INCREASING FOOD ACCESSIBILITY AMONG URBAN POOR: PROVIDING AN ALTERNATIVE SOLUTION THROUGH A CITY-WIDE COMMUNITY GARDEN PLAN

by

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ABSTRACT

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Community Gardens have been entitled as an emerging solution to food security and injustice issues especially among socially disempowered communities. US Department of Agriculture has designated more than half of the census tracts in City of Dallas as food deserts, representing inadequate access to fresh food in these areas. As an alternative solution, this study proposes a methodology to identify suitable locations for community gardens to increase access to fresh food for disadvantaged population. The suitability analysis was used by primarily taking the relevant socio-economic factors into consideration. The reclassification and weightings are derived through a combination of qualitative and quantitative method such as surveys and Analytical Hierarchy Process. This study identifies suitable areas of 11.2 sq. miles for community gardens all over the City of Dallas, however spatially they are more concentrated in the southern part of the city. It also identifies the physical factors for the site-specific analysis as the next step and provides strategic and institutional framework for implementation. This research lays the foundational work for adopting community garden as a part of planning for the City of Dallas.

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INTRODUCTION

1.1 Background

“To grow your own food gives you a sort of power and it gives people dignity. You know exactly what you’re eating because you grew it. It’s good, it’s nourishing and you did this for yourself, your family and your community.”

-Karen Washington

A food desert is a low-income area where a considerable number or share of residents has low levels of access to supermarkets or large grocery stores (Regan & Rice, 2012). Food deserts have been receiving growing attention in the past decade as a symbol of urban injustice issues. Statistics shows that 23.5 million people in United Status live in a food desert, and more than half of them (13.5 million) are low-income (USDA, 2011).

The innovative approach of urban agriculture or as it is more commonly known; community gardens (community gardens fall under the umbrella of urban agriculture) can provide a solution for inadequate, unreliable, and irregular access to fresh and healthy food. However, this process requires the involvement of local communities. (Zeeuw & Dubbeling, 2009). In the case of Detroit Michigan, approximately 135 acres of city land have been transformed into 1,410 community gardens through the efforts of local families, schools, communities, and entrepreneurs. The effort included 5,000 local adults and 15,000 local youth (Atkinson, 2012). Community gardens are also known for bringing communities together. Community gardens boost local economic development by serving local needs with locally grown fresh food, and providing a significant amount of additional green space to communities (Zeeuw, Dubbeling, Veenhuizen, and Wilbers, 2009). Figure 1.1 provides holistic view of multi-dimensional benefits of Urban Agriculture:

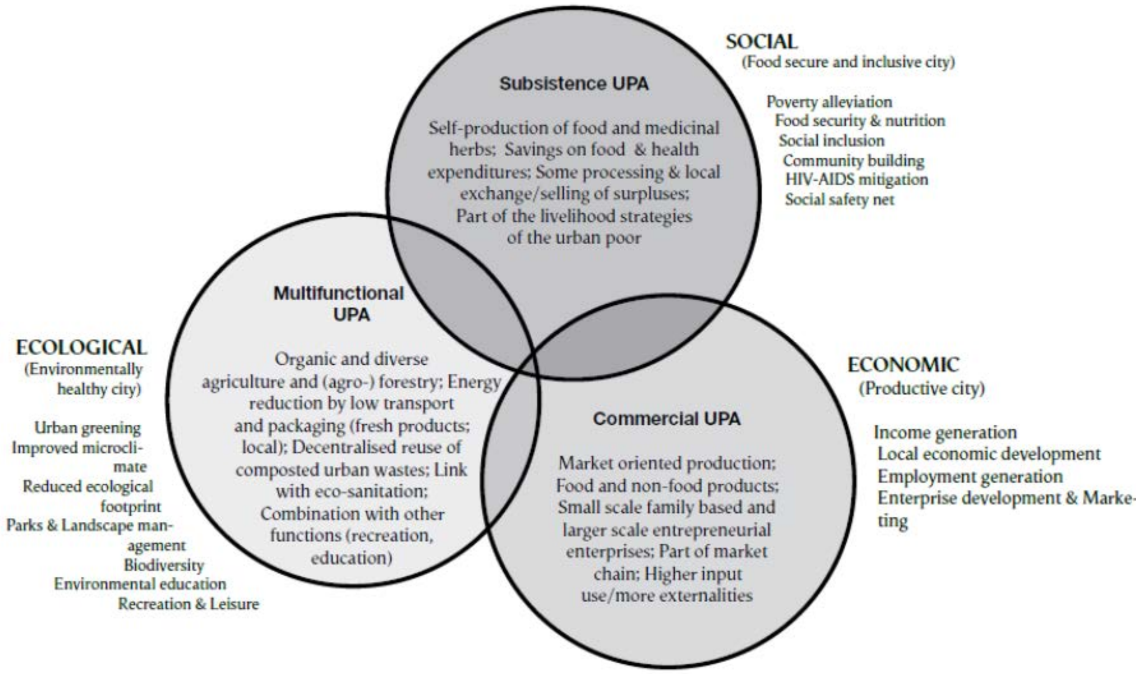

Figure 1.1 UA fulfilling sustainability triangles (Zeeuw et al., 2009, Page 6)

In the past few years many cities in North America have adopted reassuring food system policies and programs (Neuner, Kelly, & Raja 2011). Cities such as Minneapolis, Baltimore, and Vancouver have written urban agriculture plans which include food production in citywide sustainability strategies, facilitate the integration of agriculture into new buildings and provide city property for new urban farms (Reynolds, 2014). Although many city ordinances have hindered the initiation of urban agriculture; various cities have amended zoning ordinances and building codes to legalize and support urban agriculture. These efforts have ensured that dedicated lands for urban agriculture are in compliance with city ordinances (Mukherji and Morales, 2010).

The multifunctional benefits of urban agriculture, allow planners to play a central role in promoting community gardens. Benefits are increased across multiple sectors such as public health, social justice, energy, water, land, transport, and economic development, thus ensuring food security for the residents (Morgan, 2010). In food system planning, planners contribute to identifying suitable areas for urban agriculture, providing food system policies and programs, and helping implantations through amending zoning ordinances.

Given this call for planners' role in improving urban food systems, this study will demonstrate a methodology for citywide urban agriculture planning, particularly focusing on community gardens in the City of Dallas, Texas. Dallas was selected as a case study because of its potential for utilizing urban agriculture as a way to alleviate urban food deserts.

According to the U.S. Department of Agriculture (USDA, 2011), large areas in South Dallas have been identified as food deserts (Cherones, Foster, Gilbert, II, & Wondrack, 2011). This situation portrays a potentially serious health issue among the low-income residents since they have limited access to fresh food and groceries.

The portion of residents highlighted in Figure 1.2, lacks access to fresh food. The green and orange represent areas with no grocery stores or supermarkets within a 1-mile and half-mile radius respectively.

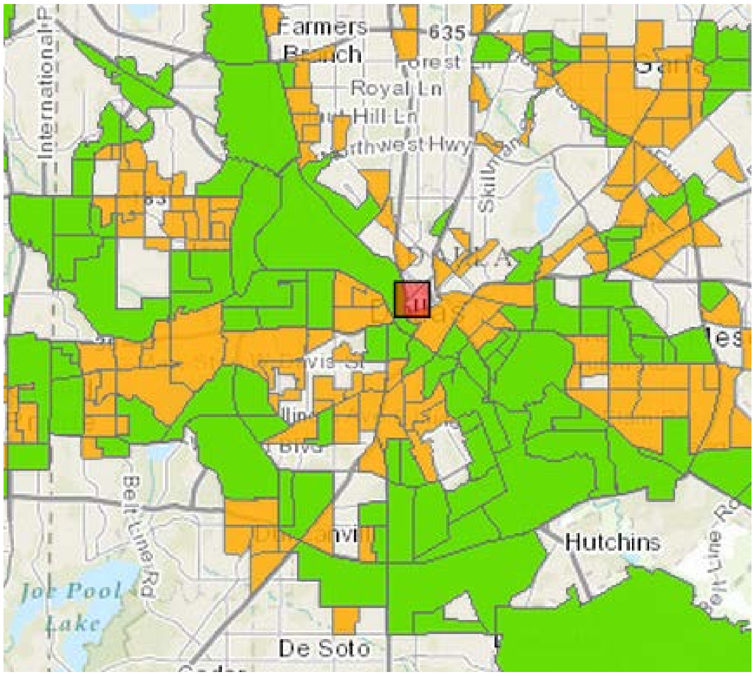

Figure 1.2 Food Deserts in Dallas and vicinity (United States Department of Agriculture, 2014)

1.2 Objectives

This paper aims to provide a basic framework for a citywide community garden plan in the City of Dallas. The study focuses on the various benefits generated by urban agriculture and aims to find suitable locations for community gardens. Additionally, the study will provide a holistic approach to implementing the results to maximize the socio-economic benefits. The goal is expanded through two objectives:

1. Identify suitable areas for community gardens to increase food access for socially disadvantaged population as an alternative solution.
2. Provide a structural and institutional framework for implementation measures

Chapter 2 provides a literature review to build the groundwork for fulfilling the objectives. Chapter 3 demonstrates the methodology, outlining how the suitability analysis has been conducted using Geographical Information Systems (GIS). Since this study focuses on city-wide planning rather than site specific analysis, where the physical factors bear greater importance, the suitability analysis here has been conducted primarily based on the socio-economic factors. Chapter 4 presents the results of the suitability analysis at a city-wide scale using a series of maps. Finally, Chapter 5 discusses the steps and strategies to implement the results of suitability analysis in the City of Dallas.

CHAPTER 2

LITERATURE REVIEW

Literature related to urban agriculture and suitability analysis was selected for review. The literature review of urban agriculture is geared towards finding the most important factors related to suitable locations of community gardens. Although the research is primarily focused on the community garden level of urban agriculture, the whole concept of urban agriculture has been closely observed in the literature review. A review of the background and detailed process of suitability analysis was also conducted to inform the main method of this study.

2.1 Urban Agriculture and Community Gardens

2.1.1. Definition

Urban agriculture defined in simple terms is “the growing, processing, and distribution of food and other products through intensive plant cultivation and animal husbandry in and around cities” (Hodgson, Campbell, & Bailkey, 2000). In simple words, any type of food production activity in urban areas can be considered urban agriculture.

The Council on Agriculture, Science and Technology (CAST) takes into account the whole process of urban agriculture and the multiple associated benefits in their definition. According to their definition, urban agriculture is a complex system generating a blend of interests, where primary activity involves the production, processing, marketing, distribution, and consumption of food (Bailkey & Nasr, 2000). Those benefits encompass recreation and leisure, economic vitality and business entrepreneurship, individual health and well-being, community health and well-being, landscape beautification, and environmental restoration and remediation (Brown, 2002). Figure 2.1 provides a holistic picture of the diversified benefits community gardens generate.

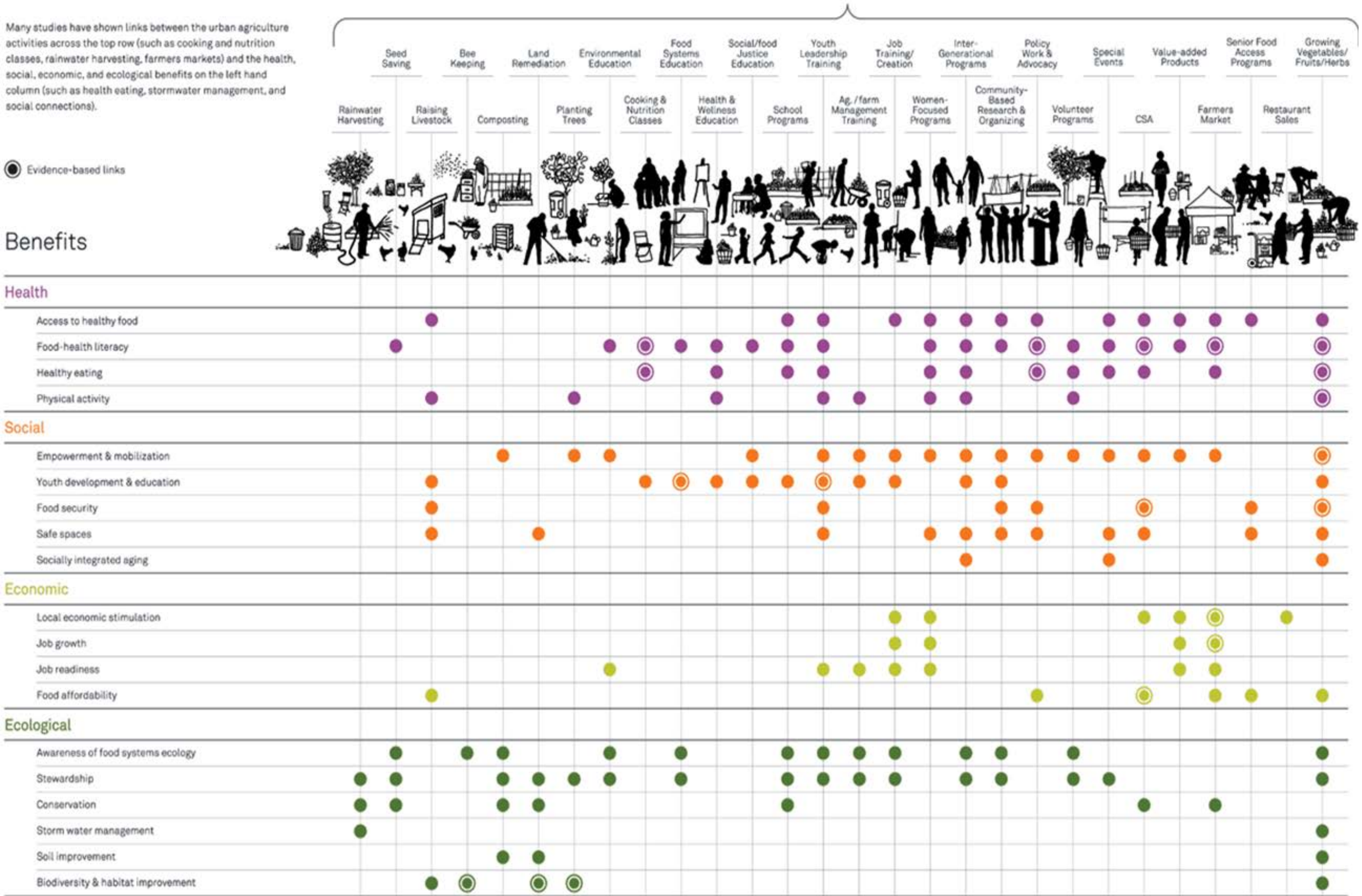

Figure 2.1 Metrics Framework for Benefits of Urban Agriculture (Five Borough Farm, 2014)

For this study, urban agriculture is defined as any sort of food production activity on a dedicated space within a city boundary, conducted by residents of the community. Furthermore, the focus on urban agriculture is confined to public spaces (e.g. community gardens as opposed to backyard farming on private properties) that can be initiated and managed by the city, the community or a third-party organization and specifically targeted towards enlarging socioeconomic benefits.

2.1.2. Socioeconomic Benefits of Urban Agriculture

Historically, the perception that food production is an entirely rural activity hinders the appreciation of urban agriculture. Food production activities never vanished in the starved cities of the global south and are re-emerging in the more viable cities of the global north, where they have experienced the loss of open spaces in the cities for the last few decades and now urban designers are re-imagining 'the city as a farm' (Morgan, 2010). The question arises under what combination of circumstances is urban agriculture most likely to emerge and make an important contribution to urban welfare.

Increasing urban poverty is a challenge in urban areas, and they can potentially receive considerable benefits from urban agriculture. Poor families spend 60-80% of their income on food and still remain food insecure (Hodgson, Campbell, & Bailkey, 2000). Consumer food prices in many cities of the developing world have spiked upward since the removal of subsidies and price controls accompanying structural adjustment policies in the 1980s and 1990s (Bon & Moustier, 2010). For instance, food prices in Harare, Zimbabwe rose 534% between 1991 and 1992, spurring poor urban consumers to access food from outside of traditional marketing channels and through home production (Dueñas, Plana, Salcines, Benítez, Medina, & Dominí, 2009). In Chicago, "Growing Home" is a job training program and organic urban farm for homeless people and former prisoners (Mukherji & Morales, 2008). Most of the "Urban Agriculture" type initiatives have so far emerged from the need of the economically disempowered to have increased access to healthy food (Alaimo, Reischl, & Allen, 2010).

Urban Agriculture is an innovative approach towards urban poverty and food insecurity by countering inadequate, unreliable and irregular access to fresh and healthy food. This food insecurity concept includes inequitable and unaffordable access to food with regards to various criteria of quality, quantity, hygiene and cultural preferences along with inadequate food (Leete, Bania, & Sparks-Ibanga, 2012). Producing food in the urban areas greatly decreases food insecurity among urban poor and immigrants (Leete, Bania, & Sparks-Ibanga, 2012). Moreover, reduced food mileage with lower transportation and distribution cost reduces food price and at the same time provides options for fresher food (Zeeuw & Dubbeling, 2009). Building social capital is also one of the observed benefits of urban agriculture. The community garden works as a common place for the community to come and meet thus developing a “sense of belongingness” among the people (Kransy & Tidball, 2009). It provides the community a source of culturally appropriate food unavailable in typical grocery stores (Mukherji & Morales, 2008).

Promoting the local economy is another strong argument for urban agriculture. Urban poor or immigrants save money from producing crops and foods that contribute to their quality of life. Significant amount of income generation is possible from sales of surplus crops, ornamental plants or processed food. Increasing employment through urban agriculture has been strengthened with training and skill programs in several UA projects. (Thibert, 2012) Urban agricultural land makes productive use of space which would otherwise have no economic output (Zeeuw, et. al, 2009).

A number of cases clearly show socioeconomic benefits of urban agriculture. In Santa Cruz, CA, for example, the Homeless Garden Project raises vegetables, herbs and flowers on 3.5 acres. Daily, 25 garden workers eat lunch freshly made from the garden’s produce. The remaining vegetables are sold wholesale, distributed to their community supported agriculture (CSA) subscribers, and donated to a soup kitchen and an AIDS project. Their estimated annual income from all sales, including dried flower wreaths and other crafts as well as fresh produce, is $26,000 (Brown, 2002). As an example of city-wide implementation, New York City has more than 1000 community gardens (some 80% of which produce food), nearly 300 school gardens, about two dozen community operated farms, a handful of commercial farms, and dozens of neighborhood composting projects (Ackerman 2011). This extensive network of community gardens and urban farms reflects the city’s diversity, as well as historical and shifting neighborhood demographics. For instance, studies have found that African Americans and Latino/as (with representation from a number of regions in Central and South America) represent the majority of community gardeners in the city, and that urban agriculture sites, particularly community gardens, are concentrated in low-income communities and communities of color (Eizenberg 2008). Although gentrification has changed the demographics of the gardeners to some extent, it is still evident that community gardens are extremely helpful for minority communities (Reynolds, 2014).

Although urban agriculture has provided a coping strategy for the urban poor in multiple dimensions (Smit, Nasr, & Ratta, 2001), the extent of benefits of urban agriculture have been largely underestimated. The words “urban” and “agriculture” do not sound very attuned which is why urban agriculture has always been informal in the past in terms of land occupied, the labor market, and the sales of production (Brown, 2002). No official authority dealt with informal activities (Broadway and Broadway, 2011). Recently, more efforts and attentions are made to develop a systematic food system plan and measure their benefits. American Planning Association has recognized the effects of municipal policies on urban agriculture and thus started promoting ways to overcome those. Zoning is identified as one of the several tools to integrate urban agriculture with a city’s other ordinances (Mukherji & Morales, 2008). Partnering with nongovernmental organizations such as community groups, businesses, and land trusts can also provide an effective way of directing resources toward urban agriculture without having to dedicate substantial resources to management (Mukherji & Morales, 2008). More examples of how urban agriculture is promoted in planning are described in the following section.

2.2 Urban Agriculture and Planning

In recent years, more cities have been including the aspects and prospects of urban agriculture in their planning tools. For example, in the City of Madison, Wisconsin, Comprehensive Plan Update recognizes the processed food sector as one of the city's important industry clusters that should be enhanced. Completed in 2006, it includes objectives to preserve farming operations within the city; encourage new, smaller farming operations such as Community Supported Agricultural (CSA) farms; identify areas on the city's periphery suitable for long-term preservation for diverse agricultural enterprises compatible with urban land uses, such as apiaries, orchards, and vineyards; and promote the sale of foods grown in its county (Pothukuchi, 2014).

Portland, Oregon's Diggable City Project is one of the promising cases that shows a systematic planning approach to urban agriculture. In November 2004, the Portland City Council unanimously passed a resolution calling for an inventory of city-owned lands suitable for agricultural uses. A group of urban planning graduate students from Portland State University undertook an inventory of all 289 unused city-owned parcels to determine their feasibility for urban agriculture use. Supported by the city government, their research used GIS, focus groups, and soil studies. In June 2005 the students returned to the council with their report, The Diggable City: Making Urban Agriculture a Planning Priority. Council accepted the report and directed the Portland Food Policy Council to advise them on how to proceed. In 2006, a report was presented to the city council which included recommendations on identifying suitable land for urban agriculture, creating three pilot projects on plots of land in the inventory, and exploring policy changes to remove barriers to urban agriculture, which included redefining the allowed uses, permitting agricultural activities in previously restricted zoning, even change of zoning (City of Portland, 2005). This report provides an initial successful case of using land inventory and suitability analysis for urban agriculture planning.

2.3 Suitability Analysis

2.3.1. Basic Concept

As seen in Portland's Diggable City project, suitability analysis along with land inventory can be used to identify suitable locations for a particular land use, including community gardens. Suitability analysis or land-use suitability analysis, in wider terms, is a tool to identify the most appropriate spatial pattern for a specific future land use such as wildlife habitats, certain facilities or shops, tree planting, suitable routes for various modes of transportation based on provided requirements and preferences (Malczewski, 2003).

The applications of hand-drawn overlay techniques used by American landscape architects in the late nineteenth and early 20th century are the roots of GIS-based approaches to land-use suitability analysis. By using the overlay techniques, Ian McHarg proposed a procedure that involved mapping data on the natural and human-made attributes of the environment of a study area. He then presented this information on individual, transparent maps using light to dark shading (high suitability to low suitability, see Figure 2.3) and superimposed the individual transparent maps over each other to construct the overall suitability map (Figure 2.4). The limitation of this procedure was the assumption of equal importance of the attributes or variables. Later on, this drawback had been overcome by the introduction of a weighted overlay technique where each variable can be given different weights based on subjective judgments (Steiner, 2008).

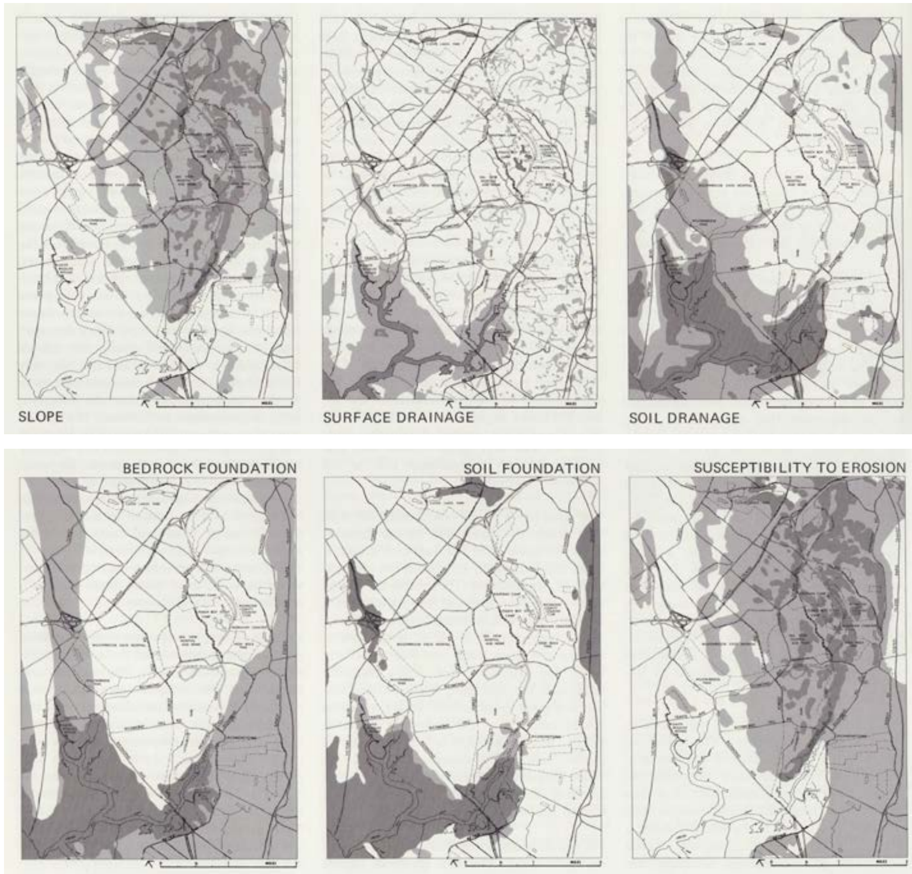

Figure 2.3 Factor Map Series Example (McHarg, 1969, Page 38)

Figure 2.4 Composite Suitability Map (McHarg, 1969, Page 39)

2.3.2. Various Methods in Suitability Analysis

There are various methods of the suitability analysis; the computation has become more powerful over the years with the assistance from GIS software. The following will introduce some of the major methods of suitability analysis mainly referring to Hopkins (1977).

Gestalt method is the simplest method and can be executed through field observation or through studying aerial maps. First, the study area is divided into regions (based on topographic similarities or other characteristics). Second, a table is created that describes the effects that will occur if each land use is located there. Third, a set of maps is drawn to show each region in terms of its suitability. There are a number of limitations in using the Gestalt method. The analyst typically does not have the local knowledge to be able to classify each region. Land suitability analyses, without an explanation of factor consideration, is difficult for decision makers to accept.

The Ordinal Combination method is sometimes referred to as the McHarg method because it is the method used in McHarg's Richmond Parkway study (1968). The first step for this method is to designate each factor in a map. The step is the creation of a table to specify the level of suitability for each land use based on each factor. Suitability maps are then created for each factor. In the final step, each map is overlaid to generate a composite map. The biggest limitations of this method are that it fails to recognize that all factors might not be equally important and it does not account for interdependence in factors.

The Linear Combination method uses weighting in order to address this interdependence of factors. The factors of suitability are given an "importance" weight and used as a multiplier for each factor. After the ratings for each factor are determined, it is multiplied by the weight. The resulting suitability rating is the sum of each weighted rating.

The Rules of Combination method addresses both the limitation of the linear combination method: interdependence of factors as well as factor importance. The suitability of a parcel is established through a set of rules. This method is styled as a compromise between the nonlinear combination method and the factor combination method. In this study, the Linear Combination Method is used to take into account both the “rating” and “weighting” of the factors.

2.4 Previous Literature on Urban Agriculture Planning

Most of the existing literature generally describes the benefits and potential challenges of urban agriculture. Although the socio-economic advantages of urban agriculture are strongly addressed in many literatures, few studies have been conducted to quantify the relative importance of each benefit or to identify suitable locations for urban agriculture using multiple quantitative measures. However, studies have mentioned the importance of the spatial location of urban agriculture (City of Portland, 2005).

The Diggable City project conducted a suitability analysis to identify the proper locations of community gardens. The study takes into consideration physical factors, for example, tree canopy, water availability, slope etc. for site specific analysis. One of the major limitations of this study is that they have not considered the socio-economic factors related to urban agriculture (City of Portland, 2005). This paper attempts to overcome this limitation and takes into account mostly the socio-economic factors. For the latter phase of this research, the physical factors for site specific analysis are identified.

In this study, the selection of variables are based on literature review; however, the reclassification and weighting of the selected variables are based on the most efficient method of classification available, interviews with local experts, author’s subjective opinion and Analytical Hierarchy Process (AHP), due to the limited availability of quantitative findings from previous studies.

For weighting, the methodology of this study is heavily influenced from Hossain et al. (2009) especially for the use of AHP introduced by Saaty in 1990. As for the reclassifications, Hossain et al. (2009) largely focused on environmental factors and relied on available standards. But it is specifically challenging for this study to establish the reclassification standards for each socio-economic variable because it will vary across different time and geographic conditions. So this research relied on the qualitative data received from the survey and transformed them into quantitative reclassifications through Natural Break classification method (where applicable) which maximizes the similarity of numbers in groups while maximizing the distance between the groups and is regarded as one of the most efficient ways of data classification (Jenks, 1967).

Based on the factors presented throughout the research that urban agriculture benefits socially disadvantaged people (Smit, Nasr, & Ratta, 2001), the research has been geared towards finding suitable locations for urban agriculture for socially disadvantaged populations in the City of Dallas. A combination of qualitative and quantitative methods is used. To reduce the issues of subjectivity on weighting variables, the results of interviews with local experts are used for the weighting decision. More details on the methodology will be described in the following chapter.

CHAPTER 3

METHODOLOGY

3.1 Study Area

The City of Dallas is selected as the study area for this research. The City of Dallas is located in Dallas-Fort Worth metropolitan area (DFW), which is one the fastest growing metropolitan regions of United States (Principal Real Estate Investors, 2012); DFW is projected to add 720,095 new residents over the five-year forecast period (Principal Real Estate Investors, 2012), a fair share of which will have be bore by the City of Dallas.

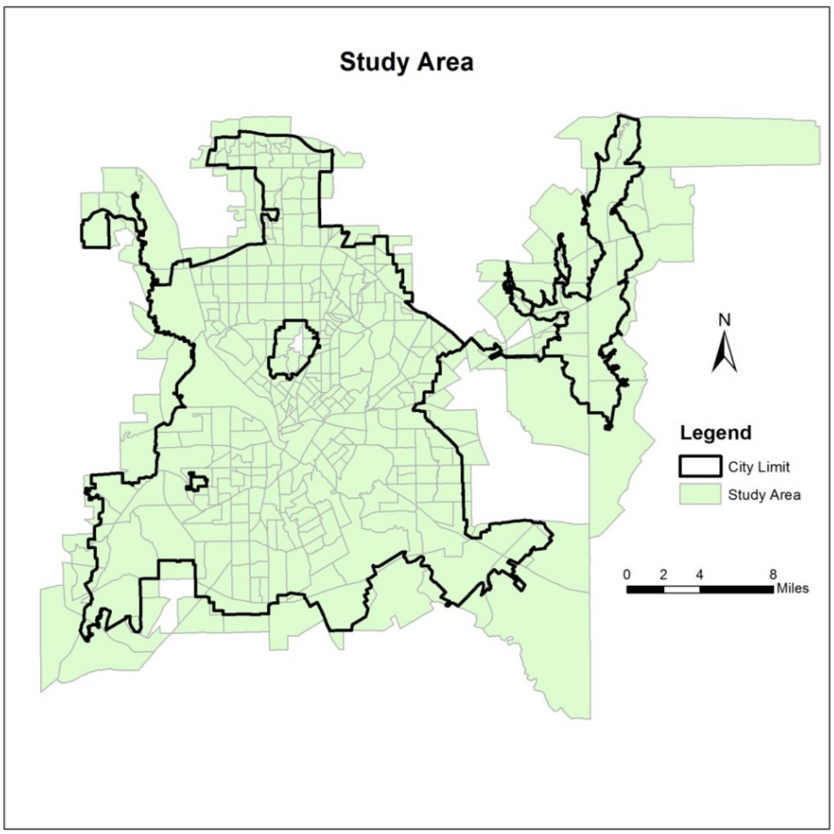

Figure 3.1 Study Area

This geographical condition puts the city in a position to diversify its local economies in order to meet the increased influx of population. These urban migrants, along with the economically disadvantaged population, need access to fresh food. In order to better incorporate socioeconomic data mostly from the U.S. Census American Community Survey, the census tracts adjacent to the city boundary are included in the spatial analysis.

3.2 Determination of factors

Variables affecting urban agriculture ranges from environmental attributes to economic attributes to social attributes. As this study focuses on increasing access to fresh food for the economically disadvantaged groups, incorporating income, employment and poverty is important. As practice of urban farming and access to food is an issue of household level, median household income was selected to represent income factor. Unemployment rate and poverty rate was chosen to represent unemployed population and population living below the poverty level. The locations of food deserts that are currently designated by USDA is also included to present areas that are underserved with regards to fresh food access. The locations of churches are included as a variable to represent the potential resources of creating new community gardens because the interviewees mentioned that many community gardens have been assimilated through churches in DFW area.

Physical factors are also important to assess the suitability of community gardens to a large extent. As the safety of the grown food is very important, existing toxic sites are included to exclude hazardous areas from the potential sites. Lastly, land use is included to make sure the community gardens will be suggested a compatible land use.

In summary, the variables selected for this study are:

- Median Household Income
- Poverty Rate
- Unemployment Rate
- Food Deserts
- Churches
- Toxic sites
- Land use

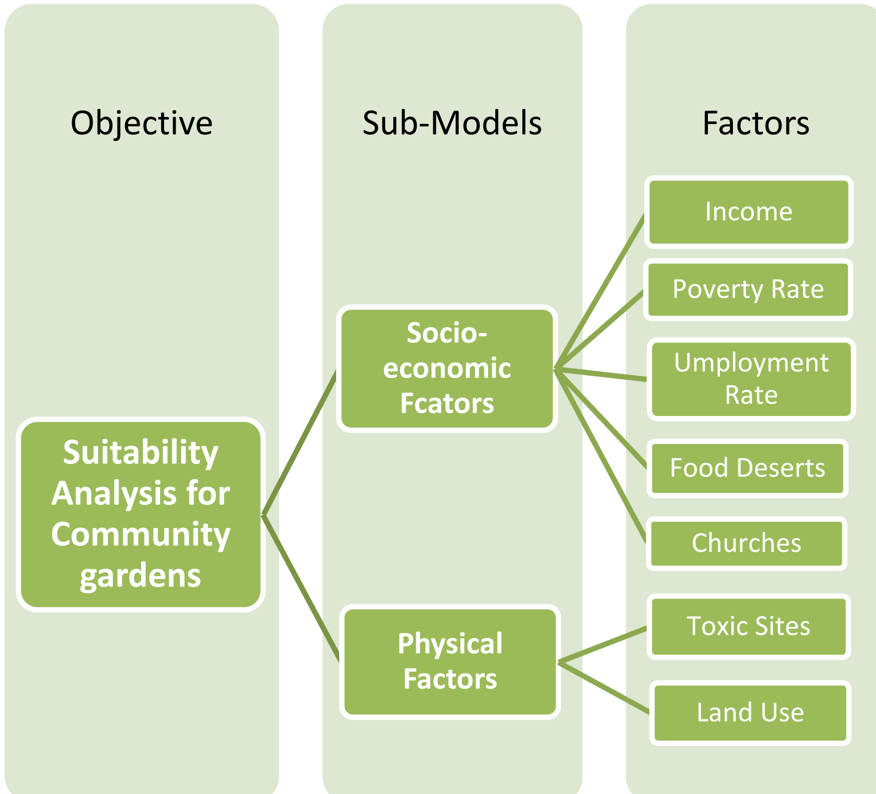

Figure 3.2 Factors Selection

3.3 Data Collection and Data Processing

3.3.1. Data Collection

After the variables were selected and finalized, different sources were explored to find proper spatial and tabular data for each variable. The sources of data collection are provided in Table 3.1. Census tract level data is the most disaggregated level available for all socio-economic data that are used, except for median household income. Although median household income is available in block group level, the margin of error is high which represents low level of reliability (U.S. Department of Commerce, 2010). Keeping the reliability of the data in mind, all socio-economic data are collected in census tract level.

Table 3.1 Data Sources

Data Set	Sources
City Boundary	City of Dallas
Census tracts	Tiger Shapefiles
Median Household Income	American Fact Finder
Poverty Rate	American Fact Finder
Unemployment Rate	American Fact Finder
Food Deserts	USDA Atlas
Churches	NCTCOG
Toxic Sites	TCEQ Data Clearinghouse
Land Use	NCTCOG
Existing Community Gardens	Gardeners in Community Development, 2010 and Geocoded by the author

* All tabular data has been attained for the year of 2010.

3.3.2. Data Processing

Joining the spatial and tabular data is the first step towards making the data ready for the final analysis. Since all the data were available either at state level or at regional level, the following tools are used to attain them for the study area.

Table 3.2 GIS tools for data processing

Factors	Tool used
Median household income	"Select by Location"
Poverty rate	
Unemployment rate	
Food Deserts	
Churches	
Toxic sites (Municipal solid waste landfill and Superfund sites)	"Merge" and "Select by Location"
Land use	"Clip"

The next step is to convert all the vector data into raster datasets. The Churches and the Toxic sites deal with proximity since the distance from the site determines their suitability, so the "Euclidean Distance" tool from Spatial Analyst is used for these two factors. For the other factors, the "Polygon to Raster" conversion tool is used.

3.4 Reclassification

The raster data for all variables are reclassified in this step. Reclassifying is usually used to assign values of preference, sensitivity, priority, or some similar criteria to a dataset (Hossain et al, 2009). Using the "Reclassify" tool in Spatial Analyst, the reclassification process is utilized to assign new values to the data based on their suitability on a scale of -2 to 5: -2 being the most unsuitable and 5 being the most suitable. However, the negative ratings are only taken into account for Toxic Sites and Land Use factors, because these factors by their own characteristics require identifying not only the less suitable areas, but also the unsuitable areas. Interviewees provided their valuable inputs on relative importance of each variable; the quantitative reclassification tables were developed by combining their inputs and "Jenk's Natural Breaks" method of classification as mentioned in the literature review. The justifications are provided in the following sections.

3.4.1. Median Household Income

The median household income variable is reclassified with the intention of assigning more suitability to economically disadvantaged households. For example, households with median income of around 10000 USD to 33000 USD are given the highest suitability rating "5", households with more than 33000 USD income and less than 50000 USD are given second highest rating "4" and so on (Figure 3.3). Natural Breaks are used as the method of classification.

Table 3.3 Median Household Income Reclassification

143482 USD – 249194 USD	1
77192 USD – 143482 USD	2
51701 USD – 77192 USD	3
33441 USD – 51701 USD	4
10396 USD – 33441 USD	5

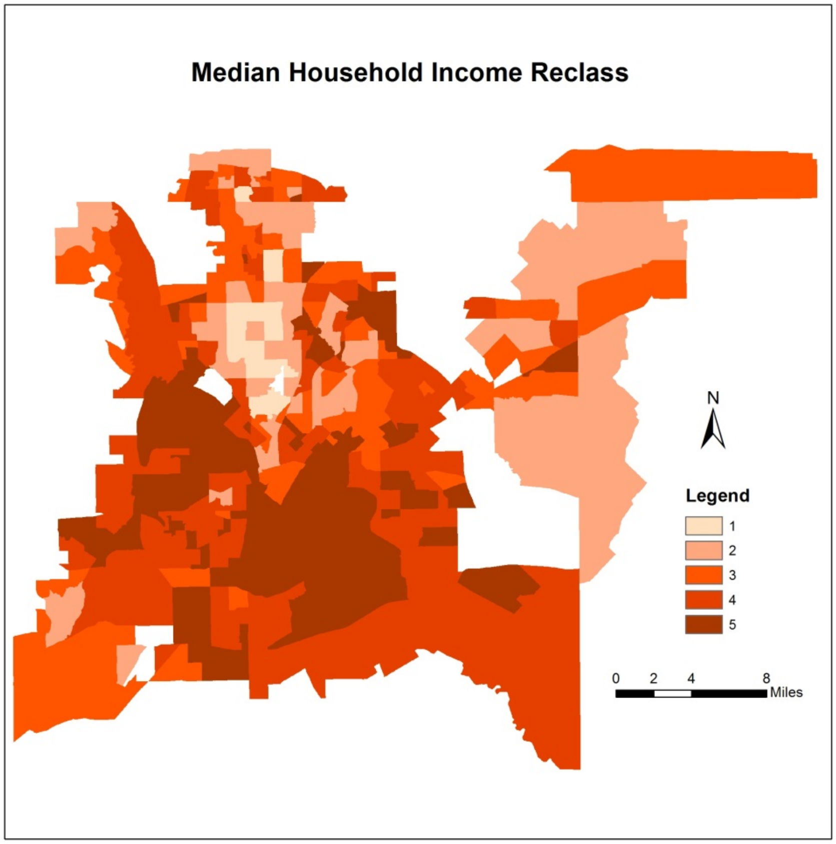

Figure 3.3 Median Household Income Reclassification

3.4.2 Poverty rate

In addition to median household income, areas with more residents living below poverty level are given higher suitability based on the same criteria and method (Natural break) used for reclassifying the median household income. Areas with poverty rate 48% or higher are given suitability rating “5”, on the other hand, areas with poverty rate even less than 9% were given the lowest suitability rating “1”. (Figure 3.4)

Table 3.4 Poverty Rate Reclassification

0% - 9%	1
9% - 19%	2
19% - 30%	3
30% - 48%	4
48% - 71%	5

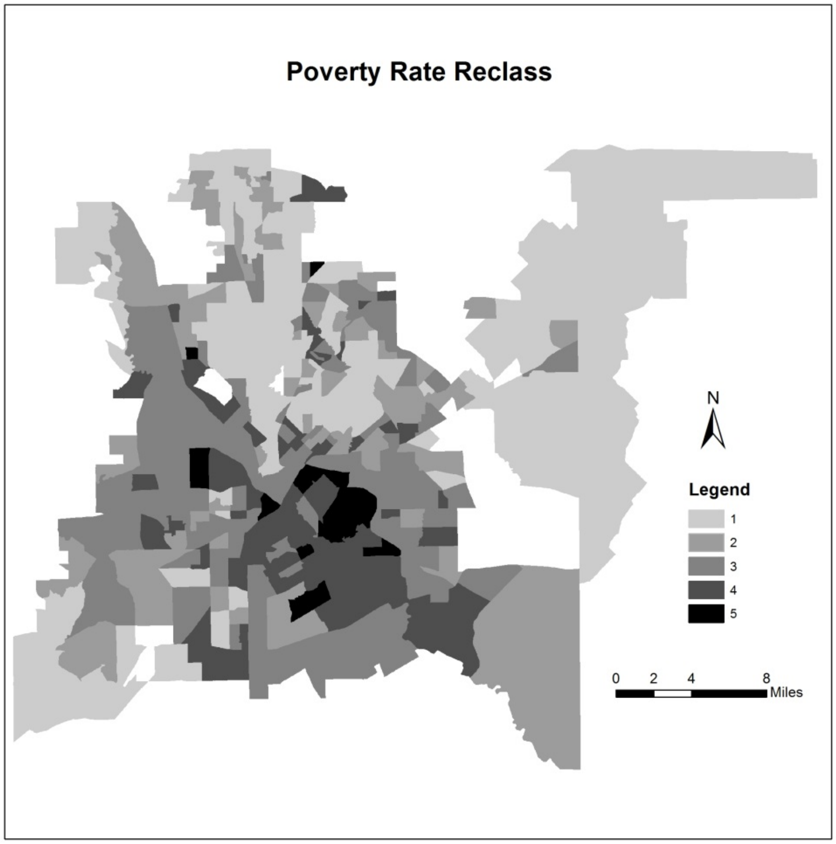

Figure 3.4 Poverty Rate Reclassification

3.4.3 Unemployment rate

To encourage job creation benefits to socially disadvantaged neighborhoods, areas with higher rate of unemployment are depicted as more suitable for nurturing urban agriculture. Similar logic as the poverty rate is used for reclassifying the unemployment rate variable. Areas with unemployment rate more than 11% are given the highest rating “5” (Figure 3.5)

Table 3.5 Unemployment Rate Reclassification

0% - 2%	1
2% - 4%	2
4% - 7%	3
7% - 11%	4
11% - 20%	5

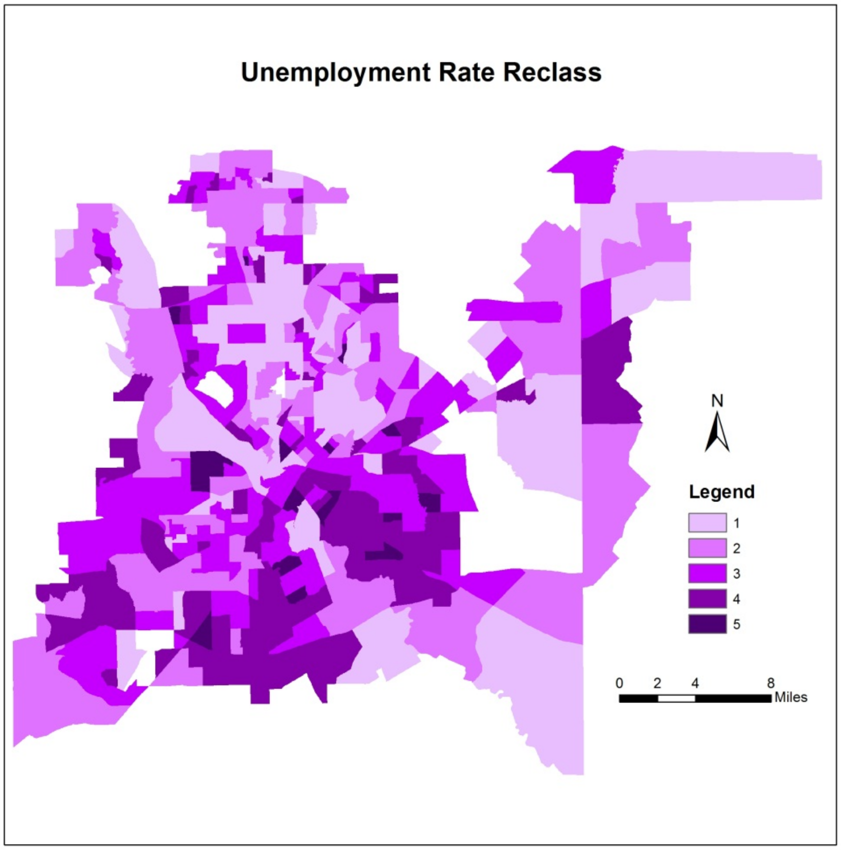

Figure 3.5 Unemployment Rate Reclassification

3.4.4 Food Deserts

According to the Food Access Research Atlas, a census tract is considered to have low access if a significant number or share of individuals in the tract is far from a supermarket, supercenter, or large grocery store ("supermarket" for short). The Atlas provides two categories for classifying low access census tracts: food access within 0.5 mile demarcation and food access within 1 mile demarcation. In this study, 0.5 mile demarcation is assigned with suitability rating of “4” and 1 mile demarcation with suitability rating “5”. The areas that are not identified as low access by USDA were assigned with a suitability rating of “3”. No suitability rating “1” or “2” are given to this variable because even the areas that are not identified as low access may also have low access to fresh foods.

Table 3.6 Food Desert Reclassification

Not Identified as low access	3
Low access for 0.5 mile	4
Low access for 1 mile	5

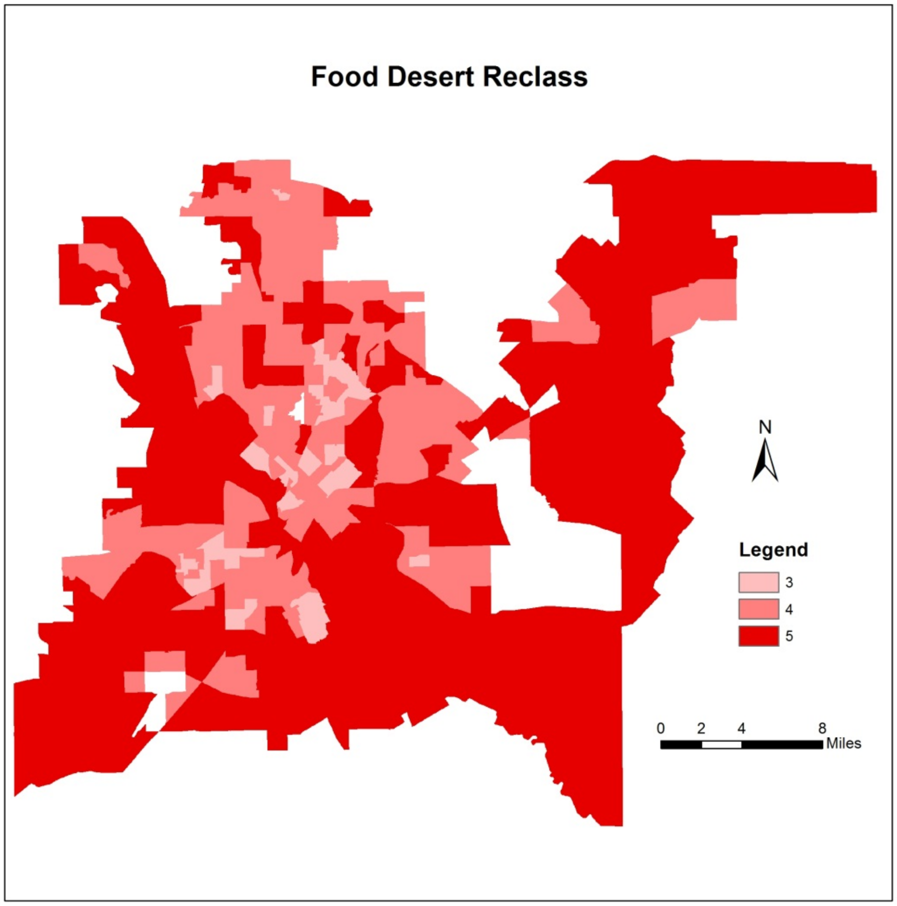

Figure 3.6 Food Deserts Reclassification

3.4.5 Churches

Many existing community gardens in DFW are operated through churches because they provide spaces for community activities such as gardening. In this regard, the reclassification is made based on the assumption that the closer the areas are from churches, the more suitable it is for community gardens. Highest suitability score “5” is assigned to areas that are within 0.5 mile of a church which is confirmed as the most comfortable walking distance by the survey respondents; suitability score “4” to the areas that are within 0.75 mile and so on (Table 3.7).

Table 3.7 Proximity to Churches Reclassification

>2 miles	1
2 miles	2
1 mile	3
0.75 miles	4
0.5 miles	5

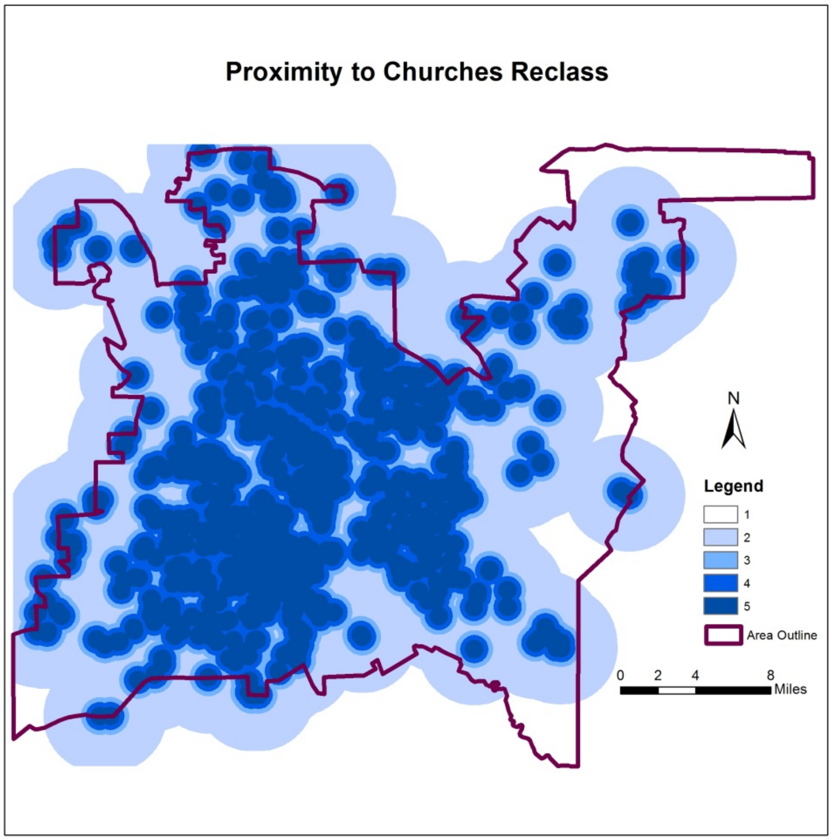

Figure 3.7 Proximity to Churches Reclassification

3.4.6 Toxic Sites

The toxic sites include municipal solid waste sites and superfund sites from TCEQ Data Clearinghouse. The municipal solid waste landfills in many cases effectively control chemical contamination for their surroundings; they generally cause odor that may restrict gardening activities. The superfund sites, on the other hand, are likely to contain contaminated soils on site. For the safety of the food, gardeners and consumers, positive suitability ratings are assigned to areas that are within a reasonable distance from the toxic sites. For example, suitability rating of “-2” is provided for proximity of less than 0.25 mile; “-1” for proximity of 0.25 mile to 0.5 mile (Table 3.8).

Table 3.8 Proximity to Toxic Sites Reclassification

>.25	-2
.25 to .5 miles	-1
.5 miles to .75 miles	0
.75 miles to 1 mile	1
1 mile to 2 miles	2
2 miles to 3 miles	3
3 miles to 4 miles	4
>4 miles	5

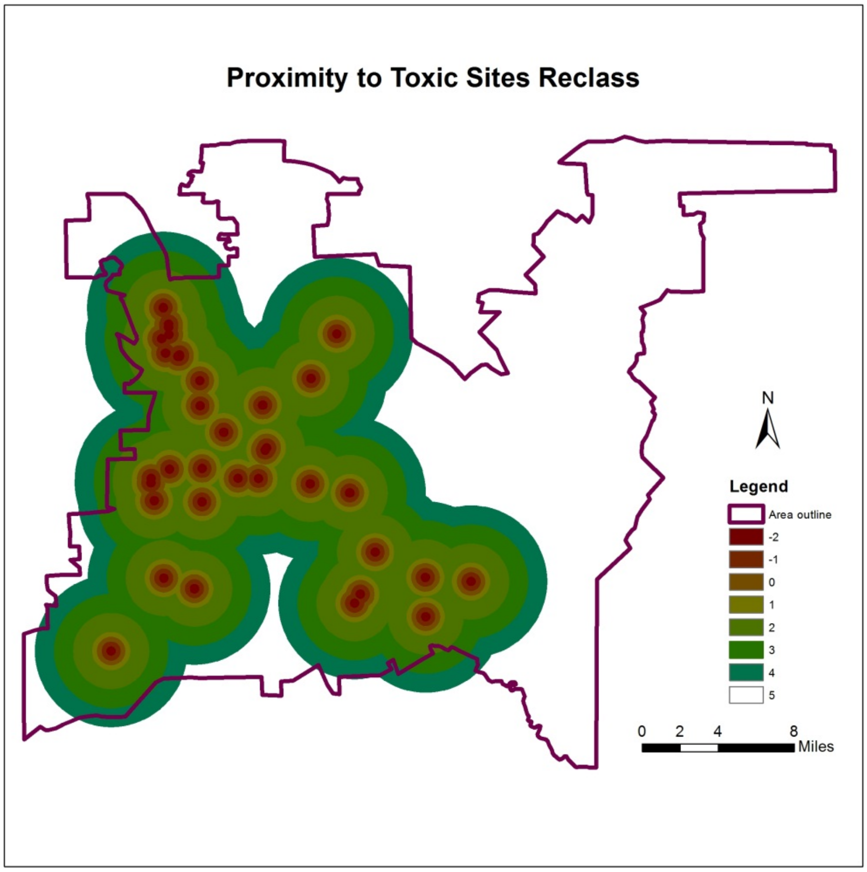

Figure 3.8 Proximity to Toxic Sites Reclassification

3.4.7 Land Use

Land use is included to make sure that the new community gardens are not being suggested to incompatible land uses. Mostly the interviewee's opinions are used in this reclassification. Many cases show that most community gardens are added on vacant lands and other public open spaces; the highest suitability rating "5" is assigned to vacant lands along with parks and recreational use. On the other hand, the industrial uses, roadways, and utilities are given suitability rating of "-2" which are highly unsuitable for community gardens.

Table 3.9 Land Use Reclassification

Industrial/Roadways/Airports	-2
Utilities/Stadium//Construction/Parking	-1
Landfill/Commercial/Water	0
Transit/Communication	1
Mixed/Mobile Home/Commercial	2
Single family/Multi family	3
Flood Control/Institutional/ Ranch	4
Vacant/Educational/Parks/Farmland	5

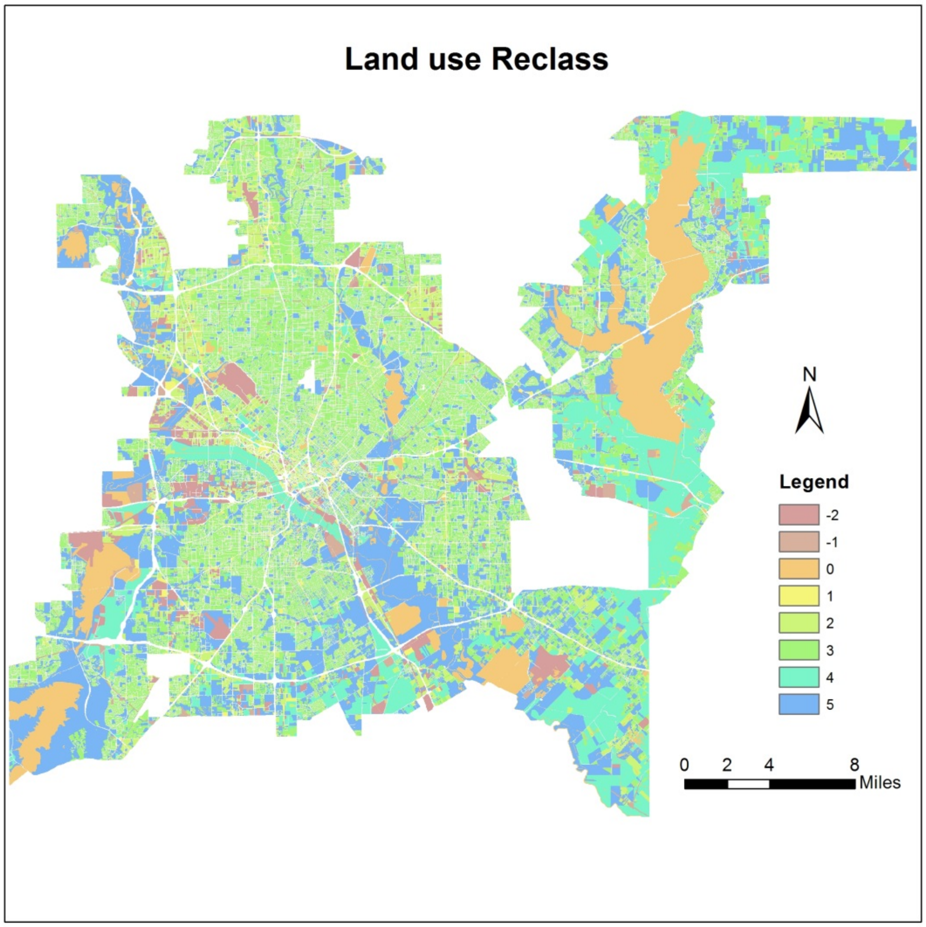

Figure 3.9 Proximity to Land Use Reclassification

3.5 Weights and Score

The development of weights is attained through Analytical Hierarchy Process (AHP) developed by Thomas Saaty (1980), which is commonly used for multi-criteria decision analysis (Hossain et al., 2009). The process is based on a pair-wise comparison matrix of selected variables. The comparisons address the relative importance of two criteria involved in determining suitability for the stated objective. In order to use this procedure, it is required for all assigned weights to sum up to 1. The relative ranking of the factors is made before completing the pair-wise comparison matrix. Scores are assigned in rank order according to the number of factors involved in the evaluation for community gardens without repetition (Hossain et al., 2009). Ratings are systematically scored on a scale from ¼ (least important to 4 (most important) shown in Table 3.10.

Table 3.10: Systematic Scale for pair-wise comparison (based on Hossain, 2009)

0.25	0.50	0.75	1	2	3	4
Very Strongly	Strongly	Moderately	Equally	Moderately	Strongly	Very strongly
LESS IMPORTANT				MORE IMPORTANT		

To help reduce the subjectivity and verify the reliability of weights generated, surveys are conducted among three local experts on community gardens. The comparison matrixes developed by the experts are provided in Appendix. Since the consistency ratio is the most acceptable from the weights assigned by the author, the weights from the author are used for the final analysis. The comparison matrix developed by the author is presented in Table 3.11

Table 3.11 Pair-wise comparison by the author

	Income	Poverty Rate	Unemployment Rate	Food Deserts	Churches	Toxic Sites	Land Use
Income	1	2	1	0.5	1.33	1.33	2
Poverty Rate	0.5	1	0.5	0.25	0.75	0.5	1
Unemployment Rate	1	2	1	0.5	2	1.33	2
Food Deserts	2	4	2	1	3	3	4
Churches	0.75	1.33	0.5	0.33	1	1	1.33
Toxic Sites	0.75	2	0.75	0.33	1	1	1.33
Land Use	0.5	1	0.5	0.25	0.75	0.75	1

As the primary focus of this study is increasing food access for economically disadvantaged population, median household income, unemployment rate and food deserts are assigned with higher weights than the other factors. Poverty rate was assigned with lesser weight since it is highly correlated with median household income and unemployment rate which are already given higher weights. The locations of churches, toxic sites and the land use factors are given lower importance but still significant enough to affect the results. The final weights are presented in Table 3.12.

In order to confirm the final weights, each cell in the matrix is divided by the summation of its respective column and this calculation provides a normalized comparison matrix (Saaty, 1980) which is presented in Appendix. The formula used is:

$$\overline{a}_{jk} = \frac{a_{jk}}{\sum_{l=1}^{m} a_{lk}}.$$

In the next step, the final weights are derived (Table 3.12) from averaging the entries of each row of the normalized pair-wise matrix (Saaty, 1980) using the following formula:

$$w_j = \frac{\sum_{l=1}^{m} \overline{a}_{jl}}{m}.$$

Table 3.12 Final weights

Median Household Income	15%
Poverty rate	7%
Unemployment rate	16%
Food Deserts	31%
Churches	11%
Toxic Sites	12%
Land Use	8%

Consistent ratio is commonly used in multi-criteria decision analysis to ensure that the weights are not generated by chances (Saaty, 1980). In this study, two indicators are calculated: the Consistency Index and the Consistency Ratio. Consistency Index is the deviation or degree of consistency and Consistency Ratio is the percentage of inconsistency. Typically, the results are acceptable if the Consistency Rate < .1 or 10%.

The pair-wise comparison matrix is multiplied with the derived weights. The results are divided by the weights. In the next step the Consistency Index (CI) is derived from the following formula where x is the average of the results derived in the previous step and m is the number of factors (Saaty, 1980). In this calculation, CI is 0.003832.

$$CI = \frac{x - m}{m - 1}.$$

To calculate the Consistency Ratio (CR), the Consistency Index is divided by the Random Index (RI). RI represents the mean consistency index of random matrices generated by Saaty for different number the entries. RI is derived from the table of values of RI for small problems ($m<10$) that is presented in Appendix. The consistency ratio (CR) from the author's matrix is 0.0029. This is the most consistent among the matrices generated by the interviewees and is smaller than 0.1 indicating a very small probability that the weights were developed by chances (Saaty, 1980). The results of the suitability analysis are presented in the next chapter.

By incorporating the determined weights using “Weighted Sum” tool from Spatial Analyst, the preliminary suitability map is derived (Figure 3.10). The green areas represent high suitability and the red represent the reverse. The suitable areas are mostly located in the south-east part of Dallas and as discussed in previous chapters, those are the areas with socially disadvantaged population suffering from low access to fresh food.

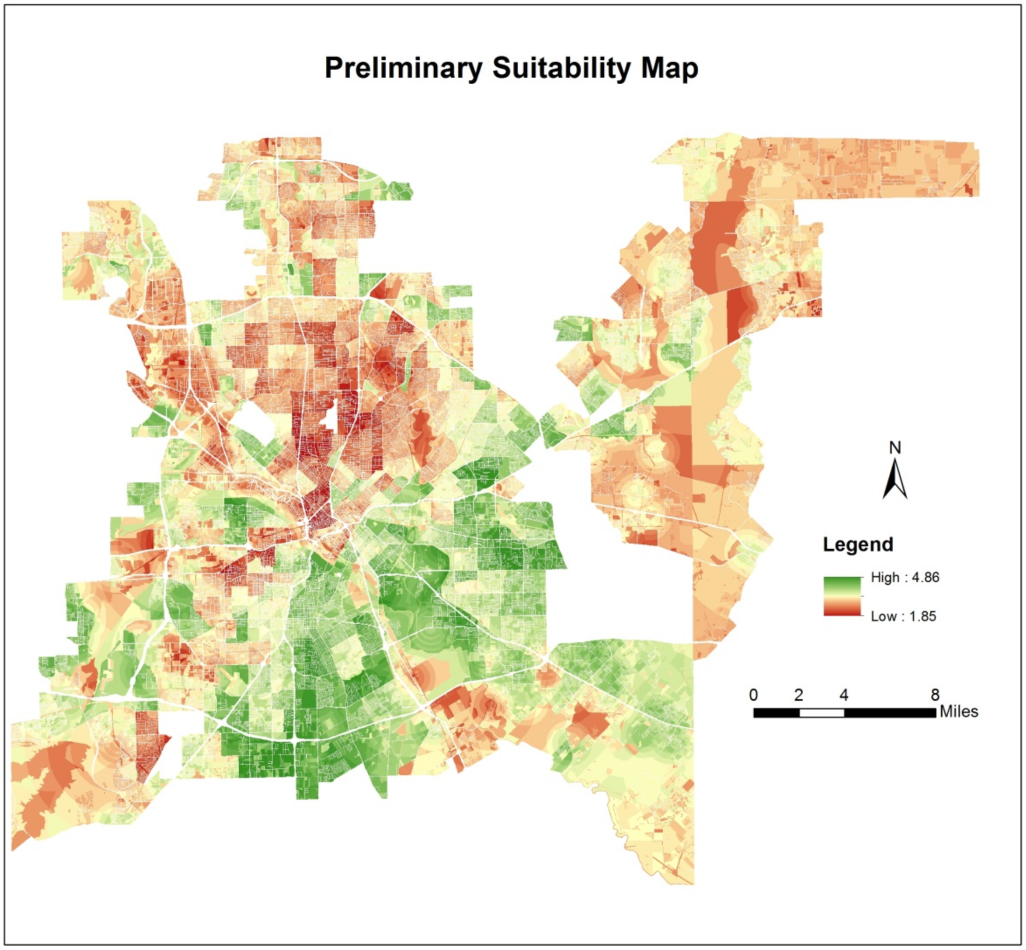

Figure 3.10 Preliminary Suitability Map

In order to provide more specific implementation strategies, Figure 3.11 shows the areas that show suitability score equal to or greater than 4 as “Act-Now” areas and the other areas would be considered as “Future Considerations”. Total “Act-Now” area is 13.9 sq. miles.

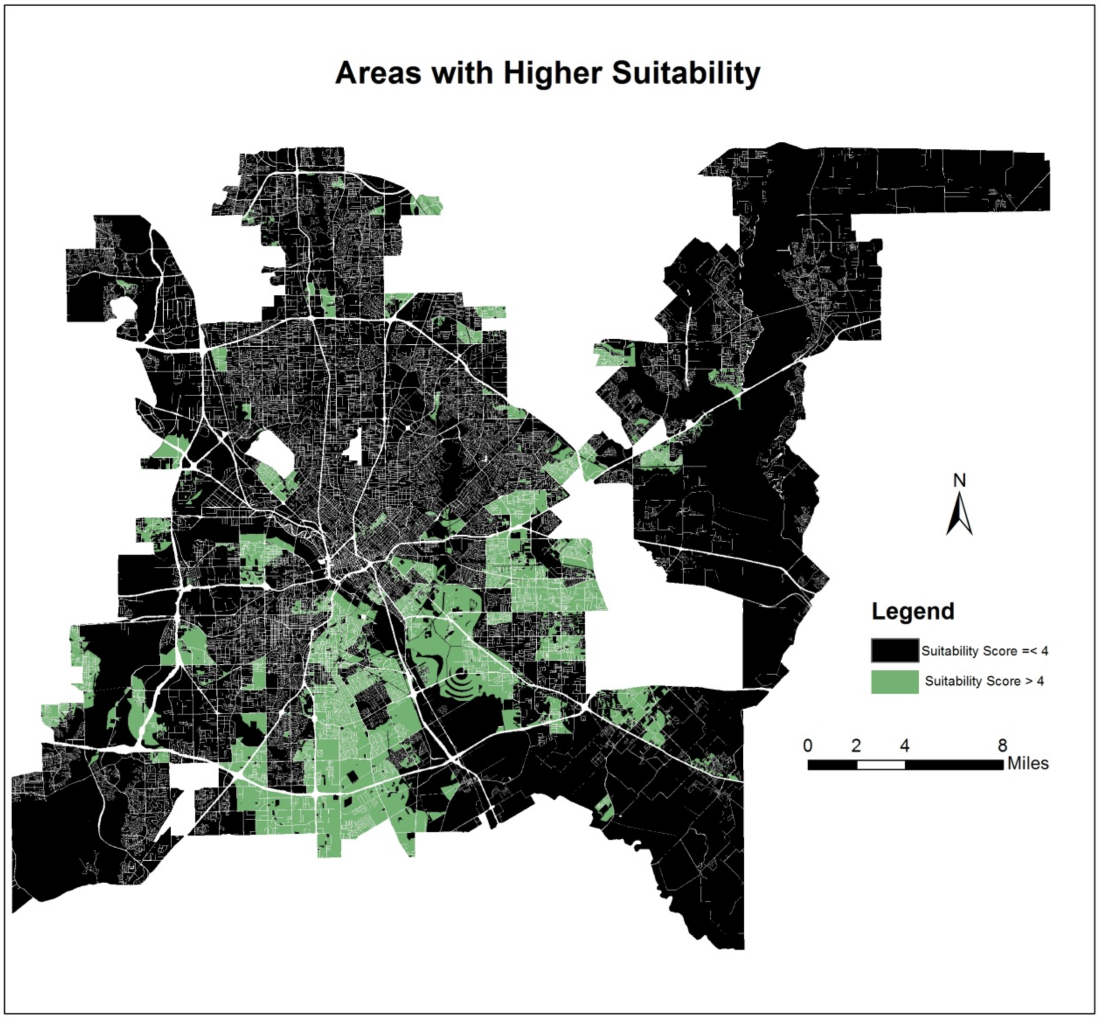

Figure 3.11 “Act-Now” and Future Consideration” Areas

3.6 Knock-Out Constraints

The knock-out constraints method is used in order to completely extract the areas where community gardens are not needed or are not suitable. Even though Toxic Sites and Land use are included as factors in the suitability analysis, these are also included in knock-out constraint analysis in order to completely rule out the detrimental areas.

Existing community gardens are taken into consideration as “knock out constraints” assuming that there is little need to add more gardens near existing gardens. Currently, there are 25 community gardens in City of Dallas (Gardeners in Community Development, 2010); 23 of them are plotted in the map by geocoding. As Figure 3.12 demonstrates, most of the existing gardens are situated in the low suitability area. The most suitable areas, which according this study are also the most needed ones have very few community gardens to serve their needs. This situation even strengthens the need of implementing this research. To extract the areas affected/ benefitted by the existing community gardens, a half-mile buffer was drawn around each of them (Figure 3.12)

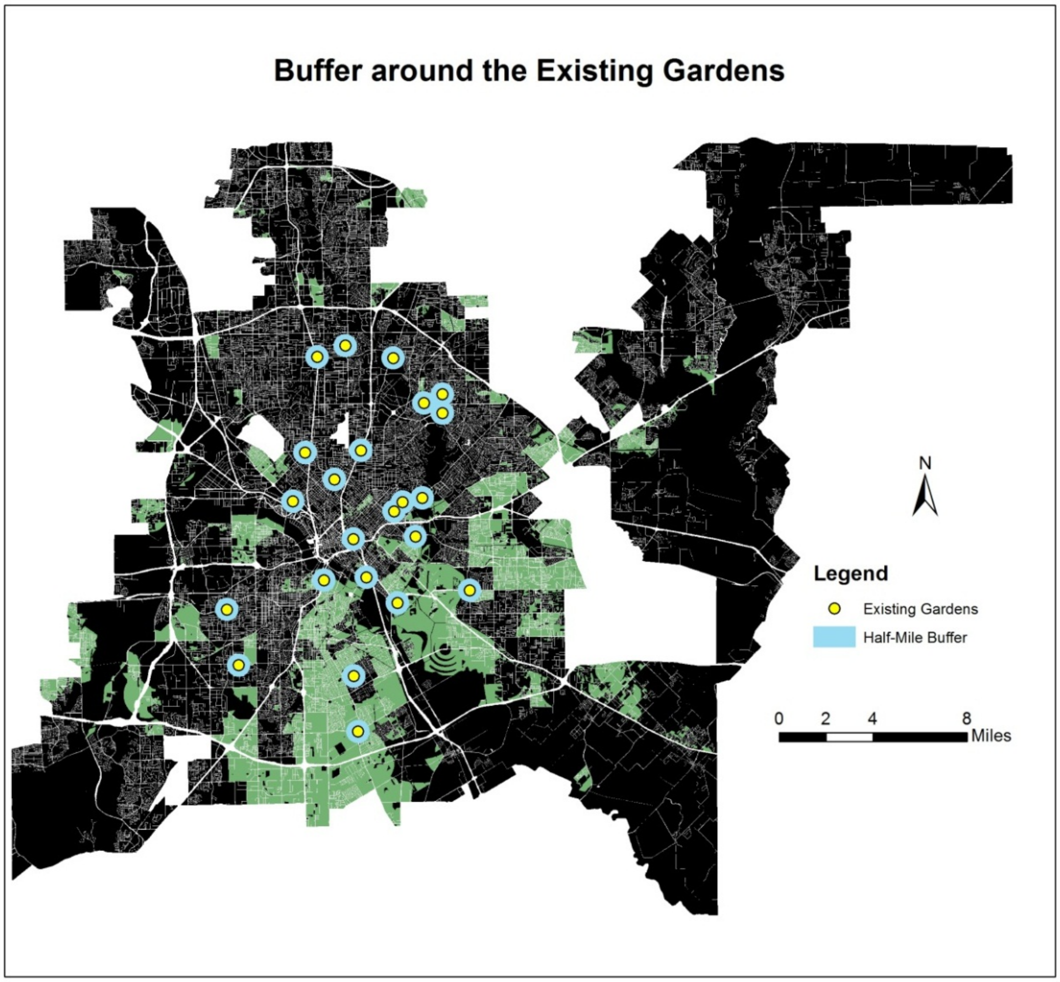

Figure 3.12 Buffer around the existing gardens

Although the areas with toxic sites in close proximity are provided with negative rating in the reclassification, there remains a little possibility of those areas remaining in the suitability map because of the greater weighting of other factors or the overlaying limitations. So the toxic sites are plotted to completely knock-out the areas with probable contamination. To completely extract the areas with probable contamination from toxic sites, a half-mile buffer was drawn around each of them (Figure 3.15)

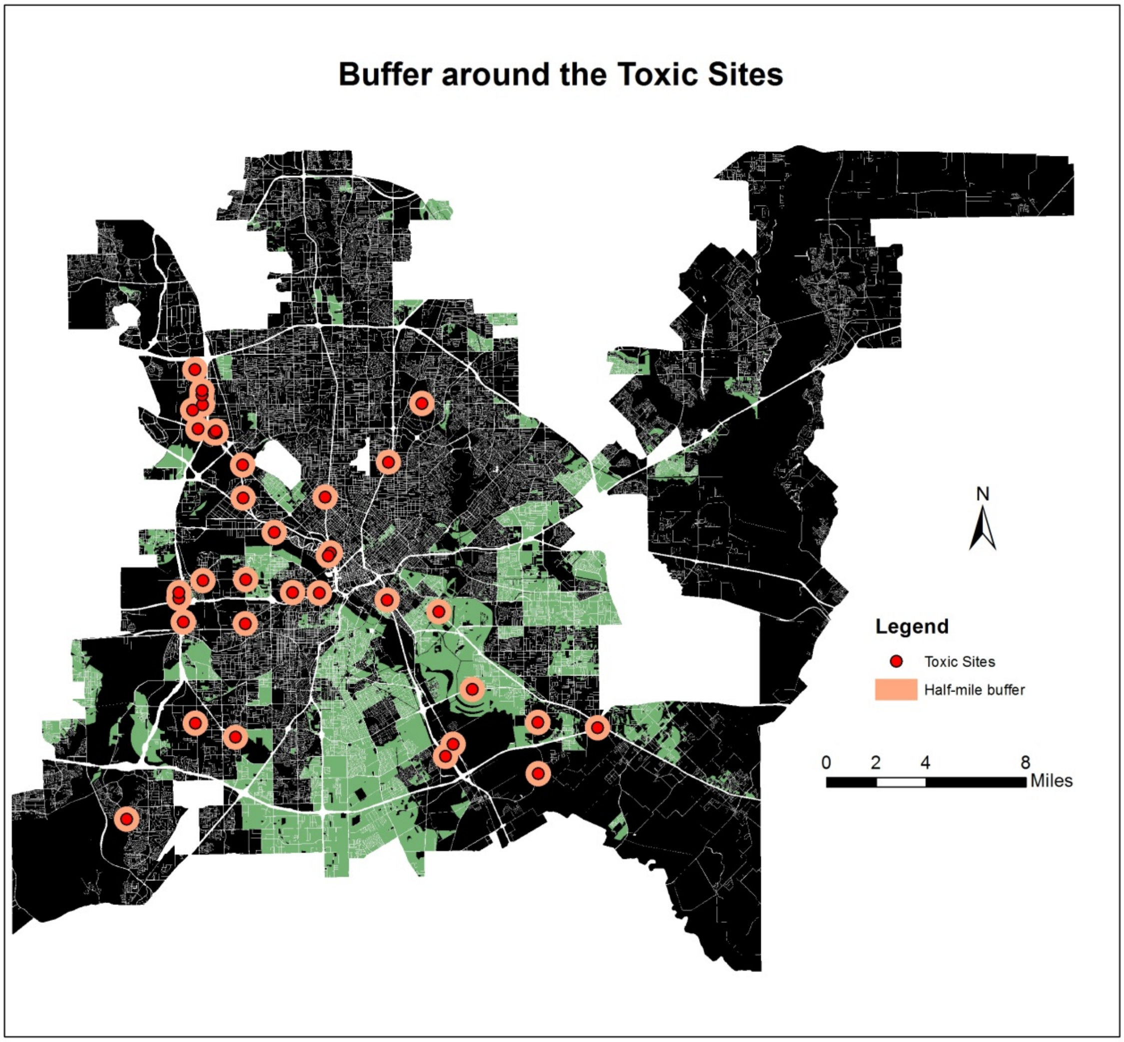

Figure 3.13 Plotting of the Toxic Sites

Similar assumptions are used of knocking-out detrimental land uses as well. The uses that are unsuitable for community gardens (Industrial, Roadways, Airport, Under Construction, Utilities, Stadium, Parking) thus were given negative ratings are ruled out in this stage of the study.

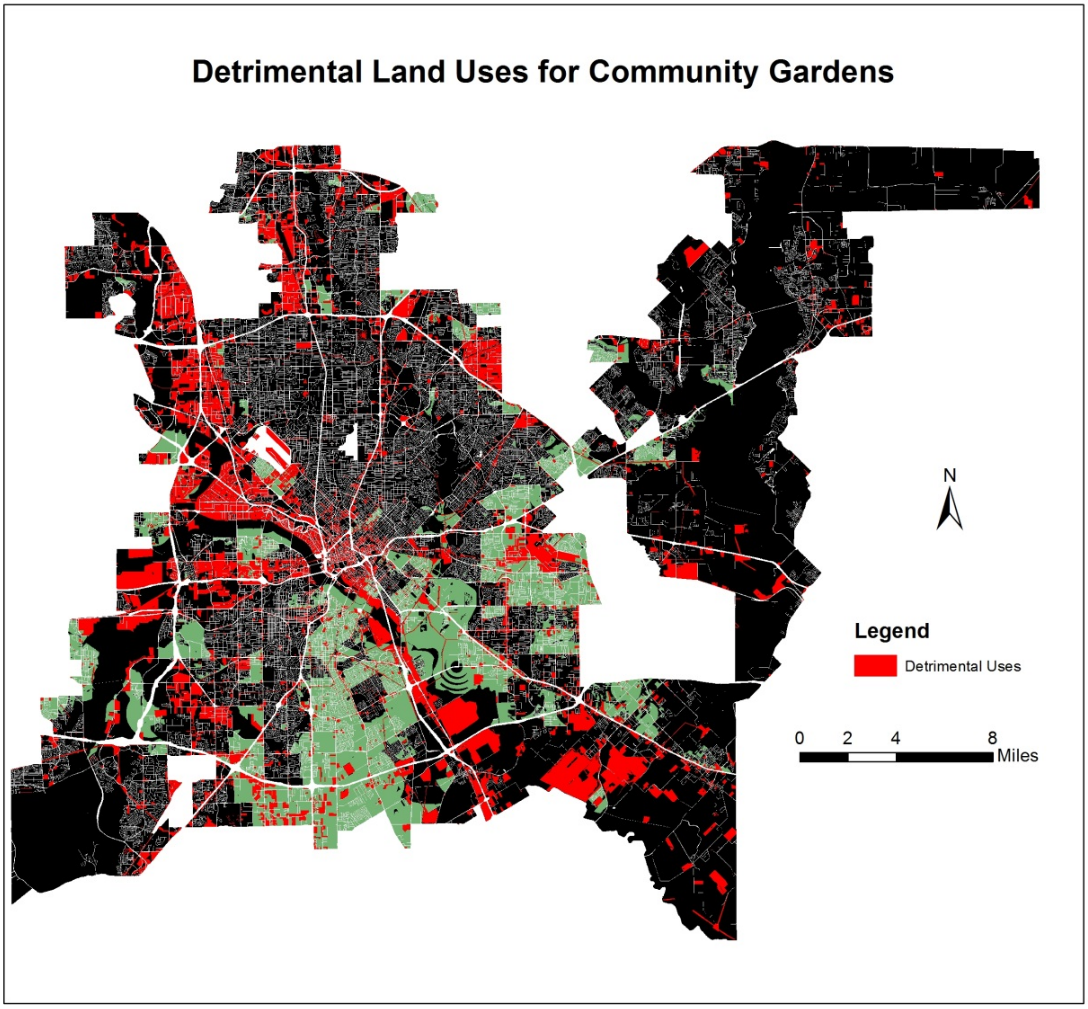

Figure 3.14 Plotting of Detrimental Land Uses

The final suitability map is derived by extracting the half-mile buffer areas around the existing community gardens and the toxic sites and the detrimental land uses. The final map is presented in the next chapter.

CHAPTER 4

RESULTS

The half-mile buffers were eliminated from the map resulting in the final suitability map (Figure 4.1). The total “Act-now” areas reduces from 13.9 sq. miles to 11.2 sq. miles in the final suitability maps.

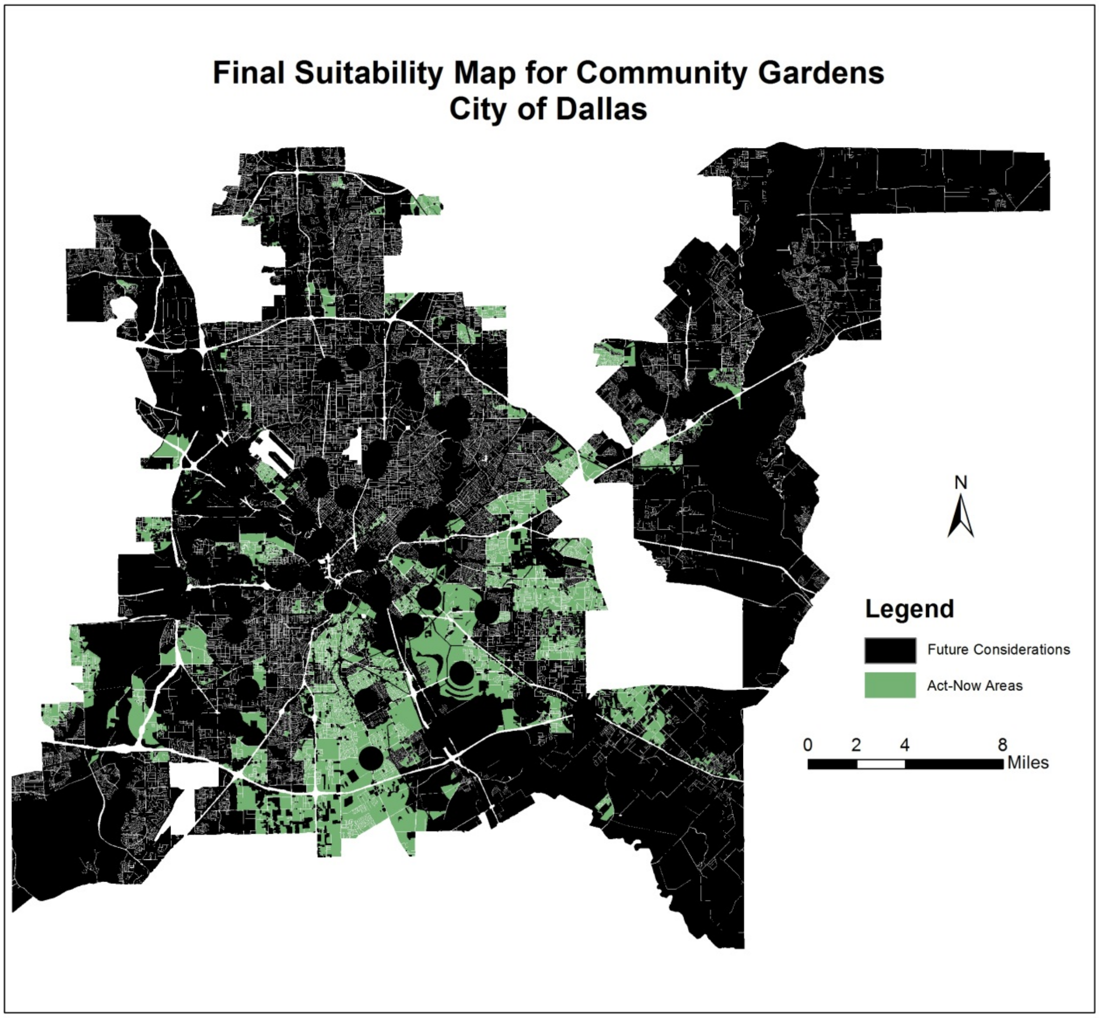

Figure 4.1 Final Suitability Map

These “Act-Now” areas mainly have socially disadvantaged population: people with low income, people with high poverty rate and unemployment rate having low access to fresh food. These areas are also close to different churches so that initiating community gardens would be easier but are at a reasonable distance from the toxic sites for the safety reasons. None of these "Act-Now" areas are situated in a detrimental land use.

The final suitability map is overlaid with google map for primary examination of their compatibility for siting a community garden. Three random sites are selected from the Act-Now areas in order to analyze their surrounding based on the factors. This is completely author's choice and is subject to alteration.

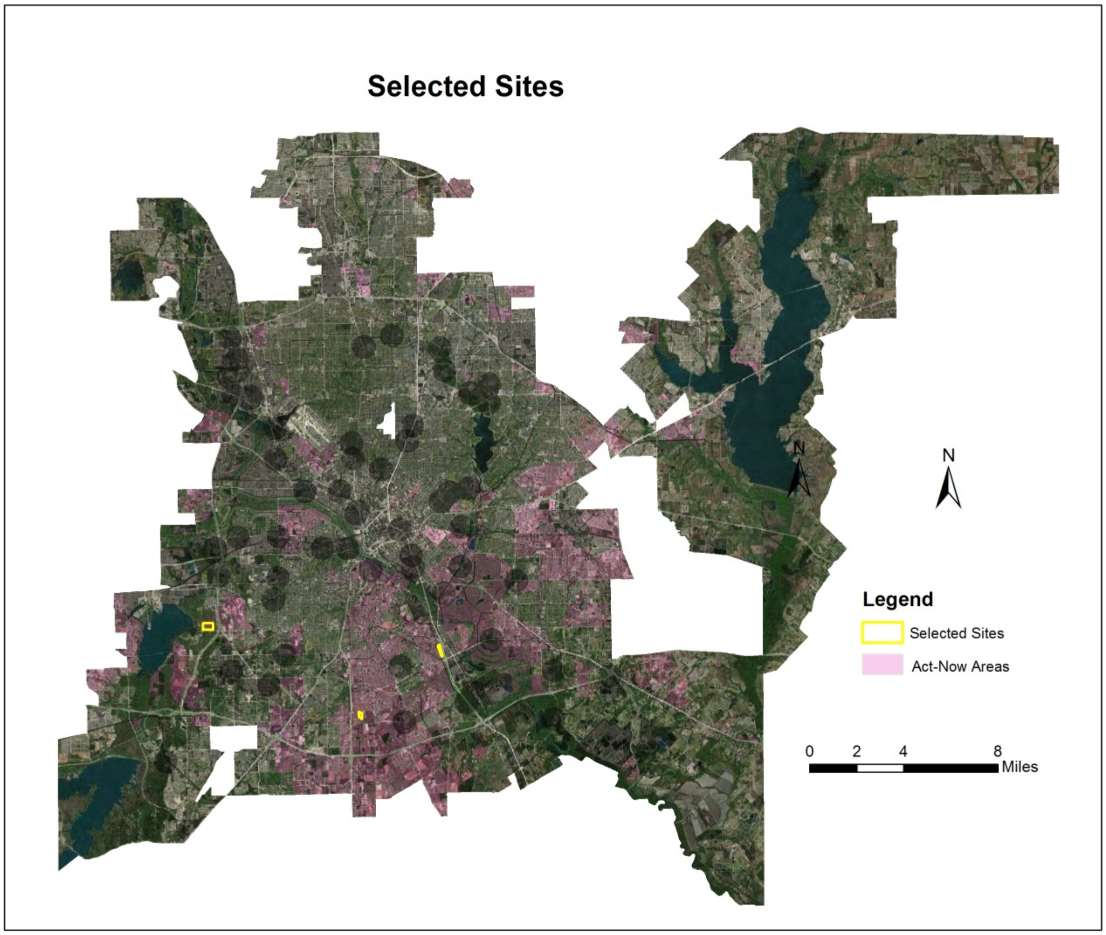

Figure 4.2 Overlaid suitability map and selected sites

Each of the sites is analyzed in order to provide a basic idea about them. They are analyzed based the factors used in the suitability analysis and the knock-out constraint analysis. A SWOC analysis (Strength, Weakness, Opportunity, Challenge) is conducted on these sites.

Site 1:

Figure 4.3 Site 1

It has a park and recreational land use, which provides an opportunity to incorporate the community garden with the Park and Recreational Plan. More details are provided in the next Chapter about this kind of policy actions. The site is close to a lake, so recreational purpose will also be served through this garden. It is at a reasonable distance from the toxic sites and from any existing garden, 1.5 miles away from the nearest church that is not on the other side of the highway. Even though it might not be the most comfortable distance for walking, but it can still be considered to be in close proximity. The surrounding areas in general host low-income, socially disadvantaged population. One of the drawback of this site is it is close to the highways. Also, the google image shows a good amount of tree canopy which can become a barrier as well.

Strength **S**	Weakness **W**
- Recreational value - Distance from Toxic sites and Existing Community Gardens	- Distance from Church
Opportunity **O**	Challenges **C**
- Parks and Recreational Land	- Proximity to a highway - Existing tree canopy

Site 2:

Figure 4.4 Site 2

It is a vacant lot and surrounded by low-income population. It is far away from any toxic site, also away from the influence area of the existing gardens. There are some commercial land uses in close proximity but still at a significant distance to make it work. The nearest church is only 800 feet away. No tree canopy is seen from google imagery in this site.

Strength **S** - Proximity to Church - Distance from Toxic sites and Existing Community Gardens	Weakness **W** - Proximity to Commercial uses
Opportunity **O** - Vacant lot - No tree canopy	Challenges **C** - N/A

Site 3:

Figure 4.5 Site 3

This site has very close proximity to several churches so there are more options for building social capital. It is also a vacant lot. It is close to a highway and some commercial uses which might affect the garden environment. There are very low-income and socially disadvantaged neighborhoods around so they will benefit a lot from the garden here. Toxic sites and existing gardens are too far way to have any influence over this site. This site also does not have tree canopy.

Strength **S** - Proximity to Church - Distance from Toxic sites and Existing Community Gardens	Weakness **W** - Proximity to Commercial uses
Opportunity **O** - Vacant lot - No tree canopy	Challenges **C** - Proximity to a highway

All three sites fall under the 1 mile low food access demarcation by USDA. Further considerations are needed to finalize a site and those are described in the next chapter.

CHAPTER 5

CONCLUSION

From the results of the suitability analysis, 11.2 sq. miles of areas are identified as "Act-Now". Most suitable areas for community gardens are located in the southern part of the city, largely influenced by the socio-economic factors. This chapter further explores the practical steps to implement the results by addressing the concerns raised from the local experts regarding implementation.

5.1 Next steps

Site-scale suitability analysis will further identify specific sites for initiating community gardens from the "Act-now" areas. The analysis can be conducted using the same methodology as described in the previous chapter; only the scale will need to be shifted from the city level to "Act-now" area level. For the site specific analysis, other factors such as physical and management factors can be more emphasized in addition to the socio-economic factors. The physical factors would be important in determining the suitable physical conditions for community garden sites such as sunlight access, soil quality, and water access (City of Portland, 2005). The socio-economic factors may not need to be heavily considered in this stage because they are already incorporated in the citywide analysis like this study and many socio-economic data only are available at the aggregated units (e.g. block groups or census tracts). The physical factors include but are not limited to the following:

- *Sunlight Exposure:* Growing plants has a direct relationship with sun-light exposure. The site should receive at least 6 hours of direct sunlight. However, the more light, the better it is for produce (Natural Resources Conservation Service, 2009).
- *Soil quality:* Although this study has ruled out the areas with probable toxic contamination, the soil test will find out the farming fertility pH and presence of heavy metals, which affect the soil suitability for safe farming and food

consumption (Heinegg, Maragos, Mason, Rabinowicz, Straccini, & Walsh, 2002) and also whether or not the type of soil is suitable for gardening. For example, the most desirable type of soil is usually Loam (Natural Resources Conservation Service, 2009). However, since most of the community gardens use raised plots and the gardeners put the dirt in the plots by themselves, other types of soil are also acceptable (Berle & Westerfield, 2013)

- *Water access:* Water pipe installation is quite expensive and water costs are highly variable depending on location and usage (City of Portland, 2005). Taking into consideration the detail for water access is critical in site-specific analysis.
- *Tree Canopy:* Removing existing trees is not desirable because it appears to be the “green against the green” idea (City of Portland, 2005). The areas with existing tree canopy would have low suitability rating and should be preserved for providing other ecosystem services.
- *Slope:* Steep slope has a risk of soil erosion. They are also difficult to walk on and may be impossible for disabled and elder gardeners. The site should be best where the difference in height is no more than 1 to 2 feet for every 100 feet of garden area (Berle & Westerfield, 2013). However, DFW area is mostly flat so this will not be a significant factor.

Once the site-specific analysis is conducted focusing on physical factors, the management issues need to be considered to finalize the sites:

- *Land ownership and costs:* The land can be donated or leased for a small amount from an individual, a company or a municipality (Mukherji & Morales, 2008). The more the land cost is, the less suitable it will be for siting community gardens.
- *Garden Shape:* The garden shape has an effect on how easy it is to manage. If the garden area is to be tilled and cultivated each year with a power tiller, a rectangular shape will be better. Gardens that will be worked only by hand tools

will serve better as square (Natural Resources Conservation Service, 2009). If the garden site has shape limitations then a compromise between efficient use of space and ease of tilling must be made.

- *Access:* If most gardeners intend to arrive by car, then a proper place for parking will be needed nearby. If by foot, then sidewalks along the street is preferred for safer access for the gardeners (Berle & Westerfield, 2013). Since, public transport is not very common in Dallas, it is not discussed here.
- *Compost:* A formal or informal composting place is desirable in every community garden (Berle & Westerfield, 2013). The composting should serve as the fertilizers (Natural Resources Conservation Service, 2009)
- *Weed Control:* There are several methods for weed control depending on the life span and size of the garden: Smother Crop, Solarization etc. (Natural Resources Conservation Service, 2009). The proper method should be used for weed controlling in the garden.
- *Tool Storage:* An easy-to-access location is to be used to storing all the tools; adequate space is needed for hand tools, a wheelbarrow or cart, shovels and rakes, garden hoses and any other tools shared by the gardeners (Berle & Westerfield, 2013)

The interviewees mentioned strong needs for a strategic and institutional framework for successful initiation and effective operation of the gardens. The next two sections suggest the strategies and institutional framework for implementation.

5.2 Implementation Strategies

The intention of this study is not only finding suitable areas for community gardens for increasing food access to urban poor but also providing a preliminary foundation for a citywide community garden plan. This section provides some strategic recommendations to promote the concept of community gardens and to reduce legal obstacles for successful implementation of the study results. The suggested implementation strategies are as below:

Garden Permits

The City of Dallas currently permits community garden uses in all of its zoning districts (City of Dallas, 2011). This open approach may be helpful by allowing it anywhere but also may lead to initiation of gardens in detrimental zoning districts. Limiting the community gardens in only the applicable districts such as residential districts or mixed use districts may help community gardens in proper locations.

City-sponsored urban farming subsidy programs

The city-sponsored urban farming subsidy programs can promote the initiation of community gardens on locations that are close to socially disadvantaged residents. Some cities donate or lease vacant land to land trusts that initiate community gardens. The City of Boston also provides free shipments of compost to the gardens. Several cities offer their gardeners and farmers discounted rates on municipal water (Mukherji & Morales, 2008). The city can introduce a “Garden bank” where seeds, dirt and other materials would be made available at minimum price or if possible, for free for low-income residents. The city can formulate educational programs providing the basics of gardening and farming. Jersey City is an example of such opportunities. The Adopt-a-lot gardens programs operated by The Jersey City Department of Health and Human Services provide assistance to aspiring community gardeners with material resources and educational support (Jersey City, 2007)

Building Social Capital for UA

Building social capital among gardeners and with local residents is one of the key managing factors that make community gardens sustain for the long-term ((Kohen & Reynolds, 2014). According to Cynthia Ellis (City of Arlington staff who also works as a coordinator for UTA community garden), average life-span of a community garden in DFW area is 3 years and that is because of lack of social capital. The City of Arlington Park and Recreation provides gardeners of the UTA Community Garden with the support for their meetings and communication tools in order to build social capital among gardeners especially in the initial stage of the garden (Personal Communication, 2014). Promoting cultures can also an effective way of building social capital, especially for immigrants. The Acres community garden, an existing community garden in City of Dallas was initiated by a number of immigrants for being able to produce and eat culturally appropriate food for themselves (Survey Respondent, 2014). Connecting community gardens with farmers markets is also an effective way to create a common thread between local gardeners and residents. The Brighton Community Garden in Town of Brighton, New York is joined the Brighton Farmers' Market and is perceived as a community-building tool to encourage residents to eat more local, sustainably-grown food (Brighton Farmers Market, 2012).

A network among different community gardens can also enable gardeners to build a broader social capital by generating and exchanging innovative ideas for managing gardens and preparing for local events together. With a mission to "Reduce hunger", the Elgin Community Garden Network (ECGN) in Elgin, Illinois brought their existing 16 gardens under a single umbrella and holds events for their gardeners on a regular basis (American Community Garden Association, 2008). Currently, "Gardeners in Community development" is working on creating a network among gardener groups across North Texas (Gardeners in Community Development, 2010). However, a network for the gardeners among the City of Dallas will help the city-wide community garden plan to grow more productively.

Contributing to the broader community sustainability

Collaborating with a school/college/university in close proximity can create mutual benefits and raise more awareness on the benefits of community gardens among young generation, especially when Dallas has a growing rate of child obesity. According to the Center for Disease Control, the number of obese students in Dallas rose from 14.9 percent in 1999 to 21 percent in 2005 (Hamilton, Gonzalez, Wallis, Russell, & Ravandi, 2008). Community gardens can serve as an educational tool for urban farming, urban ecology and nutrition and encourage students' volunteer activities as a community service learning. Community gardens can directly contribute to students' health by linking with schools' meal plan. Denver Urban Gardens has worked in partnership with Denver Public Schools for over a decade now with a believe that "the lessons offered in a garden are life changing for children of all backgrounds, but in particular, those from disadvantaged neighborhoods" (Denver Urban Garden, 2010) South Dallas, possessing mostly low-income neighborhoods and also most of the identified suitable locations for community gardens, has 32 schools in total including elementary, middle and high schools. So, this approach has a wide scope for execution. Also, educational land use was given higher suitability rating so establishing gardens on the school ground can be another approach.

Lastly, community gardens are emerging as a part of the city's green infrastructure system by creating urban green space in the city (Zeeuw et.al, 2009). Low income neighborhoods generally lack green space compared to affluent neighborhoods (Sherer, 2003); community gardens can contribute to enlarging green spaces for socially disadvantaged population in South Dallas. Collaboration with the Parks and Recreation Department can bring up the opportunity to place a community garden in a park or to integrate community gardens into the city's open space plan and the comprehensive plan. Dallas Parks and Recreational Department has a "Trees Please" planting program to for the Dallas community to participate in tree planting program by volunteering to plant tree, provide funding or in-kind services for irrigation and other related items (City of Dallas, 2011), however, planting for growing food is not yet taken into consideration. Like Boston's Grassroots program and Chicago's Neighborspace program who allow residents to use city parks for gardening (Mukherji & Morales, 2008), Dallas Parks and Recreation Department can also dedicate park land for community gardens. Keeping this in mind, parks and recreational land use was given higher suitability rating during the suitability analysis. Community Development Block Grant, which is designed to benefit the low to moderate income population (Dallas Parks and Recreation, 2011) can be used for community garden plan.

5.3 A Conceptual Institutional Framework

A conceptual framework for the institutionalization of community gardens is developed given the fact that the interviewees showed deep concerns about the absence of institutional framework in the City of Dallas. Many interviewees argued that collaboration and cooperation among the city, the churches and the community can start running successful gardens in Dallas area. Therefore, I propose the "Three C" approach to demonstrate the institutional structure for community gardens (Figure 5.1).

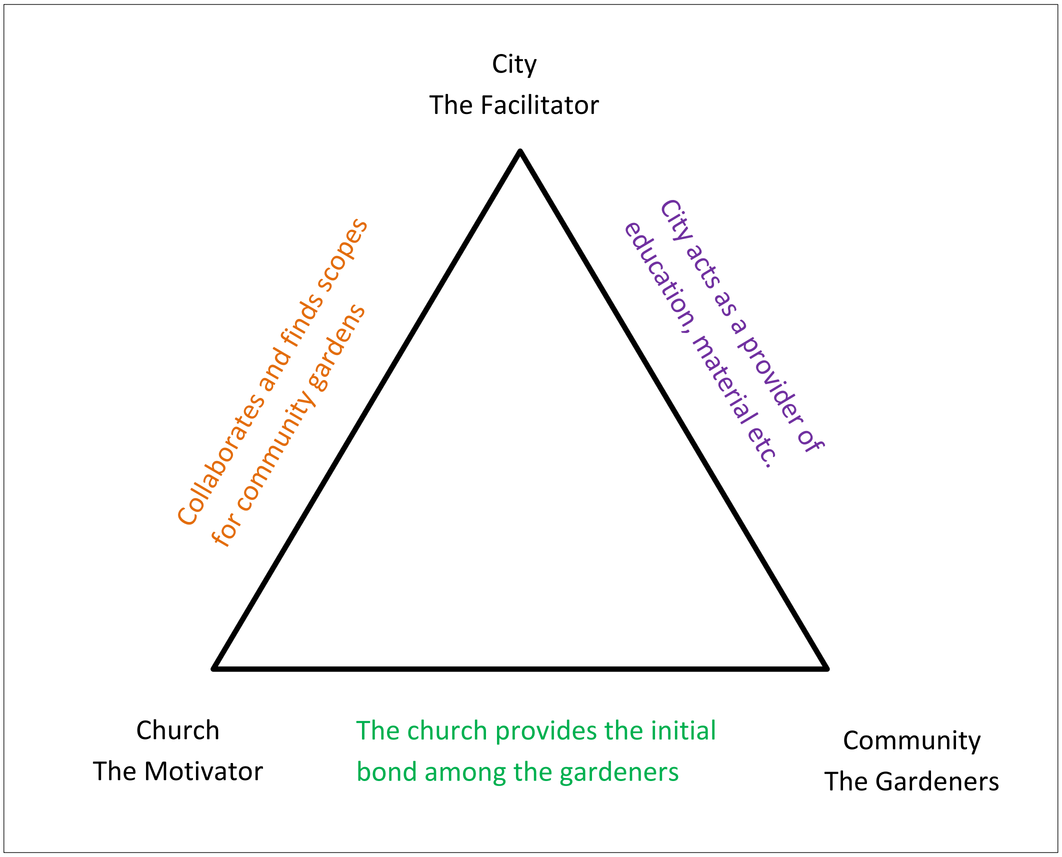

Figure 5.1 A conceptual institutional framework for community gardens

The City

The city can play a role as a facilitator in this framework for community gardens as well as an initiator for some gardens. Supports can include but are not limited to providing transport for food that are donated, arranging education seminars and garden club meetings for the community's social capital. The city can work with other non-profit organizations including churches to find potential opportunities for creating new gardens.

The Church

According to the interviewees, churches or other religious institutions provide the social bond to initiate and maintain the gardens in DFW. The role of the church can be organizing the people to gather and maintain for community gardens within exiting strong social capital among church members, thus providing an initial foundation for expanding it to the broader community.

The Community:

The community is the heart and soul of the community garden. They produce, they consume, they feel for the gardens the most and they benefit the most from the gardens. It is very important to keep the leadership of the garden in the hands of the community. A garden committee consisting with only the community members can be formed for operational purposes.

5.4 Concluding note

This study presents "Act-Now" areas to be suitable for community garden as a solution for inadequate food access in Dallas, TX in order to increase food accessibility among urban poor and shows a higher proportion of the areas in the southern part of the city. Although surveys are used to support the relative importance of each variable to reduce subjectivity, an inherent limitation of suitability analysis, it should be noted that the results would be different if different rates and weights were used for the analysis.

This results of the analysis and the implementation strategies and institutional framework can be used to develop the city's community development plans integrating community gardens. Once implemented, the gardens will provide socially disadvantaged people with various benefits in multiple dimensions – accessing affordable fresh foods that they are grown by themselves, bring families together within a community bonding, and creating green open spaces for the community. This study provides a foundation for the start-up initiative to make Dallas a “Garden City” of modern times.

APPENDIX

ADDITIONAL ATTACHMENTS

Questionnaire

Name: Date:

Profession:

- Do you think that urban agriculture is important in DFW Metroplex? If so, please explain why? If not, please explain why as well.

  YES ( )
  No ( )
  Reason:

- What types of urban agriculture do you think would be most essential in building sustainable DFW? Please explain why.

  Community gardens
  Backyard farmings
  ….. (list more)

- What are the socio-economic factors that should be considered for finding the suitable locations for community gardens? Check all that applies and include factors that you think are important but not listed here-
  Income
  - ✓ Poverty rate
  - ✓ Unemployment rate
  - ✓ Race
  - ✓ Food Desserts
  - ✓ Churches
  - ✓ Toxic sites
  - ✓ Tree canopy
  - ✓ Water system
  - ✓ Land Use
  - ✓ …………………..
  - ✓ …………………..

For each one of the factors you have selected or listed, please place your rationale behind your preference (e.g. if you think Income Group is an important factor for selecting community garden (CG) sites, please describe what income group should have a priority than others. For example, you may think that low-income group needs more CG sites to bring more social justice; or do you think that high-income group should have priority because they are more interested in CG and are more likely to participate in CG practice as actual urban farmers?) (Please use the next page if needed)

- Based on Table 1 provided below, please complete the pair-wise comparison matrix (Table 2) for assessing the relative importance of different factors:

Table 1: the relative importance of two criteria

0.25	0.50	0.75	1	2	3	4
Very Strongly	Strongly	Moderately	Equally	Moderately	Strongly	Very strongly
LESS IMPORTANT			MORE IMPORTANT			

Table 2: Pair-wise comparison matrix

	Income	Poverty rate	Unemployment rate	Food Deserts	Church	Toxic Sites	Land use
Income							
Poverty rate							
Unemployment rate							
Food Desserts							
Churches							
Toxic Sites							
Land Use							

- Please put your valuable comment on anything you would think might be useful for the suitability analysis of community gardens in DFW Metroplex.

Normalized Pair-wise Comparison Matrix by First Author

	Income	Poverty Rate	Unemployment rate	Food Deserts	Churches	Toxic Sites	Land use
Income	0.15384615	0.15003751	0.16	0.15822785	0.1353001	0.14927048	0.157978
Poverty Rate	0.07692308	0.07501875	0.08	0.07911392	0.07629705	0.05611672	0.078989
Unemployment rate	0.15384615	0.15003751	0.16	0.15822785	0.2034588	0.14927048	0.157978
Food Deserts	0.30769231	0.30007502	0.32	0.3164557	0.3051882	0.33670034	0.315956
Churches	0.11538462	0.09977494	0.08	0.10443038	0.1017294	0.11223345	0.105055
Toxic Sites	0.11538462	0.15003751	0.12	0.10443038	0.1017294	0.11223345	0.105055
Land Use	0.07692308	0.07501875	0.08	0.07911392	0.07629705	0.08417508	0.078989

Consistency Ratio= 0.0028

Pair-wise Comparison Matrix by Respondent 1

	Income	Poverty rate	Unemployment rate	Food Deserts	Church	Toxic Sites	Land use
Income	1	2	2	3	1	1.33	2
Poverty rate	0.5	1	1	2	1.33	2	2
Unemployment rate	0.5	1	1	2	0.5	1.33	3
Food Deserts	0.33	0.5	0.5	1	0.5	0.5	1
Churches	1	0.75	2	2	1	1.33	2
Toxic Sites	0.75	0.5	0.75	2	0.75	1	1.33
Land Use	0.5	0.5	0.33	1	0.5	0.75	1

Normalized Pair-wise Comparison Matrix from Respondent 1:

	Income	Poverty rate	Unemployment rate	Food Deserts	Church	Toxic Sites	Land use
Income	0.218341	0.32	0.263852	0.230769	0.179211	0.161408	0.162206
Poverty rate	0.10917	0.16	0.131926	0.153846	0.238351	0.242718	0.162206
Unemployment rate	0.10917	0.16	0.131926	0.153846	0.089606	0.161408	0.243309
Food Deserts	0.072052	0.08	0.065963	0.076923	0.089606	0.06068	0.081103
Churches	0.218341	0.12	0.263852	0.153846	0.179211	0.161408	0.162206
Toxic Sites	0.163755	0.08	0.098945	0.153846	0.134409	0.121359	0.107867
Land Use	0.10917	0.08	0.043536	0.076923	0.089606	0.091019	0.081103

The Consistency Ratio for Respondent 1= 0.03

Pair-wise comparison matrix by Respondent 2:

	Income	Poverty rate	Unemployment rate	Food Deserts	Churches	Toxic Sites	Land use
Income	1	0.5	0.4	1.33	0.25	1	0.33
Poverty rate	2	1	1	1.33	0.25	1	0.33
Unemployment rate	2	1	1	1	0.25	0.5	0.33
Food Desserts	0.75	0.75	1	1	0.25	0.5	0.33
Churches	4	4	4	4	1	2	1.33
Toxic Sites	1	1	2	2	0.5	1	0.33
Land Use	3	3	3	3	0.75	3	1

Normalized Pair-wise Comparison Matrix from Respondent 2:

	Income	Poverty rate	Unemployment rate	Food Deserts	Church	Toxic Sites	Land use
Income	0.072727	0.044444	0.032258	0.097365	0.076923	0.111111	0.082915
Poverty rate	0.145455	0.088889	0.080645	0.097365	0.076923	0.111111	0.082915
Unemployment rate	0.145455	0.088889	0.080645	0.073206	0.076923	0.055556	0.082915
Food Deserts	0.054545	0.066667	0.080645	0.073206	0.076923	0.055556	0.082915
Churches	0.290909	0.355556	0.322581	0.292826	0.307692	0.222222	0.334171
Toxic Sites	0.072727	0.088889	0.16129	0.146413	0.153846	0.111111	0.082915
Land Use	0.218182	0.266667	0.241935	0.219619	0.230769	0.333333	0.251256

The Consistency Ratio for Respondent 1= 0.02

RI Index

m	1	2	3	4	5	6	**7**	8	9	10
RI	0	0	.58	.9	1.12	1.24	**1.32**	1.41	1.45	1.49

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