Socioeconomic Topography
Inner City Economic Development and Geographic Information Systems

by
Hideo SAKAMOTO
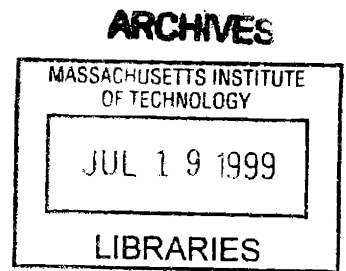B.E. Architecture
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Abstract

Targeting project areas and defining the objectives are the most important procedures to plan neighborhood economic development, such as the Boston Main Street Program. Which shopping district is to be encouraged and how? However, this has not been an easy task, especially when the neighborhood is in the inner city, because the inner city is so diversified that planners can not find clear spatial patterns on which to base their decisions.

This paper attempts to extract patterns of socioeconomic phenomena relevant to economic development and map them. The advancing technology of Geographic Information Systems (GIS) has made it easier to apply raster (grid cell or bit pattern) analysis to studying urban spatial patterns. A map that shows socioeconomic phenomena via rasterization and smoothing processing is called "socioeconomic topography" here. Just as conventional topography shows us geographical features, socioeconomic topography illustrates the spatial pattern and clustering of socioeconomic features of a given area.

The following maps are created as socioeconomic topography to support planning of inner city economic development: (1) land use allocation, (2) land value, (3) business variation, (4) shopping convenience, and (5) leading industrial clusters. On each map, spatial patterns stand out clearly from the chaos of Boston's inner city. Socioeconomic topography offers a new way of understanding the inner city and illuminates the need of made-to-order projects for each shopping district.

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Executive Summary

Just as a conventional topography shows us geographical features, socioeconomic topography is an attempt to illustrate the socioeconomic features of a given area. This thesis examines the possibility that this new concept might work for the planning of the inner city economic development.

Introduction

Problem statement

The Boston Main Streets Program is one of the leading efforts by the city government to revitalize the inner city economy. Among the 15 participating districts, or shopping strips, some are doing very well and some are not. Even though the inner city is very diversified from area to area and though the challenges vary from shopping strip to shopping strip, assistance from this program is equally distributed to all the districts. At the level of blocks and parcels, the inner city is a chaotic cosmos of people and their activities. It has been very difficult for planners to recognize the characteristics and the stage of development of each program district in order to apportion the assistance according to the specific needs, and to find the opportunities of each neighborhood.

Purpose of the study

The purpose of this study is to examine whether the new mapping method (socioeconomic topography) helps us to extract patterns of business activity within the diversified inner city that are useful in understanding and measuring economic development opportunities. Better understanding of the inner city may urge us to formulate more effective plans of economic development for each neighborhood. This paper focuses on the processing of data for the purpose of mapping socioeconomic patterns clearly. These maps, if made correctly, would be useful in selecting project districts of the Boston Main Streets Program and in making appropriate plans for each shopping street, based on its individual character.

Scope

First, the socioeconomic topography is applied to understanding the relevant economic phenomena, such as land allocation, land value, business count, and business variation (Chapter 3). Secondly, the socioeconomic topography is examined to determine if it is efficient as a supporting tool for planning business strategies, such as the shopping convenience of the neighborhoods, and linkage between leading industries and neighborhood businesses (Chapter 4).

Background or Attributes of the Boston Inner City

The Boston inner city has remarkable attributes in comparison to the rest of the Boston Metropolitan Area. By definition, the inner city is a place where the median household income is small while the unemployment rate and poverty ratio is very high. These three indicators should be the target items of economic development in such an area.

Demographically, the inner city is very rich with racial and ethnic diversity. Many immigrants are coming and keeping their cultures, such as food and language. Inner city residents have relatively more children and lower educational attainment than the other residents do in the surrounding metropolitan area. These facts may be useful when the residents are considered as potential workers and consumers in the planning of economic development.

The inner city has some advantages as a business location. First, the buying power (US$/acre) is very high. Even though each household is not rich, population concentration makes the area a very attractive market. The residents have a unique pattern in their expenditures. In spite of their relatively low disposable income, they spend a higher fraction of it on specific items, such as garments and personal care. This market still remains untapped, and many inner city residents shop and purchase services out of their neighborhoods. The strategic location of the inner city is another advantage. Business firms in the inner city can enjoy access to the central business district (CBD) as well as to the suburban areas where there are leading industries and many job openings.

Linkage between inner city businesses and the leading industries in the CBD or in the suburbs could encourage the economy of the inner city.

Theory and Methodology

The latest GIS software (Arcview with Spatial Analyst Extension) provides rasterization method and associated "Neighborhood Statistics" functions that facilitate the systematic construction of the socioeconomic topography. The operational concept of this function is as follows:

(1) Obtain a parcel map of the study area with polygons (boundary data with digital format) and data tables, or use a street map to plot locations of business firms.

(2) Divide the above maps into small grid cells (50 feet x 50 feet, for example), and tag each cell with the characteristic of the parcel or business that it falls within (e.g., land value or the Standard Industrial Classification (SIC) code).

(3) Calculate a new set of values as a function of the original cell values in the immediate vicinity, for example, within a 200m radius circle around the center cell. Assign the calculated values and map the result. Then process the value of the next cell. The neighborhood can be set as any size circle or rectangle. Calculation can be selected from minimum, maximum, mean, median, sum, range, standard deviation, majority, minority, and variety. "Calculate the median of land value around a grid cell within 200m radius circle" is an example. If the original value of the cell is $15/square foot but neighboring cells tend to be higher, then the computed new value might be $18/square foot. Hence, the 'neighborhood' calculation smoothes out the original values and represents an average of all values in the vicinity, rather than the specific value present within the cell location.

(4) Differentiate the grid with color gradations, contour lines, or 3D extractions so that spatial patterns become clear. Mapping result tends to be sensible to the settings, such as cell size, neighborhood size and distance metric. Trial and error may be necessary to find the most appropriate set of parameters.

Results and Discussions

Ten socioeconomic topography maps have been processed.

Land Allocation (Fig. 3-1-3, 3-2-1-1, 3-2-1-2, 3-2-2)

The commercial, industrial and tax-exempt land allocations are shown in the maps. These maps show general land use patterns in the inner city and help us to understand the character of each neighborhood. Higher concentration of commercial land allocation has clearer correlation with the presence of shopping centers rather than the location of conventional shopping strips like Main Streets program areas.

Land Value (Fig. 3-3-1)

The map indicates a clear pattern of land value. Land value has very little to do with commercial land use or accessibility to public transportation. Rather, correlation is found with the income of the neighborhood residents. High income residential areas imply a potential marketing target.

Number and Variation of Businesses (Fig. 3-4-1, 3-4-2, 3-5-1, 3-5-2)

Four maps are made based on the data from the city government (parcel land use data) and data from the State Business Directory CD (business location data with SIC code). Comparison of these four maps (1) tells different stories for several areas, which may imply a difference between the city's recognition of these areas for taxation purposes and actual business activities, and (2) implies presence of agglomeration economy.

Shopping convenience of neighborhoods (Fig. 4-1-1)

This map illustrates the accessibility to ten essential businesses by counting their presence or absence within 400m from each grid cell. The map shows the ratio of shopping convenience. Ten essential retail or service businesses are selected to create this map. Few program districts are equipped with a complete set of business mixes, and many residential areas remain under-served by the defined essential businesses.

Leading Industrial Clusters (Fig. 4-2-1)

This map shows leading or exporting industries of Boston, such as medical, finance, consulting and legal services. These industries have a stronger presence in the region in terms of employment, wage, growth and so on. Some

shopping strips in the inner city fall within area of high concentration of these industries and some are not.

Conclusion

This study offers a new method of recognizing socioeconomic patterns in the inner city. Ten maps clearly show that characteristics of the shopping districts are diversified and their levels of development vary in ways that can be quantified and mapped using generally available and spatially disaggregated urban data. This illuminates a new possibility for targeting economic development programs to local neighborhood characteristics and need that are economically viable. With a capacity to recognize the socioeconomic patterns in the chaos of the inner city, planners could prescribe policies that allocate made-to-order assistance to all 15 districts of the Boston Main Street Program. This methodology could be applied broadly to any kind of socioeconomic phenomenon, so far as polygons and relevant data are available.

1.

Boston Main Street Program

This chapter introduces the Boston Main Street Program, one of the most prominent efforts of the inner city economic development. The various aspects of the program are reviewed here such as history and structure, distinctive features, expected benefits, objectives, and challenges. Then, geographic information systems are suggested as a tool for inner city analysis, for a better and more precise understanding of the chaotic diversity.

1-1. History and Structure of the Program

One of the most prominent efforts for inner city economic development is the Boston Main Streets Program. This is a part of the Main Street program, which is an economic development initiative at the national level. The Main Street program was begun in 1977 by the National Trust for Historic Preservation (NTHP) to encourage downtowns of rather small communities in local districts. Conventional shopping districts downtown areas have lost their customers and vitality in the last 40 years. Downtowns in local communities were so depressed that there were many vacancies in the business properties. This was a crisis for the historic buildings in downtown areas, and the National Trust for Historic Preservation thought that economic development would fill the vacancies and maintain the historic heritage. Thus the National Trust for Historic Preservation was motivated to begin the Main Street program.

They did not adapt their program to the inner cities of the Metropolitan areas until 1985, when Mr. Thomas MENINO (a city council member at that time) took the initiative in applying this program to Roselindale shopping district in Boston. He recognized this program to be popular with local shop owners and residents, and later as Mayor of Boston, employed this program on a larger scale to revitalize the shopping districts all over Boston. The participating districts number 15, and some more will be added in 1999.

There are seven city officials and two stuff architects working for this program in the Office of Business Development, Department of Neighborhood Development:

(1) One Main Street Director

(2) Four program managers

(3) One business workshop coordinator

(4) One construction engineer

(5) Two architects for façade improvement.

Other than the managers in the city office, each shopping district has one full time project manager in the area. The program districts and the City Government share the salary of the managers. District managers coordinate the

project of each shopping district based on the Main Street Approach. This is the main concept of the program.

The Main Street Approach consists of four points:

(1) Design

This is to improve the physical appearance and the image of the inner city shopping districts. The City government allocates matching subsidy to shop owners who renovate shop facade during the project period. Design also includes window display, street banners, signs, and trashcans.

(2) Organization

This is to organize the neighborhood to achieve a sustainable economic development. Economic viability of a neighborhood is not only the concern of the local business owners. There should be broad participation of various stakeholders.

(3) Promotion

This is to promote positive images of the participating districts through promotional activities and events. Program districts hold festivals with subsidy from the City Government.

(4) Economic Restructuring

This is to enrich the business mix of the program districts and improve the inventories of each shop. Activities to strengthen a shopping strip include encouraging the existing businesses to stay and expand, or recruiting businesses of a missing category. For example, inviting a super market as key retail anchor is an effort of this approach.

1-2. Distinctive Features of the Program

The two most noticeable characteristics of this program are that it facilitates the collaboration among the stakeholders and that it intends to enable the shopping districts.

●**Collaboration**

Stakeholders in this program are shop owners and their associations of shopping districts, corporate buddies (leading business firms that have close

relations to the neighborhood economy), community based organizations, the city government and so on. Even though the project goal of each participating district is clearly defined as "economic development," each stakeholder has its own motivation and objective to collaborate in this program. Detail will be discussed later in Section 1-4. The Main Street manager of each district must arrange the collaboration so that each constituency makes its own contribution to this program and get returns from it to achieve individual objectives.

●**Enabling Program**

The Boston Main Street program places a strong emphasis on enabling. With this program, the city government expects each participating, or shopping district, to be self-reliant within four years. Being self-reliant includes having a good management system and fundraising ability, and collaboration with local stakeholders. Assistance from the city government for each shopping district stops at the end of the fourth year, since the project is considered to be acceleration period for an independent cruise flight.

1-3. Expected Benefits of the Program

The inner city economic development needs a united front to win the revitalization. Constituencies of this task force come from various sectors around the area, and they all have individual interests or objectives as they join the project. An improvement project for a neighborhood shopping district must be coordinated in such a way that each stakeholder can get its return according to its input or investment. In this section, expected benefits from neighborhood economic development are reviewed in order to make the objectives of stakeholders clear. These benefits are returns for stakeholders of each project.

If these benefits can be measured at the beginning and at the end of an economic development project, the figures are good indicators of the project performance. The followings are several examples of benefits, some of which can be mapped and analyzed with GIS.

●Sales and profit (for business owners)

This is, of course, the most straightforward objective of an inner city economic development project.

- Employment, or income (for job seekers)

    Inner cities are suffering from high unemployment and high poverty ratio. Neighborhood economic development is expected to generate job opportunities so that local households can be more self-reliant.

- Pay increase (for low-wage workers)

    Inner city residents are working for smaller salaries. Economic development would offer better positions to the low-wage workers, which makes them better off.

- Convenience of shopping and getting service (for residents)

    Economic development would improve the service level of the local business firms as a whole. This may serve the neighborhood better and fewer local residents would go outside the area for shopping.

- Higher Rent profit (for real estate owners)

    Better economy in the inner city would fill the vacancies in business properties as well as housing properties, because business can be more successful and the area is more livable in terms of job opportunity and shopping convenience. As floor rent and room rent account for significant parts of the business cost and household expenditure, decreasing vacancy would profit property owners and encourage them to reinvest in renovations and maintenance.

- Better return for financial investment (for banks and investors)

    Local financial firms, such as commercial banks, are interested in the revitalization of the inner city economy. An economically vital neighborhood requires more financing, and this is an opportunity for the local financial firms to expand their business. Most of the corporate buddies for the Main Street Program district are banks. Their roles in the program are to offer (1) sizable donation to the projects, and (2) business consultation to the shops and firms in the program districts. If the economic development is successful, banks and investors will get good returns.

•Tax revenues (for Governments)

Better economy in the inner city would pay for the governments also. The federal government would get better corporate and income tax, the state government would enjoy increasing sales tax, and the city government can expect larger revenue from the property tax. Job opportunities would invite new residents and settle the foreclosure properties scattered across the inner city. Private housing properties yield 1.344% of their value as annual property tax. Of course, fewer vacancies in business properties increase the city revenue with a better rate, i.e. 3.704% of their value annually. Better revenue gives a good financial base to local government, and facilitates public service for the local businesses and residents.

•Historic Preservation (for the National Trust for Historic Preservation)

A good economic condition of the Boston inner city increases the chance of good maintenance of the commercial and residential buildings. Making use of historic buildings for contemporary needs adds diversity to the neighborhood and makes the area more attractive. This is the original intention of the association for historic preservation.

•By-products

Some by-products are expected from an economic development project. They are crime decrease, public improvement, transportation convenience, good physical appearance of neighborhood, pride of place, and so on. They are common benefits for all the constituencies in the neighborhoods.

1-4. Challenges of the Program

Management of inner city economic development requires very different know-how from that of national level economic development, suburban shopping malls, or private franchise chains. Some difficulties of inner city economic development are enumerated here from the observation of the Boston Main Streets Program and its participating shopping strips.

•No total management

A manager of a shopping center or a mall has much greater responsibility and resources than a manager of a Main Street district. A mall manager

selects tenants and can apply different floor rents to each of them. She/he bears direct responsibility for the appearance and conditions of the mall property, for crime prevention, for public relations, and for the profit of the mall. On the contrary, a Main Street district manager has very limited responsibility and power over resource allocations, because a shopping strip is a group of independent shops and the Main Street district manager has no authority to give directions to shop owners. She/he is just a coordinator. There are many stakeholders in each shopping district, and basically consensus of all the stakeholders is required to make things happen.

●Non-economy-related factors

There are many factors that determine the prosperity of a shopping strip. Some of them cannot be controlled directly by the shop owners or business associations. Crime prevention, improvements of public transportation, and human resource development are examples that significantly influence local businesses. Total and long term coordination and efforts are required to cope with these problems.

●Resource Allocation

Impartiality or fairness is the main rule of this kind of government program. Table 1-4 shows the plan of resource allocation for each program district within its four-year period. This plan categorizes the 15 participating districts into two groups by the income level of each area.
Public assistance for the lower-income districts is more than that for the higher-income districts. However, project activities of each district are very uniform. Having a full time manager, managing four kinds of committees[1], improving the physical appearance, holding promotional events: these activities are mandatory to all the participating districts. A problem is that each participant is at its own level economic development. One program district may need one more full time staff member as an assistant manager

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[1] General Committee, Promotion Committee, Design Committee, and Economic Restructuring Committee

Table 1-4 Boston Main Streets Baseline Funding Strategy
(1) Standard Income District

	Year 1	Year 2	Year 3	Year 4	Total
Promotion					
City	2,000	2,000	2,000	2,000	8,000
Fundrising	2,000	2,000	2,000	2,000	8,000
Total	**4,000**	**4,000**	**4,000**	**4,000**	**16,000**
Programming & Administration					
City	25,000	25,000	12,500	12,500	75,000
Fundrising	15,000	15,000	27,500	27,500	85,000
Corporate Buddy	10,000	10,000	10,000	10,000	40,000
Total	**50,000**	**50,000**	**50,000**	**50,000**	**200,000**
Technical Servise & Studies					
City	5,000	15,000	10,000	0	30,000
Total	**5,000**	**15,000**	**10,000**	**0**	**30,000**
Phisical Improvements					
City	25,000	50,000	25,000	0	100,000
Property Owner	25,000	50,000	25,000	0	100,000
Total	**50,000**	**100,000**	**50,000**	**0**	**200,000**
Totals					
City	57,000	92,000	49,500	14,500	213,000
Fundrising	17,000	17,000	29,500	29,500	93,000
Corporate Buddy	10,000	10,000	10,000	10,000	40,000
Property Owner	25,000	50,000	25,000	0	100,000
Total	**109,000**	**169,000**	**114,000**	**54,000**	**446,000**

(2) Low-Moderate Income District

	Year 1	Year 2	Year 3	Year 4	Total
Promotion					
City	2,000	2,000	2,000	2,000	8,000
Fundrising	2,000	2,000	2,000	2,000	8,000
Total	**4,000**	**4,000**	**4,000**	**4,000**	**16,000**
Programming & Administration					
City	35,000	35,000	25,000	12,500	107,500
Fundrising	5,000	5,000	15,000	27,500	52,500
Corporate Buddy	10,000	10,000	10,000	10,000	40,000
Total	**50,000**	**50,000**	**50,000**	**50,000**	**200,000**
Technical Servise & Studies					
City	5,000	15,000	10,000	0	30,000
Total	**5,000**	**15,000**	**10,000**	**0**	**30,000**
Phisical Improvements					
City	25,000	50,000	25,000	0	100,000
Property Owner	25,000	50,000	25,000	0	100,000
Total	**50,000**	**100,000**	**50,000**	**0**	**200,000**
Totals					
City	67,000	102,000	62,000	14,500	245,500
Fundrising	7,000	7,000	17,000	29,500	60,500
Corporate Buddy	10,000	10,000	10,000	10,000	40,000
Property Owner	25,000	50,000	25,000	0	100,000
Total	**109,000**	**169,000**	**114,000**	**54,000**	**446,000**

The income district for a Local Main Street Program is determined by census tract data. Of the 15 existing Boston Main Street Programs, 12 are low-mod income districts 3 are standard income district.

for better institution-building of the area. Another district might need to recruit a grocery store as a key anchor. Having another indicator or diagnostic tool beside the area income is essential to evaluating the developing stage of each shopping strip. Geographic Information Systems may be effective in this respect.

1-5. GIS as an Analysis Tool for the Inner City Economy

One of the most important procedures of the planning process is to recognize the situation properly. However, this is also the most difficult task, especially when the target is the inner city economy. There are hundreds of stores, restaurants, and service firms scattered in each neighborhood. Every person who is engaged in economic development in the Boston inner city has her/his own perception of each area.

- Shopping strip **A** has a richer business mix than shopping strip **B**.
- Land price of neighborhood **C** is somewhat more expensive than that of neighborhood **D**.
- Access to shops for daily needs looks more convenient in area **E** than in area **F**.
- There seem to be wholesale grocery businesses concentrating in the district **G**.

These individual perceptions are sometimes common and sometimes not among the people concerned. Also some perceptions may not be correct.

The Geographic Information Systems (GIS) offers a rich common ground for discussion of such issues by indicating patterns in the locational disposition of inner city businesses and relevant phenomena. Especially, the new method introduced later in this paper, "socioeconomic topography," shows clear patterns of the following phenomena, which has been difficult with conventional GIS.

- Allocation patterns of commercial, industrial, and tax exempt land use.
- Land value
- Business variation
- Convenience of neighborhoods

•Location of leading business agglomerations

Recognizing the business activities is the first step to identifying problems to be solved and to making appropriate proposals for effective economic development projects. Shopping Strip **A** may have (1) a large variation of shops, (2) a high-income neighborhood in its service area, (3) small retail leakage, and (4) good linkages to the leading industries. On the contrary, Shopping Strip **B** may have none of these advantages. In this case, is it appropriate to choose Shopping Strip **A** as a Boston Main Street Program district and allocate resources to improve the situation? Or does façade improvement have priority in Shopping Strip **B**? Different goals need different projects and assistance. Even though strip **B** may be more in need of city help, it may not always make sense to try to promote all the general alternatives for economic development that could be viable in strip **A**. It is better to focus on an appropriate first step like improving business mix or making a sophisticated goods inventory.

As the first action of the Main Street Program, which intends to encourage shopping streets with appropriate assistance, "ailing" shopping streets must be identified. Remedies for each problem vary based on the symptoms of each patient. Socioeconomic topography can be a tool for spatial diagnosis for the inner city economy. It would be helpful in selecting participating districts of the Boston Main Street Program and in making an appropriate plan for each shopping street, based on its individual condition and stage of development.

2.

Characteristics of the

Boston Inner City

This chapter will focus on attributions of the Boston inner city and answer
following basic questions;

●Where is it?

●Who lives there?

●What is happening there socially and economically?

In addition to that, two concepts for economic development i.e., retail coverage,
and linkage to leading industries are introduced at the later part of this chapter.

2-1. Defining Inner Cities in the Metropolitan Area

Even though it is a term which literally means just a location, "Inner City" implies many social and economic phenomena. Inner Cities in the American metropolitan area are where many of the urban problems are apparent. Then, how can the location of the Boston inner city be specified as the first step of GIS analysis?

2-1-1. Proposed Criteria for the Definition

There are numerous socioeconomic attributions of inner cities in comparison with the other areas such as whole nation, MSA and the rest of the cities. Population and its density, crime, immigrants, languages spoken at home, children with single parents, educational attainment, income, unemployment, number of cars per household, house ownership, welfare households and so on: any of the indicators or a combination of them can be used for the inner city definition.

Among the definitions of inner cities in the biggest American cities, an methodology proposed by the Boston Consulting Group[2] seems most consistent with the topic of this thesis. This paper focuses on economic development of inner cities, expecting that economic development would increase employment and income or make inner city households economically self-reliant and sustainable. From this point of view, unemployment rate, median household income, and poverty ratio would make the best combination to monitor how "inner city" an area is.

The idea of an inner city's definition by the Boston Consulting Groups is as follows:

(1) Use zip code area as comparison boundaries. Because not only demographic data but also various economic data[3] are available at the zip code area level.

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[2] The Boston Consulting Group (1996) Strategies for Boston's Inner-city Business Growth.

[3] Such as zip code area economic pattern (by US Census Bureau), expenditure survey (by US Labor Department), unemployment rate (by Massachusetts state government), and CD version of various telephone directories (Yellow Pages).

(2) Use the 50% differentiation of the three indicators, i.e. unemployment rate, median household income, and poverty ratio.

(3) Make a composite indicator called "income index[4]" from household income and poverty ratio.

> [Income index]
>
> = [Median Household Income] / [Poverty Ratio]

2-1-2. Spatial Distribution of Inner City Phenomena

Fig. 2-1-2-1 illustrates zip code areas defined as inner city in the Commonwealth of Massachusetts by the above criteria. The poorest zip code area in the Metropolitan Area are distributed at (1) Sea side of Boston City and its vicinity, (2) Downtown of the major local cities such as Lowell, Lawrence, and Springfield, (3) Isolated area with transportation difficulty. If we add "population density" as an another criteria for the inner city definition, the areas categorized in (3) above would be omitted.

Fig. 2-1-2-2 shows Boston and its inner city with study area of this paper. The poorest areas are concentrating in a specific part of the city. For a faster

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[4] This index indicates the income distribution of each area. Suppose there are two zip code areas A and B, with median household income $40,000 and $50,000 respectively. If the ratio of poverty household in each area is 20% and 40%, the Income Index is calculated in the following way.

Income Index of area A   40,000 / 20 = 200

Income index of area B   50,000 / 40 = 125

Table. 2-1-1 Concept of Income Indicator

area	Household Income	Poverty Ratio	Income Index
A	$40,000	20%	200
B	$50,000	40%	125

The median household income of area B is larger than that of area A. However, the bigger poverty ratio of 40% implies an uneven income distribution among the households in area B. On the other hand, in area A, even though the median household income is smaller than that of the area B, the income is evenly distributed and the income index is bigger. With this index system, a higher median household income is discouraged by a bigger poverty ratio, and a lower median household income is encouraged by a smaller poverty ratio.

data processing and mapping, the blue square area are set as the study area of this paper. The size of the study area is 5 mile x 5 mile, or 8000m x 8000m, and contains the six poorest zip code area and their vicinity. This square area will be referred as Study Area, hereafter.
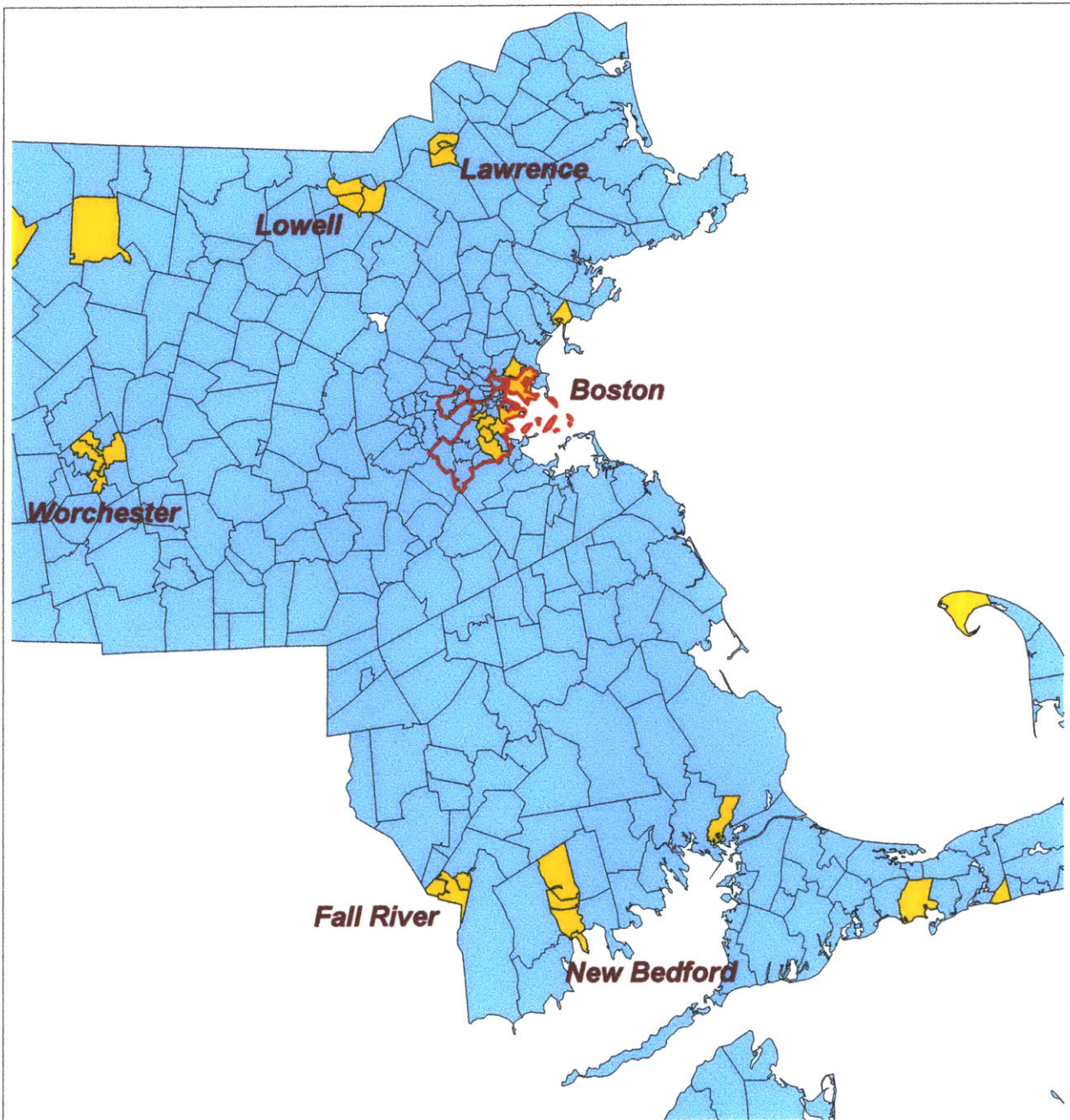
Fig. 2-1-2-1
Inner Cities in Massachusetts

⬜ Boston City Boundary

0   5   10   15   20   Miles

N

Definition of Inner CIty
(50% differentiation with two indicators)
 Unemployment Rate >9.3%
 (PMSA Unemploynment Rate = 6.2%)
Income Index < 3252
(PMSA Income Index = 4878)
Income Index
= Median Household Income ($)
   / Poverty Ratio (%)
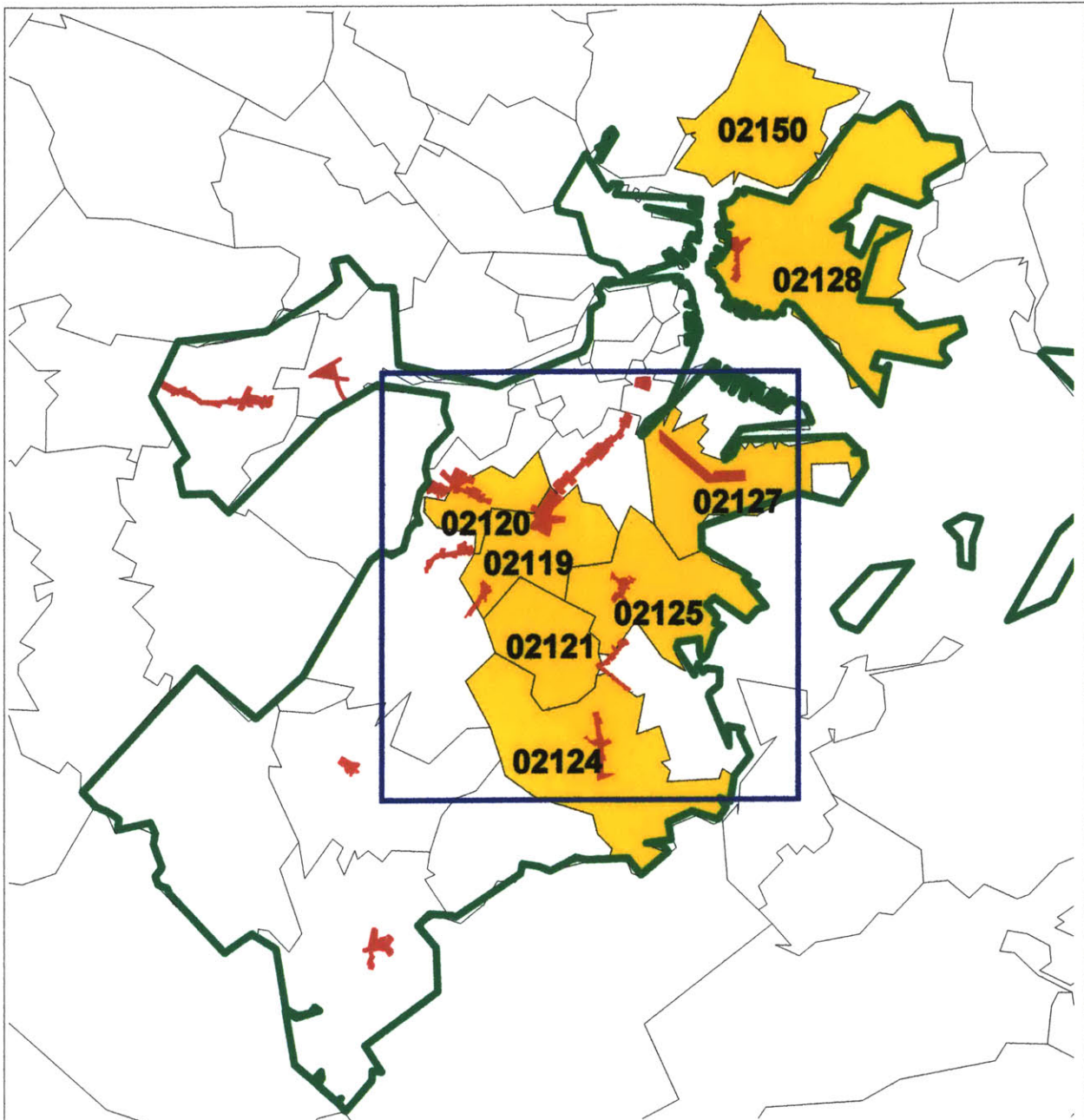
Fig. 2-1-2-2
Inner City in Bosotn

Boston City Boundary
Main Street Districts
Study Area (5miles x 5 miles)

Definition of Inner CIty
   (50% differentiation with two indicators)
   Unemployment Rate >9.3%
   (PMSA Unemploynment Rate = 6.2%)
   Income Index < 3252
   (PMSA Income Index = 4878)
   Income Index
= Median Household Income ($)
   / Poverty Ratio (%)

0   1   2   3 Miles

N

2-2. Demographic Analysis

Census and other data show us peculiar attributes of the demography in the inner city. This section reviews five characteristics of the Boston inner city residents, namely median household income, racial minorities' status, language, immigration status, and educational attainment. If inner city economic development is an attempt for the benefit of the inner city residents, these data are essential to understand who they are.

2-2-1. Median Household Income

The low income of the residents is the key motivation of all the inner city economic developments from the government point of view. Fig. 2-2-1 illustrates the clear tendency of the low income in the Boston inner city in comparison to its vicinity. The concentration of poor households may be correlated to any of the demographic characteristics of the inner city residents such as racial minorities' status, languages, immigrant status, and educational attainment.

2-2-2. Ratio of Racial Minorities

Fig.2-2-2 shows the ratio of racial minorities in the Boston Metropolitan Area. Areas with more than 30% of racial minorities are extremely concentrated in the Boston inner city. This map is very consistent with the story of the white exodus from the inner city in the last 40 years. Inner city population has been decreased to 2/3 of what it used to be, and simultaneously, a big part of the white population has been replaced by the urban immigrants of racial minorities. There are advantages for the racial minorities living close to each other. They have common languages, food, lifestyles, and sentiments. A report[5] reveals that minority business owners tend to hire more minority workers than white business owners do.

Of course, being a minority is not necessarily negative. Some of the ethnic oriented businesses in the inner city are very successful. A good Vietnamese

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[5] Horgan, A., & ICIC. (1997) Ownership and employment of inner city based businesses: Who is employed and why?

restaurant in Mission Hill attracts many non-Vietnamese customers. Hispanic people living in the suburbs do not hesitate to drive an hour to shop at a Hispanic grocery store in Hyde and Jackson. Racial diversity implies a business chance.

2-2-3. Ratio of English is Not Spoken at Home

Many residents in the Boston inner city do not speak English at home. Fig. 2-2-3 shows the ratio of population who speaks other language than English at home. Language variation is an indicator of ethnic diversity. Many immigrants have difficulties in getting jobs because of the language constraint. Some business owners at Hyde and Jackson Main Street Program District, where Spanish is the main language, do not feel comfortable with English speaking customers. On the other hand, many inner city residents are bi-lingual or tri-lingual. Speaking more than one language is a precious skill in specific situations. The question is how to make these situations happen.

Main household languages in the City of Boston are as follows[6]:

English	400,756 speakers
Spanish	51,233 speakers
French	19,525 speakers
Chinese	14,255 speakers
Italian	11,406 speakers
Portuguese	7,728 speakers
Vietnamese	4,212 speakers
Russian	3,211 speakers

2-2-4. Ratio of Immigrants

Fig. 2-2-4 illustrates that there is a higher concentration of immigrants in Boston and Cambridge. However, if observed carefully, the inner city area has a lower ratio of immigrants than the surrounding area in the City of Boston. Comparison with Fig. 2-2-2 implies that the racial minorities born in the US live at the core of the inner city and immigrants live in the direct vicinity of the core.

---

[6] Data source: Census 1990. Speakers are defined as "persons with age 5 and above." And counted 538,511.

2-2-5. Ratio of Lower Educational Attainment

Fig. 2-2-5 clearly indicates the lower educational attainment of the inner city residents. The Boston inner city is a place where people with lower educational attainment live together. This is a problem when we think of inner city residents as a work force.
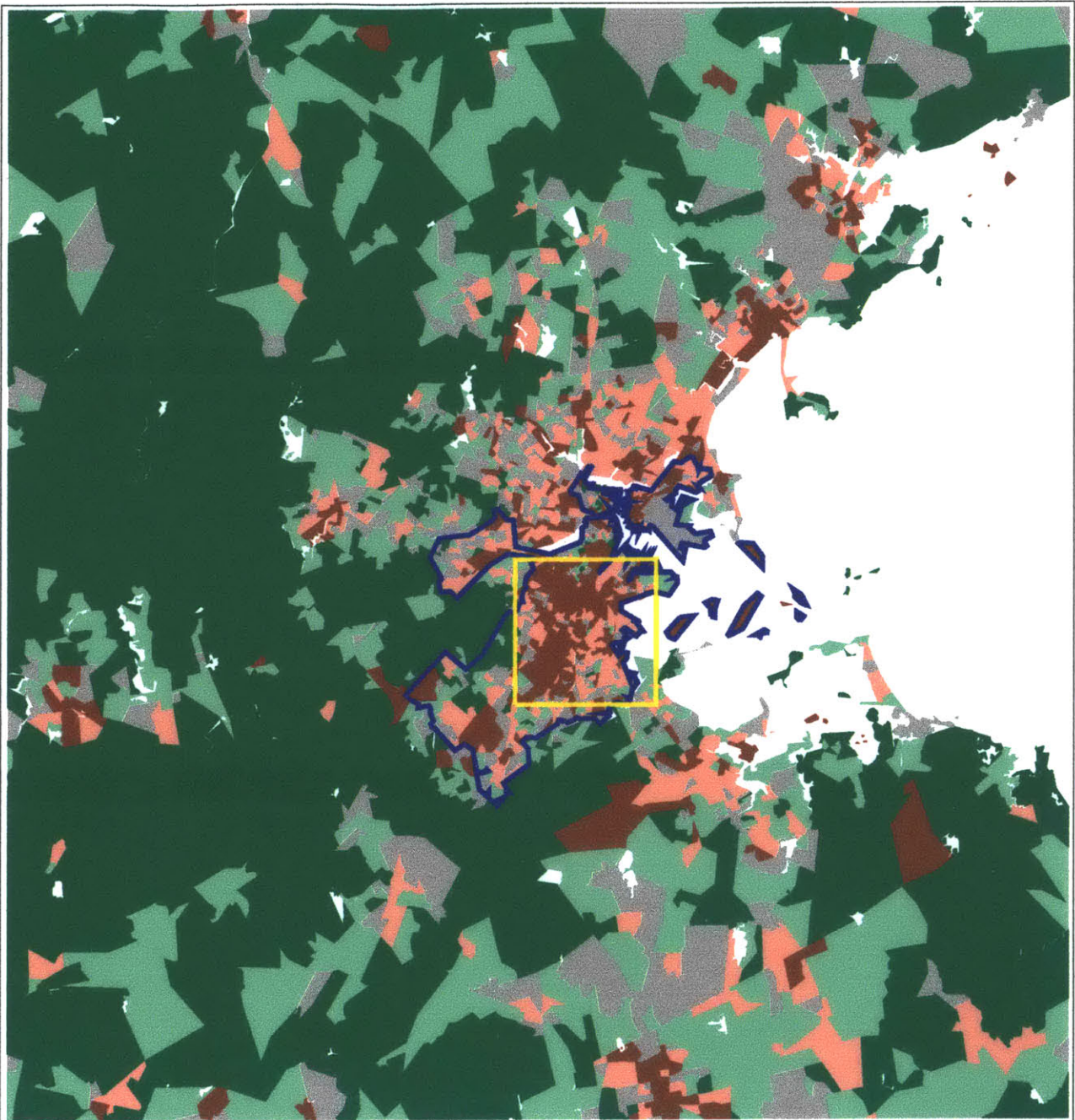
Fig. 2-2-1
Median Household Income
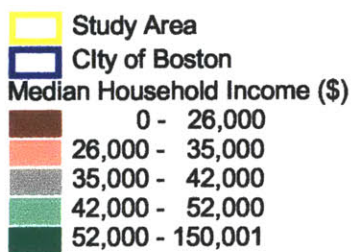
Study Area
City of Boston
Median Household Income ($)
- 0 - 26,000
- 26,000 - 35,000
- 35,000 - 42,000
- 42,000 - 52,000
- 52,000 - 150,001

Data Source: Census 1990
Polygon: Census Block Groups

0   2   4   6   8   10 Miles

N

Fig. 2-2-2
Ratio of Racial Minorities

Study Area
City of Boston
Racial Minorities (%)
0
0 - 2
2 - 6
6 - 15
15 - 100
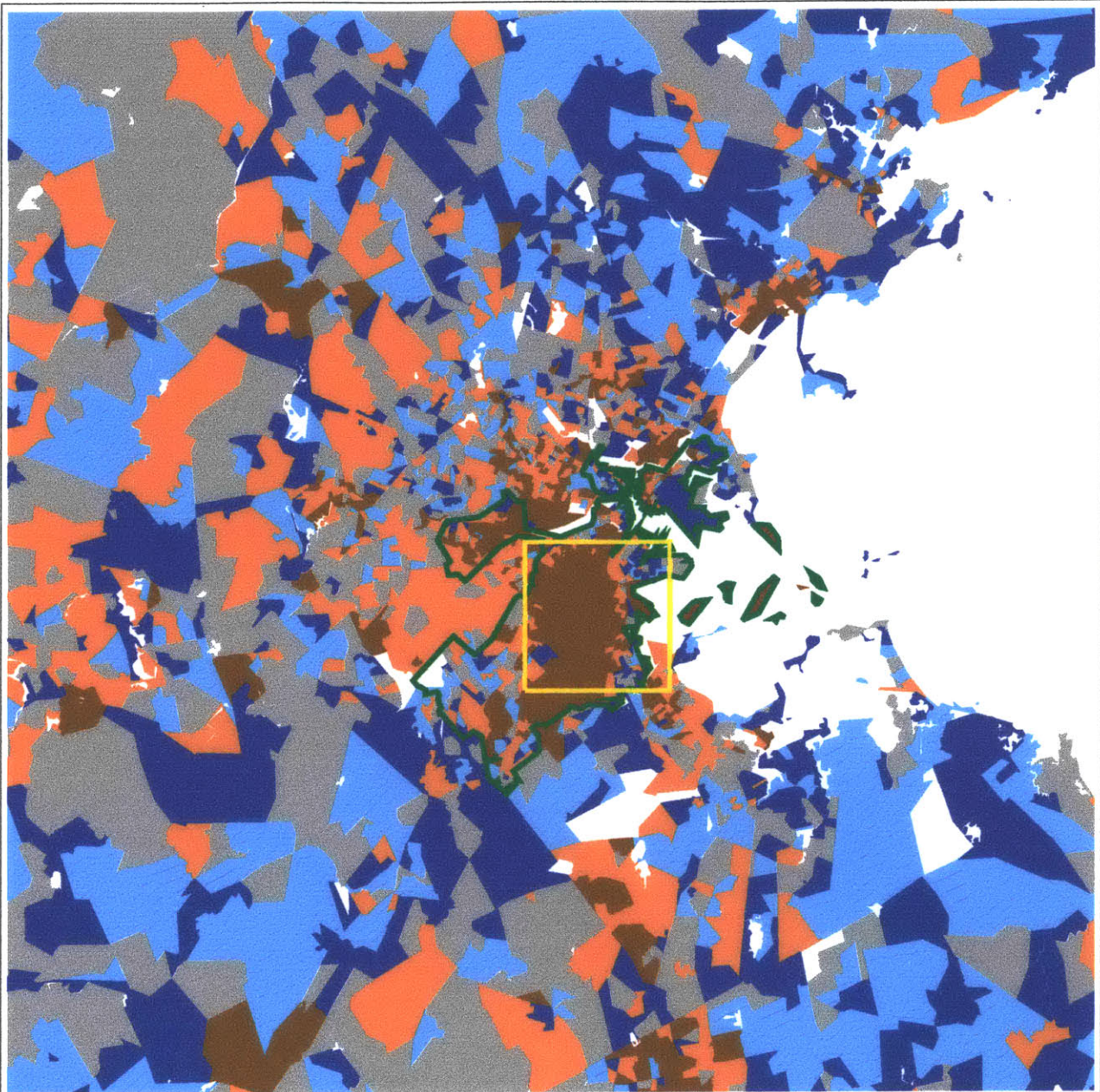
Definition of Minoritie:
= (Total Population) - (White)
Data Source: Census 1990
Polygon: Census Block Groups

0   2   4   6   8   10 Miles

N

Fig. 2-2-3
Ratio of English is Not Spoken at Home

Study Area
City of Boston
Foreign Language Ratio (%)
0 - 4.9
5 - 9.9
10 - 14.9
15 - 24.9
25 - 100
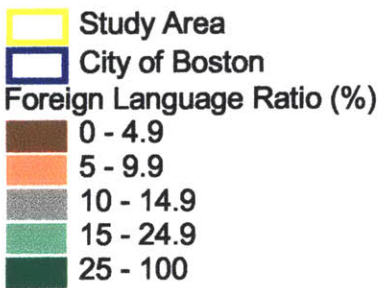
Definition:
= Percent of person who does not
  speak English at home
Data Source: Census 1990
Polygon: Census Block Groups

0   2   4   6   8   10 **Miles**

N

Fig. 2-2-4
Ratio of Immigrants

Study Area
City of Boston
Ratio of Immigrants (%)
0 - 5
5 - 10
10 - 15
15 - 20
20 - 88
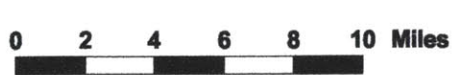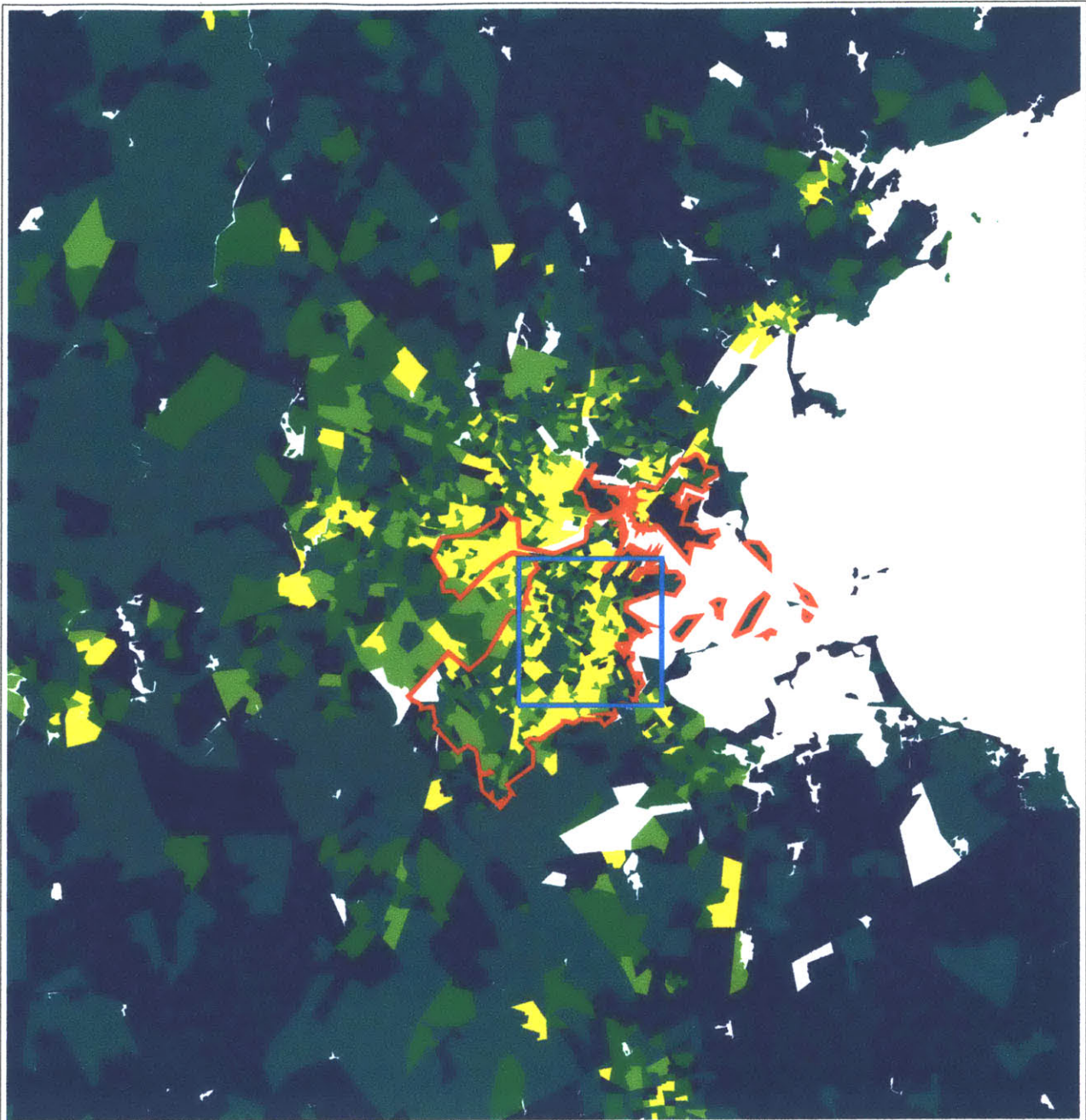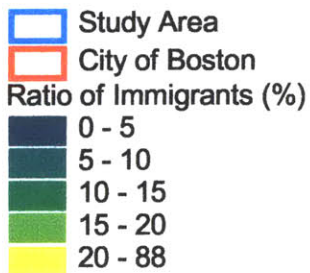
Definition of "Immigrants":
Person who were born out of the US
Data Source: Census 1990
Polygon: Census Block Groups

0   2   4   6   8   10 Miles

N

Fig. 2-2-5
Ratio of Lower Educational Attainment

Study Area
Clty of Boston
Lower Education Ratio (%)
- 0 - 9.9
- 10 - 14.9
- 15 - 19.9
- 20 - 32.9
- 33 - 100
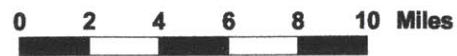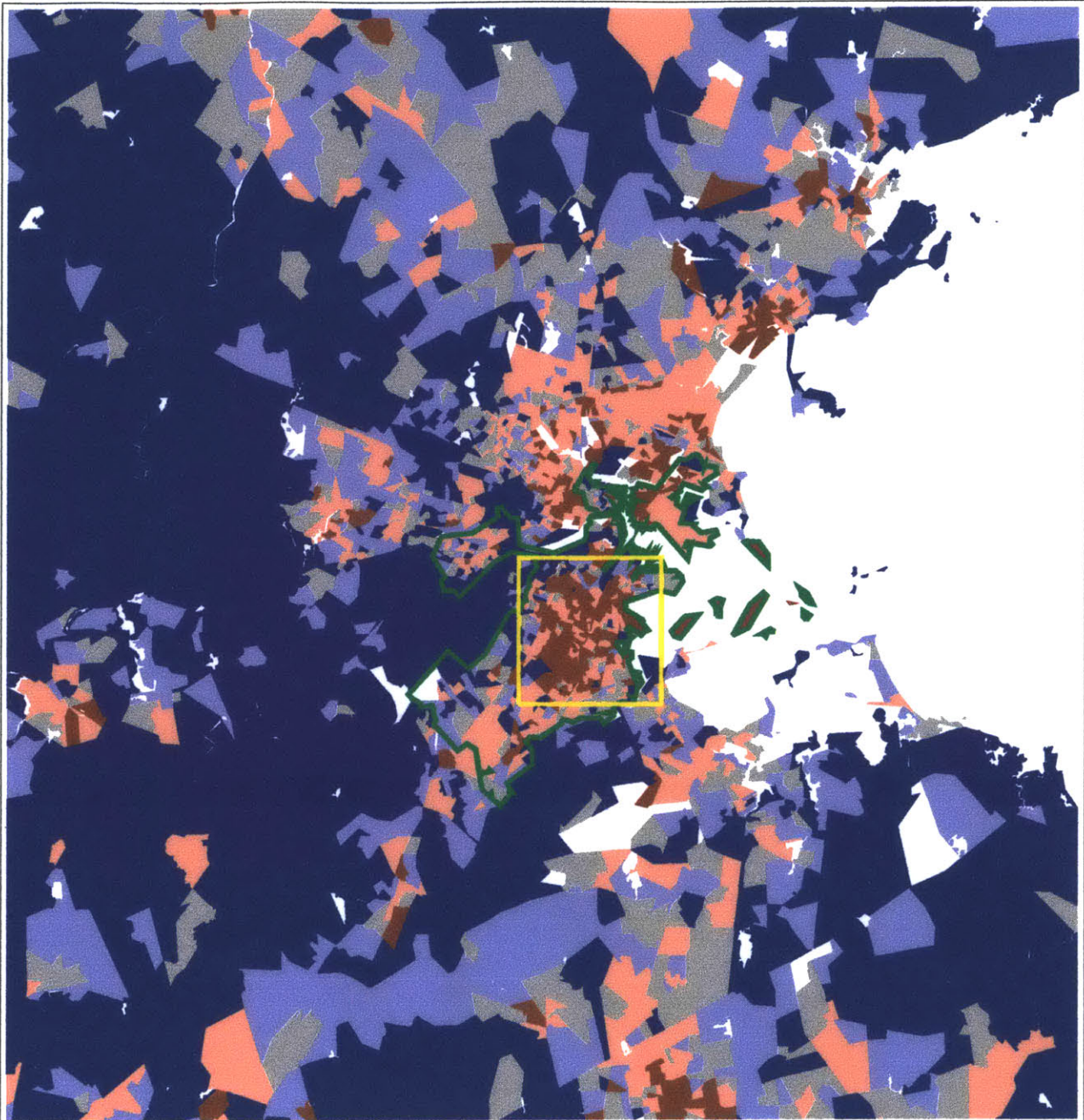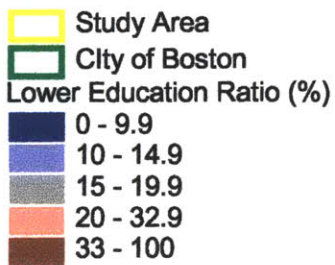
Definition of "Lower Educational Attainment"
= Person older than 25 and does not have
   high school diploma
Data Source: Census 1990
Polygons: Census Block Groups

0   2   4   6   8   10 **Miles**

N
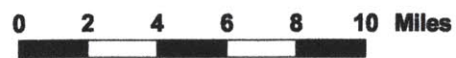
2-3. Economic Analysis

2-3-1. Income Density

Even though the average income of the inner city residents is low, the income per unit area (US$/Acre) is very high. Fig. 2-3-1 illustrates that the income density of the Boston inner city is much larger than its suburbs. Income density is as much a function of how dense the population as how rich the residents are. A business location in the inner city means the proximity to greater disposable income.

2-3-2. Expenditure Pattern of Inner City Household

The low household income does not mean that the inner city residents spend constantly less on each expenditure item. On the contrary, they spend more than the average metropolitan counterpart on some items. Fig. 2-3-2 shows that inner city households spend more on garments and personal care services. This phenomenon implies a business opportunity also.

2-3-3. Strategic Location

The strategic location of the inner city, i.e. good access to the Central Business District (CBD) and main transportation artery, must not be underestimated. Fig. 2-3-3 shows the 5 miles buffer from the central business districts of Boston, and entrances of the main express ways. This advantage can encourage linkage to the "exporting industries" in the accessible distance.

2-3-4. Job Openings / Job Seekers

If unemployment is the main motivation of inner city economic development, the "job-opening / job-seekers" ratio of the area is worth noticing. Fig. 2-3-4-1 and Fig. 2-3-4-2 show density of job seekers and Ratio of job openings to job seekers[7]. The blue rings indicate the Boston inner city. They are like hoops around an invisible column which stands on the inner city. In the maps "job"

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[7] These maps are sited from the research study of Dr. Qing SHEN (Associate Professor of the Department of Urban Studies, MIT).

- 35 -

means unskilled job only, so if skilled jobs are included the feature of the maps differ a little. The upper map illustrates that the density of "job seekers" (or "unemployment persons", in other words) are as high as 2,000 persons per square miles.

On the other hand, the lower map shows that the ratio of job openings to job seekers in the inner city is as low as around 0.50. The map demonstrates that there is significant ratio[8] of job openings at the north of the inner city area. This north area is the central business district of the downtown Boston.

---

[8] Finding by Dr. Qing SHEN indicates that not only the "ratio" but also the "substantial" number of job openings is also significant in the central business district.

**Fig. 2-3-1
Income density**

Study Area
City of Boston
Income Density (US$/Acre)
0 - 25,000
25,000 - 75,000
75,000 - 150,000
150,000 - 300,000
300,000 - 600,000
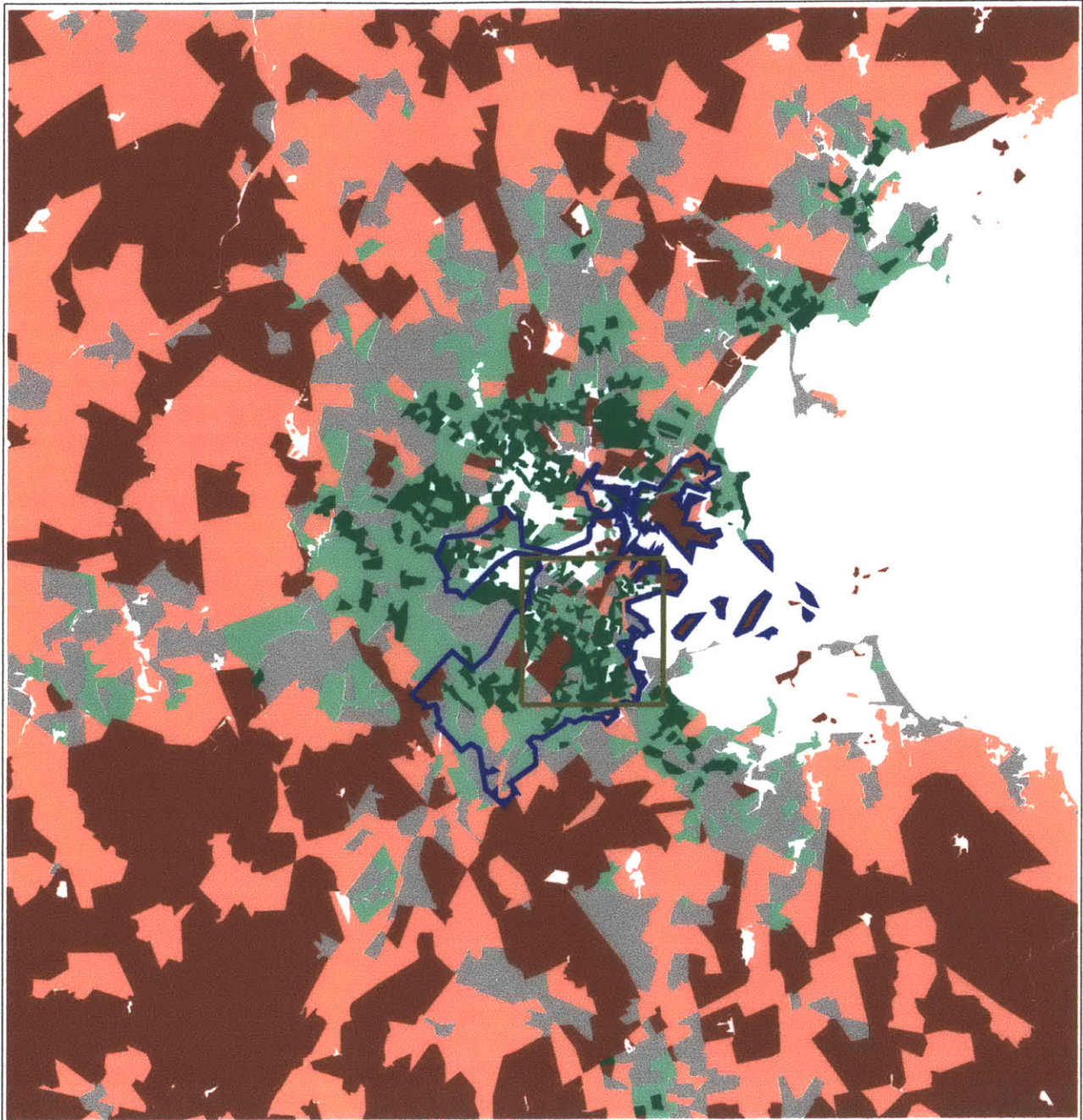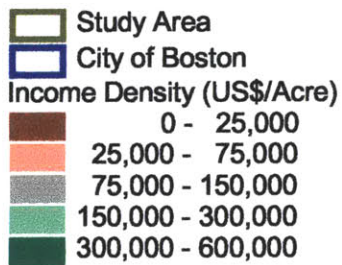
Definition:
= [Income per capita] x [Total Population]
  / [Land area of the block group]
Data: Census 1990
Polygon: Census Block Groups

0   2   4   6   8   10 Miles

N
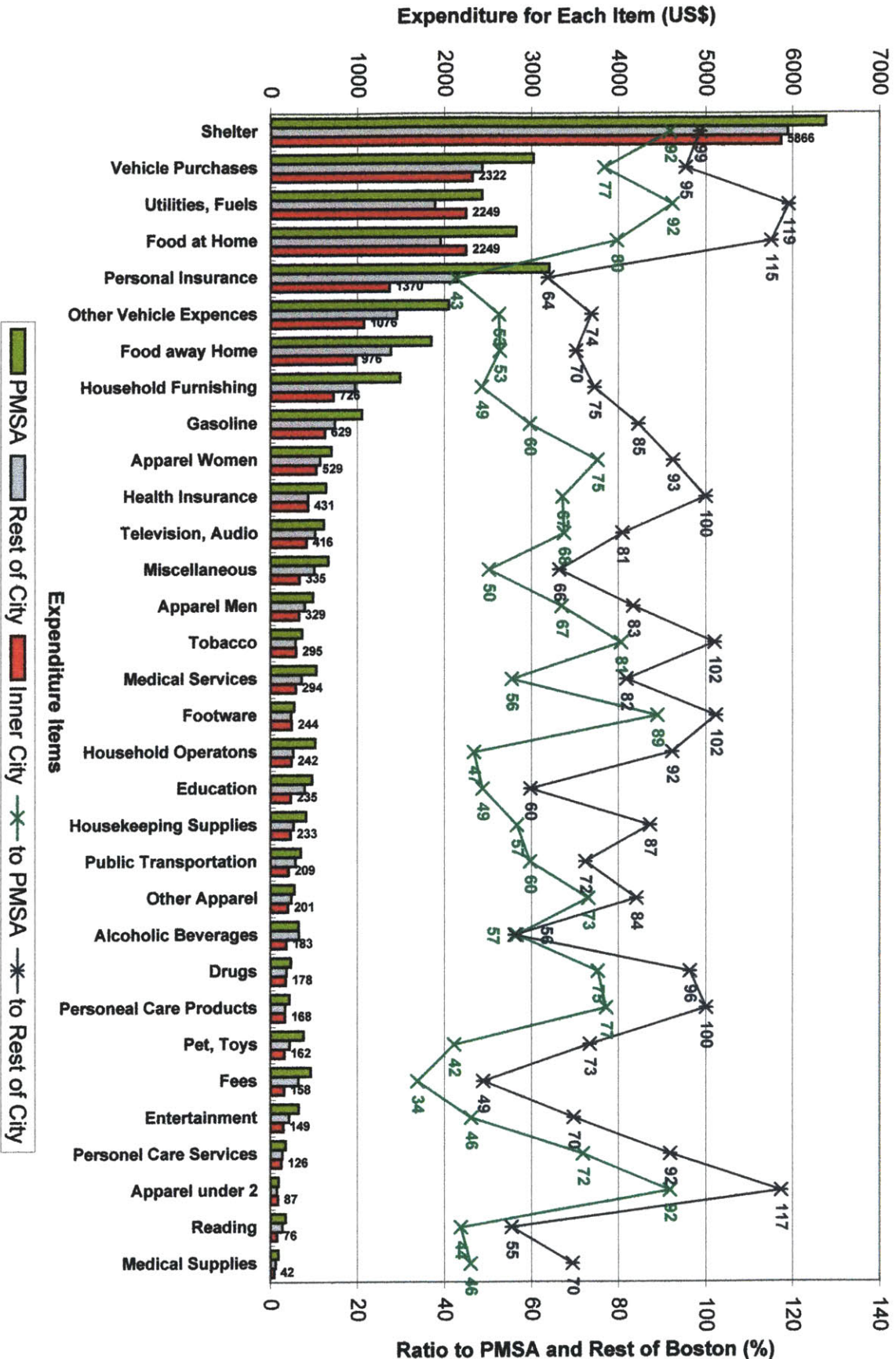
Fig. 2-3-2 Expenditure Pattern of Inner City Household

Fig. 2-3-3
Strategic Location

EAST BOSTON: MAVERICK/CENTRAL

Airport

ALLSTON VILLAGE

CHINATOWN

BRIGHTON

WASHINGTON ST GATEWAY

MISSION HILL

SOUTH BOSTON: BROADWAY

Hyde/Jackson

DUDLEY SQ

UPHAMS CORNER

EGLESTON SQ

BOWDOIN/GENEVA

CODMAN SQ

ROSLINDALE VILLAGE
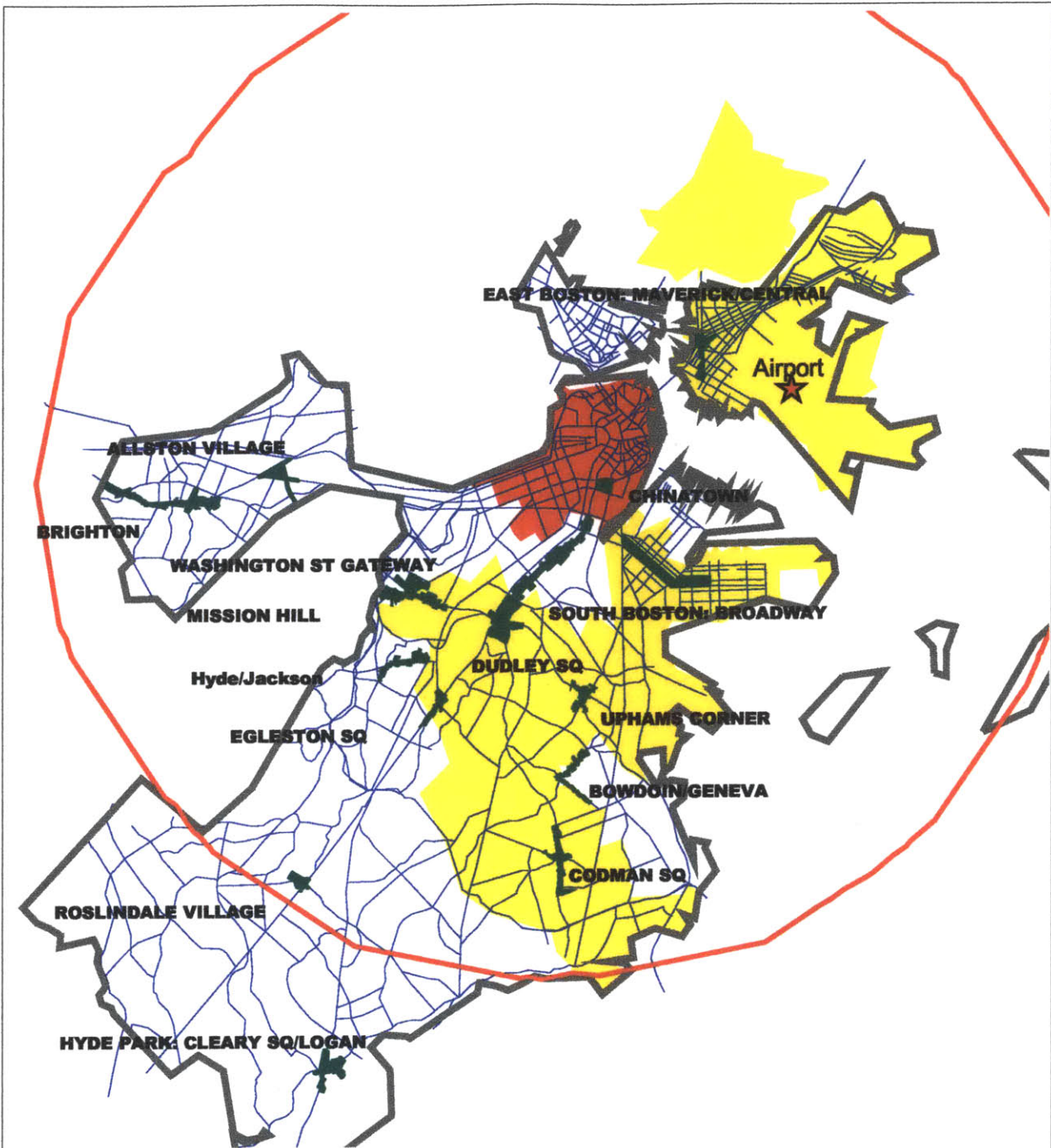
HYDE PARK: CLEARY SQ/LOGAN

● Central Business District (CBD)

○ Inner City by ZIP area difineition

▭ 5 miles range from CBD

▭ Boston City Boundary

▬ Main Street Districts

〜 Major Roads

Inner City has a good access to
the Central Business DIstrict,
airport, railroad station, and
entrences of major highways.

0   1   2   3 Miles

N

Fig. 2-3-4-1 Density of Job Seekers in Boston Inner City

Job Seekers' Density
(persons / square mile)
- 0 - 5
- 5 - 10
- 10 - 15
- 15 - 20
- 20 and over (max. 2279)
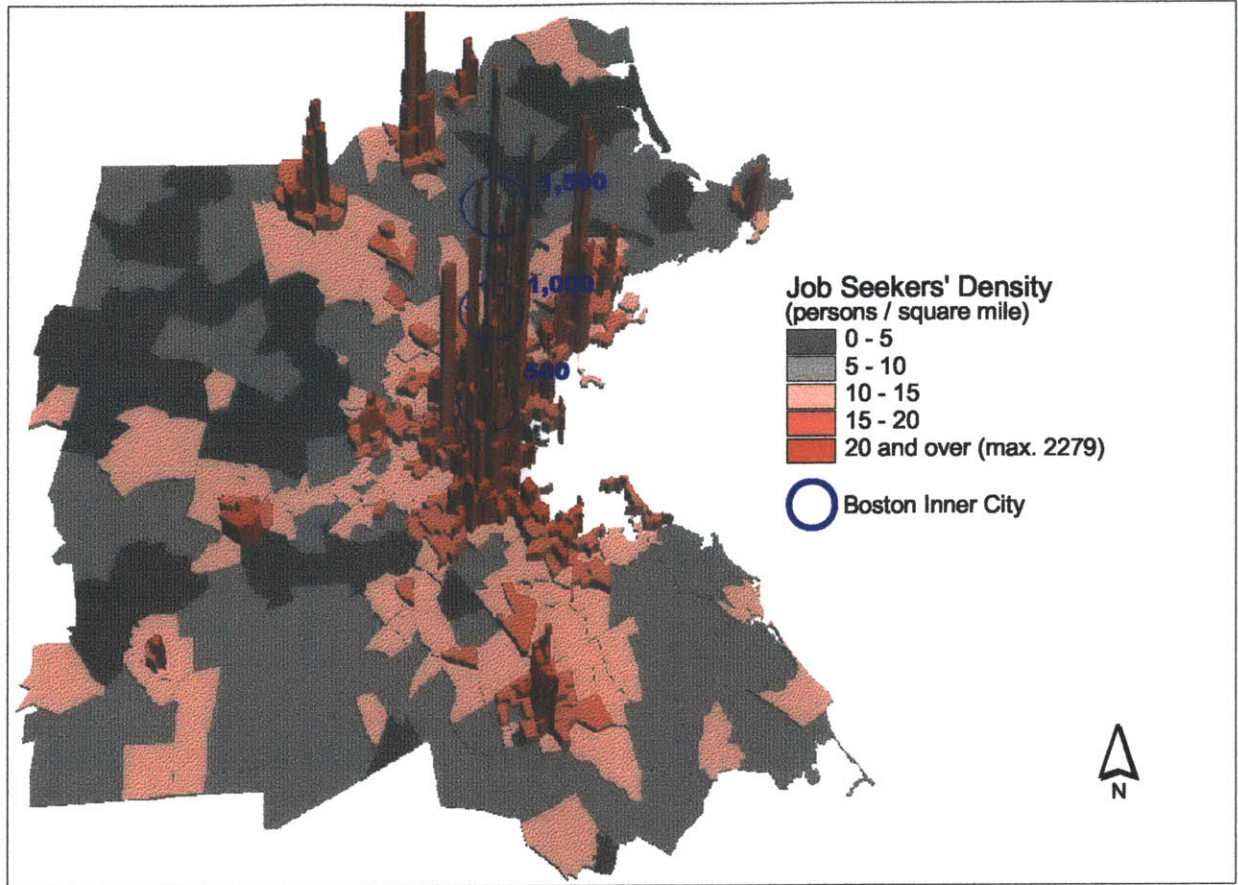
◯ Boston Inner City

Fig. 2-3-4-2 Ratio of Job Openings to Job Seekers in Boston Inner City

Job Opening to Seekers Ratio
- 0.00 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 and over (max. 135)

◯ Boston Inner City
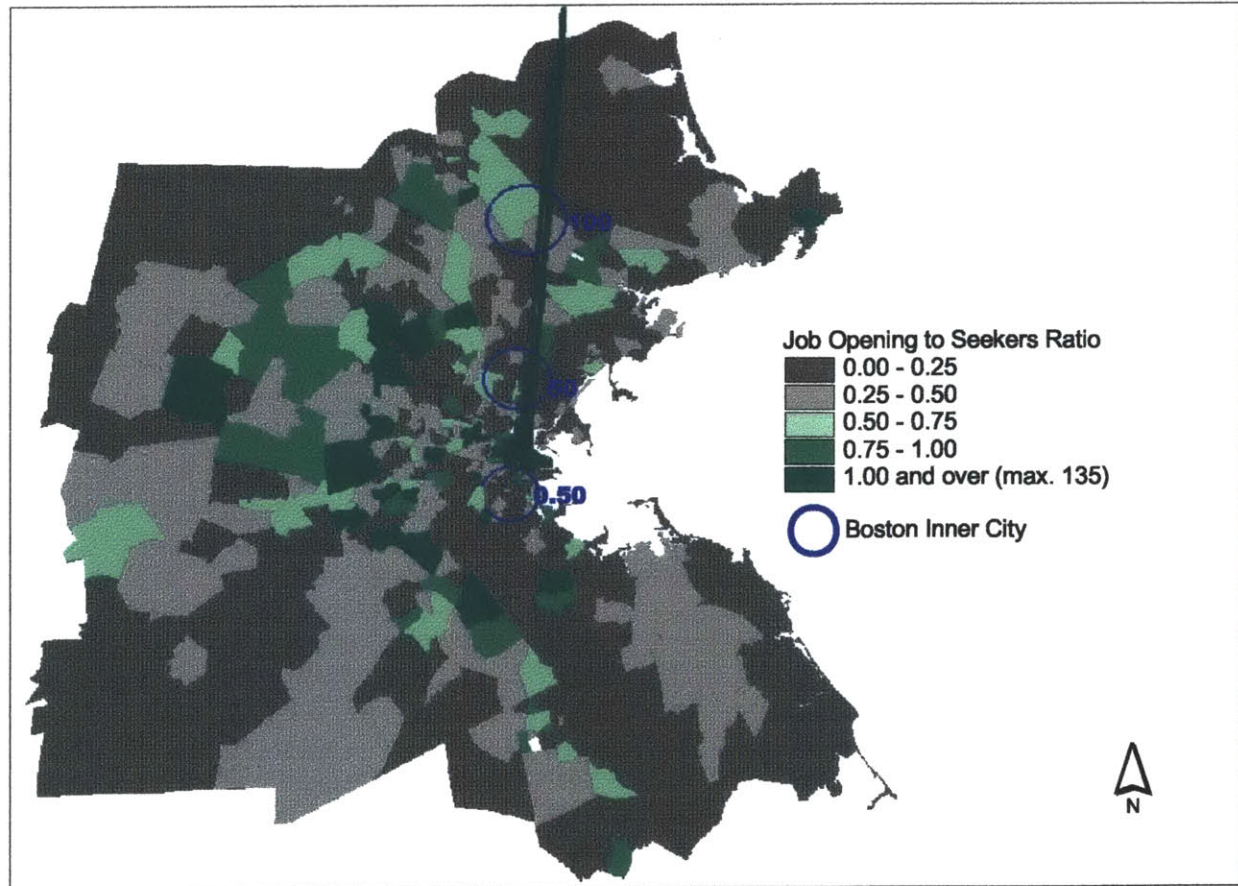
2-4. Retail Expenditure Coverage

One of the strategies for neighborhood economic development is to seize the consumption that generates from the area itself. Where income of local households is not spent far away but circulating in the area as expenditure, probably, the local service demands are satisfied. There may be enough retail and daily service industries to serve the neighborhood with enough employment and investment. Retail expenditure coverage is an indicator to evaluate the local service as whole.

2-4-1. Concept of Expenditure Coverage

Expenditure coverage is a comparison sale of an area with expenditure by the local residents. If the inner city area is under-served and the residents have to go to the suburban malls, there is a gap between local demand and local supply. Expanding existing businesses or setting up new ones to meet the local demand are the ways to fill the gap. How do we know if the local households are well served or under-served?

"Expenditure Coverage" is a good indicator of this general business performance. This figure indicates the ratio of local sales to the local expenditure, and it is calculated in the following way:

$$C = S / E$$

Where C is Expenditure Coverage

S is total sales of the entire shops in the area

E is total expenditure of entire households in the area

Let's suppose three cases exist. First, there is no shop in an area and residents must go out of the area for any kind of purchasing. In this case, there is no expenditure coverage at all.

[Coverage] = [Sales of Area] / [Expenditure] = 0 %

Second, there is a harmonizing area in terms of the expenditures of the residents and sales of the shops in the districts. Some residents may shop out of the area;

however, some non-residents spend the same amount of money in the area. In this case, expenditure of the residents and sales of local stores are balanced.

[Coverage] = [Sales of Area] / [Expenditure] = 100%

Finally, there is an area full of shops and not only the local people but also people from outside come for shopping. Sales of the shops may be five times larger than the expenditure of the local households.

[Coverage] = [Sales of Area] / [Expenditure] = 500%

In this section, arguments are limited to retail businesses, because the other industries i.e. manufacturing, transportation, wholesale, financial, and service industries have bigger frameworks to manage and competition is far beyond the neighborhood level.

2-4-2. Expenditure Coverage in the Inner City

How can we get the figure **E**, or retail expenditure of the local residents? The following equation and procedure give us an estimate of **E** for every zip code area.

[Retail expenditure] = [Income] x [Retail expenditure share]

(1) Get a figure of the total area income[9] in each ZIP code area. This data is available from the 1990 Census.

Table 2-4-2-1 Total Area Income in Boston Inner City

ZIP code	Area Population	Per Capita Inocme	Total Area Income	MedHsIn
02119	25,081	$8,794	$220,562,000	$18,390
02120	14,645	$9,641	$141,192,000	$21,321
02121	25,608	$10,102	$258,692,000	$22,010
02124	49,049	$12,096	$593,297,000	$29,468
02125	31,414	$11,318	$355,544,000	$27,742
02127	29,162	$14,673	$427,894,000	$25,440

[9] [Total Area Income] is [Area Population] by [Per Capita Income].

[Median Household Income] x [Households] would make a wrong and much smaller estimation.

(2) Calculate the retail expenditure share of household income. This figure
    can be processed from the data of Consumer Expenditure Survey by
    the Bureau of Labor Statistics[10]. Among the numerous household
    expenditures, retail items are defined as shown in the table below. The
    last line of the table indicates the ratio of the expenditure on retail items
    in the income of each range.

Table 2-4-2-2   Retail Expenditure Share by Household Income Range

Retail Expenditure Items \ Range of Household Income	Average	Less than $5,000	$5,000 to $9,999	$10,000 to $14,999	$15,000 to $19,999	$20,000 to $29,999	$30,000 to $39,999	$40,000 to $49,999	$50,000 to $69,999	$70,000 and over
Food.............................										
Food at home...........................	2,835	1,355	1,758	2,126	2,471	2,650	2,882	3,292	3,682	4,426
Food away from home...................	1,834	744	560	941	1,381	1,353	1,779	2,464	2,780	3,943
Alcoholic beverages......................	337	207	60	195	221	250	223	429	360	1,029
Housing.............................										
Housekeeping supplies..................	467	147	192	303	441	409	460	618	633	845
Household furnishings and equipment.....	1,228	395	408	589	800	905	1,257	1,294	1,810	3,064
Apparel and services.....................	2,028	878	640	1,168	1,218	1,722	1,705	2,290	3,090	4,726
Transportation..........................										
Vehicle purchases (net outlay)..........	1,754	532	589	744	762	1,334	1,806	2,755	2,832	3,728
Gasoline and motor oil.................	881	435	292	460	627	792	1,016	1,213	1,301	1,542
Health care.............................										
Drugs.............................	245	91	169	266	365	285	238	224	262	251
Medical supplies......................	94	30	41	51	103	85	91	106	143	163
Entertainment...........................										
Television, radios, sound equipment.....	514	275	235	336	352	419	489	604	757	1,012
Pets, toys, and playground equipment....	283	81	91	126	221	250	328	339	481	504
Other supplies, equip., and services....	332	163	40	74	269	140	285	351	508	1,098
Personal care products and services......	433	155	161	265	333	353	399	516	616	941
Reading................................	193	112	79	128	151	176	190	213	259	383
Education..............................	551	749	371	213	132	236	505	586	618	1,600
Tobacco products and smoking supplies....	285	206	218	211	273	310	289	365	367	280
Total Retail Expenditure	14,294	6,555	5,904	8,196	10,120	11,669	13,942	17,659	20,499	29,535
Income before taxes	36,924	1,897	7,582	12,437	17,365	24,535	34,655	44,684	57,914	110,143
Retail Expenditure Share	38.7%	345.5%	77.9%	65.9%	58.3%	47.6%	40.2%	39.5%	35.4%	26.8%

Source: Consumer Expenditure Survey, 1991-92, Northeast region by income before taxes

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[10] Web site address is http://stats.bls.gov/csxcross.htm#y8990

(3) Estimate the retail expenditure of the area, or how much the inner city households spend on the retail items. To get the figure, substitute [Income] and [retail expenditure share] in the following equation with the value given in the above tables[11].

[Retail Expenditure]= [Income] x [Retail Expenditure Share]

Values are shown in the fifth column of the Table 2-4-2-4.

How can we get the figure **S**, or retail sales of an area? This figure is available for every ZIP code area from Economic Census 1992[12]. This figure should be modified with the Consumer Price Index[13] because the calculation of retail expenditure above is based on 1990 Census, which gives us the data of 1989.

Table 2-4-2-3   Sales of Retail Industry

ZIP code	Sales 1992	Modifier	Equivalent in 1989
02119	$91,109,000	0.88382	$80,523,956
02120	$7,897,000	0.88382	$6,979,527
02121	$11,122,000	0.88382	$9,829,846
02124	$256,558,000	0.88382	$226,751,092
02125	$51,073,000	0.88382	$45,139,339
02127	$108,885,000	0.88382	$96,234,741
Inner City total	$526,644,000	0.88382	$465,458,500

Consumer Price Index (1989/1992) = 124.0/140.3 = 0.88382

Finally, Table 2-4-2-4 shows the Coverage of Retail Expenditure of the Boston inner city by Zip code area. This estimation shows us that only 48.1% of the retail purchases have been done locally. More than half of the retail trade has taken place outside the inner city[14]. This is a very strong proof that retail demand is not met in the inner city. At the same time this low coverage implies a growth

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[11] Figures for the retail expenditure share in Table 2-4-2-2 vary so widely. More sophisticated values could be computed by interpolating the effect of household income on the retail expenditure share, however, figures in the table are applied directory in this study.

[12] The latest economic census was in 1997; however, results are not available at this moment (May 1, 1999). Data of 1992 is available in the format of compact disc.

[13] This data is available online. Web site address is "http://stats.bls.gov/cpihome.htm"

[14] Sales leakage **L** is given with $(1 - S/E)$

opportunity for the retail business in the inner city. The Boston inner city has a strong concentration of buying power ($/acre) and yet the demand is not met locally.

Table 2-4-2-4 Coverage of Retail Expenditure

ZIP code	Total Area Income	Median Income	Retail Share	Retail Expenditure	Retail sales	Coverage
02119	$220,562,000	$18,390	58.3%	$127,507,000	$80,523,956	63.2%
02120	$141,192,000	$21,321	47.6%	$66,756,000	$6,979,527	10.5%
02121	$258,692,000	$22,010	47.6%	$122,310,000	$9,829,846	8.0%
02124	$593,297,000	$29,468	47.6%	$280,510,000	$226,751,092	80.8%
02125	$355,544,000	$27,742	47.6%	$168,101,000	$45,139,339	26.9%
02127	$427,894,000	$25,440	47.6%	$202,308,000	$96,234,741	47.6%
-	$1,997,181,000	-	-	$967,492,000	$465,458,500	48.1%

2-4-3. Retail Expenditure Coverage in the Metropolitan Area

The retail expenditure coverage is found to be as low as 50%. The coverage would become very close to 100% when we calculate a bigger economic area, such as all of Massachusetts. Then what is the spatial distribution of the retail expenditure coverage in the Boston Metropolitan Area?

Fig. 2-4-3 is a map made with the same procedure as the above section. Though the coverage in the inner city is less than 100%, no clear "donut phenomenon" patterns are observed on the map like the demographic maps shown in Section 2-2. However, if we overlay the location of shopping centers, the correlation is apparent. ZIP code areas along the regional main roads have higher coverage (red areas on the map), and concentration of shopping centers is more significant in these areas. This map tells the history of retail business in the last 40 years. Shopping centers in the suburbs and in the central business district are winners and dominate the retail business. On the other hand, the losers are downtowns of local communities and inner city of the Metropolitan core, i.e., Boston inner city. This pattern is consistent with the fact that the project districts of the Main Street Program are inner cities, and downtown areas of local communities. The Main Street Program is an attempt of retail-losers to recover their share of the retail expenditure of households in each neighborhood.

Fig. 2-4-3
Coverage of Retail Expenditure
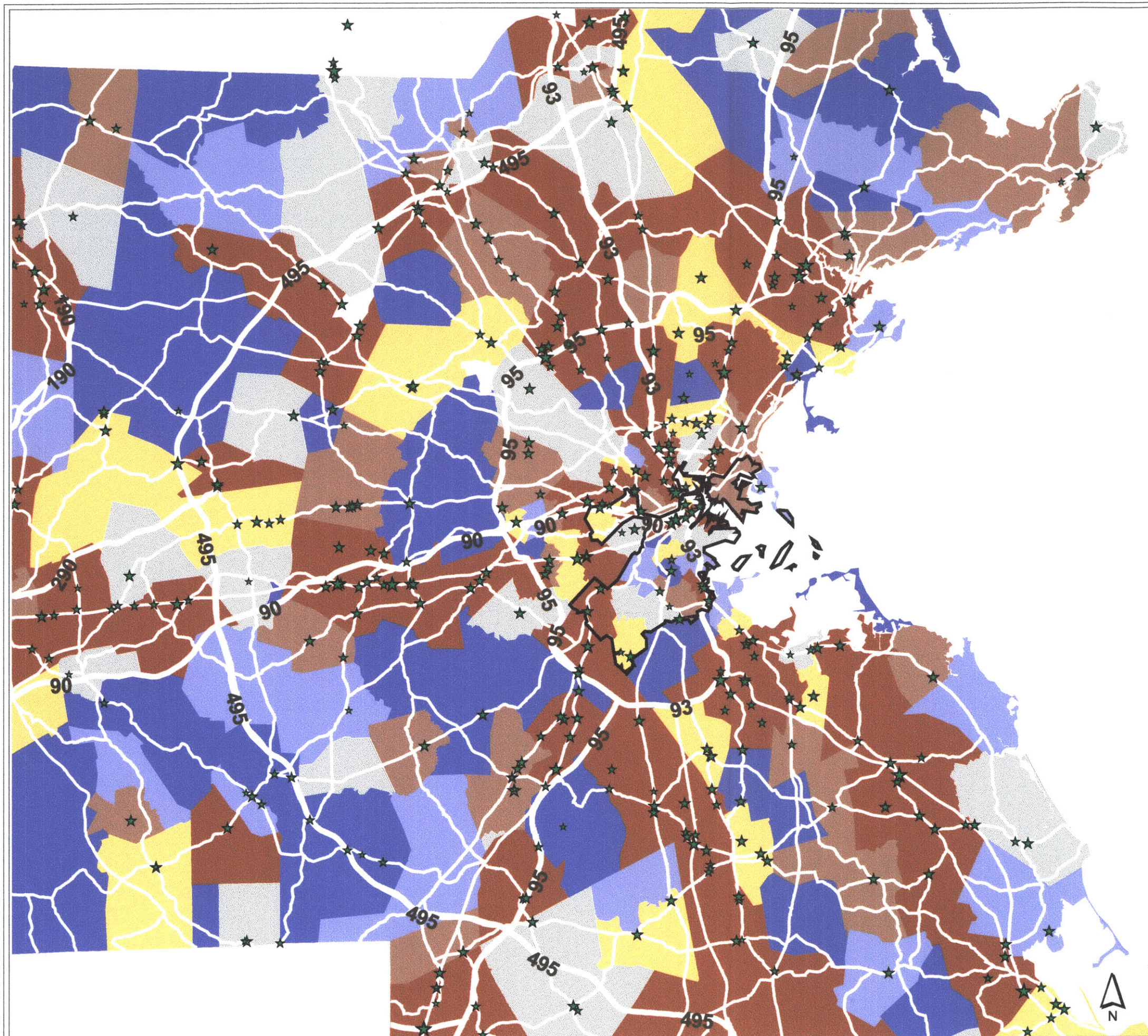
Shopping Centers
★ Retail
★ Community Center
★ Neighborhood Center
★ Regional Mall
★ Super Regional Mall
▭ Boston City Boundary
Major Roads
Retail Expenditure Coverage
0 - 19 %
20 - 39 %
40 - 59 %
60 - 79 %
80 - 99 %
100 - 2,220 %

Mapping Data
Polygon: ZIP code Area
Definistion:
C=S/E
 where
 C=[Coverage of Retail Expenditure]
 S=[Sales of Retail Industries]
 E=[Expenditure on Retail Items by Residents]

0 2 4 6 8 10 Miles

CRL
Computer Resource Lab
Department of Urban Studies and Planning
Massachusetts Institute of Technology

2-5. Leading Industries in Boston

This section focuses on an analysis to find leading industries in Boston. Each region has some industries that lead the economy. Leading industries have a big presence in the area with their terms of employment and wages distributed. They often export their products or services to the outer area or the majority of their customers are out of the area. To facilitate "exporting" industries is also one of the most important strategies for neighborhood economic development. Exporting businesses acquire currency from the "outside world."

2-5-1. Five Criteria of Leading Industries

Table 2-4-2-1 shows 40 leading industries in Suffolk County[15], where Boston holds a significant majority of its employment. This table is a result of integrated evaluation of all the industries by 4-digit SIC code.

Five criteria were employed for this evaluation. They are as follows:

(1) Substantial number of employment of the industry

This figure is the most essential condition of leading industries. A big work force in a specific industry implies an important contribution to the local economy. For example, the hospital industry (SIC#8060, or the 14th ranking in Table 2-4-2) has 57,091 employees in Suffolk County and plays an important role in the local economy.

(2) Location quotient of employment[16]

---

[15] Data of Suffolk County is used for this analysis because the necessary data (employment, payment, and number of establishments by 4-digit SIC code for every year) is available by county level and not by local government level. However, the economy of Boston is so dominant in Suffolk County that we can almost treat the data of Suffolk County as that of Boston.

[16] Location quotient (LQ) is defined as "Ratio of the share of an industry for a region to the share of that same industry's national share."

$$LQ_i = (e_{i,r} / e_r) / (E_{i,n} / E_n)$$

Where $e_{i,r}$ is employment of industry "I" in the area

e_r is the total employment of the area

$E_{i,n}$ is employment of industry "I" in the whole nation

If there is an exporting industry in the area, the ratio of the employees in the local economy is larger than the ratio of the national average. For example, the number of workers in investment office (SIC#6720, or the 1st ranking in Table 2-4-2-1) is 45.58 times more significant than the national average. The proportion of the employment (not necessarily the employment itself) of this industry is much larger than the other areas.

(3) Location quotient of establishment

A company can have a hundred thousand employees and demonstrate a big presence in the area. However, this is not a cluster. Location quotient by number of establishments is an indicator to see if an industry with a big work force formulates a cluster in the area or not. Numerous firms with diversified cultures, approaches, and ideas may facilitate innovation through rivalry and encourages the agglomeration economy. Location

---

E_n is the total employment of the nation

For example, the industry with SIC code #56 is apparel and accessory stores. If the percentage of employment in this specific industrial category is 2% of the total employment of an area (such as Suffolk County), while the national percentage is 1%, the presence of the industry in the area is twice as big as national average.

There are several alternative on which area to take for this analysis. This analysis on all the US vs. Suffolk County tells us the exporting industries of metropolitan or national market range. With this US – County analysis, taxi and car parking services would show their significant presence. This happens because the whole US contains many local areas, where taxi and car parking cannot demonstrate their presence. These service industries may have a bigger significance in any urban area in comparison with the total US. These industries have just local markets and are not really exporting ones. On the other hand, hospitals and entertainment industries may have bigger market. They can attract customers from the corner of the metropolitan area. Furthermore, higher education and financial industries has the biggest market range. Students are coming to prominent universities from all over the world and money also moves beyond national borders for better returns.

The question is how to define outside and inside. If each neighborhood is the inside world, a prominent restaurant or category killer retail such as Toysarus is an exporting business, because they attract customers from outside of the neighborhood. A bigger concept of inside would be the Boston Metropolitan Area. With this bigger framework, computer, medical care, and financial

quotient of establishment is calculated with the same procedure as location quotient of employment, and shows how large is the number of firms in each industry. A bigger location quotient by employment with a smaller location quotient by establishment implies that the size of firms in the area is bigger than the national average. Monopoly or oligopoly would be found in this case.

(4) Average annual income of employees

Even if an industry holds a large employment and offers a large number of working opportunities, the industry is less attractive when the wages is not high enough. If inner city residents can find a job with good wage, they may spend more in the neighborhood and stimulate the neighborhood economy. Table 2-4-2-1 shows that the average annual income of a worker in an investment office (SIC#6720, or the 1st ranking in the table) is $93,138 and much larger than the whole industry's average, which is about $35,000.

(5) Growth rate by employment

Lastly, growth rate is an essential criterion to define leading industries. If the other conditions are the same, an industry with a higher growth rate is preferable. According to the data from the census department, Boston's employment growth from 1990 to 1995 is just 1.2% while the national employment growth is 7.6% in the same time span. Many industries are declining in terms of employment even though they have substantially big work forces. And during the same period, also many industries have increased their employment.

All the five criteria were considered to make the ranking. All the industries by SIC 4-digit were ranked by the each criterion, and numbers for ranking order were given as their score. If as industry defined as 9999 by SIC code is ranked 1st by all the five criteria, then the total score of this industry is 1+1+1+1+1=5.

---

services are the example of exporting industries from the defined inside world. The Location Quotient theory with employment data would help to identify these industries.

The column on the far right in Table 2-4-2-1 shows the total scores thus calculated.

2-5-2. Leading Industry Groups

It is easily noticed that some industries in Table 2-4-2-1 have very close relation. The first three industries are all investment-related business. The fourth industry "Books" may have linkage to the "Periodicals" (No.13, SIC2720) and to the "Books and Periodicals" (No.32, SIC5192). Thus ten leading industry groups are presumed[17], and shown in Table 2-4-2-2.

This table contains most of the famous industries in Boston, and is consistent with our general perception. This result has been processed from the data of Suffolk County and these industries are prominent and preferable in terms of the five criteria we used.

---

[17] The methodologies of this grouping of industries are mostly by:

    (1) Proximity of SIC code, such as

        "Fruits & Vegetable Wholesale" (SIC#5148 / ranking14) and

        "Fish & Seafood" (SIC#514 / ranking33).

    (2) Relation of industrial stream, such as

        "Books-manufacturing" (SIC#2730 / ranking 4), and

        "Books & Periodicals-wholesale" (SIC#5192 / ranking32)

Table. 2-4-2-1 Leading Industries in Suffolk County

No.	SIC code	Name of Leading Industries	Employ- ment	Employ LQ	Establish. LQ	Annual Income	Growth 90 - '95	Total Score
1	6720	Investment Offices	5,438	45.6	9.3	93,138	770.1%	63
2	6280	Security & Commodity Servic	15,491	25.3	6.3	75,931	82.7%	73
3	6210	Security Brokers & Dealers	11,800	6.1	3.1	77,062	35.3%	146
4	2730	Books	4,006	5.9	3.0	46,775	88.3%	214
5	6799	Investors	484	4.0	3.9	145,114	infinete	246
6	4812	Radiotelephone Communicatio	2,259	4.9	2.1	45,481	2011.2%	262
7	7311	Advertising Agencies	2,220	3.1	2.5	67,403	32.7%	273
8	7372	Prepackaged Software	1,631	2.0	2.5	51,315	277.5%	278
9	8742	Management Consulting Servi	4,777	2.7	2.8	85,916	7.4%	284
10	8100	Leagal Services	15,504	3.2	2.8	54,139	-1.2%	306
11	4813	Telophone Communications	5,056	1.2	1.8	52,686	infinite	336
12	7375	Information Retrieval Servi	364	1.8	3.3	58,742	213.8%	375
13	2720	Periodicals	1,227	2.0	3.2	50,616	20.4%	387
14	5148	Fruits & Vegetables (Whole	989	1.8	4.4	50,470	16.8%	403
15	8743	Public Relations Services	428	2.5	4.0	50,668	38.1%	407
16	8712	Architectural Services	2,282	3.3	3.6	42,598	2.8%	408
17	5983	Fuel Oil Dealers	539	2.2	2.6	39,460	infinite	430
18	4510	Air Transportation, Schedul	9,141	3.0	3.7	33,869	3.9%	431
19	6310	Life Insurance	10,423	3.7	1.7	46,086	-1.8%	431
20	6090	Functions Related ot Banking	429	1.4	1.9	104,548	infinite	433
21	8733	Noncommercial Research	3,290	8.1	4.5	26,024	38.3%	451
22	8010	Medical Clinics	11,188	1.3	0.9	57,471	80.6%	484
23	4730	Freight Transportation Arra	1,690	2.6	3.7	34,014	10.4%	489
24	8711	Engineering Services	8,658	2.5	1.2	53,472	-6.7%	520
25	2337	Women's Suits and Coats	695	4.0	5.2	40,315	-3.5%	523
26	8744	Facilities Support Services	335	0.9	2.0	65,101	infinite	524
27	4830	Radio & Television Broadcas	2,652	2.1	1.2	49,034	14.0%	525
28	7336	Commercial Art & Graphic De	726	2.4	2.4	35,652	27.6%	533
29	6150	Business Credit Institutions	646	1.3	2.3	74,420	8.0%	534
30	8060	Hospitals	57,091	2.2	1.5	35,278	2.7%	536
31	7929	Entertainers and Groups	833	2.2	1.3	35,206	infinite	552
32	5192	Books & Periodicals (Whole	606	1.3	1.5	44,234	98.0%	565
33	5146	Fish and Seafood	646	4.2	5.9	45,260	-18.8%	565
34	8720	Accounting, Auditing & Book	6,964	2.3	0.9	42,938	17.1%	571
35	8220	Colleges and Universities	31,636	5.0	3.7	22,316	-3.5%	571
36	8290	Schools & Educational Servi	1,569	2.5	2.6	21,983	79.7%	574
37	4725	Tour Operators	483	2.6	1.7	33,491	114.7%	575
38	8320	Individual & Family Service	7,086	2.4	2.0	17,513	68.6%	602
39	7330	Mailing, Reproduction, Sten	1,926	1.4	2.1	33,242	16.5%	607
40	8620	Professional Organizations	459	1.5	2.4	43,407	10.1%	607

"Growth '90-'95" is growth in employment. "Infinite" means "no data available in 1990."

Table 2-4-2-2 Leading Industry Groups in Suforlk County

No.	Leading Industry Groups (Employment in 1995)	Group Components	
		SIC	Industry Name
1	Medical Services (68,279 workers)	8010	Offices and clinics of medical doctors
		8060	Hospitals
2	Finance and Insurance (66,817 workers)	60**	Depository institutions
		61**	Non-depository institutions
		62**	Security and commodity brokers
		63**	Insurance Careers
		6720	Investment offices
		6799	Investors
3	Education (31,636 workers)	8220	College and Universities
		8290	School and Educational Service
4	Consulting Services (29,628 workers)	87**	Engineering and Management
5	Legal Services (15,504 workers)	8100	Legal services
6	Transportation Services (15,405 workers)	45**	transportation by air
		47**	Transportation services
7	Printing and Publishing (15,095 workers)	27**	Printing and publishing (manufacturing)
		5192	Books, periodicals, and news paper (wholesale)
8	Communications (10,066 workers)	48**	Communication
9	Computer Services (4,984 workers)	737*	Computer and data processing service
10	Wholesale Groceries (4,019 workers)	514*	Groceries and related products

These industry groups defined here are mapped and their spatial dispersions are discussed in Section 4-2.

3.

Surveying Inner City Economy

with

Socioeconomic Topography

There are numerous economic activities going on simultaneously in the Boston inner city. This chapter focuses on spatial analysis of the inner city phenomena that are relevant to the economic development. The study area is surveyed in terms of (1) commercial, industrial or tax-exempted land allocation, (2) land value, and (3) business variation. Geographic Information Systems helps us to extract socioeconomic patterns from the chaotic inner city.

3-1. Socioeconomic Topography

3-1-1. Idea

If we have a color marker and a map of the Boston inner city area, we can mark the shopping strips with the information from the Boston Main Street Program. We can also mark the location of shopping centers (those of regional, community, neighborhood, or retail levels) on the map based on information, such as from the Yellow Pages. However, this map (Fig. 3-1-1) does not tell us how active the business activities are in these districts and their vicinities. As a next step of mapping, we can get parcel data with land use information for each parcel and make a map with this data (Fig. 3-1-2). Land parcels classified as commercial, industrial, residential, and tax exempt land are shown on this map. Although we may get some idea of distribution of each parcel group in the inner city, the picture is still not clear.

The next map (Fig. 3-1-3) is based on the same information as for Fig 3-1-2, but it attempts to measure the location of business clusters in a systematic and easily replicated way. This method, which we call socioeconomic topography, can tell us much more about spatial patterns than the previous map.

3-1-2. Methodology

Processing procedures from Fig. 3-1-2 to Fig. 3-1-3 are as follows:

(1) Divide the map (Fig. 3-1-2) with a grid pattern. In this case the size of each grid cell is 15 meters by 15 meters[18] (50 feet by 50 feet). If the map area is 7,500 meters by 7,500 meters, there are 500 rows and 500 lines of cells or 250,000 cells in the map area. Each cell is loaded with a variable value. The value is "1" when the land use for the parcel at the center of the grid cell is categorized as "commercial land." The value is "0" when the cell is not

---

[18] In this study the original parcel map is divided into grid cells of 15m x 15m. Most of the parcels are bigger than this size and at least one grid cell can represent the smallest parcels on most occasions.

commercial land. The definition of the "commercial land" comes from the Assessor's Office Data '96, City of Boston.

(2) Set a survey area for neighborhood statistics. A survey area can be a rectangle or a circle of any size.   In this case the survey area is a circle with a 200 meter (1/8 mile) radius.

(3) Count the value of the cells in the survey area around a specific cell. Generate a new variable where the value of the cell is the sum of the values (either zero or one) on all the surrounding 559 cells. Suppose the cell is not commercial land, and 185 commercial cells are found in the survey area. The value "0" is replaced by "185." The area of a cell is 225 m^2 (15m x 15m). The area of a survey area is 125,664 m^2 or 31.05 acres (πr^2 = 3.1416 x 200m x 200m), and it contains 559 cells (125,664m^2 / 225m^2). Repeat the same operation with all the 250,000 cells. Any cells with missing data values must be excluded from the computation.

(4) Calculate the percentage of commercial land in a survey area. Load the center cell with the value. If there are 185 commercial land cells in the survey area around a cell, the value of the cell is "33%" (185cells / 559cells). Set a classification with appropriate colors, and color the center cell accordingly. The specific cell mentioned above becomes dark red, based on the classification given in Fig. 3-1-3. A grid cell colored dark red indicates that more than 33% of the land within a 200m radius from the cell is allocated for commercial purposes. In other words, more than 10.25 acres out of 31.05 acres is used for commercial purposes. Repeat the same operation with all the 250,000 cells.

3-1-3. Merits

Fig. 3-1-3 is the result of the above processing. The rest of the maps in Chapter 3 and 4 are formulated with the same or a similar method. Maps created with this concept and methodology are called "**Socioeconomic Topography**" hereafter. The socioeconomic topography may help us to grasp economic situations more precisely than maps generated by the conventional methods. It is more precise in the following ways:

(1) Areas are clearly defined with color or contour lines.

With a conventional map, one may say "Land value around this neighborhood is rather so and so." And with a socioeconomic topography one may say "land value of this pink colored area is so and so."

(2) Phenomena are measured and stated in figures.

With a socioeconomic topography one may say,

"Commercial land allocation in this pink is between 20% and 33%";

"Land value beyond this contour line is more than $8 per square feet";

"Business variation in this green area is just between one and three";

"This red area is very convenient, because more than nine services that are essential to daily life are within walking distance."

"More than three firms in the consulting service industry are within 1/4 mile range from this brown area.

(3) It shows result of a statistic calculation.

Socioeconomic topography consists of hundreds of thousands of grid cells, and each of them is assigned a value of statistical calculation. The latest GIS software (Arcview with Spatial Analyst Extension) is provided with a "Neighborhood Statistics" function. The neighborhood can be set as any size circle or rectangle. Calculation can be selected from minimum, maximum, mean, median, sum, range, standard deviation, majority, minority, and variety. "Calculate the median of land value around a grid cell within 200m radius circle" is an example of such a selection. If the original value of the cell is $15/square foot but neighboring cells tend to be higher, then the computed new value might be $18/square foot. This value is an attribute of the neighborhood around the center cell. This function of statistic calculation could reveal urban characteristics which could not be shown with conventional maps.

These merits are discussed and interpreted in the following sections.
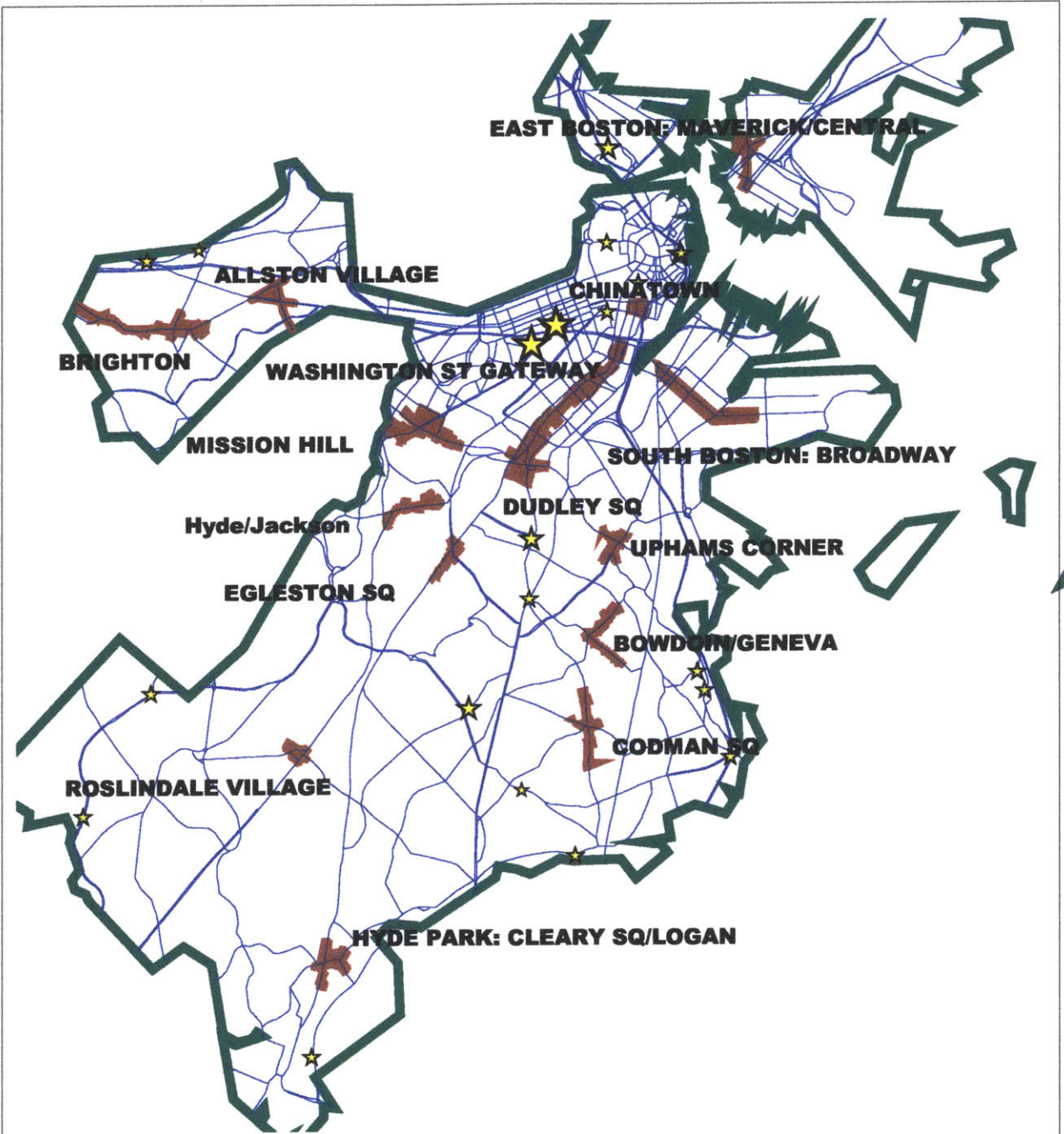
Fig. 3-1-1
Shopping Strips and Shopping Centers

Shopping Centers

★ Regional Mall

★ Community Center

★ Neighborhood Center

★ Retail

/\/ Major Streets

■ Main Street Program Districts

▭ Boston Boundary

0   1   2   3 Miles

N

Map labels:
EAST BOSTON: MAVERICK/CENTRAL
ALLSTON VILLAGE
CHINATOWN
BRIGHTON
WASHINGTON ST GATEWAY
MISSION HILL
SOUTH BOSTON: BROADWAY
DUDLEY SQ
Hyde/Jackson
UPHAMS CORNER
EGLESTON SQ
BOWDOIN/GENEVA
CODMAN SQ
ROSLINDALE VILLAGE
HYDE PARK: CLEARY SQ/LOGAN

SOCIOECONOMIC TOPOGRAPHY
Inner City Economic Development and Geographic Information Systems
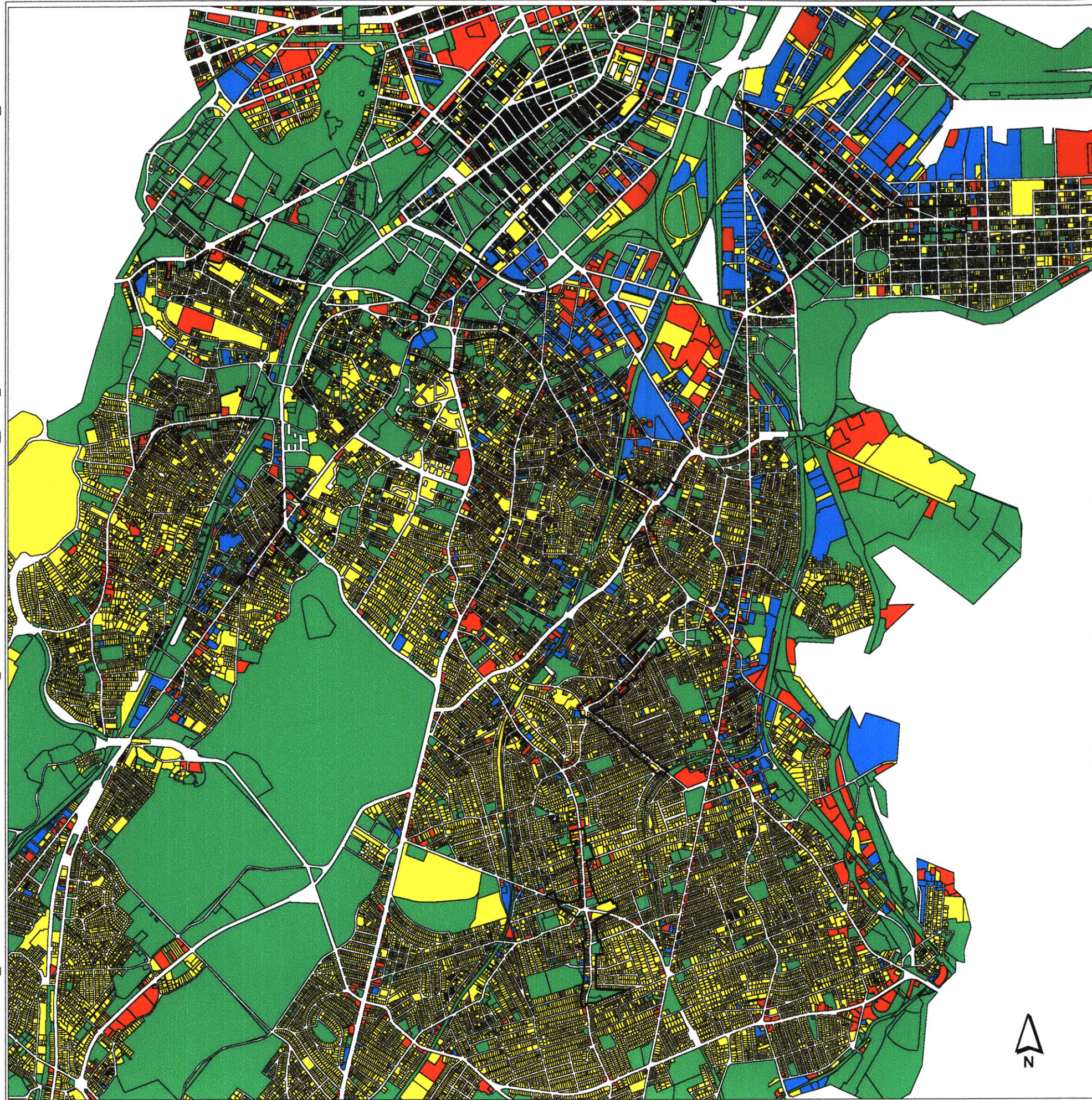
Fig. 3-1-2
Categorized Land Use

Legend

☐ Main Street Districts

Land Use Category
- 🟥 Commercial
- 🟦 Industrial
- 🟩 Tax Exempt
- 🟨 Residential

0 0.2 0.4 0.6 0.8 1 Kilometers

0 0.2 0.4 0.6 0.8 1 Miles

Data Source:
Assessors Office, Boston City Government '96

WASHINGTON ST GATEWAY
MISSION HILL
Hyde/Jackson
DUDLEY SQ
SOUTH BOSTON: BROADWAY
UPHAMS CORNER
BOWDOIN/GENEVA
EGLESTON SQ
CODMAN SQ
Study Area

N

CRL
Computer Resource Lab
Department of Urban Studies and Planning
Massachusetts Institute of Technology
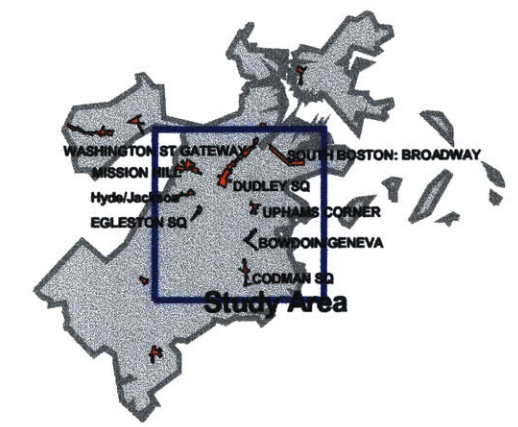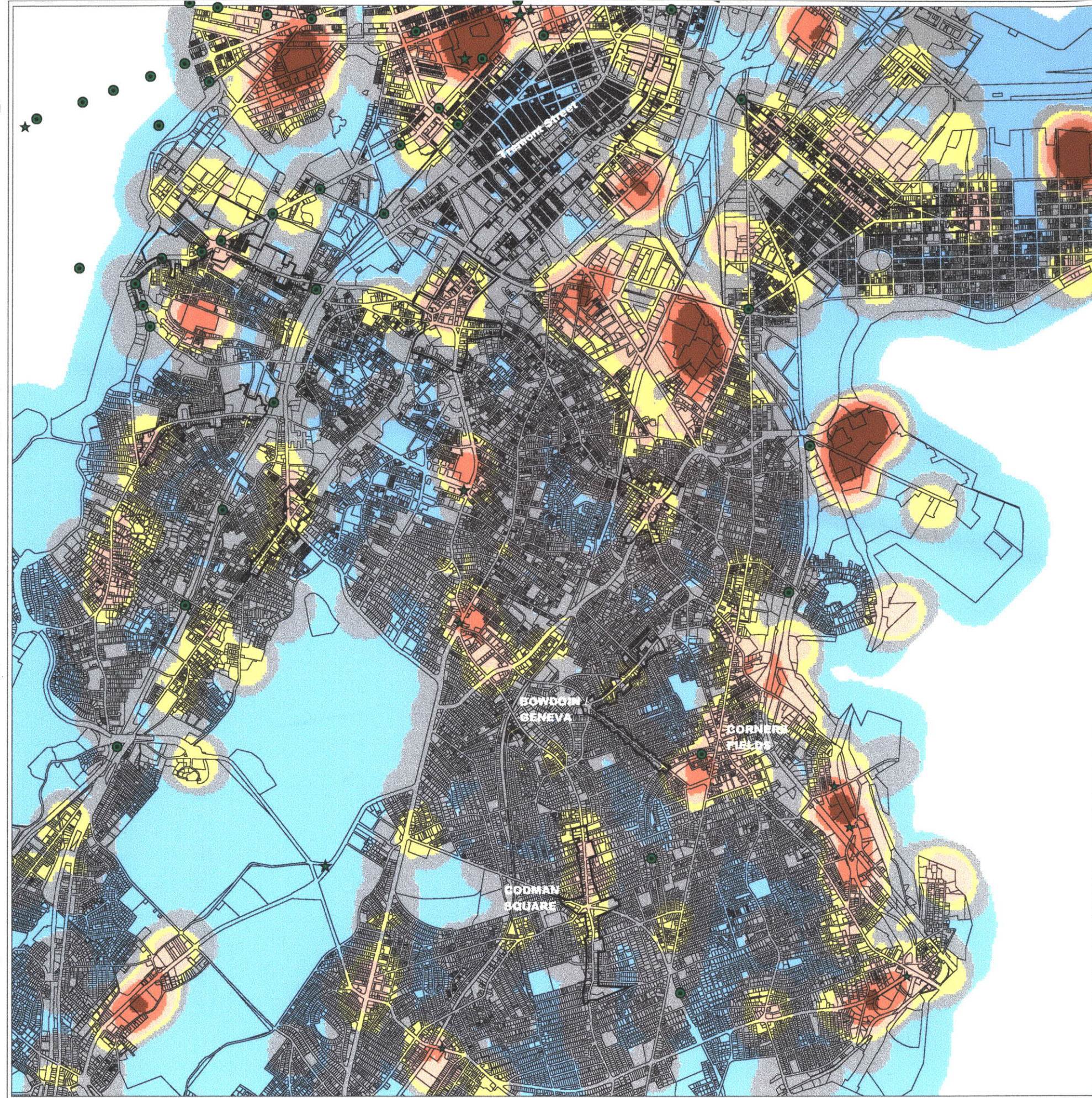
Fig. 3-1-3
Commercial Land Allocation

Legend

☐ Main Street Program Districts
● T stops
Shopping Centers
★ Regional Mall
★ Community Center
★ Neighborhood Center
★ Retail
Commercial Land Allocation

- 0 %
- 0 - 5 %
- 5 - 10 %
- 10 - 20 %
- 20 - 33 %
- 33 - 75%
- No Data
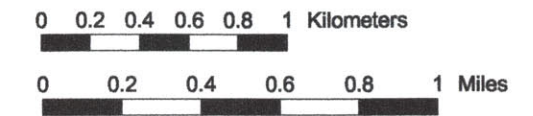
0 0.2 0.4 0.6 0.8 1 Kilometers

0   0.2   0.4   0.6   0.8   1 Miles

Mapping Data:
Grid Cell Size:15m x 15m (50feet x 50feet)
Detection Area:Circle with 200m (1/8miles) Radius

Value of Grid Cells:
Percentage of commercial land area
within each detection range

Data Source:
Assessors Office, Boston City Government '96
Difinition of commercial land:
land categolized as "C", "CL" or "CC"
by the State Land Use Classification.
(See Appendix 6-2)

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Department of Urban Studies and Planning
Massachusetts Institute of Technology
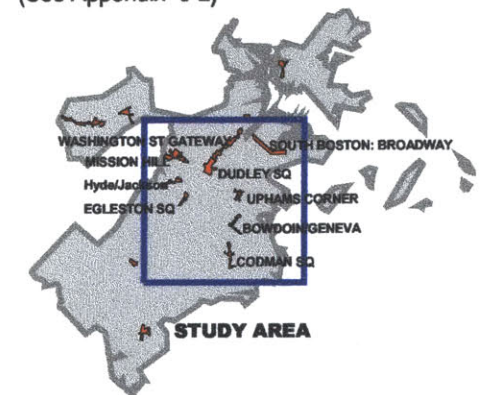
3-2. Land Allocation

3-2-1 Idea and Procedure of Mapping

The ratio of business land allocation within a given area can be an indicator of how active the businesses in the area are. If we pick a point in a residential area, we may observe very little land allocated for business use around the point. On the other hand, if the observation point is set in a busy business zone, we may observe that a large percent of the land around the point is used for business activities.

Business includes not only commercial activities but also industrial and service activities. The state land classification system categorizes the land uses into four major groups: residential, commercial (includes service industries), industrial and tax-exempt land. Information about tax-exempt land is important, because trading of these parcels is not expected; hence, the assessor's office less focussed on accurate land uses classification and evaluation of these parcels. Tax-exempt parcels in built environments may indicate the presence of different activities from businesses, such as religion (churches), education (schools), medical care (hospitals), and other not-for-profit efforts.

Fig. 3-2-1-1 and Fig. 3-2-1-2 are maps of industrial land allocation and tax-exempt land distribution respectively, with the same mapping concept of Fig. 3-1-3. These three maps tell us the general land use patterns in the Boston inner city.

3-2-2 Result and Discussion

No significant commercial land allocations are observed in the shopping strips or Main Street Program Areas in Fig. 3-1-3. This may be because commercial activities are "only skin deep" in the shopping strips. Just one row of parcels is allocated for commercial activities in traditional shopping strips. Behind the skin of shops are residential zones, which are service areas of the shops. Then what kind of area becomes red in this map, where there is much land allocation for commercial purposes? Big parcels used for commercial activities, such as shopping centers, are factors of big commercial land allocations. In this map, locations of shopping centers match the red areas.

Another reason why the neighborhood shopping streets are not distinctive on Fig. 3-1-3 is just that the color classification is not designed appropriately. Red is assigned for the grid cells around which more than 33% of commercial land allocation is counted in Fig. 3-1-3. This assignment can be changed as we like.

Is 200m (1/8 mile) too big for the survey range, because shopping activities are only skin deep? Can more business land allocation be found along the shopping strips, if the survey range is changed to a 100m radius (110 yards) circle? Or does the presence of the neighborhood shopping strips become clear with a change of the classification?

Fig. 3-2-2 is made to answer these questions. The survey ranges are circles of 100m radius, and red is assigned to an even lower percentage of commercial land allocation, as low as 17.5%. Quantile is employed for this change of classification. The appearance of Fig. 3-2-2 is much different from that of Fig. 3-1-3. Most of the yellow areas on Fig. 3-1-3 have become red on Fig. 3-2-2, and participating districts of the Boston Main Streets Program can be identified as commercial areas. The difference between the two maps is mainly attributed to the change of classification, and the reduction of the radius from 200m to 100m does not make a significant contribution to the change on the map. There can be another method to detect the presence of linear processions of commercial lands using the street network rather than just employing geometric calculations like this study. This topic is beyond the scope of this thesis but warrants further work.

The industrial land allocation in Fig. 3-2-1-1 shows different spatial distributions from the commercial land allocation. Manufacturing industries may need bigger parcels for their operations
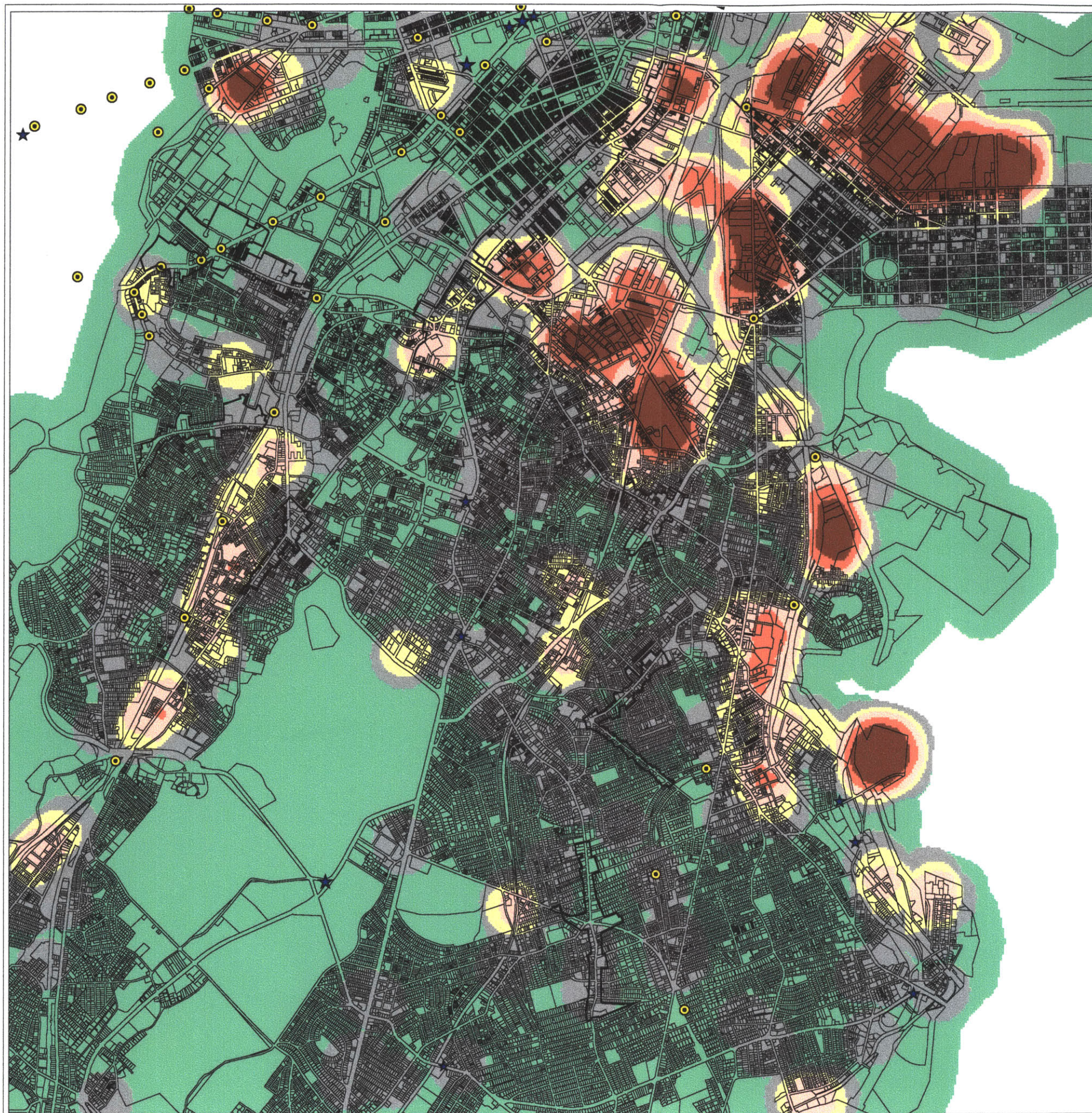
Fig. 3-2-1-1
Industrial Land Allocation

Legends

☐ Main Street Program Districts
⊙ T stops

Shopping Centers

★ Regional Mall
★ Community Center
★ Neighborhood Center
★ Retail

Industrial Land Allocation

- 0 %
- 0 - 5 %
- 5 - 10%
- 10 - 20 %
- 20 - 33 %
- 33 - 91%
- No Data

```
0  0.2 0.4 0.6 0.8  1  Kilometers
0     0.2   0.4   0.6   0.8   1  Miles
```
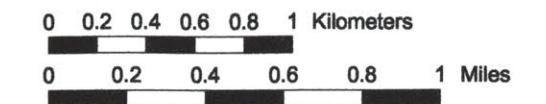
Data Source:
Assessor's Office '96, City of Boston
Diffinition of Industrial Land:
Land categorized as "I" by the State
Land Use Classification. (See Appendix 6-2)

Mapping Data
Value: Percentage of industrial land area within
each detection range
Grid Cell Size: 15m x 15m (50feet x 50 feet)
Detection Range: Circle with 200m (1/8miles) radius

Value of Grid Cells:
Percentage of commercial land area
within each detection range

WASHINGTON ST GATEWAY
MISSION HILL
Hyde/Jackson
EGLESTON SQ
SOUTH BOSTON: BROADWAY
DUDLEY SQ
UPHAMS CORNER
BOWDOIN/GENEVA
CODMAN SQ

Study Area

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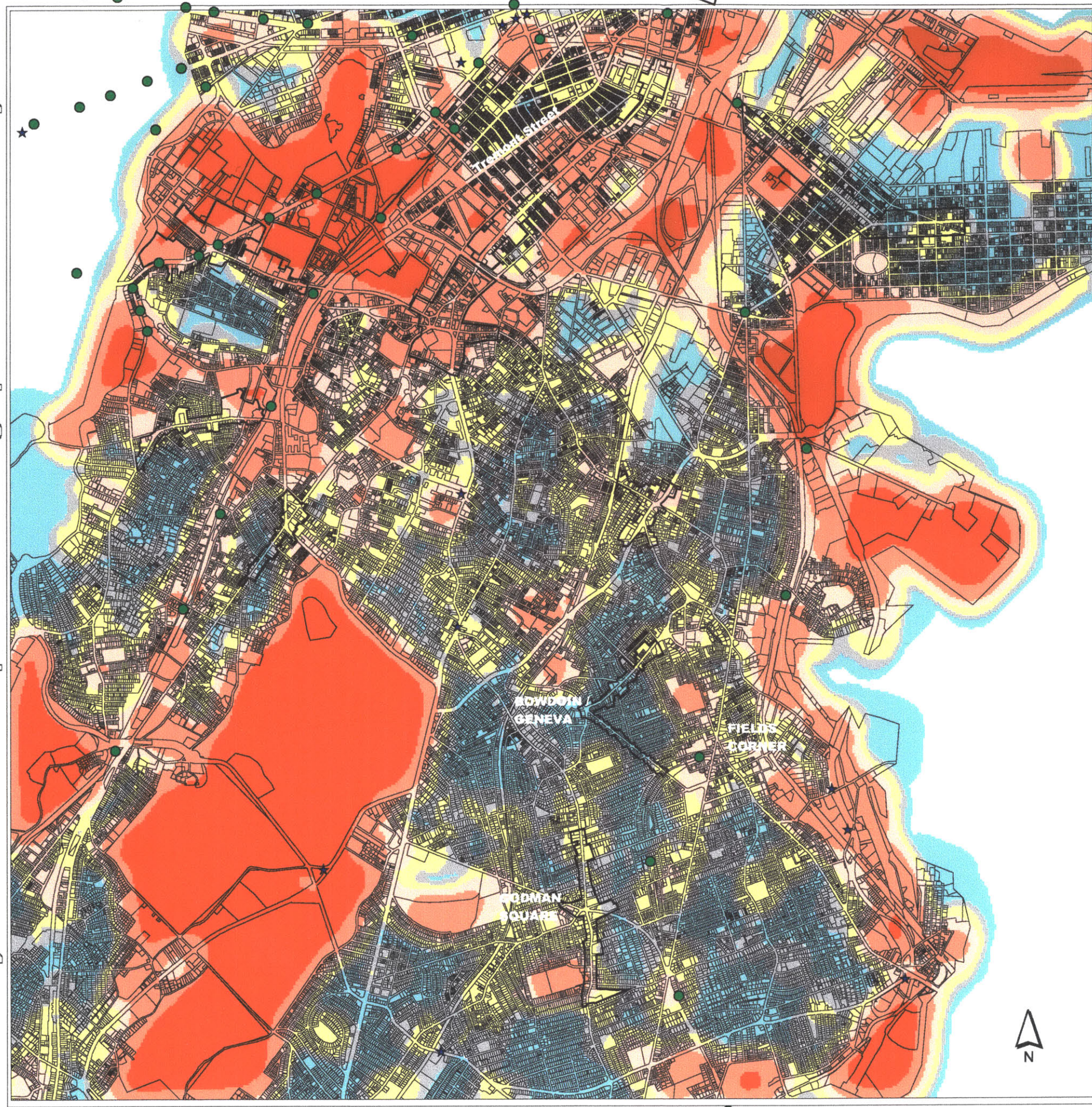
Fig. 3-2-1-2
Tax-Exempt Land Distribution

Legend

- ● T stops
- ★ Shopping Centers
- ▭ Main Street Program Districts

Tax Exempt Lanf Distribution

- 0 - 5%
- 5 - 10%
- 10 - 20%
- 20 - 33%
- 33 - 99%
- 100%
- No Data
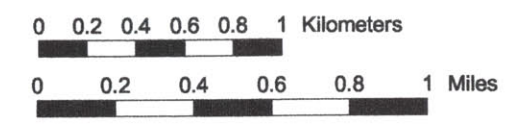
0 0.2 0.4 0.6 0.8 1 Kilometers

0 0.2 0.4 0.6 0.8 1 Miles

Mapping Data
Grid Size: 15m x 15m (50feet X 50feet)
Detection range: Circle with 200m (1/8miles) Radius

Value of cells:
Percentage of tax-exempt land
area within the detection range

Data Source:
Assessors Office, Boston City Government '96

Difinition of Tax exempt land:
Land with landuse "E" in the table of
State Land Use Classification
(See Appendix 6-2)
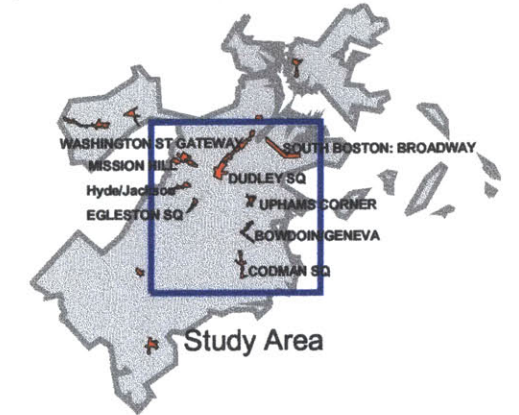
Study Area

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Massachusetts Institute of Technology

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Inner City Economic Development and Geographic Information Systems
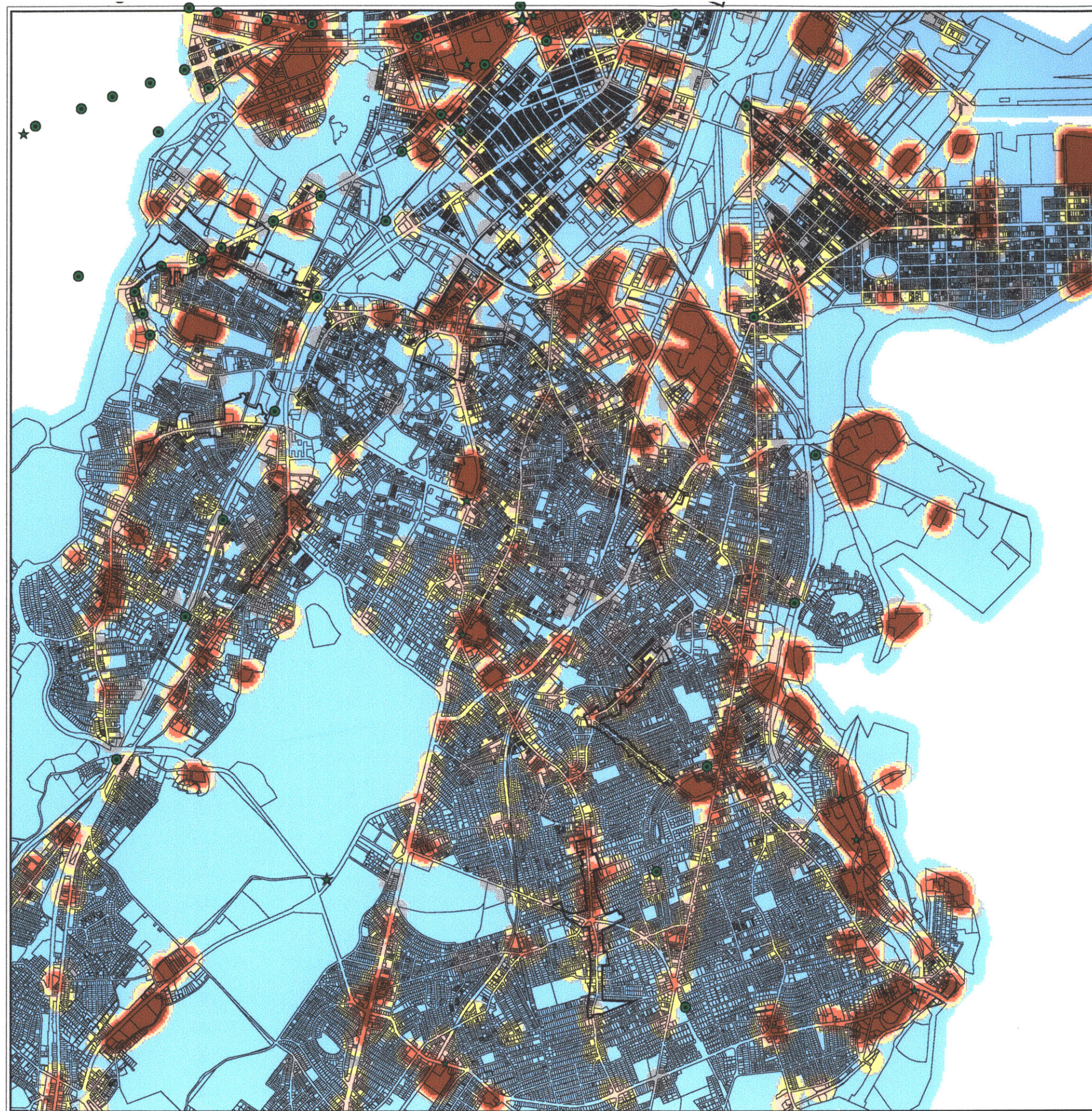
Fig. 3-2-2
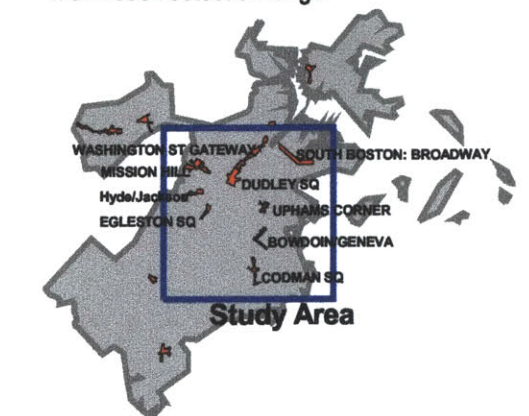**Commercial Land Allocation**
(within circles of 100m radius)

Legend
- ☐ Main Street Program Districts
- ● T stops

Shopping Centers
- ★ Regional Mall
- ★ Community Center
- ★ Neighborhood Center
- ★ Retail

Commercial land Allocation
- 0 %
- 0 - 2.1 %
- 2.1 - 4.9 %
- 4.9 - 9.1 %
- 9.1 - 17.5 %
- 17.5 - 80.9 %
- No Data

0 0.2 0.4 0.6 0.8 1 Kilometers

0 0.2 0.4 0.6 0.8 1 Miles
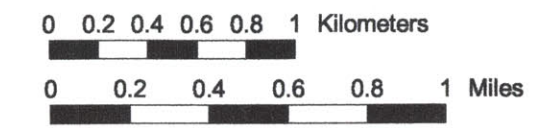
Mapping Data:
Grid Cell Size:15m x 15m (50feet x 50feet)
Detection Area:Circle of 100m (110 yars) Radius

Value of Grid Cells:
Percentage of commercial land area
within each detection range

Data Source:
Assessors Office, Boston City Government '96
Difinition of commercial land:
land categolized as "C", "CL" or "CC"
by the State Land Use Classification.
(See Appendix 6-2)

WASHINGTON ST:GATEWAY   SOUTH BOSTON: BROADWAY
MISSION HILL   DUDLEY SQ
Hyde/Jackson   UPHAMS CORNER
EGLESTON SQ   BOWDOIN/GENEVA
    CODMAN SQ

STUDY AREA

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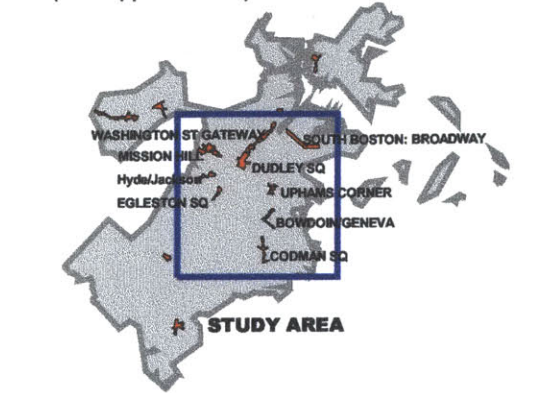
3-3. Land value

3-3-1. Idea and Procedure of Mapping

Real estate value may have some correlation with business activities. Purchasing land for business is an investment and a piece of land that makes more profit becomes more expensive. Land allocated for business purposes may bear higher return in comparison with land allocated for residential or public purposes. Also we expect some correlation between the locations of successful shopping strips and high-income neighborhoods, where presumably land value is high.

Fig. 3-3-1 shows the median land value within a 200m radius from each grid cell. The number of grid cells in the map is 530 x 530 = 280,900. The computer calculated the median land values around each grid cell, and colored the center cell according to the classification given in the legend of the map. Areas, which are not defined as parcels (such as roads, sea, and the other local government territories), as well as zero-value parcels and tax-exempt lands (those allocated for Not-for-Profit activities) are ignored with this median calculation. Even though tax-exempt land parcels have assessed value, they are not trustworthy. This map is the result of 280,000 repetitions of the calculations. A grid cell colored dark red means the total land value within a 200m radius from the grid is more than $20 / square foot.

3-3-2. Result and Discussion

The first finding with this map is that land value in the Boston inner city has very little to do with commercial activities, accessibility to main roads and T (subway) stations. Patterns found in Fig. 3-1-3 and Fig.3-3-1 give us no clear correlation. Some of the residential areas in the inner city are more expensive in their value than commercial strips. If the dominant factor of inner city land value is not economic activity, what can it be?

Fig. 3-3-2 shows a combination of median household income and land value contour lines. This map tells us that income of residents is more correlated to land value than the public transportation and business activities in the Boston inner city. Some interviewees from the Main Street Program Areas mentioned

that these rich residents drive out to the outer shopping malls and seldom shop at local shops. The residents in these high-income and high-land-value residential areas can be targets of sales promotions of the local shopping strips.

SOCIOECONOMIC TOPOGRAPHY
Inner City Economic Development and Geographic Information Systems
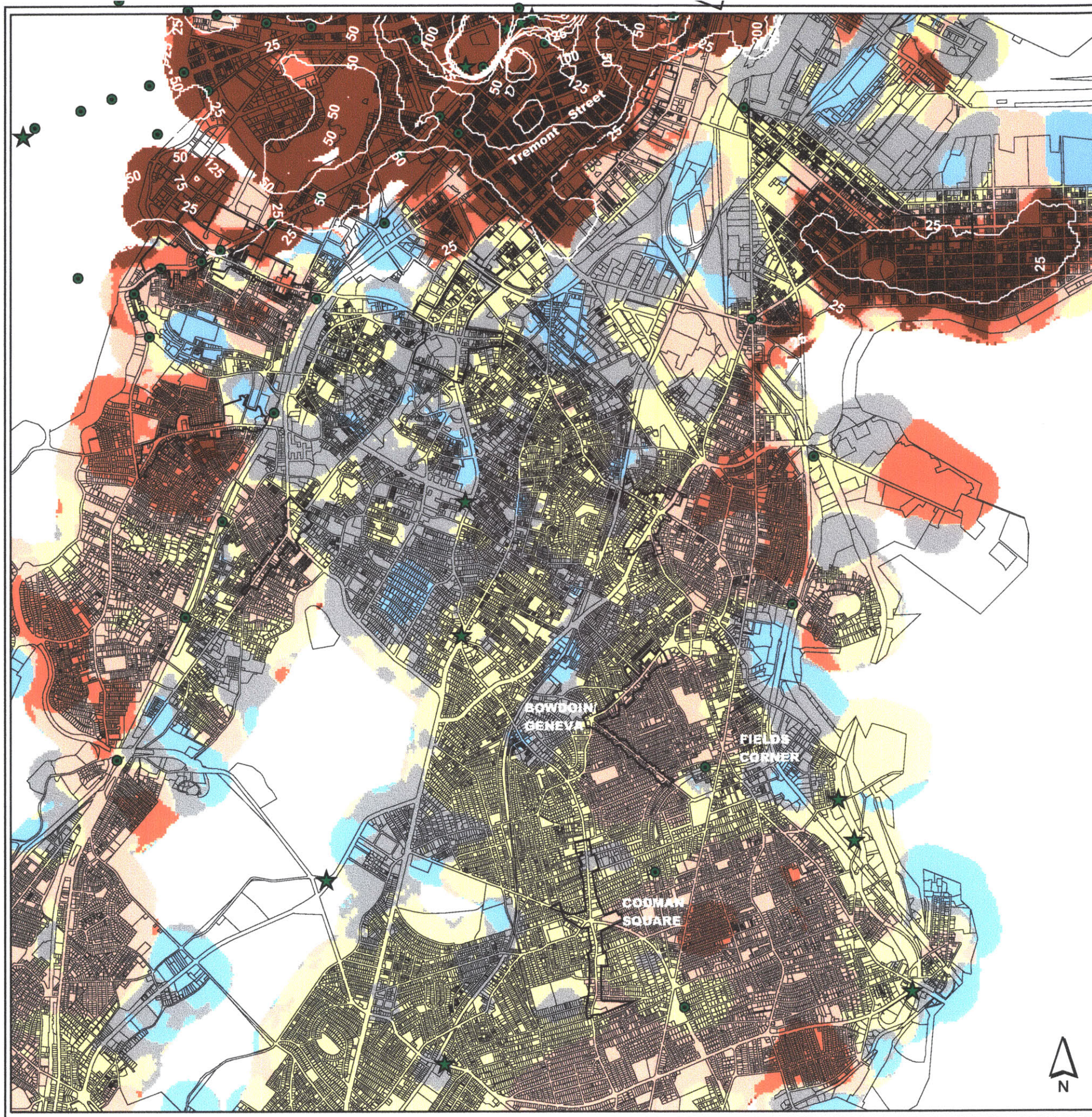
Fig. 3- 3-1
Land Value

Legend
▢ Main Street Program Districts
╱ Contours of Land Value
● T stops
★ Shopping Centers

Land Value (US$/square foot)
▢ 1 - 4
▢ 5 - 6
▢ 7 - 9
▢ 10 - 14
▢ 15 - 19
▢ 20 - 201
▢ No Data

0 0.2 0.4 0.6 0.8 1 Kilometers

0   0.2   0.4   0.6   0.8   1 Miles

Data Source:
City of Boston
Assessor's Office Parcel Data '96

Value of Grid Cells:
Median land value within
each detection range

Mapping Data
Grid Size: 15m x 15m (50feet X 50feet)
Detection Area: Circle with 200m (1/8miles) Radius
Caluculation: Median of Unit Land Value
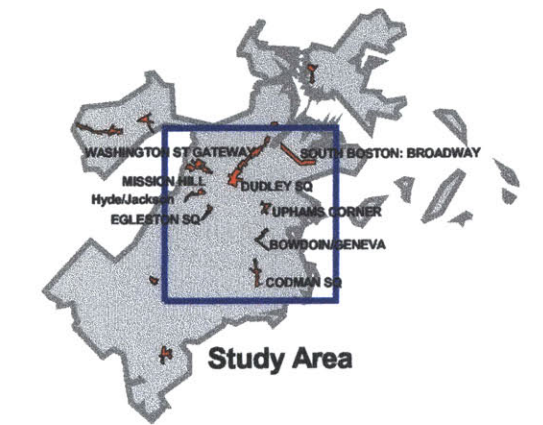
Study Area

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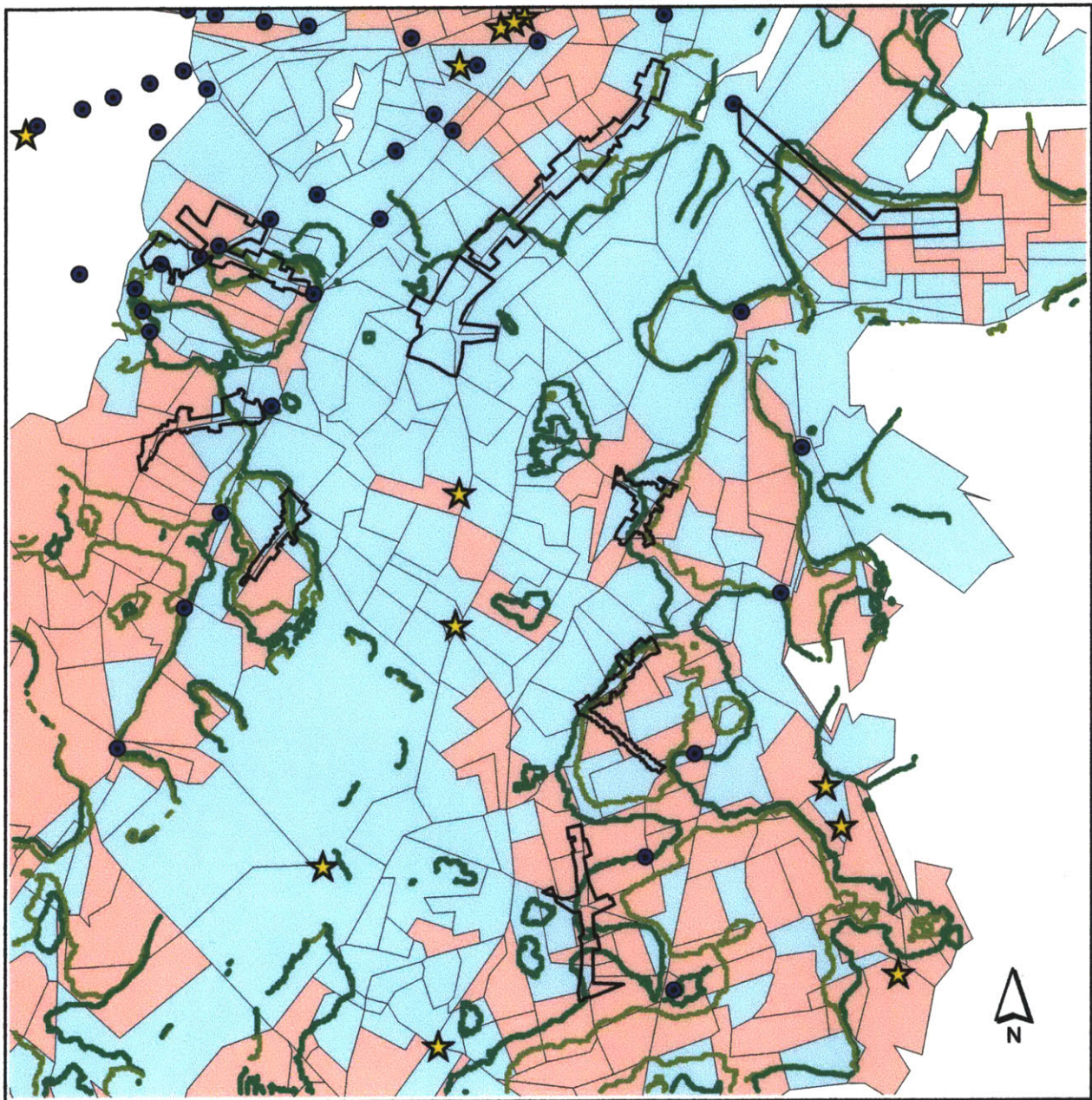
Fig. 3-3-2
**Median Household Income
and Land Value**

Main Street Program Districts
● T stops

Contours of Land Value (US$/square foot)
⋀ $7/ Sq.foot
⋀ $9 / Sq.foot
★ Shopping Centers

Median Household Income

lass than $30,000
more than $30000
by Census Block Group

Data Source:
-City of Boston
 Assessor's Office Parcel Data '96
-Census 1990

WASHINGTON ST GATEWAY   SOUTH BOSTON: BROADWAY
MISSION HILL   DUDLEY SQ
Hyde/Jackson
EGLESTON SQ.   UPHAMS CORNER
                         BOWDOIN GENEVA
                         CODMAN SQ

STUDY AREA

0 0.2 0.4 0.6 0.8 1 Miles
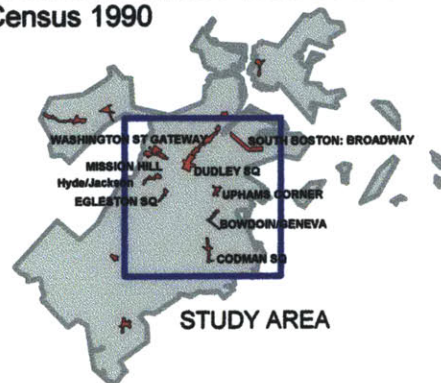
3-4 Number of Businesses

3-4-1 Idea and Procedure of Mapping

A business district is an area where many shops and business firms are located. So the most common way of finding business districts by GIS may be to count the number of businesses in a given range. Can we count the number of businesses by using the parcel data from the Boston City Assessor's office? It may be difficult, because the data does not include the number of businesses. Instead, we can count the number of parcels allocated for commercial purposes in specifically defined areas, such as circles of a 200m (1/8miles) radius from each grid cell. The number of commercial land parcels cannot be identified as the number of businesses. Potential errors are, (1) a commercial parcel may accommodate more than one business, (2) a business firm may occupy more than one commercial parcel, and (3) not only the commercial parcels contain businesses.

Fig. 3-4-1 shows the number of parcels used for commercial purposes. To create this map, (1) Assign each commercial land parcel a unique identifier, (2) Define the detection areas as circles of a 200m (1/8miles) radius from each grid cell, and (3) Count the "variations" of the cell values in the detection area. This operation gives us the "number" of the commercial land parcels, because grid cells that represent an original parcel have the same unique identifier. If ten variations of identifiers are found in a detection area, it means there are ten commercial land parcels in the area.

3-4-2 Results and Discussion

This map (Fig. 3-4-1) indicates very rough distribution of commercial lands, and many of the Boston Main Streets Program districts are illuminated in yellow, pink, or red. Some program districts contain many residential parcels, and these parts of the districts are easily perceived with this map. However, as is mentioned above, this map might have many errors.

The next map (Fig. 3-4-2) has been processed with the same idea and method, but from a different data source, i.e., Yellow Page Compact Disc. More

than 9,200 business firms are plotted (this operation is called "geocoding" in GIS) on this map to find the number businesses within the neighborhoods. This data is free from the classification of land parcels, and includes all businesses located in the same parcel and businesses housed in all categories of lands. Many more businesses are observed in Fig. 3-4-2 than in Fig. 3-4-1, however, general patterns are identical for these two maps. This means the Boston City assessor understands well the business activities in the city territory and classifies the land accordingly.

The business variation around Tremont Street is among a few exceptions that do not follow the similarity of the two maps. While Fig. 3-4-1 indicates few business variations in the Tremont Street area, Fig. 3-4-2 tells that there are numerous businesses in the same area. There is less land allocated for commercial activities in this area according to Fig. 3-1-3. On the other hand, Fig. 3-3-1 illustrates very high land value of the area. Can a reasonable explanation be extracted from this information?

This area is called the South End and in the process of rapid gentrification. The accessibility to the regional shopping centers in the Back Bay area as well as to subway stations is very good. The South End is a famous historic preservation area, and the neighborhood has a taste of history. Buildings in this area look like a combination of shops on the ground floor with apartments on the upper floors. Even though very energetic business activities are detected here, for some reason, the Boston City Assessor categorizes the parcels here as residential land.

SOCIOECONOMIC TOPOGRAPHY

Inner City Economic Development and Geographic Information Systems
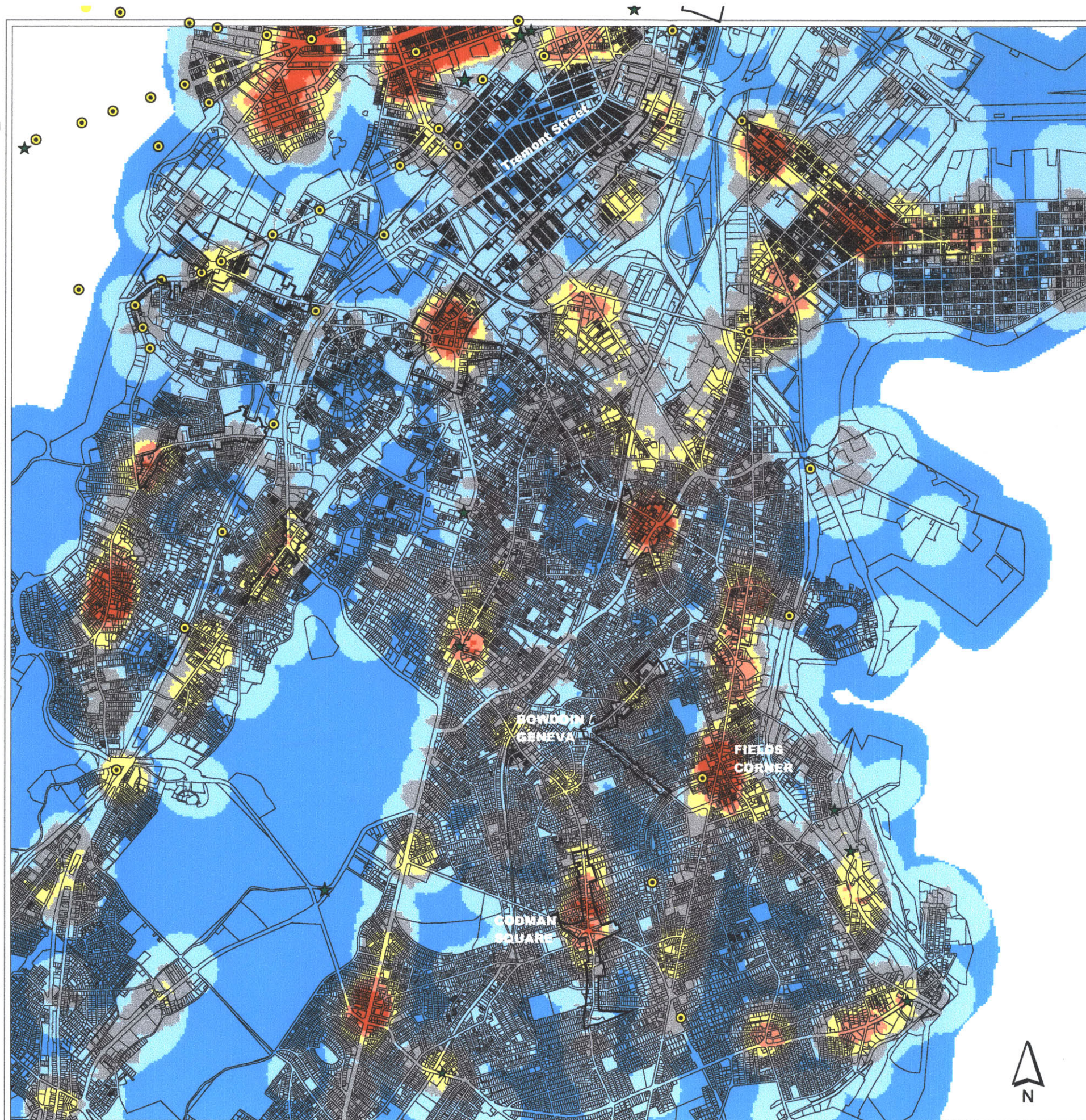
Fig. 3-4-1
Number of Parcels Used
for Commercial Purposes

Legend

□ Main Street Program Districts
Shopping Centers
★ Regional Mall
★ Community Center
★ Neighborhood Center
★ Retail
⊙ T stops
Number of Parcels
■ 0
■ 1 - 4
■ 5 - 9
■ 10 - 14
■ 15 - 19
■ 20 - 52

0 0.2 0.4 0.6 0.8 1 Kilometers

0   0.2   0.4   0.6   0.8   1 Miles
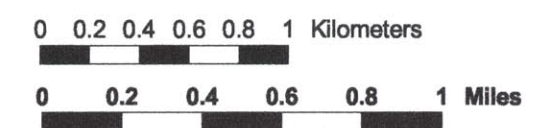
Data Source:
City of Boston
Assessor's Office Parcel Data '96

Value of Grid Cells:
Number of commercial parcels
by state land use classification
within each detection range.

Mapping Data:
Grid size: 15m x 15m (50feet x x50feet)
Detection Area: Circle with 200m (1/8miles) radius

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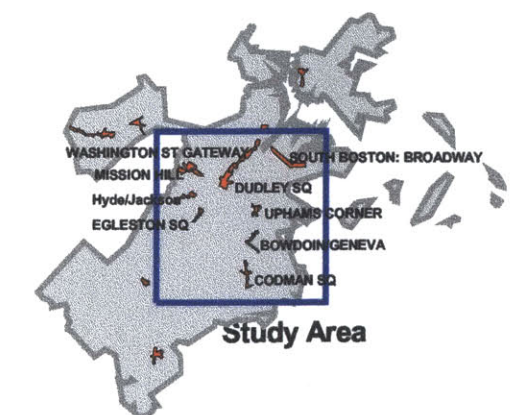
SOCIOECONOMIC TOPOGRAPHY
Inner City Economic Development and Geographic Information Systems

Fig. 3-4-2
Number of Business Firms
by SIC Code
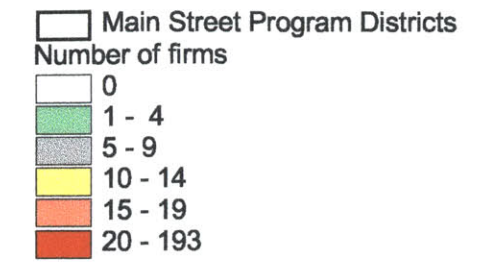
☐ Main Street Program Districts
Number of firms
☐ 0
☐ 1 - 4
☐ 5 - 9
☐ 10 - 14
☐ 15 - 19
☐ 20 - 193

0 0.2 0.4 0.6 0.8 1 Kilometers

0   0.2   0.4   0.6   0.8   1 Miles

Mapping Data:
Grid Cell Size: 15m x 15m (50feet x x50feet)
Detection Range: Circle with 200m (1/8miles)
                 radius
Value: Number of Business Firms
       within each detection range
Data Source: State Business Directory
              (CD Yellow Pages)
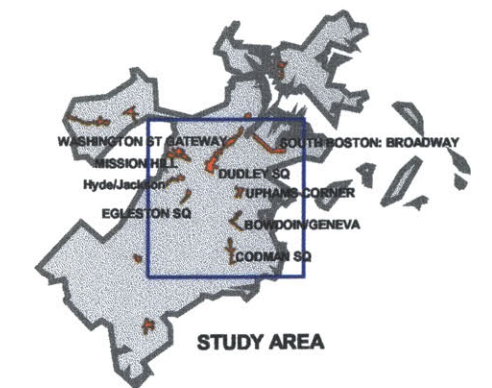
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3-5. Business Variation Counts

3-5-1 Idea and Procedure of Mapping

Commercial activities or shopping strips can be defined by the variation of business types within a given range around a particular point. The inner city residents have a variety of demands for retail and services. If the business variation of an area is bigger, there may be a better business mix in the area and more people will go there. A consumer has a tendency to minimize a trip distance for shopping, and a good business mix in a shopping strip may reduce this distance. So presumably an area with higher business variation counts is a busy place with people who are visiting more than one business in the area. The area has multiple service functions for the neighborhood.

Fig. 3-5-1 shows the variation counts of commercial land use within a 200m radius around each grid cell. Again, this map is the result of 280,000 observations from the center grid cells. A grid cell colored red indicates that there are more than ten variations of business activities within a 200m radius. The meanings of the other colors are given in the legend of the map. If the same classification for the other maps (Fig. 3-4-1. Fig. 3-4-2, and Fig. 3-5-2) is applied to this map, it would look bland and no significant differences are found among neighborhoods.

3-5-2. Result and Discussion

This map (Fig. 3-5-1) may help us to know urban nodes that people visit for various purposes. A decisive constraint of this map for business analysis is the attribution of data. The data source for this map is the Boston City Assessor's Office. And the state land use classification, which is the basis of this data, is not sufficient for economic analysis. For example, state land use classification No.325 is "retail store detached." So with this classification, the majority of shops in a shopping strip fall into the same category and ten different retail businesses make just one variation.

Fig. 3-5-2 is a map made from the other data source i.e. Yellow Page Compact Disc. More than 9,000 business firms are plotted (this operation is

called "geocoding" in GIS) in this map to find the business variation within survey areas. This map illustrates richer variations of business activities in the inner city in comparison to Fig. 3-5-1.

A comparison with Fig. 3-4-2 and Fig. 3-5-2 would draw an interesting discussion. Fig. 3-4-2 shows the "number" of businesses in the neighborhood and counts five barbershops as five. On the other hand, Fig. 3-5-2 illustrates the "variation" of businesses in the neighborhoods and counts five barbershops as one. Some areas are very red on Fig. 3-4-2 and not so red on Fig. 3-5-2. What does the difference between these two maps imply? What is happening in these areas? One interpretation is that concentration of the same kind of businesses into the areas. A concentration of the same industry facilitates the agglomeration economies, and implies the presence of leading industries. The agglomeration economies and leading industries are discussed and mapped later in Chapter 4.

SOCIOECONOMIC TOPOGRAPHY
Inner City Economic Development and Geographic Information Systems
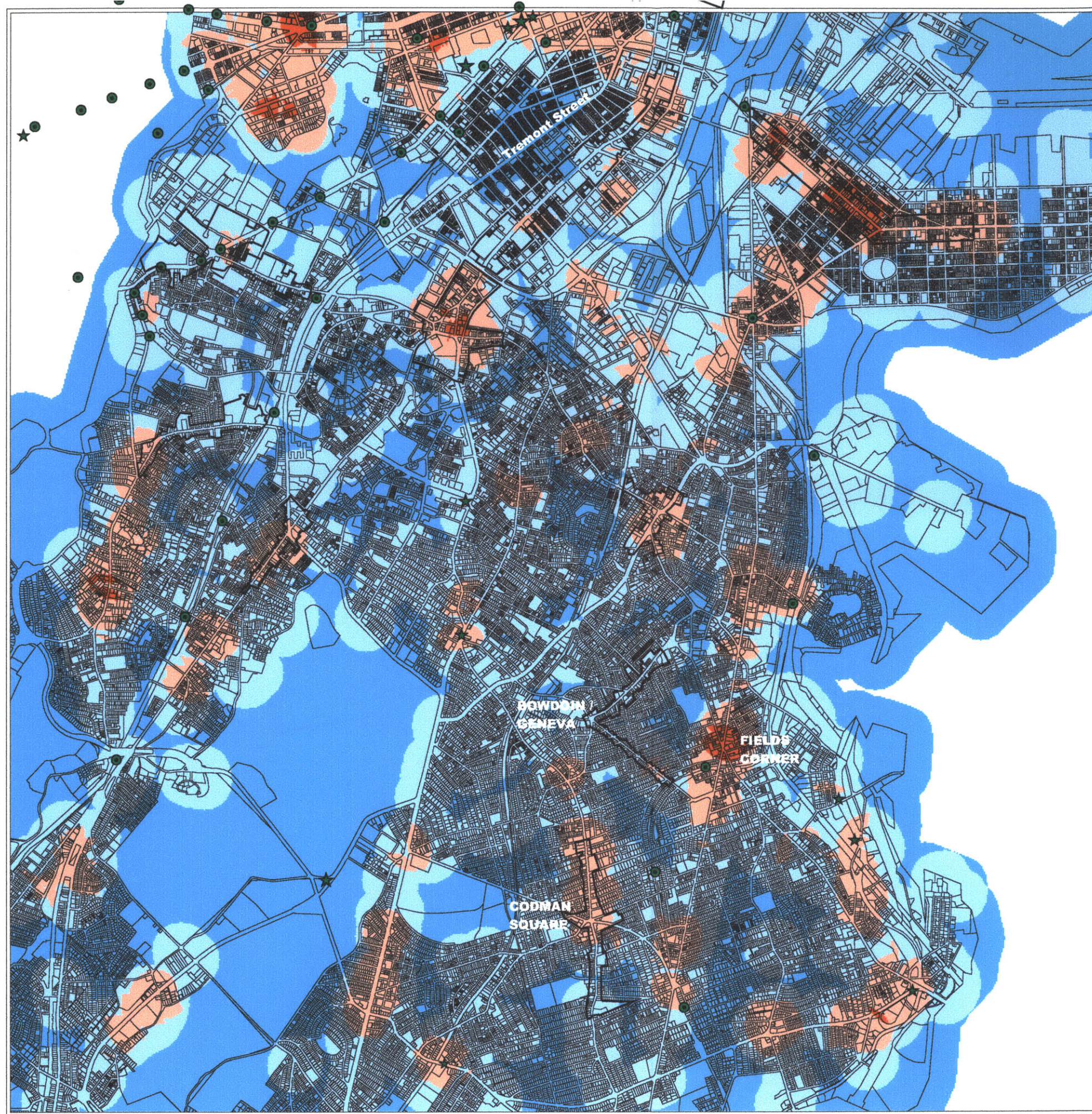
Fig. 3-5-1
Commercial Land Use Variation
by State Land Use Classification

Legend

☐ Main Street Program Districts
Shopping Centers
★ Regional Mall
★ Community Center
★ Neighborhood Center
★ Retail
● T stops
Commercial Land Use Variation
■ 0
■ 1 - 4
■ 5 - 9
■ 10 - 14
☐ (15 - 19) No Area
☐ (20 - 53) No Area

0 0.2 0.4 0.6 0.8 1 Kilometers

0   0.2   0.4   0.6   0.8   1 Miles

Data Source:
City of Boston
Assessor's Office Parcel Data '96

Value of Grid Cells:
Variation count of commercial
land use variation
by state land use classification
within each detection range.

Mapping Data:
Grid size: 15m x 15m (50feet x x50feet)
Detection Area: Circle with 200m (1/8miles) radius

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Labels on map:
Tremont Street
BOWDOIN / GENEVA
FIELDS CORNER
CODMAN SQUARE

Inset map labels:
WASHINGTON ST GATEWAY
MISSION HILL
Hyde/Jackson
EGLESTON SQ
DUDLEY SQ
UPHAMS CORNER
BOWDOIN GENEVA
CODMAN SQ
SOUTH BOSTON: BROADWAY
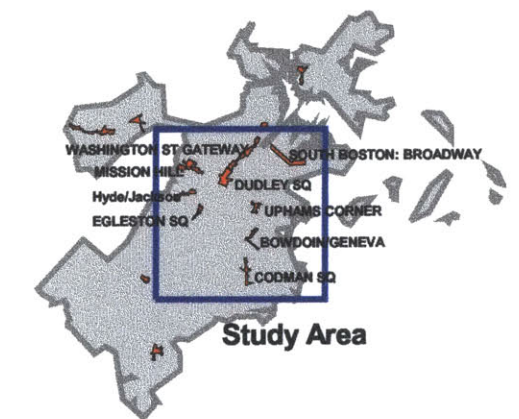
SOCIOECONOMIC TOPOGRAPHY

Inner City Economic Development and Geographic Information Systems
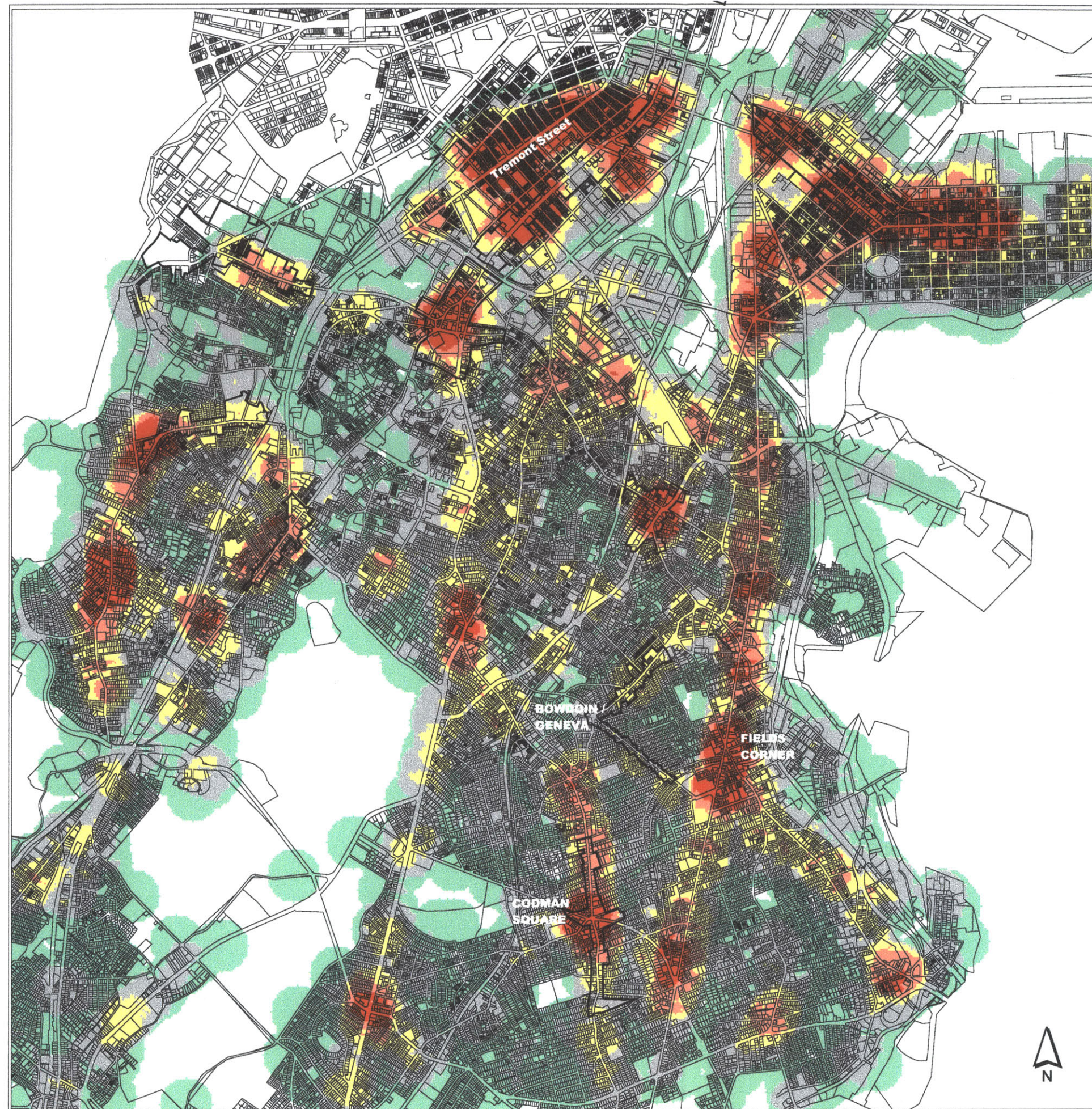
Fig. 3-5-2
Business Variation by SIC Code

Legend

☐ Main Street Program Districts
Business Variation Counts
☐ 0 or No Data
☐ 1 - 4
☐ 5 - 9
☐ 10 - 14
☐ 15 - 19
☐ 20 - 36
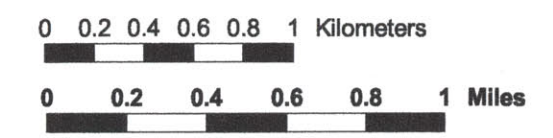
0 0.2 0.4 0.6 0.8 1 Kilometers

0   0.2   0.4   0.6   0.8   1 Miles

Mapping Data:
Grid Cell Size: 15m x 15m (50feet x x50feet)
Detection Range: Circle with 200m (1/8miles)
                          radius
Value: Variation of Business by 3-digit SIC code

Data Source: State Business Directory (CD)
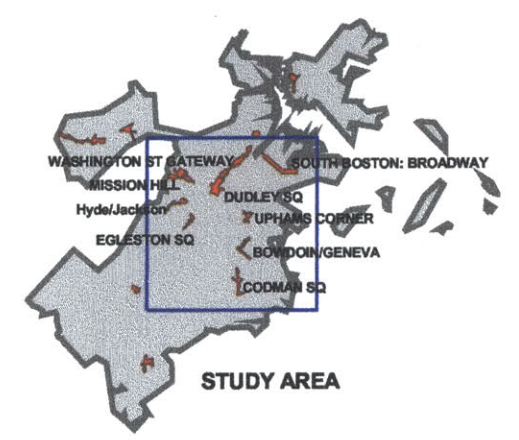
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4.

Neighborhood Convenience

and

Leading Industry Groups

As discussed in Section 2-4, there are two strategies to improve local businesses. They are (1) to fill the gap between local service demands and existing services, and (2) to develop or make linkages to the leading industries. This chapter focuses on how GIS socioeconomic topography can help us to understand the spatial distribution of neighborhood convenience and leading industries.

4-1. Service Clusters and Convenience of Neighborhoods

There are hundred thousands of people living densely in the study area, and thousands of businesses are operated in the same area. However, as we saw in the previous map (Fig. 3-4-2), businesses are not evenly distributed. This implies that some areas are more convenient than the others in terms of access to shops and services. In general, proximity to the local commercial zones means easy access to the necessary services. Nevertheless, inner city shopping strips are often missing essential businesses for daily life.

In the Roselindale[19] shopping area, where the Main Street Program started as early as in 1985, the absence of grocery stores has been keeping even the neighborhood residents away from the shopping strip. As an anchor, a grocery store of a certain scale is essential to a shopping strip for the convenience of the customers. A person needs to shop very often at a grocery store and feels well served if the other services are close to it. In corporation with the Boston City Government, the Roselindale Project focused on their effort to recruit this essential store into their area, and finally in 1997, they opened a grocery store which is really encouraging the whole retail and service situation in the shopping district.

In the Bowdoin / Geneva district, an another Main Street Program district, the most requested businesses to be added to the present portfolio are cloth and grocery[20]. Dissatisfaction of these essential businesses makes local consumers shop in another areas. There is a rival shopping strip named "Fields Corner" very closely located to the Bowdoin and Geneva district. This rival is along the Dorchester Avenue, a local main traffic artery, has a subway station, and lines up numerous variations of businesses, including cloth and grocery. A significant part of the local residents shop there, as well as South Bay Mall and Bradlees / Morissey Blvd, instead of the Bowdoin / Geneva shopping strip. This is a vicious

---

[19] Roselindale is one of the 15 Boston Main Streets Program Districts. However, it is out of the study area of this thesis. For the location, see the Fig. 3-1-1.

[20] McDermott/O'nell & Associates. (1995) Neighborhood Market Strategy, Study Area: Bowdoin Street / Geneva Avenue

circle. People do not shop at Bowdoin / Geneva partly because it does not offer good cloth and groceries, and investors do not want to open their shops there because they expect fewer customers. This circle should be eliminated by cooperative effort of the local merchants and agencies concerned. It may need a good collaboration among stakeholders of the shopping district and total backup from the local government. Roselindale district made it.

Neighborhood residents may be well aware of missing essential services of the area or convenience / inconvenience of the area in terms of access to necessary services. Then, how can a planner recognize the general convenience of the whole inner city? To recognize the gap between service demand and service available is the first step to improve the business mix of each shopping district and well serve the local residents.

However, accuracy of this analysis is totally depends on the data available. And businesses are not stable at any moment. Detailed field surveys are required for actual action plan to enrich the business mix of a shopping district.

4-1-1. Idea and Procedure of Mapping

With the following operation, we can make a map, which shows us areas where we cannot find essential shops and services within walking distance.

(1) Define by SIC a set of important businesses for the local people

(2) Assign SIC code to each grid cell based on the information from Yellow Pages Compact Disk

(3) Search by SIC these essential firms within 400m (1/4mils)-radius area from all the grids, which requires 250,000 times of searching.

(4) If most of the defined firms are found within the area, color the grid green.

(5) If few variations of firms are found within the area, color the grid red.

(6) Classify the number of variations and specify colors that match the classification.

How can we select essential businesses out of hundreds of variations? There can be thousands ways of choosing ten essential ten businesses out of

hundreds of business variations in the inner city. Based on the inner city household expenditure (Fig. 2-3-2) and research papers on Boston Main Streets Districts, the following 10 businesses are chosen by 3-digit SIC code. The listing order does not indicate any ranking of their importance.

- Food store   (SIC 541,542,543)
- Apparel shop   (SIC 561,562,565)
- Drug store   (SIC 591)
- Liquor shop   (SIC 592)
- Eating place   (SIC 581)
- Health service   (SIC 801, 806)
- Footwear shop   (SIC 566)
- Kitchenware and home furnishing shop   (SIC 571)
- Beauty or barber shop   (SIC 723,724)
- Commercial Bank   (SIC 602)

4-1-2. Result and Discussions

Fig. 4-1-2 is the map created using the above mentioned idea and service definition. The color gradation in the map shows shopping and service rating of each grid. Green areas are well-served and the red areas are under-served. Residential areas can be recognized from the road and parcel patterns in the map. When we see the residential areas on the map, there are a lot of red or pink areas overlaid on them. This illustrates that significant parts of the residential area in the Boston inner city are under-served with essential businesses. All the Main Street Program districts are associated with the light-green areas to some extend. The other light-green areas that are out of the program districts also indicate the presence of clustered business activities.

There are some limitations to this map. First, this map counts the "variations" of the defined ten essential businesses. The scale of each business

is not considered. In other words, a big super-market with a floor area of 50,000 square feet has the same value as a small mom-and-pop food shop[21].

Second, there is no complete reasoning for setting the survey area 400m (1/4 miles) from each grid cells. It is employed because a 1/2-mile (round trip) is a comfortable walking distance. Another distance setting would show another picture. Moreover, a big store attracts customers from miles away, while a small shop serves just the people who are in the immediate vicinity.

Under-served area indicates business opportunity, because demands and supplies are not matching in the area. In the under served red color area in the map, we could identify that a missing service is grocery store, for example. Residents of the area are suffering from inconvenience because there are no grocery store within walking distance from their houses. So the red area implies proposed location for a new grocery store. Next action to be taken may be organize team to discuss the action plan to supplement the missing business.

---

[21] This problem could be solved with a GIS program of a following logic:

(1) Prepare a table of business scale (sales or employment as the value) that are connected with the business location in a map

(2) Count the values (sales or employment) of a specific industry defined by SIC code. In case there are several drug stores in the area, sum the values up.

(3) If the count is big enough, we evaluate the center cell as well served with the specific industry.

(4) Repeat the same procedure for all the ten businesses and see how many industries out of the ten satisfy the service demand of the center grid cell.

(5) Repeat the whole calculation with each grid cells and assign them with the new value of the service rate (from one to ten depends on the calculation)

(6) Color each grid cells according to its value.

However, this computing is not available with the ordinal ready-to-use GIS software, and it may require an advanced skill of a programming language.

SOCIOECONOMIC TOPOGRAPHY
Inner City Economic Development and Geographic Information Systems
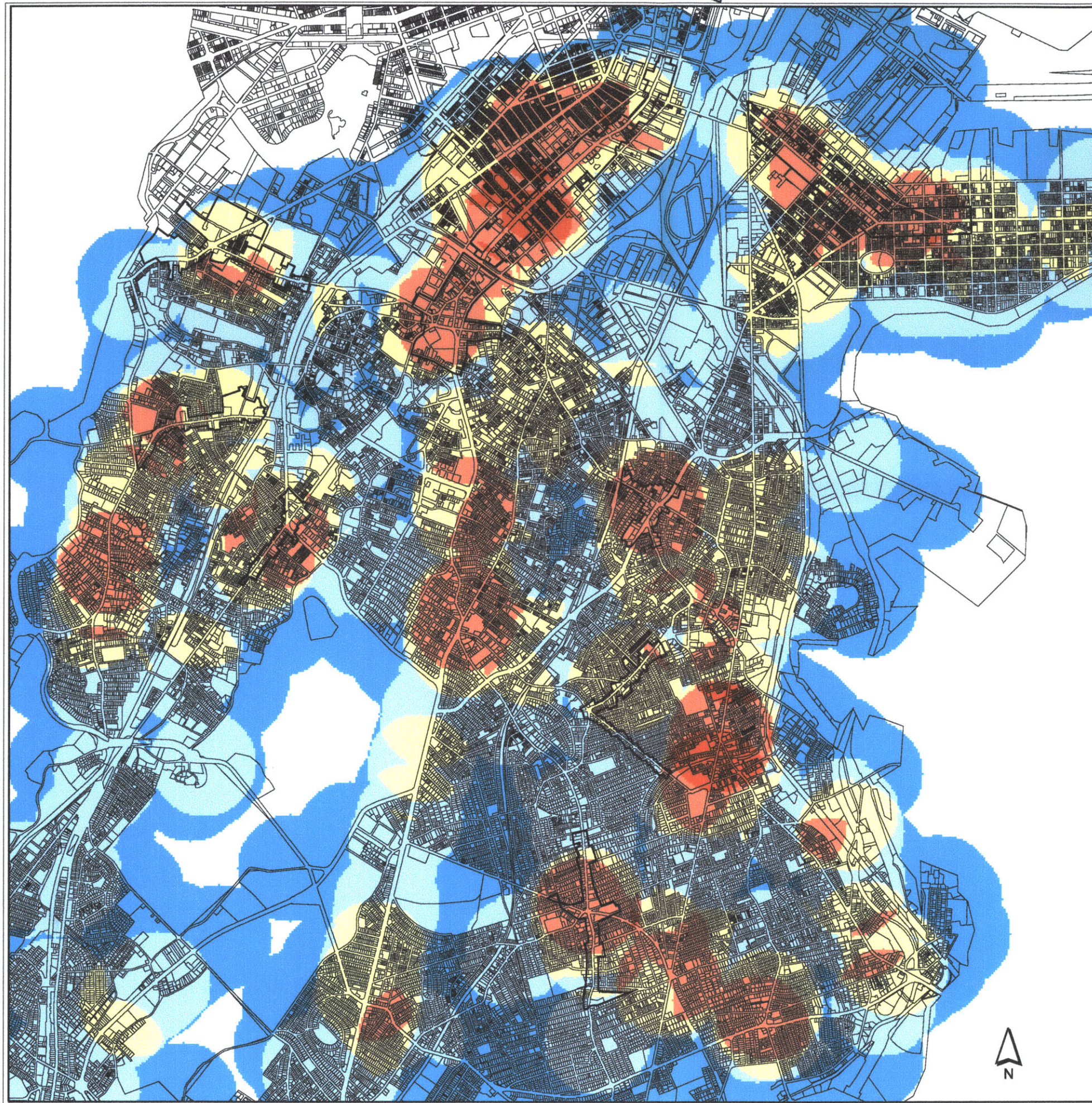
Fig. 4-1-2
Neighborhood Convenience

Legend

☐ Main Street Program Districts
Access to Services

- 1 - 2
- 3 - 4
- 5 - 6
- 7 - 8
- 9 - 10
- No data

0 0.2 0.4 0.6 0.8 1 Kilometers

0 0.2 0.4 0.6 0.8 1 Miles

Mapping Data:
Grid Cell Size: 15m x 15m (50feet x x50feet)
Detection Range: Circle with 400m (1/4miles)
       radius
Value: Variation of essential services
       by 3-Ddigit SIC code

Data Source: State Business Directory (CD)
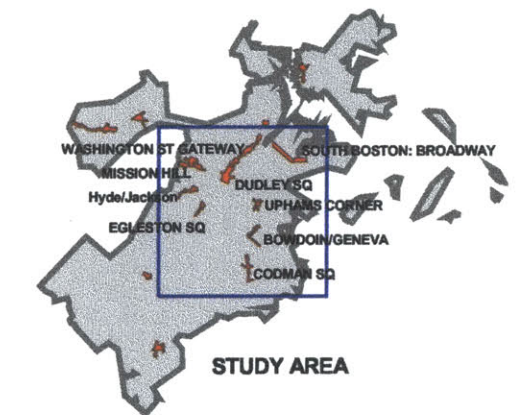
WASHINGTON ST GATEWAY   SOUTH BOSTON: BROADWAY
MISSION HILL   DUDLEY SQ
Hyde/Jackson   UPHAMS CORNER
EGLESTON SQ   BOWDOIN/GENEVA
   CODMAN SQ

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4-2. Leading Industrial Clusters

Other than meeting the demand of the local residents, to develop exporting industries is also important strategy for the inner city economy. This section focuses on how these leading or exporting industries are found with GIS.

4-2-1. Idea and Procedure of the Map

As analyzed in Chapter 2, ten industry groups, which have the most significant presence in Suffolk County, are shown in Table 2-4-2-2. Making linkage between these leading industry groups and the local businesses would enhance the inner city economy. "Making linkage" does not mean to run the core business of the leading industry. For example, there is a health care business cluster in Boston. This cluster may contains many industries such as hospital (as the core), medical and nursing schools, pharmacies, medical equipment retails, pest control services, cleaning services, special diet food suppliers, or even lunch delivery services to the employees. Because this cluster has a big presence and growing as a group, there may be no difficulties to find chances to make linkage for the local business owners. There are several advantages for the inner city economy to be connected to the exporting industries.

First, the strong presence of these industries means competitive advantages to the region. Advantages may be infrastructure, resources, policies of the local governments, accumulation of business know-how, prominence and so on. This environment will encourage entrepreneurs and make them confident of their success.

Second, the market area of these exporting businesses is much bigger than the neighborhood business and more growth possibilities can be expected. Growth is an important factor in selecting industries to be encouraged in the inner city.

Third, the location advantage of the Boston inner city would facilitate the linkage between the inner city economy and the leading industries. Many of the leading industries locate in the Central Business District (CBD) and out of the Boston City's boundary. However, the proximity of the Boston inner city to the CBD and to the main arteries (Inter state highways, railways, port, and airport) of

the regional transportation system makes it easy to join the exporting business and to have big service areas.

Procedures of the mapping of leading industry groups are as follows:

(1) Plot the location of firms with 4-digit SIC code into the study area

(2) Rasterize (divide into small pieces) the study area

(3) Define a leading industry group by SIC code. For example, SIC code for the medical service industry is 8010 and 8060.

(4) Count the number of firms with the defined SIC code within a 400m (1/2miles) radius from the first grid cell. Color the cell according to the count. Map can be made with color gradations or contour lines.

(5) Extract the area where the count is more than three and illustrate the area with contour line. For example, medical service contour line is red in Fig. 4-2-1.

(6) Repeat the (3), (4) and (5) for all the ten industries given in Table2-4-2-2, and draw contour line for each leading industry group.

4-2-2. Results and Discussions

Fig. 4-2-2 shows the leading business groups in the Boston inner city. Each colored boundary indicates a cluster. In the boundary, more than three firms of the group can be found within 400m (1/4miles). For example, the red enclosed territory is where we can find the medical services (Offices and clinics of medical doctors, and Hospitals) within 400m of each other. Out of the ten industry groups in Table 2-4-2-2, education and communication industries do not make clusters.

What can we observe with this map? Business clusters are distributed partially to specific areas, some districts have established good linkages to leading industries and some have not. Tremont Street at the South End, for example, shows many layers of the leading industries. This area has been well developed and becoming a part of the central business district. On the other hand the three shopping strips i.e., Uphams Corner, Bowdoin/Geneva, and Codman Square have no linkage with any of the leading businesses. Leading or

exporting industries are mostly not retail business, and promotion of these industries may request actions of bigger scale, such as development of real estates. Even though it may not be easy to invite exporting industries to the inner city neighborhoods, it is worth making effort. It is widely believed that the exporting industries (or basic sector[22]) are much more influential to the local economy than the non-exporting businesses (businesses that serve its neighborhood only).

There are several limitations to this map. First, the mapping area is just around the Boston inner city, and it does not contains either the Central Business District or the suburban area where there are many exporting industries that can be connected with the inner city economy. The second limitation is that relation between industries is not automatically defined. Most probably there are some kinds of relation among the printing industries (SIC#27**). However, can a bookstore be a part of this business group and take advantage of the location concentration? If there are many bookstores in Boston, it can be because there are many educational institutes there, or because Boston is just the core of the Metropolitan area from which much information are sent to its hinterland. Whether the strong presence of bookstores has something to do with the publishing industry of the region is another study topic.

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[22] This is a classic economic theory named "export base model" by Somber (1908). He discussed that the basic sector (or exporting industries) enables urban areas to exist.

SOCIOECONOMIC TOPOGRAPHY

Inner City Economic Development and Geographic Information Systems

Fig. 4-2-2
Industrial Clusters

Legend

- **Medical Services**
- **Finance & Insurance**
- **Consulting Services**
- **Legal Services**
- **Transportaion Services**
- **Printing & Publishing**
- **Computer services**
- **Wholesale Groceries**
- **Main Street Pogram Districts**

0 0.2 0.4 0.6 0.8 1 Kilometers

0   0.2   0.4   0.6   0.8   1 Miles

Mapping Data:
Grid Cell Size:15m x 15m (50feet x 50 feet)
Detection Range:Circle with 400m (1/4miles)
 radius
Value: More than three firms in same
 industrial group
Data Source: State Business Directory (CD)

STUDY AREA

WASHINGTON ST GATEWAY
SOUTH BOSTON: BROADWAY
MISSION HILL
Hyde/Jackson
DUDLEY SQ
EGLESTON SQ
UPHAMS CORNER
BOWDOIN/GENEVA
CODMAN SQ

CRL

Computer Resource Lab
Department of Urban Studies and Planning
Massachusetts Institute of Technology

N
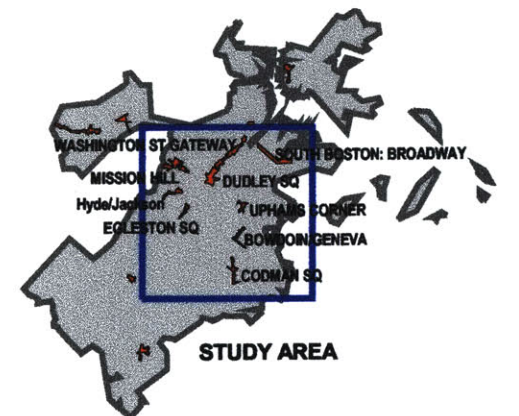
5.

Conclusion

and

Possible Applications

5-1. Conclusions

This study has offered a new method of recognizing socioeconomic patterns in the inner city. Ten maps clearly showed that characteristics of the shopping districts are diversified and their levels of development vary. This illuminates some of the prospects for fine tuning the economic development program. With a capacity to recognize the socioeconomic patterns in the chaos of the inner city, planners could prescribe policies that allocate made-to-order assistance to each district of the Boston Main Street Program.

The Main Street Program stresses the need for the total improvement of shopping districts. It says that simultaneous efforts on design, organization, promotion, and economic restructuring make a shopping strip sound and prosperous. This is true and not true. Neighborhood economic development may be compared with human resource development. A student needs abilities in English, mathematics, physical exercise, and music. All of the abilities are to be developed simultaneously. A problem is that the development stages are not uniform among students, and a specific student needs particular care with a specific subject. The shopping streets are similar.

Let us pick three districts and examine what we can tell about them from the maps. Bowdoin/Geneva, Fields Corner, and Codman Square make good examples of how to adapt socioeconomic topography to understand the conditions of shopping strips in the inner city. Among the three, Fields Corner has no designation as a Boston Main Streets Program district.

How is the commercial land allocated in these shopping strips? Figure 3-1-3 shows a distinctive pattern among the districts. Fields Corner holds the most significant commercial land allocation. The same map also tells that Fields Corner is along Dorchester Avenue (a major road in Boston), and close to a train station. On the other hand, Bowdoin/Geneva has very little commercial land, and has no location advantage to encourage the customer's access.

How is the tax-exempt land distributed in the three districts? Fig. 3-2-1-2 indicates that 20-33% of the land at Fields Corner is tax-exempt. This may imply that there is a significant amount of public or not-for-profit activities in this district. Codman Square has less tax-exempt land and Bowdoin/Geneva has even less or

almost no tax-exempt land. This implies that there is less diversity in people's activities at the Bowdoin/Geneva district.

What is the pattern of the land value in these shopping strips? Fig. 3-3-1 illustrates a pattern opposite those shown in the other maps mentioned above. Land values are most expensive in Bowdoin/Geneva, less expensive in Codman Square, and least expensive at Fields Corner. Hence, the Bowdoin/Geneva area may be holding its own as a residential neighborhood, but this need not imply that the area is viable or promising as a neighborhood commercial center.

Are there any distinctive differences in the business variation among the three commercial areas? Fig. 3-5-2 may answer this question. The richest variation is observed at Fields Corner. The intersection of Codman Square is likely to be a busy commercial zone. On the other hand, very little business diversity is found in Bowdoin/Geneva. The business variation is so poor that the area cannot be recognized as a shopping area from the map.

Do these three shopping strips serve neighborhoods sufficiently? Fig. 4-1-2 points out that Fields Corner is serving the neighborhood very well. Almost all the essential services for daily life are available in Fields Corner. This is one of the few areas with such a good performance in the whole inner city, and may attract customers from a distance. Codman Square holds a fair service function for its neighborhood, while Bowdoin/Geneva has very limited capacity to satisfy its neighborhood. Even the residents in the Main Streets program area might shop at Fields Corner.

Do these shopping districts have any linkage to the leading industries? The pink area at Fields Corner in Fig. 4-2-2 indicates that there are some firms in the finance & insurance industry, which implies exporting characteristics of the business agglomeration. Red spots close to Codman Square suggest that there are medical service clusters in the area. These clusters may draw more people from the surrounding neighborhoods and increase foot traffic in Codman Square.

Table 5-1 summarizes implications given by the maps. Site observations and detailed surveys may give us much more information. However, analysis of socioeconomic topography such as those in Table 5-1 could have provided a basis for early questioning of the viability of Bowdoin/Geneve as a Main Streets

district, or at least have suggested which economic development strategy had more and less likelihood of working.

Table 5-1 Comparison of Three Shopping Districts

	Bowdoin/Geneva	Fields Corner	Codman Square
Commercial Land Allocation (Fig. 3-1-3)	5-10% at most most of the strip is 0-5%	20-33% Distinctive among the three	5-20%
Tax exempt (Fig. 3-2-1-2)	0-5%	20-33%	10-20%
Land Value (Fig. 3-3-1)	$10-14/sq.ft	$5-14/sq.ft	$7-9/sq.ft
Business Variation (Fig. 3-4-2)	11-15 variations at most	16-36 variations	21-36 variations
Neighborhood Convenience (Fig. 4-1-2)	3-6 essential services	9-10 essential services	7-8 essential services
Industrial Clusters (Fig. 4-2-2)	None	Finance & Insurance	Medical Services

Then, apart from the information from the maps, what is the reality of the Main Street Project at Bowdoin/Geneva district? Interview with City officials who are engaged in the Boston Main Streets Program have confirmed that project progress in Bowdoin/Geneva has encountered more difficulty than in most other Main Street districts.

The following are problems observed in project implementation.
(1) Shortage of Volunteers
   Almost all the manpower for the each Main Street district depends on volunteers. Members of the four committees in each project are not paid. Because of a limited number of businesses in Bowdoin/Geneve, total volunteer hours generating from the area is also very limited. Fewer attendants to the project activities make the project implementation difficult.
(2) Difficulty in Fundraising

Since there is weakness in the economic base of the most inner city shopping areas, each district can allocate very limited funds to economic development. When returns are not clearly anticipated, merchants and investors are reluctant to put their money into this project, unless the economic base of the Main Street project is built up to a self-sustaining level. Recently, the City Government decided that it would subsidize the salary of the program manager of each participating district for another two years after the termination of the four-year project period ($35,000 x 2 years). However, less successful districts, such as Bowdoin/Geneva, are more at risk of collapse when the public assistance stops.

(3) Limited Initiative Among the Local Stakeholders

The presence of the business association is not strong in Bowdoin/Geneva area, and it has no political power to integrate the various local stakeholders into one direction i.e., economic development. Youth programs and crime prevention projects may get a broader support from the community than the business promotion does in this district.

The reality of the project mentioned above coincides with the implications of the maps. Not all the inner city shopping strips can be prosperous. Some neighborhoods may be better off focusing on other type of neighborhood development rather than expanded shopping zones. In some case, it may be more appropriate to allocate public resources for social activities rather than for economic development.

Improving the public policies, including Boston Main Streets Program, so that the City can deliver made-to-order assistance may need further study and consideration at political and administrative levels. What the Main Streets Program needs are good indicators that show the economic situation of the potential and participating districts. Of course, information based on detailed surveys, such as vacancies of commercial properties, sales and profitability of firms, and number of employees, may work as indicators. However, socioeconomic topography explored in this thesis can use readily available administrative data together with the modern GIS methodology to identify relevant

spatial attributes of each neighborhood and shopping district. Such indicators can provide consistent, affordable, and timely indication of neighborhood strength and weakness.

My suggestions for improving the Boston Main Streets Program are as follows:

(1) Use the socioeconomic topography to formulate the criteria for evaluating the stages of development of each shopping district in the inner city. This may help the City Government distinguish the areas to be supported by the program. A better understanding of each area would facilitate the City Government to make more precise area targeting, more effective resource allocation, and more feasible scheduling and staging of development opportunities.

(2) Set appropriate goals for each individual participating district and allocate reasonable assistance to achieve the goals. Assistance should differ from district to district according to their levels and needs. One program district may have clear competitive advantages while another one may be less mature as a shopping district. It is not fair to allocate the same assistance package to each.

Some participating districts are in the home stretch of this four-year program, and the City Government must decide whether these shopping streets will graduate from the program or will repeat their projects. Socioeconomic topography has a potential to support this decision-making process also.

5-2 Future of Socioeconomic Topography

The raster analysis method has been used in very limited areas such as precise agriculture, and botany. This study is an early trial to apply this method to the socioeconomic field. There are two factors which have made this possible. First, computer hardware and GIS software are rapidly improving and becoming more sophisticated and user-friendly[23]. A few years ago, making a raster-analyzing map required intensive computer literacy[24] and it also took several times longer for data processing.

Second, more and more socioeconomic data are available in digital format. For example, census data and relevant polygons (digital data of geographical boundaries), and parcel data from the Assessors Office, Boston City Government are available in compact discs. MassGIS also has available a vast variety of geographic data on its web site.

A software package, Microsoft Office, now has a GIS component "Map Point 2000." This software might not be sufficient for analytic or research purposes; however, it will contribute to the diffusion of GIS knowledge among office workers within a few years. Moreover, inserting maps into a desktop publishing process will become standard with management consultants. Some of them could then proceed to get GIS skills at the research level. The mapping methodology shown in this paper would be a standard procedure for socioeconomic research in the near future.

Only ordinary data and equipment are used for this study. No survey was conducted and no data was newly obtained. Data came from the governmental agencies or from popular commercial CDs. Also, the computer hardware and software used for this study are very ordinary; anybody can get them easily. So the proposed socioeconomic topography can be applied to any other inner cities in the US.

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[23] The spec of the PC used are:

CPU 450mega Hz, Main memory 248mega bite, Hard disc of 10-giga bite, and 100 mega bites ZIP drive.

[24] Knowledge of computer languages like UNIX was essential for sophisticated GIS analysis.

5-3. Possible Applications of Socioeconomic Topography

The analytic methodology that is introduced in this study is called
"Socioeconomic Topography." Mapping topography or height of land is popular
among the GIS engineers; however, mapping socioeconomic phenomena is a
relatively new attempt. If polygons (boundary data in digital format) and
corresponding data tables are available, any socioeconomic phenomena can be
mapped with color gradation, contour lines, or 3D extrusions. Scale of the
polygons is not necessarily parcel level; it can be block groups, census tracts, or
zip code areas, if the mapping range is large enough

The followings are some examples of maps that can be created with the
methodology of the socioeconomic topography:

(1) **Topography maps of building age**

   The ages of buildings are available from the Assessors Office of the Boston
   City Government. This map will interest people engaged in historic
   preservation or the tourist industry.

(2) **Topography maps of demography**

   Topics include racial minority, educational attainment, income and poverty, in
   any metropolitan area in the US, or in whole US. All these data are available
   or easily processed from the 1990 Census at the level of zip codes, census
   tracts, or block groups. A comparison of '80 map and '90 map would give us
   many implications that would be worth studying.

(3) **Topography maps of business cluster concentrations in the US**

   Number of firms by SIC code is available at the zip codes level. This map will
   show us clear images of the location of any specific industrial clusters at the
   national level.

(4) **Topology map of crime**

   Some people keep the inner city at a distance because they think inner city is
   not secure. This may be true or may be not. What kind of crime actually takes
   place? In which part of the inner city? What are the correlation between
   crimes and urban land use or locations of various facilities? Topology map of
   crime would answer all these questions. This map potentially offers a basic
   material for an interesting planning discussion i.e., "crimes and planning."

6. Appendix

6-1. Bibliography

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6-2. Table of State Land Use Classification

Stateclass	Categoryid	Landuse	Descript
10	MU	RC	Condo Multi-Use
12	MU	RC	Res/Open Space Use
13	MU	RC	Res/Commercial Use
19	MU	RC	Res/Exempt Use
25	MU	RC	RC: One Res Unit
26	MU	RC	RC: Two Res Units
27	MU	RC	RC: Three Res Units
31	MU	RC	Com/Res Multi-Use
101	RP	R1	Single Fam Dwelling
102	RP	CD	Residential Condo
103	RP	R1	Mobile Home
104	RP	R2	Two-Fam Dwelling
105	RP	R3	Three-Fam Dwelling
106	RP	RL	Res Ancill Improvement
107	RP	RL	Other Residential
108	RP	CP	Condo Parking (Res)
109	RP	R3	Multiple Blds/1 Lot
110	RP	CD	Condo Storage (Res)
111	RA	R4	Apt. 4-6 Units
112	RA	A	Apt. 7-30 Units
113	RA	A	Apt. 31-99 Units
114	RA	A	Apt. 100+ Units
115	RA	A	Co-Op Apt.
116	RA	RL	Small Parking Garage
118	RG	A	Elderly Home
121	RG	A	Rooming House
122	RG	A	Fraternity House
123	RG	A	Residence Hall
125	RG	A	Subsd S-8
126	RG	A	Subsd Housing S-231D
127	RG	A	Subsd Housing S-202
130	RG	RL	Residential Land
131	RG	RL	Res Land (Secondary)
132	RG	RL	Res Land (Unusable)
140	RG	A	Child Care Facility

Stateclass	Categoryid	Landuse	Descript
202	RG	RL	Underwater Land
211	RG	RL	Non-Productive Land

Stateclass	Categoryid	Landuse	Descript	Stateclass	Categoryid	Landuse	Descript
300	CP	C	Hotel	350	CO	C	Postal Service
301	CP	C	Motel	351	CO	C	Training/Priv Educ
302	CP	C	Inn, Resort, Bed & Brk	353	CO	C	Social Club
303	CP	C	Priv City Club	354	CO	C	Mausoleum
304	CP	C	Nursing/Conv Home	355	CO	C	Funeral Home
305	CP	C	Hospital: Taxable	356	CC	CC	Comm Condo
306	CP	C	Laboratory	357	CC	CC	Retail Condo
307	CP	C	Veterinary Hospital	358	CC	CC	Office Condo
309	CP	C	Med Clinic Outpatient	359	CC	CC	Condo Parking (Com)
310	SW	C	Laundry Operation	360	CT	C	Museum, Gallery
311	SW	C	Laudromat/Cleaner	361	CT	C	Night Club
312	SW	C	Mini-Storage Warehouse	362	CT	C	Movie Theatre
313	SW	C	Lumber Yard Storage	363	CT	C	Drive-In Theatre
314	SW	C	Truck Rental	364	CT	C	Stage Theater
315	SW	C	Piers/Dock	365	CT	C	Auditorium/Sport Center
316	SW	I	Warehouse	366	CT	C	Fieldhouse/Track
317	SW	I	Storage/Garage	367	CT	C	Race Track
318	SW	I	Cold Storage Warehouse	368	CT	C	Fairground, Park
319	CR	C	Strip Center/Stores	370	CT	C	Bowling Alley
320	CR	C	Retail/Warehouse/Service	371	CT	C	Arena: Ice Skating
321	CR	C	Discount Store	372	CT	C	Arena: Roller Skating
322	CR	C	Department Store	373	CT	C	Swimming Pool
323	CR	C	Shopping Center	374	CT	C	Health Spa/Club
324	CR	C	Supermarket	375	CT	C	Tennis/Racquet Club
325	CR	C	Retail Store Detached	376	CT	C	Gym/Athletic Facility
326	CR	C	Restaurant/Service	377	CT	C	Recreation Bldg
327	CR	C	Restaurant/Lounge	380	CT	C	Golf Course
328	CR	C	Fast Food Restaurant	381	CT	C	Tennis Court(s)
329	CR	C	Bar/Tavern/Pub	382	CT	C	Stable, Kennel
330	AU	C	Showroom (Auto)	383	CT	C	Swimming Pool-Outdoor
331	AU	C	Auto Supply/Service	384	CT	C	Boat House/Marina
332	AU	C	Repair/Service Garage	385	CT	C	Taxable Bldg Only
333	AU	C	Self-Service Station	386	CT	C	Campground Facility
334	AU	C	Service Station	387	CT	CL	Pay Parking Lot
335	AU	C	Car Wash: Automatic	388	CT	C	Air Rights Property
336	AU	C	Com Parking Garage	389	CT	C	Bldg: Chap 61B Land
337	AU	CL	Parking Garage	390	CL	CL	Commercial Land
338	AU	C	Subterranean Garage	391	CL	CL	Com Land (Secondary)
339	AU	C	Car Wash: Self-Service	392	CL	CL	Com Land (Unusable)
340	CO	C	Office (Attached)	393	CL	CL	Com Greenhouse
341	CO	C	Bank Building	394	CL	CL	Utility Bldg/Shed
342	CO	C	Medical Office	395	CL	C	Air Terminal
343	CO	C	Office 1-2 Story	396	CL	C	Hangar: Storage, Maint
344	CO	C	Office 3-9 Story	397	CL	C	Bus Terminal
345	CO	C	Office: Class B	398	CL	C	Railroad Terminal
346	CO	C	Office: Class B+				
347	CO	C	Office: Class A-				
348	CO	C	Office Tower: Class A				

Stateclass	Categoryid	Landuse	Descript
400	IP	I	Old Manufacturing
401	IP	I	Whse: Industrial
402	IP	I	Office: Industrial
403	IP	I	New Manufacturing
404	IP	I	Light Mfg/R & D
405	IP	I	Industrial Loft
406	IP	I	Computer Equip Bldg
407	IP	I	Machine Shop (Small)
408	IP	I	Newspaper Plant
410	IP	I	Mining, Quarrying
412	IP	I	Metal Processing
413	IP	I	Auto Salvage Yard
414	IP	I	Food Processing Plant
415	IP	I	Bottling Plant
416	IP	I	Cannery
417	IP	I	Dairy
420	IU	I	Tanks: Above Ground
421	IU	I	Tanks: Under Ground
422	IU	I	Electic Power Plant
423	IU	I	Electric Trans Row
424	IU	I	Electric Substation
425	IU	I	Gas Manufacturing Plant
426	IU	I	Gas Pipeline Row
427	IU	I	Gas Storage
428	IU	I	Gas Pressure Station
430	IU	I	Telephone Exchange Station
431	IU	I	Telephone Relay Tower
432	IU	I	Cable TV Facility
433	IU	I	Radio/TV Trans Facil
435	IU	I	Radio/TV Studio
436	IU	I	Studio/Remote Control
440	IU	CL	Industrial Land
441	IU	CL	Ind Land (Secondary)
442	IU	CL	Ind Land (Unusable)
445	IU	I	Railroad Prop
446	IU	I	Water/Sewer Utility
450	IU	I	Industrial Condo
465	IU	C	Com Billboard

Stateclass	Categoryid	Landuse	Descript
900	EO	E	US Government
901	EO	E	Commonwealth of Mass
902	EO	E	City of Boston
903	EO	E	Bost Redevlop Authority
904	EO	E	Private School/College
905	EO	E	Charitable Organization
906	EO	E	Religious Organization
907	EO	EA	121-A Property
908	EO	E	Boston Housing Authority
950	EP	E	Retail Condo: Exempt
960	EP	E	Office Condo: Exempt
965	EP	E	Gov't Office Bldg
970	EP	E	Church, Synagogue
971	EP	E	Rectory, Convent
972	EP	E	Correctional Bldg
973	EP	E	Administrative Bldg
974	EP	E	Fire Station
975	EP	E	Police Station
976	EP	E	School
977	EP	E	College (Academic)
978	EP	E	Library
979	EP	E	Hospital (Exempt)
980	EP	E	Water Treatment Plant
981	EP	E	Incineration Plant
982	EP	E	Armory (Military)
983	EP	E	Cemetery
984	EP	E	Public Beach
985	EP	E	Other Exempt Bldg
986	EP	E	Other Public Land
995	EP	CM	Condo Main (No Value)

Source: City of Boston Assecing Department

Acknowledgement

It has been a big challenge for me to implement this thesis study, because I was short of the three most essential qualifications besides the English fluency. They are (1) an understanding of the American urban society and its problems, (2) a background of business and economics, and (3) a high standard of computer literacy. The famous Helen Keller with triple difficulties would have been happier than I was, when she began to learn language.

I would not have chosen this topic if I had not met Professor Joseph Ferreira, Jr., my thesis advisor, who has been teaching GIS to me from the absolute zero stage. It would have been impossible for me to write a thesis on the American community, if Professor Langley Keyes, my thesis reader, had not been mentoring me as sincerely as a thesis adviser. My mapping skill would never have reached this level, if Associate Professor Qing Shen had not let me work as his GIS research assistant for a whole year.

This experience has taught me that it is impossible to attempt this kind of challenge without heartwarming support and encouragement from others. Ms. Ana Impellizeri, a Boston Main Streets Program Manager at City Hall, has helped me a lot during and since my internship at her office. Ms. Claire Kaplan, a researcher for Initiative for a Competitive Inner City (ICIC), gave me not only a chance to have an intern opportunity but also useful suggestions on my maps. Dr. Alvero Lima, Managing Director of Boston Advisor Inc., gave me much insightful advice from a business consultant's point of view.

I advise all the readers of this thesis not to assign themselves such time consuming research, if they do not have a patient wife like Sumi who has offered me full understanding and full support. Besides the 24-hour GIS environment of the Computer Resource Laboratory of MIT, this work needs children like Miharu and Isaya who always give me a cheer when I leave and welcome me when I come back to the on-campus family apartment.

Let me express my deep appreciation toward all the people who supported me and let me concentrate on my studies for these two years at MIT.