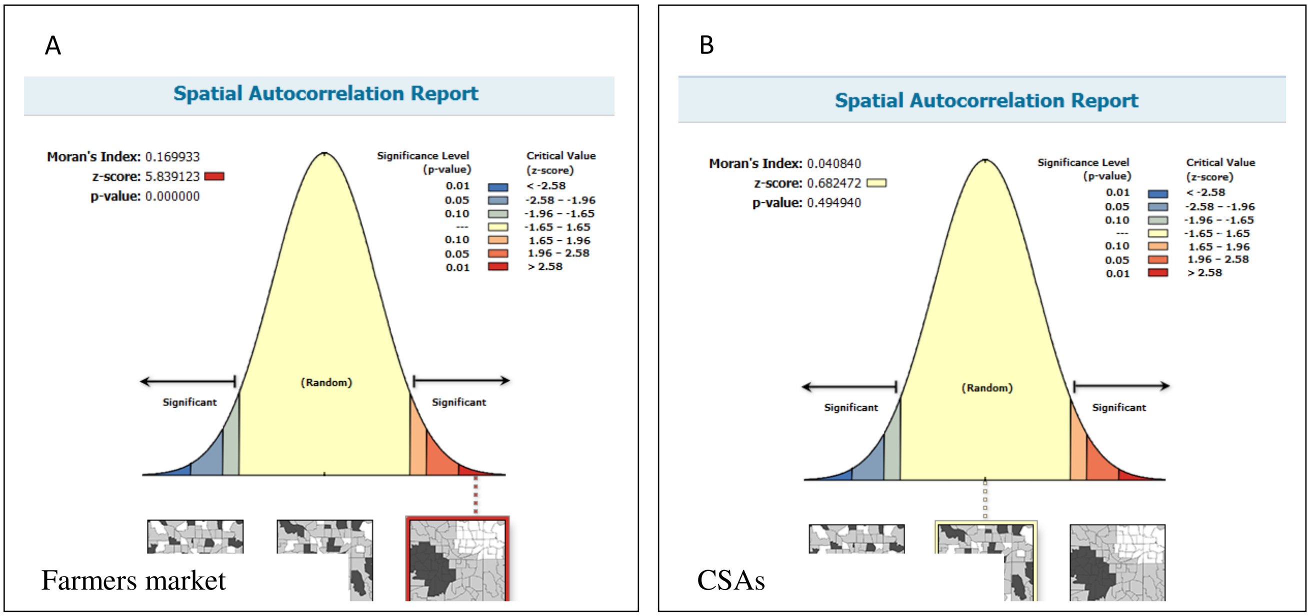

Figure 5.2 Spatial autocorrelation report of farmers' markets and CSAs.

The analysis of spatial autocorrelation led to a positive value of Moran's I (Moran's I=0.169933, Exp. Moran's I=-0.009901, z-value= 5.8391) which indicates positive spatial autocorrelation and result is statistically significant (p = <0.05) (Fig 4). Hotspot analysis also shows that the farmers' markets are highly concentrated to the Cook, Dupage and Will counties (Fig 5.1B).

The CSAs are also important factors of local food systems like farmers market. To understand the spatial distributional pattern of CSAs, I conducted a spatial autocorrelation using Moran's I and a hotspot analysis. The result indicates that (Moran's I=0.040840, Exp. Moran's I=-0.009901, Z-value= 0.682472) the distribution pattern of the CSAs are random in nature and the value is not statistically significant (Fig 5.2B). However, the hotspot analysis indicated that

CSAs are mainly concentrated in two regions: central and south central part of the state (e.g. Shelby, Macoupln, Jersey, Payette, Effingham, and Mclean counties).

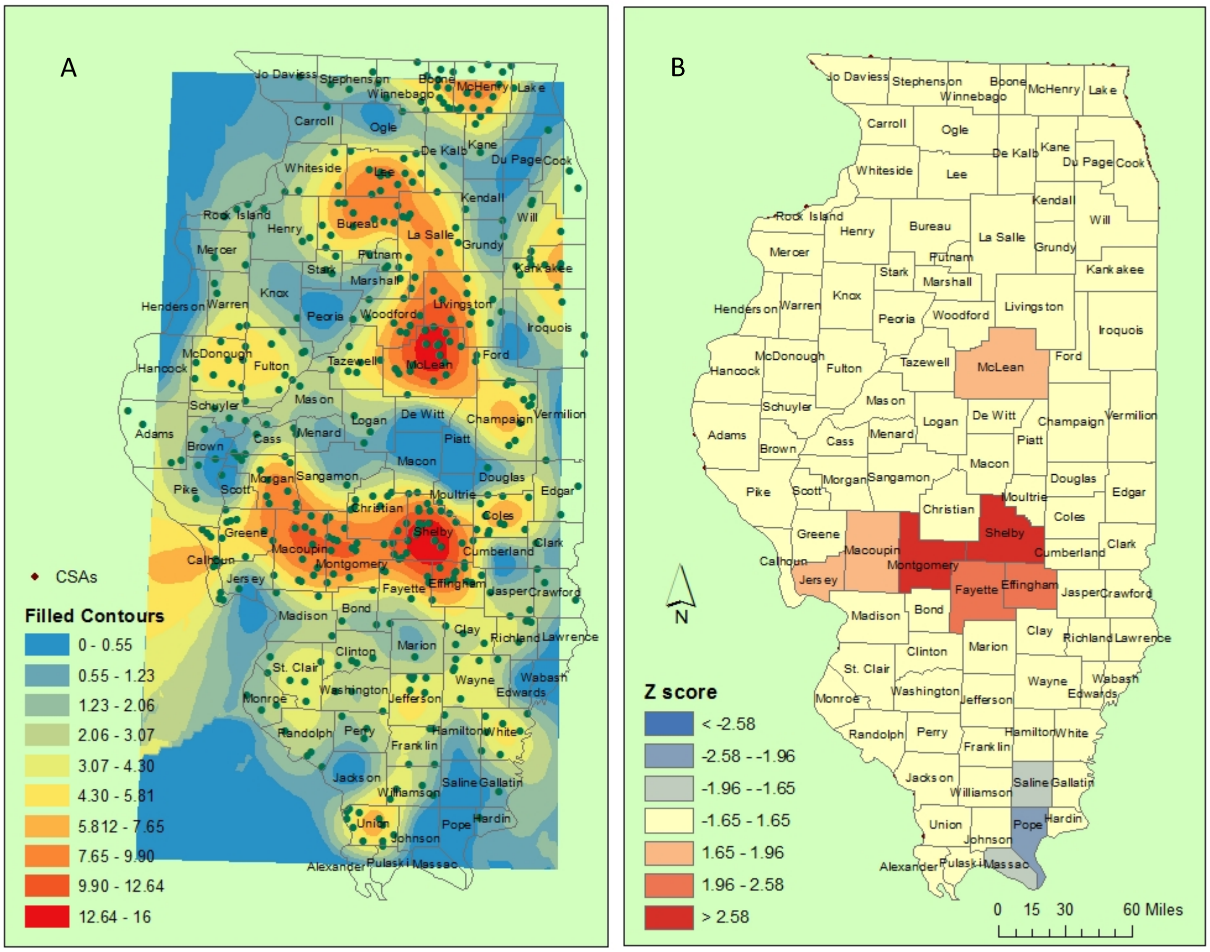

Figure 5.3 A) CSAs distribution pattern; B) CSAs hot spot analysis.

The production, harvest, and total acres of fresh vegetables often indicate the potential location of local food systems. In this research three important factors related to fresh vegetables: fresh produce harvested acres, fresh produce farms, and diversity of vegetables were studied and their spatial analysis was performed using spatial autocorrelation (Moran's I). The spatial autocorrelation of fresh vegetables harvested acres shows (Moran's I=0.057177, Exp Moran's

I=-0.009901, Z-value= 0.956681) a positive spatial correlation which indicates a clustered pattern (Table 5.1).

Table 5.1 Different factors and their concentration in different counties.

Factors	Hot Spot (Counties)	Moran's I
Fresh vegetables harvested acres	Kankakee, La Salle, Whiteside, Henry, Tazewell, Mason	I= 0.057177
Vegetables farms	Lake, McHenry, Marshal, Tazewell, Mcdonough, Moutlie, Coles	I= 0.210863
Vegetables diversity	Whiteside, Winnebago, Boone, McHenry, Peoria, Woodford, McLean, Monroe, St. Clear, Kenkakee, Will	I= 0.218152

Fig 5.4 A displays that at the north-central part of the state, farmers are more interested to produce fresh vegetables and use their land to grow vegetables. More specifically, the highest fresh produce harvested counties are Kankakee, La Salle, Whiteside, Henry, Tazewell, and Mason. However, spatial analysis of the number of fresh produce shows that most farms are located in the central and northern part of the state (e.g. Lake, McHenry, Marshal, Tazewell, McDonough, Moutlie, Coles counties) (Fig 5.4B).

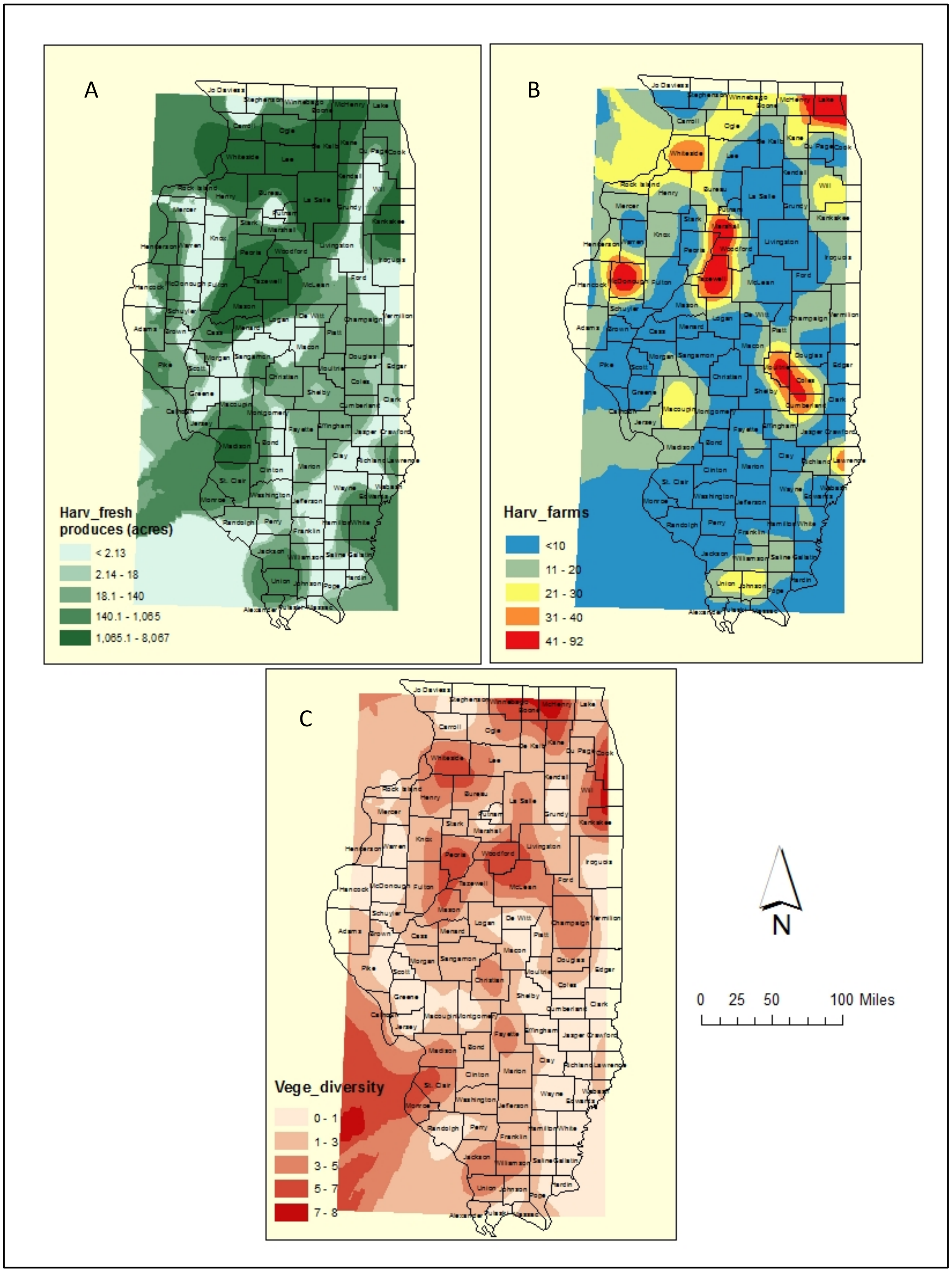

Figure: 5. 4 A) Vegetables harvested acres, B) Vegetables farms, C) Vegetables diversity.

The diversity of fresh produces is also important for any region and for the agroecology. In Illinois, around 64 different kinds of vegetables are being produced. This research has studied the production of major eight varieties of vegetables (Pumpkin, sweet corn, tomato, horse radish, bean, cucumber, peas, and cabbage). Their spatial distribution indicates that the north and central part of the state have the highest vegetables diversity (Fig 5.4C).

Thus, from the spatial autocorrelation of fresh produce harvested acres, vegetable farms, and vegetables diversity, it can be stated that La Salle, McHenry, Tazewell, Woodford, Boon, Whiteside counties are producing more fresh vegetables compared to other regions. These counties have the potentials to be identified as suitable locations for local food systems.

The socioeconomic variables, such as population density, income, poverty, urban areas, and road network also play an important role for development of local food systems. To understand the spatial distribution of population density, spatial autocorrelation (Global Moran's I) method was performed (Moran's I=0.284431, Exp Moran's I=-0.009901, Z-value= 6.35930). The positive Moran's I value implies positive spatial correlation. The value indicated clustered distributional pattern of the population which is also statistically significant. Fig 5.5A displays the highest population density which observed in northeastern part of the state in Chicago (2340-5293people/ sqm). The rest part of Illinois (most of the counties) has low population density (11-174 people sqm.). Other populated areas are East St. Louis, Springfield, Urbana-Champaign, etc.

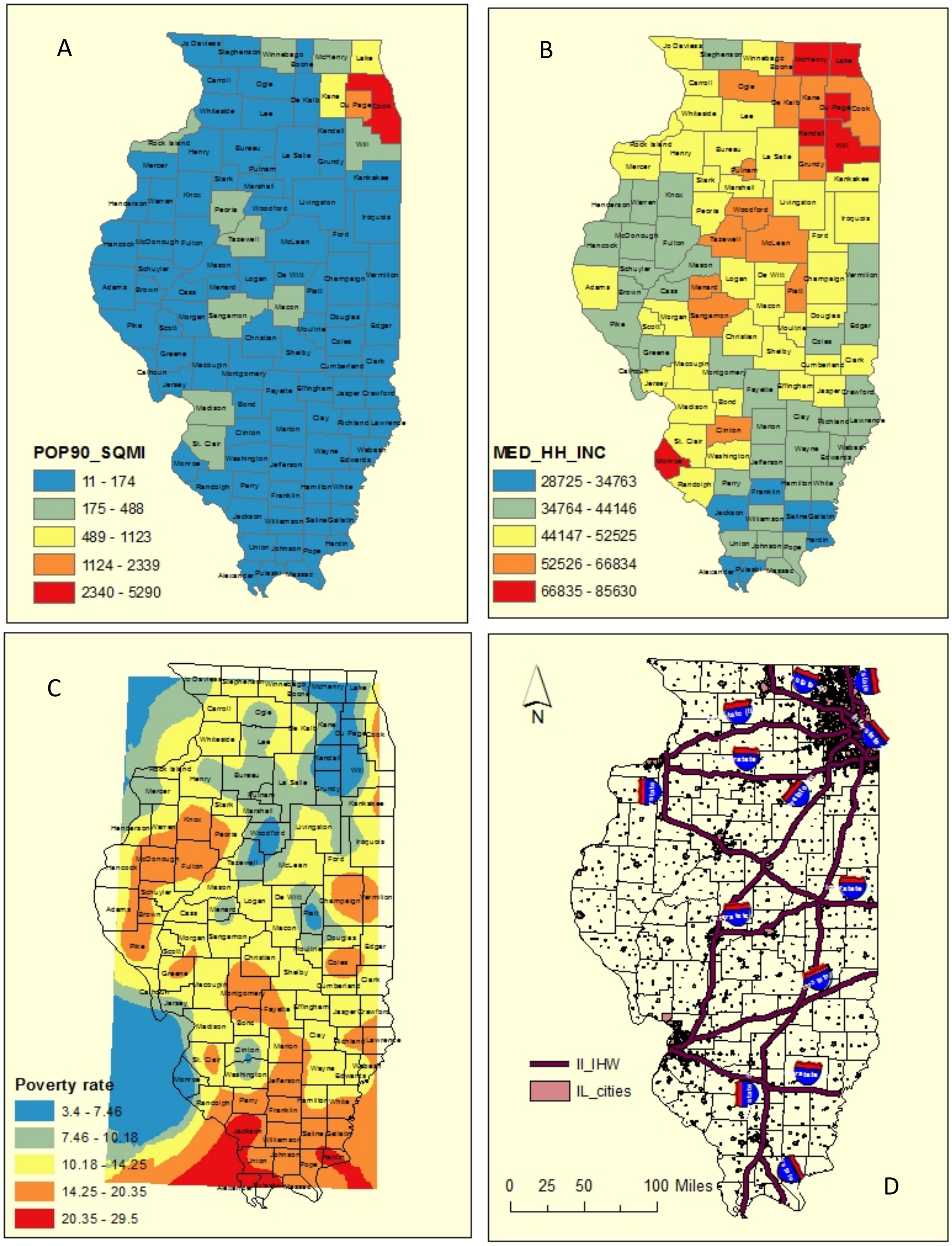

Figure 5.5 A) Population density, B) Income distribution pattern, C) Poverty distribution, D) Illinois urban areas.

Again, to understand the spatial distribution of income pattern in Illinois counties, a spatial autocorrelation (Moran's I) method was performed where the value of Moran's I is 0.682674, Exp Moran's I is-0.009901, and z-value is 9.293078). The positive Moran's I value indicates that income distribution pattern is clustered and it is statistically highly significant. Fig 5.5B shows that north-eastern region (Chicago) of the state has the highest income and where low income observed in the southern part of the state.

The physical factors e.g. topography, soil, and precipitation are also very important for determining the suitable location of local food systems. An analysis of Illinois topography shows that most of the northern part and some of the central and southern part of the state are relatively higher than the rest of the state. Except the Shawnee forest area, most of the southern Illinois is flat (Fig 5.6A). For any kind of crop production, precipitation is an essential factor. Fig 5.6B displays the spatial distribution of precipitation. In Illinois, higher precipitation observed at the southern part of the state. The average annual precipitation for Illinois varies from just over 48 inches (1,200 mm) at the southern tip to just under 32 inches (810 mm) in the northern portion of the state. In Illinois, May and June are the wettest months of the year. Lowest precipitation has been observed in the west-central part of the state. Some of the counties that experience lowest precipitation are Knox, Tazeweel, Menrad, Cass, McDonoguh, Fulton, and Piatt. Some of the eastern counties also falls under lowest precipitation region e.g. Cumberland, Clerk, Edwards, Gallatine.

Not all of the water we receive through precipitation is available for crop production. Availability of water in the crop growing season is more important and practical. In Illinois, according to the Natural Resources Defense, the De Witt, Will, and Grundy counties would be facing water shortage in next 50 years. Overall this state has enough water to produce agricultural crops.

Temperature variation also observed in different part of the regions. The highest annual temperature has been observed in the southern part of the region and lowest in the northern part. In Illinois, the Mollisols soil occupied about 45 percent of the state's land area and is most extensive in central and northern Illinois. This type of soil is good for producing crops and vegetables (NRCS, 2012). Fig 5.4A shows that most the vegetables harvested area is located in the Mollisols soil zone.

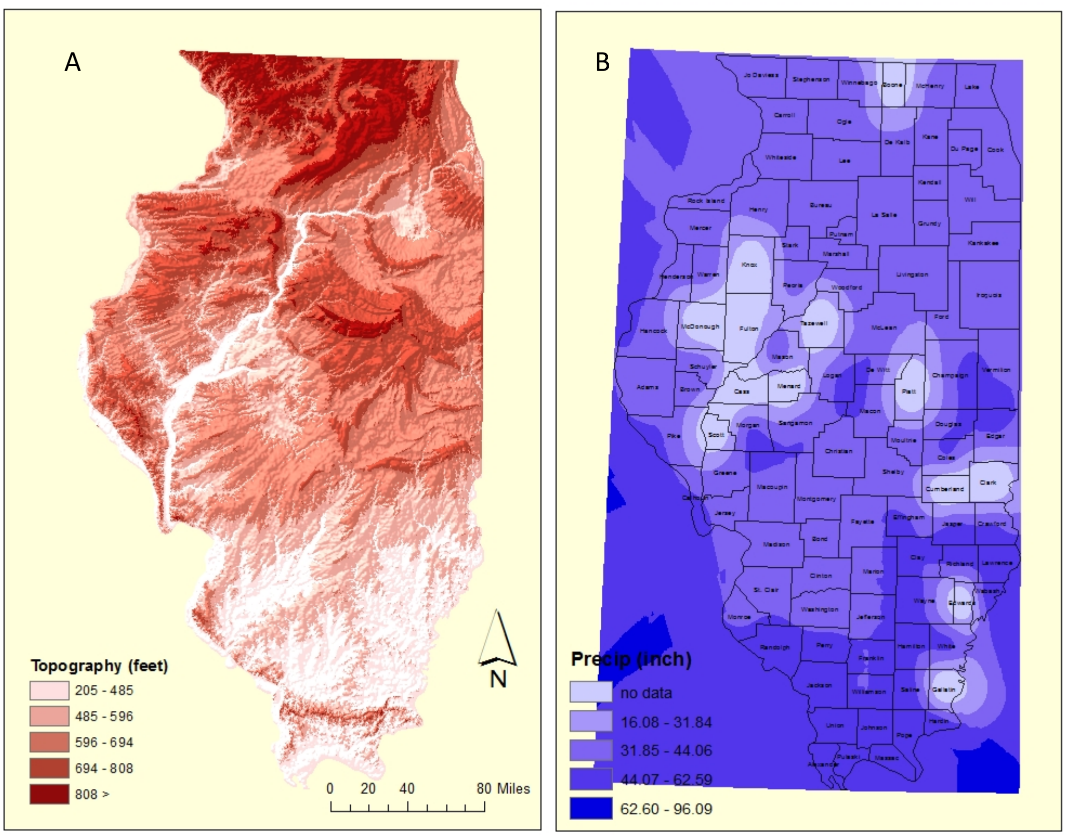

Figure 5.6 A) Illinois topography, B) Precipitations distribution.

Spatial Relationships of Different Factors:

This research made some effort to understand the relationships between different agroecological and socioeconomic factors and examine which factors and the relationships are important for a local food system. The tools and techniques used for these spatial analyses are: spatial autocorrelation, radial basis functions, overlay, mean center, directional mean. Based on these analyses, this research found that following relationships are most influential in developing a local food system:

- farmers market and road network (Fig 5.7)
- vegetables harvested acres and topography (Fig 5.8)
- vegetables harvested acres and precipitation (Fig 5.9)
- farmers market and metropolitan counties (Fig 5.10A), and
- farmers market and Illinois higher income (Fig 5.10B)

It is convention al that road network often influence the location of different factors. This research has again proved that interstate highways are extremely important in development a local food system. Fig 5.7 displays the relationship between location of farmers' market and Interstate highway system. Most of the farmers' market in Illinois are in proximity (within 20 miles buffer zone).

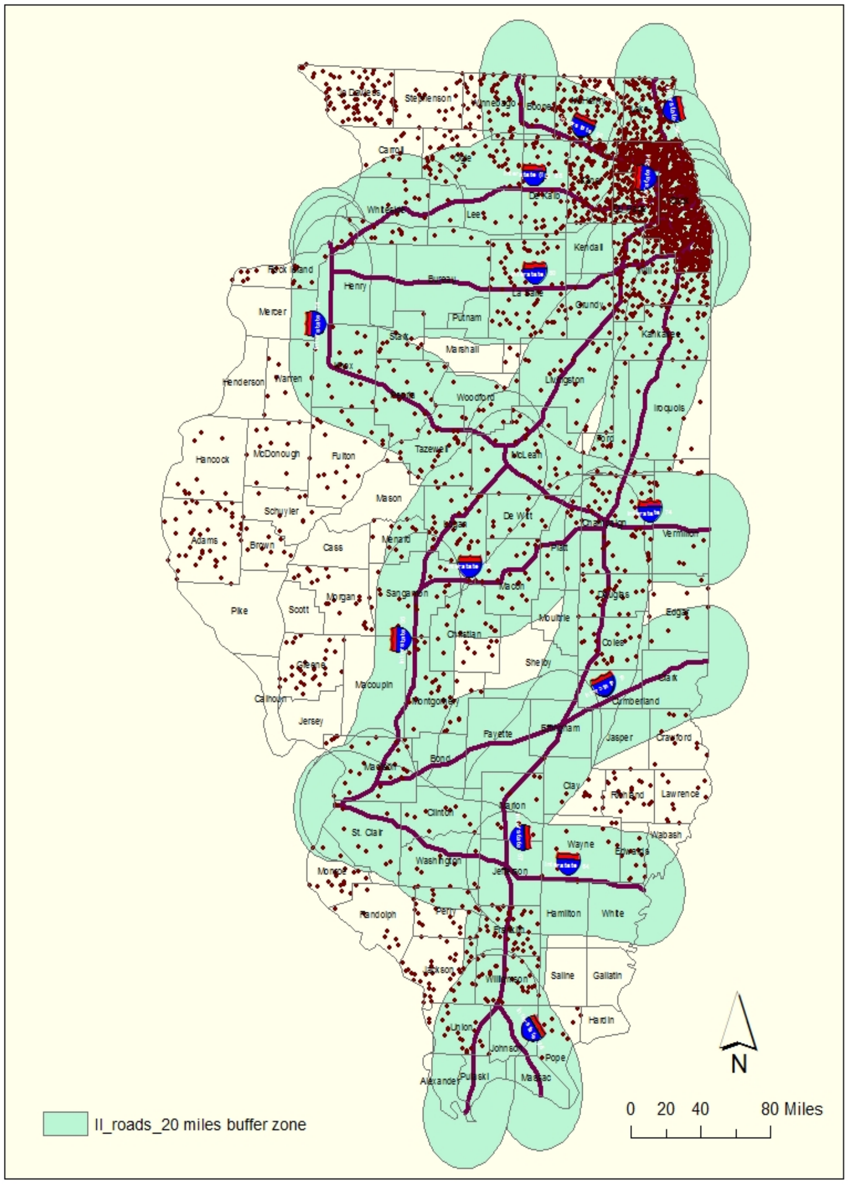

Figure 5.7 Location of farmers' markets and 20 miles buffer zone of Illinois Interstate highway.

The relationship between topography and vegetables harvested acres shows that hilly areas (> 694 feet) in the northern part of Illinois are mostly used for vegetable production (Fig 5.8). However, the average precipitation of this region is <39 inches and the temperature is <52^0F which made the region more favorable for vegetable production (Fig 5.9).. However, average temperature and precipitation in other parts of the state are relatively higher than this region. This also proved that temperature, precipitation and topography are very important in developing a local food system.

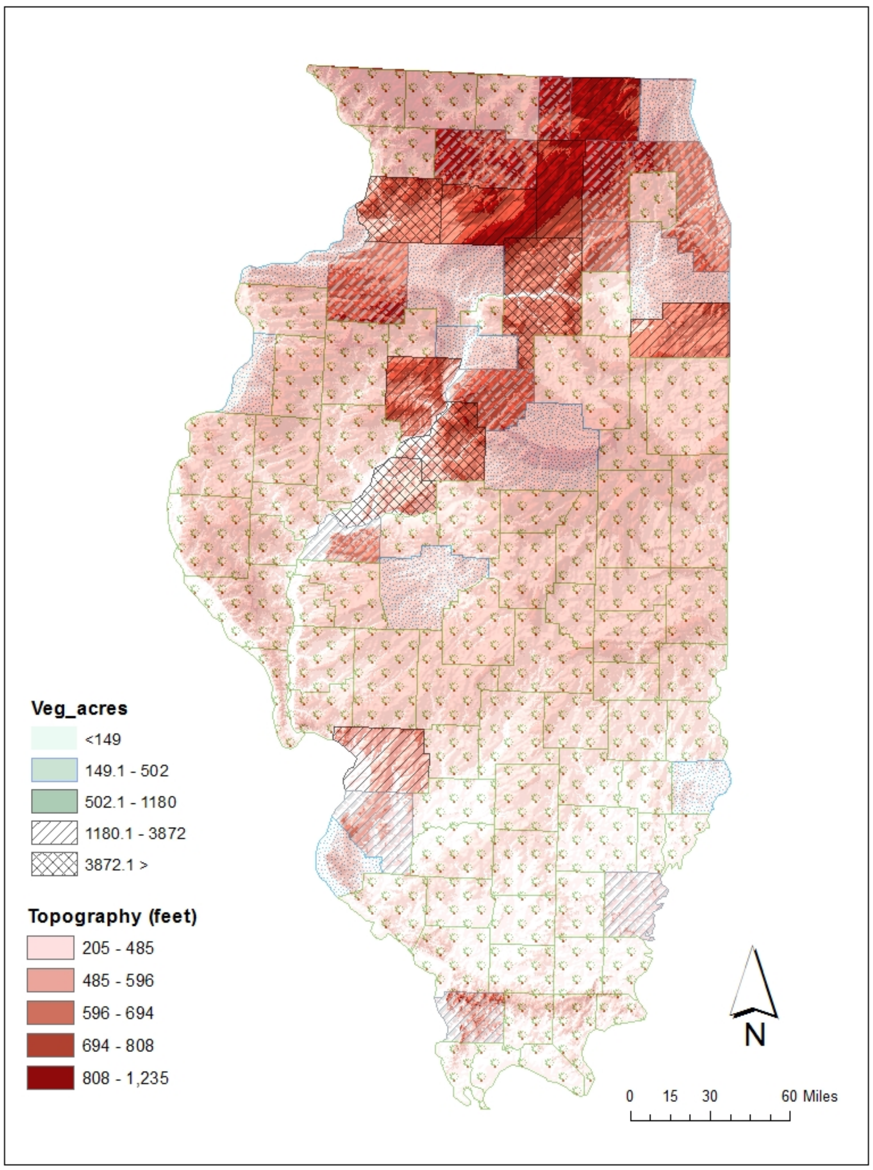

Figure 5.8 Relationship between vegetables acres harvested and the topography (highest value identified by using overly method).

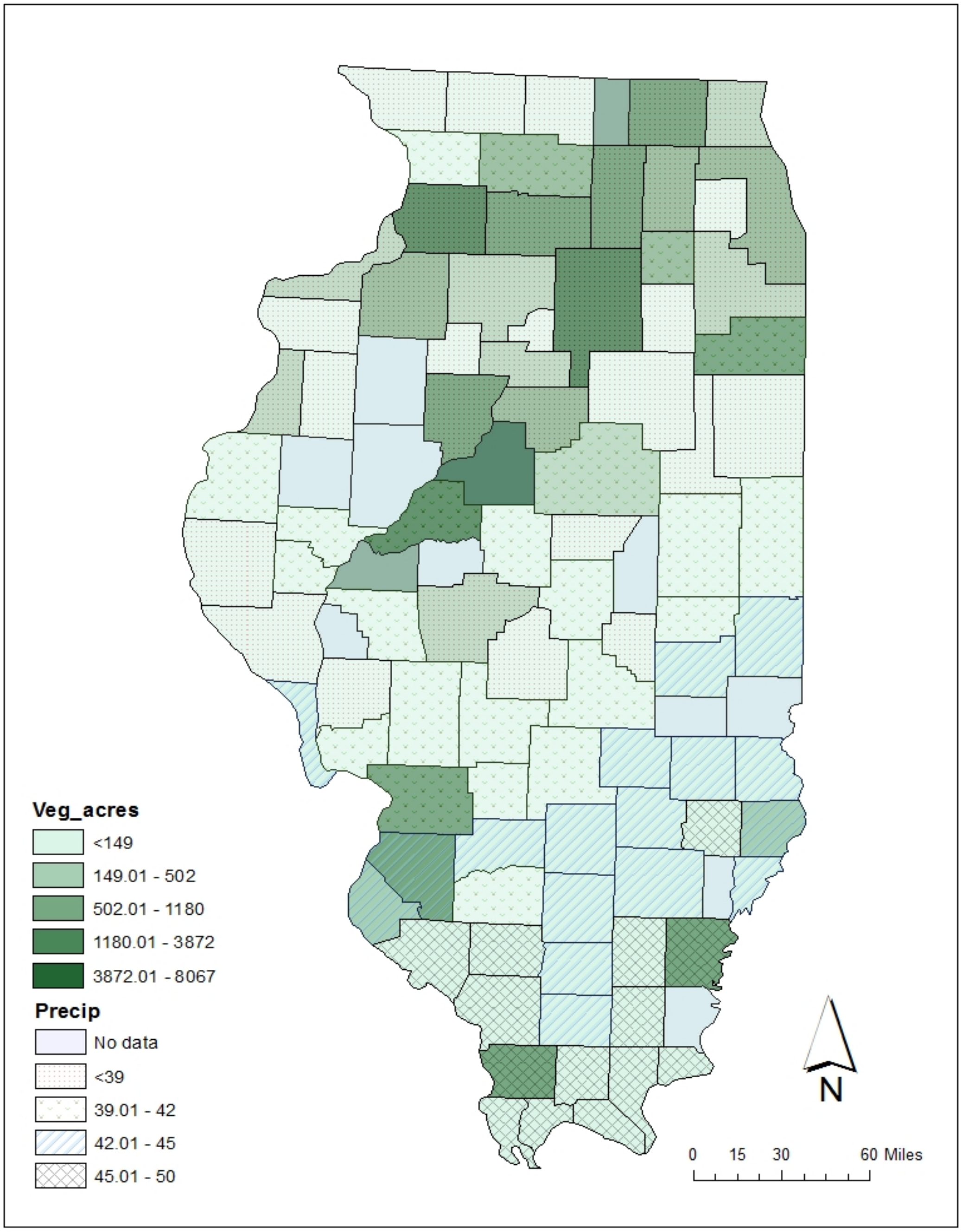

Figure 5.9 Relationship between vegetables acres harvested and precipitation (highest value identified by using overly method).

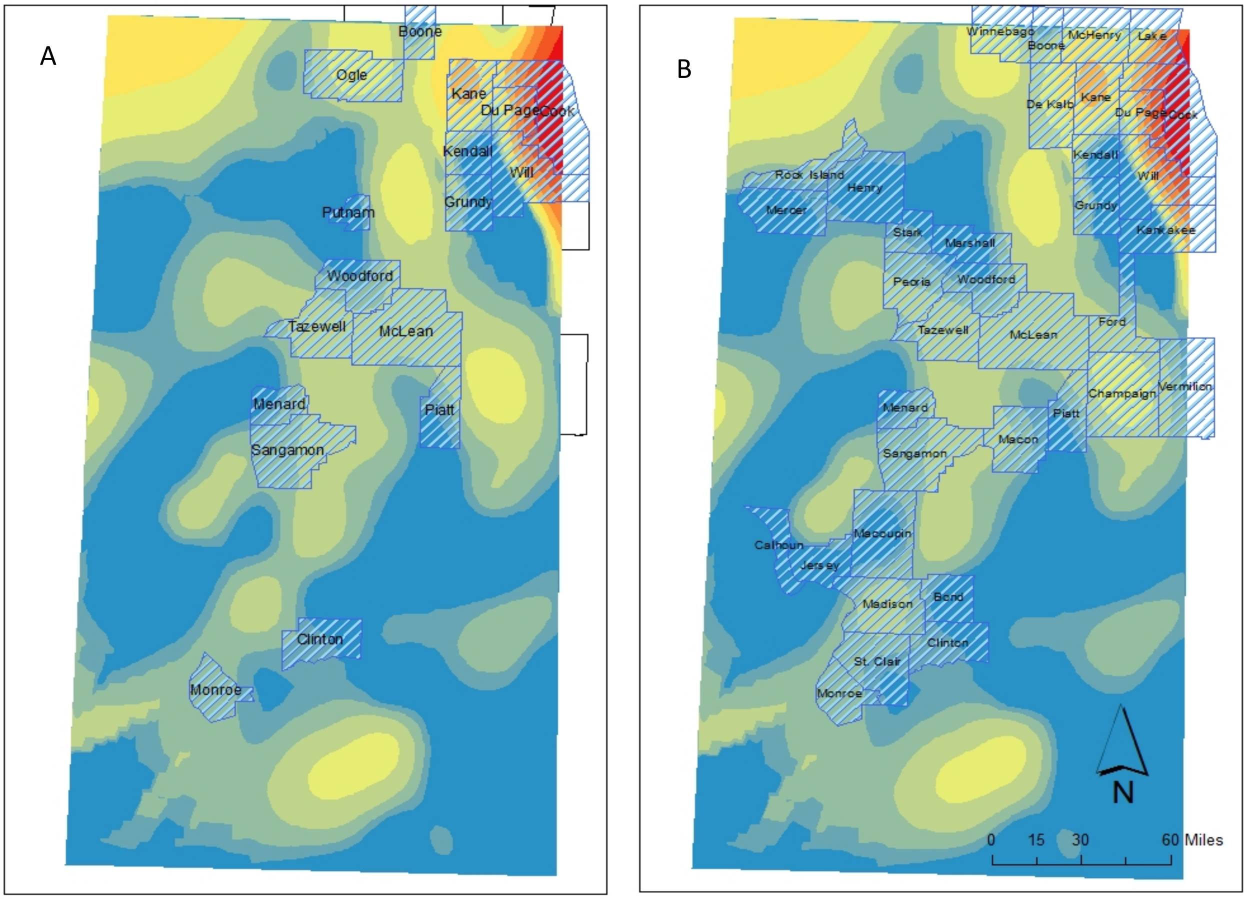

Figure 5.10 A) Illinois metropolitan counties and FMs distribution, B) High HH income counties and FMs distribution.

Fig 5.10A displays the relationship between location of farmers' market and urban areas. The spatial analysis shows that farmers markets are highly concentrated in the counties that are very urbanized (i.e. metropolitan areas). These areas relatively have higher household income than the rural areas of Illinois (Fig 5.10B). Thus, the analyses presented in the figures 10 A and B show that farmers' market develop in the vicinity of urban or metropolitan areas where household income is higher.

An analysis presented in figure 5.11 revealed an important observation on the locations of farmers' market and the CSA. This research found that farmers' markets and CSAs are not concentrated in the same areas, but in two different locations. Where the highest concentrations of CSAs are found, the concentration of farmers market was lowest there (Fig 5.11A & B).

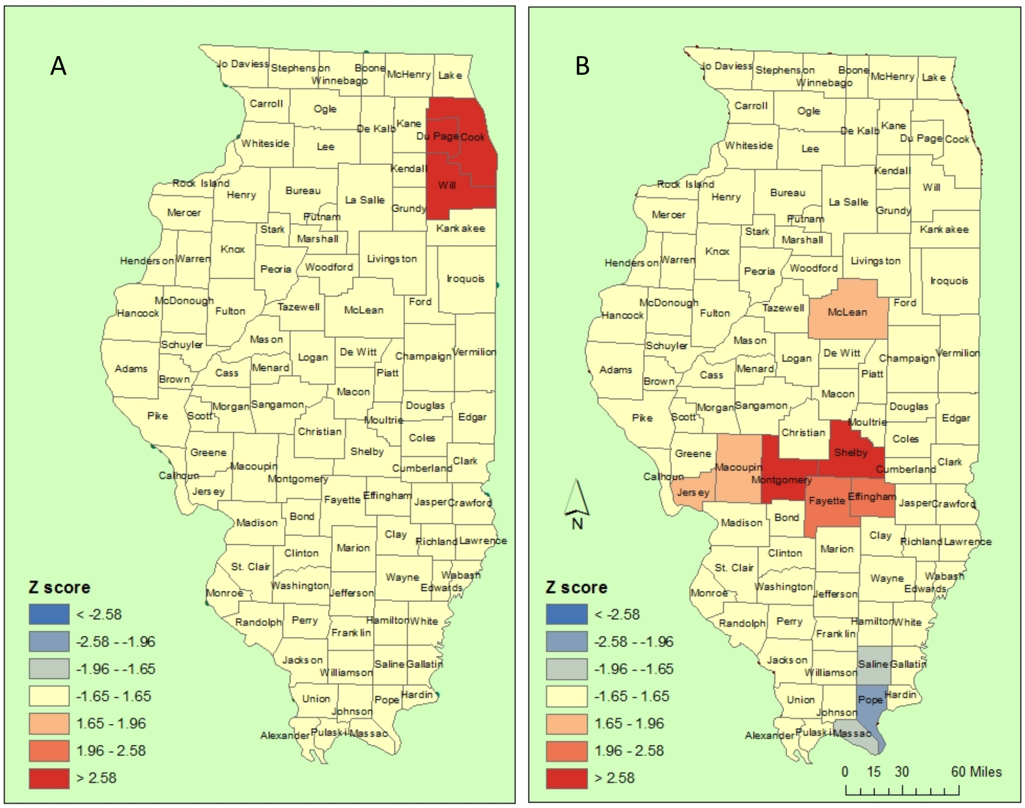

Figure 5.11 A) Farmers markets hot spot, B) CSAs hot spot in Illinois.

Research Question 2: **Which locations are suitable /potential for building local food systems in Illinois?**

One of the main objectives of this research is to identify potential locations of local food systems in Illinois. Previous sections studied several agroecological and socioeconomic factors and developed a series of map to learn the importance of these factors and identify potential locations of local food systems.

This research conducted a multicriteria decision analysis (MCDA) to identify suitable locations for local food systems in Illinois. Integration of MCDA with the GIS is considered as an advanced land suitability analysis that produce a suitability index and as a result produce a location map that clearly delineate a suitable location. This research adopted the suitability index model from Wang (2008), Mabin and Beattie (2005), and Saaty (1980). The steps for developing a suitability model are described in the methodology section. By following the MCDA process, this research has developed a suitability index through the integration of agroecological and socioeconomic factors. The suitability index of the 13 agroecological and socioeconomic factors is presented in Table 5.2.

Table 5.2 Factors, relative importance and weight.

Factors	Relative Importance	Weight
1. No. of farmers' market	5	.12
2. Pop. density	5	.12
3. Income	4	.09
4. Precipitation	4	.09
5. Metropolitan area	4	.09
6. Direct farm sale (DFS)	4	.09
7. Vegetables diversity	3	.07
8. Topography	3	.07
9. Vegetables harvested acres	3	.07
10. Temperature	3	.07
11. Soil	2	.05
12. Vegetables harvested farms	2	.05
13. Interstate highway	1	.02
Sum	43	1

Finally, using the suitability model and combining all the weights from Table 5.2, this research identified the counties that are suitable for local food systems in Illinois. Map 5.12B shows the most suitable locations for developing a local food system in Illinois. Table 5.3 summarizes and presents the most suitable counties based on suitability classes.

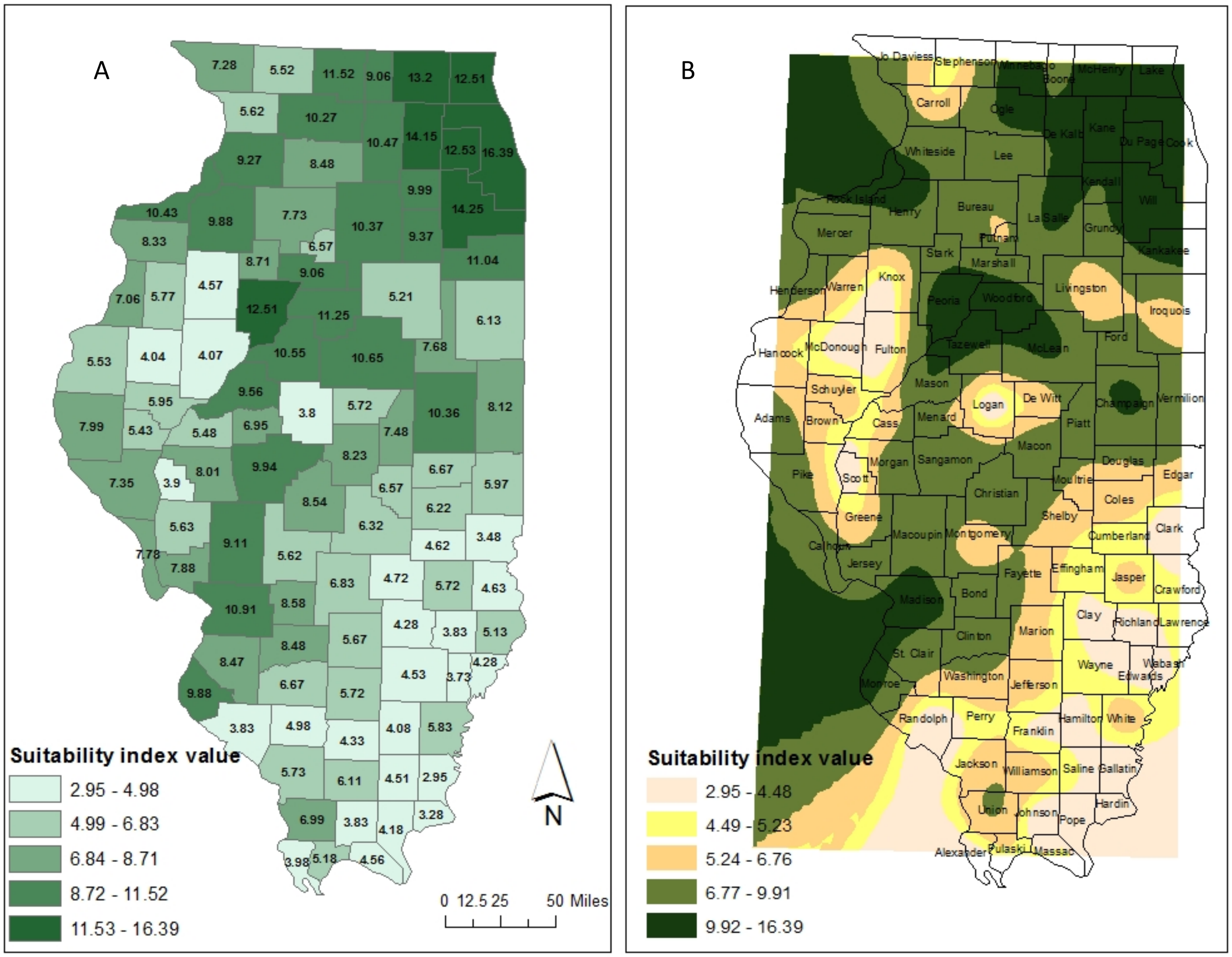

Figure 5.12 A) Suitability model: counties with total weights, B) Suitable locations of "Local Food Systems" in Illinois.

Table 5.3 Total weight classes, suitability classes and counties in Illinois.

Total weight class	Suitability class	Counties
11.53-16.39	Very high	Cook, Will, Kane, McHenry, DuPage, Lake, Peoria, Winnebago
8.72-11.52	High	Woodford, Kankakee, Madison, McLean, Tazewell, DeKalb, Rock Island, Lasalle, Champaign, Ogle, Kendall, Sangamon, Henry, Monre, Mason, Grundy, Whiteside, Macoupin, Boone, Marshall, Stark
6.84-8.71	Medium	Bond, Christian, Clinton, Lee, St. Clair, Mercer, Macon, Vermilion, Morgan, Adams, Jersey, Calhoun, Bureau, Ford, Piatt, Pike, Jo Daviess, Henderson, Union, Menard
4.99-6.83	Low	Douglas, Washington, Moultrie, Putnam, Shelby, Coles, Iroquois, Williamson, Edgar, Schuyler, White, Warren, Jackson, De Witt, Jasper, Jefferson, Marion, Greene, Carroll, Montgomery, Hancock, Stephenson, Cass, Brown, Livingston, Pulaski, Lawrence, Perry
2.95-4.98	Very low	Effingham, Crawford, Cumberland, Knox, Massac, Wayne, Salin, Franklin, Clay, Wabash, Pope, Hamilton, Fulton, McDonough, Alexander, Scott, Johnson, Randolph, Richland, Logan, Edwards, Clark, Hardin, Gallatin

However, this research made another effort to verify the distributional pattern of the potential locations of local food systems presented in Figure 5.12B. Using Global Moran I method, this research intended to examine whether distributional patterns are clustered or dispersed or random. The analysis derived a Moran's I value 0.633247 and the z-value 8.524882. Here, the positive Moran's I value indicates positive spatial autocorrelation which means distribution pattern of suitable location is clustered.

CHAPTER 6

CONCLUSIONS

Using various spatial tools and multicriteria decision analysis, this research identified potential locations for local food systems in Illinois. The research found that the counties of Cook, Will, Kane, McHenry, DuPage, Lake, Peoria, and Winnebago are most suitable for a local food system. However, 24 counties are not very suitable for developing a local food system (Table 5.3). Some agroecological and socioeconomic factors and their specific conditions determine the locations that are suitable for local food systems. Table 6.1 summarizes certain agroecological and socioeconomic conditions of the 8 counties that found most suitable.

Table 6.1 Certain conditions for development of LFS in Illinois.

Suitable counties: Cook, Will, Kane, McHenry, DuPage, Lake, Peoria, and Winnebago	
Factors	Conditions/Characteristics
No. of farmers markets	>14
No. of CSAs	<4
Direct farm sales (in $)	>700
No. of vegetables farms	>23
No. of vegetables	>5
Pop. density (in sqm)	>489
Poverty rate (%)	<8.5
Median HH Income (in $)	>52,525
Urban areas	>50,000
Transportation system	Interstate and state HW
Topography (in feet)	More than 694 feet
Precipitation (inches)	18 -32
Temperature (^{0}F)	$<52^{0}$
Soil	Mollisols soil

Among the agroecological factors, topography is one of the most influential factors. Land terrain is very high in the northern and central areas of Illinois and these areas are more favorable for vegetables production as water can drain out very easily. Beside moderate precipitation, low temperature is also important for vegetables production. Availability of water is very crucial for production of vegetables. Illinois is very resourceful for its surface and groundwater. Thus, availability of water in determining a local of local food systems in Illinois is not a controlling factor. However, this may be very important for other states.

It is evident from the study that farmers' market is the most influential factors and most of the farmers' market are concentrated in northeastern part of the state. The population density and income are other two important socioeconomic factors and they are also concentrated in the same region. The study also found that farmers' market concentration is high where household income is relatively higher.

Interestingly, the result found that CSAs and farmers' markets are not clustered in the same area. CSAs are mainly clustered to a location where farmers' markets are randomly distributed. However, highly clustered CSA areas represent relatively higher level of poverty and low population density.

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APPENDIX

APPENDIX-1

Appendix 1. County level information on population, direct farm sale, farmers' market, harvested acres, CSAs, vegetables diversity, precipitation and poverty rate.

County	Pop. (2010)	Direct Sale $ (000)	Farmers Markets (2010)	Vegetables Farms (2007)	Vegetables harvested areas 2007 (acres)	Fresh vegetables farms (2007)	CSA (2007)	Vegetables diversity	Precipitation	Median HH income	Poverty rate (%)
Adams	67103	139	4	16	135	16	3	3	37.33	44555	12.4
Alexander	8238	0	0	3	6	3	0	1	48.6	28725	29.5
Bond	17768	16	0	5	6	5	2	2	41.27	45930	14.3
Boone	54165	921	1	25	866	18	6	7	0	62531	7.5
Brown	6937	38	1	1	0	1	1	1	39.21	42660	15.1
Bureau	34978	289	0	18	502	12	8	4	36.18	46891	9.9
Calhoun	5089	123	0	10	94	9	6	3	44.57	44146	10.8
Carroll	15387	208	1	11	0	10	1	0	39.64	45301	11.4
Cass	13642	26	0	9	696	8	2	2	0	40561	12.4
Champaign	201081	454	5	17	59	17	7	5	40.31	45840	18.7
Christian	34800	146	2	9	115	8	6	4	37.38	44711	13.6
Clark	16335	30	0	4	13	4	1	0	0	48357	12.2
Clay	13815	57	1	1	0	1	3	1	44.57	39490	13.8
Clinton	37762	74	1	8	7	8	3	1	43.5	55683	7.8
Coles	53873	94	2	9	24	8	8	1	42.7	38377	19.2
Cook	5194675	0	94	32	679	29	2	6	38.17	54559	14.8
Crawford	19817	38	1	3	0	1	2	1	44.25	42564	13.6
Cumberland	11048	98	0	3	68	3	0	1	0	45301	11.7
DeKalb	105160	622	4	39	2247	13	1	2	36.98	55266	12.1
De Witt	16561	168	1	1	0	1	0	0	38.59	47645	10.2
Douglas	19980	161	2	11	25	11	1	3	40.95	45359	9.2
DuPage	916924	136	14	3	0	3	0	1	37.97	77040	5.8
Edgar	18576	129	1	3	22	3	2	0	42.35	42522	13.3
Edwards	6721	6	1	1	0	1	0	1	0	41275	11.1
Effingham	34242	113	0	5	60	3	8	0	43.73	45192	10.8
Fayette	22140	89	0	13	103	13	4	4	40.52	39534	15.1
Ford	14081	0	2	11	0	10	0	2	36.72	51313	9.8
Franklin	39561	34	4	2	0	2	3	2	44.6	34456	18.3
Fulton	37069	136	2	11	27	11	5	3	0	40135	15.1
Gallatin	5589	117	0	5	0	3	1	0	0	34580	18.6
Greene	13886	11	3	3	0	3	6	0	38.32	38678	15.1
Grundy	50063	16	1	4	0	4	1	0	37.91	60738	6.5
Hamilton	8457	30	0	7	9	7	1	1	47.46	38115	12.9
Hancock	19104	56	1	4	0	4	0	0	39.48	41730	11.3
Hardin	4320	0	0	2	0	2	1	0	49.86	31547	20.6
Henderson	7331	149	0	7	373	4	0	2	36.75	43252	11.8
Henry	50486	165	0	23	888	23	2	4	37.81	48959	9.9
Iroquois	29718	92	1	15	0	15	3	0	38.36	46529	10.8
Jackson	60218	700	4	13	90	13	0	4	47.17	34763	22.9
Jasper	9698	114	0	1	0	1	2	0	44.12	44445	10.9

County	Pop. (2010)	Direct Sale $ (000)	Farmers Markets (2010)	Vegetables Farms (2007)	Vegetables harvested areas 2007 (acres)	Fresh vegetables farms (2007)	CSA (2007)	Vegetables diversity	Precipitation	Median HH income	Poverty rate (%)
Jefferson	38827	144	0	7	0	7	5	2	43.4	38875	17.2
Jersey	22985	19	0	2	0	2	1	0	40.6	51256	9.8
Jo Daviess	22678	303	7	15	106	15	1	2	36.63	51237	8.5
Johnson	12582	18	0	4	0	4	0	1	49.28	42382	17
Kane	515269	1434	12	28	1180	26	2	5	37.76	66834	9
Kankakee	113449	842	3	27	3394	25	6	6	39.16	49987	13.7
Kendall	114736	0	0	19	664	18	1	1	40.37	85630	3.4
Knox	52919	35	2	8	15	8	1	3	0	38996	16.5
Lake	703462	924	12	25	390	25	1	1	36.77	78617	7.6
LaSalle	113924	447	6	92	6983	32	8	4	37.94	49617	10.4
Lawrence	16833	27	1	6	318	4	0	2	45.94	38999	17.3
Lee	36031	109	1	42	3872	11	9	3	38.4	50391	9.9
Livingston	38950	146	2	6	18	6	7	2	36.65	50972	11.4
Logan	30305	58	3	3	0	2	2	1	39.6	52525	12.3
McDonough	32612	104	1	7	26	7	6	0	0	39874	20.8
McHenry	308760	2644	8	56	1896	54	9	8	35.51	79656	5.2
McLean	169572	306	3	27	198	27	14	5	39.34	58474	11.4
Macon	110768	59	2	6	23	6	0	1	40.32	45664	13.5
Macoupin	47765	372	0	6	51	6	10	1	39.06	45009	12.6
Madison	269282	678	3	30	1946	24	2	4	41.6	51207	12.6
Marion	39437	175	1	13	74	12	1	2	43.88	41759	14.6
Marshall	12640	276	0	9	245	8	1	1	37.6	50701	8.8
Mason	14666	126	0	55	8067	12	2	5	39.8	42022	13.5
Massac	15429	41	0	6	17	6	0	2	48.22	38735	15.6
Menard	12705	43	1	3	7	3	1	2	0	57884	9.1
Mercer	16434	121	0	7	0	5	2	1	37.29	51437	9.4
Monroe	32957	82	2	13	244	13	2	5	43.18	70904	4.4
Montgomery	30104	128	3	4	8	4	10	0	41.39	41358	16.8
Morgan	35547	531	2	9	36	9	8	2	39.45	45944	14
Moultrie	14846	149	0	9	94	8	1	1	37.77	48447	9.9
Ogle	53497	515	5	47	1147	36	0	3	39.26	56452	8.5
Peoria	186494	287	2	29	2013	14	0	6	38.42	49634	15
Perry	22350	62	2	5	17	5	2	1	46.3	41224	16.3
Piatt	16729	68	1	9	22	7	0	1	0	59515	6.4
Pike	16430	47	0	11	149	10	2	1	38.58	40205	15.6
Pope	4470	0	1	2	0	2	0	1	49.86	38071	19.3
Pulaski	6161	12	0	4	0	4	1	0	49	31261	26.6
Putnam	6006	0	0	1	0	1	2	0	36.18	57786	7.4
Randolph	33476	21	1	5	3	5	3	0	47.17	45276	14.4
Richland	16233	23	2	2	0	2	3	0	47.42	39267	14.9
Rock Island	147546	197	2	14	381	12	2	1	37.96	45606	12
St. Clair	270056	99	1	28	612	25	4	5	42.73	47876	15.3
Saline	24913	13	0	8	19	8	0	1	49.86	33812	19.2
Sangamon	197465	261	2	20	177	20	1	2	37.43	53408	11.4
Schuyler	7544	13	1	2	0	2	2	1	40.16	43053	12.4
Scott	5355	0	0	2	0	2	1	0	0	45456	10.9
Shelby	22363	138	0	3	0	3	16	0	39.3	46378	10.3

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Stark	5994	109	1	6	146	5	2	1	37.3	45357	10.8
Stephenson	47711	122	2	9	17	9	2	0	36.06	43247	12.9
Tazewell	135394	397	3	57	6854	13	4	3	0	55964	7.8
Union	17808	555	2	25	674	25	7	4	50.38	39090	17.6
Vermilion	81625	216	1	12	8	12	0	0	42.02	41292	14.6
Wabash	11947	21	0	0	0	0	0	1	45.94	43642	13.5
Warren	17707	36	1	3	3	3	3	0	38.52	43558	12.6
Washington	14716	132	1	8	37	8	2	2	40.12	52103	8.5
Wayne	16760	15	1	10	0	10	4	0	44.26	38114	13.7
White	14665	30	0	12	1078	4	5	0	47.42	40118	14.9
Whiteside	58498	659	2	39	7669	15	3	6	37.76	47045	11.3
Will	677560	1346	12	31	307	30	3	5	36.81	76561	6.5
Williamson	66357	47	3	11	28	11	3	5	44.6	38721	18.5
Winnebago	295266	357	5	28	60	28	4	7	36.24	47646	13.8
Woodford	38664	650	1	22	605	16	6	7	37.67	64944	5.9

Source: USDA, Census Bureau, NRCS.

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