A STUDY ON THE LAND VALUE OF SAVAR MUNICIPALITY

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By

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The author wishes to dedicate this Master's thesis to his beloved wife

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Executive Summary

Pricing land in small town offers a challenging irony. During high economic growth time, the conventional believe is that land values should soar with increasing demand and decreasing vacancies. Conversely, accurate forecasting of these values is problematic since comparable transactions are relatively infrequent and thus time factors are often erratic. As land, especially in the periphery of the capital city of Bangladesh, becomes increasingly short in supply, developing useful supply, demand, and pricing models is demand of the contemporary era. However, land represents not only a bundle of physical characteristics but also sets of location-specific, transport, urban amenity, socio-economic and environmental characteristics. Accumulation of locational coordinates and site area to other land characteristics makes it potential to estimate a land valne surface as well as the hedonic prices attached to local patterns of land use and other neighborhood characteristics. One can subsequently estimate how the value of such location-specific characteristics is capitalized into land prices along with other ones by applying Spatial Auto-regression model. The goal of this study is to carry out an empirical analysis to examine the effects of different land characteristics (physical, neighborhood, transport, services and facilities, socio-economic and environmental characteristics) on land prices in Savar municipality by using Spatial Auto-regression (SAR) model. Spatial Auto-regression model generates a more pragmatic method of estimating relationship between land value and explanatory factors. Specifically, spatial econometric procedures and hedonic price analysis were used to evaluate the impact of land characteristics on land prices across land market of Savar municipality. Among the spatial econometric tools, spatial autocorrelation (Moran's *I*) estimation was conducted in the study as a spatial diagnostic test for the detection of spatial dependence and heterogeneity and to identify neighboring effects on the determination of land prices. Aftermath, the Spatial Auto-regression model reveals that the transportation or accessibility attributes, services and facilities characteristics, and socio-economic characteristics have significant inflnence on the land price of the transacted plots in 2006. In recapitulaiton, the study concluded that transport attributes of the land at Savar municipality have most significiant relationship with the land value along with other explanatory variables like municipal amenities, physical characteristics of the plot, employment attraction, and commercial services.

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Chapter I

INTRODUCTION

Chapter 1
Introduction

1.1 Problem statement

The U.N. Habitat Conference of 1976 identified various issues to improve housing conditions in Third World cities. However, it has been realized at the 2nd Habitat Conference of 1996 that housing conditions for lower income group people in most Third World cities have not improved, especially in respect of tenure, affordability and overall quality of housing, while total number of people in cities has grown considerably. In order to address this issue there was a necessity to look at the predicaments where we should focus on various attributes of housing such as accessibility and affordability of land for housing, availability of finance or credit facilities, government intervention through legislation and other institutional supports. Consequently, the 2nd Habitat Conference has appropriately recognized 'land' and 'credit' as two very imperative areas for those concerned with understanding and then improving shelter conditions in Third World cities. Such internationally identified burning issues in housing provide stimulus for studies to come forward so that an appropriate understanding of these two vital aspects of housing could be developed (Amitabh, 1997).

During the 1980s and 1990s much of the stimulus to study urban land markets in the Third World was produced by the 'informal' and 'illegal' sub-divisions that were carried out by the 'urban poor' and 'low income households' on the peripheries of developing cities (Gilbert, 1981; Gilbert and Ward, 1985; Trivelli, 1986; Ward, 1989; Jones, 1991; Brennan, 1993). This was particularly factual in Latin American cities, where there was a mounting spotlight on studies of urban land markets at this time[1]. On the contrary, very little documentation is available on the nature of peripheral sub-divisions in Africa, although a recent survey of some Kenyan cities suggests that 'Latin-American' style processes may be occurring there (Macoloo, 1996). In the case of Guinea and Nigeria, most land tenures are publicly-owned (Durand-Lasserve,

[1] For detail of urban land market research in Latin America, see: Geisse and Sabatini, 1982; Mohan and Villamizar, 1982; Haddad, 1982; Gillbert and Ward, 1985; Gillbert and Healey, 1985; Ward, 1989; Jones, 1991; Ward et al., 1993.

1991; Omirin, 1992), while a study of Cairo suggests that land sub-divisions in the peripheral areas of some North Africans cities are no more 'illegal', 'informal' or 'invaded' than one would expect to find in most Latin American cities. In most South Asian countries signs of 'Latin-American' style sub-divisions on the periphery of cities are recently observed.

However, the complexity of the urban land market led to the development of three markets, which in theory are distinct but, in practice, are quite intertwined: (i) the market of purchase and sale of land, (ii) the housing market and (iii) the renting market. Such urban land market as a whole is actually not an organized market where there is a buying and selling place, as it would be for mobile merchandise, but an aggregate of uncountable businesses, big and small, which involve plots or constructions totally heterogeneous. Perhaps due to complexity of the concerned transactions, to the number of stakeholders and to the permanent unbalance between demand and offer in each type of market, the specialized literature shows a series of imperfections of the urban land market. For some researchers these imperfections are endogenous, which, to their opinion, justifies the intervention of the State (Toulmin and Quan, 2000), while for others these are temporary imperfections which are essentially due to the persistent intervention of the State in the market activities (Binswanger and Deininger, 1993; Antwi and Adams, 2003; Teklu, 2004).

In addition, the urban government does not have, nor will have at a short or medium term, the possibility to urbanize new land, build infrastructure and install social equipments at the same speed as the demand growth. For this reason, the access to urban land through the market will tend to increase. The unplanned urban growth will increase at rhythms difficult to be controlled and urban poverty will increase (Negrão *et al.*, 2004).

It is therefore urgent to develop instruments that allow city councils and surrounding municipalities to foresee what will happen in the coming years in order to take preventive measures and, thus, reverting the trend of increased urban poverty (Negrão *et al.*, 2004).

Nevertheless, the construction of instruments for anticipating the land price is complicated due to the significance of various spatial, temporal and socio-economic attributes on the land price. Like the other highly populated developing cities, the rapid augmented urban population in Dhaka City in recent decades has made the decreasing land-man ratio more complicated. The supply of urban land is highly limited. On the other hand, demand for land for industrial, commercial as well as residential purposes is growing up. This results in high land value. But value of plots varies from area to area even from plot to plot. The spatial differences in land values are caused by spatial differences in these features. Furthermore, the economic characteristics (e.g. land price) of space depend on physical factors, spatial structure of an area, transportation, neighborhood and environmental factors like type of the neighborhood, distance of the main road, distance of the access road, distance of the nearest market place, distance of the nearest health facility, distance of the nearest school, distance of the Central Business Districts (Rcaechiff, 1977). This is a specific system of prevalent planning functions the manner of land development which particularly 'attract' or 'repel' demand and the specificity of human behaviour and resulting differences in perceiving the attractiveness of particular areas.

Thus, the influence of such locational elements on the land value can be estimated by using Spatial Autoregressive (SAR) model if we consider the spatial correlation among the properties.

1.2 Objectives

The foremost purpose of this study is to determine the factors influencing land price in order to identify the change of land price resulting from change of any of the factors as part of local, regional and national spatial planning efforts. However, the study aims to show the influence of factors on determining the land prices in Savar municipality. The broad objectives of the study are —

- To identify different types of factors influencing land price; and
- To estimate the extent of influence of locational factors on land price by using spatial autoregressive model.

1.3 Justification of the study

Savar, an important satellite town of Dhaka city, is a suburban area to the west of Dhaka Metropolitan Area (DMA). The area experienced a rapid growth of population, urban expansion and a change in traditional agrarian land use during the past nineteen years due to the influences of urbanization process of the Dhaka Metropolitan Area (DMA). This gives rise to various problems at the same time providing the space for accommodating more and more urbanities in the municipality (Fouzdar, 2005). One of the problems is unpreceding growth of land price. Savar municipality is selected as the study area because of the dynamic uplift of land price during the last twenty years. The average land price growth rate of Savar municipality during the last 1985-1995 was 928 percent, which was 225 percent during the period of 1995-2005. The amazing growth during the period of 1985-95 because of the declaration of Savar urban area as municipality and construction of urban infrastructures. In case of ward wide land price in Savar municipality, during the period of 1985-95 the growth rate was 160 percent. 117 percent, 127 percent, 3342 percent 2355 percent, 1608 percent, 256 percent, 244 percent and 145 percent in ward no. 1, 2, 3, 4, 5, 6, 7, 8 and 9 respectively. On the other hand, during the period of 1995-2005, it was 182 percent, 152 percent, 193 percent, 178 percent, 128 percent, 339 percent, 382 percent, 230 percent and 239 percent in ward no. 1, 2, 3, 4, 5, 6, 7, 8 and 9 respectively.

However, the determination and anticipation of the land market values of Savar municipality is essential for regulating the transmissions of land rights either through the market, through government allocation or through consuetudinary systems. The more accurate is the determination and dissemination of these values, the less will be the transaction costs for the potential "buyer" and the potential "seller", the less will be the possibility of corrupting concerned employees and the higher will be the revenues of the government. The higher is the fiscal revenue, the greater will be the benefit through the improvement of living standards in the Savar municipality (Negrão *et al.*, 2004).

1.4 Limitations of the study

- It is assumed that land value is the present value of all future benefits discounted by the sum of the risk free rate and the land's risk premium rate. The risk premium can be indirectly estimated by determining the historical standard deviation of return in excess of the standard deviation of the (risk free asset) market return. Future benefits consist of all estimated future cash flows derived directly or indirectly from the ownership of the asset. This concept is integral to the need to formulate a valuation method, which is based on an estimate of future value adjusted for risk. This future value can only be estimated however by analyzing the underlying historical relationships between value and those factors which may influence it. Future benefits can better be understood and estimated through an understanding of the historical relationships. Nevertheless, this study does not derive the present value of the future benefit because of the absence of historical data and relationship.

- Scarcity and authenticity of land transaction data. An evidence of huge deviation was observed among the data obtained from the Savar Sub-Registry Office, Stakeholders of the transacted land and the local people.
- In the year 2006, a total number of 32000 plots were transacted in different Mouzas of Savar Upazila. Nevertheless, this study is concerned with the Savar municipality. Therefore, it was quite difficult to sort those transacted plots, which are within Savar municipality.
- In order to verdict the authenticity of the data obtained from the Savar Sub-Registry Office, data apropos of the price of transacted plots were cross checked aftermath by conducting a questionnaire survey of the stakeholders (buyer or seller). The addresses of the stakeholders were collected from the documents stored in the Savar Sub-Registry Office. It was an extensive work to find out the buyers/sellers in their mentioned locations because of their locational diversity.
- A lot of studies regarding the factors influencing the land price were conducted in abroad but there is no such strong evidence of studies on this issue in Bangladesh especially by applying the Spatial Auto Regression Model.
- Spatial Auto Regressive Model is not so familiar in Bangladesh comparing to Hedonic Pricing Model in the context of determining the land price. So, the study requires an extensive literature review on this model and application tools such as GeoDa.
- Some significant economic factors, which may have significant influence on the land price. cannot be incorporated in this experimental model because of the scarcity of the data at Mouza level. These are unemployment rate, effective purchasing power of the target groups, and equilibrium of supply-demand interaction.

- Temporal or trend analysis has also significant impact along with spatial analysis on land price. This study, however, has a pitfall of not incorporating the temporal analysis.

1.5 Organization of the thesis

No single study can anticipate to tackle all or even most of the questions apropos of the land market. This study precincts itself to a spatial analysis of the persuasion of factors on land market. The study focuses on the application of Spatial Auto Regressive Model in order to determine spatial significance of factors of land on the determination of land price. It is supposed that the points of focus considered in this study will allow the study to offer an interesting 'corrective' to certain biases those currently consider as the determining factors for the land market.

The rest of the thesis comprises of six substantive chapters and a conclusion. Chapter II describes the research design in order to achieve the goal and objectives of the study. This chapter encompasses research questions, preparation of sample size, variable identification based on the research questions, the methodology used in collecting data on land prices and other associated variables. It also presents a comprehensive description of the techniques of data analysis. Chapter III presents an account of land use distribution, road network, and spatio-economic growth of Savar municipality. Chapter IV provides an overview of the analytical tools for spatial analysis and spatial regression analysis of land price, and testing of spatial dependence of property on neighbor properties. Chapter V describes the result of data analysis by applying Ordinary Least Square (OLS) Hedonic Price Model, which incorporates diagnosis of OLS Hedonic Price Model, categorization of transacted plots based on the diagnosis, and category-wise derivation of Hedonic Price Model of the transacted plots. Chapter VI focuses on the diagnosis test of spatial dependence (spatial autocorrelation) of a particular plot on the neighborhood plots by applying Moran's *I*. Chapter VII corresponds to the outcomes of spatial autoregressive analysis of the relationship between explanatory variables and land price. Eventually, Chapter VIII draws the principal research findings together and discusses the major issues and relevant recommendations those arise from the study.

Chapter II

RESEARCH DESIGN

Chapter II

Research design

Research design describes steps taken to achieve the goal and objectives of the study. It is the most imperative ingredient of any research work as the quality and the anticipated consequences of the research depend on it and a well-designed methodology persuade researcher to attain goal and objectives very straightforwardly. Thus, the study was carried out following the methods described below—

2.1 Research questions

The research questions related to the above objectives were: What is the spatial interaction of land market in the study area? What is the spatial relationship between land values and explanatory factors?

2.2 Selection of the study area

The nine wards of Savar municipality were considered as the study area to get factual and vivid picture of land prices of the Savar municipality.

2.3 Literature review

Relevant information was reviewed extensively. Theses, journals, articles in newspapers and periodicals and the internet contributed immense help to make the study affluent.

2.4 Sample size

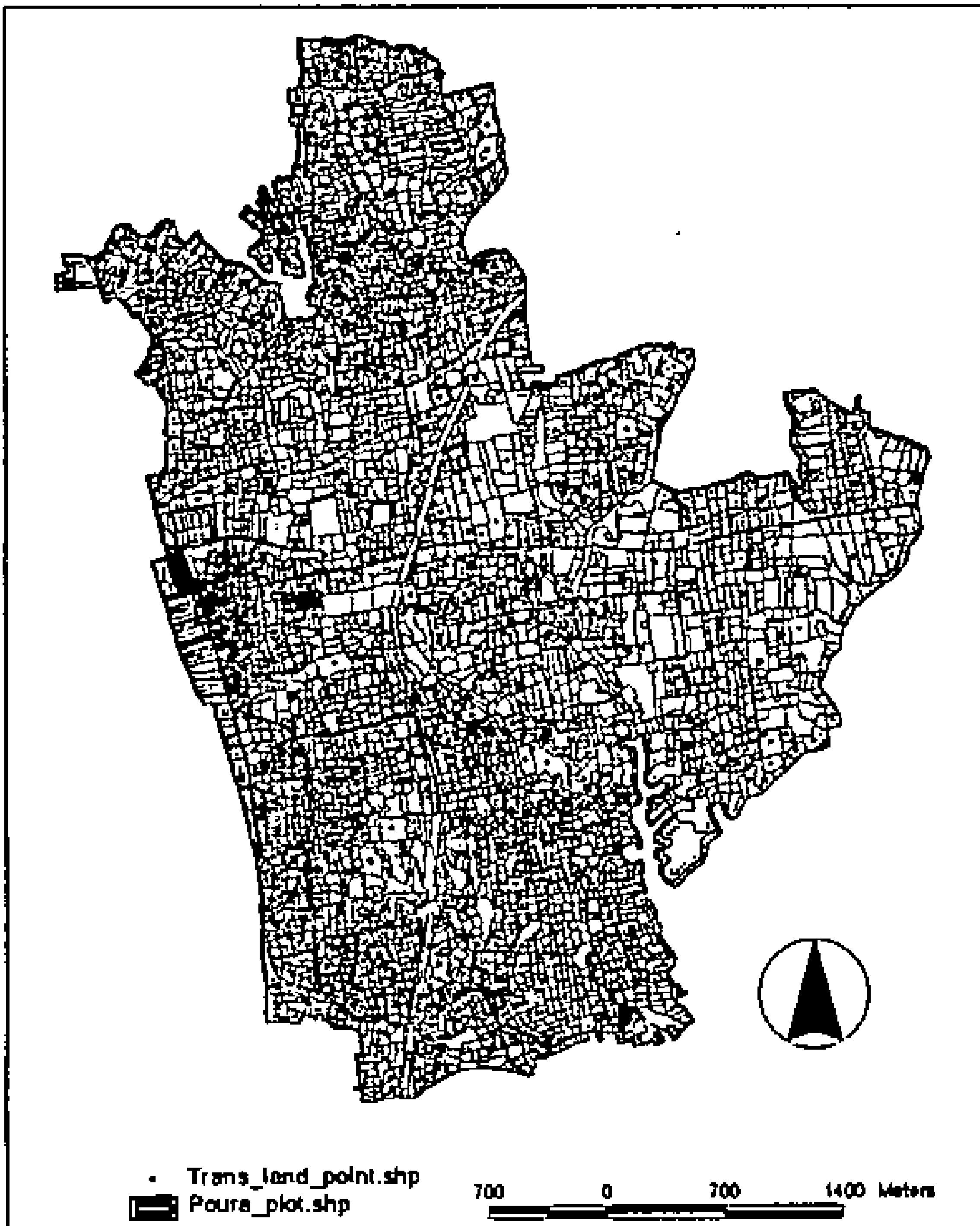
In 2006, a total of 971 plots were transacted in Savar municipality. Out of these, 862 transaction data were encoded based on the availability of information on land class, Mouza no., land area and land price. Furthermore, lots, which were partially transacted at several times in the year 2006, were amalgamated in order to evade any kind of complexity during the spatial analysis. Thus the total number of sample size is 574 (Map 2.1). The transacted plots in 2006 in different mouzas are given in Table 2.1 and Apendix A.

Table 2.1: Mouza-wise transacted plots of Savar municipality

Mouza Name	No. of plots	Average price (TK) per decimal	Standard deviation (TK) per decimal
Aichanoyadda	36	29410	16451
Akran	6	32708	7547
Anandapur	25	40611	7557
Arapara	5	33247	5627
Badda	33	63128	97175
Bagmibari	2	21202	10
Balimohor	33	31617	16375
Boraigram	5	40695	5992
Dakhin Dariyarpur	8	41826	7039
Dakhin Ramchandrapur	12	39854	9898
Dgormera	8	48710	8825
Diagaon	8	30225	5857
Genda	118	120466	31248
Imandipur	4	40609	6609
Jaleswar	23	33616	7035
Jamshing	80	35435	12589
Karnapara	11	42909	4570
Katlapur	12	40961	6411
Majidpur	40	43145	14013
Purbo Vobanipur	2	34000	2828
Rajashan	33	24127	9871
Sadhapur	22	25319	7632
Savar	16	33732	7980
Shyampur	13	36458	5749
Vatpara	14	42515	11876

Source: Savar Sub-registry Office, 2007

But due to the extreme diversity of price comparing to the rest of the plots in particular mouzas, some plots were excluded from the analysis, such as 2, 2, 6, 3, and 2 plots were excluded from the Aichanoyadda, Badda, Genda, Jamshing, and Majidpur mouzas respectively (Apendix A). This resulted in average and standard deviation of land price in the Aichanoyadda, Badda, Genda, Jamshing, and Majidpur mouza as TK 26493 and TK 11366; TK 39674 and TK 10613; TK 122370 and TK 16709; TK 36374 and TK 11869; TK 44465 and TK 13062 respectively.



Source: Prepared by author, 2009

Map 2.1: Transacted plots of Savar Municipality

2.5 Variables Identification

Various methodologies can be deployed in order to identify the explanatory variables of the land price. Appraisal methodology is one of them. Appraisal methodology derives from the general theory that, at equilibrium, the value of land is a function of utility, scarcity, desire, and effective purchasing power. Land pricing models are equilibrinm models because they estimate market value as the interaction of supply and demand at equilibrinm.

Traditional Theoretical Mono-centric City models, developed by Alonso (1964), Mills (1967), and Muth (1969), assume distribution of land uses on a featureless plain around a central bnsiness district (CBD). Land rent in these models pursues declining gradient from CBD and land price can be easily associated to land rent by simple constant, time discount rate (interest rate). which is implicit to be general for all market participants (Fujita, 1989). In more recent times, these models have been customized more pragmatic and intricate by incorporating polycentric cities, different expectations pertaining to the future, etc. (Anas *et al.*. 1998).

Correspondingly, effects of LRT (Light-Rail Transit), subways and highways on land valnes have also been quantified in hedonic models (Haider and Miller, 2000). In a study, Al-Mosaind and others (1995) used a sample of 235 properties and observed 'a affirmative capitalization of propinquity to LRT stations for honses within 500 meters of actual walking distance' (Al-Mosaind *et al.*, 1995). They argned that proximity to LRT improves resident's accessibility to CBD and other urban areas with employment opportunities.

Other gronp of models, known as the public finance/spatial amenities models (Mieszkowski and Mills, 1993), is derived from the Tiebout (1956) model and according to these models individuals prefer their property based on location-specific public goods. That is, individuals "vote with their feet" for a package of services as well as local fiscal and non-fiscal amenities in their choice of property position (Hoyt and Rosenthal, 1997). However, in functional field, which is dominated by hedonic approach and largely based on aggregate spatial data such as censns data, both strands of theoretical models snch as distance measures and neighborhood measures has been tried to integrate (Dubin, 1988; Dubin, 1992; Can, 1990; Can, 1992; McMillen, 1974; and McMillen, 1995).

Besides much of the concern in land prices in recent literature focuses npon the nonlinearity between the price of urban land and parcel size. Recent empirical studies report that land value increases at a decreasing rate as parcel size increases. Colwell and Sirmans (1980) investigated this phenomenon using land sales from Edinburgh, Scotland and Urbana-Champaign, Illinois to estimate the parameters of four different models of the relationship between size and value. Their results suggest that a standard Cobb-Douglas constant elasticity functional form gives the best fit. Kowalski and Colwell (1986) also established that land value increased at a decreasing rate as parcel size increased using sales of industrial land in a single sector of western Wayne County, a suburban area outside Detroit.

In an analogous study of land prices near Chicago, Chicoine (1981) included data on more property characteristics than Colwell and Sirmans, counting whether the buyer and seller are individuals or not (e.g. corporations, partnerships, etc.). The coefficient of Chicoine's buyer and seller variable is negative and statistically noteworthy. Additionally, Chicoine well-versed a negative and significant interface between the buyer and seller variables and commercial zoning suggesting that his buyer and seller variable may be acting as a surrogate for an omitted variable related to commercial zoning.

Garrod and Willis (1992) examined neighborhood or environmental characteristics of countryside land parcels in the United Kingdom using a hedonic price model. The picturesque sight (of woodlands. for example) and the presence of water were important amenity attributes in their research. Bockstael (1996) developed a hedonic model in order to predict probabilities associated with converting undeveloped land to developed lands. Important variables included lot size, public services, zoning, propinquity to population centers and variables associated with the percent of agricultural use, forestlands and open space in the watershed. This model helped in understanding land use attributes and parcel value.

Although effects of urban amenity attributes on land price are analyzed in several articles, but few to date have incorporated the spatial specificity afforded by GIS (Geographic Information System) measurement. Kennedy and others (1996) conducted a hedonic rural land study using GIS. The analysis identified rural land markets in Louisiana based on economic, topographic and spatial variables. GIS was used for defining distance to market as well as soil type variables. Geoghegan and others (1997) developed GIS data for two landscape indices and incorporated them in a hedonic model for Washington. DC, suburban properties. Their measure of fragmentation was distinct as perimeter to size ratio. They also used land cover measure as an index of land use type, which is a surrogate for flora and fauna habitat. Their study provides a discerning assortment of landscape indices. Bastian and others (2002) used GIS data in a hedonic price model to estimate impact of amenities and agricultural production characteristics of land on price per acre for a sample of Wyoming County of USA.

In addition. Sengupta and Osgood (2003) used ranchette sales data as dependent variable and satellite greenness indices as explanatory variables along with access to roads and cities.

However, based on the literature review. local knowledge, and expert opinions, the significant explanatory variables of land price under six parameters have been recognized for this study. The selected parameters are structural characteristics of transacted plots (size of the property, compactness and topographical elevation): neighborhood attributes (population and household density of the concerned Mouza, percentage of residential, commercial, agricultural, industrial and open spaces in the concerned Mouza); transport attributes (distance from the nearest bus terminal, national highway. municipality road, pucca road, semi-katcha road and katcha road); environmental characteristics (distance from the nearest toxic industry and brick field); services and facilities (distance from the nearest shopping center, post office, police station, hospital, wholesale market, educational institution, municipality facilities, dustbin, and bank); and socio-economic characteristics (distance from the nearest recreational facility, religious center, employment attraction and development organization). Through trial and error, the following variables were determined as significant ones (Table 2.2).

Table 2.2: Matrix of factors influencing land value

Main factors		Variables	Data level	Data source
Land price (Dependent variable)			Quantitative	Sub Registration Office Local people Buyers and sellers
Explanatory variable	Structural factors	• Size of the property	Quantitative	Sub Registration Office
		• Shape of the property (compactness)	Quantitative	Map
		• Topographical elevation (Contour)	Quantitative	Department of Geography, JU
	Neighbor hood factors	• Population density (Mouza)	Quantitative	Secondary survey
	Transportation factors	• Euclidian distance to the nearest public transport (Bus terminal)	Quantitative	Primary survey
		• Euclidian distance to katcha road	Quantitative	Primary survey
		• Euclidian distance to semi-katcha road	Quantitative	Primary survey
		• Euclidian distance to pucca road	Quantitative	Primary survey
		• Euclidian distance to municipality road	Quantitative	Primary survey
		• Euclidian distance to national highway	Quantitative	Primary survey
			Quantitative	Primary survey
	Environmental quality	• Euclidian distance to the nearest industry	Quantitative	Primary survey
		• Euclidian distance to the nearest brick field	Quantitative	Primary survey
	Services and facilities	• Euclidian distance from property to post office	Quantitative	Primary survey
		• Euclidian distance to police station	Quantitative	Primary survey
		• Euclidian distance to nearest market/ shopping centers	Quantitative	Primary survey
		• Euclidian distance to nearest hospital	Quantitative	Primary survey
		• Euclidian distance to nearest wholesale market	Quantitative	Primary survey
		• Euclidian distance to education institution	Quantitative	Primary survey
		• Euclidian distance to municipal facilities	Quantitative	Primary survey
		• Euclidian distance to bank	Quantitative	Primary survey
		• Euclidian distance to solid waste management (dust bin)	Quantitative	Primary survey
			Quantitative	Primary survey
	Socio-economic characteristics	• Euclidian distance to recreational facilities	Quantitative	Primary survey
		• Euclidian distance to religious center	Quantitative	Primary survey
		• Euclidian distance to employment attraction	Quantitative	Primary survey
		• Euclidian distance to development organization	Quantitative	Primary survey

2.6 Data collection

All studies of urban land price changes in Third World cities have to face up to a complex range of methodological problems, of which two main ones stand out. First, land price data are scarcely available. When data can be dug out from government and unpublished public or private sources, the reliability of such data is often an immense predicament. Secondly, a wide range of data sources and methods of analysis have been employed by researchers working in Third World countries (Dowall, 1989a and 1990; Jones, 1991; Ward *et al.*, 1993). The assortment is extensive enough to prevent factual comparisons across studies and to contain generalizations. This indicates the lack of a unanimously acceptable methodology in urban land price research (Amitabh, 1997).

Dowall's (1989b) endeavor to analyze land price changes in Bangkok was different from what Ward (1989) proposed for a study of two Mexican cities. Dowall's (1989b) study of Bangkok relies on data supplied by different categories of brokers in service in the city. On the other hand, studies of Mexican cities by Ward (1989), Jones (1991) and Ward and others (1993), rely on data supplied by both newspaper advertisements and household surveys. Their major concern was not to investigate land price changes in terms of center-periphery relationships, as proposed by Dowall (1989b), but to examine why and how land prices changed in Mexican cities over a given period of time.

However, any comparison of the resnlts of these studies wonld be franght with difficnlties. Snch a comparison would become more complex still if one takes another study into account; for instance, the Town and Country Planning Organization (TCPO) (1984) study of Indian cities was based on unpublished data sources from government institutions. Dowall, Ward, Jones, the TCPO, and various other land price researchers in the Third World, had all tried to rationalize their methodologies and data sets, but they have also distinguished that the lack of availability of land price data is a widespread and solemn dilemma (Amitabh, 1997).

To face up to these problems, Ward (1989) proposed a research schema, which wonld encourage other researchers to work under one umbrella. Jones (1991), Ward and others (1993), Macoloo (1996) and Amitabh (1997) concentrated to this call and varnished their research in comportment that would aspire to use analogous data sources, methodologies and approaches. This research agenda-as-protocol was further discussed at the Firzwilliam Workshop in Cambridge in 1991. At the end of the workshop, researchers agreed that there are 'conflicting methodologies' in urban land price research in developing countries, and there are currently problems in analyzing trends in land prices because of an inconsistency in comparing studies. It was snggested researchers should develop at least certain common checkpoints while collecting and analyzing land price data (Firzwilliam Memorandum, 1991).

However, in this study, data apropos of the transacted plots in 2006 were collected from three different sources such as Savar Sub-registration Office, buyers/sellers of the transacted land (buyer or seller) and local people. The addresses of the buyers or sellers were collected from the documents available in the Savar Sub-registration Office. From the survey, it exposed that collected information on land price from Savar Sub-registration Office and buyers/sellers were intimately related than those accumulated from the local people. Because of the matter of authenticity, the preceding sources are pondered as the pivotal sources.

Thereafter, location of different variables, germane to this study, was identified by reconnaissance survey (Table 2.2). The compactness of the transacted plots was premeditated by applying GPS (Global Positioning System). In addition, topographical elevation of the plots was collected from Dr. Shahidur Rashid, Professor of the Department of Geography and Environment, Jahangirnagar University (Map 2.2).

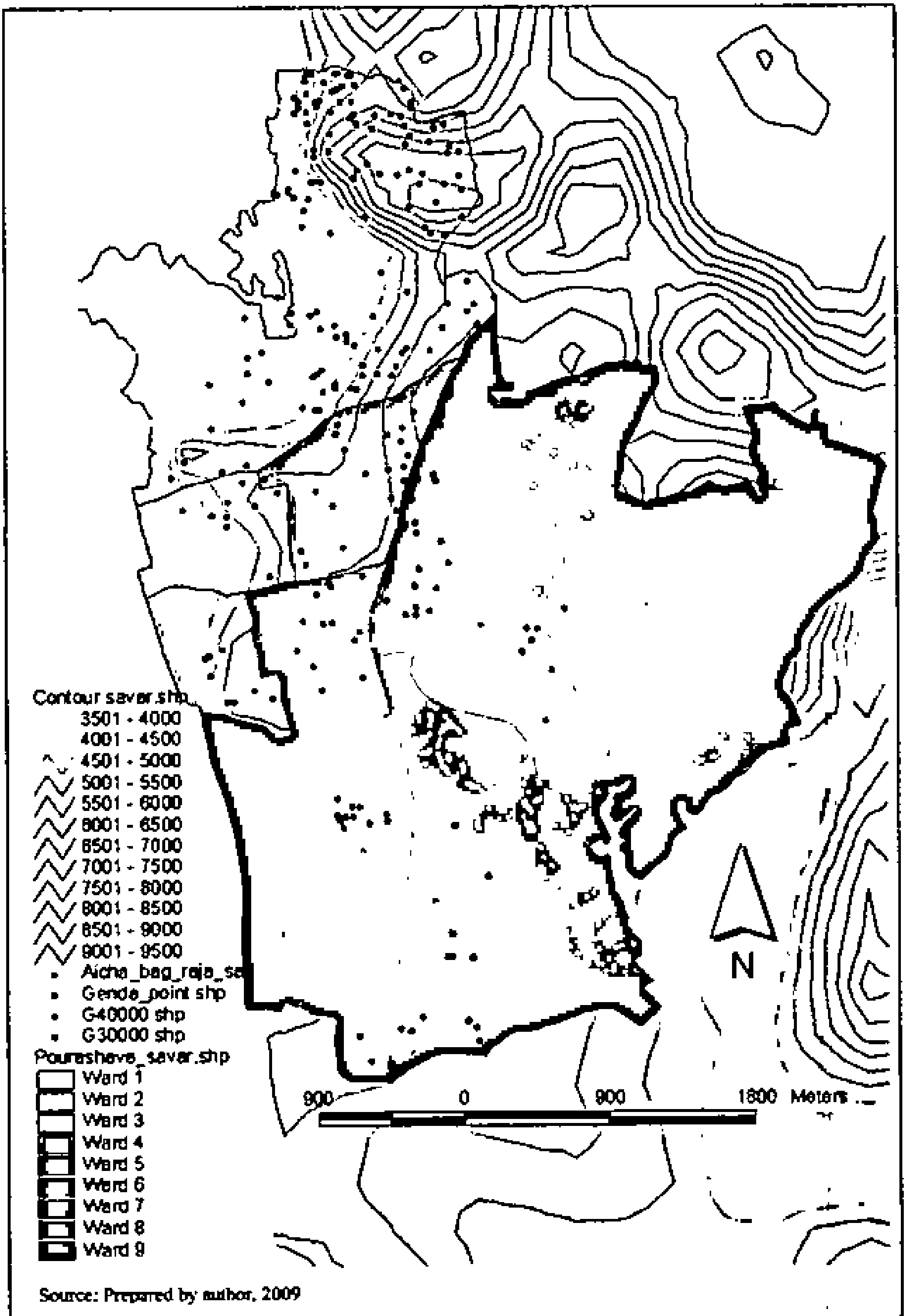
2.7 Map preparation

Land use map of Savar municipality along with location of the selected variables were prepared by applying ArcGIS 9.1.

2.8 Data analysis

In a market whose prices are to be determined by location, a reasonable expectation is that spatial econometric techniques should demonstrate valuable in an analysis of land prices. For example, spatial econometric techniques can prove useful in estimating a land price model when the sales price of a specific plot is similar to that of a nearby plot for reasons not fully incorporated into the model (Cohen and Coughlin, 2007). The exclusion of spatial considerations can origin biased estimates of parameters and their statistical significance as well as errors in interpreting standard regression diagnostic tests[1].

[1] See Brasington and Hite (2005) for a discussion of ways to model the influence of different types of omitted variables in spatial models.



Map 2.2: Topological Elevation map of Savar Municipality

First of all, the fitness of data was tested by pertaining probability distribution function, Chi-square test and percentage distribution in order to determine which method of regression analysis is best fitted to the collected data. Based on the fitness test, land price was regressed against a set of pre-determined explanatory variables by applying spatial econometric technique – Hedonic pricing model. The development of a hedonic model relies heavily on the model developed by Can and Megbolugbe (1997). The basic relationship implies as below—

$$y_i = c + \sum_{j=1}^{n} \left(B_j x_{ij} \right) + \varepsilon \qquad (1)$$

Where y_i is the price of the i^{th} plots. x_{ij} is the j^{th} attribute for the i^{th} plots. B_j is the parameter to be estimated for the j^{th} attribute (implicit empirical marginal price for the attribute). ε is the random error (Habib, 2002).

However, the linear combination of the variables is clearly endogenous and correlated with the error term. Formally speaking, the random component of jth land price is equal to the inner product of the jth row of the matrix $(I - \rho W)^{-1}$ and the vector of errors, ε. Thus, each element of the transacted land depends on all of the error terms and consequently OLS estimates are inconsistent. As such, this study tagged on the literature using the spatial autoregressive model (or spatial lagged dependent variable model) of the form (Ledyaeva, 2007):

$$y = \rho W y + X\beta + \varepsilon$$
$$\varepsilon \rightarrow N(0, \delta^2 I_n) \qquad (2)$$

Where y and X are the dependent variable's vector and explanatory variables matrix, respectively; W is known as spatial weight matrix; and the parameter ρ is a coefficient of the spatially lagged dependent variable, Wy. The coefficient ρ measures how neighboring observations affect the dependent variable. This effect is independent of the effects of exogenous variables. If Equation (2) is correct, then ignoring the spatial autocorrelation term means that a significant explanatory variable has been omitted. The consequence is that the estimates of β are biased and all statistical inferences are invalid. The impetus for advocating Spatial Auto Regression (SAR) techniques is premised on the assumption that spatial autocorrelation exists in property data. Spatial autocorrelation describes the relation between the similarity of a considered indicator and spatial proximity. Anselin (1998) noted that it is generally painstaking to mean the lack of independence among observations in cross-sectional data sets. Thus, positive spatial autocorrelation implies a clustering in space. Similar values, either high or low, are more spatially clustered than could be caused by chance. Negative autocorrelation points to spatial proximity of contrasting values (Anselin and Bera 1998).

Moran's I and Geary's c can be calculated to enumerate spatial autocorrelation. A weight matrix w_{ij} can be specified by relying on level of adjacency among properties.

Moran's I is defined as following:

$$I = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}\left(y_i - \bar{y}\right)\left(y_j - \bar{y}\right)}{\left[\sum_{i=1}^{n}\left(y_i - \bar{y}\right)^2\right]\left(\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}\right)} \tag{3}$$

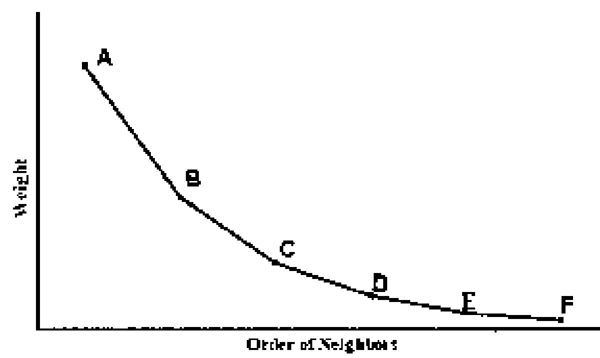
Geary's c is defined as following:

$$c = \frac{(n-1)\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}\left(y_i - y_j\right)^2}{2\left(\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}\right)\left(\sum_{i=1}^{n}\left(y_i - \bar{y}\right)\right)^2} \tag{4}$$

Where n is the number of transacted plots (574); y_i is the land value at a particular plot; y_j is the land value of neighbor plot; $\bar{y}$ is the mean of land price; and w_{ij} is a weight (distance) applied to the comparison between plot i and j.

According to Anselin and others (2004), the first stage to implement a spatial econometric strategy is the construction and estimation of the weight matrix. given the spatial arrangement of the observations. While a spatial weight matrix may take on several different forms of which two are of main concern. The first is the Delaunay triangular fixed weight matrix of a symmetric form that leads to a variance covariance matrix that is dependent upon the autoregressive parameter alone.

The other is a flexible spatial weight matrix. The nearest neighbor method is a flexible weight matrix that assumes that spatial dependence depends on a decay relationship and the number of neighbors. Specifically, the nearest neighbor weight covariance matrix is an asymmetric matrix that depends upon three parameters; the autoregressive parameter α; the number of neighbors m; and the rate weight decline ρ, also referred as the decay parameter (Soto, *et al.*, n.d.).



Source: Soto, *et al.*, n.d.

Figure 2.1: Hypothetical decay relationship of decay weight

The conceptual relationship embedded in the nearest neighbor method is illustrated in Figure 2.1. Weight in the vertical axis represents the weight given by the rate of weight decline to the power of the order of neighbors. For this example, let's assume that ρ=0.5 and m=6 neighbors (points A through F). Therefore, a ρ of 0.5 indicates that the first neighbor will give half the weight of the first neighbor (point A). the second neighbor a quarter of the weight of the first neighbor (point B), and so on. Nearest neighbor point F in Figure 2.1 does not significantly influence a given observation (Soto, *et al.*, n.d.).

However, following Blonigen and others (2006), this study calculated weights using a simple inverse distance function where the shortest bilateral distance receives a weight of unity and all other distances receive a weight that declines according to:

$$W(d_{ij}) = \frac{\min\_d_{ij}}{d_{ij}} \forall i \neq j \qquad (5)$$

Where, d_{ij} is the distance between plots i and j, measured between transacted lands; $\min\_d_{ij}$ is the minimum distance in the sample. Under the above rule, a non-zero entry in the kth column of row j indicates that the kth observation will be used to adjust the prediction of the jth observation ($j \neq k$). W is a square matrix and the diagonal elements of W are set equal to zero in order that no observation of land price predicts itself. Thus, W appears as:

$$W = \begin{bmatrix} 0 & w(d_{21}) & \ldots & w(d_{n,2}) \\ w(d_{2,2}) & 0 & \ldots & w(d_{n,2}) \\ \ldots & \ldots & 0 & \ldots \\ w(d_{1n}) & w(d_{2n}) & \ldots & 0 \end{bmatrix} \quad (6)$$

In $W(d_{ij})$, i is the column number and j is the row number. Thus, $w(d_{12}) = w(d_{21})$ would be the inverse distance function for plots 1 and 2.

In case of presence of spatial correlation in the form substantial spatial dependence, the hedonic price model function is expressed as following spatial antocorrelation function (Magalhães *et al.*, 2000).

$$\hat{y}_i = c + \rho W y_i + \sum_{j=1}^{n}\left(B_j x_{ij}\right) + \varepsilon \quad (7)$$

Where Wy_i is the spatial lag for land price and ρ is the spatial lag coefficient.

$$Wy_i = \sum_{i=1}^{n}\sum_{j=1}^{n}\left(w_{ij} y_j\right) \text{ and } \varepsilon = \sigma^2 I \quad (8)$$

Where W is spatial contiguity matrix, w_{ij} is an element of spatial contignity matrix, σ is standard deviation of the price of lots.

Then the Spatial Autoregression model was obtained by applying Classic, Spatial Lag and Spatial Error regression model. These models were run by GeoDa (Version 9.0.5.i) software.

Chapter III

DESCRIPTION OF THE STUDY AREA

Chapter III

Description of the Study Area

Savar municipality is located at the northwestern side of Dhaka City and on the Dhaka – Aricha Highway. The total area of Savar upazila is 280.13 sq. km. of which municipality covers an area of 16.67 sq. km. It has a population of 161600 with a population density of 9694 per sq. km. Three rivers - Turag River on the east and west. Dhaleshwari and Bangshi River and Buriganga on the south - surround the study area. The existing municipality area was declared as 2nd class municipality in December 14, 1991. Aftermath, Savar was upgraded as 'class A' municipality in July 29, 1997 (Rahman, 2006).

After the establishment of Savar municipality in 1991 a massive industrialization was started along Dhaka-Aricha Highway and Bangshi River. For example, only four industries were established in Savar municipality during 1972-1980 and six new industries were established during the period of 1980-1990. But in 1996, the total number of industries was 26. During the 1995-2000, this number increased to 45 and currently they are 70 in number. These industries created the job opportunity of about 25000 and among the workers most of them are migrated people. On an average, about 4000 people are migrated in Savar municipality ever year because of the establishment of new industries. This additional people are increasing superfluous pressure on the existing housing condition. It is estimated that additional 800 units of houses is required every year in order to make provision of accommodation for this migrated people. This resulted in the conversion of agricultural land into non-agricultural uses. During the period of 1990-2000, the agricultural land was decreased by 70 percent (Samad, 2006).

3.1 Land use of the study area

The analysis of land parcel data by applying GIS enables planners to better understand the locational and spatial characteristics of a land area, along with its social, economic and environmental dimensions. Land use data is an important source in formulating future urban growth scenario. Existing land use information appended to land parcel boundaries was acquired form Sheltech Pvt. Ltd. This spatial data layer comprises approximately 19500 land parcels (excluding roads and water bodies) and classified into thirteen generic land use categories (Table 3.1 and Map 3.1). Out of the total land uses of the municipality, 53.36 percent is residential, 15.02 percent is agricultural, and 20.75 percent is open space and water bodies (Table 3.1 and Map 3.1).

Table 3.1: Land use categories of Savar Municipality

Category	Number of land parcel	Total area (acre)	Percentage
Agriculture	2236	598.613	15.02
Circulation network	4732	138.013	3.46
Commercial activity	789	35.087	0.88
Community services	158	126.499	3.17
Forest area	126	29.495	0.74
Manufacturing and processing	274	62.133	1.56
Mixed use	38	10.008	0.25
Residential	12589	2127.173	53.36
Restricted area	90	16.567	0.42
Service activity	57	15.657	0.39
Vacant land	3284	556.797	13.97
Water body	1765	270.219	6.78
Total	26138	3986.261	100

Source: Sheltech Pvt. Ltd., 2008

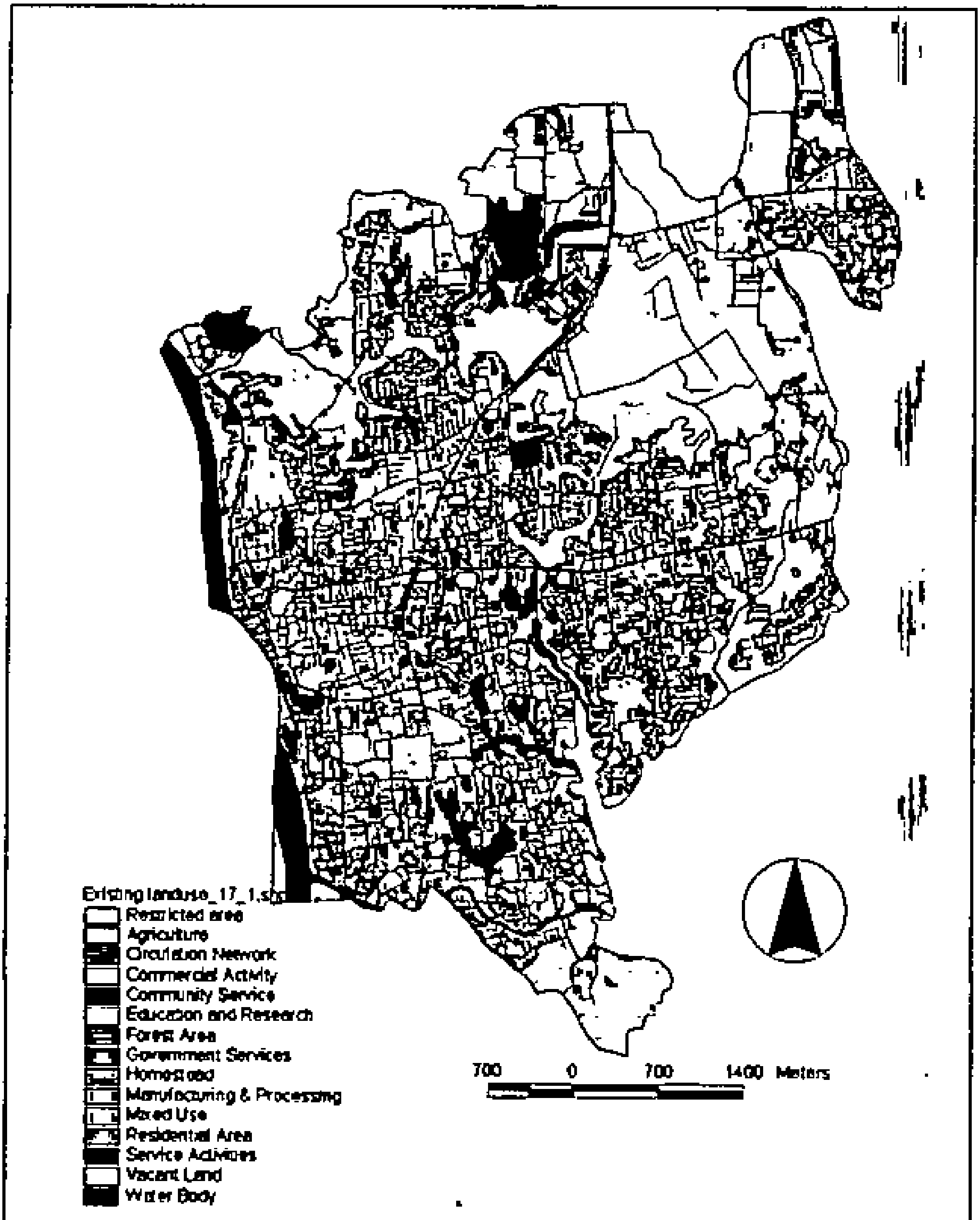
On the other hand, according to Urban Government Infrastructure Improvement Project of Local Government Engineering Department (2007), 52.40 percent of total land use is residential, 25.28 percent is agricultural, and 6.81 percent is open space and water bodies (Table 3.2 and Map 3.2).

Table 3.2: Land use categories of Savar Municipality

Land use	Sq. meter	Percent
Admin Area	14884.15	0.09
Agriculture land	4170533.60	25.28
Commercial	759178.61	4.60
Educational	328473.02	1.99
Health facility	22950.47	0.14
Industrial	352715.85	2.14
Open space	1033402.35	6.26
Pond	28344.76	0.17
Residential	8644513.05	52.40
River Network	62259.78	0.38

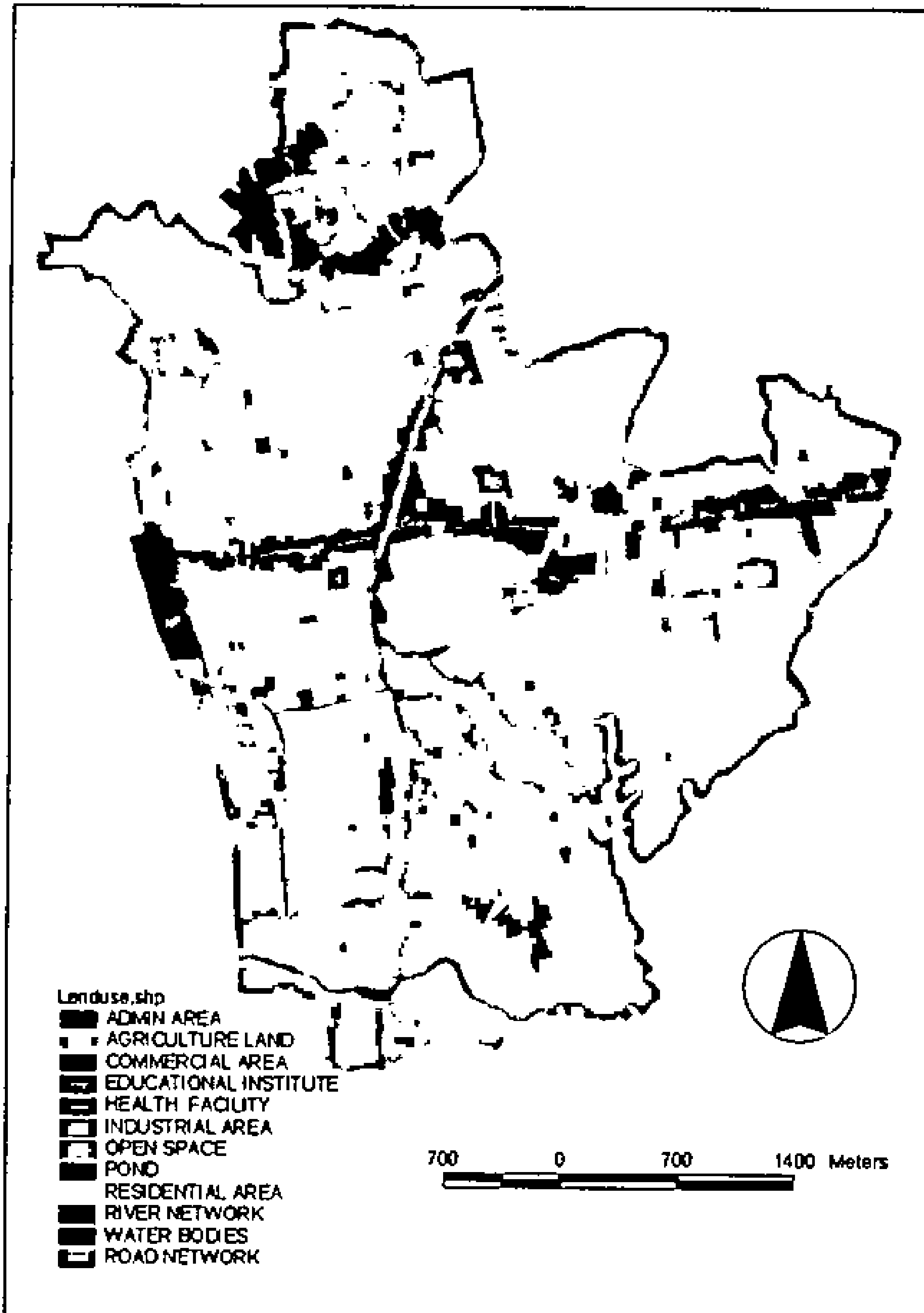
Road Network	502301.66	3.04
Water Body	577239.87	3.50
Total Area	16496797.16	100.00

Source: LGED, 2007



Source: Sheltech Pvt. Ltd., 2008

Map 3.1: Land use map of Savar Municipality



Source: LGED, 2007

Map 3.2: Land use map of Savar Municipality

Furthermore, in case of ward-wise land use distribution, residential land use has major portion than the others such as 44.18 percent, 81.44 percent, 82.98 percent, 65.40 percent, 83.07 percent, 61.12 percent, 59.53 percent, 40.66 percent and 49.24 percent in Ward no. 1, 2, 3, 4, 5, 6, 7, 8 and 9 respectively (Table 3.3). On the contrary, agricultural land use has significant coverage in ward no. 1 (32.76 percent) 8 (41.22 percent) and 9 (30.96 percent) (Table 3.3).

Table 3.3: Percentage distribution of land use in different wards of Savar Municipality

Land use	W1	W2	W3	W4	W5	W6	W7	W8	W9
Residential	44.18	81.44	82.98	65.40	83.07	61.12	59.53	40.66	49.24
Commercial	-	14.78	6.39	28.46	7.82	0.47	8.11	5.97	-
Industrial	1.39	0.29	0.42	-	-	10.39	0.24	0.92	4.38
Institutional	-	2.32	2.3	4.80	7.56	8.25	3.09	1.92	1.13
Agricultural	32.76	-	7.39	-	-	15.73	17.47	41.22	30.96
Road network	0.49	1.17	0.53	1.34	1.55	0.62	0.67	0.58	0.7
Water bodies & open space	21.18	-	-	-	-	3.42	10.89	8.73	13.59

Source: Rahman, 2006

Nonetheless, because of the unplanned growth of Savar municipality, certain portion of main flood flow, sub flood flow and high value agricultural areas are encroached by different land uses (Table 3.4). For instance, residential land use encroached 40.73 percent, 5.85 percent and 43.50 percent main flood flow, sub-flood flow and high value agricultural land of the Savar municipality respectively (Table 3.4).

Table 3.4: Unplanned growth of land uses in Savar Municipality

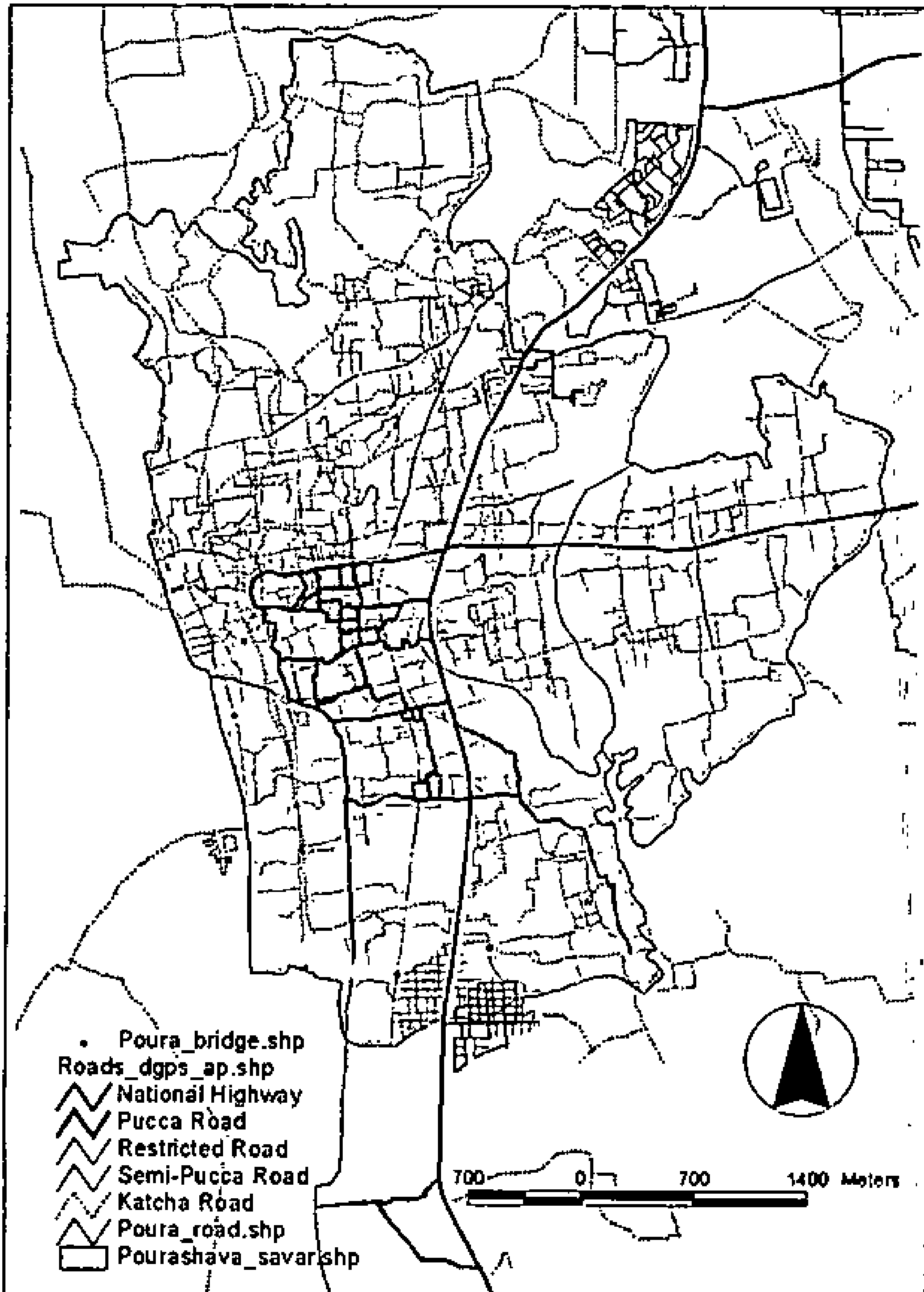
Land use	Main flood flow		Sub flood flow		High value agriculture	
	Area (acre)	Percent	Area (acre)	Percent	Area (acre)	Percent
Agriculture	9.299	4.44	0	0	80.118	29
Circulation network	7.099	3.39	0.025	0.15	6.195	2.24
Commercial	6.436	3.07	0	0	0	0
Conservation	0	0	0.01	0.06	8.338	3.02
Industrial	6 084	2.91	0	0	9.644	3.49

Residential	85.285	40.73	0.975	5.85	120.163	43.50
Social infrastructure	2.634	1.26	0	0	8.136	2.95
Undeveloped	55.874	26.67	15.53	93.14	36.65	13.27
Water body	36.697	17.53	0.134	0.8	6.989	2.53

Source: Sheltech Pvt. Ltd., 2008

3.2 Road network of the study area

Savar has a better communication with Dhaka City and Dhaka EPZ (Export Processing Zone); and a large number of people reside here engaged in different occupations in Dhaka City, Dhaka EPZ and nearby areas. In Savar municipality, the total length of road of all types is 205 km of which 110 km is in good condition but most of them are very narrow with insufficient space for widening or construction of drains (Map 3.3). In addition, there are 7 bridges and 23 culverts in the municipality area (Savar Municipality, 2006). However, the transportation system of municipality is very much diverse consisting of motorized transport and non-motorized transports. Uncontrolled land-use, huge number of non-motorized vehicles and inadequate bus facilities deteriorate the congestion and ultimately increase trip time and reduce number of trips a vehicle can make in a day.



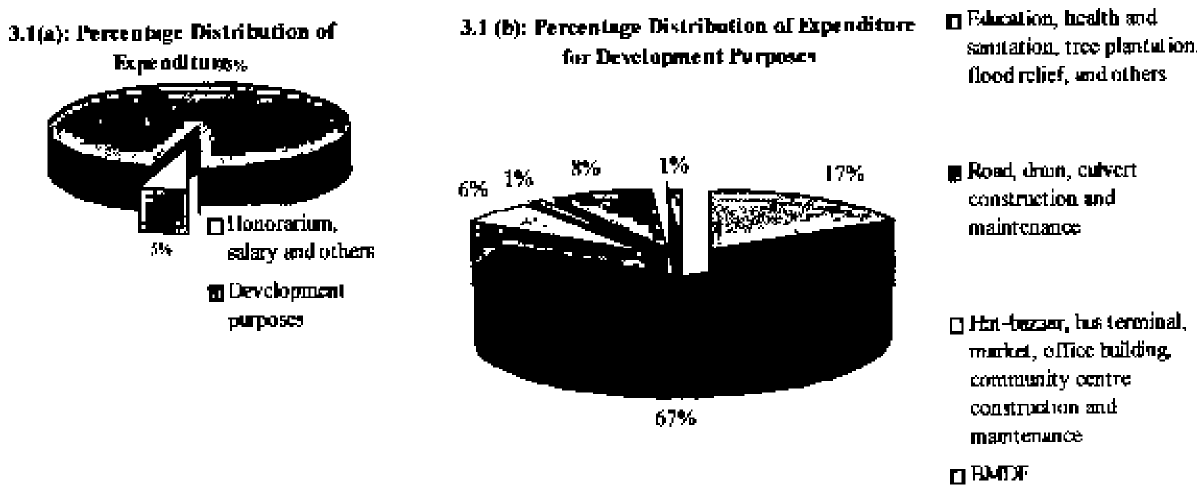
Source: LGED, 2007

Map 3.3: Road network of Savar Municipality

3.3 Spatio-Economic Growth of Savar Municipality

Municipality usually disburses the annual budget for honorarium and salary of chairman, commissioners and official staff and development purposes (Figure 3.1a and 3.1b). The proportion allocated for annual development works mainly contribute to the economic growth. As the municipality is basically a spatial notion, the development should reflect on the spatio-economic growth consistently right through the municipality.

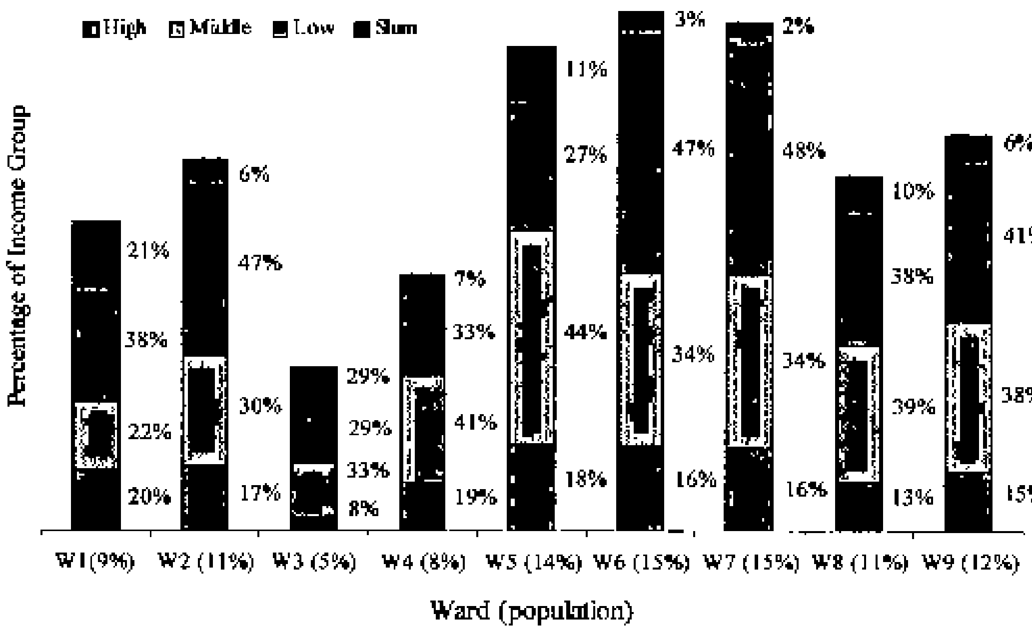
Figure 3.1: Percentage distribution of expenditure in the 2006 annual budget of Savar municipality



Source: Amin and Tamima, 2007

Savar municipality disburses a significant portion of its annual budget for the development of which allocation for road, drain culvert construction and maintenance is most noteworthy (67 percent of total development budget). But the present circumstance of the land use pattern of different wards of Savar Municipality does not persuade this avowal. According to Bangladesh Gazette 2004, for an urban area the share of road should be 25 percent of total land. Unfortunately, Savar municipality has 3.46 percent of total land area for road network (Table 3.2). Even the municipality does not provide sufficient infrastructure and services that may attract the investors on commercial and industrial sectors (0.88 percent and 1.56 percent of land use for commercial and industrial purposes respectively) (Table 3.2). The distribution of commercial and industrial activities is not equally distributed among the wards; for example, the percentage share of commercial land use is moderately much higher in ward no. 2 (14.78 percent) and 4 (28.46 percent) than that of others (Table 3.2). On the other hand, the industries are much more concentrated in ward no. 6 (10.39 percent) (Table 3.2).

Figure 3.2: Income-wise distribution of population of Savar municipality



Source: Amin and Tamima. 2007

Nevertheless, the population distribution in different wards is not in conjunction with the economic activities in the corresponding wards. It is revealed from the Figure 3.2 that Ward no. 5, 6 and 7 encompass major share (14 percent, 15 percent and 15 percent respectively) of population of Savar municipality where slum and low-income groups contribute half of the total population in ward no. 6 and 7. The economic growth of ward no. 6, based on commercialization and industrialization, is high compared to other wards. The major segment of the population of ward no. 6 is low-income group who are mainly engaged in industrial activities and facilitate with higher institutional facilities. Therefore, the spatio-economic growth in ward no. 5, 7, 9 and 2 get hold discrimination because of trivial and least level of industrialization, road network and economic growth. The circumstances are much more relentless in ward no. 1 which shares 9 percent of total population. There is no provision of commercial and institutional facilities and only a diminutive scrap of industrial land use out of total land. Yet the proportion of road network is not very worth mentioning. The situation is almost same for ward no. 4 and 5, which have 8 percent and 14 percent of the total population of Savar municipality respectively (Figure 3.2).

Therefore, industries and commercial activities are developed in some wards disproportionately and low-income groups are mainly concentrated in those wards but the service provision and infrastructure facilities by the municipality are scarce. On the other hand, some wards e.g. ward no. 4 are facilitated with somewhat high institutional and infrastructure although the economic growth, percentage share of population (8 percent of total population) and percentage share of low-income and slum dwellers (33 percent and 7 percent of ward population) are stumpy (Figure 3.2).

Chapter IV

DESCRIPTION OF ANALYTICAL TOOLS

Chapter IV

Description of Analytical Tools

The use of spatial analysis in particular has become increasingly common in social science applications, in fields ranging from anthropology (Aldenderfer and Maschner, 1996), to criminology (Weisburg and McEwen, 1998), epidemiology (Lawson *et al.*, 1999a), real estate analysis (Can, 1998) and socio-economic analysis of tropical deforestation (Liverman *et al.*, 1998). Recently, the focus in these applications has moved from simple data manipulation and visualization to spatial data analysis, both exploratory and confirmatory (e.g. Anselin, 1998a). Considering the wide field of spatial analysis, this study is concerned with a very specific aspect therein, namely that of modeling spatial phenomena in regression analysis.

However, pricing land in urban areas offers an exigent inconsistency. During economic "boom" times, the conventional understanding is that land values should ascend with increasing demand and decreasing vacancies. Conversely, accurate forecasting of these values is problematic since analogous transactions are relatively sporadic and thus time factors are often erratic. As developable urban land becomes increasingly diminutive in supply, developing useful supply, demand, and pricing models is more than a scholastic exercise (Mundy and Kilpatrick, 2000).

Generally accepted appraisal methodology (i.e. first generation techniques) leaves much to be desired in this context. A straightforward sales comparison approach is deficient, since aggregate adjustments to sales - particularly for market conditions - can often exceed 100 percent of the unadjusted sales price due to rapidly changing markets. A land extraction method (extracting the depreciated value of the building from the sales price to arrive at land values) can be fraught with errors due to judgmental issues in determining depreciation and verifying data[1].

As such, second generation techniques (e.g.regression modeling, survey techniques) are increasingly appropriate for valuing urban building sites (Mundy and Kilpatrick,

[1] The Appraisal of Real Estate, 11th, (Chicago: Appraisal Institute, 1996), pg.521, illustrates other problems with this technique.

2000). Bruce and Sundell (1977) shows that regression analysis has apparently been used in real estate valuation since 1924 and more recently Colwell and Dilmore (1999) show that a 1922 monograph by G.C. Haas of the University of Minnesota's Division of Agricultural Economics utilized this methodology in the analysis of rural land prices. The modern regression models to estimate land prices (often referred to as "hedonic models" when used to value real estate) owe their roots to the work of Colwell and Sirmans (1980), Chicoine (1981), Kowalski and Colwell (1986), and others. Isakson (1997) recently extended these models to value urban land using sale data, distance from an interstate corridor, zoning, and buyer and seller characteristics as explanatory variables.

These regression models can be viewed as a variation of the sales adjustment grid, a long-standing mainstay of first-generation appraisal methodology. While appraisers would traditionally use two or more "paired sales" to estimate adjustments which then would be applied in an adjustment grid, the hedonic model collapses these two steps into one, and uses a richer data set coupled with a more advanced set of statistical tools (Mundy and Kilpatrick, 2000).

Indeed, in this context, the rich set of analytical tools implicit in hedonic modeling may make it a preferred variant on the sales adjustment grid, when properly applied. Wolverton (1998) shows that normative paired-sales has an implicit linear relationship, and thus fails to account for diminishing marginal price effects[2]. Pace (1998a and 1998b) and Ramsland and Markham (1998) show that using the hedonic model improves on the sales adjustment grid solution. Colwell, Cannady, and Wu (1983), in their review of the sales comparison approach, suggest that coefficients estimated from a regression equation should be used as factors in the adjustment grid. Isakson (1998) further applies the hedonic model to the appraisal review process.

However, urban planners frequently use regression analysis for the empirical estimation of land price models, which are used to investigate the spatial structure of a city/town (even urban fringe area) or to calculate the implicit price of environmental

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[2] Diminishing marginal prices are observed when the market pays differential prices for each subsequent unit of a good. In raw land, plottage effects are but common one example of this.

characteristics. A concern with this kind of analysis is that often spatially associated or heterogeneous data are used, which leads to estimation pitfalls, most notably spatial autocorrelation and model structural instability over space (Pace, *et al.*, 1998).

Furthermore, in previous studies, Vandeveer and others (2002) showed the importance of applying spatial econometrics to a rural land market to estimate implicit prices. Geographical Information Systems (GIS) and spatial econometric procedures were used to model the rural land market in Louisiana. These procedures are indispensable for testing the data for spatial dependence and estimating models in the existence of spatial dependence. Pace and others (1998) indicated that land and spatial statistics harmonize each other, and employing spatial estimators endow with benefits over ignoring dependencies in the data. The benefits include improved prediction, better statistical inference through unbiased standard errors, and better estimates because of the way that location is handled within the spatial modeling procedure.

A comprehensive exposition of modern urban economic theory is provided by e.g. Fujita (1989). Fujita observed that land is a commodity like any other; apart from that it is completely stationary. A parcel of land may diverge in size but most prominently it is associated with a unique location in geographical space. These two characteristics of land entail strong non-convexities in consumers' preferences, and concave household indifference curves for distance and parcel size. Other studies have found location to have a significant influence in explaining the discrepancy in land markets. In an Oklahoma study, Kletke and Williams (1992) concluded that location within the state was likely to be as significant as any other factor in determiniug value. Adrian and Cannon (1992) found that land values in the urban fringe of Dothan, Alabama were almost three times the values in the rural segment. More recent literature has emphasized the need to consider spatial characteristics in conducting economic research (Krugman, 1995).

4.1 Spatial regression analysis of land price

Urban theory predicts that land values should fall at a constant percentage per increment of distance from the city center. Henderson (1977) and Segal (1977) provide useful summaries of the theoretical structure. The relationship between land prices and distance can be modeled by using a semi-logarithmic functional form. This specification regresses the log of the land price per square meter on the linear distance from the center of the city. The semi-log functional form is (Dale-Johnson and Brzeski, 2001):

$$lnP(x) = lnP_0 - \gamma x + \varepsilon \qquad (9)$$

$P(x)$ is the price of land at distance x from the center of the city, γ is the percentage rate of decline per distance measure and ε is the residual. As transportation costs for the land increase, the absolute value of γ increases. If the residual variance is constant and the residuals are spatially uncorrelated, ordinary least squares (OLS) would yield best, linear, unbiased estimators of the parameter γ (Dale-Johnson and Brzeski, 2001).

Many factors can complicate the fundamental relationship depicted in Equation (9). Polynomial terms and other descriptors that might proxy for some of the spatial variation in land prices may be included. A more general specification follows:

$$Z = \log P = X\beta + \varepsilon \qquad (10)$$

Where $\varepsilon \approx N(0, \sigma^2 I)$ so that $Z = N(X\beta, \sigma^2 I)$. The coefficients estimated with OLS are described in Equation (11):

$$b = (X^T X)^{-1} X^T Z \quad \text{where } b \rightarrow N(\beta, \sigma^2 (X^T X)^{-1}) \qquad (11)$$

Previous studies have demonstrated the expediency of using hedonic analysis in land market research. In an early study, Rosen defined hedonic prices as implicit prices of attributes and notes that they are revealed to economic agents from observed prices of differentiated products and the specific amounts of characteristics associated with them.

Hedonic price theory assumes that a commodity such as a plot can be viewed as an aggregation of individual components or attributes (Griliches, 1971). Consumers are assumed to purchase goods embodying bundles of characteristics that capitalize on their underlying utility functions (Rosen, 1974). Hedonic price theory originates from Lancaster (1966) proposal that goods are inputs in the activity of consumption, with an end product of a set of characteristics. Bundles of characteristics rather than bundles of goods are ranked according to their utility bearing abilities. Attributes (for example, characteristics of a plot such as plot size, accessibility, neighborhood characteristics, and environmental characteristics etc.) are implicitly embodied in goods (land) and their observed market prices. The amount or existence of attributes associated with the commodities defines a set of implicit or "hedonic" prices (Rosen, 1974). The marginal implicit values of the attributes are obtained by differentiating the hedonic price function with respect to each attribute (McMillan *et al.*, 1980). The advantage of the hedonic methods is that they control for the characteristics of properties, thus allowing the analyst to distinguish the impact of changing sample composition from actual property appreciation (Calhoun, 2001).

Hedonic regression assumes that sales price or rent of a property is a function of structural characteristics (S), neighborhood characteristics (N), location characteristics (L), environmental characteristics (E), and the time rent or value is observed (T) (Malpezzi, 2002), as is shown in Equation (12).

$$sale\_price = f(S, N, L, E, T) \quad (12)$$

However, a standard hedonic price model can be specified as:

$$ln(sale\_price_i) = \beta x_i + \varepsilon \quad (13)$$

Where x_i is a vector of asset-specific characteristics of the properties (the hedonic variables), ε is normally distributed mean zero random error.

On the other hand, in spatial data analyses, when a valne observed in one location depends on the values at neighboring locations, there is a spatial autocorrelation. Since the price of a property may be influenced by the characteristics of its neighboring properties, the proposed study also need to take spatial effects into consideration. Spatial data may show spatial autocorrelation in the variables (spatial lag) or error terms (spatial error). Accordingly, this study will address the spatial autocorrelation with spatial-lag model and spatial-errer model developed by Luc Anselin (1999).

In the spatial lag case, the dependent variable *y* in place *i* is affected by the independent variables in both place *i* and its neighboring areas. With the existence of spatial lag, the assumption of uncorrelated error terms of Ordinary Least Square (OLS) estimation is violated; in addition, the assumption of independent observations is also violated. As a result, the OLS estimates are predisposed and bungling (Diao, 2007). In the spatial lag model, 'spillover' means the values of independent variables in one location will affect the values of dependent variable in adjacent areas (Anselin, 1999). The spatial lag can be addressed by adding an additional regressor in the form of a spatially lagged dependent variable to the regression equation, as is shown in Equation (14).

$$Y = \rho W_y + \beta X + \varepsilon \qquad (14)$$

Where *Wy* is the spatial lag variable, ρ is the autoregressive coefficient. A spatial lag of a specified variable is computed by taking the weighted average of surrounding spatial units. The weights can take different forms, for example contiguity based weights, distance based weights, and K-nearest neighbor weights (Anselin 2003b). The existence and magnitude of 'spillover' effects are indicated by the estimated value of the coefficient for the spatial lag variable (autoregressive coefficient).

On the contrary, a spatial-error model can be seen as a special case of a regression with a non-spherical error term. The off-diagonal elements of the covariance matrix articulate the structure of spatial dependence. The spatial error model can be esrimated by (Diao, 2007):

$$Y = \beta X + \varepsilon$$

$$\varepsilon = \lambda W_\varepsilon + u \qquad (15)$$

Where u is an error term that meets the OLS assumptions; W_{ε} is the weighted average of error terms in neighboring areas. In the case of land price, the spatial error model assumes that the spillover occurs indirectly through spatial correlation in the error terms for neighboring properties. That is, the explanatory variables have only local effects, but factors missing from the model specification are spatially correlated.

In recapitulation, the spatial econometric technique discussed in this study is based on approach proposed by Luc Anselin (1999). There are still other approaches that could be utilized in the study, for example the Cokriging approach (Chica-Olmo 2007) and Geographically Weighted Regression approach (Fotheringham *et al.*, 2002).

4.2 Test of Spatial autocorrelation and derivation of Spatial Autoregression model

Social scientists often study the form, direction and strength of the association exhibited by two quantitative variables measured for a single set of *n* observations. A scatterplot envisages this relationship, with a conventional correlation coefficient describing the direction and strength of a straight-line relationship of the overall prototype. A variant of conventional correlation is serial correlation, which pertains to the correlation between values for observations of a single variable according to some ordering of these values. Its geographic adaptation is spatial autocorrelation, the relationship between a value of some variable at one location in space and nearby values of the same variable. An *n*-by-*n* binary geographic connectivity/weights matrix can identify these neighboring values. Positive spatial autocorrelation means that geographically nearby values of a variable be apt to be analogous on a map: high values tend to be located near high values, medium values near medium values, and low values near low values. Demographic and socio-economic characteristics like population density and land price are good examples of variables exhibiting positive spatial autocorrelation.

Therefore, there are two primary rationales to measure spatial autocorrelation. First, autocorrelation complicates statistical analysis by altering the variance of variables, changing the probabilities that statisticians commonly attach to making incorrect statistical decisions (e.g., positive spatial autocorrelation results in an increased tendency to reject the null hypothesis when it is true). It signifies the presence of and quantifies the extent of redundant information in geo-referenced data, which in turn affects the information contribution each geo-referenced observation makes to statistics calculated with a database. Second, the measurement of spatial autocorrelation describes the overall pattern across a geographic landscape, supporting spatial prediction and allowing detection of striking deviations. Griffith and Layne (1999) reported that exploiting it tended to increase the R-squared value by about 5 percent, and obtaining 5 percent additional explanatory power in this way was much easier and more reliably available than getting it from collecting and cleaning additional data or from using different statistical methods.

As self-correlation spatial autocorrelation is interpreted literally: correlation arises from the geographic context within which attribute values transpire. In isolation it can be uttered in terms of the Pearson product moment correlation coefficient formula, but with neighboring values of variable Y replacing those of X:

$$\frac{\sum_{i=1}^{n}(x_i-\bar{x})(y_i-\bar{y})/n}{\sqrt{\sum_{i=1}^{n}(x_i-\bar{x})^2/n}\sqrt{\sum_{i=1}^{n}(y_i-\bar{y})^2/n}} \text{ becomes } \frac{\sum_{i=1}^{n}\sum_{j=1}^{n}c_{ij}(y_i-\bar{y})(y_j-\bar{y})/\sum_{i=1}^{n}\sum_{j=1}^{n}c_{ij}}{\sqrt{\sum_{i=1}^{n}(x_i-\bar{x})^2/n}\sqrt{\sum_{i=1}^{n}(y_i-\bar{y})^2/n}} \quad (16)$$

The left-hand expression converts to the right-hand one by substituting y for x in the right-hand side, by compnting the numerator term only when a 1 appears in matrix C, and by averaging the numerator cross-product terms over the total number of pairs denoted by a 1 in matrix C. The denominator of the revised expression (16) is the sample variance of Y, s_Y^2. Coupling this with part of the accompanying numerator term renders $\frac{(y_i-\bar{y})}{s_Y}\sum_{j=1}^{n}c_{ij}\frac{(y_j-\bar{y})}{s_Y}$, where this summation term is the quantity measured along the vertical axis of the modified Moran scatterplot; the right hand part of expression (16) is known as the Moran Coefficient (MC). Accordingly, positive spatial autocorrelation occurs when the scatter of points on the associated Moran scatterplot reflects a straight line sloping from the lower left-band to the npper right-hand corner: high values on the vertical axis tend to correspond with high values on the horizontal axis, medium values with medium values, and low values with low values. Negligible spatial autocorrelation occurs when the scatter of points suggests no pattern: high values on the vertical axis correspond with high, medium and low values on the horizontal axis, as would medium and low values on the vertical axis. Negative spatial autocorrelation occurs when the scatter of points reflects a straight line sloping from the upper left-hand to the lower right-hand corner: high values on the vertical axis tend to correspond with low values on the horizontal axis, medium values with medium values, and low values with high values. These patterns are analogous to those for two different quantitative attribute variables—X and Y—rendering, respectively, a positive, zero, and negative Pearson product moment correlation coefficient value.

As redundant information spatial autocorrelation represents duplicate information contained in geo-referenced data, concerning it to missing values estimation as well as to notions of effective sample size and degrees of freedom. Richardson and Hémon (1981) promote this view for correlation coefficients computed for pairs of geographically distributed variables.

The most commonly used spatial process specification is the autoregressive model (SAR). Formally, for a vector of error terms,

$$\varepsilon = \lambda W \varepsilon + u \qquad (17)$$

Where λ is the spatial autoregressive parameter, W is the weights matrix and u is a vector of errors with variance σ^2. As is well known in the spatial econometrics literature, after solving equation (17) for ε, as

$$\varepsilon = [I - \lambda W]^{-1} u \qquad (18)$$

The variance-covariance matrix for the random vector ε follows as

$$E[\varepsilon \varepsilon'] = \sigma^2 \left[(I - \lambda W)^{-1} (I - \lambda W)^{-1'} \right] \qquad (19)$$

The structure of this variance-covariance matrix is such that every location is correlated with every other location in the system. But closer locations more so, in effect are following Tobler's first law (Tobler, 1979). This can been seen by considering the expanded form of equation (18). Since (in most cases) $|\lambda| < 1$ and the elements of W are less than 1 as well (for row-standardized spatial weights), a "Leontief expansion" of the matrix inverse in equation (18) follows as

$$[I - \lambda W]^{-1} = I + \lambda W + \lambda^2 W^2 + .. \qquad (20)$$

and its transpose is obtained by applying the transpose operation to every matrix in (20). The complete structure of the variance-covariance matrix then follows as the product of equation (20) with its transpose, yielding a sum of terms containing matrix powers and products of W, scaled by powers of λ. Specifically, the lowest order term is I, followed by λW and $\lambda W'$, $\lambda^2\left(W^2 + WW' + W^{2'}\right)$, etc. For a spatial weights matrix corresponding to first order contiguity, each of the powers involves a higher order of contiguity, in effect creating bands of ever-larger reach around each location, relating every location to every other one.

Moreover, the powers of the autoregressive parameter (with $|\lambda| < 1$) ensure that the covariance decreases with higher orders of contiguity, hence satisfying the second condition of Tobler's Law[3].

In addition to the structure for the covariance terms, it is also interesting to note that the diagonal elements in (18), or, the variance of the process at each location, depend on the diagonal elements in W^2, WW', etc. These terms are directly related to the number of neighbors for each location. If the neighborhood structure is not constant

[3] For other types of spatial weights, the specific interpretation in terms of higher order neighbors does not hold in a strict sense, although the general principle of increasing denseness of the weights and smaller importance for higher orders applies.

across the landscape (as is the case in most irregular lattice structures), heteroskedasticity results, even though the initial process (17) is not heteroskedastic. The type of spatial covariance structure induced by the SAR model is referred as global, since it relates all the locations in the system to each other. In practice, for small value of λ, the covariance may approach zero after a relatively small number of powers, but "in principle" the covariance matrix is a dense and full matrix.

4.3 Spatial regression analysis by GeoDa

The basic diagnostics for spatial autocorrelation, heteroskedasticity and non-normality are implemented for the standard ordinary least squares regression. Estimation of spatial lag and spatial error models is supported by means of the Maximum Likelihood method. An extensive overview of the relevant methodology is beyond the scope of this document, but can be found in Anselin and Bera (1998).

The estimation techniques implemented for the Maximum Likelthood approach are based on the algorithms outlined in Smirnov and Anselin (2001). These algorithms were developed to address the estimation of spatial regression models in very large data sets. GeoDa has been successfully applied to spatial regression in a data set of 330,000 observations (estimation and inference were complete in a few minutes).

The asymptotic inference consists of a Likelihood Ratio test as well as an estimate of the asymptotic covariance matrix, using a new algorithm developed by Smirnov (2003). All methods use sparse weights of either GAL or GWT format. However, so far, estimation only works for weights that reflect a symmetric spatial arrangement, such as contiguity weights or distance-based weights (row-standardized), but not for k-nearest neighbor weights (Anselin, 2003a).

Chapter V

ORDINARY LEAST SQUARE HEDONIC PRICING MODEL

Chapter V

Ordinary Least Square Hedonic Pricing Model

Regression method has been widely used in statistical analysis (Mark and Goldberg, 1988; Murphy, 1989; Ambrose, 1990; Fehribach *et al.*, 1993; Ramsland and Markham, 1998; Panayiotou *et al.*, 1999; Isakson, 2001). The common problem with regression analysis is multicollinearity between explanatory variables that causes coefficient estimates to be unstable. Multiple regression analysis has been demonstrated, as being the primary technique used in the mass appraisal. Therefore this study employed multiple regressions as an initial in order to derive the Spatial Autoregressive model. It is basically a hedonic model, attempting to disaggregate value into different contributing factors such as physical, neighborhood, socio-economic, transportation, facilities and services, and environmental characteristics of the plots. In order to get an accurate and effective model, all attributes should be properly accounted for (Yu and Basuki, 2002).

5.1 Diagnosis of Ordinary Least Square (OLS) Hedonic Pricing model

The descriptive analysis explored that average price of transacted plots in 2006 is TK 66794.28 per decimal and standard deviation is TK 191702.113 per decimal, which revealed extensive divergence of price of the transacted plots in the study area. This may have decisive manipulation on the outputs of the regression analysis. Therefore, a comprehensive evaluation of the outputs of the regression analysis was obligatory.

The first concern in the model estimation was to identify relative correlation between the dependent variable and the explanatory variables and also among the explanatory variables themselves (multicollinearity). In order to testify at least some relationship (above 0.3 preferably) between dependent variable (land price) and the explanatory variables, the study pigeonholed that not a single coefficient of correlation had accomplished the prerequisite (Appendix B.1). On the contrary, in order to avoid the multicollinearity effects among the explanatory variables we should keep in mind that the correlation between each of the independent variables is not too high. Tabachnick and Fidell (1996, p. 86) suggested that you 'think carefully before including two variables with a bivariate correlation of, say, 0.7 or more in the same analysis. If you find yourself in this situation you may need to consider omitting one of the variables or forming a composite variable from the scores of the two highly correlated variables.' In this study, most of the explanatory variables have strong correlation (more than 0.7) among themselves except in the cases of area of the transacted plot (area), topological elevation (contour), distance from the dustbin (d_dustbin), distance from the poura road (d_poura_rd) and distance from the Dhaka-Aricha highway (d_nh) (Appendix B.1).

Furthermore, the analysis was also weighed up based on the R-square, which usually elucidates how much of the variance in land price is explained by the model (which includes all the variables). In this case, the value 0.121 explained that this model embodies only 12.10 percent of the variance in the land price. This was not a satisfactory depiction.

Another modus operandi of substantiating the model is 'collinearity diagnostics'. If this value is very low (near 0), this signifies that the multiple correlations with other explanatory variables are high, portentous of the likelihood of multicollinearity. In this analysis, 'tolerance' of the significant number of variables was low, which resulted in high multicollinearity. In the case of significance level, most of variables had significance level of more than 0.05, which required being less than 0.05 (Table 5.1).

Table 5.1: Coefficients and model summary of the linear OLS hedonic model

	Unstandardized Coefficients		Standardized Coefficients	T	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
(Constant)	143651.07	59026.65		2.43	0.02		
pop_den	0.00	0.00	0.06	0.24	0.81	0.03	33.36
area	-0.43	0.43	-0.04	-1.00	0.32	0.98	1.02
Contour	-0.37	2.41	-0.01	-0.16	0.88	0.79	1.26
d_brickfld	-54.73	19.60	-0.35	-2.79	0.01	0.10	9.68
d_edu	67.32	60.20	0.08	1.12	0.26	0.28	3.58
d_postoff	-81.08	120.55	-0.26	-0.67	0.50	0.01	93.41
d_haz_ind	-126.22	63.89	-0.60	-1.98	0.05	0.02	57.93
d_police	70.56	64.03	0.16	1.10	0.27	0.08	12.58
d_relig	105.47	48.88	0.59	2.16	0.03	0.02	47.53
d_bus_ter	-36.24	48.74	-0.13	-0.74	0.46	0.05	20.09
d_muni	-66.19	74.92	-0.25	-0.88	0.38	0.02	49.26
d_bank	-84.88	60.72	-0.20	-1.40	0.16	0.08	12.90
d_dev_org	-54.22	36.48	-0.16	-1.49	0.14	0.13	7.64
d_hosp	212.03	63.97	0.86	3.31	0.00	0.02	42.09
d_market	63.20	128.81	0.18	0.49	0.62	0.01	79.93

d_job	-71.12	53.76	-0.35	-1.32	0.19	0.02	42.69
d_recre	151.00	46.48	0.50	3.25	0.00	0.07	14.87
d_dustbin	-26.82	97.48	-0.02	-0.28	0.78	0.43	2.33
d_poura_rd	-25.54	25.13	-0.09	-1.02	0.31	0.19	5.19
d_up_rd	1.41	4.43	0.01	0.32	0.75	0.87	1.15

Source: Calculated by author, 2009

One of the ways that the outliers, normality, linearity, homoscedasticity and independence of residuals can be verified is by inspecting the residuals scatterplot and the Normal Probability Plot (NPP) of the regression-standardized residuals those were considered as part of fitness test of the analysis.

In the scatterplot of the standardized residuals it is expected that the residuals will be roughly and rectangularly distributed with most of the scores concentrated in the center. This assumption of validation test was not also satisfied (Figure 5.1) in case of distribution of the land price.

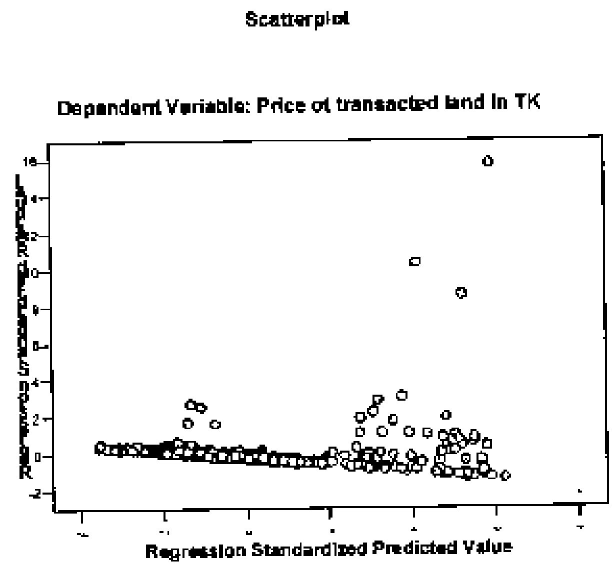


Figure 5.1: Scatterplot of the standardized

On the other hand, in the NPP, it is expected that the points will lie in a reasonably straight diagonal line from bottom left to top right. This would suggest no major deviations form normality. Nevertheless, in this analysis no such NPP was observed.

5.2 Categorization of plots in different groups

It is obvious that with these blunder outcomes of the multiple analysis of the selected variables, ultimate result could not underscore the pragmatic circumstances of the analogous factors influencing land price of the Savar municipality. This is why; the land price of different transacted plots needs to be stratified. Based on the available data on land price and trail and error basis for minimizing the standard deviation of land price, transacted plots were categorized into four groups such as

- Group 1 (land price TK 20000- less than TK 30000 per decimal) in which plots of Aichanoyadda, Bagmari, Rajashan and Sadhapur mouzas are included. There are 88 plots in this group (Map 5.1) and the mean and standard deviation of the land price are TK 25272.59 and TK 9846.52 per decimal respectively. Moreover, the land price distribution is also persuaded the basic assumption of residuals scatterplot (Figure 5.2) and the Normal Probability Plot (Figure 5.3).

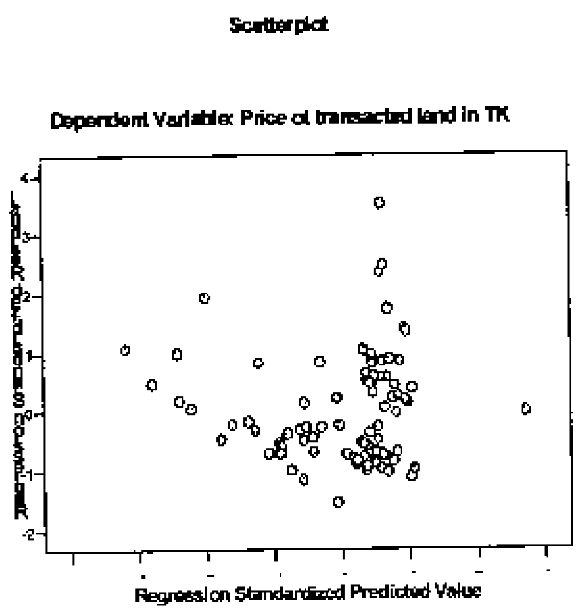


Figure 5.2: Scatterplot of the standardized residuals for Group 1 plots

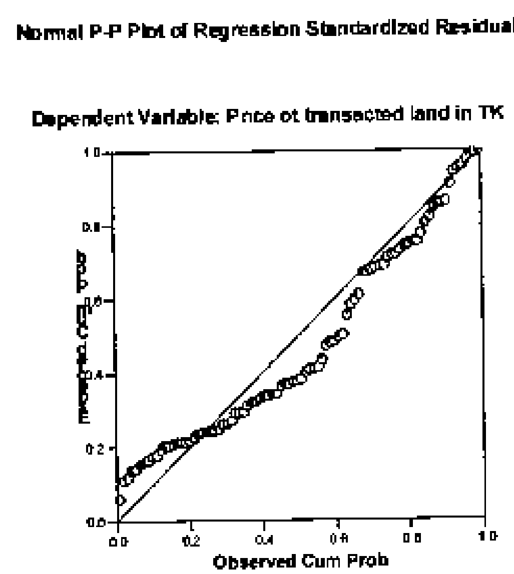
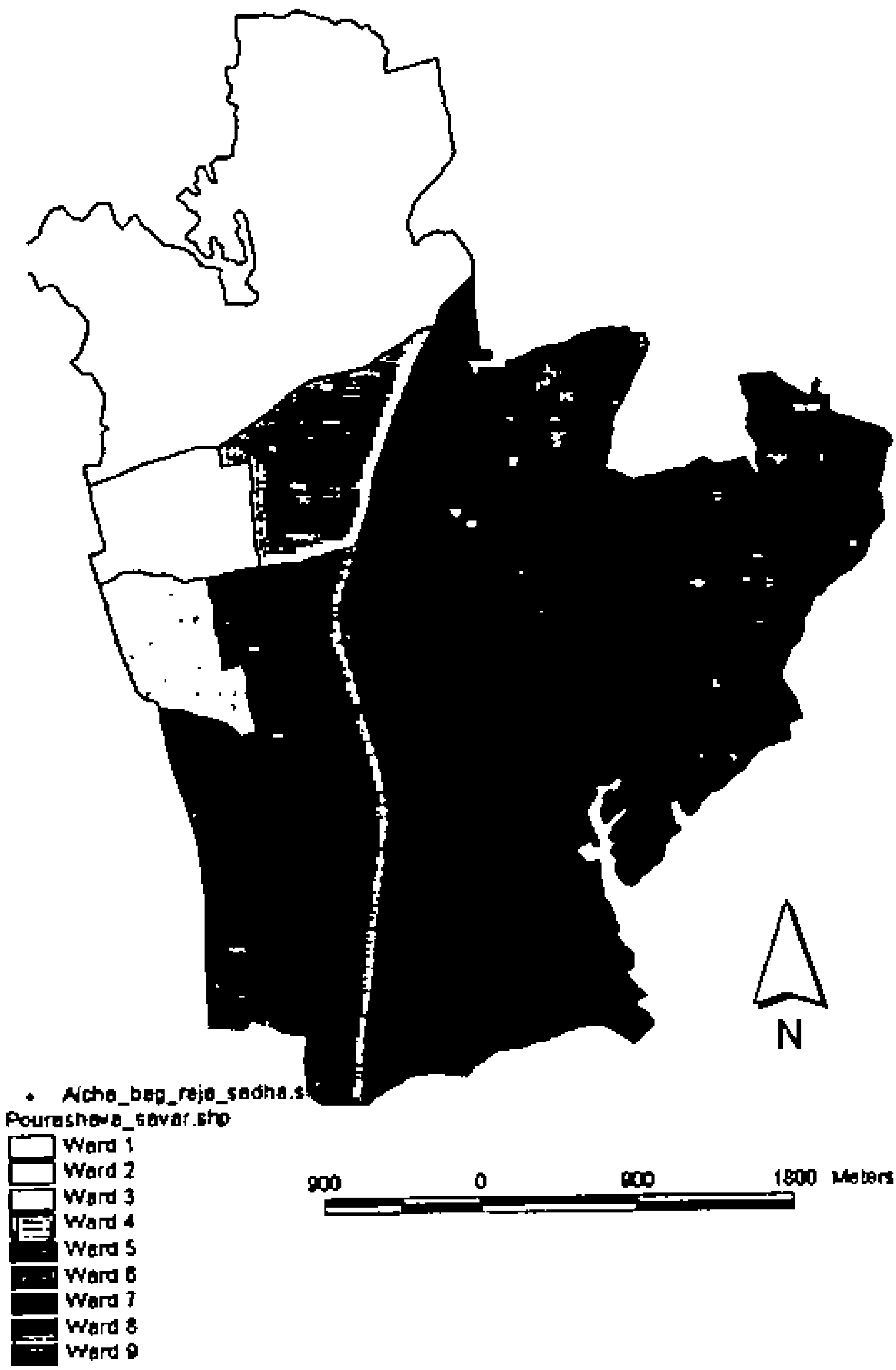


Figure 5.3: Normal P-P of the regression standardized residual for Group 1 plots



Source: Prepared by author, 2009

Map 5.1: Location map of transacted plots of Group 1 category

- Group 2 (land price TK 30000- less than TK 40000 per decimal) in which plots of Akran, Arapara, Balimohar, Dakhin Ramchandrapur Diagaon, Jaleswar, Jamshing, Purbo Vobanipur, Savar and Shyampur mouzas are included. There are 200 plots in this group (Map 5.2) and the mean and standard deviation of the land price are TK 34697.90 and TK 11425.68 per decimal respectively. Furthermore, the land price distribution is also persuaded the basic assumption of residuals scatterplot (Figure 5.4) and the Normal Probability Plot (Figure 5.5).

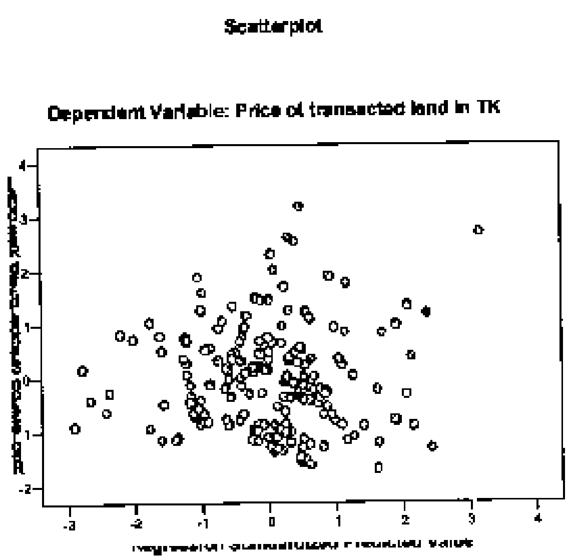


Figure 5.4: Scatterplot of the standardized residuals for Group 2 plots

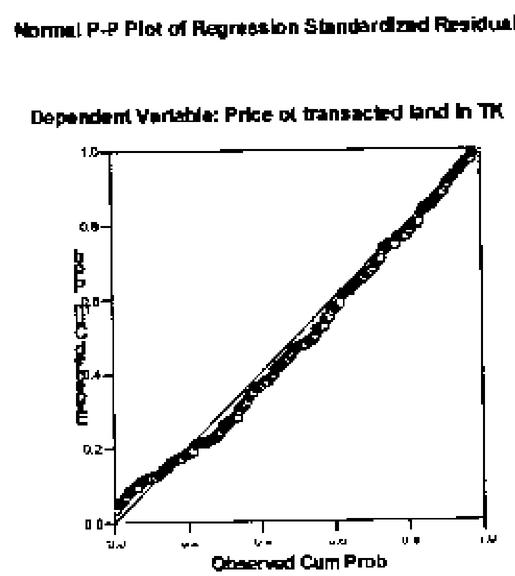
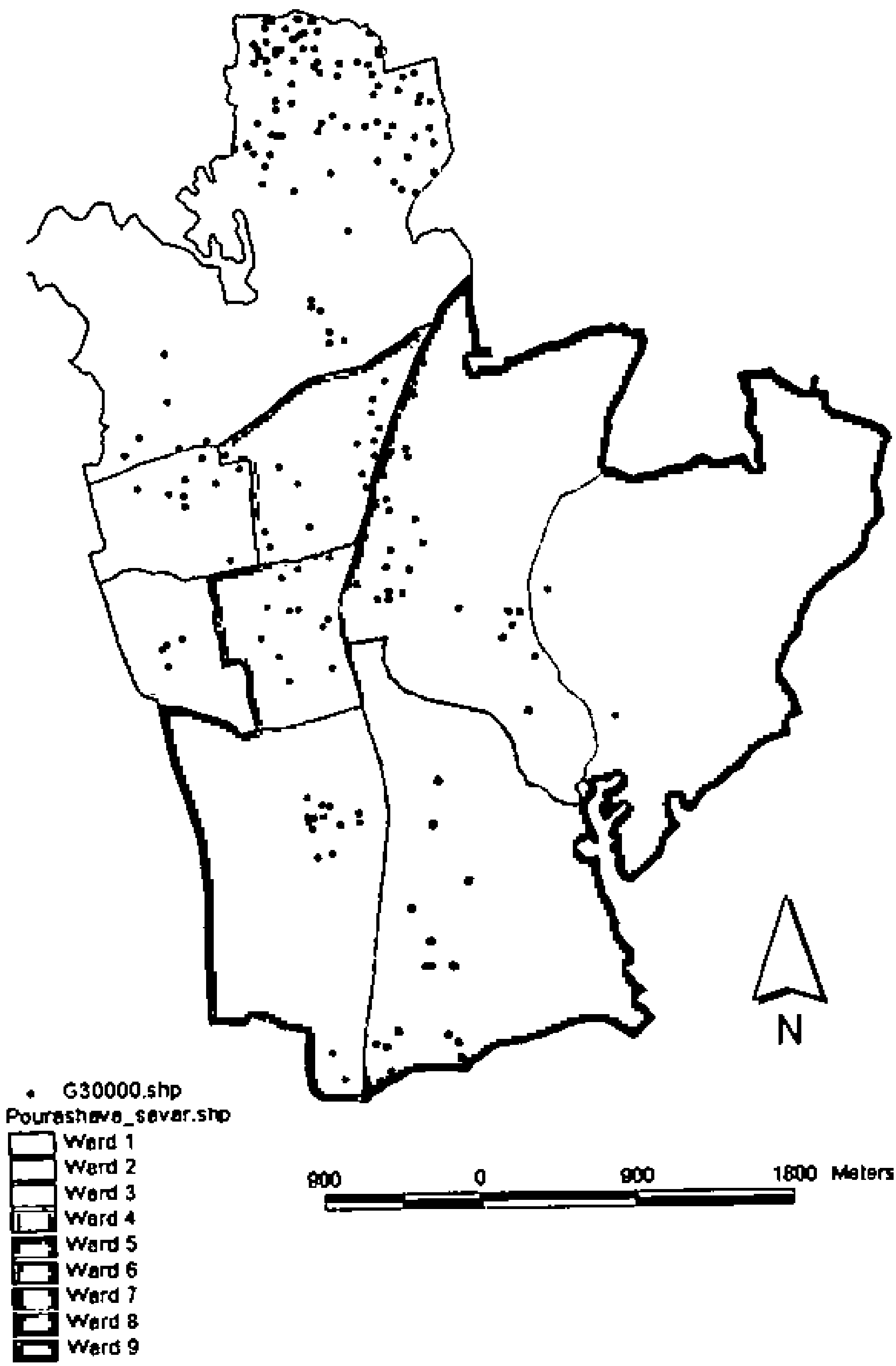


Figure 5.5: Normal P-P of the regression standardized residual for Group 2 plots



Source: Prepared by author, 2009

Map 5.2: Location map of transacted plots of Group 2 category

- Group 3 (land price TK 40000 – TK 80000 per decimal) in which plots of Anandapur, Badda, Boroigram, Dakhin Dariyarpur, Dogornera, Imandipur, Karnapara, Katiapur, Majidpur and Vatpara mouzas are included. There are 156 plots in this group (Map 5.3) and the mean and standard deviation of the land price are TK 42203.62 and TK 10021.45 per decimal respectively. Along with these land price distribution is also persuaded the basic assumption of residuals scatterplot (Figure 5.6) and the Normal Probability Plot (Figure 5.7).

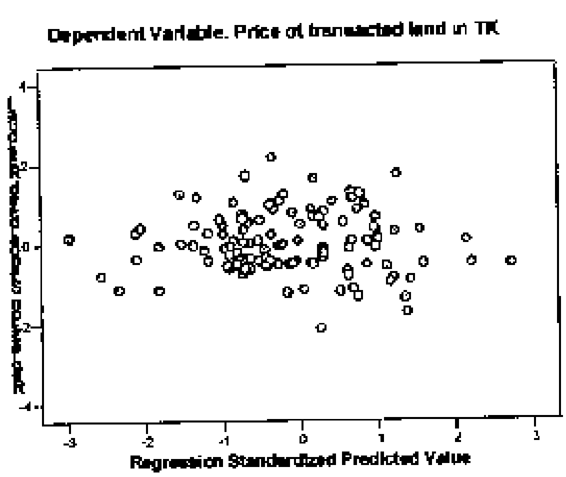


Figure 5.6: Scatterplot of the standardized residuals for Group 3 plots

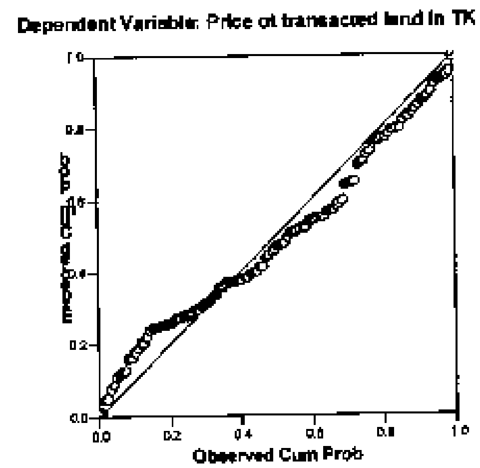
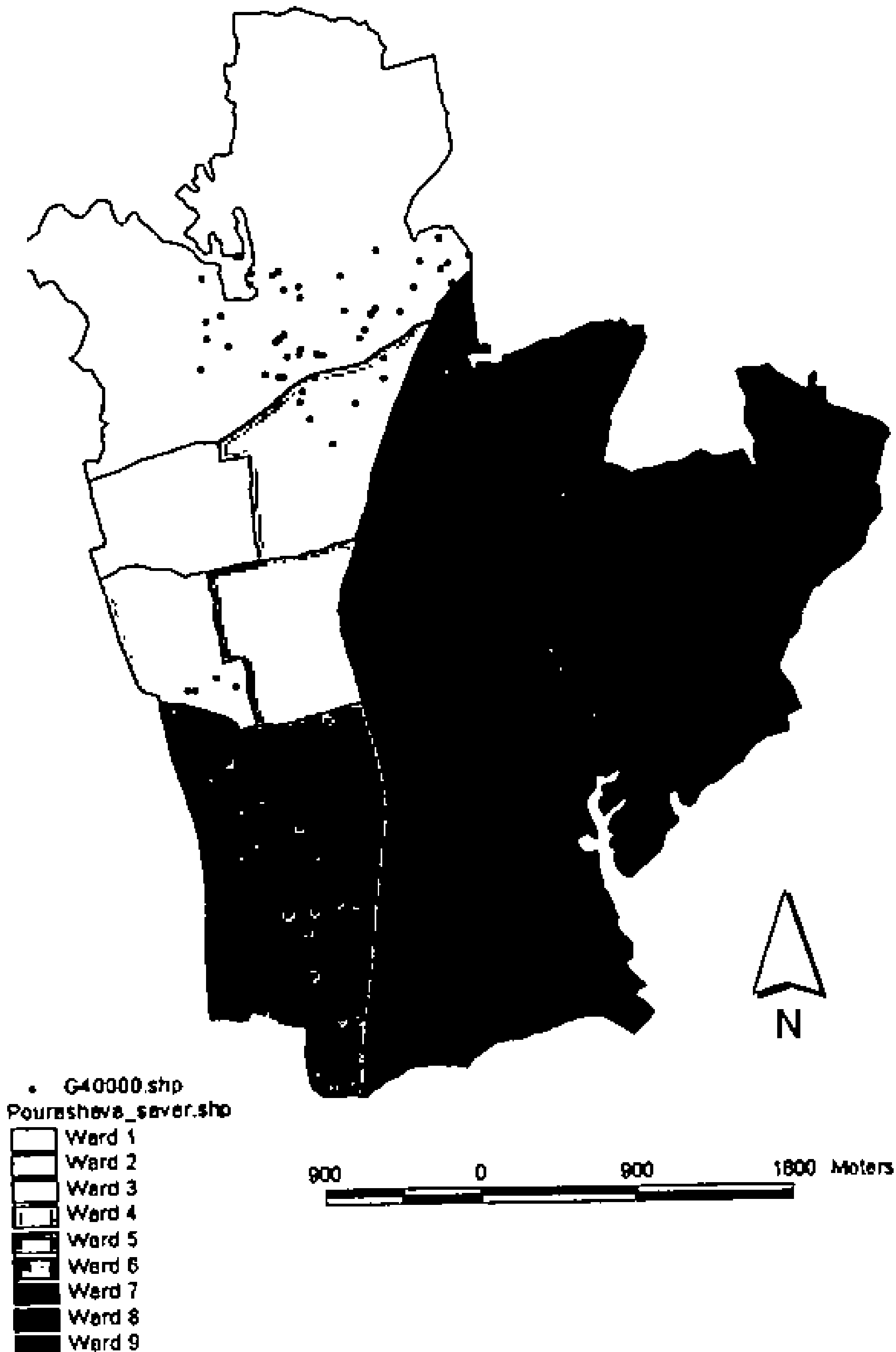


Figure 5.7: Normal P-P of the regression standardized residual for Group 3 plots



Source: Prepared by author, 2009

Map 5.3: Location map of transacted plots of Group 3 category

- Group 4 (land price TK 88182 – TK 150000 per decimal) in which 112 plots of Genda mouza (Map 5.4) were transacted and the mean and standard deviation of the land price are TK 120466 and TK 31248 per decimal respectively. Like other groups the land price distribution of the Genda mouza persuades the basic assumption of residuals scatterplot (Figure 5.8) and the Normal Probability Plot (Figure 5.9).

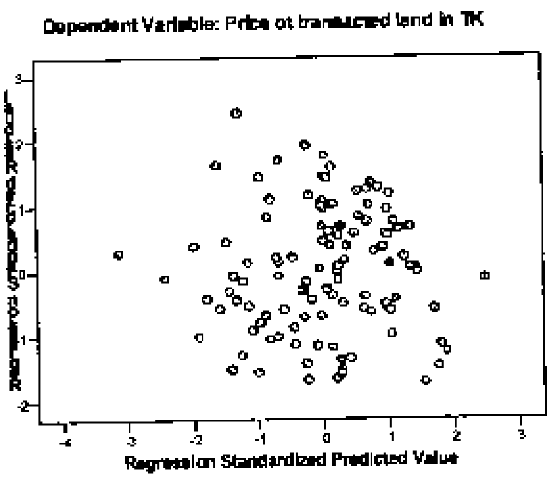


Figure 5.8: Scatterplot of the standardized residuals for plots of Genda

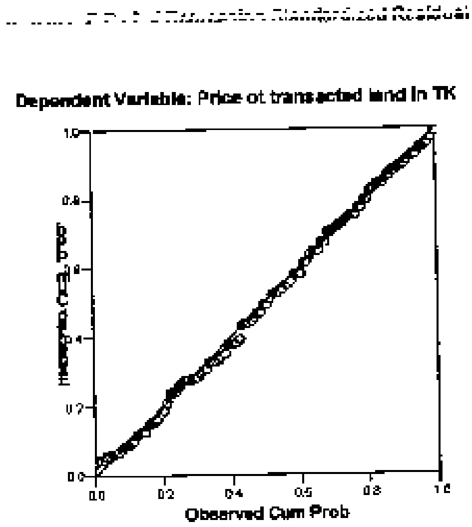
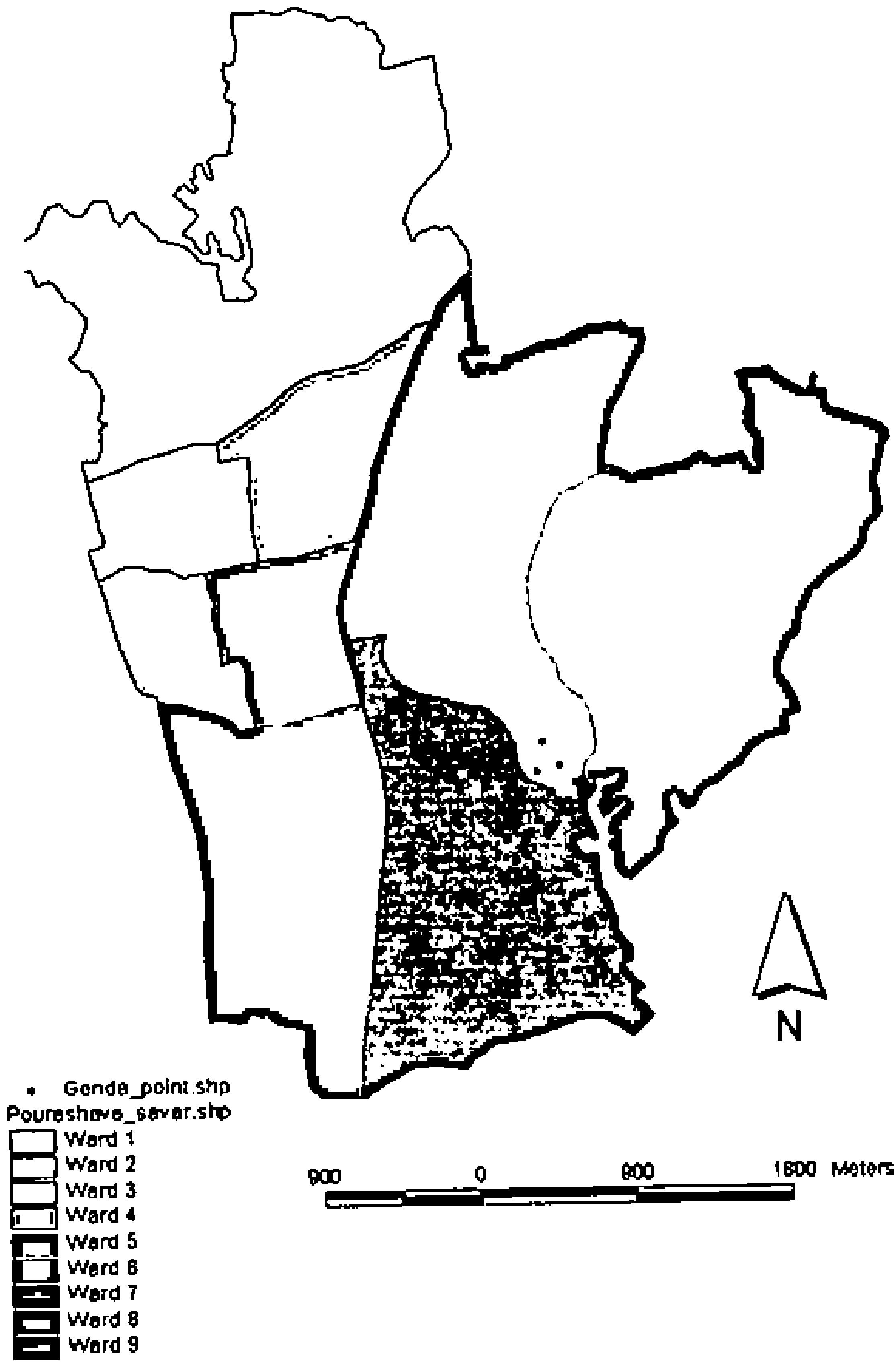


Figure 5.9: Normal P-P of the regression standardized residual for plots of Genda



Source: Prepared by author, 2009

Map 5.4: Location map of transacted plots of Group 4 category

5.3 Testing of the fitness of data for Spatial Autoregressive analysis

In order to use the data in the Spatial Autoregressive analysis, probability density functions of the data of transacted land price per decimal mush be specified and a distribution table needs to be created. Data would be better vigorous for regression analysis if they were normally distributed. The basic assumption of the normal distribution curve is that the height of the normal curve is at its maximum at the mean (Gupta and Gupta, 2000). In the case of above-mentioned four groups of plots, data of land price are normally distributed with maximum height of the normal probability function curve at the mean of the price (Figure 5.10, 5.11, 5.12 and 5.13). As the land prices of all the groups are normally distributed it is implicit that data can be functional for the Spatial Autoregressive analysis.

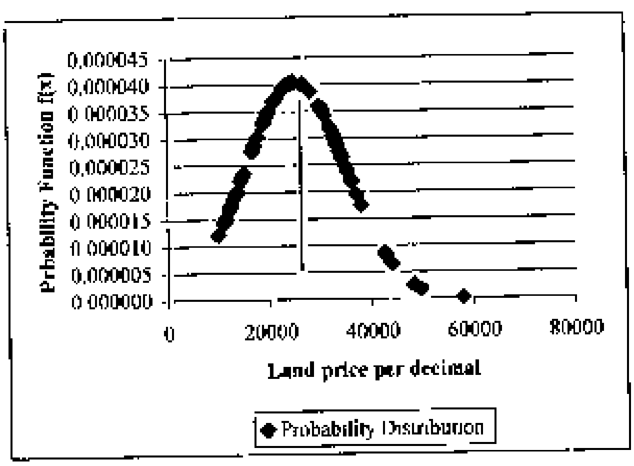


Figure 5.10: Normal probability distribution of price for Group 1 plots

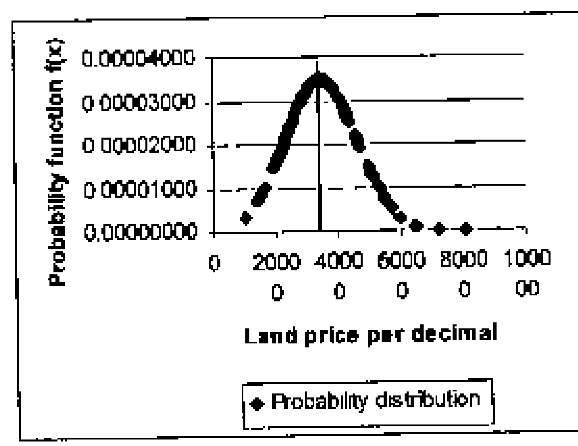


Figure 5.11: Normal probability distribution for price of Group 2 plots

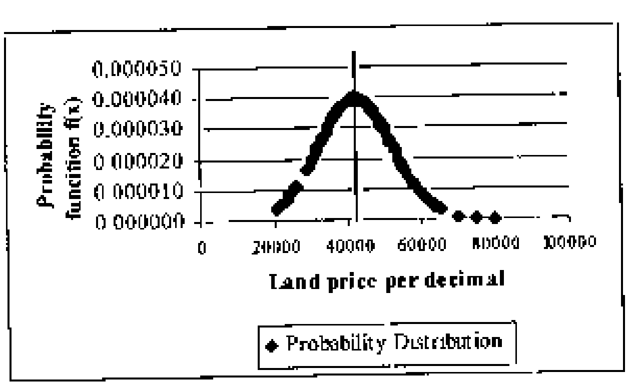


Figure 5.12: Normal probability distribution for price of Group 3 plots

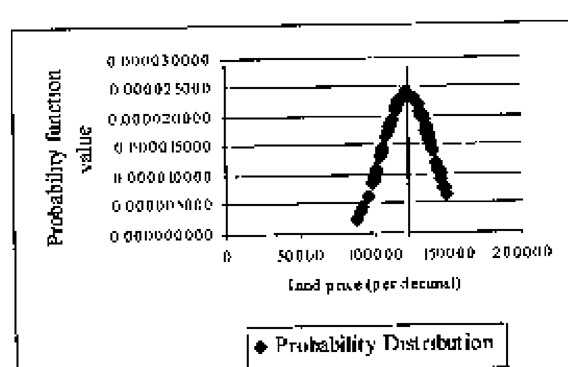


Figure 5.13: Normal probability distribution for price of Genda plots

The percentage distribution of data of different groups can be identical to represent the probability of average land price less than the given value. In case of Group 1 plots, the 1. 5, 15, 30, 50, 75, 95, 99 and 100 percent chance of average land price are TK 10966.57. TK 12209.5, TK 14720.7, TK 19849.7, TK 23047, TK 32750.25, TK 42857, TK 50769.43 and TK 58000 respectively. Therefore, more than 50 percent chance of data will be within the average land price (TK 25272.59) of group 1 (Figure 5.14).

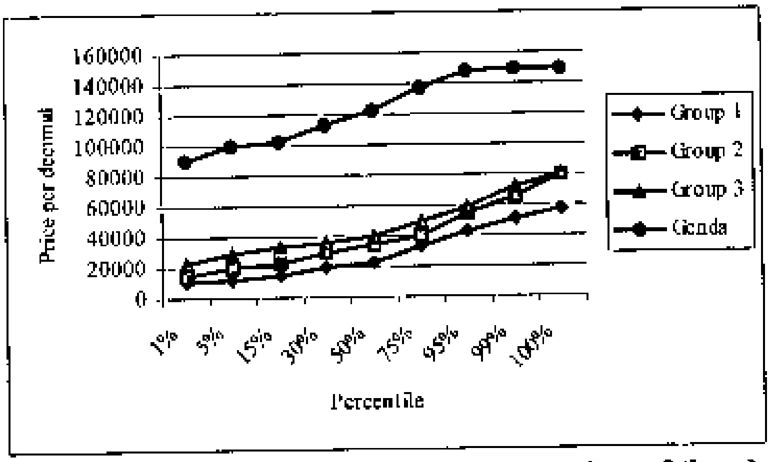


Figure 5.14: Percentile distribution of the prices of the plots

Similarly, in case of Group 2 plots, the 1, 5, 15, 30, 50, 75, 95, 99 and 100 percent chance of average land price are TK 14990, TK 20000, TK 22641.95, TK 28678.3, TK 35044. TK 40545.25, TK 55260.1, TK 65069.7 and TK 80508 respectively. Therefore, about to 50 percent chance of data will be within the average land price (TK 34697.96) of group 2 (Figure 5.14).

In Group 3, the 1, 5. 15, 30, 50, 75, 95, 99 and 100 percent chance of average land price of the selected plots are TK 22615.7, TK 29118.25, TK 33030, TK 36196.5, TK 40000, TK 49708.5, TK 58759.75, TK 72250 and TK 80000 respectively. Hence, more than 50 percent chance of data will be within the average land price (TK 42203.62) of group 3 (Figure 5.14).

In Genda, the 1, 5, 15, 30, 50, 75, 95, 99 and 100 percent chance of average land price of the selected plots are TK 91063.89, TK 99795.25, TK 102667, TK 113250, TK 123101, TK 136841.8. TK 148333, TK 150000 and TK 150000 respectively. Hence, about to 50 percent chance of data will be within the average land price (TK 120466) of Genda (Figure 5.14).

In addition, Chi-square test was conducted in order to determine goodness-of-fit of the data for the analysis. The quantity of Chi-square test describes the magnitude of discrepancy between theory and observation. If the value is zero, it means that the observed and expected frequencies completely coincide. The calculated value of Chi-square is compared with the table value for given degree of freedom at specified level of significance. If the calculated value is greater than the table value, the difference between theory and observation is considered to be significant. On the other hand, if the calculated value is less than the table value, the difference between theory and observation is not considered significant (Gupta and Gupta, 2000, p. 633).

In case of this study, the null hypothesis was 'the average and standard deviation of the land price data are within TK 25272.59 and TK 9846.52 for group 1; TK 34697.96 and TK 11425.68 for group 2; TK 42203.62 and TK 10021.45 for group 3; TK 120466 and TK 31248 for Genda.' The calculated values of Chi-square at 5 percent significance level for group 1, 2, 3 and 4 were 0.876, 2.263, 5.336 and 0.145 respectively. Nevertheless, the table value of Chi-square at degree of freedom 1 and significance level 5 percent is 3.84. Therefore, the null hypothesis was accepted for group 1, 2 and 4 data. The contrast was ensued in case of group 3 but it contented the normal distribution and percentile distribution. In recapitulation, the data of all four groups are en-suited for the spatial regression analysis.

5.4 Category-wise derivation of Hedonic Pricing Model

Group 1 (land price TK 20000-TK 30000 per decimal)

The coefficients of correlation of the dependent variable with the explanatory variables revealed that land price has significant relationship with elevation of the plots (0.34), distance from the brickfield (-0.26), distance from the educational institution (-0.26), distance from the hazardous industries (0.27), distance from the bus terminal (-0.27), and distance from the poura road (-0.30), upazila road and Dhaka-Aricha highway (-0.28). While land price has strong relationship with population density (0.48), distance from the development organization (-0.49) and distance from the hospital (0.51). In contrast, if we consider the multicollinearity effect, most of the explanatory variables have less than 0.7-coefficient correlation with others variables. Nonetheless, exceptionality was observed in case of distance from the hospital and distance from the Dhaka-Aricha Highway who both have more than 0.7-coefficient correlation with four variables. But due to their strong correlation with the dependent variable (land price), they were taken into consideration (Appendix B.2).

The value of R-square explained 34.30 percent of the variance of the land price. While 'collinearity diagnostics' indicated that 'tolerance' of the population density (pop_den), distance from the hazardous industries (d_haz_ind), distance from bus terminal (d_bus_ter), distance from development organization (d_dev_org), distance from hospital (d_hosp), distance from dustbin (d_dustbin), distance from poura road (d_poura_rd) and distance from Dhaka-Aricha Highway (d_nh) was high resulting in low multicollinearity. In addition, the significance levels of these variables are within 0.10 (Table 5.2). Therefore, these variables were considered for the 2nd level iteration process in order to accomplish the exact relationship between the land price and the explanatory variables.

Table 5.2: Summary of the linear OLS hedonic model for group 1

	Unstandardized Coefficients		Standardized Coefficients	Sig.	Collinearity Statistics	
	B	Std. Error	Beta		Tolerance	VIF
(Constant)	74679.72	53988.32		0.17		
area	-0.11	0.24	-0.05	0.64	0.94	1.06
pop_den	-3.20	3.17	-0.54	0.03	0.45	22.33
contour	-0.02	0.15	-0.02	0.09	0.78	1.29
D_brickfld	-2.63	7.99	-0.12	0.07	0.09	10.61
D_edu	2.06	14.05	0.04	0.88	0.15	6.84
D_haz_ind	-3.48	13.40	0.07	0.09	0.80	5.28
D_police	-50.51	114.79	-2.74	0.66	0.00	2979.55
D_relig	11.10	16.40	0.28	0.50	0.07	13.38
D_bus_ter	62.99	120.04	3.34	0.06	0.32	3128.71
D_muni	-12.10	49.40	-0.80	0.81	0.00	814.04
D_bank	13.11	48.03	0.85	0.79	0.00	747.78
D_dev_org	-5.13	15.35	-0.24	0.03	0.74	38.22
D_hosp	3.78	20.32	0.26	0.01	0.85	145.73
D_market	11.22	65.09	0.68	0.86	0.00	1211.05
D_recre	-34.25	58.03	-1.70	0.56	0.00	638.49
D_dustbin	-1.64	17.41	-0.07	0.02	0.93	43.44
D_poura_rd	-6.12	13.43	-0.10	0.07	0.27	3.74
D_up_rd	0.15	9.60	0.01	0.10	0.85	11.72
D_nh	-7.58	4.59	-0.54	0.10	0.12	8.19

Source: Calculated by author, 2009

Aftermath, the dependent variable was regressed against the selected explanatory variables. In this case, the dependent variable has significant correlation with the factors and there is no multicollinearity effect among the explanatory variables. Simultaneously, the value of R Square was 0.275 resulting 27.5 of the dependent variable explanation by this model.

The collinearity diagnosis indicated that the tolerance values of the variables were high resulting in low multicollinearity among the explanatory variables. Along with the significance levels in case of all variables were within 0.10 (Table 5.3).

Table 5.3: Summary of the 2nd time regression for Group 1

	Unstandardized Coefficients		Standardized Coefficients	Sig.	Collinearity Statistics	
	B	Std. Error	Beta		Tolerance	VIF
(Constant)	74950.87	12143.83		0.00		
pop_den	-2.92	2.21	-0.50	0.09	0.80	12.01
d_haz_ind	2.58	8.72	0.05	0.07	0.40	2.48
d_bus_tr	-3.84	-3.64	-0.20	0.06	0.42	4.11
d_dev_org	-10.72	9.04	-0.49	0.04	0.70	14.71
d_hosp	-1.54	4.54	-0.10	0.04	0.82	8.07
d_dustbin	-9.06	-8.21	0.39	0.07	0.90	10.72
d_poura_rd	-9.07	9.96	-0.15	0.07	0.44	2.28
d_nh	-6.15	3.90	-0.44	0.02	0.15	6.57

Source: Calculated by author, 2009

Thereafter, in order to derive the hedonic pricing model, the 'unstandardized coefficients' are taken into consideration for the corresponding explanatory variables. The standardized coefficient (Beta) is important only when comparative evaluation is required among the variables. Finally the OLS hedonic pricing model was (Table 5.3):

$$Y=74950.87+(-2.92)\,pop\_den + 2.58\,d\_haz\_ind + (-3.84)\,d\_bus\_tr + (-10.72)\,d\_dev\_org + (-1.54)\,d\_hosp + (-9.06)\,d\_dustbin + (-9.07)\,d\_poura\_rd + (-6.15)\,d\_nh \quad (21)$$

This OLS regression equation was promoted to cross-checked with the average data of the explanatory variables in order to verify whether the equation could look at the precise anticipation of the land price of the plots within the group 1 (Table 5.4). Thus the average data of the explanatory variables were inputted into the equation (21) and resulted in the average land price per decimal as TK 28589.73. This result has deviation of TK 3317.14 from the average land price TK 25272.59 per decimal of group 1 plots. This deviation may be the consequence of spatial error.

Table 5.4: Coefficient and average data of selected variables in case of Group 1 plots

Variables	Coefficients	Average data
Constant	74950.87	
Population density (person per sq.km.)	-2.92	3541
Distance from hazardous industry (m)	2.58	442
Distance from bus terminal (m)	-3.84	2885
Distance from development organizations (m)	-10.72	855
Distance from hospital (m)	-1.54	1406
Distance from dustbin (m)	-9.06	846
Distance from poura road (m)	-9.07	193
Distance from upazila road (m)	-6.15	497

Source: Calculated by author, 2009

Group 2 (land price TK 30000-TK 40000 per decimal)

The coefficients of correlation of the dependent variable with the explanatory variables revealed that land price has significant relationship with area of the plots (0.26), population density (pop_den) (-0.33), elevation of the plot (contour) (0.48), distance from the brickfield (d_brickfld) (0.56), distance from the educational institution (d_edu) (-0.32), distance from the hazardous industries (d_haz_ind) (0.49), distance from market and shopping center (d_market) (-0.33), and distance from the poura road (-0.44), and Dhaka-Aricha highway (-0.49). In contrast, if we consider the multicollinearity effect, most of the explanatory variables have less than 0.7-coefficient correlation with other variables. Nonetheless, exceptionality was observed in case of distance from hazardous industry and distance from market and shopping center that both have more than 0.7-coefficient correlation with more than three variables. Due to their strong correlation with the dependent variable, they were taken into account (Appendix B.3).

The value of R-square was satisfactorily explained 38.88 percent of the variance of the land price. While 'collinearity diagnostics' indicated that 'tolerance' of area of the plot (area), the population density (pop_den), elevation of the plot (contour), distance from the brickfield, distance from the educational institution (d_edu), distance from the hazardous industries (d_haz_ind), distance from market and shopping center (d_market), distance from employment attraction (d_job), distance from dustbin (d_dustbin), distance from poura road (d_poura_rd) and distance from Dhaka-Aricha Highway (d_nh) was high resulting in low multicollinearity. In addition, the significance levels of these variables were within 0.10 (Table 5.5). Therefore, these variables were considered for the 2nd level iteration process in order to attain the precise relationship between the land price and the explanatory variables.

Table 5.5: Summary of the linear OLS hedonic model for Group 2

	Unstandardized Coefficients		Standardized Coefficients	Sig.	Collinearity Statistics	
	B	Std. Error	Beta		Tolerance	VIF
(Constant)	61345.85	11631.12		0.01		
area	-0.04	0.10	-0.03	0.08	0.90	1.11
pop_den	-0.29	0.23	-0.23	0.02	0.14	7.03
contour	0.50	1.29	0.05	0.07	0.29	3.45
d_brickfld	-2.71	2.87	-0.19	0.03	0.12	8.48
d_edu	-10.07	7.24	0.22	0.07	0.18	5.49
d_haz_ind	18.89	13.17	1.18	0.05	0.01	143.35
d_police	-8.27	7.32	-0.78	0.26	0.01	100.49
d_relig	1.16	10.76	0.01	0.91	0.44	2.25
d_bus_ter	14.33	8.31	1.59	0.09	0.01	179.58
d_muni	0.77	6.31	0.05	0.90	0.02	42.04
d_bank	-1.53	9.62	-0.12	0.87	0.01	127.74
d_dev_org	-1.99	9.59	-0.09	0.84	0.03	39.44
d_hosp	5.66	8.12	0.31	0.49	0.02	42.66
d_market	-12.54	9.01	1.10	0.07	0.01	131.44
d_job	-34.77	15.46	-2.25	0.48	0.03	210.38
d_recre	-11.32	8.68	-1.09	0.19	0.01	147.89
d_dustbin	-1.81	6.43	-0.10	0.04	0.78	27.09
d_poura_rd	-11.46	15.15	-0.06	0.05	0.78	1.28
d_up_rd	3.81	3.11	0.29	0.22	0.09	11.53
d_nh	-0.48	0.28	-0.13	0.08	0.90	1.11

Source: Calculated by author, 2009

Aftermath, the dependent variable (land price) was regressed against the selected explanatory variables. In this case, the dependent variable has significant correlation with the factors and there was no multicollinearity effect among the explanatory variables. Simultaneously, the value of R-square was 0.325 resulting 32.5 of the dependent variable explanation by this model.

Table 5.6: Model summary of the 2nd time regression for group 2 plots

	Unstandardized Coefficients		Standardized Coefficients	Sig.	Collinearity Statistics	
	B	Std. Error	Beta		Tolerance	VIF
(Constant)	61641.80	8805.40		0.00		
Area	0.04	0.10	0.03	0.06	0.93	1.08
pop_den	0.03	0.12	0.02	0.03	0.52	1.92
Contour	0.64	0.86	0.06	0.06	0.64	1.55
D_brickfld	0.62	1.99	0.04	0.06	0.25	4.06
D_edu	-2.23	6.23	-0.05	0.02	0.25	4.05
D_haz_ind	9.98	11.95	0.63	0.04	0.01	117.69
D_market	-9.86	3.68	-0.86	0.01	0.05	21.86
D_job	-21.51	11.41	-1.39	0.06	0.01	114.34
D_dustbin	-2.58	2.24	-0.14	0.05	0.31	3.28
D_poura_rd	-18.86	14.58	-0.10	0.02	0.84	1.19
D_nh	-0.38	0.27	-0.10	0.06	0.93	1.07

Source: Calculated by author, 2009

The collinearity diagnosis indicated that the tolerance values of the variables were high resulting in low multicollinearity among the explanatory variables. Besides the significance levels in case of all variables were within 0.10 (Table 5.6). Thereafter, the ultimate OLS hedonic pricing model for group 2 plots was:

Y= 61641.80 + 0.04 area + 0.03 pop_den + 0.64 contour + 0.62 d_brickfld + (-2.23) d_edu + 9.98 d_haz_ind + (-9.86) d_market + (-21.51) d_job + (-2.58) d_dustbin + (-18.86) d_poura_rd + (-0.38) d_nh (22)

This OLS regression equation (22) was promoted to cross-checked with the average data of the explanatory variables in order to verify whether the equation could look at the precise anticipation of the land price of the plots within the group 2 (Table 5.7). Thus the average data of the explanatory variables were pierce into the equation (22) and resulted in the average land price per decimal as TK 42385.29. This result has deviation of TK 7687.33 from the average land price TK 34697.96 per decimal of group 1 plots. This deviation may be the consequence of spatial error.

Table 5.7: Coefficient and average data of selected variables for Group 2 plots

Variables	Coefficients	Average data
Constant	61641.80	
Area of transacted plot (sq.ft.)	0.04	3046
Population density (person per sq.km.)	0.03	8070
Contour (cm)	0.64	7045
Distance from brick field (m)	0.62	2273
Distance from schools (m)	-2.23	334
Distance from hazardous industry (m)	9.98	785
Distance from market (m)	-9.86	1259
Distance from job (m)	-21.51	751
Distance from dustbin (m)	-2.58	1042
Distance from poura road (m)	-18.86	51
Distance from upazila road (m)	-0.38	1079

Source: Calculated by author, 2009

Group 3 (land price TK 40000 –TK 80000 per decimal)

The coefficients of correlation of the dependent variable with the explanatory variables revealed that land price has significant relationship with population density (pop_den) (-0.30); elevation of the plots (0.39); distance from the brickfield (-0.26); and distance from the educational institution (-0.47). While land price has strong relationship with area of the plot (0.63); distance from the hazardous industry (d_haz_ind) (0.49); distance from bus terminal (-0.49); distance from health care establishment (-0.59); distance from the employment opportunity (d_job) (-0.51); and distance from poura road (d_poura_rd) (-0.52), upazila road (up_rd) (-0.68) and Dhaka-Aricha Highway (d_nh) (-0.49). One of the positive signs of the validation of this model was absence of multicollinearity effect among the explanatory variables (Appendix B.4).

The value of R-square was satisfactory explained 34.40 percent of the variance of the land price. While 'collinearity diagnostics' indicated that the value of 'tolerance' of the area of the plot (area), the population density (pop_den), elevation of the plot (contour), distance from the educational institution (d_edu), distance from the hazardous industries (d_haz_ind), distance from bus terminal (d_bus_tr), distance from market and shopping center (d_market), distance from hospital, distance from employment attraction (d_job), distance from poura road (d_poura_rd), upazila road (up_rd), and distance from Dhaka-Aricha Highway (d_nh) were high resulting in low multicollinearity among the explanatory variables. In addition, the significance levels of these variables are within 0.10 (Table 5.8). Therefore, these variables were considered for the 2nd level iteration process in order to achieve the accurate rapport between the land price and the explanatory variables.

Table 5.8: Summary of the linear OLS hedonic model for Group 3 plots

	Unstandardized Coefficients		Standardized Coefficients	Sig.	Collinearity Statistics	
	B	Std. Error	Beta		Tolerance	VIF
(Constant)	39129.37	26536.38		0.14		
Area	0.01	0.03	0.04	0.07	0.95	1.05
pop_den	0.15	0.64	0.06	0.08	0.14	7.05
Contour	0.35	2.86	0.04	0.10	0.90	9.55
d_edu	-11.67	13.37	-0.13	0.04	0.39	2.58
d_haz_ind	-6.94	21.02	-0.14	0.05	0.74	20.27
d_police	-10.09	10.65	-0.60	0.35	0.02	43.53
d_relig	3.53	14.99	0.03	0.81	0.49	2.03
d_bus_ter	-6.93	8.81	-0.59	0.02	0.43	61.07
d_muni	-1.09	7.40	-0.03	0.88	0.17	5.86
d_bank	-3.58	11.10	-0.12	0.75	0.06	15.39
d_dev_org	3.10	12.24	0.06	0.80	0.14	7.18
d_hosp	-10.35	10.96	-0.29	0.09	0.35	10.53
d_market	-7.43	10.11	-0.31	0.05	0.46	19.09
d_job	-16.14	22.36	-0.33	0.04	0.47	23.48
d_recre	-0.28	10.48	-0.02	0.98	0.02	44.35
d_dustbin	1.63	9.82	0.06	0.87	0.07	15.24
d_poura_rd	-33.57	19.92	-0.21	0.10	0.59	1.69
d_up_rd	-4.27	7.89	-0.23	0.05	0.59	19.12
d_nh	-3.90	11.86	-0.18	0.03	0.74	31.86

Source: Calculated by author, 2009

Consequently, the dependent variable (land price) was regressed against the selected explanatory variables. In this case, the dependent variable has noteworthy correspondence with the factors and there was no multicollinearity effect among the explanatory variables. Simultaneously, the value of R-square was 0.678 resulting 67.8 of the dependent variable explanation by this model.

Table 5.9: Model summary of the 2nd time regression for Group 3 plots

	Unstandardized Coefficients		Standardized Coefficients	Sig.	Collinearity Statistics	
	B	Std. Error	Beta		Tolerance	VIF
(Constant)	273262.05	198622.64		0.00		
Area	0.15	0.02	0.51	0.00	0.72	1.38
Pop_den	-17.49	1.32	-6.88	0.00	0.01	86.36
contour	275.62	20.29	28.41	0.00	0.00	1398.64
d_brickfld	-485.96	35.74	-33.15	0.00	0.00	1901.35
d_edu	-373.16	29.03	-4.27	0.00	0.03	35.28
d_haz_ind	52.56	63.29	17.41	0.00	0.00	534.19
d_bus_tr	39.86	17.57	20.28	0.00	0.00	706.22
d_hosp	-361.96	27.25	-10.22	0.00	0.01	189.30
d_market	-10.88	3.14	-0.45	0.00	0.19	5.34
d_job	-284.32	22.45	-5.87	0.00	0.01	68.75
d_poura_rd	-861.76	61.82	-5.36	0.00	0.02	47.22
d_up_rd	-515.84	37.54	-27.24	0.00	0.00	1256.33
d_nh	-657.58	48.21	-29.83	0.00	0.00	1529.16

Source: Calculated by author, 2009

The collinearity diagnosis indicated that the tolerance values of the variables are high resulting in low multicollinearity among the explanatory variables. Along with the significance levels in case of all variables are within 0.10 (Table 5.9). Eventually the OLS hedonic pricing model was (Table 5.9):

Y= 273262.05 + 0.15 area + (-17.49) pop_den + 275.62 contour + (-485.96) d_brickfld + (-373.16) d_edu + 52.56 d_haz_ind + 39.86 d_bus_tr + (-361.96) d_hosp + (-10.88) d_market + (-284.32) d_job + (-861.76) d_poura_rd + (-515.84) d_up_rd + (-657.58) d_nb (23)

This OLS regression equation (23) was promoted to cross-checked with the average data of the explanatory variables in order to verify whether the equation could look at the precise anticipation of the land price of the plots within the group 3 (Table 5.10). Thus the average data of the explanatory variables were pierce into the equation (23) and resulted in the average land price per decimal as TK 42385.29. This result has deviation of TK 181.67 from the average land price TK 42203.62 per decimal of group 3 plots. This deviation may be the consequence of spatial error.

Table 5.10: Coefficient and average data of selected variables for Group 3 plots

Variables	Coefficients	Average data
Constant	273262.05	
Area of transacted plot (sq.ft.)	0.15	4991
Population density (person per sq.km.)	-17.49	10281
Contour (cm)	275.62	6686
Distance from brick field (m)	-485.96	1711
Distance from schools (m)	-373.16	226
Distance from hazardous industry (m)	52.56	341
Distance from bus terminal (m)	39.86	1751
Distance from hospital (m)	-361.96	647
Distance from market (m)	-10.88	770
Distance from job (m)	-284.32	317
Distance from poura road (m)	-861.76	54
Distance from upazila road (m)	-515.84	469
Distance from Dhaka-Aricha Highway (m)	-657.58	521

Source: Calculated by author, 2009

Group 4 (land priceTK 88182 – TK 150000 per decimal)

The coefficients of correlation of the dependent variable with the explanatory variables exposed that land price has considerable correlation with area of the plot (0.49), population density (pop_den) (0.62); elevation of the plots (0.27); distance from the brickfield (-0.38); and distance from the educational institution (-0.28), distance from hazardous industry (d_haz_ind) (-0.41), distance from religious center (d_relig) (0.31), distance from municipal service (d_muni) (-0.29), distance from bank (d_bank) (-0.27), distance from poura road (d_poura_rd) (0.38), distance from upazila road (-0.75) and distance from Dhaka-Aricha Highway (d_nh) (-0.39). The multicollinearity effect among the explanatory variables is also less in the model (Appendix B.5).

The value of R-square was satisfactory explaining 52.10 percent of the variance in the land price. While 'collinearity diagnostics' pointed out that the value of 'tolerance' of the area of the plot (area), the population density (pop_den), elevation of the plot (contour), distance from the hazardous industries (d_haz_ind), distance from municipal service (d_muni), distance from bank (d_bank), distance from healthcare establishment (d_hosp), distance from employment attraction (d_job), distance from recreation facility (d_recre), distance from dustbin (d_dustbin), distance from poura road (d_poura_rd), upazila road (up_rd), and distance from Dhaka-Aricha Highway (d_nh) were high resulting in low multicollinearity among the explanatory variables. In addition, the significance levels of these variables are within 0.10 (Table 5.11). Therefore, these variables were considered for the 2nd level iteration process in order to attaining the exact relationship between the land price and the explanatory variables.

Table 5.11: Summary of the linear OLS hedonic model for the Group 4 plots

	Unstandardized Coefficients		Standardized Coefficients	Sig.	Collinearity Statistics	
	B	Std. Error	Beta		Tolerance	VIF
(Constant)	-275653388220728000	299938286441718000		0.36		
Area	1.29	0.87	0.15	0.04	0.77	1.29
pop_den	1090660607161130	1186747152693930	0.11	0.06	0.59	1.70
Contour	7.70	10.53	0.23	0.07	0.08	12.07
d_edu	-32.09	51.60	-0.40	0.54	0.02	52.25
d_haz_ind	21.60	41.46	0.16	0.06	0.09	11.63
d_police	4.02	31.99	0.06	0.90	0.04	26.31
d_relig	85.25	27.81	0.60	0.00	0.21	4.85
d_bus_ter	244.45	145.32	6.45	0.10	0.00	1853.45
d_muni	-1.75	55.63	-0.02	0.03	0.97	36.46
d_bank	-104.12	53.61	-1.50	0.06	0.01	75.11
d_dev_org	26.87	46.74	0.55	0.57	0.01	114.84
d_hosp	-46.88	87.75	-1.14	0.00	0.59	575.76
d_market	118.38	69.29	2.94	0.09	0.00	374.05
d_job	-9.27	36.48	-0.11	0.04	0.80	24.78
d_recre	-152.97	95.57	-2.97	0.00	0.11	434.38
d_dustbin	-149.92	128.19	-5.16	0.00	0.25	2457.46
d_poura_rd	-41.89	29.71	-0.16	0.06	0.59	1.70
d_up_rd	-59.72	19.94	-0.40	0.00	0.45	2.20
d_nh	-7.70	6.91	-0.16	0.07	0.40	2.51

Source: Calculated by author, 2009

Aftermath, the dependent variable (land price) was regressed against the selected explanatory variables. In this case, the dependent variable has significant correlation with the factors and there was no multicollinearity effect among the explanatory variables. Simultaneously, the value of R-square was 0.678 resulting 67.8 of the dependent variable explanation by this model.

Table 5.12: Coefficients and model summary of the 2nd time regression

	Unstandardized Coefficients		Standardized Coefficients	Sig.	Collinearity Statistics	
	B	Std. Error	Beta		Tolerance	VIF
(Constant)	248901	84791.93		0.12		
Area	1.31	0.86	0.15	0.03	0.84	1.19
contour	8.30	10.17	0.24	0.09	0.42	10.59
D_haz_ind	-25.35	27.72	-0.36	0.05	0.36	18.58
D_muni	-60.55	40.31	-0.58	0.06	0.14	18.01
D_bank	-0.08	28.82	0.00	0.05	1.00	20.42
D_hosp	-90.94	63.64	-2.21	0.00	0.16	284.86
D_job	32.40	32.63	0.39	0.05	0.32	18.65
D_recre	32.10	30.19	0.62	0.02	0.29	40.77
D_dustbin	-33.37	37.47	-1.15	0.01	0.38	197.51
D_poura_rd	-33.58	28.92	-0.13	0.05	0.66	1.51
D_up_rd	-43.12	19.66	-0.29	0.03	0.50	2.01
D_nh	7.50	7.01	0.15	0.09	0.41	2.44

Source: Calculated by author, 2009

The collinearity diagnosis indicated that the tolerance values of the variables are high resulting in low multicollinearity among the explanatory variables. Besides the significance levels in case of all variables were within 0.10 (Table 5.12). Thus, the ultimate OLS hedonic pricing model is (Table 5.12):

Y= 248901 + 1.31 area + 8.30 contour + (-25.35) d_haz_ind + (-60.55) d_muni + (-0.08) d_bank + (-90.94) d_hosp + (32.40) d_job + (32.10) d_recre + (-33.37) d_dustbin + (-33.58) d_poura_rd + (-43.12) d_up_rd + (7.50) d_nh (24)

This OLS regression equation was further cross-checked with the average data of the explanatory variables in order to determine whether the equation explores the exact anticipation of the land price of the plots within the group 4 (Table 5.13). Consequently the average data of the explanatory variables were entered into the equation (24) and resulted in the average land price per decimal TK 153124.87. This result has deviation of TK 32658.87 from the average land price TK 120466 per decimal of group 4 plots. This deviation may be the consequence of spatial error.

Table 5.13: Coefficient and average data of selected variables

Variables	Coefficients	Average data
Constant	248901	
Area of transacted plot (sq.ft.)	1.31	1529
Contour (cm)	8.30	6384
Distance from hazardous industry (m)	-25.35	424
Distance from municipal services (m)	-60.55	1056
Distance from bank (m)	-0.08	1072
Distance from hospital (m)	-90.94	683
Distance from job (m)	32.40	318
Distance from recreation facilities (m)	32.10	865
Distance from dustbin (m)	-33.37	1434
Distance from poura road (m)	-33.58	65
Distance from upazila road (m)	-43.12	123
Distance from Dhaka-Aricha Highway	7.50	452

Source: Calculated by author, 2009

In recapitulation, it can be said that explanatory variables like population density, distance from the industry, distance from bus terminal, distance from development organizations, distance from hospital, distance from dustbin, distance from poura road and distance from upazila road are significant attributes of land price of the plots in group 1. Among them distance from dustbin, distance from poura road, distance from the upazila road and distance from the development organization are the most significant ones. On the other hand, other three groups (2,3 and 4) have some common significant explanatory variables of land price such as area of the transacted plots, topological elevation (contour), distance from hazardous industry, distance from employment (job), distance from poura road and distance from upazila road. Excluding these explanatory variables of land price, group 2 has other attributes like population density, distance form brickfield, distance from school, distance from market, and distance from dustbin. Group 3 has communality apropos of the explanatory variables in addition to the previously mentioned variables e.g. population density, distance from brickfield, distance from school, and distance from market. On the contrary, only one variable 'distance from dustbin' is not significant in case of group plots but significant for group 3 plots.

On the other hand, comparison of group 4 with group 2 and group 3 regarding the explanatory variables it reveals that explanatory variables like distance from municipal services (street lighting), distance from bank and distance from recreational facilities are significant for the land price of group 4 plots which is totally dissimilar with the plots of group 1, 2 and 3. While distance from bus terminal is the significant attribute for land price in group 1 and 3. Implausibly, distance from dustbin is common for group 1, 2 and 4. In addition, distance from the Dhaka-Aricha Highway is common attribute in case of group 3 and group 4 and distance from hospital is common attribute in case of transacted plots of group 1, 2 and 4 except group 3.

Chapter VI

ANALYTICAL TEST OF SPATIAL DEPENDENCE

Chapter VI

Analytical Test of Spatial Dependence

Recognition and examination of spatial autocorrelation has distinct a new-fangled paradigm in land economics. Attention to spatial pattern can direct to impending that would have been otherwise disregarded, while paying no attention to space may lead to counterfeit conclusions about land price affairs.

Aforementioned to developing hedonic models of the land price, data were tested for spatial autocorrelation. In this study, spatial autocorrelation transpires if the price is allied with itself over space. Acquaintance of spatial autocorrelation is of apprehension because its existence means there is interdependence in the data, whereas most statistical methods assume independence in the data.

The statistic known as Moran's *I* is extensively used to experiment the presence of spatial dependence in observations taken on a lattice. Given its unfussiness, Moran's *I* is also recurrently used outside of the formal hypothesis testing setting in exploratory analyses of spatially referenced data. Values of Moran's *I* range between -1 and 1 with positive values corresponding to positive autocorrelation, zero indicating randomness, and negative values representing negative autocorrelation. Positive significant values point toward resemblance at the scale of the lag distance, or distance between pairs of points. Negative significant values demonstrate the distance between peaks and troughs. Spatial richness patterns are thus indicated by a series of significant positive and negative values (Equation 15).

However, Moran's *I* was premeditated in GeoDa software by means of global spatial autocorrelation statistic and its visualization in the form of a Moran Scatter Plot. Moran Scatter Plot is a special case of a scatter plot and as such has the same basic options. The four quadrants in the graph provide a classification of four types of spatial autocorrelation: high-high (upper right), low-low (lower left), for positive spatial autocorrelation; high-low (lower right) and low-high (upper left), for negative spatial autocorrelation.

The Moran's I of the transacted plots in Group 1 exposed that there is a noteworthy positive spatial autocorrelation (0.5646) among the plots (Figure 6.1). Nevertheless, a perceptible spatial diffusion of two plots (plot no. 186 and 331 of Sadhapur and Bamibari mouza respectively) subsists comparing to the spatial integrity of others. Hence, 'exclude Selected option' is activated for these two plots and resulted in the recalculation of Moran's I (0.6262) (for a layout without the selected plots) (Figure 6.2).

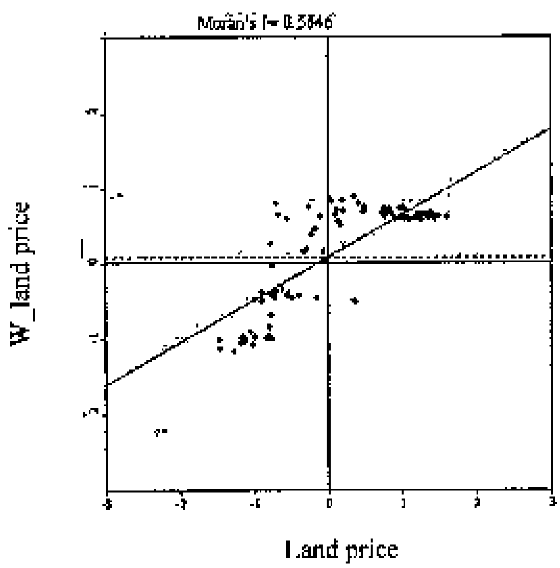


Figure 6.1: Moran scatter plot for the plots of Group 1

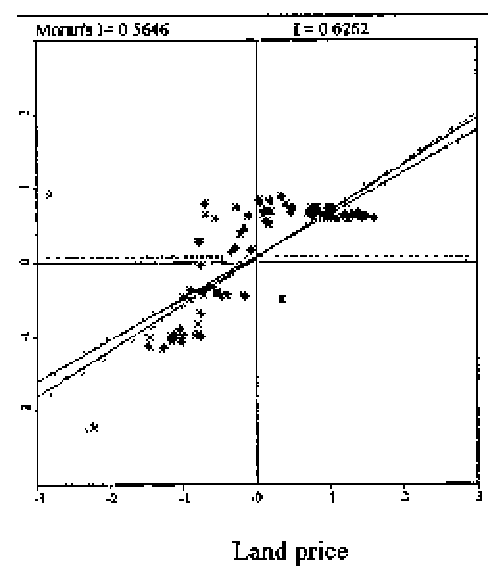


Figure 6.2: Moran scatter plot excluding the selected plots of Group 1

Correspondingly, Moran's *I* of the other three categories of transacted plots defined significant positive spatial autocorrelation such as 0.8376 for Group 2 (Figure 6.3), 0.8416 for Group 3 (Figure 6.4) and 0.6176 for Group 4 (Figure 6.6) respectively.

Eventually there is no such spatial disintegrity of transacted plots of group 2.

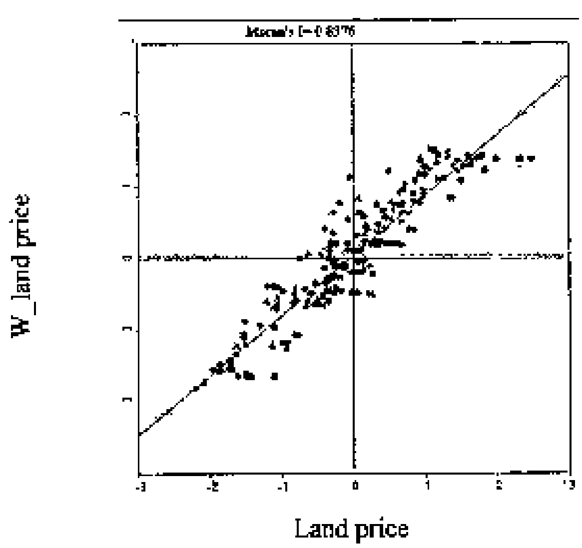


Figure 6.3: Moran scatter plot for the plots of Group 2

Furthermore, in case of other two categories (Group 3 and 4) spatial disintegrity was identified. Therefore excluding the selected plots, the resultant Moran's I for group 3 and group 4 are 0.8889 (Figure 6.5) and 0.7369 (Figure 6.7) instead of 0.8416 and 0.7412 (respectively).

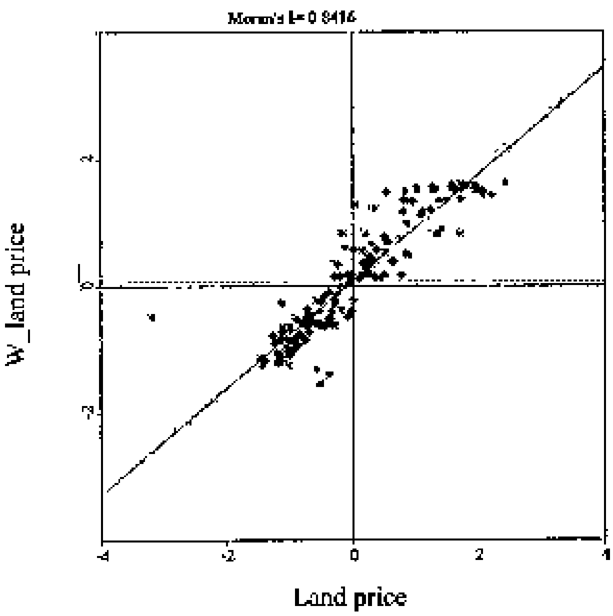


Figure 6.4: Moran scatter plot for the plots of Group 3

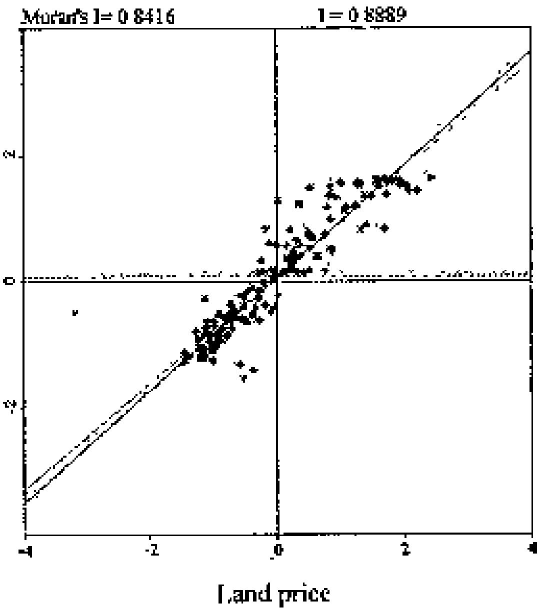


Figure 6.5: Moran scatter plot excluding the selected plots of Group 3

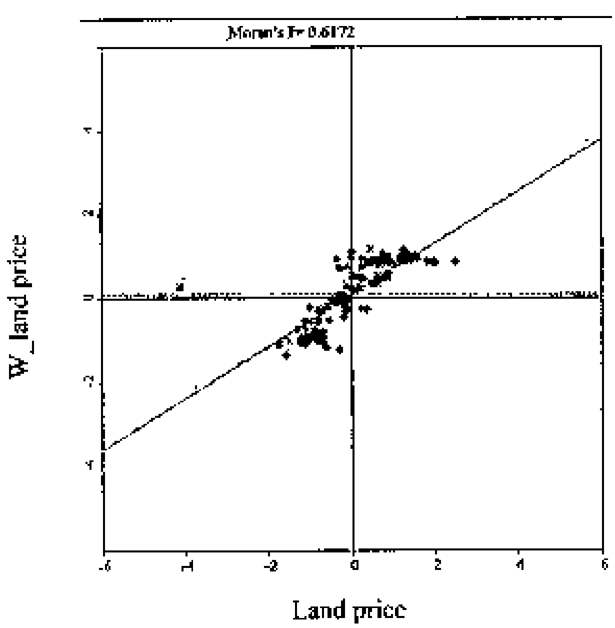


Figure 6.6: Moran scatter plot for the plots of Group 4

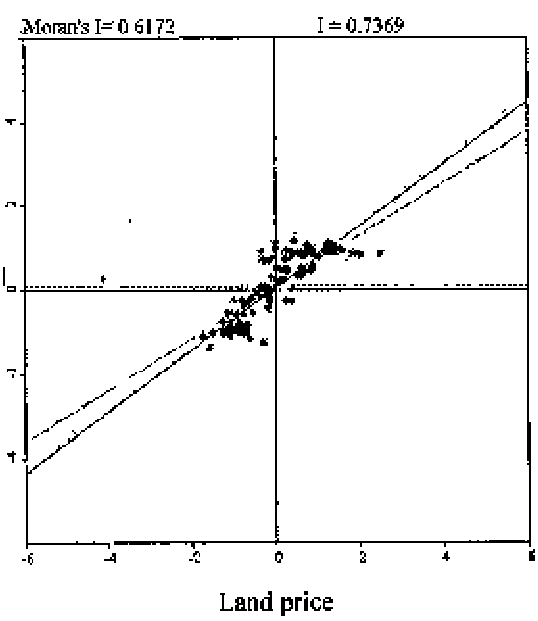


Figure 6.7: Moran scatter plot excluding the selected plots of Group 4

Chapter VII

FITNESS TESTING AND DERIVATION OF SPATIAL AUTO-REGRESSION MODEL

Chapter VII

Fitness Testing and Derivation of Spatial Auto-Regression Model

Early concern in the statistical implications of estimating spatial regression models supported to the revolutionary results of the statistician Whittle (1954), followed by others such as Besag (1974), Ord (1975), and Ripley (1981). It was commenced in quantitative geography through the works of Cliff and Ord (1973 and 1981) and Upton and Fingleton (1985). Paralleling this was the development of the field of spatial econometrics, started by regional scientists who were concerned with spatial correlation in multiregional econometric models (Paelinck and Klaassen, 1979; Anselin, 1988a). By the late 1980s and early 1990s, several compilations had appeared that included technical reviews of a range of models, estimation methods and diagnostic tests, including Anselin (1988b), Griffith (2000) and Haining (1991). In addition, the publication of the text by Cressie (1991) provided a near comprehensive technical treatment of the statistical foundations for the analysis of spatial data.

In recent years, the interest in spatial analysis in general and spatial data analysis in particular has seen an almost exponential growth, especially in the social sciences (Goodchild *et al.*, 2000). Spatial regression analysis is a nucleus facet of the "spatial" methodological toolbox and several recent texts covering the state of the art have appeared, such as Haining (2003), Waller and Gotway (2004), Banerjee and others (2004), Schabenberger and Gotway (2005), and Arbia (2006). There have also been a number of edited volumes, dealing with more advanced topics, such as Bartels and Ketellapper (1979), Anselin and Florax (1995), Anselin and others (2004), Getis and others (2004), and LeSage and Pace (2004). In addition, special issues of several journals have recently been devoted to the topic, and they provide an excellent overview of important research directions. Such special issues include Anselin (1992 and 2003b), Anselin and Rey (1997), Pace and others (1998), Nelson (2002), Florax and van der Vlist (2003), and LeSage and others (2004).

However, prior to spatial regression analysis of land price, it is necessary to provide guidance in identifying the correct model (i.e., spatial lag or spatial error) for estimation after conducting the test of spatial dependence. A spatial lag model is a formal depiction of the equilibrium outcome of processes of social and spatial interaction. Since the observations are for a single point in time, the actual dynamics of the interaction among agents (peer effects, neighborhood effects, spatial externalities) cannot be observed, but the correlation structure that results once the process has reached equilibrium is what can be modeled (Brock and Durlauf 2001, Durlauf 2004). This is also referred to as a spatial reaction function (Brueckner 2003). On the other hand, in spatial error models, the spatial autocorrelation does not enter as an additional variable in the model, but instead affects the covariance structure of the random disturbance terms. The typical motivation for this is that unmodeled effects spill over across units of observation and hence result in spatially correlated errors.

In empirical practice, there are often no strong priori reasons to consider a spatial lag or spatial error model in a cross-sectional situation. Instead, the need for such a specification follows from the result of model diagnostics. Specifically, diagnostic tests derived from the residuals of a regression carried out by means of ordinary least squares (OLS) may point to violations of the underlying assumptions, including the uncorrelatedness of errors. Ignoring a spatially lagged dependent variable is equivalent to an omitted variable error, and will yield OLS estimates for the model coefficients that are biased and inconsistent. On the other hand, ignoring spatially correlated errors is mostly a problem of efficiency, in the sense that the OLS coefficient standard error estimates are biased, but the coefficient estimates themselves remain unbiased.

To test the success of the regression model a test can be performed on R-square. Ord (1975) gives the Maximum Likelihood methods for estimating the spatial lag and spatial error SAR models. If lots of very small numbers are multiplied together (say all less than 0.0001) then a result with a number that is too small to be represented by any calculator or computer as different from zero. This situation will often occur in calculating likelihoods, when we are often multiplying the probabilities of lots of rare but independent events together to calculate the joint probability. With log-likelihoods, we simply add them together rather than multiply them (log-likelihoods will always be negative, and will just get larger (more negative) rather than approaching 0).

In addition, different social scientists proposed the widening of spatial econometrics to include Bayesian techniques because of the information that this yields around the specific point estimates reached in standard modelling. The Bayesian Information Criterion (BIC) is sometimes also named the Schwarz Criterion, or Schwarz Information Criterion (SIC). Given any estimated models, the model with the lower value of BIC or SIC is the one to be preferred. That is, unexplained variation in the dependent variable and the number of explanatory variables increase the value of BIC. Hence, lower BIC implies either fewer explanatory variables, better fit, or both. The BIC penalizes free parameters more strongly than does the Akaike information criterion (AIC). AIC is a measure of the goodness of fit of an estimated statistical model. It is offering a relative measure of the information lost when a given model is used to describe reality and can be said to describe the tradeoff between bias and variance in model construction, or droopily speaking that of exactitude and convolution of the model. The AIC is not a test on the model in the sense of hypothesis testing; rather it is a tool for model selection.

Similarly, the Jarque-Bera (JB) test is a goodness-of-fit measure of departure from normality, based on the sample kurtosis and skewness. The statistic JB has an asymptotic chi-square distribution with two degrees of freedom and can be used to test the null hypothesis that the data are from a normal distribution. The null hypothesis is a joint hypothesis of the skewness being zero and the excess kurtosis being 0. In additon, Lagrange multiplier (LM) tests are used to test for spatial dependence.

Eventually, in order to authenticate the fitness of OLS, Spatial Lag and Spatial Error models, five criteria e.g. R-square, Log likelihood, Akaike Information Criterion, Schwarz Criterion and Likelihood Ratio Test was taken into comparative evaluation based on the availability of derived data.

7.1 Spatial auto-regression model of Group 1 plots

Incase of transacted plots of Group 1, 19.06 percent, 65.58 percent and 49.57 percent variance of dependent variable was explained by the OLS, Spatial Lag and Spatial Error models respectively resulting in fitness of Spatial Lag model comparatively. On the other hand, both Akaike Information Criterion (1760.03) and Bayesian techniques/Schwarz Information Criterion (1782.33) indicated the significant acceptance of OLS model because lower AIC and SIC implies fewer explanatory variables and better fitness. Nevertheless, ignoring a spatial lagged dependent variable and spatially correlated errors is the subject of model's biasness, inconsistency and efficiency. This is why; the study can not consider the OLS model. Therefore, comparative evaluation between Spatial Lag and Spatial Error model apropos of the Akaike Information Criterion (1881.7 and 1881.35 respectively) and Schwarz Information Criterion (1906.47 and 1903.65 respectively) indicates Spatial Error model has better fitness. Similarly, Spatial Error model has better fitness comparing to the rest ones base on the Log Likelihood critirion (-931.677, -930.85 and –871.015 for the Spatial Error, Spatial Lag and OLS models respectively) because Log Likelihood will always be negative and will just get larger (more negative) rather than approaching 0 (Table 7.1).

Table 7.1: Spatial diagnosis test of the models for the plots of Group 1

Criteria of evaluation	OLS	Spatial lag	Spatial error
R-square	0.19064	0.65577	0.49566
Log likelihood	-871.015	-930.85	-931.677240
Akaike Inf. Criterion	1760.03	1881.7	1881.35
Schwarz criterion	1782.33	1906.47	1903.650511
Likelihood Ratio Test Probability		(0.8799294) 0.3482210	(0.8773561) 0.3489269

Source: Calculated by author, 2009

In summary, Spatial Error model is best suited based on the selected criteria. So, the coefficients of the explanatory variables[1] derived by applying Spatia Error model are considered for determining the level of influence of the explanatory variables on the dependent variable i.e. Land price. The summary outputs of the Spatial Error model calculated the coefficient of spatial lag as -0.292585 (Table 7.2). On the other hand,

[1] Only those explanatory variables were entered which had significant correlation with the dependent variable, significance level was not more than 0.10, and tolerance level was high (see Equation 21).

the value of Moran's *I* in this case, which was calculated in the spatial dependency testing, is 0.5646. so, the spatial error is 17840.9391 (Equation 20).

Table 7.2: Summary outputs of the Models for the plots of Group 1

Variables	OLS	Spatial lag	Spatial error
Lag coefficient		-0.261501	-0.292585
Constant	2785.35	27560.14	25819.29
POP_DEN	-0.5084973	1.420082	-0.1491618
D_INDUS	0.3878276	-3.161575	-3.289287
D_BUS	-1.738913	-1.076763	-1.739886
D_DEV	-1.315947	-0.3280055	-2.204803
D_HOS	-2.617117	-4.504297	-1.586092
D_DUSTBIN	-1.928034	-0.688503	-2.336271
D_POURA_RD	-2.97661	-9.372701	-5.069334
D_UP_RD	-0.6926369	-10.87327	-2.400886

Source: Calculated by author, 2009

Eventually the Spatial Auto Regressive model for the group 1 plots is (Table 7.2):

Land price = 43660.2291 + (-0.292585) spatial lag + (-0.1491618) pop_den + (-3.289287) d_Indus + (-1.739886) d_bus + (-2.204803) d_dev + (-1.586092) d_hos + (-2.336271) d_dustbin + (-5.069334) d_poura_rd + (-2.400886) d_up_rd (25)

From the Equation 25, it can be explained that distance from hazardous industries and distance from poura road has strong negative correlation with the land price. One significant observation is that all the explanatory variables have negative correlation with the land price that means there is inverse relationship between the explanatory variables and the land price. Another important observation is that in this group the land price is determined mainly by employment or job related variables excluding other variables. Even considering the relationship between distance from the hazardous industries and the land price, it should be the positive relationship in an ideal condition. But the interest groups of the land property are not concern about the environmental factors rather they are concerned about the spatial proximity of income generating activities such as industries and development organizations (NGOs). Although the population density has significant relationship with the land price, its influence is very negligible. However, these are not all. Land price of the plots in this group is also determined by the distance from urban services e.g. hospitals and dustbins. Finally, it can be said that instead of the plot characteristics land price of plots is dependent on the external factors especially on the transport factors at a great extent.

Later on. the regression equation (25) was promoted to cross-checked with the average data of the explanatory variables in order to verify whether the equation could look at the precise anticipation of the land price of the plots within the group 1. Thus the average data of the explanatory variables (Table 5.4) were inputted into the equation (25) and resulted in the average land price per decimal as TK 25026.6091. This result has deviation of TK 245.9809 from the average land price TK 25272.59 per decimal of group 1 plots.

7.2 Spatial auto-regression model of Group 2 plots

The OLS, Spatial Lag and Spatial Error models explained 27 percent, 29 percent and 26 percent variance of the land price respectively resulting in better fitness of Spatial Lag model comparatively. On the other hand, both Akaike Information Criterion (4304.66) and Bayesian techniques/Schwarz Information Criterion (4344.243187) indicated the significant acceptance of Spatial Error model. Similarly, Spatial Error model has better fitness comparing to the rest ones base on the Log Likelihood critirion (-2140.39, -2140.12 and –2140.33 for the OLS, Spatial Lag and Spatial Error models respectively) with high negative value almost similar to that of OLS (Table 7.3).

Table 7.3: Spatial diagnosis test of the models for the plots of Group 2

Criteria of evaluation	OLS	Spatial lag	Spatial error
R-square	0.27	0.29	0.26
Log likelihood	-2140.39	-2140.12	-2140.331690
Akaike Inf. Criterion	4304.77	4306.23	4304.66
Schwarz criterion	4344.35	4349.11	4344.243187
Likelihood Ratio Test Probability		(0.5368434) 0.4637439	(0:1073078) 0.7432302

Source: Calculated by author, 2009

In summary, Spatial Error model is best suited based on the selected criteria. So, the coefficients of the explanatory variables[2] derived by applying Spatia Error model are considered for determining the level of influence of the explanatory variables on the dependent variable i.e. Land price. The summary outputs of the Spatial Error model calculated the coefficient of spatial lag as (-0.057921) (Table 7.4). On the other hand, the value of Moran's I in this case, which was calculated in the spatial dependency testing, is 0.8376. so, the spatial error is 13690.51 (Equation 20).

Table 7.4: Summary outputs of the Models for the plots of Group 2

Variables	OLS	Spatial lag	Spatial error
Lag coefficient		-0.113465	-0.057921
Constant	28457.3	22585.59	28540.99
AREA	0.0959343	0.09799121	0.0979053
POP_DEN	0.09125976	0.08304539	0.08741852
CONTOR	2.527235	2.613123	2.508712
D_BRICK	0.7046747	0.6251276	0.7574042
D_SCH	-7.096942	-7.161874	-7.203303
D_INDUS	8.781036	8.453857	9.174279
D_MARKET	-6.680645	-7.019618	-6.3612
D_JOB	-14.97623	-15.26231	-14.84855
D_DUSTBIN	-4.048357	-4.368965	-4.01954
D_POURA_R	-7.464437	-7.518127	-7.624095
D_UP_R	-0.2454125	-0.2365623	-0.2377236

Source: Calculated by author, 2009

Eventually the ultimate Spatial Auto Regressive model for group 2 plots is (Table 7.4):

Land price = 42231.5 + (-0.057921) spatial lag + (0.0979053) area + (0.08741852) pop_den + (2.508712) contor + (0.7574042) d_brick + (-7.203303) d_sch + (9.174279) d_indus + (-6.3612) d_market + (-14.84855) d_job + (-4.01954) d_dustbin + (-7.624095) d_poura_rd + (-0.2377236) d_up_rd (26)

From the equation 26 it is revealed that land price of plots has positive correlation with the physical characteristics of the plots such as area of the plots and

[2] Only those explanatory variables were entered which had significant correlation with the dependent variable, significance level was not more than 0.10. and tolerance level was high (see Equation 22).

topographical elevation. Nevertheless, there influence on determining the land price is not so mentionable. On the other hand, like group 1 plots, land price is also strongly influenced by the distance from industries and in this case environmental consideration is not the major concern in the land market. Environmental factor is considered only in case of relation between the land price and distance from brickfield although the relationship is not so strong.

The equation also reveals that the land price equation is mainly derived by the economic consideration of the interest groups such as distance from market, distance from industries (whether it is hazardous or non-hazardous), distance from job and distance from poura road. This is because of the locational characteristics of this area. The field survey observed that this area is not urbanized or developed rather this is mainly the area of industrial zone. This is why, economic characteristics rather than the physical characteristics of the plots are the major determining factors of the land market in Group 2 area.

Later on, the regression equation (26) was promoted to cross-checked with the average data of the explanatory variables in order to verify whether the equation could look at the precise anticipation of the land price of the plots within the group 2. Thus the average data of the explanatory variables (Table 5.7) were inputted into the equation (26) and resulted in the average land price per decimal as TK 34898.224. This result has deviation of TK 200.264 from the average land price TK 34697.96 per decimal of group 2 plots.

7.3 Spatial auto-regression model of Group 3 plots

OLS, Spatial Lag and Spatial Error models explained 67.56 percent, 67.11 percent and 48.60 percent variance of the dependent variable respectively resulting in fitness of OLS and Spatial Lag model comparatively. Similarly, Spatial Lag model has better fitness comparing to the Spatial Error model base on the Log Likelihood critirion (-1649.55 for Spatial Lag Model and –1648.13 for the Spatial Error model). On the other hand, both Akaike Information Criterion (3324.25) and Bayesian techniques/Schwarz Information Criterion (3366.95) indicated the significant acceptance of Spatial Error model resulting in better fitness (Table 7.5).

Table 7.5: Spatial diagnosis test of the models for the plots of Group 3

Criteria of evaluation	OLS	Spatial lag	Spatial error
R-square	0.67563	0.6711	0.4860
Log likelihood	-1650.85 [redacted]	-1649.55 [redacted]	-1648.125988
Akaike Inf. Criterion	3329.71	3329.09	3324.25 [redacted]
Schwarz criterion	3372.4	3374.84	3366.949960 [redacted]
Likelihood Ratio Test Probability		2.610128 [redacted] (0.1061832) [redacted]	5.453032 (0.0195344)

Source: Calculated by author, 2009

In summary, Spatial Lag model is best suited based on the selected criteria. Therefore, the coefficients of the explanatory variables[3] derived by applying Spatia Lag model are considered for determining the level of influence of the explanatory variables on the dependent variable i.e. Land price. The summary outputs of the Spatial Lag model calculated the coefficient of spatial lag as (-0.2731996) (Table 7.6). Besides, the value of Moran's *I* in this case, which was calculated in the spatial dependency testing, is 0.8416. So, the spatial error is 63553.6694 (Equation 20).

Table 7.6: Summary outputs of the Models for the plots of Group 3

Variables	OLS	Spatial lag	Spatial error
Lag coefficient		-0.2731996	-0.437689
Constant	38087.27	48015.78	39835.99
AREA	0.01671932	0.01553915	0.01318107
POP_DEN	0.1080898	0.147329	0.2357718
CONTOR	0.04599663	0.03476969	-0.6295103
D_BRICK	-0.4296755	-0.04360441	0.0687372
D_SCH	-9.719114	-10.46348	-13.75408
D_INDUS	-2.586274	0.6305138	4.104484
D_BUS	-0.6668885	-1.138357	-2.002665
D_HOSP	-5.612977	-6.548532	-6.722572
D_MARKET	-1.439944	-1.302906	-1.235296
D_JOB	-10.76355	-8.687336	-3.104901
D_POURA_R	-34.9726	-38.98455	-40.7389
D_UP_R	-4.199384	-5.516988	-6.879795
D_NH	-1.834545	-1.503839	-2.382287

Source: Calculated by author, 2009

[3] Only those explanatory variables were entered which had significant correlation with the dependent variable, significance level was not more than 0.10, and tolerance level was high (see Equation 23).

Eventually the Spatial Auto Regressive model for group 3 plots s (Table 7.6):

Land price = 111569.4494 + (-0.2731996) spatial lag + (0.01553915) area + (0.147329) pop_den + (0.03476969) contor + (-0.04360441) d_brick + (-10.46348) d_Sch + (0.6305138) d_Indus + (-1.138357) d_bus + (-6.548532) d_hosp + (-1.302906) d_market + (-8.687336) d_job + (-38.98455) d_poura_rd + (-5.516988) d_up_rd + (-1.503839) d_nh (27)

In case of plots of Group 3, transport accessibility from the plots is the major determining factor of land market. Land price has strong positive correlation with the distance from the poura road, upazila road (LGED) and Dhaka-Aricha Highway. In addition, distance from the bus terminal has also strong negative correlation with the land price. On the contrary, other physical factors have no significant influence on the land price. Another important observation is the location of hospital and markets has significant relationship with the land price of the plots. That means, provision of urban services is the determining factor of land price.

It can be remarked that due to the locational advantage and close proximity to transport facilities and urban facilities the land price of this group is considerable higher than that of other groups.

Later on, the regression equation (27) was promoted to cross-checked with the average data of the explanatory variables in order to verify whether the equation could look at the precise anticipation of the land price of the plots within the group 3. Thus the average data of the explanatory variables (Table 5.10) were inputted into the equation (27) and resulted in the average land price per decimal as TK 42637.5584. This result has deviation of TK 433.9384 from the average land price TK 42203.62 per decimal of group 3 plots.

7.4 Spatial auto-regression model of Group 4 plots

OLS, Spatial Lag and Spatial Error models explained 66.14 percent, 70.86 percent and 67.33 percent variance of the dependent variable respectively resulting in fitness of Spatial Lag model comparatively. On the other hand, both Akaike Information

Criterion (2499.53) and Bayesian techniques/Schwarz Information Criterion (2534.87) indicated the significant acceptance of Spatial Error model. Similarly, Spatial Error model has better fitness comparing to the rest ones base on the Log Likelihood critirion where Log Likelihood value is -1236.81, -1236.59 and –1236.76 for the OLS, Spatial Lag and Spatial Error models respectively (Table 7.7).

Table 7.7: Summary outputs of the Models for the plots of Group 4

Criteria of evaluation	OLS	Spatial lag	Spatial error
R-square	0.66140	0.70855	0.67326
Log likelihood	-1236.81	-1236.59	-1236.764059
Akaike Inf. Criterion	2499.63	2501.17	2499.53
Schwarz criterion	2534.97	2539.23	2534.868604
Likelihood Ratio Test Probability		(0.4540666) 0.5004101	(0.09714426) 0.7552839

Source: Calculated by author, 2009

In summary, Spatial Error model is best suited based on the selected criteria. So, the coefficients of the explanatory variables[4] derived by applying Spatia Error model are considered for determining the level of influence of the explanatory variables on the dependent variable i.e. Land price. The summary outputs of the Spatial Error model calculated the coefficient of spatial lag as (0.065050) (Table 7.8). On the other hand, the value of Moran's *I* in this case, which was calculated in the spatial dependency testing, is 0.6172. so, the spatial error is 181672.7845 (Equation 20).

Table 7.8: Summary outputs of the Models for the plots of Group

Variables	OLS	Spatial lag	Spatial error
Lag coefficient		0.1099824	0.065050
Constant	-8594.015	-11997.96	-5027.555
AREA	1.308301	1.352072	1.364536
CONTOR	8.365578	7.791531	8.130839
D_INDUS	-25.31622	-24.21792	-26.25236
D_MUNIC	-59.77029	-53.58454	-56.66778
D_BANK	-0.2540989	-2.658607	-3.067364
D_HOSP	-89.73498	-79.32169	-84.6925
D_JOB	32.50479	30.34643	30.32396
D_RECRE	-32.0256	-30.46335	-32.27558
D_DUSTBIN	-32.64752	-27.03873	-29.7243
D_POURA_R	-33.73462	-30.9088	-31.63951

[4] Only those explanatory variables were entered which had significant correlation with the dependent variable, significance level was not more than 0.10, and tolerance level was high (see Equation 24).

D_UP_R	-43.2016	-43.53258	-43.81113
D_NH	7.468489	7.715176	7.347918

Source: Calculated by author, 2009

Eventually the Spatial Auto Regressive model for Genda mouza plots is (Table 7.8):

Land Price = 176645.2295 + (0.065050) spatial lag + (1.364536) area + (8.130839) contour + (-26.25236) d_indus + (-56.66778) d_munic + (-3.067364) d_bank + (-84.6925) d_hosp + (30.32396) d_job + (32.27558) d_recre + (-29.7243) d_dustbin + (-31.63951) d_poura_rd + (-43.81113) d_up_rd + (7.347918) d_nh (28)

Genda mouza is the urban area of Savar municipality. The major portion of Genda mouza is residential land use. Obviously, in this mouza urban facilities and services should be the prior explanatory variables comparing to the other variables. For example, distance from municipal services, distance from bank, distance from hospitals, distance from recreational facilities and distance from dustbin has strong correlation with the land price. Furthermore, physical characteristics of land are also major concern.

After that, the regression equation (28) was further cross-checked with the average data of the explanatory variables in order to determine whether the equation explores the exact anticipation of the land price of the plots within the group 4. Consequently the average data of the explanatory variables (Table 5.13) were entered into the equation (28) and resulted in the average land price per decimal TK 121074.4095. This result has deviation of TK 608.4095 from the average land price TK 120466 per decimal of group 4 plots.

Finally, it can be said that the spatial auto regressive equations explores the true and vivid scenario of land market in the context of different group of plots. Because we know, urban land market is usually determined by the physical characteristics, socio-economic characteristics and urban services and amenities. From the above discussion, it is revealed that land price equation of Genda mouza justifies the Genda mouza as an urban area and consequently the land price is highest in this area. On the other hand, land market of the Group 3 plots is strongly determined by the transport accessibility i.e. bus terminals and connective roads. This is why; land price in the category is comparatively higher than rest of the groups (Group 1 and 2).

In case of group 1 and group 2 plots, actual determining factors of land markets have no significant relationship with the land price. Although some physical characteristics of the plots have relationship with the land price, their correlations are not so significant. In addition, transport accessibility is the main determining factors for these groups. This is because; these areas are the industrial area and mainly resided by the labourers along with others.

Chapter VIII

RECOMMENDATIONS AND CONCLUSION

Chapter VIII

Recommendations and Conclusion

8.1 Recommendations

Traditional hedonic approach to valuation consists of regression models adjusted with several variables, including location variables. Location variables are important to market value but are non-observable directly in real market and then are adjusted by an expert, on a subjective basis. These models are commonly estimated with multiple regression analysis (MRA), which provides a well-known approach to property valuation. Because of problems with regression assumptions, like miss-specification of functional form and multicollinearity, artificial neural networks have been proposed to improve market models in the last years and are an alternative tool to estimate property values. However, there are some difficulties using this approach in Computer-Assisted Mass Appraisal (CAMA), mainly in estimating measures for location within neighborhoods or for a large area. Of course, even experts generally are unable to define a fine, micro-neighborhood pattern to thousand of blocks. To obtain correct measures of the location values is important to improve CAMA and several alternative approaches has been presented in literature to estimate a data-driven value surface to location. However, Trend Surface Analysis (TSA) is proposed as an alternative technique.

It is assumed that land value is the present value of all future benefits discounted by the sum of the risk free rate and the land's risk premium rate. The risk premium can be indirectly estimated by determining the historical standard deviation of return in excess of the standard deviation of the (risk free asset) market return. Future benefits consist of all estimated future cash flows derived directly or indirectly from the ownership of the asset. This concept is integral to the need to formulate a valuation method, which is based on an estimate of future value adjusted for risk. This future value can only be estimated however by analyzing the underlying historical relationships between value and those factors which may influence it. Future benefits can better be understood and estimated through an understanding of the historical relationships. Therefore, the present value of the future benefits of the land needs to be taken into consideration during the spatial economic analysis of urban land market.

Additional study is needed to confirm or refute the findings of this study and to identify other buyer and seller characteristics that might influence real estate transactions. Unfortunately, traditional data sets do not include information regarding buyers and sellers. Data sets of plot sales with buyer and seller characteristics, such as income, family size, occupation of head of household, age of children, etc., should be gathered for subsequent analysis in order to better understand the role of buyer and seller characteristics in land market.

The value of land strongly contributes to the degree of plan conformity. Residential developers are often eager to purchase comparatively inexpensive property outside of urban areas originally containing wetlands or agricultural operations. Just as higher profit margins attract developers, more affordable housing prices in locations away from the congestion of cities appeal to prospective homebuyers, particularly seasonal residents. This phenomenon is driven by what Mattson (2003) called rising "trigger levels." The trigger level is defined as the point within the development process when a combination of declining agricultural prices, rising public service costs, and increased local property tax assessments cause an urban-rural fringe property owner to sell his or her land. By selling, the landowner perpetuates the occurrence of sprawl and unintended development outside of urban areas. Because of the location of Savar municipality within the close proximity of Dhaka City and relative low land price, Savar municipality is under tremendous pressure of nonconforming development.

Given that inexpensive land appears to be one of the strongest predictors of nonconforming development, planners and other public officials must be conscious of the way they assess and tax real property. Currently, land is taxed based on its highest and best use, which tends to elevate trigger levels. Preferential tax treatments, on the other hand, can assess property based on actual current uses rather than its potential. In areas where pressure to develop in outlying areas not intended by the original plan create higher property values and tax burdens, current use assessments can provide tax relief to landholders who chose to continue to pursue agricultural, or conservation land uses. Another financial incentive approach to maintaining development conformity is the use of tax credits. In this instance, tax deductions are offered to a landowner who donates a portion of his or her property to a land trust as open space or an open space easement. This provision simultaneously rewards the landowner for reducing the potential development of his or her land and provides a potential buffer for sprawling development outward from the urban core.

8.2 Conclusion

Land is a heterogeneous possession and there are distinctive differences on the characteristics composing the worth of land. The general objective of this study was to use spatial econometric measures to model land values at the Savar Municipality – satellite town of the Dhaka City. At the initial stage of the study, the transacted plots were categorized into four groups in order to overcome extensive deviation of land price. Aftermath, spatial statistics along with GIS procedures, were used to test for spatial autocorrelation among the transacted plots in 2006. Moran's *I* value of all the groups was significant revealing the spatial dependence of land price of a certain plot on the neighboring plots. In addition, high value of spatial error was observed in case of all groups of transacted plots. Based on these tests, an OLS model was estimated and further diagnostic tests were conducted due to the significant presence of spatial autocorrelation in the model. Diagnostic tests resulted in the presence of spatial autocorrelation and results of these tests suggested the use of spatial error model for all groups of transacted plots except for group 3 (for which Spatial Lag Model was better fitted) in order to derive the Spatial Autoregressive Model of land price.

The Spatial Auto regressive model reveals that the transportation or accessibility attributes, services and facilities characteristics and socio-economic characteristics have significant influence on the land price of the transacted plots in 2006. For example in case of group 1 plots, distance of plots from the bus terminal, development organizations, hospitals, dustbin, Pourashava road and upazila road (LGED road) has negative relationship with the land price of the concerned plots. Interestingly, the distance of the hazardous and toxic industry has negative relationship with the land price, which was perceived to be positive because of the environmental concern. Nevertheless, the field survey revealed that the opinions of the buyers or sellers of the transacted lands were more economic oriented rather than focusing on the environmental issues.

On the other hand, area of the plots, populaiton density in the concerned mouza, topological elevation of the plots have positive relationship with the value of group 2 plots. In addition, the distance of hazardous and toxic industries from the transacted plots has positive relation with the land value, which is very usual regarding the environemntal issue. Like the plots of the previous category, it has also negative relationship with the different variables of the transport, socio-economic and amenities characteristics.

Similarly, plots of group 3 have positive interaction between the land price and different physical and neighboring attributes such as area of the plots, popoulation density of the concerned mouza and eleveation of the plot. In addition, the distance of some explanatory variables have negative impact on the land value. They are – distance from the bus terminal, distance from the hospitals or health care establishments, distance from the markets or shopping centers, distance from the schools or educational institutions, distance from the employment opportunities, distance from the pourashava road, distance from the LGED road and distance from the Dhaka-Aricha Highway.

Among the mouzas in Savar municipality, Genda (group 4) is comparatively urbanized area. Therefore, the relationship between land price and explanatory variables had focused on the significant influence of the municipal amenities e.g. street lighting, recreational facilities, and dustbin. And because of availability of industries and occupational dependence, the land price is negatively correlated with the distance of industries. In addition, distance of pourashava road, LGED road and Dhaka-Aricha Highway has negative relationship with the price of the transacted plots. Nonetheless, the surprising observation is that distance of job has positive relationship with the land price, which is unusual. During the field survey, it was revealed that most of the purchaser of the plots are employed in organizaitons or agencies or industires at Dhaka City or Dhaka Export Processing Zone (DEPZ).

In summary, the study outlines that although the transacted plots in 2006 of Savar municipality have strong and significant interaction with the transport or accessibility variables, other explanatory variables like municipal amenities, physical characteristics of the plot, employment attraction, and commercial services have also significant impact on the land value.

Finally, the study needs to be further researched by incorporating temporal data along with spatial data. And from the planning perspective, restriction of sprawl development of Savar municipality needs to be considered by taking immediate actions in order to counterfeit the trigger level effects.

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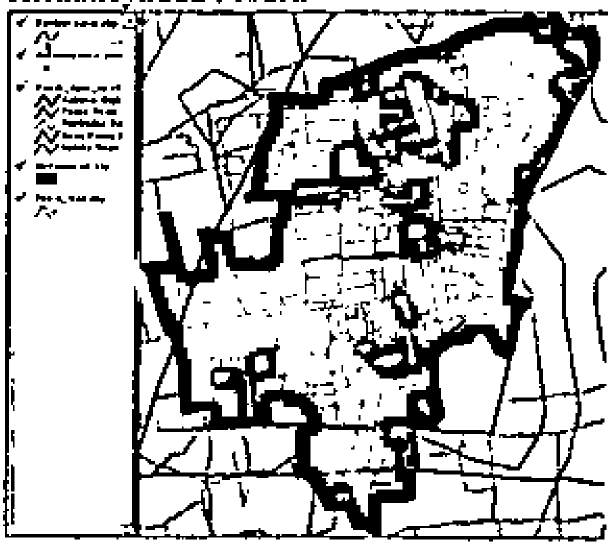
APPENDICES

Appendix A

Transacted plots in different mouzas of Savar Municipality

Aichanoyadda Mouza



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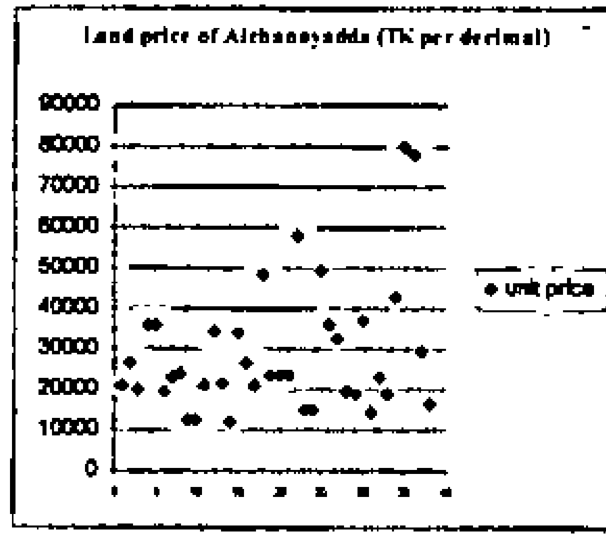
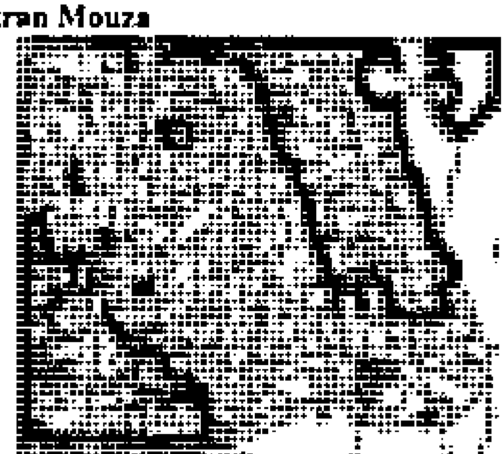


Scatter plot of land price

Akran Mouza



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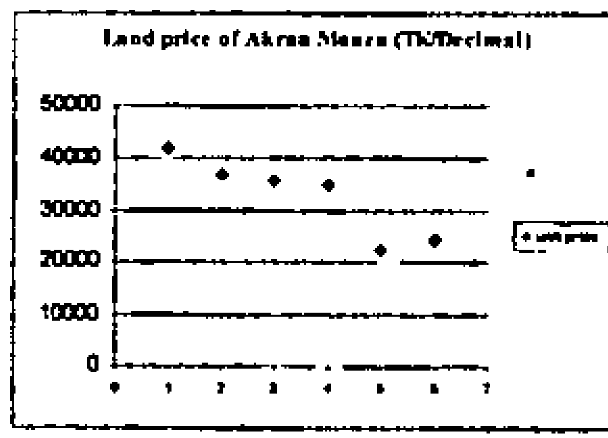

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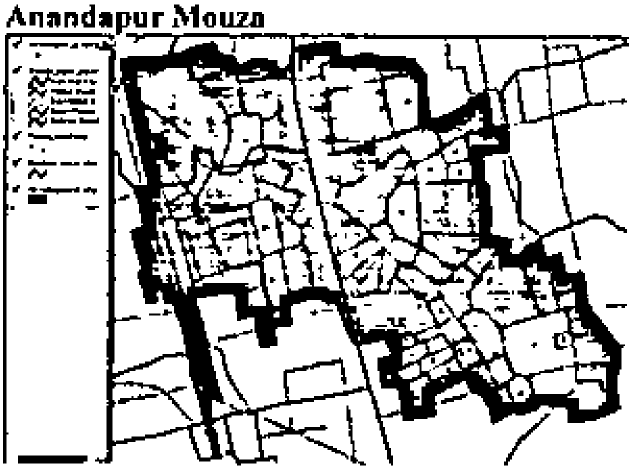
Anandapur Mouza



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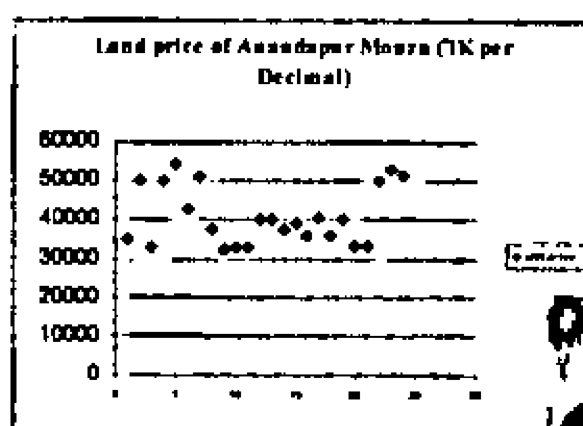

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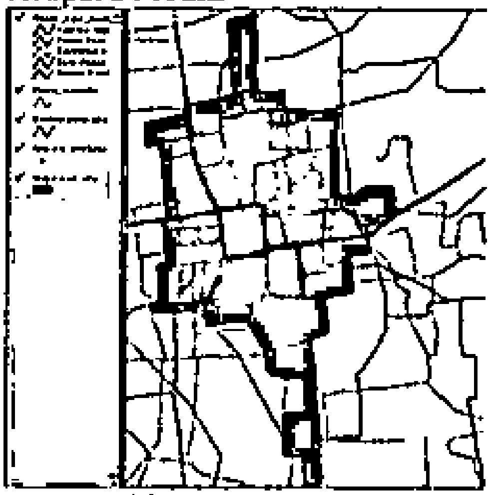
Arapara Mouza



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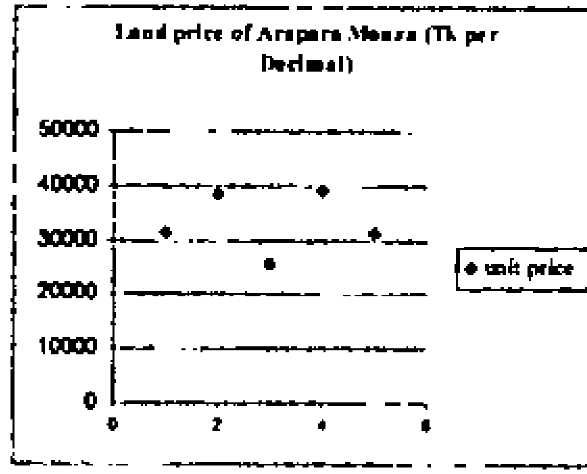

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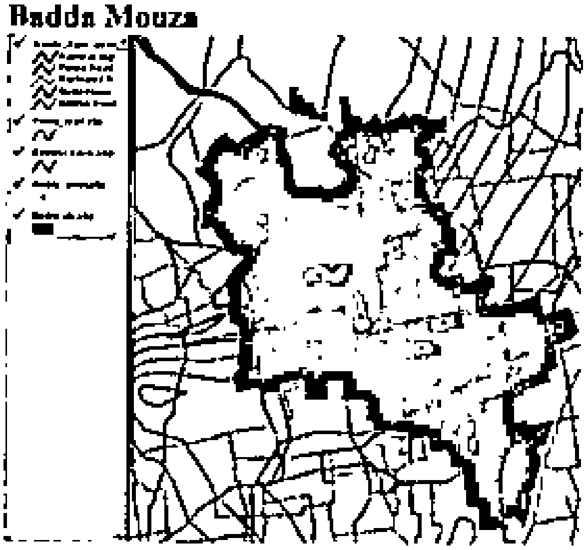
Badda Mouza



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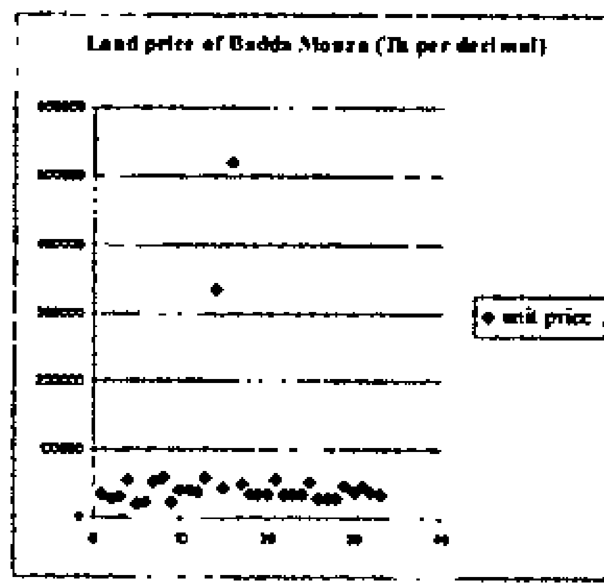

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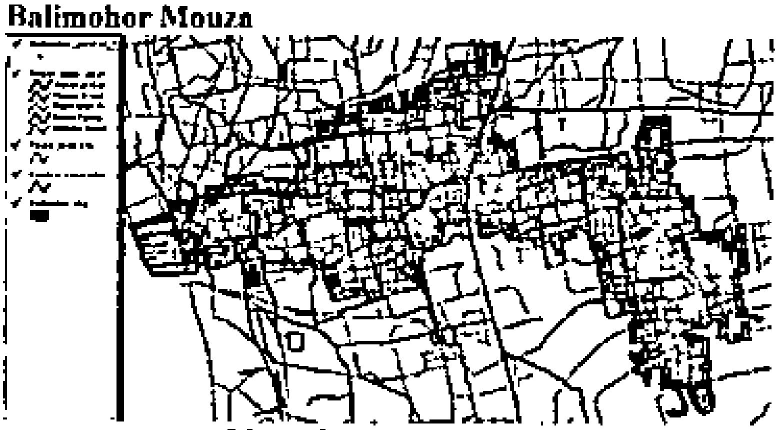

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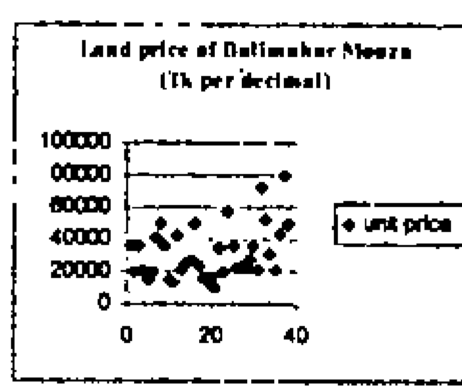

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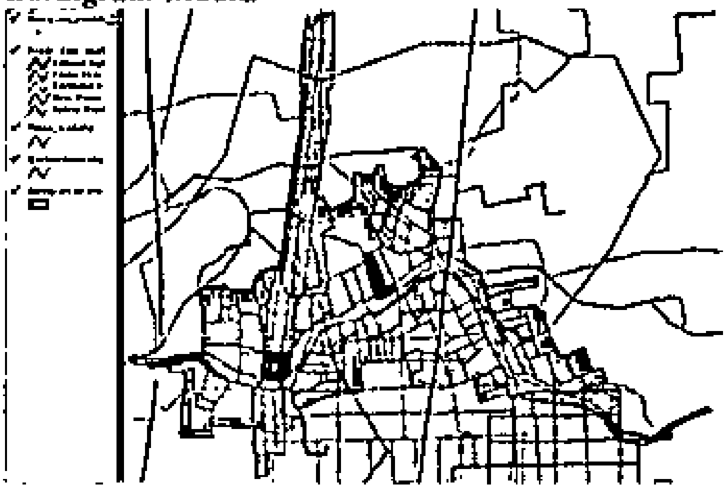
Boraigram Mouza



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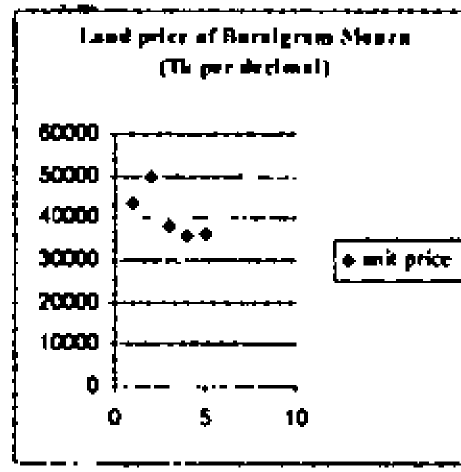

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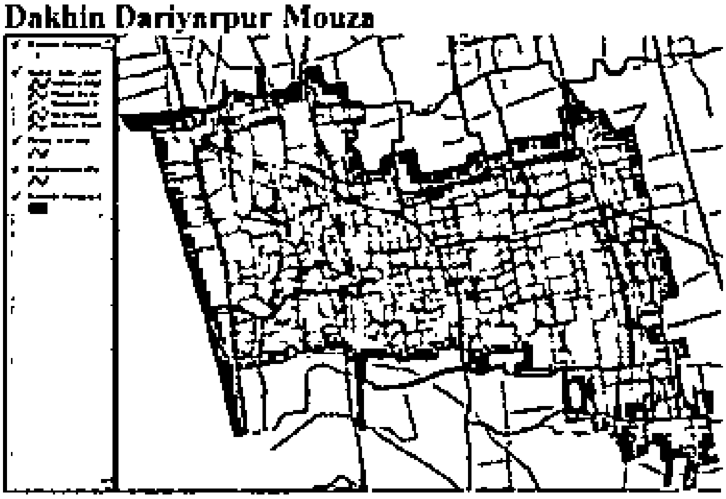

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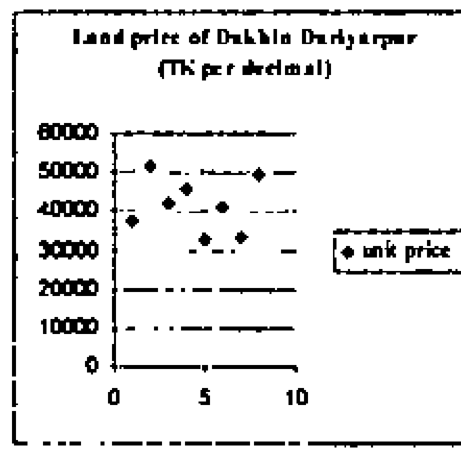

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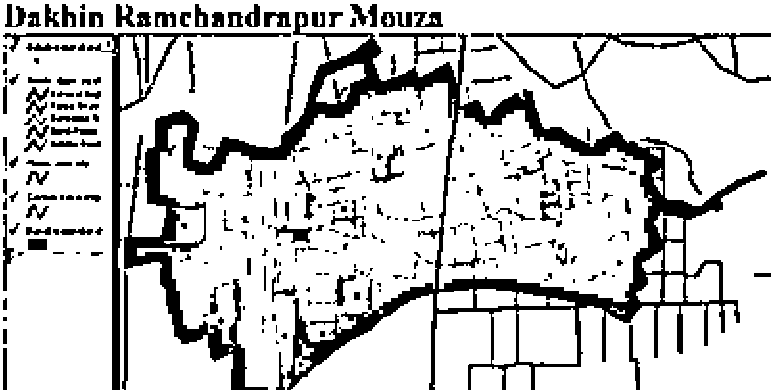

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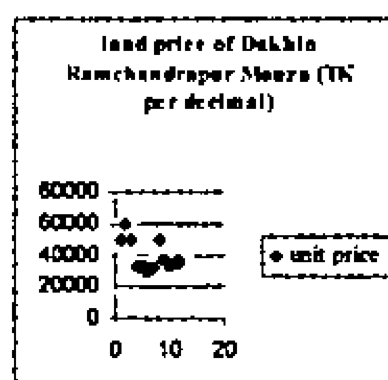

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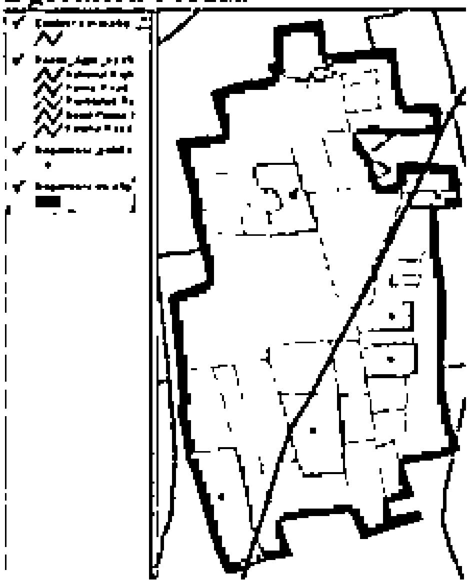

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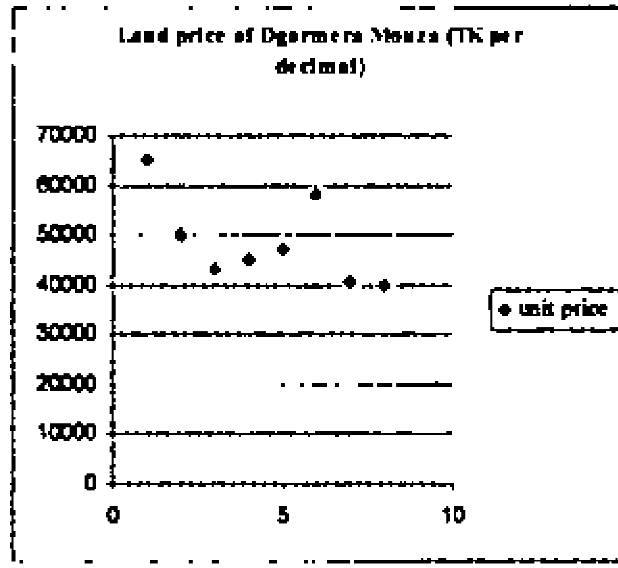
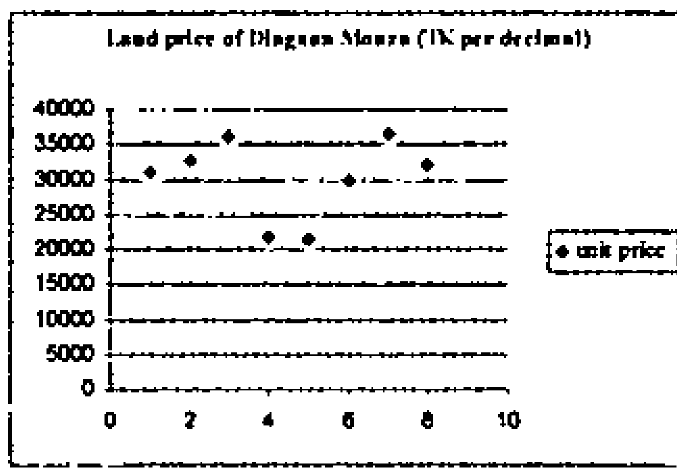


Scatter plot of land price

Diagaon Mouza

Map of transacted plots



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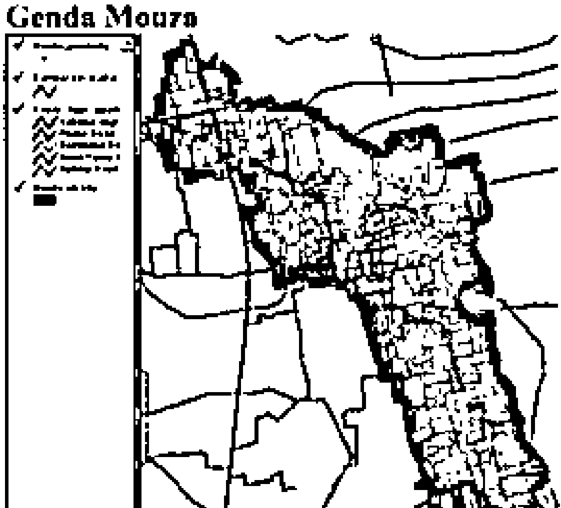
Genda Mouza



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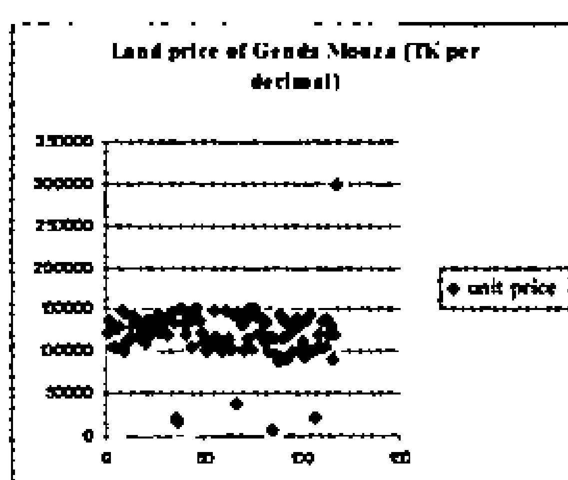

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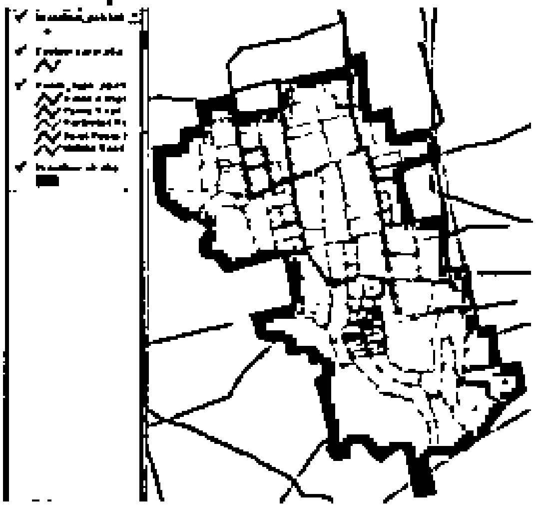

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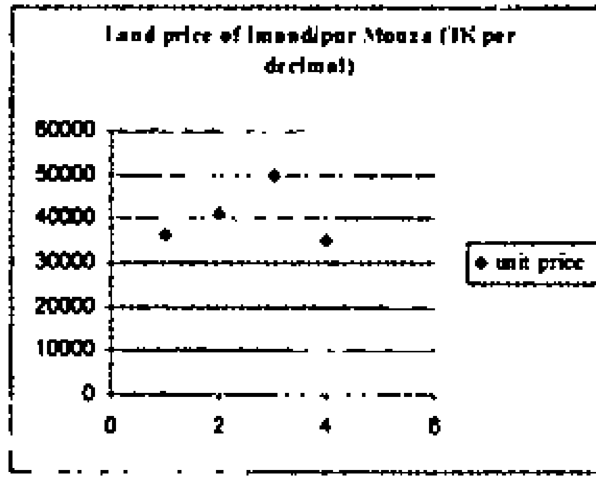

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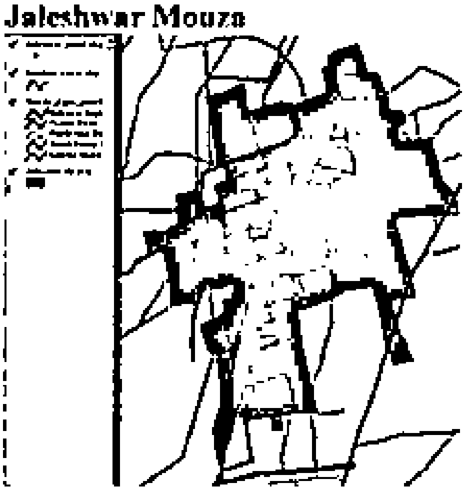
Jaleshwar Mouza



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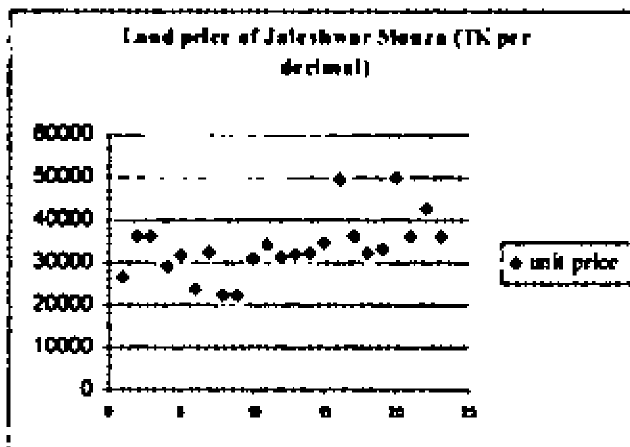

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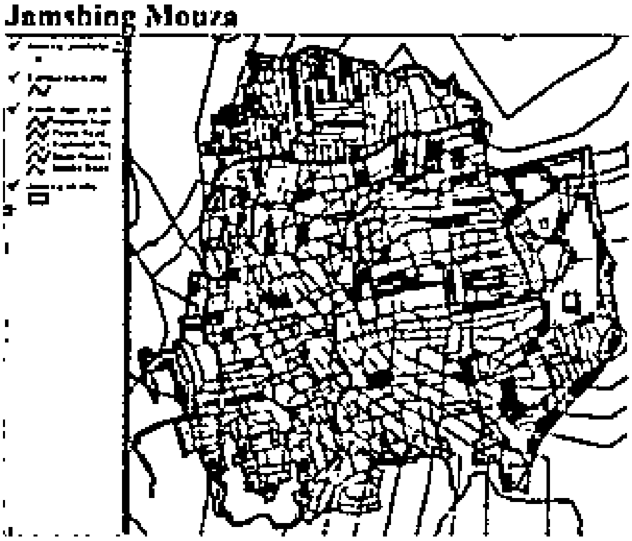

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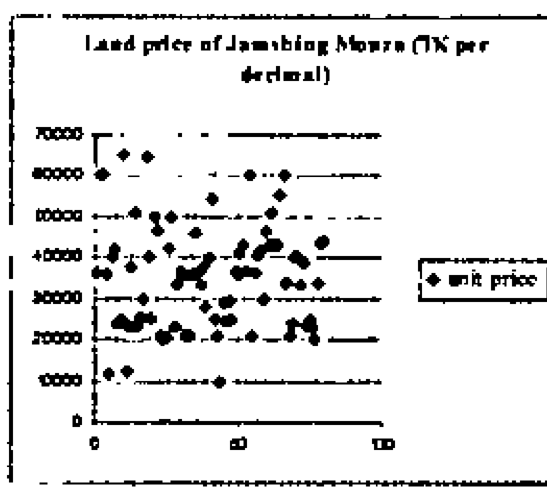

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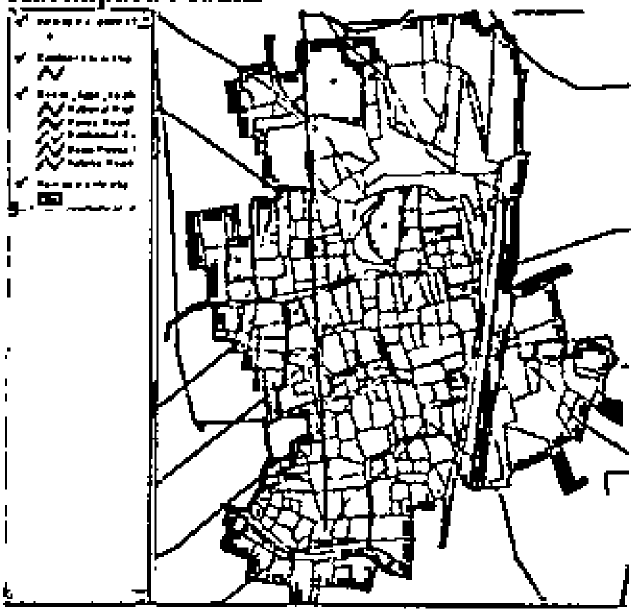
Karnapara Mouza



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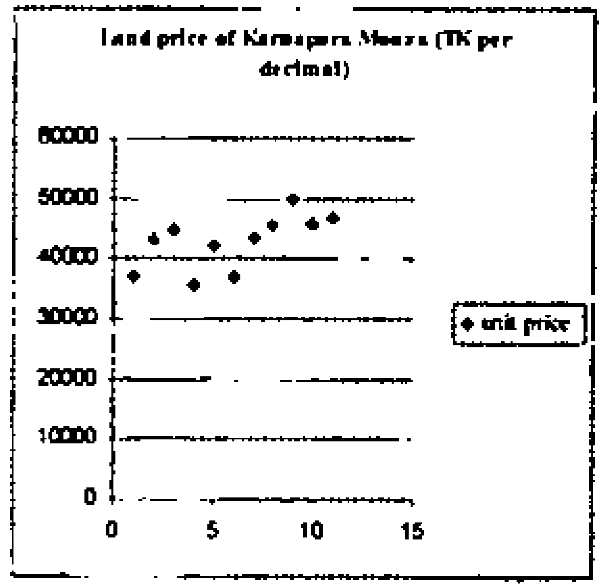

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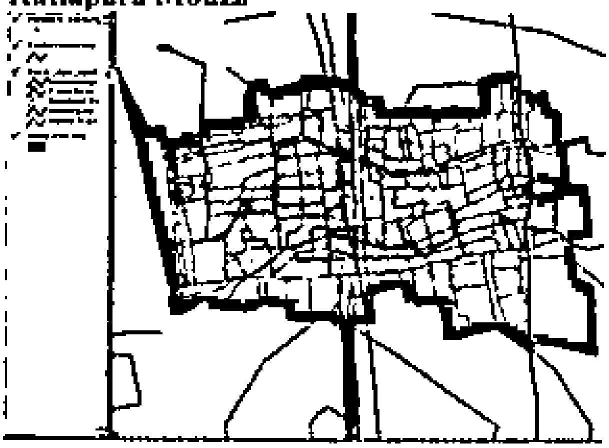

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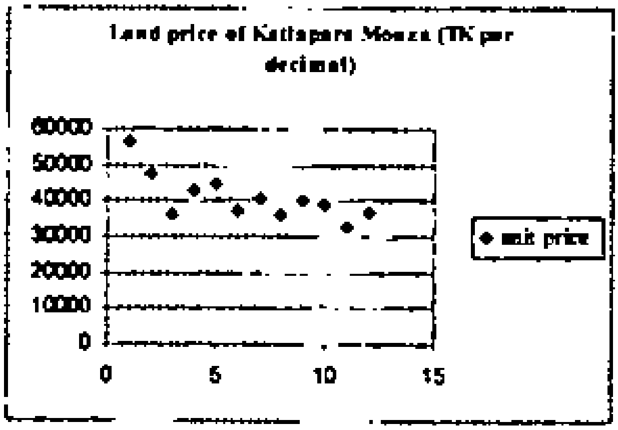

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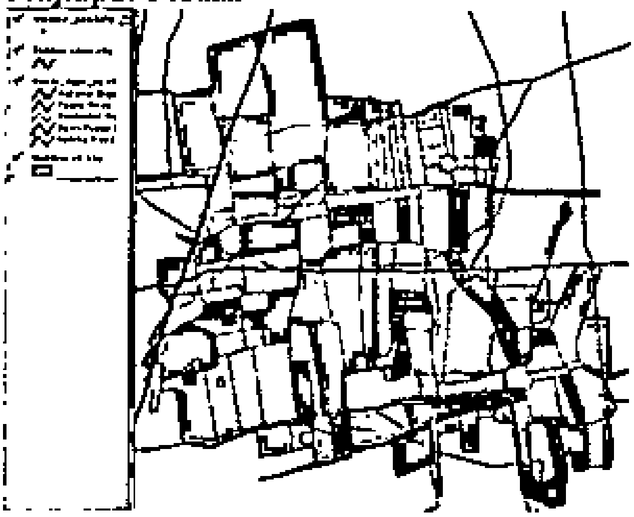

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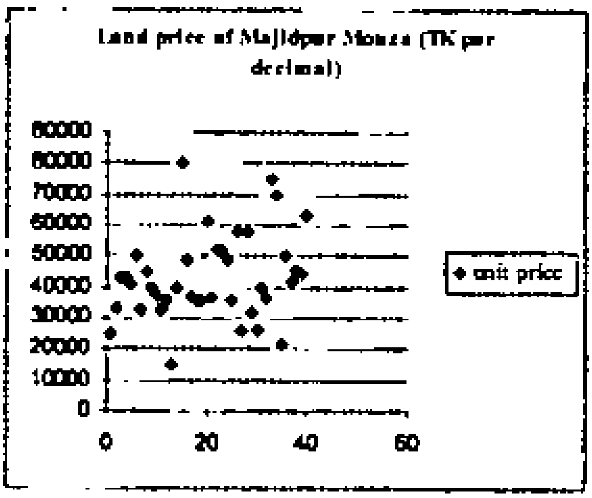

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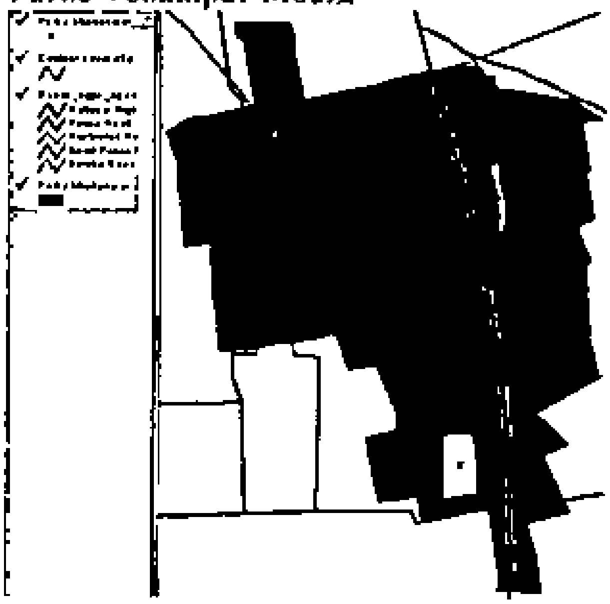

Map of transacted plots

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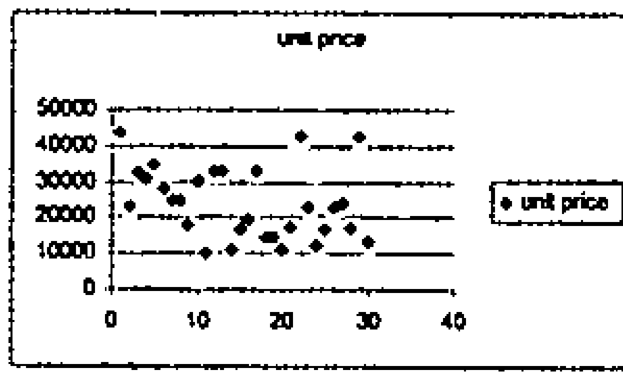
Map of transacted plots

Rajashan Mouza

Map of transacted plots



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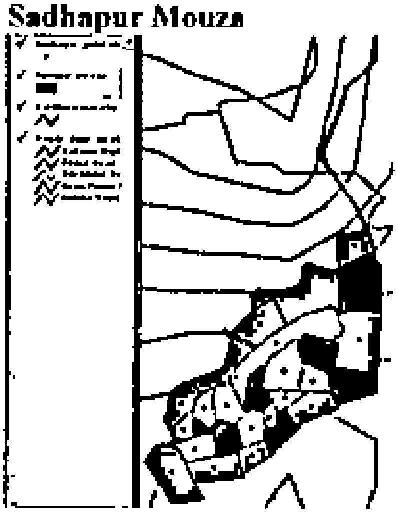

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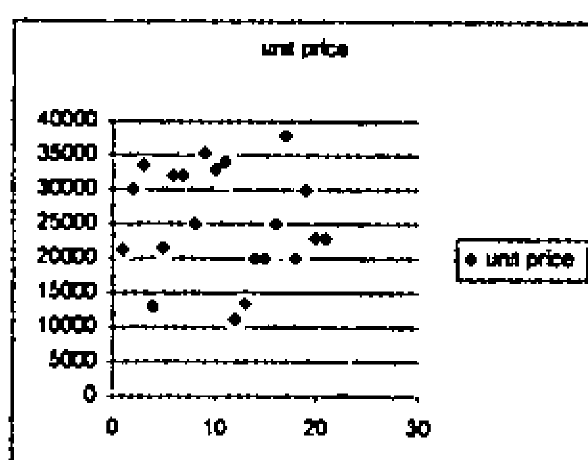

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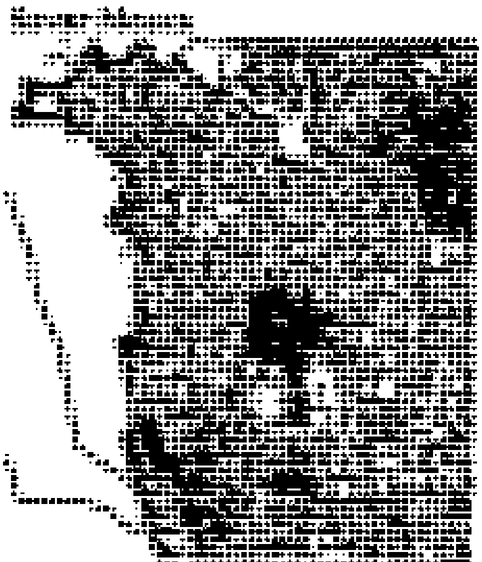

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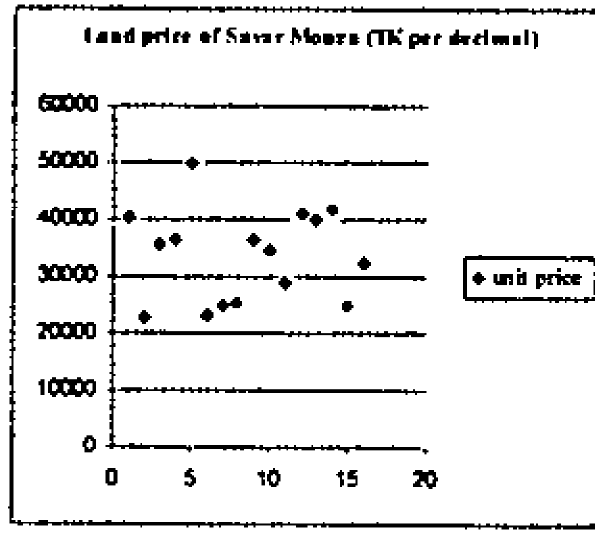

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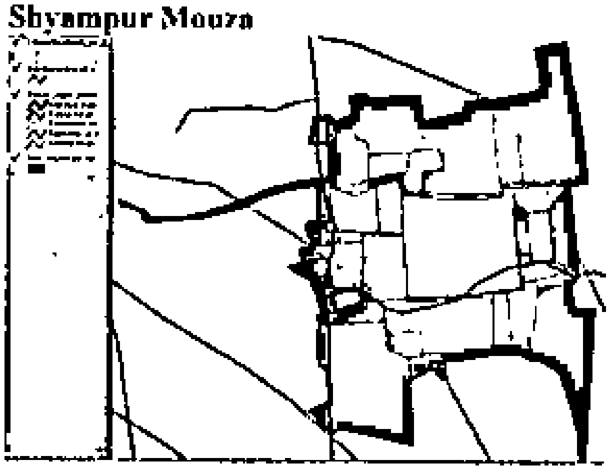
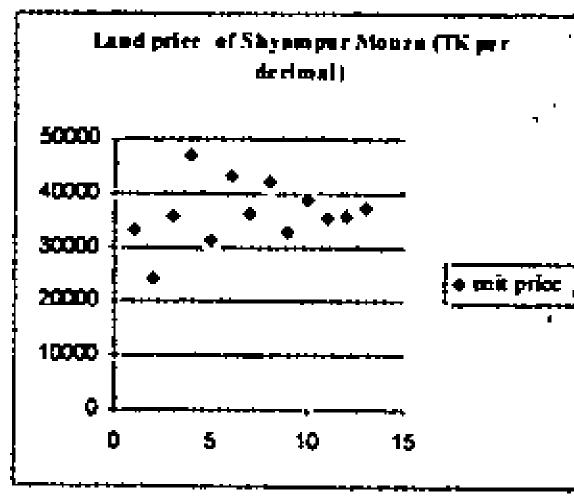
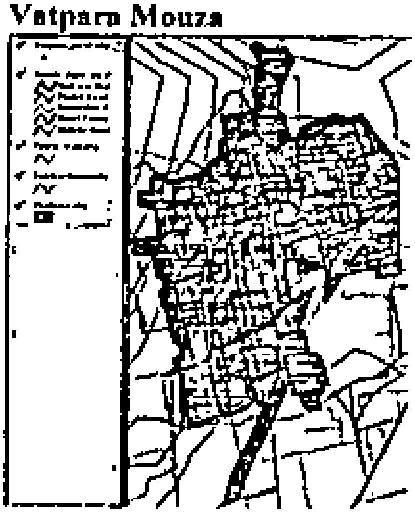


Map of transacted plots

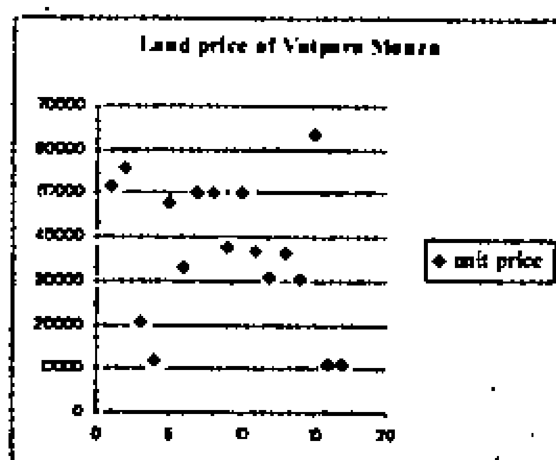


Scatter plot of land price

Vatpara Mouza



Map of transacted plots



Scatter plot of land price

Appendix B

Appendix B.1: Coefficients of correlation of all explanatory variables

Variable Id	Price	pop_den	area	contour	d_brickfld	d_edu	d_postoff	d_haz_ind	d_police	d_relig	d_bus_ter	d_muni	d_bank	d_dev_org	d_hosp	d_market	d_job	d_recre	d_dustbin	d_poura_rd	d_up_rd	d_nh
price	1.00	-0.03	-0.03	-0.04	-0.07	-0.01	0.03	-0.02	0.04	-0.02	-0.03	-0.01	0.01	0.03	0.04	0.02	-0.02	-0.08	0.20	-0.01	-0.09	-0.02
pop_den	-0.03	1.00	0.01	-0.28	0.72	0.49	-0.25	0.58	-0.24	0.94	-0.22	0.41	0.03	0.26	-0.06	-0.09	0.26	-0.13	0.40	0.56	-0.04	-0.05
area	-0.03	0.01	1.00	-0.02	0.01	-0.01	-0.03	-0.04	-0.03	0.01	-0.05	-0.05	-0.05	-0.03	-0.02	-0.04	-0.05	-0.06	0.02	-0.03	-0.01	-0.03
contour	-0.04	-0.28	-0.02	1.00	-0.27	-0.22	0.16	-0.17	0.16	-0.23	0.17	-0.06	0.03	-0.13	0.03	0.06	-0.07	0.19	-0.22	-0.18	-0.01	0.03
d_brickfld	-0.07	0.72	0.01	-0.27	1.00	0.52	-0.10	0.73	-0.10	0.65	0.01	0.37	0.13	0.34	0.05	0.13	0.56	0.00	0.40	0.27	0.37	0.05
d_edu	-0.01	0.49	-0.01	-0.22	0.52	1.00	0.40	0.74	0.40	0.55	0.42	0.68	0.55	0.72	0.47	0.53	0.69	0.47	0.47	0.56	0.46	0.14
d_postoff	0.03	-0.25	-0.03	0.16	-0.10	0.40	1.00	0.41	1.00	-0.11	0.94	0.64	0.82	0.62	0.80	0.88	0.62	0.87	0.36	0.14	0.62	0.22
d_haz_ind	-0.02	0.58	-0.04	-0.17	0.73	0.74	0.41	1.00	0.41	0.60	0.47	0.74	0.62	0.72	0.41	0.59	0.93	0.49	0.59	0.43	0.59	0.14
d_police	0.04	-0.24	-0.03	0.16	-0.10	0.40	1.00	0.41	1.00	-0.11	0.94	0.64	0.82	0.63	0.80	0.88	0.62	0.86	0.36	0.15	0.62	0.22
d_relig	-0.02	0.94	0.01	-0.23	0.65	0.55	-0.11	0.60	-0.11	1.00	-0.11	0.50	0.17	0.32	0.05	0.04	0.31	-0.02	0.40	0.64	0.01	-0.01
d_bus_ter	-0.03	-0.22	-0.05	0.17	0.01	0.42	0.94	0.47	0.94	-0.11	1.00	0.59	0.76	0.59	0.68	0.85	0.69	0.95	0.19	0.11	0.75	0.25
d_muni	-0.01	0.41	-0.05	-0.06	0.37	0.68	0.64	0.74	0.64	0.50	0.59	1.00	0.88	0.79	0.74	0.78	0.73	0.60	0.56	0.48	0.51	0.17
d_bank	0.01	0.03	-0.05	0.03	0.13	0.55	0.82	0.62	0.82	0.17	0.76	0.88	1.00	0.78	0.79	0.95	0.72	0.75	0.40	0.32	0.62	0.23
d_dev_org	0.03	0.26	-0.03	-0.13	0.34	0.72	0.62	0.72	0.63	0.32	0.59	0.79	0.78	1.00	0.75	0.79	0.76	0.61	0.63	0.41	0.61	0.23
d_hosp	0.04	-0.06	-0.02	0.03	0.05	0.47	0.80	0.41	0.80	0.05	0.68	0.74	0.79	0.75	1.00	0.80	0.55	0.60	0.53	0.19	0.51	0.22
d_market	0.02	-0.09	-0.04	0.06	0.13	0.53	0.88	0.59	0.88	0.04	0.85	0.78	0.95	0.79	0.80	1.00	0.75	0.83	0.38	0.23	0.71	0.27
d_job	-0.02	0.26	-0.05	-0.07	0.56	0.69	0.62	0.93	0.62	0.31	0.69	0.73	0.72	0.76	0.55	0.75	1.00	0.68	0.52	0.28	0.75	0.18
d_recre	-0.08	-0.13	-0.06	0.19	0.00	0.47	0.87	0.49	0.86	-0.02	0.95	0.60	0.75	0.61	0.60	0.83	0.68	1.00	0.08	0.20	0.69	0.25
d_dustbin	0.20	0.40	0.02	-0.22	0.40	0.47	0.36	0.59	0.36	0.40	0.19	0.56	0.40	0.63	0.53	0.38	0.52	0.08	1.00	0.29	0.20	0.03
d_poura_rd	-0.01	0.56	-0.03	-0.18	0.27	0.56	0.14	0.43	0.15	0.64	0.11	0.48	0.32	0.41	0.19	0.23	0.28	0.20	0.29	1.00	0.08	0.03
d_up_rd	-0.09	-0.04	-0.01	-0.01	0.37	0.46	0.62	0.59	0.62	0.01	0.75	0.51	0.62	0.61	0.51	0.71	0.75	0.69	0.20	0.08	1.00	0.30
d_nh	-0.02	-0.05	-0.03	0.03	0.05	0.14	0.22	0.14	0.22	-0.01	0.25	0.17	0.23	0.23	0.22	0.27	0.18	0.25	0.03	0.03	0.30	1.00

Source: Calculated by author, 2009

Appendix B.2: Coefficients of correlation of all variables for Group 1 plots

Variable id	price	pop_den	area	contour	d_brickfld	d_edu	d_postoff	d_haz_ind	d_police	d_relig	d_bus_ter	d_muni	d_bank	d_dev_org	d_hosp	d_market	d_job	d_recre	d_dustbin	d_poura_rd	d_up_rd	d_nh
price	1.00	-0.04	0.48	0.34	-0.26	-0.26	-0.14	0.27	-0.14	-0.05	-0.41	-0.15	-0.15	-0.49	-0.51	-0.15	0.29	-0.10	0.00	-0.27	-0.30	-0.28
pop_den	-0.04	1.00	-0.01	-0.03	0.02	0.08	0.00	0.02	0.00	0.05	0.01	-0.02	-0.02	0.02	-0.05	-0.01	0.02	0.02	0.02	0.01	0.03	-0.02
area	0.48	-0.01	1.00	0.15	0.33	-0.17	-0.36	0.44	-0.36	0.08	0.00	-0.67	-0.68	-0.84	-0.73	-0.68	0.44	0.23	-0.83	-0.11	-0.86	-0.77
contour	0.34	-0.03	0.15	1.00	0.00	-0.12	-0.10	0.07	-0.10	-0.07	-0.08	-0.05	-0.08	-0.16	-0.05	-0.10	0.07	-0.09	-0.12	-0.09	-0.12	-0.10
d_brickfld	-0.26	0.02	0.33	0.00	1.00	0.21	-0.54	0.28	-0.55	-0.09	-0.46	-0.58	-0.56	-0.36	-0.54	-0.50	0.27	-0.25	-0.28	0.11	-0.40	-0.53
d_edu	-0.26	0.08	-0.17	-0.12	0.21	1.00	0.09	0.61	0.09	0.03	0.10	0.00	0.05	0.39	-0.18	0.12	0.61	0.12	0.29	0.71	0.32	-0.08
d_postoff	-0.14	0.00	-0.36	-0.10	-0.54	0.09	1.00	-0.02	1.00	0.62	0.92	0.87	0.89	0.46	0.69	0.91	-0.02	0.79	0.19	0.23	0.39	0.56
d_haz_ind	0.27	0.02	0.44	0.07	0.28	0.61	-0.02	1.00	-0.03	0.14	0.18	-0.28	-0.26	-0.13	-0.46	-0.21	1.00	0.29	-0.20	0.52	-0.18	-0.45
d_police	-0.14	0.00	-0.36	-0.10	-0.55	0.09	1.00	-0.03	1.00	0.62	0.92	0.88	0.89	0.46	0.69	0.91	-0.02	0.78	0.20	0.23	0.40	0.56
d_relig	-0.05	0.05	0.08	-0.07	-0.09	0.03	0.62	0.14	0.62	1.00	0.69	0.37	0.40	0.07	0.18	0.45	0.14	0.73	0.01	0.31	0.03	0.06
d_bus_ter	-0.41	0.01	0.00	-0.08	-0.46	0.10	0.92	0.18	0.92	0.69	1.00	0.63	0.65	0.18	0.38	0.67	0.18	0.96	-0.13	0.26	0.10	0.25
d_muni	-0.15	-0.02	-0.67	-0.05	-0.58	0.00	0.87	-0.28	0.88	0.37	0.63	1.00	0.99	0.64	0.93	0.98	-0.28	0.41	0.48	0.08	0.61	0.83
d_bank	-0.15	-0.02	-0.68	-0.08	-0.56	0.05	0.89	-0.26	0.89	0.40	0.65	0.99	1.00	0.67	0.91	0.99	-0.26	0.44	0.50	0.13	0.63	0.81
d_dev_org	-0.49	0.02	-0.84	-0.16	-0.36	0.39	0.46	-0.13	0.46	0.07	0.18	0.64	0.67	1.00	0.59	0.70	-0.13	-0.02	0.90	0.30	0.90	0.57
d_hosp	-0.51	-0.05	-0.73	-0.05	-0.54	-0.18	0.69	-0.46	0.69	0.18	0.38	0.93	0.91	0.59	1.00	0.86	-0.46	0.15	0.52	-0.11	0.60	0.90
d_market	-0.15	-0.01	-0.68	-0.10	-0.50	0.12	0.91	-0.21	0.91	0.45	0.67	0.98	0.99	0.70	0.86	1.00	-0.21	0.48	0.50	0.20	0.64	0.76
d_job	0.29	0.02	0.44	0.07	0.27	0.61	-0.02	1.00	-0.02	0.14	0.18	-0.28	-0.26	-0.13	-0.46	-0.21	1.00	0.29	-0.20	0.52	-0.18	-0.45
d_recre	-0.10	0.02	0.23	-0.09	-0.25	0.12	0.79	0.29	0.78	0.73	0.96	0.41	0.44	-0.02	0.15	0.48	0.29	1.00	-0.32	0.28	-0.10	0.02
d_dustbin	0.00	0.02	-0.83	-0.12	-0.28	0.29	0.19	-0.20	0.20	0.01	-0.13	0.48	0.50	0.90	0.52	0.50	-0.20	-0.32	1.00	0.24	0.86	0.54
d_poura_rd	-0.27	0.01	-0.11	-0.09	0.11	0.71	0.23	0.52	0.23	0.31	0.26	0.08	0.13	0.30	-0.11	0.20	0.52	0.28	0.24	1.00	0.37	-0.08
d_up_rd	-0.30	0.03	-0.86	-0.12	-0.40	0.32	0.39	-0.18	0.40	0.03	0.10	0.61	0.63	0.90	0.60	0.64	-0.18	-0.10	0.86	0.37	1.00	0.59
d_nh	-0.28	-0.02	-0.77	-0.10	-0.53	-0.08	0.56	-0.45	0.56	0.06	0.25	0.83	0.81	0.57	0.90	0.76	-0.45	0.02	0.54	-0.08	0.59	1.00

Source: Calculated by author, 2009

Appendix B.3: Coefficients of correlation of all variables for Group 2 plots

Variable id	Price	pop_den	area	contour	d_brickfld	d_edu	d_postoff	d_haz_ind	d_police	d_relig	d_bus_ter	d_muni	d_bank	d_dev_org	d_hosp	d_market	d_job	d_recre	d_dustbin	d_poura_rd	d_up_rd	d_nh
price	1.00	0.26	-0.33	0.48	0.56	-0.32	0.22	0.49	0.22	0.55	0.20	0.22	0.33	0.19	0.22	0.23	0.20	0.15	0.19	-0.44	0.23	-0.49
area	0.26	1.00	0.23	-0.05	-0.02	-0.10	-0.09	-0.08	-0.09	-0.05	-0.06	-0.07	-0.05	-0.03	-0.07	-0.05	-0.09	-0.08	-0.13	0.00	-0.05	-0.01
pop_den	-0.33	0.23	1.00	-0.03	-0.29	-0.33	-0.48	-0.47	-0.49	-0.32	-0.32	-0.49	-0.46	-0.34	-0.50	-0.43	-0.45	-0.34	-0.61	-0.11	-0.29	0.02
contour	0.48	-0.05	-0.03	1.00	-0.31	-0.19	0.14	-0.04	0.14	-0.38	0.17	-0.02	-0.01	-0.07	-0.20	0.03	-0.04	0.30	-0.16	0.11	0.04	0.02
d_brickfld	0.56	-0.02	-0.29	-0.31	1.00	0.60	0.66	0.79	0.65	0.28	0.67	0.78	0.76	0.40	0.20	0.59	0.65	0.52	0.66	0.25	0.66	0.12
d_edu	-0.32	-0.10	-0.33	-0.19	0.60	1.00	0.67	0.81	0.67	0.44	0.69	0.72	0.19	0.83	0.71	0.25	0.65	0.67	0.62	0.22	0.66	0.15
d_postoff	0.22	-0.09	-0.48	0.14	0.66	0.67	1.00	0.89	1.00	0.38	0.96	0.89	0.88	0.85	0.86	0.92	0.90	0.89	0.79	0.35	0.88	0.16
d_haz_Ind	0.49	-0.08	-0.47	-0.04	0.79	0.81	0.89	1.00	0.89	0.43	0.90	0.96	0.96	0.96	0.87	0.97	0.99	0.87	0.73	0.34	0.86	0.17
d_police	0.22	-0.09	-0.49	0.14	0.65	0.67	1.00	0.89	1.00	0.38	0.96	0.89	0.87	0.85	0.86	0.14	0.90	0.89	0.80	0.35	0.87	0.15
d_relig	0.55	-0.05	-0.32	-0.38	0.28	0.44	0.38	0.43	0.38	1.00	0.33	0.39	0.40	0.39	0.39	0.40	0.41	0.31	0.32	0.16	0.42	0.09
d_bus_ter	0.20	-0.06	-0.32	0.17	0.67	0.69	0.96	0.90	0.96	0.33	1.00	0.88	0.88	0.88	0.79	0.28	0.92	0.96	0.65	0.35	0.93	0.19
d_muni	0.22	-0.07	-0.49	-0.02	0.78	0.72	0.89	0.96	0.89	0.39	0.88	1.00	0.96	0.92	0.90	0.95	0.96	0.82	0.76	0.32	0.81	0.13
d_bank	0.23	-0.05	-0.46	-0.01	0.76	0.19	0.88	0.96	0.87	0.40	0.88	0.96	1.00	0.94	0.82	0.99	0.96	0.86	0.67	0.35	0.85	0.16
d_dev_org	0.19	-0.03	-0.34	-0.07	0.40	0.83	0.85	0.96	0.85	0.39	0.88	0.92	0.94	1.00	0.85	0.94	0.96	0.85	0.69	0.35	0.85	0.17
d_hosp	0.22	-0.07	-0.50	-0.20	0.20	0.71	0.86	0.87	0.86	0.39	0.79	0.90	0.82	0.85	1.00	0.83	0.88	0.65	0.92	0.28	0.73	0.10
d_market	0.33	-0.05	-0.43	0.03	0.59	0.25	0.92	0.97	0.14	0.40	0.28	0.95	0.99	0.94	0.83	1.00	0.97	0.65	0.68	0.37	0.57	0.17
d_job	0.20	-0.09	-0.45	-0.04	0.65	0.65	0.90	0.99	0.90	0.41	0.92	0.96	0.96	0.96	0.88	0.97	1.00	0.88	0.74	0.34	0.87	0.15
d_recre	0.15	-0.08	-0.34	0.30	0.52	0.67	0.89	0.87	0.89	0.31	0.96	0.82	0.86	0.85	0.65	0.65	0.88	1.00	0.51	0.36	0.89	0.19
d_dustbin	0.19	-0.13	-0.61	-0.16	0.66	0.62	0.79	0.73	0.80	0.32	0.65	0.76	0.67	0.69	0.92	0.68	0.74	0.51	1.00	0.24	0.56	0.05
d_poura_rd	-0.44	0.00	-0.11	0.11	0.25	0.22	0.35	0.34	0.35	0.16	0.35	0.32	0.35	0.35	0.28	0.37	0.34	0.36	0.24	1.00	0.31	0.07
d_up_rd	0.23	-0.05	-0.29	0.04	0.66	0.66	0.88	0.86	0.87	0.42	0.93	0.81	0.85	0.85	0.73	0.57	0.87	0.89	0.56	0.31	1.00	0.21
d_nh	-0.49	-0.01	0.02	0.02	0.12	0.15	0.16	0.17	0.15	0.09	0.19	0.13	0.16	0.17	0.10	0.17	0.15	0.19	0.05	0.07	0.21	1.00

Source: Calculated by author, 2009

Appendix B.4: Coefficients of correlation of all variables for group 3 plots

Variable id	Price	pop_den	area	contour	d_brickfld	d_edu	d_postoff	d_haz_ind	d_police	d_relig	d_bus_ter	d_muni	d_bank	d_dev_org	d_hosp	d_market	d_job	d_recre	d_dustbin	d_poura_rd	d_up_rd	d_nh
price	1.00	0.63	-0.30	0.39	-0.26	-0.47	0.06	0.49	0.06	-0.05	-0.49	0.01	0.00	0.01	-0.59	0.00	-0.51	0.06	0.09	-0.52	-0.68	-0.49
area	0.63	1.00	0.10	0.01	-0.05	-0.03	-0.03	-0.02	-0.03	0.02	-0.04	0.07	-0.04	-0.07	-0.04	-0.05	-0.01	-0.05	0.01	-0.04	-0.05	-0.09
pop_den	-0.30	0.10	1.00	-0.03	-0.29	0.19	-0.19	-0.03	-0.19	0.01	-0.06	0.28	0.00	0.08	-0.14	-0.18	0.06	-0.02	-0.30	0.06	0.17	-0.02
contour	0.39	0.01	-0.03	1.00	-0.78	-0.60	-0.07	-0.25	-0.06	-0.51	-0.09	-0.23	-0.46	-0.13	-0.49	-0.58	-0.27	0.06	0.17	-0.47	-0.52	-0.60
d_brickfld	-0.26	-0.05	-0.29	-0.78	1.00	0.44	-0.08	0.00	-0.08	0.41	-0.05	-0.15	0.20	-0.08	0.18	0.52	-0.01	-0.13	-0.34	0.22	0.29	0.65
d_edu	-0.47	-0.03	0.19	-0.60	0.44	1.00	0.24	0.28	0.24	0.39	0.26	0.28	0.43	0.07	0.39	0.52	0.34	0.21	-0.23	0.23	0.50	0.37
d_postoff	0.06	-0.03	-0.19	-0.07	-0.08	0.24	1.00	0.50	1.00	0.13	0.92	0.49	0.63	-0.17	0.41	0.54	0.62	0.76	0.13	0.19	0.55	-0.05
d_haz_ind	0.49	-0.02	-0.03	-0.25	0.00	0.28	0.50	1.00	0.50	0.15	0.59	0.46	0.67	0.15	0.25	0.66	0.94	0.66	-0.14	0.30	0.55	0.37
d_police	0.06	-0.03	-0.19	-0.06	-0.08	0.24	1.00	0.50	1.00	0.13	0.92	0.49	0.63	-0.17	0.41	0.54	0.61	0.76	0.13	0.18	0.54	-0.05
d_relig	-0.05	0.02	0.01	-0.51	0.41	0.39	0.13	0.15	0.13	1.00	0.10	0.18	0.40	0.30	0.43	0.43	0.18	0.04	-0.07	0.39	0.39	0.51
d_bus_ter	-0.49	-0.04	-0.06	-0.09	-0.05	0.26	0.92	0.59	0.92	0.10	1.00	0.45	0.61	-0.19	0.25	0.59	0.68	0.90	-0.16	0.23	0.68	0.11
d_muni	0.01	0.07	0.28	-0.23	-0.15	0.28	0.49	0.46	0.49	0.18	0.45	1.00	0.74	-0.05	0.23	0.45	0.49	0.35	0.05	0.28	0.32	-0.05
d_bank	0.00	-0.04	0.00	-0.46	0.20	0.43	0.63	0.67	0.63	0.40	0.61	0.74	1.00	0.12	0.32	0.87	0.70	0.61	-0.19	0.39	0.56	0.33
d_dev_org	0.01	-0.07	0.08	-0.13	-0.08	0.07	-0.17	0.15	-0.17	0.30	-0.19	-0.05	0.12	1.00	0.34	0.09	0.13	0.01	0.22	0.29	0.15	0.56
d_hosp	-0.59	-0.04	-0.14	-0.49	0.18	0.39	0.41	0.25	0.41	0.43	0.25	0.23	0.32	0.34	1.00	0.29	0.32	0.04	0.52	0.37	0.43	0.37
d_market	0.00	-0.05	-0.18	-0.58	0.52	0.52	0.54	0.66	0.54	0.43	0.59	0.45	0.87	0.09	0.29	1.00	0.65	0.62	-0.37	0.35	0.62	0.50
d_job	-0.51	-0.01	0.06	-0.27	-0.01	0.34	0.62	0.94	0.61	0.18	0.68	0.49	0.70	0.13	0.32	0.65	1.00	0.72	-0.13	0.32	0.60	0.31
d_recre	0.06	-0.05	-0.02	0.06	-0.13	0.21	0.76	0.66	0.76	0.04	0.90	0.35	0.61	0.01	0.04	0.62	0.72	1.00	-0.32	0.16	0.60	0.20
d_dustbin	0.09	0.01	-0.30	0.17	-0.34	-0.23	0.13	-0.14	0.13	-0.07	-0.16	0.05	-0.19	0.22	0.52	-0.37	-0.13	-0.32	1.00	0.01	-0.31	-0.33
d_poura_rd	-0.52	-0.04	0.06	-0.47	0.22	0.23	0.19	0.30	0.18	0.39	0.23	0.28	0.39	0.29	0.37	0.35	0.32	0.16	0.01	1.00	0.43	0.44
d_up_rd	-0.68	-0.05	0.17	-0.52	0.29	0.50	0.55	0.55	0.54	0.39	0.68	0.32	0.56	0.15	0.43	0.62	0.60	0.60	-0.31	0.43	1.00	0.67
d_nh	-0.49	-0.09	-0.02	-0.60	0.65	0.37	-0.05	0.37	-0.05	0.51	0.11	-0.05	0.33	0.56	0.37	0.50	0.31	0.20	-0.33	0.44	0.67	1.00

Source: Calculated by author, 2009

Appendix B.5: Coefficients of correlation of all variables for Group 4 plots

Variable id	Price	pop_den	area	contour	d_brickfld	d_edu	d_postoff	d_haz_ind	d_police	d_relig	d_bus_ter	d_muni	d_bank	d_dev_org	d_hosp	d_market	d_job	d_recre	d_dustbin	d_poura_rd	d_up_rd	d_nh
price	1.00	0.49	0.62	0.27	-0.38	-0.28	-0.16	-0.41	-0.16	0.31	-0.15	-0.29	-0.27	-0.12	-0.17	-0.12	-0.04	-0.13	-0.16	0.38	-0.75	-0.39
area	0.49	1.00	-0.25	0.33	0.25	-0.15	-0.31	-0.29	-0.31	-0.01	-0.31	-0.13	-0.27	-0.31	-0.28	-0.34	-0.32	-0.33	-0.30	-0.18	-0.08	-0.31
pop_den	0.62	-0.25	1.00	-0.35	-0.46	-0.10	0.02	0.47	0.02	0.32	0.02	-0.07	0.43	0.02	-0.07	0.18	0.36	0.11	0.00	0.12	0.27	0.02
contour	0.27	0.33	-0.35	1.00	0.74	-0.52	-0.73	-0.85	-0.73	-0.35	-0.74	-0.46	-0.87	-0.72	-0.64	-0.83	-0.87	-0.79	-0.70	-0.37	-0.44	-0.59
d_brickfld	-0.38	0.25	-0.46	0.74	1.00	-0.22	-0.33	-0.82	-0.33	-0.37	-0.37	-0.37	-0.78	-0.42	-0.26	-0.55	-0.80	-0.55	-0.28	-0.36	-0.58	-0.27
d_edu	-0.28	-0.15	-0.10	-0.52	-0.22	1.00	0.63	0.19	0.63	0.11	0.68	0.79	0.37	0.60	0.72	0.49	0.39	0.63	0.61	0.26	0.28	0.43
d_postoff	-0.16	-0.31	0.02	-0.73	-0.33	0.63	1.00	0.51	1.00	-0.04	0.99	0.50	0.54	0.97	0.97	0.94	0.71	0.95	1.00	0.15	0.16	0.72
d_haz_ind	-0.41	-0.29	0.47	-0.85	-0.82	0.19	0.51	1.00	0.51	0.38	0.51	0.15	0.90	0.53	0.36	0.74	0.89	0.61	0.49	0.28	0.38	0.44
d_police	-0.16	-0.31	0.02	-0.73	-0.33	0.63	1.00	0.51	1.00	-0.04	0.99	0.50	0.54	0.97	0.97	0.94	0.71	0.95	1.00	0.15	0.16	0.72
d_relig	0.31	-0.01	0.32	-0.35	-0.37	0.11	-0.04	0.38	-0.04	1.00	-0.02	0.19	0.57	0.00	-0.10	0.06	0.30	0.00	-0.06	0.34	0.38	0.06
d_bus_ter	-0.15	-0.31	0.02	-0.74	-0.37	0.68	0.99	0.51	0.99	-0.02	1.00	0.57	0.54	0.98	0.98	0.93	0.73	0.97	0.99	0.16	0.21	0.71
d_muni	-0.29	-0.13	-0.07	-0.46	-0.37	0.79	0.50	0.15	0.50	0.19	0.57	1.00	0.27	0.57	0.64	0.36	0.41	0.58	0.45	0.22	0.46	0.34
d_bank	-0.27	-0.27	0.43	-0.87	-0.78	0.37	0.54	0.90	0.54	0.57	0.54	0.27	1.00	0.53	0.39	0.71	0.81	0.59	0.51	0.42	0.41	0.43
d_dev_org	-0.12	-0.31	0.02	-0.72	-0.42	0.60	0.97	0.53	0.97	0.00	0.98	0.57	0.53	1.00	0.96	0.93	0.77	0.98	0.96	0.15	0.24	0.70
d_hosp	-0.17	-0.28	-0.07	-0.64	-0.26	0.72	0.97	0.36	0.97	-0.10	0.98	0.64	0.39	0.96	1.00	0.85	0.63	0.94	0.96	0.11	0.19	0.69
d_market	-0.12	-0.34	0.18	-0.83	-0.55	0.49	0.94	0.74	0.94	0.06	0.93	0.36	0.71	0.93	0.85	1.00	0.86	0.95	0.93	0.20	0.23	0.69
d_job	-0.04	-0.32	0.36	-0.87	-0.80	0.39	0.71	0.89	0.71	0.30	0.73	0.41	0.81	0.77	0.63	0.86	1.00	0.83	0.68	0.29	0.45	0.58
d_recre	-0.13	-0.33	0.11	-0.79	-0.55	0.63	0.95	0.61	0.95	0.00	0.97	0.58	0.59	0.98	0.94	0.95	0.83	1.00	0.93	0.18	0.31	0.69
d_dustbin	-0.16	-0.30	0.00	-0.70	-0.28	0.61	1.00	0.49	1.00	-0.06	0.99	0.45	0.51	0.96	0.96	0.93	0.68	0.93	1.00	0.13	0.12	0.71
d_poura_rd	0.38	-0.18	0.12	-0.37	-0.36	0.26	0.15	0.28	0.15	0.34	0.16	0.22	0.42	0.15	0.11	0.20	0.29	0.18	0.13	1.00	0.39	0.22
d_up_rd	-0.75	-0.08	0.27	-0.44	-0.58	0.28	0.16	0.38	0.16	0.38	0.21	0.46	0.41	0.24	0.19	0.23	0.45	0.31	0.12	0.39	1.00	0.25
d_nh	-0.39	-0.31	0.02	-0.59	-0.27	0.43	0.72	0.44	0.72	0.06	0.71	0.34	0.43	0.70	0.69	0.69	0.58	0.69	0.71	0.22	0.25	1.00

Source: Calculated by author, 2009