

Development of Sub-City Urban Indicators in China and Guatemala

**Final Report
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In cooperation with

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This report describes the first-phase work of the Virginia Commonwealth University (VCU), sponsored by the U.S. Department of Housing and Urban Development (HUD) and University Consortium for Geographic Information Science (UCGIS). The two study cities are Shanghai, China, and Guatemala City, Guatemala.

Project goals

The chief objective of our project is to develop sub-city urban indicators for Shanghai, China, and Guatemala City, Guatemala, both participants in the Urban Indicators Program of the United Nations Center for Human Settlements (UNCHS). Through the project, we have cultivated close partnerships with East China Normal University in Shanghai (Open Research Laboratory of Remote Sensing) and University of San Carlos of Guatemala in Guatemala City (Center for Urban and Regional Studies and Faculty of Architecture).

Our project goals in the first phase of the project (January 2001 – February 2002) include:

- develop long-term collaboration with international partners and transfer expertise in evaluating urban indicators to help build local capacity;
- design base maps to support display of indicator data at appropriate sub-city resolutions;
- establish a baseline set of indicators feasible for each partner city to enable continuing collection;
- assemble and disaggregate, where possible, existing indicators to describe sub-city areas of each partner city;
- design a database capable of maintaining historical data, supporting future updating, and adding new indicator data items;
- develop procedures for ongoing data collection and management to support future longitudinal studies as well as policy evaluations; and develop web publishing tools and training materials.

The choice of our international partners is based on several factors. First, local capacity is a critical factor in the case of Shanghai. The Open Research Laboratory of Remote Sensing of the East China Normal University has been very active and experienced in GIS research. Professor Jianping Wu, the key contact, has hoped that this collaborative effort would bring their research on par with international standards and help develop better analytical tools for monitoring urban changes. Second, in the case of Guatemala City, we have relied on an established relationship between the two units of University of San Carlos of Guatemala and our department (through our research assistant, Ms. Irayda Ruiz).

Collaboration with our partners has been accomplished by several on-site visits, regular communication via e-mail during the project, use of the file transfer protocol for exchanging data between VCU and the partner universities, and on-site GIS training to Guatemala partners.

Dr. Wu visited East China Normal University first at the end of December 2000 and then in July 2001. During the two visits, Dr. Wu had extensive discussion with Prof. Jianping Wu to identify sub-city indicators appropriate for Shanghai, verify data and map availability, discuss the general framework

of the training module, and explore ways in which our research efforts may become more relevant to local policy-making.

We also met with the Director of the Comprehensive Planning Division of the Shanghai Urban Planning Institute, the municipal authority responsible for drafting city and district level plans and advising on planning policies. The purpose of the meeting was to better understand the needs by municipal planning agencies for spatial information and to explore ways in which our research efforts may become more relevant to local policy-making. Based on the needs of her agency, she pointed out that our project could be most relevant if it can provide a reliable system of empirical evidence and she provided the following priorities:

- Demographic trends and comparative analysis by subdistrict
- Land use trends and historical patterns
- Industrial establishments, employment, and land consumption
- Commercial establishment and employment, and relationship with population distribution
- Demographic characteristics, geographical distribution, and employment patterns of temporary migrants

Dr. Rugg and Ms. Irayda Ruiz visited the University of San Carlos of Guatemala in February 2001 and met with our collaborators in both the Center for Urban and Regional Studies and Faculty of Architecture. We presented the Richmond Urban Indicators project to showcase the potential of indicator research, offered an introductory workshop on ArcView, identified human and hardware capabilities of our partners in Guatemala, and made contact with the Municipal Planning Department of Guatemala City. More importantly, we assisted both teams in the definition and selection of most relevant data available, matching the list provided by the United Nations (UN) global urban observatory.

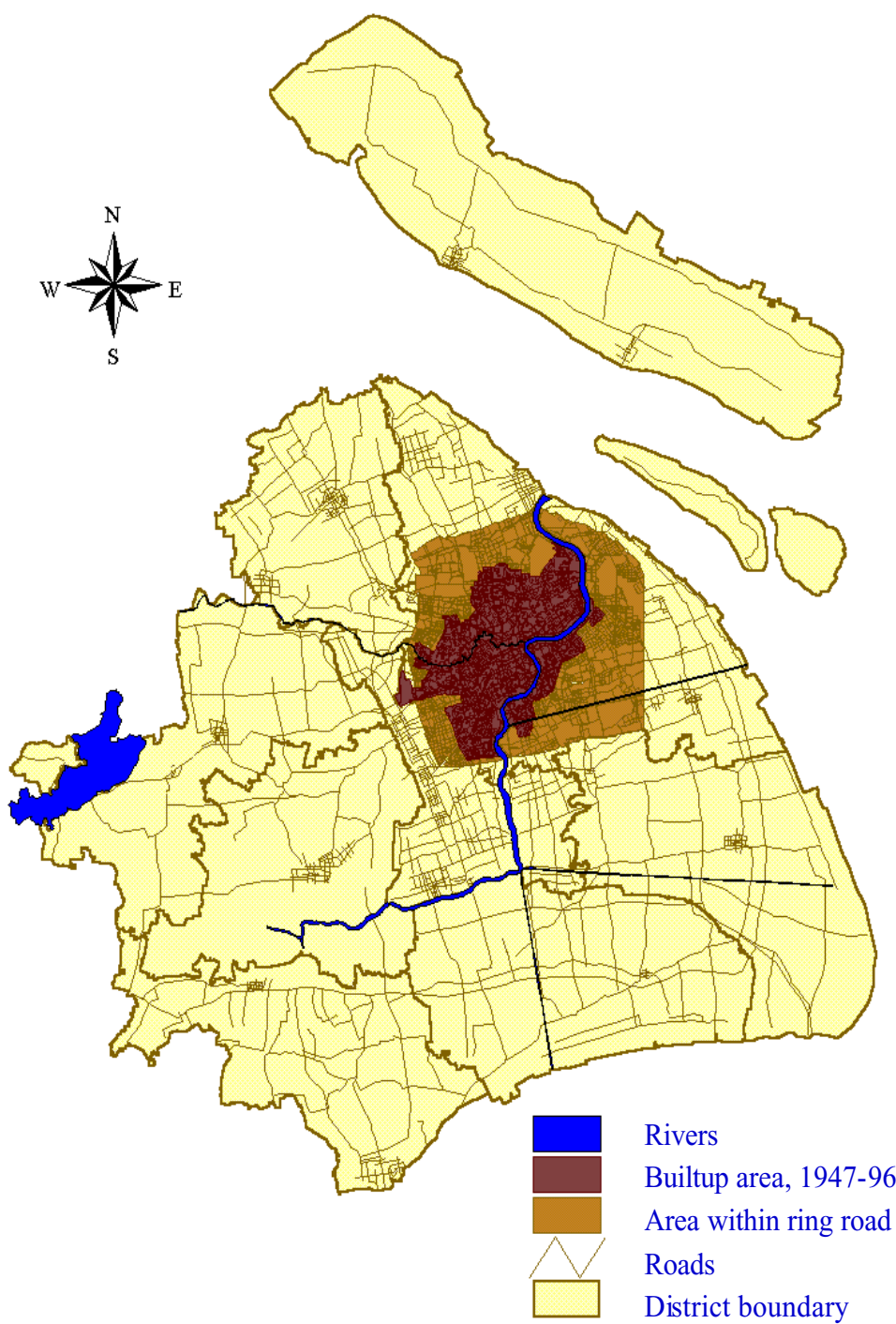
During the months of July and August 2001, Ms. Irayda Ruiz visited Guatemala again. She met with the partner research teams for discussions about map design and neighborhood boundary definition, and assisted the teams in defining an adequate format for spreadsheets to be used in ArcView maps. She also helped with the installation of ArcView and a CDRW supplied by the VCU team, and provided training to use the system. In addition, she provided training to define some basic criteria for thematic map design, joining tables, and other GIS basics (the use of point, line and polygons to present data and how to handle discrepancies between one census variable display and another).

In October 2001, Prof. Carlos Ayala, Coordinator of the Research Institute of Architecture in the Faculty of Architecture at University of San Carlos visited VCU. The research team had further discussions with him about district boundary definitions for census data in Guatemala City, digitalization of maps at the subdistrict level for the central business district, and analytical methods to be used in future research. We reached some tentative agreements that we would work towards building projection models for service delivery, particularly to squatter settlements, and towards monitoring land use and environmental changes in the metropolitan area.

As a result of these exchanges, the collaborative relationships with our international partners have strengthened significantly. We are confident such relationships will continue and benefit future research. In the case of Guatemala City, our partnership has evolved into an institutional research exchange program between VCU and the Faculty of Architecture of the University of San Carlos, beyond the scope of this research. Our efforts in transferring indicator research and GIS mapping expertise also have contributed to the building of local capacity. In the case of Shanghai, we are about to make our research available to local planning policymakers. Our research efforts in bringing

sion-making process. Together information from diverse sources are likely to help them overcome the lack of coherent and consistent data in their decision-making process.

Metropolitan Shanghai



Base maps provide a framework for spatial display and analysis of the disaggregated indicator data. Developing them at appropriate resolutions is important for the long-term collection and analysis of indicator data. Thematic maps of urban indicators can then be prepared and published.

For Shanghai, two levels of resolution are used: one at the district level (equivalent to municipalities in a metro area) and another at the sub-district level (equivalent to census tracts). An extensive set of indicator data is available for the first level, which is less than optimal for in-depth analysis. At the sub-district level, the indicators are limited to demography (population and population density) and economic activity (employment and output by sector).

With the electronic maps provided by our partner and a map developed by Dr. Wu previously, we have finalized a base map for Shanghai. This involves some map cleaning and verification. First, we have checked for subdistrict boundaries and names across the two sets of maps to ensure consistency. We now have a base map of subdistricts that is essentially based on the UTM map provided by our partner and can also incorporate other indicator attributes associated with Dr. Wu's map. After comparing the subdistrict names and boundaries in the base map to published data, we also have discovered that some subdistricts have been combined. Both the base map and data have been adjusted to link the correct data to the correct subdistricts. We then have created a district base map by merging the subdistricts

For Guatemala City, we have two sets of base map – one at the district level and another at subdistrict level, similar to Shanghai. Using an electronic map obtained from the Geographic Institute of the University of San Carlos, we have finalized a base map at the district level that would allow us to show census indicators for the entire metropolitan area. We also have used this level of resolution to showcase the 286 squatter settlements within the metropolitan area of Guatemala City identified and surveyed by the Center for Urban and Regional Studies.

With the Faculty of Architecture, we have identified several difficulties to obtain a digitized map of Guatemala City at subdistrict (zone) level. Our final solution is to manually digitize a hard-copy map of the central business district. This will allow us to have a partial base map of the city by zone (sub-district level) to display indicator data collected by the Faculty of Architecture and to analyze land use changes in the area. But the database still has some design problems and we have been assisting our partner in creating some guidelines for data entry and linkages.

Both Guatemala City and Shanghai participate in the UNCHS Urban Indicators Program. As such, each city has available a comprehensive set of aggregate indicators in such subject areas as socio-economic development, infrastructure, transportation, environmental management, local government, and housing.

As part of this project, we have identified the most suitable geographic resolution(s) for each data item and an extendable database is designed to hold the baseline data. The database design includes capabilities for maintaining historical data, supporting future data collection and updating, and adding new indicator data items as they become available.

The identification of appropriate indicators is based on several factors. First, we have started with the list of key urban indicators provided by the UNCHS Urban Indicators Program. With some exceptions, our set of indicators falls within this list. Second, we have consulted with our international partners extensively on several occasions on the selection of sub-city indicators so that local research needs and interests can be fulfilled. Last, data availability is a critical factor in our selection, given that sub-city data is often lacking in many developing cities

Shanghai

Based on information provided by our partner and collected from Shanghai, we have developed and enriched our baseline set of sub-city urban indicators. As of now, the following categories of indicators have been developed for Shanghai (all at district level unless specifically noted):

Demography

- Population and population density, 1996, 1997 and 1999
- Natural population growth rate, 1997 and 1999
- Sex ratio, 1995
- Population age structure, 1995
- Population and population density by subdistrict, 1997

- Urban economy

- Employment by sector, 1995
- Employment by occupation, 1995
- Unemployment, 1995
- Employment and establishment by subdistrict, 1996
- Revenue by sector by subdistrict, 1996

- Social conditions

- Hospital beds per thousand population, 1997 and 1999
- Doctors per thousand population, 1997 and 1999
- Educational levels, 1995
- Illiteracy level by gender, 1995
- Distribution of primary schools, 2000
- Distribution of high schools, 2000
- Elementary schools student and teacher ratio, 1997 and 1999
- Middle schools student and teacher ratio, 1997 and 1999
- Vocational schools student and teacher ratio, 1997 and 1999
- Per capita green space, 1997 and 1999
- Waste water treated, 2000

- Housing

- Housing by type, 1997 and 1999
- Older housing stock, 1997 and 1999
- Per capita housing area, 2000

- Land use (aggregate)

- Land use changes within Shanghai's built-up area at eight time periods, 1947-1996
- Boundary changes within Shanghai's built-up area at eight time periods, 1947-1996
- Land use pattern in Shanghai metropolitan area, 1994
- Land use pattern within Shanghai's second ring road, 2000

Guatemala City

We have been able to develop the following sub-city indicators (all at district level unless otherwise specified):

- Population

- Percent of the region's population that lives in each district in 1994, 1981, 1973
- Population density persons per square kilometers in 1994, 1981 and 1973
- Sex ratio 1994, 1981, 1973.
- Percent of urban and rural population in 1994
- Age structure (0 to 14 years, 15 and 64 years, and 65 or older) in 1994, 1981, 1973
- Number of households in 1994
- Household size in 1994

- Education

- Literacy rates in 1994, 1981, 1973
- Percent of persons without formal education in 1994 by district
- Educational levels (preschool, elementary school, middle or high school, and college) in 1994

- Workforce

- Gender makeup of work force in 1994
- Total workforce in 1981 and 1973

- Housing

- Percent of housing units located in each district in 1994 and 1981
- Single family homes (classified as formal housing) in 1994 and 1981
- Multi-family housing (apartments) formal construction in 1994 and 1981
- Percent of formal housing by district in 1994 and 1984
- Formal housing deficit (formal housing less number of households) in 1994

- Squatter settlements (covering a total of 286n the metropolitan area)

- Number of inhabitants in each settlement.
- Number of families
- Location
- Housing ownership status
- Infrastructure and services, including water, electricity and sewage.
- Level of risk from natural hazards (proximity to seismic falls, water sheets, and deforestation)

This project does not involve a research hypothesis in the usual sense. Given the emphasis on data management and display, the key objective for the project is to develop database tools and training materials that are understandable and can be implemented by colleagues at a remote site in a non-English-speaking environment.

The evaluation of urban indicators depends heavily on continuing collection of data through time, modeling of causes and effects, and monitoring of results. This initial project has only generated indicator data for selected time periods. However, to be most useful for evaluation, the indicators must continue to be gathered over multiple time periods. The primary emphasis of this project initially is not on evaluation, but on developing tools and training procedures to support collection of indicator data on an ongoing basis through multiple past and future time periods.

Although the key purpose of first phase of the research project is to build the necessary infrastructure for indicator data collection and spatial display, we are hoping to use these indicators to monitor and project changes in urban land use, environmental quality, and demographic movements.

With a permanent population of more than 13 million and land area of 6,340 square kilometers in the metropolitan area, Shanghai is the largest city in China (see Table 1).

The metropolitan area, governed by the Shanghai Municipal Government—equivalent to a provincial government because of Shanghai's special administrative status—consists of 17 urban districts (10 of them are located in the central city) and 3 suburban counties. Another 3 million or so migrants, largely from rural areas of China, reside in Shanghai.

For Shanghai, our preliminary analysis shows land use trends in the central portion of the metropolitan area (Table 2). During the entire period of 1946-1996, rapid urbanization has occurred largely after 1979 when economic reforms commenced. This concurs with the fact that urban expansion had been severely restricted prior to 1979. Economic reforms have unleashed the force of development and subsequently urbanization.

Table 1. Aggregate indicators for Shanghai, 2000

Metropolitan land area (square kilometers)	6,340
Resident population (millions)	
1910	1.29
1950	4.98
1960	10.56
1970	10.73
1980	11.47
1990	12.83
2000	13.22
Population density (persons/square kilometer)	2,084
Annual natural growth rate (%)	-1.9
Average household size (persons)	2.8
Household formation rate (%)	1.2
Per capita income (US\$)	4,180
Annual economic growth rate (%)	9.5
Unemployment (%)	3.5
Infant mortality (per thousand, 1997)	6.47
Hospital beds (persons/bed)	18.2
Life expectancy at birth (years)	78.8
Adult literacy rate (percent)	93.8
Per capita housing area (square meters)	24.0
Housing tenure type (percent)	
Private housing	26.6
Commercial housing	35.9
Private rental housing	5.6
Public rental housing	26.6
Others	5.2
Waste water treated (percent)	76

Sources: Shanghai Statistics Bureau, *Shanghai Statistical Yearbook 2001* (Beijing: China Statistics Press, 2001); Yiren Zhou, *A Study of Population Change in Old Shanghai* (*jiu shanghai renkou bianqian de yanjiu*) (Shanghai: People's Press, 1980).

Another significant trend in Shanghai after 1979 has been the unprecedented influx of migrants, mostly from rural areas of China. Because of their official temporary status, they have very limited access to urban jobs and services. The municipality still relies on the number of registered permanent residents in the city (currently at about 13 million) in determining urban service needs, such as water, gas and electricity supplies, public transport vehicles, roads, and sewerage systems. However, the large volume of temporary migrants (estimated at about 3 million) is bound to have a significant impact on the delivery of these services. As a result, analytical models that help understand and project the geographical distribution of these migrants across the city will be very helpful for policy making.

Table 2. Land Use Changes in Shanghai's Central City, 1947-1996 (percent)

	<i>1947</i>	<i>1958</i>	<i>1964</i>	<i>1979</i>	<i>1984</i>	<i>1988</i>	<i>1993</i>	<i>1996</i>
Residential	14.1	20.2	22.5	23.6	25.8	27.9	34.4	34.5
Industrial	4.9	6.7	12.9	16.5	18.2	18.7	18.6	18.6
Other urban uses	9.5	12.3	13.6	16.8	17.4	18.6	17.9	18.0
Roads	6.8	6.8	6.6	6.6	6.7	6.6	6.7	6.7
Agricultural	48.1	39.7	31.3	24.4	19.5	15.0	7.5	6.8
Village areas	8.8	7.7	5.5	4.8	4.7	3.9	3.3	3.3
Vacant	1.2	0.1	1.0	0.8	1.2	2.9	5.0	5.6
Water	6.5	6.5	6.4	6.4	6.5	6.5	6.5	6.5
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Preliminary analysis based on district-level data shows that two variables—capital construction investment and total employment in industrial & service sectors—have significant association with the number of migrants attracted to each district. Two variables are used to indicate housing availability—per capita housing area and an index (log) of private rental rate for migrants. Approximating social networks is the number of migrants in each district during the last survey (1993), under the assumption that the more migrants already living in a district, the more will be attracted in the future. The combined influence of the five independent variables on migrant location is very strong, as indicated by a high value of R-square in Table 3.

But the results of this regression analysis are less reliable as there are only 20 districts (observations) in Shanghai. So we are hoping that, when 2000 census data are made public, we can use subdistrict demographic, socioeconomic and housing indicators to analyze and project the distribution of migrant population.

Table 3. Regression of the Geographical Distribution of Migrants in Shanghai

Dependent variable: MIGRANTS (number of economic migrants from outside of Shanghai in 1997)					
<u>Independent variables:</u>					
PCHOUSE	per capita housing area in 1995 (data on 1997 not available)				
ISEMP	total employment in industrial and service sectors in 1997				
LOGPRIHS	log of percentage of economic migrants living in rented private housing in 1997				
MIGRNT93	number of economic migrants from outside of Shanghai in 1993				
CONINV	capital construction investment in 1997				
<i>Analysis of variance</i>	<i>Sum of Squares</i>	<i>Degree of freedom</i>	<i>Mean Square</i>		<i>F</i>
<i>Significance</i>					
Regression	16410635.36	5	3282127.072	12.7261	0.0001
Residual	3610676.44	14	257905.46		
Total	20021311.8	19			
<i>Coefficients</i>	<i>Unstandardized</i>	<i>Standardized t</i>	<i>Significance</i>		
	B	Standard Error	Beta		
(Constant)	533.6746	674.4451	0.7913	0.4420	
PCHOUSE	-28.3283	16.1995	-0.2685	-1.7487	0.1022
ISEMP	66.3169	21.4353	0.6507	3.0938	0.0079
LOGPRIHS	272.8918	167.6571	0.2668	1.6277	0.1259
MIGRNT93	0.0656	0.0981	0.0952	0.6683	0.5148
CONINV	0.0003	0.0004	0.1762	0.8248	0.4233
<u>Summary</u>	<u>R</u>	<u>R Square</u>	<u>Adjusted R Square</u>	<u>Standard Error</u>	
	0.9053	0.8197	0.7553	507.8439	

The training materials developed under this project are for sub-city urban indicators, as well as some training in GIS software (particularly for our partners in Guatemala City). The emphasis is on future maintenance and updating of the indicators database developed for each partner city, and spatial display of elements of the database over the web. In consultation with our international partners, we have developed the framework of the training module, which consists of the following elements:

Linking data sets with maps

A module including basic GIS concepts, particularly the link between spatial data in map form and tabular data from a database. (Spanish only)

- spatial data objects (polygons, lines, nodes, points)
- flat files – notion of observations and variables
- relational database concepts
- dbf format and translation to/from SPSS and Excel
- metadata for spatial objects

metadata for tabular data

Digitizing

A module including step-by-step procedures and instructions for digitizing existing paper maps. (Spanish only)

Map projections

A module including an overview of major projection and coordinate systems. (Spanish and Chinese)

- geographic coordinates
- UTM projection
- Other projection systems
- Choosing the right projection
- Distortions of shape, area, distance and direction
- Making area measurements

Scale

A module including the concept of scale and its relevance to GIS data. (Spanish and Chinese)

- definition of map scale
- scale of source materials in a GIS
- converting between map scales
- errors resulting from scale changes

generalizing map elements at smaller scales

Data integration

A module including methods and procedures for merging data from different sources to a common base. (Spanish and Chinese)

- projection and coordinate system conversion
- scale considerations
- joining attribute tables
- spatial joins

Aggregation/disaggregation of spatial data

A module including methods and procedures for aggregating data from smaller to larger areas and for disaggregating from larger areas if necessary. (Spanish and Chinese)

- working with original raw data sources
- statistical methods of aggregation

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- area and population bias in aggregate spatial data
- approaches to disaggregation
- errors resulting from disaggregation

Map design

A module including principles of map design for effective graphic presentation. (Spanish and Chinese)

- types of maps – dot maps, choropleth, contour, flow diagrams, etc.
- elements to be included
- symbolization of punctiform, linear, and areal objects
- background information and audience
- contrast
- balance
- use of color
- presentation media

Analysis

A module including methods and procedures for analyzing causes, effects, and trends. (Spanish and Chinese)

- tracking changes over time
- spatial relationships such as spatial correlation and accessibility
- analysis of hazardousness and precariousness
- estimating potential damages from rare events
- estimating potential impacts of improvement programs
- optimal location of services

Web publication of data

Prepared thematic maps of urban indicators will be published on the World Wide Web (the “web”) using ArcIMS, taking into account the need for confidentiality of selected data items at certain spatial resolutions. Partner universities will provide instructions to the VCU team on issues involving data security and confidentiality.

Completion of web-based training modules

The design of the procedures in the training materials plan has taken into account the need for simple straightforward approaches for users that can be re-learned as staff changes occur. We plan to complete the training materials and user interfaces, which then will be translated into Chinese and Spanish. Our goal is to develop web publishing tools and training materials that are understandable and can be implemented by colleagues at a remote site in a non-English-speaking environment.

Evaluation and disaggregation of indicator data

Using the data infrastructure already built, we hope to continue the collection of data through time, model of causes and effects, and monitor results. Specifically, for Shanghai, land use data of different years are for different study areas and of different scales, we are yet to be able to show a consistent historical trend in land use. In the next phase of the project, we plan to convert between map scales and disaggregate categories of land use to at least district level. The latter would allow us to compare land use patterns in different districts and link them with changes in demographic and employment structure.

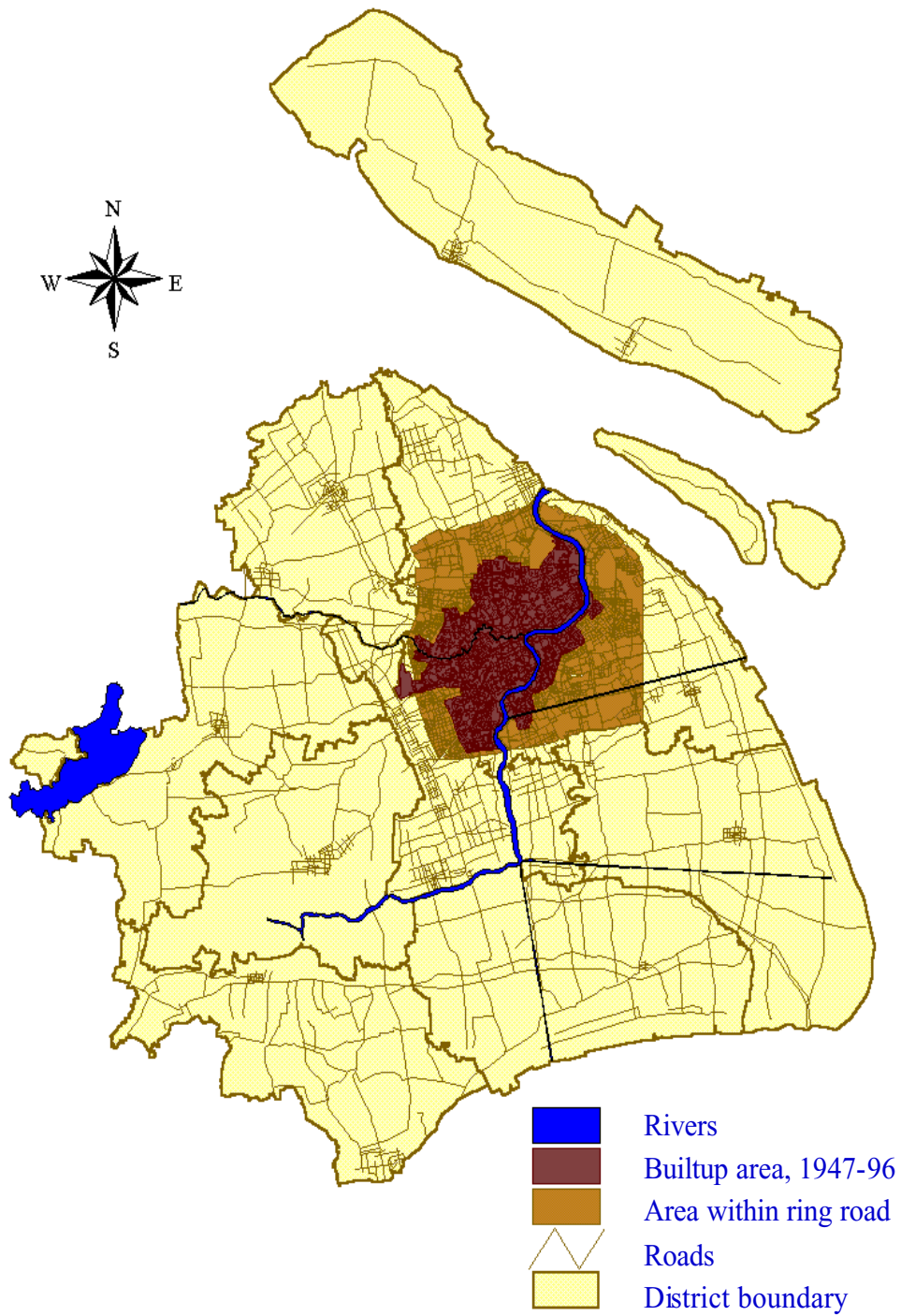
Monitoring demographic trends and spatial patterns

For Shanghai, with the likely publication of the 2000 census data, we plan to map out the spatial distribution of migrants in the metropolitan area based on their residence at the subdistrict level. Migrant spatial distribution patterns will then be compared to spatial distribution patterns of the resident population and employment activities. This will provide substantial assistance to local policy-makers.

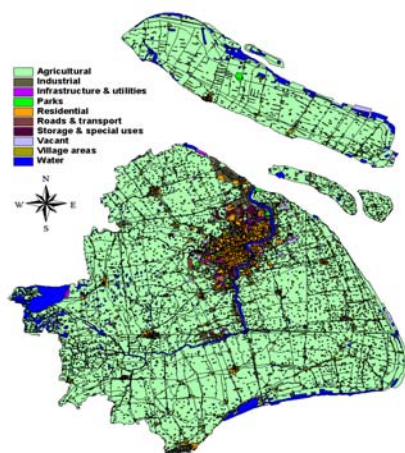
Projection of service delivery

For Guatemala City, we hope to construct a better index system of vulnerability for sub-city areas and particularly for squatter settlements. Based on this system, we plan to advise analytical methods to project service needs.

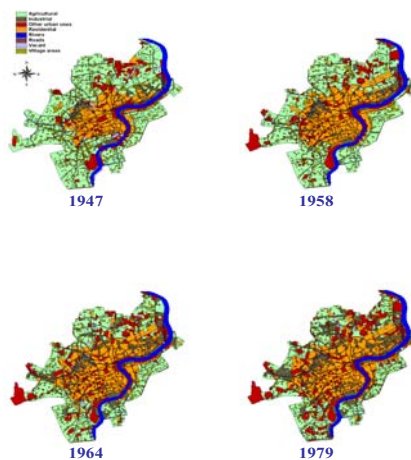
Metropolitan Shanghai



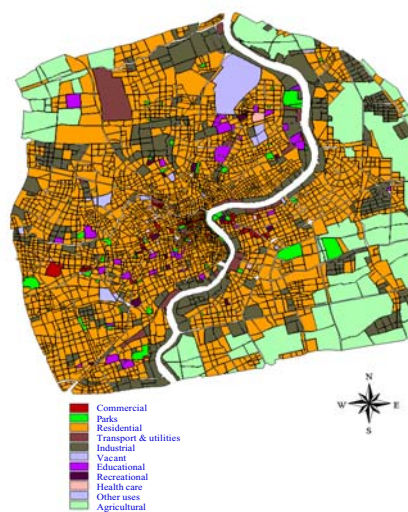
Land Use of Metropolitan Shanghai, 1994



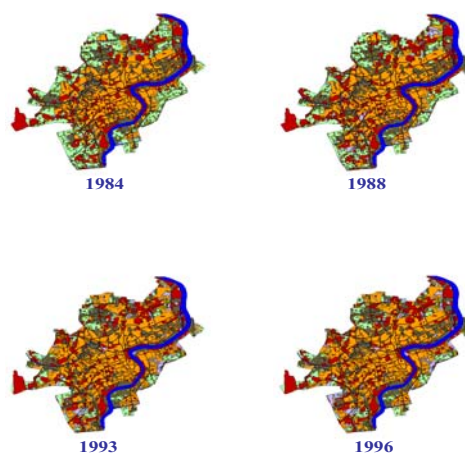
Land Use in Shanghai's Builtup Area, 1947-79



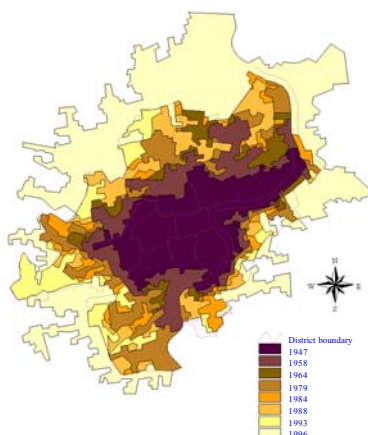
Land Use w/in Shanghai's 2nd Ringroad, 2000



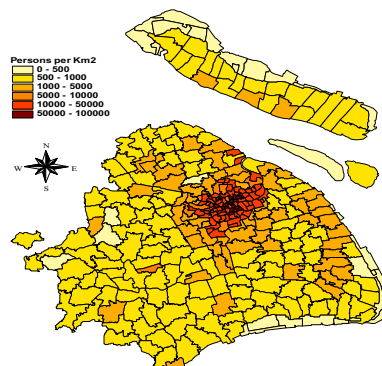
Land Use in Shanghai's Builtup Area, 1984-96



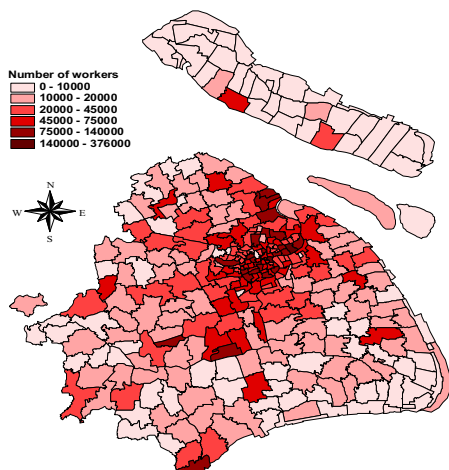
Expansion of Shanghai's Builtup Area, 1947-96



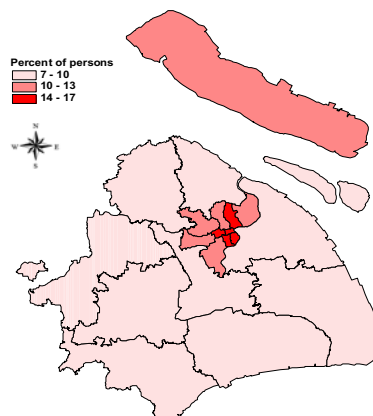
Shanghai Subdistrict Population Density, 1996



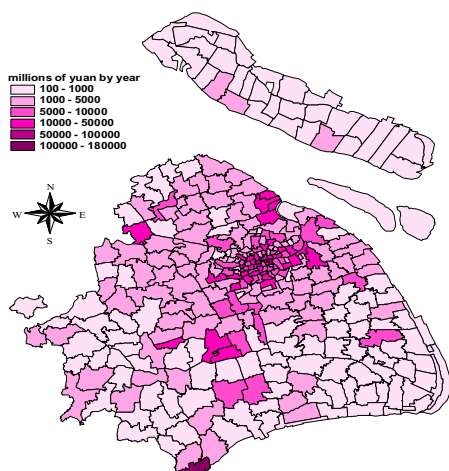
Shanghai Subdistrict Employment, 1996



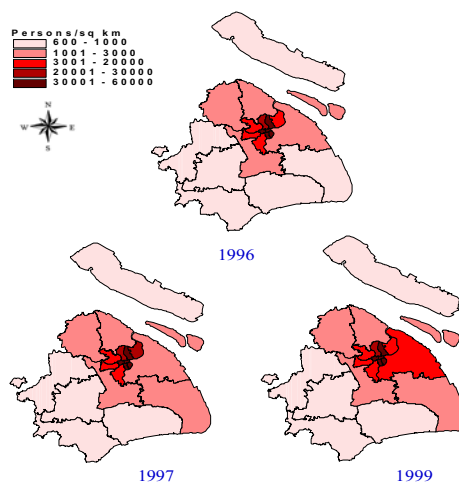
Shanghai Population 65 Years and Older, 1995



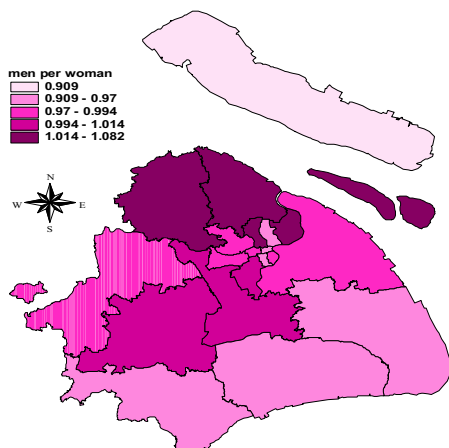
Shanghai Subdistrict Revenue, 1996



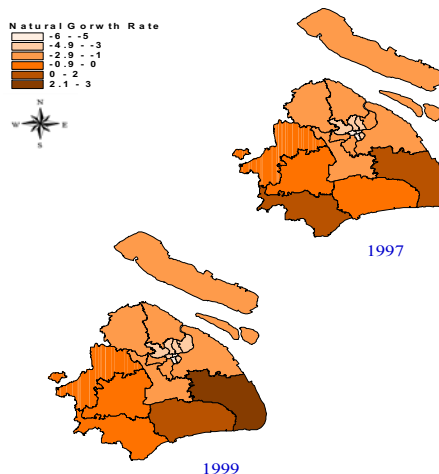
Shanghai Population Density, 1996-99



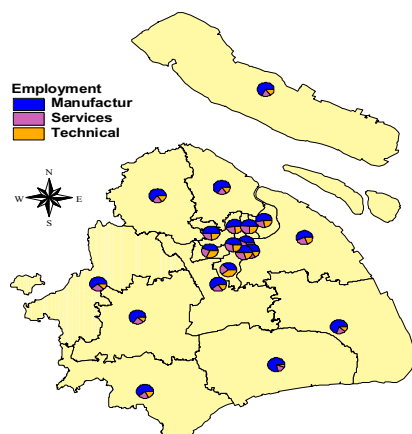
Shanghai District Sex Ratio, 1995



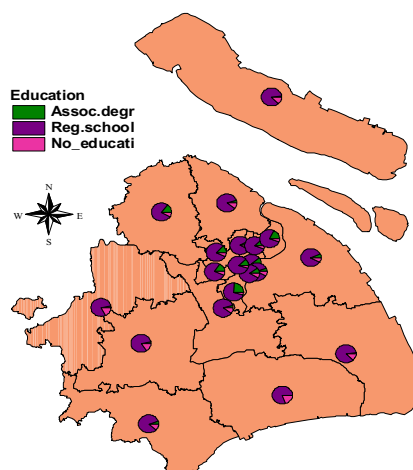
Shanghai Natural Growth Rate (%), 1997-99



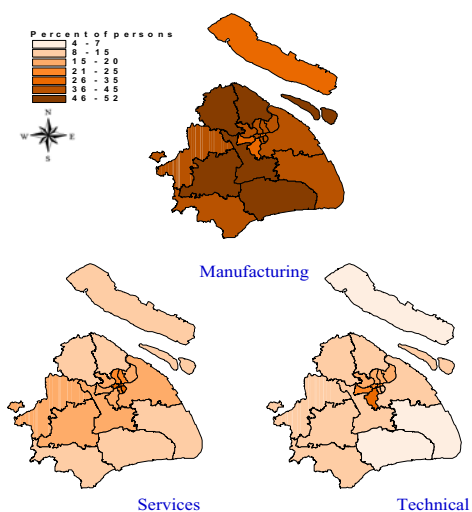
Shanghai District Employment, 1995



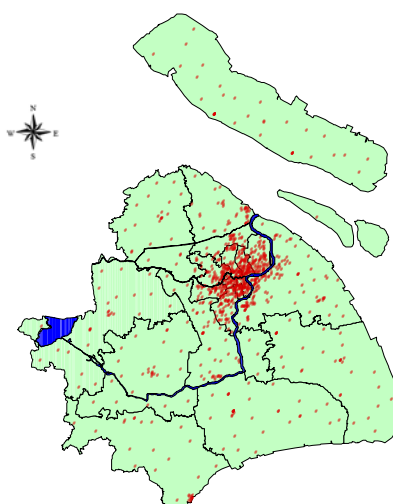
Shanghai District Educational Level, 1995



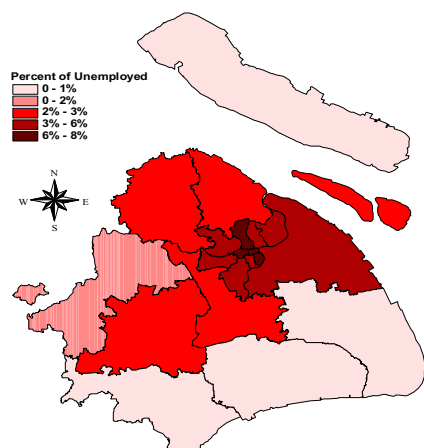
Shanghai District Employment, 1995 (II)



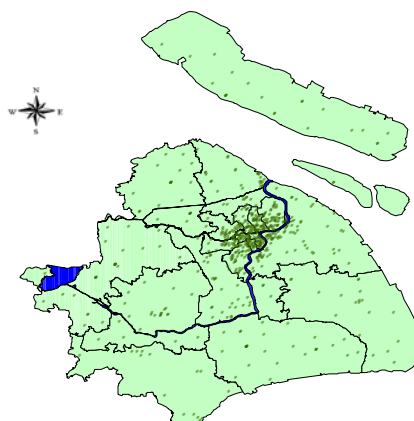
Shanghai Distribution of Primary Schools, 2000



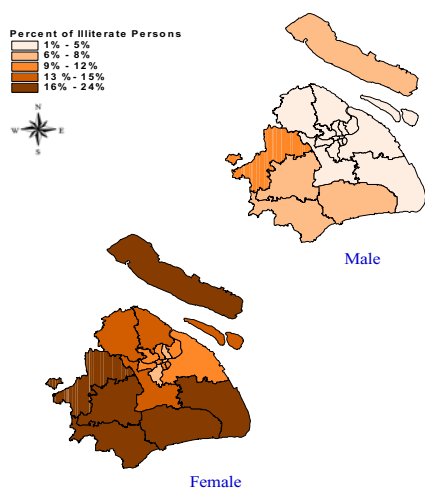
Shanghai District Unemployment, 1995



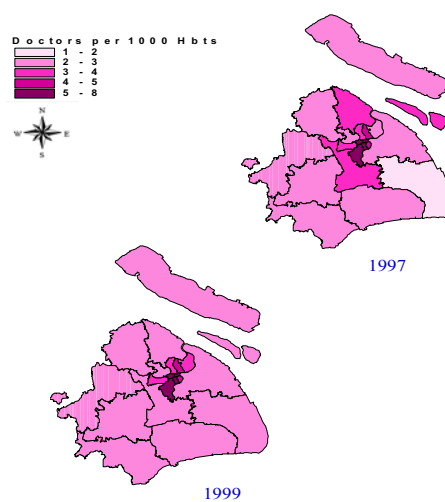
Shanghai Distribution of High Schools, 2000



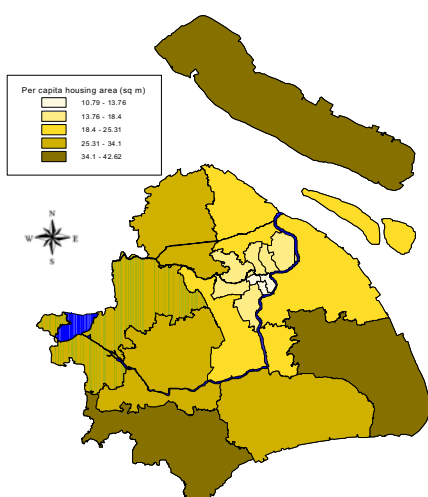
Shanghai Illiteracy Rate by Gender (%), 1995



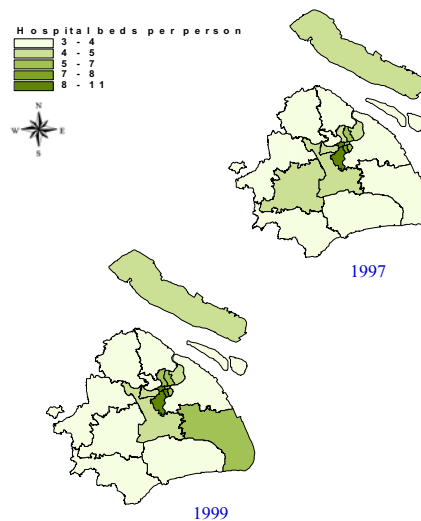
Shanghai Doctors/1000 Persons, 1997-99



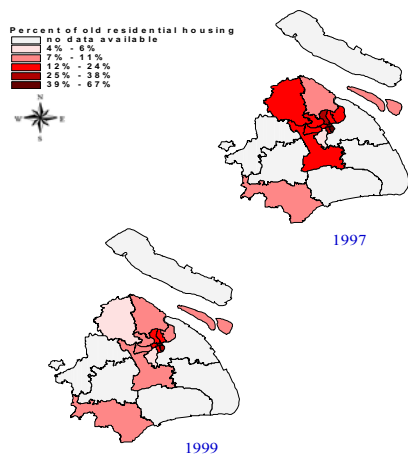
Shanghai Per Capita Housing Area, 2000



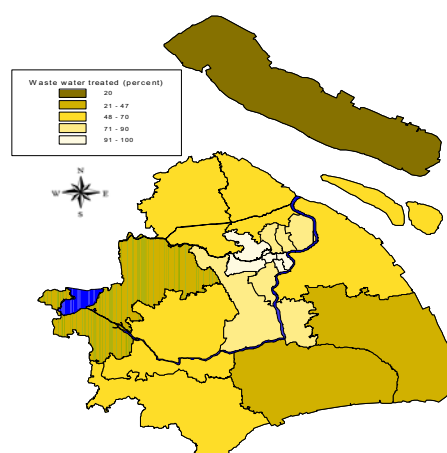
Shanghai Hospital Beds/1000 Persons, 1997-99



Shanghai Old Housing (% All Housing), 1997-99



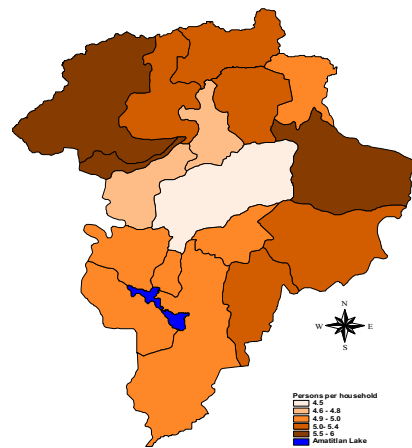
Shanghai Waste Water Treated, 2000



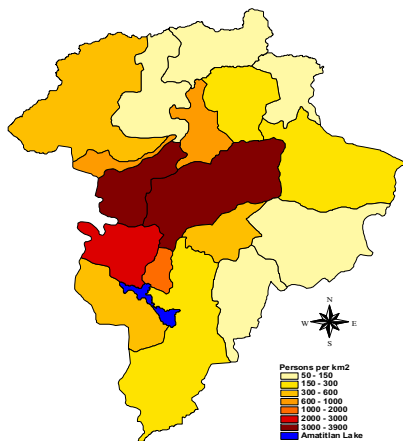
Guatemala City District Boundaries



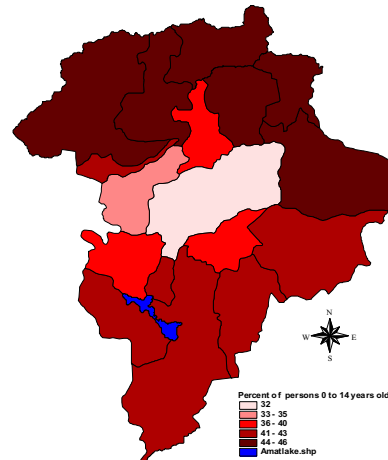
Guatemala City Household Size, 1994



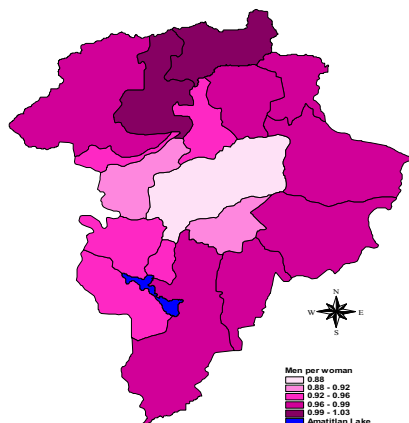
Guatemala City Population Density, 1994



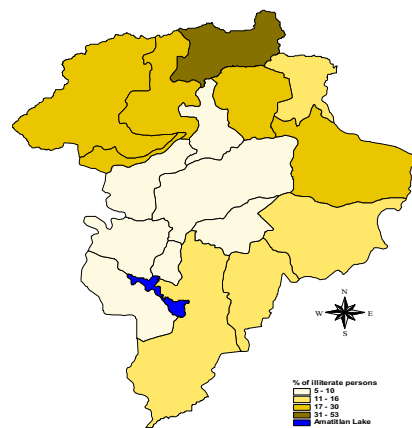
Guatemala City's Young Population (0-14), 1994



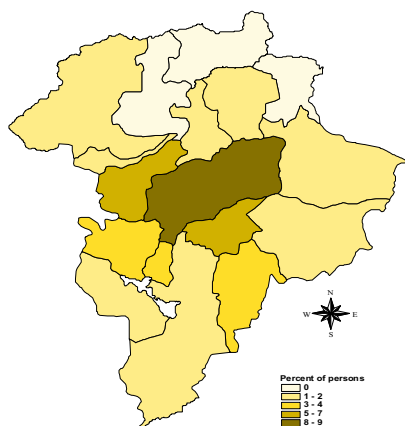
Guatemala City Sex Ratio, 1994



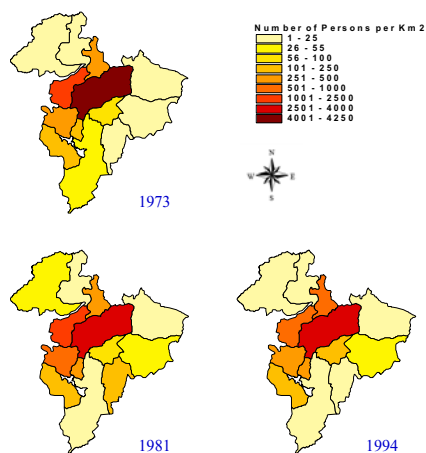
Guatemala City Illiteracy Rate, 1994



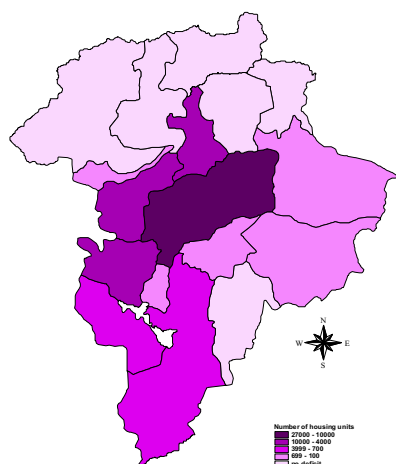
Guatemala City College-Level Population, 1994



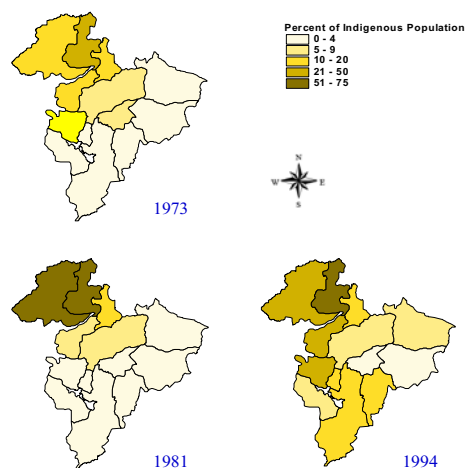
Guatemala City Population Density



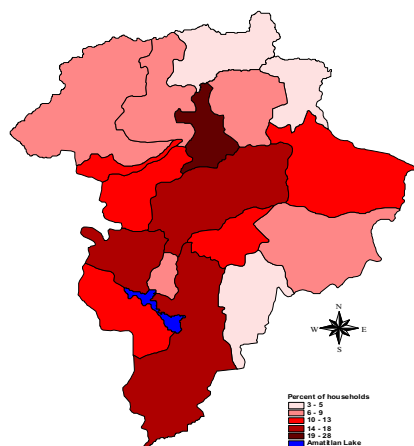
Guatemala City Formal Housing, 1994



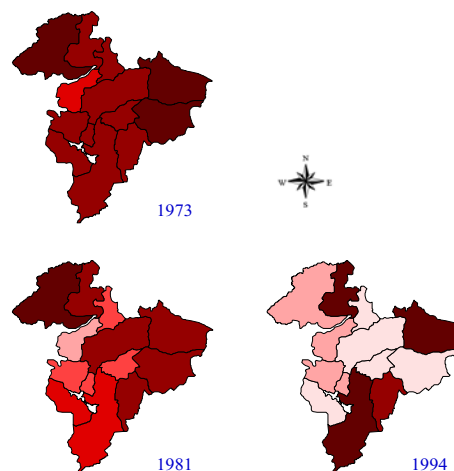
Guatemala City Indigenous Population



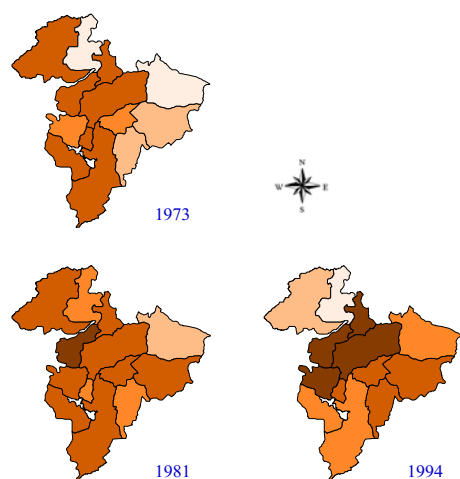
Guatemala City Informal Housing, 1994



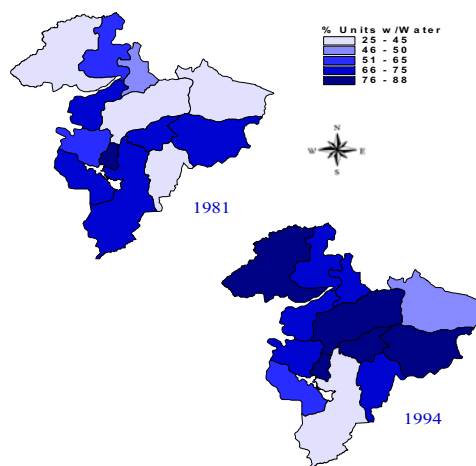
Guatemala City Illiteracy Rate



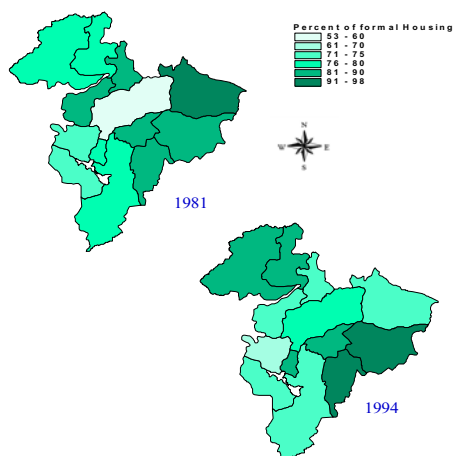
Guatemala City Participation in Work Force



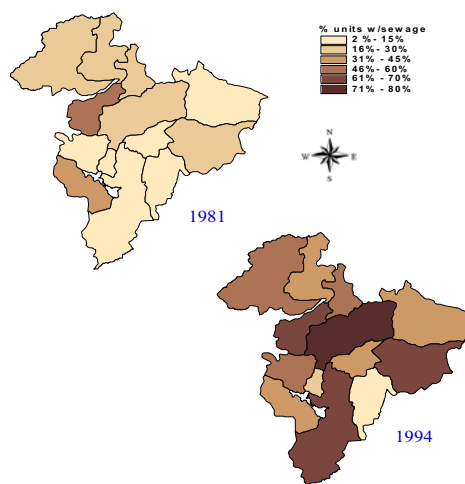
Guatemala City Water Service



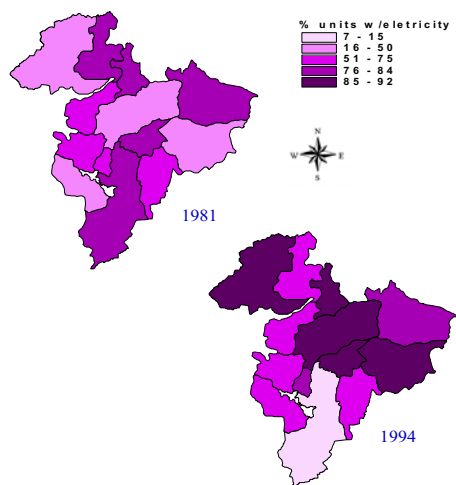
Guatemala City Formal Housing



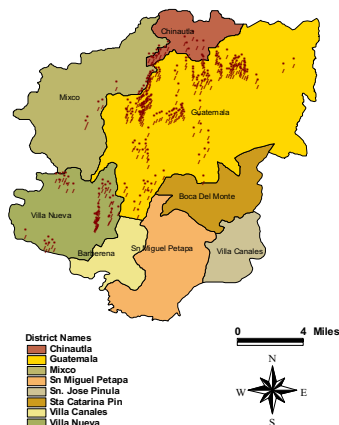
Guatemala City Sewage Service



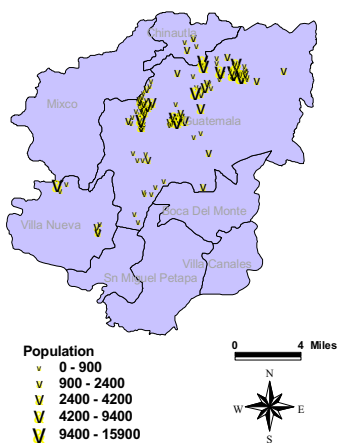
Guatemala City Electricity Service



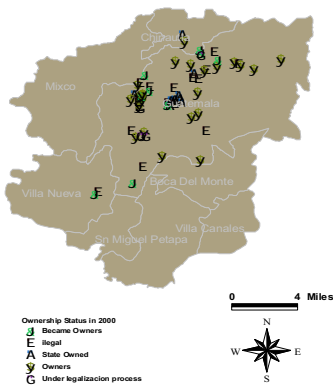
Guatemala City Squatter Settlements Location



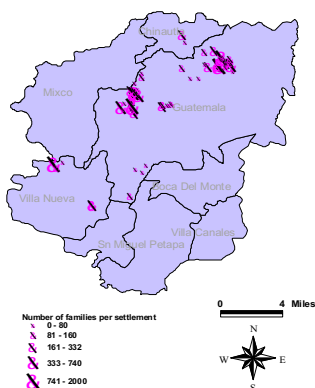
Population of Squatter Settlements



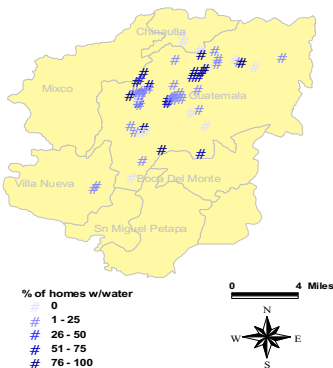
Ownership Status of Squatter Settlements



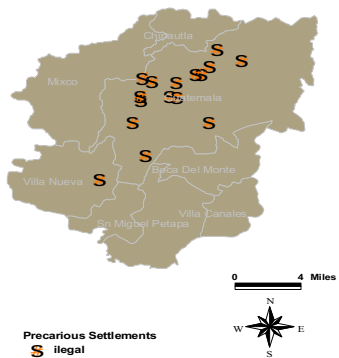
Number of Families in Squatter Settlements



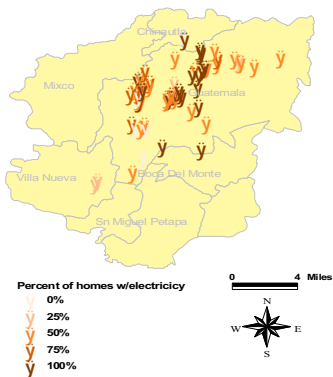
Water Services for Squatter Settlements



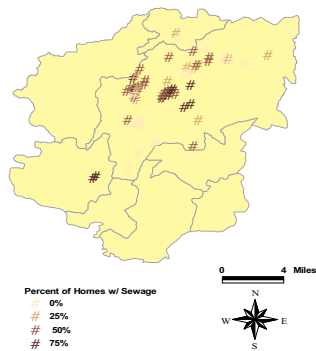
Illegally Occupied Squatter Settlements



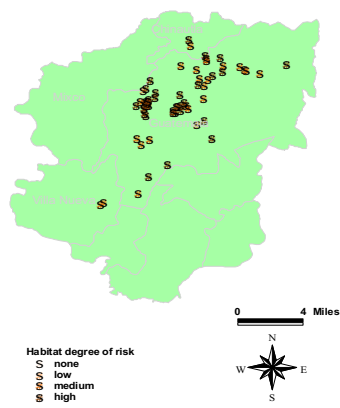
Electricity Services in Squatter Settlements



Sewage Services in Squatter Settlements



Vulnerability of Squatter Settlements (I)



Vulnerability of Squatter Settlements (II)

