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## **How the Land Use of Meatpacking District Has Been Changed Since 1840? A Geographic Information System (GIS) Application for Mapping Gentrification Using Historic Data of Land Use and Ownership Changes**

Mesfer Al-Yami<sup>a\*</sup>, Martin Phillips<sup>b</sup>

<sup>a</sup>*Researcher, Department of Geography, University of Leicester, Leicester LE1 7RH, UK*

<sup>b</sup>*Professor, Department of Geography, University of Leicester, Leicester LE1 7RH, UK*

<sup>a</sup>*Email: misfer@gmail.com*

<sup>b</sup>*Email: martin.phillips@le.ac.uk*

### **Abstract**

The possibilities for mapping gentrification using the capabilities of a Geographic Information Systems (GIS) and the historic data of property land use and ownership changes are explored by constructing GIS and then analysing and mapping the change patterns in the Meatpacking District from 1840 to 2003. In contrast to previous studies, this analysis was conducted by using historic information, with narrower definition of gentrification only as the pattern of land use change from particular businesses such as, meatpacking to other activities for instance, galleries, five star restaurants, offices, or luxury apartments. It was found that, the Meatpacking District is a definite gentrified neighbourhood, and GIS is an appropriate tool for gentrification research, particularly, once wealth information is available.

**Keywords:** Gentrification; GIS; Land use; Land cover; ownership changes.

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\* Corresponding author.

## **1. Introduction**

Gentrification refers to the transformation of property values from relatively low value properties to higher value properties as a result of the influence of redevelopment, improvement, and influx of higher income residents. This process often results in spatial displacement of the original residents and changes the essential character and flavour of that community [1]. Over the past several decades, there has been substantial gentrification and inner city revitalization of hundreds of urban neighbourhoods in America.

Gentrification has been dealt with by a number of researchers, most of them seeking to understand gentrification through the theoretical consideration of causes and consequences [1]. Generally, community discussions about gentrification issues were based on subjective or untrustworthy evidence, and even urban planning decisions were based on little more than emotional misinformation [2]. Since gentrification has become commonplace over the last several years, it is required to be analysed and mapped in order to be easily studied and understood by those it interests, such as government officials, gentrifiers, developers, and agencies.

Gentrification literature has identified the major indicators of gentrification and recognized a basic understanding of each indicator in order to determine gentrification [3]. In addition, the majority of these indicators are usually applied by using census data. However, in this project, historic information about land use and ownership change was used in order to study and map gentrification in the Meatpacking District. Thus, the indicators that were used in this study were land use change and the frequency of ownership turnover. Therefore, the impetus for this project was to see if the Meatpacking District is a gentrifying neighbourhood. This project seeks to construct GIS and map the land use and ownership changes to ascertain whether the Meatpacking District has really been transformed from an area of slaughterhouses and meat processing into an area of high cost/gentrified market retail and housing.

Two designation reports (PDF) about Gansevoort Market Historic District provide substantial information about key gentrification indicators, in our case land use and ownership change history [4]. Some geographic shape files for the proposed area's boundaries, blocks, and streets are downloaded from the BYTES of the BIG APPLE™ database published by the Department of City planning, NYC, others such as lots boundaries are created. All these data provide geographic and spatial information for the study base map. In addition, major advances in capabilities in geographic information systems (GIS) provide the necessary tools to conduct the spatial analysis on neighbourhood land use and ownership changes, as well as display neighbourhood changes using the GIS visualization capabilities. Therefore, the existence of wealth historic data sets combined with technological advances, provide those it concerns with a powerful set of tools with which to analyze and map gentrification.

A GIS is a useful tool to store, manipulate, analyse, query, and map spatial data. It has an advantage over the traditional ways when it comes to working with large amounts of data and when one wishes to perform change patterns modelling and mapping. The ArcGIS 9.3 was used to examine, analyse, and map the spatial and attribute data derived from the historic information of ownership and land use changes of Meatpacking District.

This study focused on identifying gentrification in particular, and on providing a particular study on how the historic information of property ownership and land use changes may be attained, analysed, and displayed or mapped. This study relies upon available historic information of ownership and land use changes, available geographic data from New York City planning department's website, and utilizing GIS as the primary analytic tool. It focuses on a case study of Meatpacking District, Manhattan, New York City, a neighbourhood experiencing many sure signs of successful gentrification in the 1990s.

## **2. Literature review**

### **2.1. Gentrification**

#### **2.1.1. Definition**

Gentrification is the process of neighbourhood change by which higher-income households displace lower-income residents of a community, changing the essential character and flavour of that community [5]. Displacement occurs when current residents are forced to move as a consequence of the gentrification process, because they cannot afford to live in the gentrifying neighbourhood as a result of the increase in the cost of living, property tax and often because of the loss of the original social community of the neighbourhood [6]. Furthermore, other studies have defined gentrification as an urban gentrification, which is a 'process' of changing urban areas by moving the lower class residents (or people in a state of poverty) to assigned areas and then erecting at a much higher cost of different variety of housing such as condominiums, apartelles or apartments [7]. Such a process involves a demographic shift. Those who can afford the urban developed housing move in and those who cannot would, of course, transfer to other areas with cheaper accommodation.

According to [8] the term gentrification

rose to prominence in the 1960s and 1970s, where it was often described as being equivalent with, or closely connected to, terms such as redevelopment, upgrading, improvement, and urban renaissance. This association is quite understandable given that gentrification was commonly associated with the refurbishment of housing stock. These terms came into prominence in the 1960s and 1970s, when a series of empirical studies began to record that many inner city neighbourhoods appeared to be experiencing both physical renewal and social change. Classic examples included the London boroughs of Islington, Camden and Hackney which were the focus of attention of Glass (1964) and also areas in New York such as Soho, the Lower East Side and Harlem [8]. Some people use the term 'gentrification' interchangeably with urban revitalization, to describe any commercial or residential improvements in urban neighbourhoods. Others have focused primarily on the economic actions of newcomers, namely the renovation and upgrading of the housing stock. Some consider gentrification positively, others negatively [5]. Moreover, the authors in [5] have specified three key features in order to define gentrification. First, displacement of lower income residents from their neighbourhoods, the displacement of the original residents who want to stay in their neighbourhood, but because of unjust evictions, rapidly rising rents, or increases in their property taxes, they cannot afford to do so. Second, the physical and socioeconomic components of gentrification that result in the upgrading of the housing stock in the neighbourhood. Third, the changes of the neighbourhood character as a result of gentrification.

Urban gentrification is a change in the city that is associated with population movements within that urban environment – typically movement of more affluent individuals into areas of less economic standing, and the resulting demographic shifts. As the middle and upper classes move into these areas, social and cultural changes abound – the transformation of the neighbourhood’s character and culture; changes in taxation, rents, home prices, and even land use for services demanded by this new class of people [9].

With gentrification come various changes which affect the entire neighbourhood, investors, and other members of the industrial sector. For the neighbourhood, such moving in and out will result in a change in culture and character. Those who will be living in the urbanized and/or high cost housing will have to adapt to the seemingly sophisticated environment [5]. They will acquire needs which may not be their usual requirements such as higher and more privatized education, more sophisticated modes of transport and the like. On the other hand, those who will need to move out and opt to live in more affordable housing venues will have to become accustomed to the increasing crime rates and a seemingly chaotic environment. It is because of these movements and changes in culture that gentrification has been described as a factor that leads to discrimination of race and of wealth [5].

Within the context of urbanization, geographers have identified two major trends in city growth: immigration push and immigration pull. Urban areas grow in two ways: by a natural increase (more births than deaths) and by immigration. Both are fuelled by improved food supplies, better sanitation, advances in social and medical care, and by push and pull factors. Immigration push factors cause people to migrate to urban areas for economic reasons: jobs, food, and housing. Environmental, economic, political or other conflicts may drive people from rural to urban areas as well. Immigration pull factors are the means by which a city attracts new people – greater availability of jobs, housing, trade, entertainment – upward social mobility, prestige, power, and the change for greater actualization [10].

Gentrification has changed the character of hundreds of urban neighbourhoods in America over the last 50 years. Beginning in the 1960s, middle and upper class populations began moving out of the suburbs and back into urban areas. At first, this revitalization of urban areas was “treated as a ‘back to the city’ movement of suburbanites, but recent research has shown it to be a much more complicated phenomenon” [11]. This phenomenon was coined “gentrification” by researcher Ruth Glass in 1964 to describe the residential movement of middle-class people into low-income areas of London [12]. More specifically, gentrification is the renovation of previously poor urban dwellings, typically into condominiums, aimed at upper and middle class professionals. Since the 1960s, gentrification has appeared in large cities such as Washington D.C., San Francisco, and New York. The trend for typically white, college-educated, higher income, and upper-middle class working professionals to move back into the city has caused much controversy [11]. It occurs in periodic waves: from the federally sponsored urban renewal efforts in the ‘50s and ‘60s, to the so-called “back-to-the-city” movement of the late ‘70s and early 1980s [5].

During the process of gentrification, affluent “urban pioneers” buy dilapidated buildings, usually in areas close to the central business district, and remodel them as comfortable middle-class dwellings – a process that increases not only the value of the renovated property but all that of the properties around it. However,

gentrification usually occurs in areas with particular qualities that make them desirable and ready for change. The convenience, diversity, and vitality of urban neighbourhoods are major draws, as is the availability of cheap housing, especially if the buildings are distinctive and appealing. Old houses or industrial buildings often attract people looking for investment opportunities [13].

### ***2.1.1. Theories of the Causes of Gentrification***

Over the last three decades, gentrification has affected dozens of cities in the United States and while suburbanization remains the dominant housing trend, gentrification continues to be one of the most controversial [14]. Many researchers have theorized why the wealthy desire to move back into the city. In [11] researcher believes that many wealthy people are drawn to the architectural design of some of these old houses in urban areas [11]. In [15] the authors propose a number of theories, for example they postulate that the city is so attractive to the wealthy because of its location. Since most of the main business centres of a city are located in the urban part of the city, the wealthy are closer to where they work, drastically reducing commuting time to and from work. Probably the most attractive feature of the city is its low property and housing values. City property is much cheaper than the suburban, even though many of the city houses are more spacious than the suburban houses [15]. All of these factors contribute to the attractiveness of the city to the wealthy.

Gentrification has many causes: a reinvestment effort to revitalize and turn neighbourhoods around; a change in political structures allowing the infrastructure to evolve within the inner city; governmental and private incentives for redevelopment and improved housing access, and even community activism [16].

Numerous theories abound regarding the causes of gentrification. For instance, urban renewal is socially driven; it allows recent college graduates or more affluent baby-boomers, to move closer to a transportation hub, and offers a way out of the suburban trap [17]. From the production-side theory, it holds that there is a clear economic relationship between the flow of capital and the production of urban space. As World War II rural areas devalued the urban areas, the context of the inner city changed, becoming more service and white-collar oriented, thus attracting that type of individual [18]. From the consumption-side theory, it supports that the new city supports an emerging class made up of artists, cultural professionals, and people who are revitalized by living in an urban area, by all that the city can provide in a central business district, and by the clear urban lifestyle [19]. Finally, globalization theory shows that it is the city's role in the new economic structure, where urban centres, by necessity, are ranked by their ability to proactively function in a climate where national borders are blurred. Immigration to these centres is a result of increased economic opportunities; but there are growing pains (social unrest and inequality). Indeed, this phenomenon is showing no signs of slowing down and as outsourcing from the developed world increases, the urban centres of the developing world face even greater challenges to maintain themselves through unprecedented, sometimes unplanned, and wild growth prospects [20]. However, academic literature has run a long-running debate about the causes of gentrification. As it was mentioned [5], even "the long-running debate about whether gentrification is caused primarily by social/cultural factors such as changing family structures, by economic factors such as job/housing imbalances, or by some combination of both, but the most factors that contributing to gentrification are, rapid job growth, tight housing markets, preference for city amenities, increased traffic congestion and lengthening commutes, and targeted

public sector policies” [5].

### **2.1.2. Indicators of Gentrification**

Community indicators evaluate social and economic change in an area, and are usually used in community planning and economic development. As gentrification normally has economic ramifications, consequently certain types of indicators are noticed when it is occurring or likely to occur in a specific area.

In [21] indicators were defined as “measurements that provide information about past and current trends to assist planners and community leaders in making decisions that effect outcomes”. Social, environmental, and economic factors which work together to make changes in a community or region are usually quantified and measured by these measurements. Several indicators of gentrification have been explained in the literature, some of them are regional, and others are local or relevant at the neighbourhood level. Rapid job creation, a regional indicator was identified by Kennedy and Leonard (2001), as the most significant indicator of possible gentrification. Rapid job growth has been assumed by researchers to be the key ingredient for gentrification in inner city areas [5]. Nesbitt (2005) argued that the supply of housing units in relation to demand is one of the obvious indicators of gentrification, where by the demand for housing increases, as more residents moved to an area and current residents earn higher incomes. He has stated that, housing prices will increase if the current housing supply cannot meet the demand. As a result of these price rises, and with the expensive suburban housing, the cheaper inner city housing becomes a viable alternative. Furthermore, the historic value of the housing stock, and the percentage of owners occupied housing are all indicators of gentrification at the neighbourhood level [3].

However, different researchers have suggested some indicators which demonstrate that gentrification has occurred in a neighbourhood. These indicators include ; percentage of highly educated population, average of median rent, average of median income, percentage of home ownership, shift from rental tenure to homeownership, influx of amenities that serve higher income levels, and/or influx of households and individuals interested in specifically urban amenities and cultural niches [5,22]. However, in this thesis, the ownership and land use changes have been used as the indicators of gentrification.

### **2.1.3. Impacts of gentrification**

Gentrification is a general term for the arrival of wealthier people in an existing urban district, a related increase in rents and property values, and changes in the district's character and culture. The term is often used negatively, most people who see gentrification to be problematic suggests that the displacement of poor communities by rich outsiders is the most troubling effect of gentrification. However, the effects of gentrification are complex and contradictory, and its real impact varies [14].

Gentrification process behaves as a double-edged sword. In certain respects, any gentrified neighbourhood can be a victim of its revitalization and transformation. The transformation of neighbourhoods from low value to high value is seen as extremely threatening. This is because such change has the potential to cause displacement of long-time residents and businesses. Current residents may be uprooted from their homes because they can no

longer afford to live within their communities while small local businesses are forced to close due to competition with incoming corporate retail chains. Both the economic and social effects of displacement can be considerably high [5]. On this basis, it would be possible to say that the displacement of lower income residents by higher-income households is one of the main troubling effects of gentrification [23]. Through gentrification process, a change in the value of properties also comes about. When a neighbourhood is gentrified, prices will go up, thus, homeowners, renters, and business owners may be displaced from their communities due to gentrification, whether through non-justice turnover, rent hikes, or evictions. Usually, when properties are sold, the new owners often evict the existing tenants to bring in new tenants at a higher rate. Moreover, new owners may convert their own properties into condominiums or other luxury homes. Thus, the result is the further movement away of residents to search for affordable housing since they cannot afford to stay in the gentrified area. However, there will be an increased opportunity for various investments which can be in the form of incentives for redevelopment, improvements in the access to housing loans for low-income mortgage seekers, assistance to lending to first-time home purchasers, and improvement of rental properties. This would of course result in reductions in local property crime rates, increased property prices and increased revenue to local governments from property taxes [5]. From the perspective of the economic effects, the arrival of new investment, new spending role, and a new tax base usually result in significant increased economic activity. According to the gentrification literature, housing development, decline of industrial activities, rehabilitation, new shops and restaurants, and new higher-wage jobs are often considered as consequences of gentrification. Original households may benefit from some of this development, particularly in the form of service sector and construction jobs, but much of it may be out of reach to all, except the well-educated newcomers. Moreover, some local businesses might be forced out, either by rising rents or by changing the kind of the economic activities [13]. Physical changes of a gentrified neighbourhood also accompany the gentrification process. Older buildings are usually rehabilitated and new constructions created. There will be public improvements to streets, parks, and infrastructures as new residents organize to demand public services. Usually, new arrivals push hard to change and improve the district aesthetically, and may enforce new standards in building design guidelines, and historic preservation legislation [13].

## ***2.2. Mapping Gentrification through GIS***

Demographers have traditionally studied gentrification through primary and secondary research utilizing interviews, population records, census and statistical data, and real estate information. Gentrification typically increases the average income in a neighbourhood, sometimes resulting in a decline in ethnic minorities, a reduction in the size of households, and a replacement of low-income families with many children with those of singles and childless couples. Social groups such as artists, and young married professionals are often able to transform a “poor” neighbourhood within a few years, simply by renovation and the economic draw their profile has on the surrounding businesses and services provided to them [16,24].

### ***2.2.1. Geographic Information Systems (GIS)***

Up until the arrival of technological advances, however, gentrification studies were time-consuming, labour intensive, and analytically difficult to conceptualize. For instance, relationships between social groups within an

urban area, or consumption and economic development in global cities, required a great deal of handwork, and even more hand analysis. Despite this, there were numerous marketing, sociological and anthropological benefits in studying the process of community building through gentrification [25]. Generally, community discussions about gentrification issues were based on subjective or untrustworthy evidence, and even urban planning decisions were based on little more than emotional misinformation [2]. Geographers and urban planners knew that there must be a better way to understand and map gentrification trends, and to apply these techniques to the theoretical problems associated with urban planning and sociological/anthropological studies of human populations [26]. Early in the 1960s when computers were first used for data analysis, the first Geographic Information System was developed in Ottawa Canada – used to store, analyze, and manipulate data collected for the Canadian Government [27]. Each succeeding computer generation then saw a corresponding improvement in GIS tools. For the subject of gentrification: Spatial analysis of gentrification can aid policy makers by providing information about the intensity and magnitude of change in a given neighbourhood, as well as allow for relatively easy comparative analysis across the region. This knowledge can be an effective tool in prioritizing how community funds are allocated. Moreover, a spatial analysis of neighbourhood change can provide a good starting point from which to begin an objective community dialogue around the externalities of gentrification, as well as provide policy makers with a tool to evaluate the impact of housing and economic development programs [2]. Generally, GIS is a computer-based tool that facilitates mapping and spatial analysis of the Earth's features and events. Using GIS, otherwise disparate data can be related on the basis of common geographic location, creating new information from existing data resources. Hidden in most data is a geographical component: an address, postal code, census block, city, county, or latitude/longitude coordinate. GIS software allows researchers to explore and analyze data by location, revealing hidden patterns, relationships, and trends that are not readily apparent in spreadsheets or statistical packages. When combined with other related technologies, for instance community based information systems, and even the coding of qualitative urban data, the models may be used as a more robust decision making system, as well as exported to other, similar areas that would not need to replicate the study [28]. In the multi-disciplinary study of gentrification, numerous questions may be answered with the use of GIS systems. First, we must remember that the study of urban areas, urban populations, and the ways in which human migration occurs, are done by a variety of professions for a variety of reasons. The sociologist or anthropologist may wish to answer questions about social norms and mores, and what causes certain social groups to be attracted to urbanization. The demographer wishes to have data that explain human migration patterns, and utilizes a system in which numerous subsets of data may be included to model predictive behavior patterns. The historically cultural person is likely to be curious about the demographic and psychographic movement of people based on historical, finite industrial or cultural trends, and/or the effects of historical events on gentrification and migration. A geographer might combine several of these issues into a better understanding of a particular geographic area, or what mega effects population change, technological development, or globalization may have on urban areas [29,30].

### **2.2.2. Previous Studies**

According to [5], it is really challenging to identify and determine which data is truly helpful in identifying gentrification trends. Generally speaking, that the data measuring gentrification after it occurs, such as



increasing average of incomes, a high rate of property ownership changes, an increase in the value of properties, and the displacement of the original residents, could be useful in assessing and modelling gentrification. However, most of the literature on the integration of GIS into gentrification research is descriptive and the main data that was used is the Census tracts information. In this thesis, historical information about land use and ownership changes has been used to investigate and map gentrification in the Meatpacking District, New York City. In [2] GIS technologies were used as the primary analytic tool together with Census data to provide practical guidance on how information for key neighbourhood change indicators may be attained, manipulated, analyzed and displayed. His study focuses on a case study of Portland, Oregon, a city experiencing many of the symptoms of gentrification in the 1990's. The author in [2] has found that, by applying GIS techniques with the help of rich information available such as Census data, "researchers would be able to concretely identify changing neighbourhoods. Furthermore, this technology can be an effective tool in prioritizing how community funds are allocated. It could also be used to establish community goals, identify community problems and solutions and create community specific programs" [2]. In [31] the author has used five predictors of gentrification: distance from an elite area (areas with an average income in the top quintile), distance from the central business district, density of pre-1946 dwellings relative to the city's average (an imprecise indicator of attractive architecture), "dwelling value above average", and "dwelling value below trend". He used all these data, which was driven from census information, to create and actualize a model to predict areas of social status change in Vancouver from 1991 to 1996 coupled with using the capabilities of a Geographic Information System. To test his formula, he used old data to see if it would "predict" the gentrification of areas that had in fact become gentrified. Author in [31] seems to have found some merit to his formula, but not as much as he expected. Another study in modeling gentrification was conducted in [3]. The study focused on the use of census data to model long-term patterns of change and uses them to monitor gentrification in a neighbourhood. It identified several indicators of gentrification and used them to develop a model that monitors community change and assesses the likelihood of gentrification. The study considers sixteen indicators based on the gentrification literature, and the majority of these indicators use census data as the source of the information needed. However, the study demonstrates the capabilities of statistical analysis and geographic information systems to monitor and assess the likelihood of gentrification [3].

### **2.2.3. Summary**

Among the gentrification literature, many studies have examined gentrification through the theoretical consideration of causes and consequences. Modeling, visualizing, and mapping have been largely untouched by the literature, despite some theoretical works for model-building and simulation environments for exploring ideas [1]. There is a small literature that uses GIS technologies for modelling, monitoring, or predicting gentrification. These studies focus on the use of census data to reveal patterns of change and use these changes to monitor gentrification in a neighbourhood. However, in this project, the historic change to property ownership and land-use in the Meatpacking District will be mapped. According to the literature, it can be argued that, the change in the land use of a neighbourhood from industrial use to an office or multimedia use, and the development of high-end retail commerce, restaurants, offices, clubs, galleries, apartments, and live-work lofts is a clear sign that the gentrification process has impacted or is impacting that neighbourhood. In addition, the frequency of property ownership change is considered as an indicator of gentrification.

### **3. Study area**

The study focuses on Meatpacking District, Manhattan, New York city. It is officially known as Gansevoort Market, the area just south of West 14th Street and from Hudson Street to the Hudson River, although it has extended to the north to West 16th Street and east beyond Hudson Street in recent years [32]. By 1900, Gansevoort Market was home to 250 slaughterhouses and packing plants. Today, newly renovated loft buildings and unimproved structures provide a range of rents and tenants from artists to high-end advertising agencies, giving the area an appealing and vibrant diversity. Furthermore, it is one of the last surviving market neighbourhoods in New York City, containing a rich array of 19th and early 20th century commercial and vernacular architecture [32].

#### ***3.1. The Gansevoort Market Historic District***

The Gansevoort Market Historic District consists of 104 buildings. These buildings are distinctive for their architectural character, which reflect the area's long history of continuous, varied use as a place of dwelling, industry, and commerce. This area is known particularly as a marketplace, and it has a distinctive urban layout. Most of the buildings, which date from the 1840s through the 1940s, represent four major phases of development, and include two purposes of building structures, first, designed in then-fashionable styles, and second, those later adapted for market use. The earliest buildings in the historic district were founded in the period between 1840 and 1854. Most of these buildings were built as rowhouses and town houses, and most of them became very early working-class tenements. The buildings in the district founded from the 1880s through the 1920s were designed in then-popular historical revival styles. By the 1880s the district had experienced a residential and commercial development, including a variety of building types, and was particularly spurred by two major factors. The first was that two municipal markets were created nearby the area, while the second factor that encouraged development within the historic district was the 1878 partition of real estate owned by the Astor family. The entire block bounded by Gansevoort, Horatio, Washington, and West Streets was developed between 1897 and 1935. This block was built with an attractive neo-Classical style using tan brick. Furthermore, by the completion of three major projects in the area, the Holland Tunnel (1927), the elevated Miller Highway (1931), and the New York Central Railroad's elevated freight railway (1934), a major wave of new low-rise construction and the functional conversion of existing buildings for market use in the district impacted the area. As a result, these three projects provided easier access between the area and the metropolitan region. By 1938, poultry and meatpacking was considered as the main commercial activity within the district. However, today, the Gansevoort Market Historic District is an attractive neighbourhood. Despite some remaining meatpacking businesses, it has become an area of high-end retail commerce, restaurants, offices, clubs, galleries, and apartments. Despite recent changes, the district maintains a strong and integral sense of place as a market area, due to its distinctive streetscapes and metal canopies [33]. As the Meatpacking District becomes a center of gravity in its own right, a long-hidden secret is being let out. The area that was at one time considered isolated is actually quite easy to access, bordering large parts of both the Village and Chelsea. Also, several new development projects are proposed for the area. Sinvin is the exclusive leasing agent for one of the largest building in the Meatpacking District, the dramatic speculative redevelopment at 29 Ninth Ave. The windows at 29 Ninth Ave. have been enlarged to allow in abundant natural light to flood into the loft spaces. Classic

architectural details have been preserved, such as exposed wood beams, brick walls and high ceilings. Landmark Development Company is planning a two-building project that will include an unprecedented 32-story residential condominium tower on Washington Street at the West Side Highway. The design he has put forward is by noted French architect, Stephen Touhey. Bodum, the Danish producer of stylish kitchen and coffee accessories, has opened its first U.S. store in the Meatpacking District. Alexander McQueen, now part of Gucci, has a store under construction that will be Bodum's new neighbor on 14th Street [34].

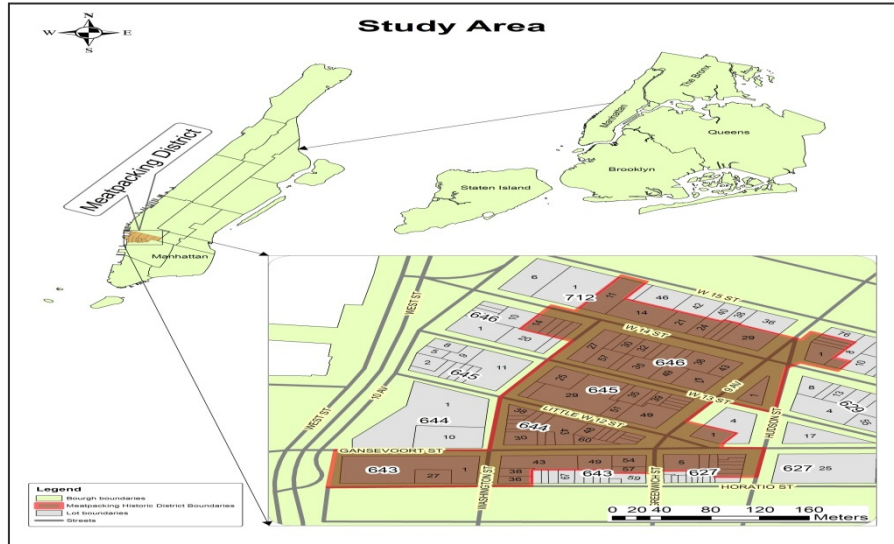


Figure 1: Study area

#### 4. Data sources and methodology

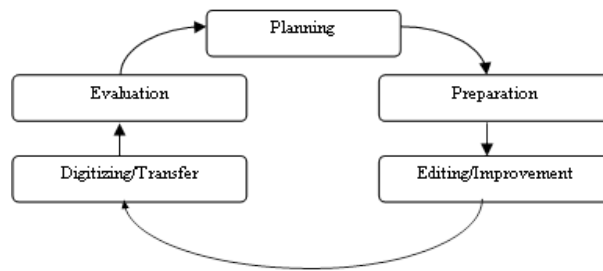
##### 4.1. Data collection

GIS can contain a wide range of geographical types of data originating from many diverse sources. From the perspective of constructing a GIS, it is convenient to classify the geographic data into primary and secondary sources. Primary data sources are those collected in digital format specifically for use in a GIS project. Secondary sources are digital and analogue datasets that were originally captured for another purpose and need to be converted into a suitable digital format for use in a GIS project. Analogue data must always be digitized before being added to a geographical database [35]. Data collection involves a series of sequential stages. The workflow starts with planning, followed by preparation, digitizing/transfer, editing and improvement, and finally, evaluation [34]. The data sources for this study can be divided into two main data sources:

- Historic and documentary data of the ownership and land use changes of the meatpacking district properties.
- Spatial and Geographical data of the study area (eg. Blocks, Tax lots, Streets,....etc)

An inventory of all available existing New York City GIS internet resources was conducted to determine

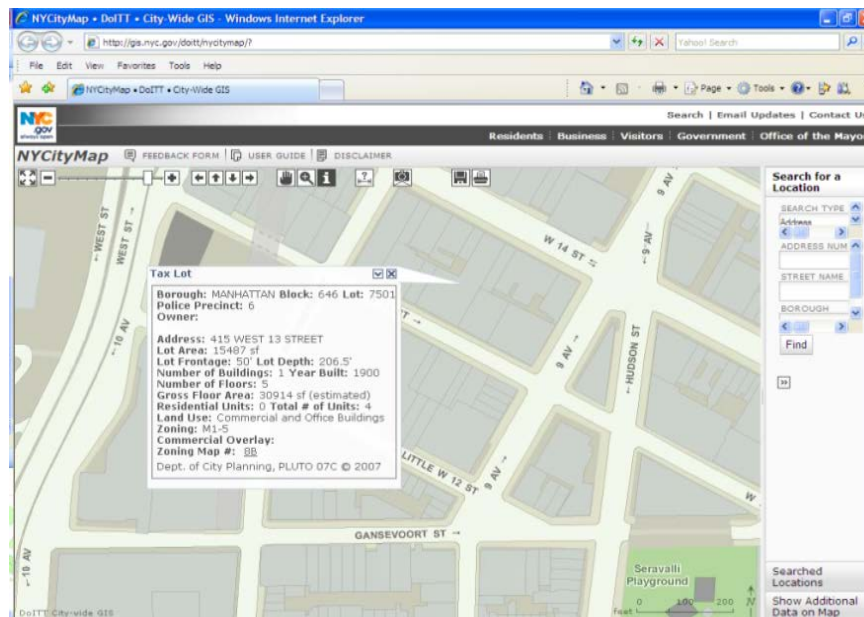
existing geographic information about Meatpacking District to include in the GIS analysis database of this district.



**Figure 2:** Stages in data collection [35].

#### 4.1.1. Ownership and Land use data

Most of the data collected comes from the New York City Department of City Planning and the Greenwich Village Society for Historic Preservation websites. Two designation reports (PDF) about Gansevoort Market Historic District were downloaded from the Greenwich Village website. These two files contain a significant amount of information about ownership and land use history for the proposed area since the earliest buildings in the historic district were founded in 1840. The individual building entries in these reports are arranged numerically by block and lot. A block map indicating lots, buildings, and addresses appears at the beginning of each block. Current photographs appear with each entry. However, since these PDF files were completed in 2003, the current ownership and land use information has been taken from the New York city-wide GIS website (Figure 3).



**Figure 3:** Screen capture of how the current property information was collected from the New York city-wide GIS website.

#### 4.1.2. Spatial and Geographic data (vector and raster )

##### 4.1.2.1. Already prepared data

In order to carry out the study and to map the ownership and land use change, a base map for the proposed district has to be made. Hence, the GIS shape file for New York City borough boundaries, the New York City census blocks for 2000 US census, the New York City census tracts for 2000 US census, Manhattan tax blocks, and the streets data are downloaded from the BYTES of the BIG APPLE™ database published by the Department of City Planning [36].



**Figure 4:** An orthoimage of Meatpacking District

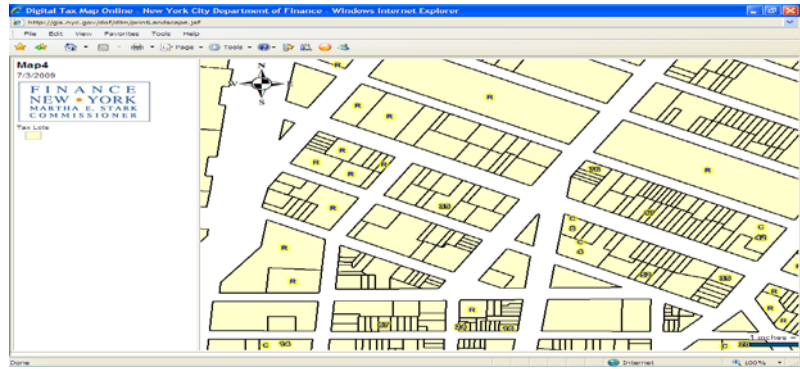
USGS High Resolution Orthoimagery for New York City, NY Urban Area was downloaded from the U.S. Geological Survey (USGS) website. This data set consists of a 2-foot resolution natural colour orthoimage, covering New York City, NY. An orthoimage is a remotely sensed image in which displacement of features in the image caused by terrain relief and sensor orientation has been mathematically removed. Orthoimagery combines the image characteristics of a photograph with the geometric qualities of a map (Figure 4).

#### 4.1.2.2. Data to be created

##### 4.1.2.2.1. Tax Lots

As the tax lot geographic boundaries data are vital for the study of gentrification, and since they cannot be downloaded directly from the Internet, they must be created. In order to do that, a tax lots map for the proposed area was downloaded as an image (Figure 5) and then geo-corrected using some control points selected from other sources for the same feature in both the raw image and the source map of the control points. After that and with the use of the capabilities of ArcGIS software, all the tax lots were digitized to create a vector map (polygons) for all the tax lots included in the study area.





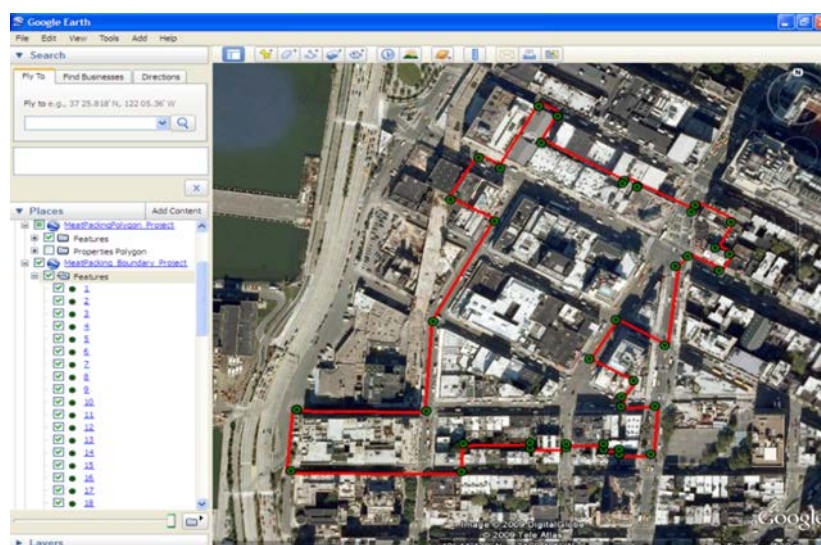
**Figure 5:** Screen capture of the map used to digitize lots boundaries

#### 4.1.2.2.2. Buildings Footprints

The same process was conducted for the Building Footprints, to produce a vector map for the buildings boundary of the study area.

#### 4.1.2.2.3. Gansevoort Market Historic District Boundaries

Our study focuses on the historic part of the Meatpacking district. However, the boundaries of the historic area cannot be downloaded from the BYTES of the BIG APPLE™ database or any other sources. Consequently, they need to be created. To do so, a map for the historic area of the Meatpacking district was created and downloaded from the New York city-wide GIS website as an image. This image-map needs to be geo-corrected in order to be spatially accurate for the digitizing of the historic boundaries. This was achieved by using some control points for the area extracted from Google Earth (Figure 6). All the newly created shape files must be projected using the same projection of the original data, the New York Long Island State Plane Coordinate System (NAD83).



**Figure 6:** Screen capture from Google Earth revealing the boundaries of the study area

#### **4.2. Data preparation**

Having collected all the necessary data, further work is needed in order to prepare a database containing all the relevant information. First, the GIS shape files for the Manhattan borough boundaries, New York City census blocks, New York City census tracts, Manhattan Tax blocks, and the streets data, are clipped to the study area (Meatpacking District). Second, after creating the entire tax lots shape files, the feature attribute table for each set of lots included in a single tax block was edited to include the fields for values of block number and lots numbers. The same process was conducted for the Buildings footprint shape files.

Since our study focuses on mapping gentrification in the Meatpacking District according to the historic data of ownership and land use change, an external main attribute table of the ownership history and buildings type was created. This table includes the fields for the values relating to each lot in the whole study area. These fields are property address, original owner, built year, number of storeys, ownership across period, date of each ownership change, buildings type, and other associated fields.

Conceptually, there are a variety of file formats that can be used within the ArcGIS. Two file formats were designed to hold geographic data, shape file and personal geodatabase. Thus, all the files relating to the project, geographic and tabular data, were stored into a geodatabase file, making them easier to organize and transfer if necessary.

#### **4.3. Methodological approach**

In order to map gentrification it is vital to identify the indicators of gentrification that will be used to study and map the likelihood of gentrification occurring in a neighbourhood. Subsequently, it is necessary to collect the appropriate data for those indicators, convert those data into usable formats, and map these data for each indicator using GIS technology.

Among the gentrification literature, the majority of the indicators discussed use census data as the main source for the input information. However, in this project a different approach was used by using historic information about the ownership and land-use change in the study area since the first building was founded. Therefore, it can be said that the indicators used were ownership and land-use change

##### **4.3.1. Property ownership change**

In this part, the study focused in mapping the historic change to property ownership in the Meatpacking District. As mentioned previously, an external main attribute table of the ownership history and buildings type was created (Table 1). After creating and editing the attribute table of the history of ownership for the properties for each lot, the number of the ownerships change for each lot were counted and added to a new field called number of ownership change. This new field was used to map the ownership change for each lot using a color-coded map. All the property ownership information was extracted from the two "PDF" files (Gansevoort Market Historic District, designation report) [4], and from the New York city-wide GIS website (identifying current ownership).

**Table 1:** Sample of ownership changes table

Block- Nu	Lot- Nu	Address	Stories Nu	Original Owner	Ownership History	Date	Nu. of OwShip
627	5	36-40 GANSEVOORT STREET	2	36 Gansevoort Corp.; Producers Distributing Agency, Inc. (lessee)	36 Gansevoort C o p / 36 Gansevoort Realty Corp	1946	5
					Plymouth Beef Co.	1978	
					Gerald Sussman	1980	
					36-40 Gansevoort Realty LLC	1995	
					The Gerald Sussman	2007	
627	7	34 GANSEVOORT STREET	5	34 GANSEVOORT STREET	William M. and Sarah Catherine Giles	1870	7
					George G. Sickles/ George Stanton Sickles/ Daniel Edgar Sickles	1877	
					Mary A. McBride/ Catherine F. McBride	1895	
					Koster Butter & Egg Co.	1923	
					City Bank Farmers Trust Co. (foreclosure)	1939	
					34 Gansevoort Street Corp.	1943	
					34 Gansevoort Realty	2007	

**4.3.2. Land-use change**

As mentioned above, the change in the land-use from specific uses such as industrial to other uses, for instance, office or multimedia, the development of high-end retail commerce, restaurants, offices, clubs, galleries, apartments, and live-work lofts is considered as a clear sign of the gentrification process. Thus, the land use change in the Meatpacking District was studied and mapped to ascertain whether it has really been transformed from area of slaughterhouses and meat processing into an area of high cost/gentrified market retail and housing.

Therefore, the historic data reporting the history of the land-use change at Meatpacking District since the first building was founded was studied carefully. An attribute table for the land use change was created. The land use changes for each tax lot were studied carefully throughout the period from 1840 to 2003, and any change in the land use was reported and edited into the attribute table. Next, once all the relevant information about the land use changes for the whole of the study area was edited, it was necessary to examine it in order to ascertain when the significant change in the land-use happened, to enable it to be mapped.

In this process, five different time periods were identified as the major time periods during that the area experienced a great deal of change in land-use. These periods are pre-1900, 1900 to 1938, 1939 to 1969, 1970 to 1993, and 1994 to 2003. These five time periods were selected according to a special technique that was used



for this purpose. By which, after completing the land use attribute table for the whole area, each lot's land use data was examined independently (as a row in the Excel file), where the first change in the land use was coloured with a different colour (e.g Green), the second change in the land use was colored with another colour (e.g Orange), and so on for the rest of the table (Blue for third change and Plum for the fourth).

Following this, by looking broadly at the land-use change table with the help of the colour strategy used, it can be noted that the first wave of the land use change from the primary uses in the area, happened between 1900 to 1938. The second major change happened throughout the period from 1939 to 1969. Nevertheless, the significant wave of land-use change hit the area in the period from 1970 to 1993. There are some other changes in land use which have been noticed in the area throughout the period of 1994 to 2003. Furthermore, the land use change will be mapped for each tax block separately. This will be done to maintain the clarity of representation and to avoid difficulties of interpretation.

## **5. Findings and results**

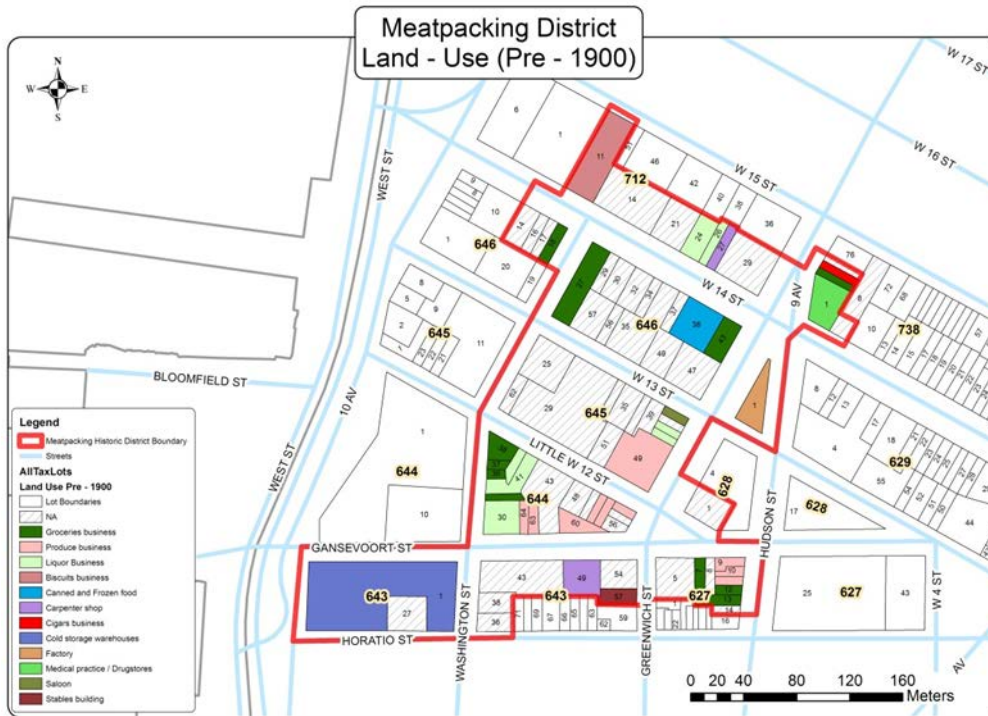
This thesis focuses on the use of the historic data of the ownership and land-use changes to construct GIS in order to map and reveal long-term patterns of ownership and land-use change and use them to study gentrification in Meatpacking District, NYC. This chapter will report the findings for ownership and land-use change separately, looking at overall changes from nearly 1840 to 2003. In addition, the general building types in the Meatpacking Historic District and its Chronology will be mapped.

### **5.1. Land-use**

According to the literature, gentrification usually encompasses ownership and land-use changes. The change from manufacturing to services, the increase of the professional and technical functions, and concentration of management sectors [18] are signs of the gentrification process. However, first we will look broadly at the land-use change throughout the whole period. Then, some special shift cases of land use changes will be examined and portrayed with details.

#### **5.1.1. Overall land-use changes**

By looking at the map (Figure 7) which reveal the land use change in the Meatpacking District for the period of pre-1900, it can be seen that the most dominant businesses in that period of time were groceries and produce associated with some other business (dairy products, eggs, and liquor ). The area experienced some slight changes in the pattern of land use, when the meatpacking business began to hit the area in the early 1900s. From Figure 8, it is clear that the meatpacking business was the most dominant business in Blocks 712 and 646 (East) at that time. However, by 1939, it can be argued that the meatpacking and poultry businesses were the main commercial activities throughout the district (Figure 9). This happened after the major phase of new low-rise with metal canopies alterations of the existing buildings coupled with functional conversion, spread throughout the historic district [4].



**Figure 7:** Meatpacking district land use map in the period of pre-1900

According to Figure 9, the meatpacking business continued as the main and significant industry in the district during the 1970s and 1980s. However, the changing character of the Meatpacking district area appeared as early as 1970 when the area experienced the presence of the first nightclub (Zoo) in 1970. This nightclub was opened on lot 57 in block 646 (East).

However, this lot used to be used for meatpacking business. Moreover, another presence emerged within the district during the 1980s, when the nine buildings on block 643 (West) were combined eternally, renovated, and converted from cold storage warehouses into luxury apartments. Another apartment building was constructed in lot 57 of block 643 (East), a conversion from a meat market building to an apartment. This could be the first indications of the changing nature of the neighbourhood of the meatpacking district.

Therefore, it can be argued that there were visible signs of the gentrification process starting to hit the area from the early 1970s. Nevertheless, according to the gentrification literature, typically a gentrifying neighbourhood will experience an increase in businesses such as; galleries (arts), professional organization, restaurants, clubs and pubs, offices, luxury apartments, multimedia, the development of high-end retail commerce.

Thus, from Figure 10, it may be inferred that, by the 1990s the area had experienced surest signs of successful gentrification, a significant shift in land use from meatpacking industry to an upscale neighbourhood. In Figure 10, galleries, clubs and bars, restaurants, professional organizations, TV and film production, offices and high-end rental have been mapped by lot

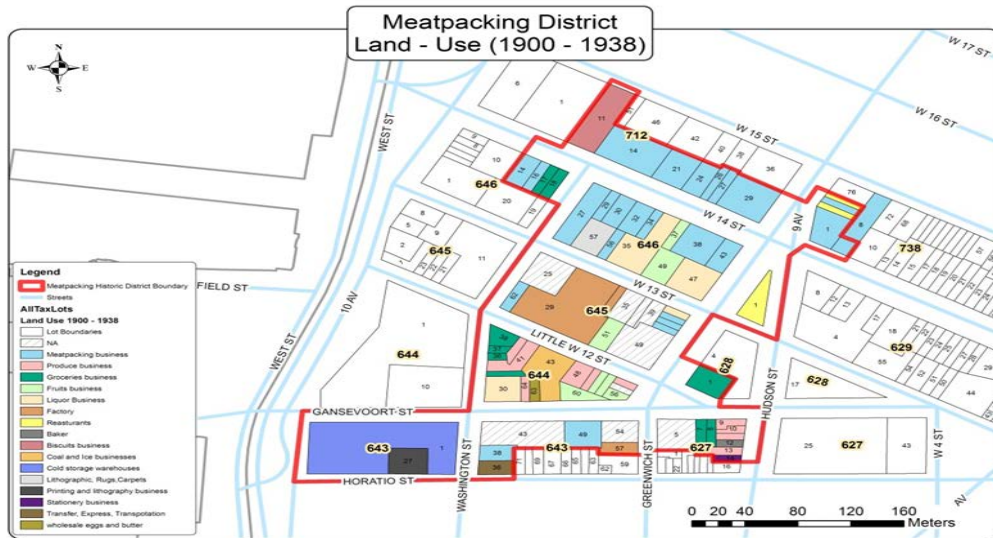


Figure 8: Meatpacking district land use map in the period between 1900 - 1938

As can be seen from the Figure below, the area has experienced a decrease in the meatpacking, produce and groceries businesses. It is clear from the map (Figure 10) that the land use of the properties in blocks 712, 643 (East), and 627 has been entirely changed from meatpacking business to other businesses such as; restaurants, apartments, offices, TV and film production, high-concept furniture, and advertising agencies. In many cases, this can confirm that such land use changes were a consequence of a gentrification process. In other words, it can be said that by the 1990s the Meatpacking District went through a transformation, from a mainly meatpacking business area to a high standard fashionable neighbourhood. However, the map illustrates that there were still some meatpacking companies remaining in the area.

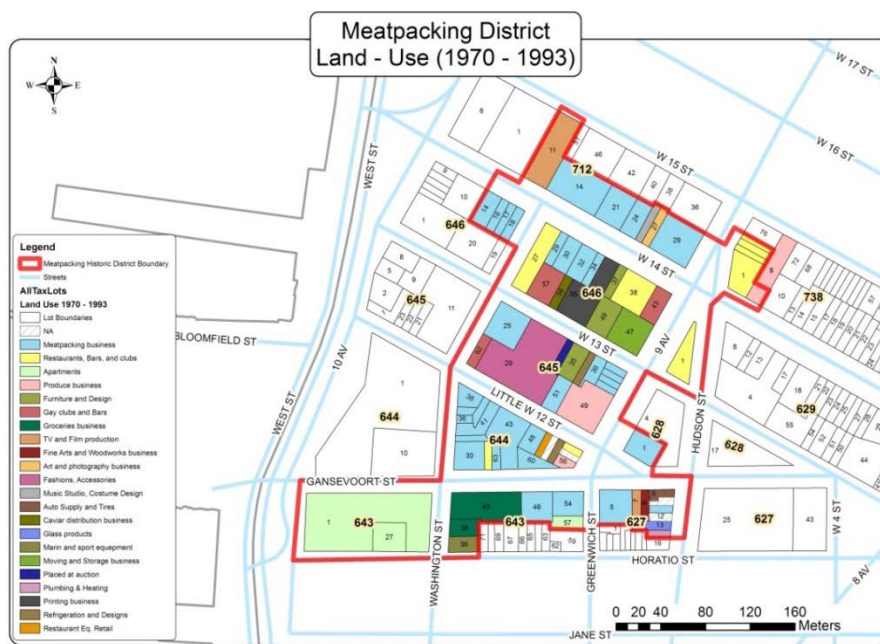


Figure 9: Meatpacking district land use map in the period between 1970 – 1993

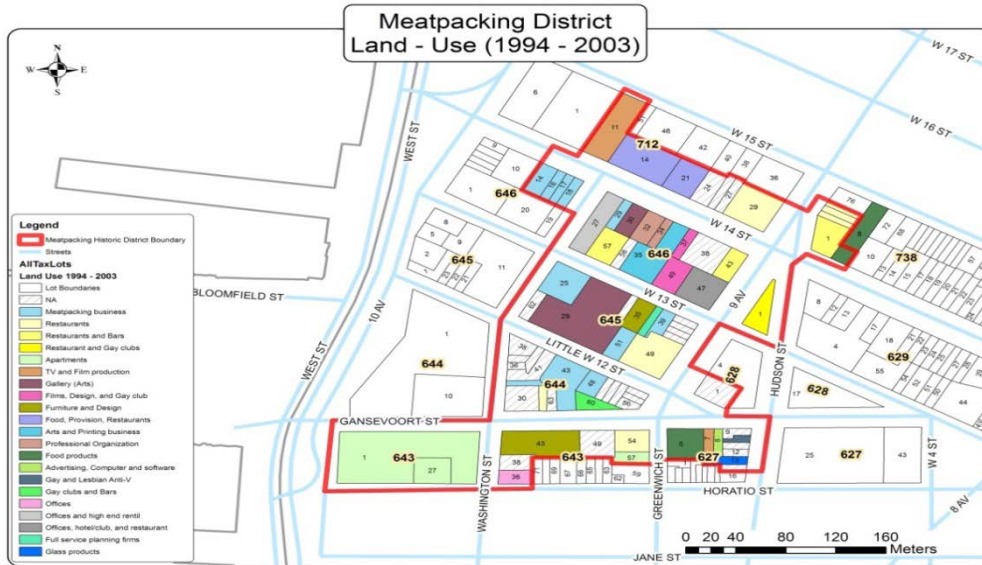


Figure 10: Meatpacking district land use map in the period between 1994 - 2003

5.1.2. Land use change in more details

Land use change was mapped in more details for each block separately. In this part, one block only will be studied to illustrate land use change in depth.

From the map below (Figure 11), it can be seen that groceries, produce, and food businesses were the only commercial activities in this block in that time (pre-1900), which were among the dominant businesses within the district. From 1900 this block, however, as the other blocks in the meatpacking district, was almost entirely used for meatpacking business until the late 1960s (Figure 12).

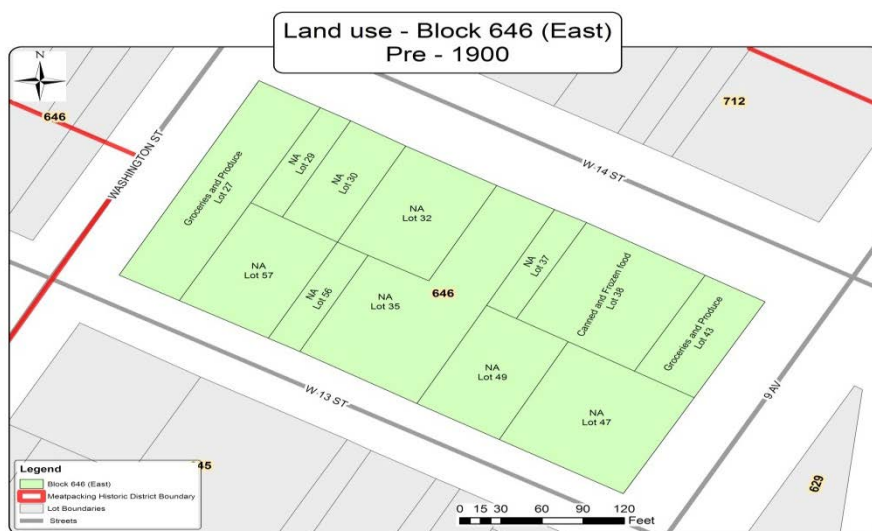


Figure 11: Block 646 (East) properties land use map in the period of pre-1900



By the early 1970s, the block had experienced different kinds of businesses. The land use had shifted from meatpacking business activity to other businesses such as; clubs, bars, restaurants, furniture, and design. Thus, it can be inferred that this block sparked the first sign of the gentrification process, when the first nightclub in the area was opened in lot 57 in this block in 1970 (Figure 13).



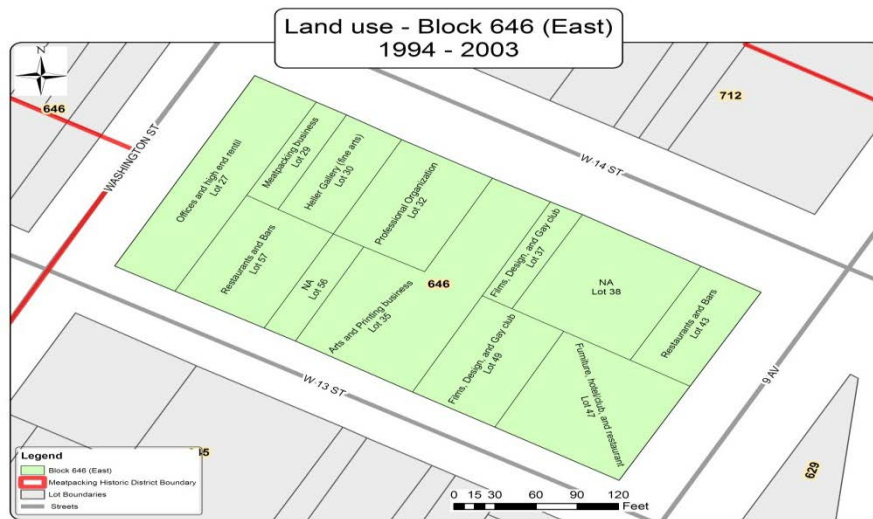
Figure 12: Block 646 (East) properties land use map in the period between 1939-1969



Figure 13: Block 646 (East) properties land use map in the period between 1970-1993

As mentioned early, and according to the gentrification literature, one of the most visible signs of a gentrifying neighbourhood is evidenced by changes the land use activities. Usually a neighbourhood that is gentrified will experience a decrease in businesses such as (in our case); meatpacking, groceries, produces businesses, on the one hand. On the other hand, the presence of businesses such as; galleries, restaurants, clubs, offices, multimedia, and professional organization will be in the picture.

Likewise, this is exactly the case in block 646 (East). Property uses in this block (Figure 14) have completely changed from meatpacking and its associated businesses to high standard businesses such as; Heller Gallery (*fine arts*), Soho House (*hotel /club*), Vitra (*Swiss furniture company displays high-concept furniture*), Jean Georges restaurant (*one of the finest dining destinations in New York City*).



**Figure 14:** Block 646 (East) properties land use map in the period between 1994-2003

According to the above discussion, it is undoubtedly clear that the Meatpacking District is a gentrified neighbourhood. Regardless of the signs of a gentrification process that appeared in the area in the early 1970s, the definite visible signs of a gentrification process among the district were monitored from the mid 1990s



**Figure 15:** Vitra, a Swiss furniture company (29 9<sup>th</sup> Avenue)

### 5.2. Ownership change

As mentioned above, the frequency of property ownership changes is considered as an indicator of the gentrification process. With the ownership changed the value of property possibly changed, which refers to the difference in the land use type of a property under a different ownership. Usually, when properties are sold, the new owners often evict the existing tenants to bring in new tenants at a higher rate. As can be seen from Figure 16, the area has exhibited varying degrees of ownership changes. It is clear that blocks 643 (East) and 646 (East) have experienced a high rate of property ownership changes, which means that they probably, compared with other blocks, have been hit by an intensive gentrification process. In addition, if we go more deeply and look at a smaller geographic unit of measurement - the lot - it can be seen that lot 38 in block 643 and lot 13 in block 627 have been the lots whose ownership has been the most changeable in the whole district. However, it is not often true that the frequent ownership change of a property means that this property is under a gentrification process. A property might be used for the same activity despite the ownership changes.

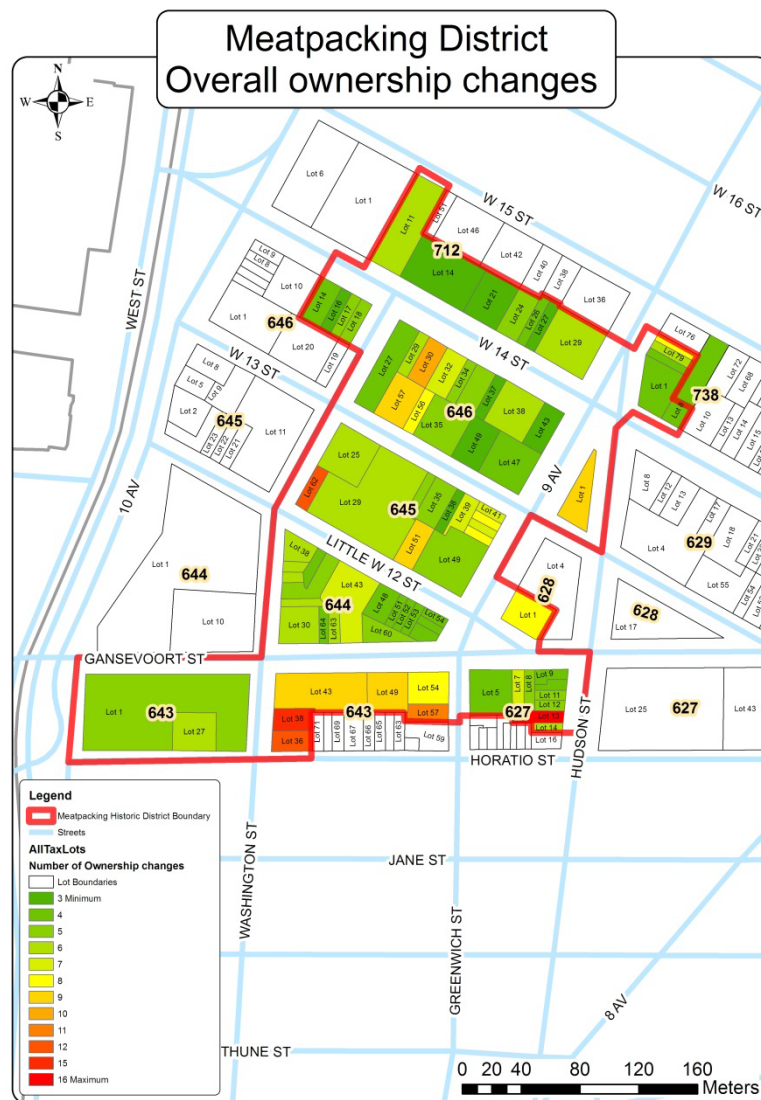


Figure 16: Meatpacking district properties overall ownership changes

### 5.3. Overall current buildings type

By looking broadly at the building uses in the area of Meatpacking district, Figure 17, it is clear that the area is being used mostly for commercial and office activities. There is a great deal of residential businesses in the area. Although the gentrification process has changed the land use of the whole district, some industrial and manufacturing businesses remain in the area.

Honestly, this map (Figure 17) reveals little about gentrification. However, there are two lots, 39 and 51, in block 645 (East) which appeared as vacant land. This could be because they were demolished in order to be rebuilt as a consequence of the gentrification process.

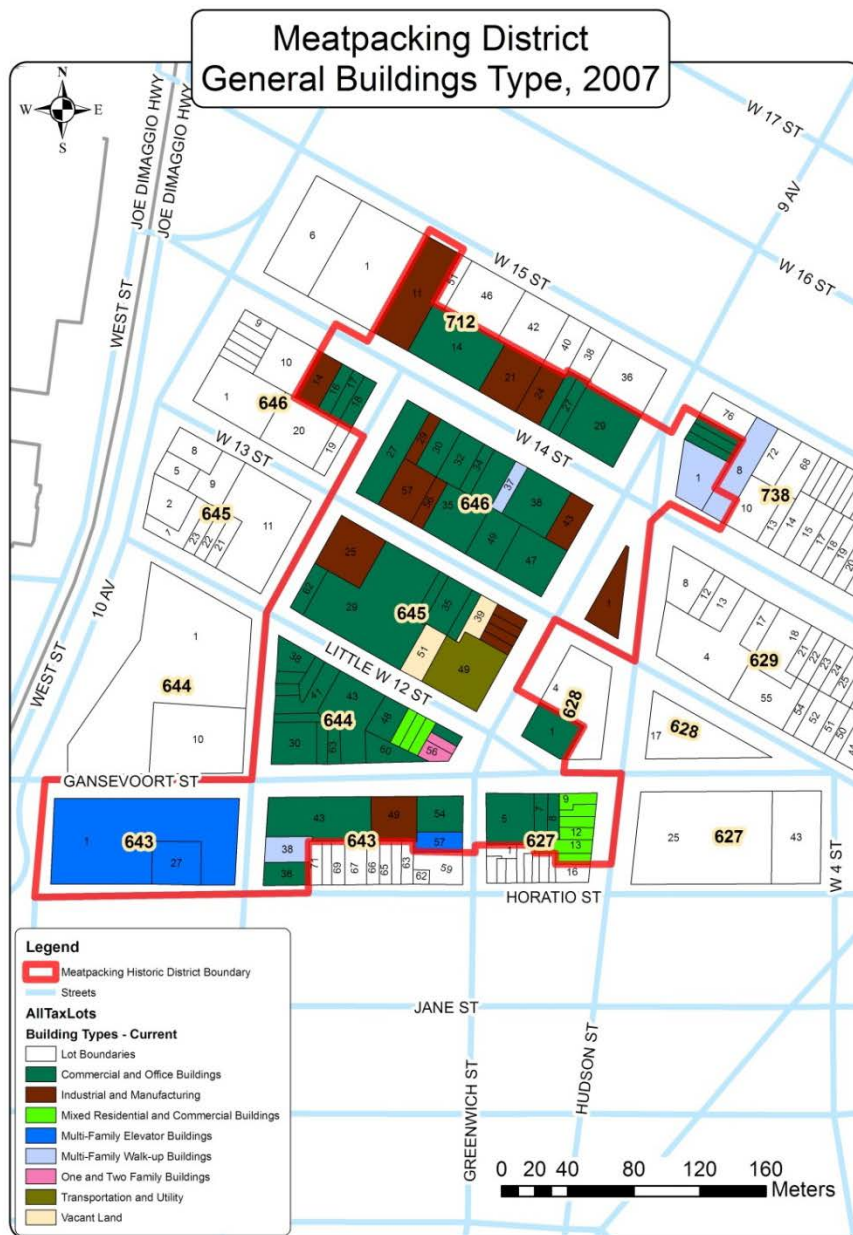


Figure 17: Meatpacking district general buildings type



## **6. Limitations**

Although this research did produce conclusive results and implications about gentrification process Meatpacking District, its findings were plagued by multiple some limitations. For example, the lot was used as the geographic unit for mapping the ownership and land-use change. Usually, any lot consists of more than one building, and each building might have many storeys. As a result, a single lot may have more than one kind of business. So, in order to deal with such a problem, the more dominant business in the whole lot was used for the mapping purposes. For instance, in block 643 (west), lot 1 covers almost 80% of the entire block and contains nine buildings. These building were used for multi-business usage, but the most dominant business was cold storage warehouses in the early years and apartments in the recent years. However, in some cases, multi businesses were listed and mapped together, for example, meat, poultry, fruit, and food businesses.

## **7. Future Research**

The methods and findings of this study provide a natural guide for future research. However, the difficulties of identifying single land use type for each lot is hard to overcome, since each lot is usually consists of more than one building and each building may contain many storeys. This problem might be reduced in any further work by using the building boundaries as the base map for mapping land use change instead of using only tax lot map. In this process, each single building included in the lot will be mapped according to its usage. This indeed will give more accurate information about the land use changes in the study area.

## **8. Conclusion**

In this study, GIS technologies were used together with the historic property ownership and land use changes information to study and map likelihood of gentrification process in the Meatpacking District. This study presents and maps evidence suggesting that gentrification was an active process since the 1970s in the Meatpacking District. However, the major wave of gentrification washed through the area with a significant process of land use change from mainly meatpacking to a high standard fashionable business from the mid 1990s.

The application of GIS, and its input, storage, output, analysis and mapping capabilities, to gentrification has been very minimal. Moreover, the data that was used in those studies was census data associated at times with some qualitative data such as questionnaire surveys. However, in this project it was found that the use of rich historic information about property ownership and land use changes is another approach with which to detect, monitor, and map gentrification.

In the case of Meatpacking District, the change of property land use from meatpacking, produce, fruit, groceries, dairy products and other similar businesses within the district into businesses such as; galleries, restaurants, clubs, offices, multimedia, and professional organization provided insight into key signs and indicators usually associated with gentrification. Moreover, the frequency of ownership change allowed for the identification of which lot probably experienced higher rates of change in land use. This provided an indication of lots that exhibited varying degrees of the gentrification process.

Overall, GIS is an appropriate tool for gentrification research, particularly, once wealth information is available to analyze neighbourhoods and gentrification in particular. The visualization capability of GIS allows researchers to explore and map out patterns and trends of changes that might not be clear just by examining tables or graphs.

### **Acknowledgement**

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### **References**

- [1] P. Torrens and A. Nara, "Modeling gentrification dynamics: A hybrid approach", *Computers, Environment and Urban Systems*, vol. 31, no. 3, pp. 337-361, 2007.
- [2] G. Clemmer, "Quantitative and Spatial Analysis Techniques for Analyzing Gentrification Patterns", Independent Research Project, PSU, 2000.
- [3] A. Nesbitt, A model of gentrification: A model of gentrification: monitoring community change in selected neighborhoods of st. Petersburg, Florida using the analytic hierarchy process. [Gainesville, Fla.]: University of Florida, 2005.
- [4] J. Shockley, Gansevoort Market Historic District : designation report. New York: New York City Landmarks Preservation Commission, 2003.
- [5] M. Kennedy and P. Leonard, *Dealing with neighborhood change: A primer on gentrification and policy choices*. Washing, D.C.: Brookings Institution, 2001.
- [6] J. Vandergrift, *Gentrification and displacement. Urban Altruism*. Grand Rapids: Calvin College Publication, 2006.
- [7] P. Marcuse, "Gentrification, abandonment and displacement: connections, causes and policy responses in New York City", *Washington University Journal of Urban and Contemporary Law*, vol. 28, 1984.
- [8] M. Phillips, *Contested worlds: an introduction to human geography*. Aldershot, Hants, England: Ashgate, 2005.
- [9] K. Pekarchik, "Alphabet City: The ABCs of Gentrification", *Bloomberg Businessweek*, 2001.
- [10] W. Tobler, "Migration: Ravenstein, Thornthwaite, and Beyond", *Urban Geography*, vol. 16, no. 4, pp. 327-343, 1995.

- [11] K. Schwirian, "Models of Neighborhood Change", *Annual Review of Sociology*, vol. 9, no. 1, pp. 83-102, 1983.
- [12] S. Zukin, "Gentrification: Culture And Capital In The Urban Core", *Annual Review of Sociology*, vol. 13, no. 1, pp. 129-147, 1987.
- [13] B. Grant, "What is Gentrification?" *POV | American Documentary Inc.*, 2003. [Online]. Available: <http://www.pbs.org/pov/flagwars/what-is-gentrification> [Apr. 11, 2009].
- [14] K. Hill and C. Pozzo, "Managing Neighborhood Change: Best practices for Communities Undergoing Gentrification", *NeighborWorks America*, Washington, DC, 2005.
- [15] T. Harvey, D. Espinoza, J. Hays, J. Friskin and B. Howard, *Gentrification and West Oakland: Causes, Effects, and Best Practices*. Berkeley: University of California, 1999.
- [16] K. Shaw, "Gentrification: What It Is, Why It Is, and What Can Be Done about It", *Geography Compass*, vol. 2, no. 5, pp. 1697-1728, 2008.
- [17] L. Lees, T. Slater and E. Wyly, *Gentrification*. London: Taylor and Francis, 2008.
- [18] N. Smith and P. Williams, *Gentrification of the City*. London: Allen and Unwin, 2007.
- [19] D. Ley, "Gentrification and the politics of the new middle class", *Environment and Planning D: Society and Space*, vol. 12, no. 1, pp. 53-74, 1994.
- [20] R. Atkinson and G. Bridge, *Gentrification in a Global Context: The New Urban Colonialism (Housing and society series)*. Taylor & Francis Group / Books, 2005.
- [21] R. Phillips, "Community Indicators", *American Planning Association*, Chicago, 2003.
- [22] R. Andrews, "A Changing Community: A Study of the Impacts of Gentrification and the Possibilities for Equitable Development in Seattle's Central District", *Public Administration MA Thesis*, Daniel J. Evans School of Public Affairs, University of Washington, 2003.
- [23] N. Smith, "New Globalism, New Urbanism: Gentrification as Global Urban Strategy", *Antipode*, vol. 34, no. 3, pp. 427-450, 2002.
- [24] E. Fouberg, C. Nash and A. Murphy, *Human Geography: People, Place, and Culture*. John Wiley & Sons, 2009.
- [25] A. Ilkucan and O. Sandikci, "Gentrification and Consumption: an Exploratory Study", *Advances in Consumer Research*, vol. 32, pp. 474-479, 2005.

- [26] J. Hackworth, *The Neoliberal City: Governance, Ideology, and Development in American Urbanism*. Cornell University Press, 2007.
- [27] "Canada Land Inventory", Agricultural and Agri-Food Canada, 2008. [Online]. Available: <http://sis.agr.gc.ca/cansis/nsdb/cli/intro.html> [May. 25, 2009].
- [28] W. Craig, T. Harris and D. Weiner, *Community participation and geographic information systems*. London: Taylor & Francis, 2002.
- [29] R. Parker and E. Asencio, *GIS and spatial analysis for the social sciences: Coding, Mapping, And Modeling*. New York: Routledge, 2008.
- [30] S. Steinberg and S. Steinberg, *Geographic Information Systems for the Social Sciences: Investigating Space and Place*. Thousand Oaks: SAGE Publications, 2005.
- [31] I. Hall, "An investigation of gentrification modeling techniques using a GIS", 1999. [Online]. Available: <http://www.geog.ubc.ca/courses/klink/g470/class98/hall/project.htm> [May. 12, 2009].
- [32] "Gansevoort Market", Greenwich Village Society for Historic Preservation, 2009. [Online]. Available: [http://www.gvshp.org/\\_gvshp/preservation/gansevoort/gansevoort-main.htm](http://www.gvshp.org/_gvshp/preservation/gansevoort/gansevoort-main.htm). [Apr. 24, 2009].
- [33] J. Shockley, *Gansevoort Market Historic District : designation report*. New York: New York City Landmarks Preservation Commission, 2003.
- [34] B. Sinder, "Packing Into Meatpacking District | Sinvin", Sinvin.com, 2001. [Online]. Available: <http://www.sinvin.com/2001/12/packing-into-meatpacking-district> [Apr. 24, 2009].
- [35] P. Longley, M. Goodchild, D. Maguire and D. Rhind, *Geographic Information Systems and Science*. Hoboken: John Wiley & Sons, Ltd., 2006.
- [36] "BYTES of the BIG APPLE™", Nyc.gov. [Online]. Available: <http://nyc.gov/html/dcp/html/bytes/applbyte.shtml#geo> [May. 12, 2009].