Simulating the Impacts of 2008 Olympic Games on Real Estate Development in Beijing Metropolitan Area: An ABM Approach

1 INTRODUCTION

Hosting Olympic Games has been found a catalyst for the development of host cities since 1984 Olympic Games in Los Angles. Beijing, as the host of 2008 Olympic Games and the capital of the largest developing country, has witnessed dramatic changes since it won the Olympic bid. From 2001 to 2008, RMB 280 billion (USD 35 billion) will be invested on the infrastructure, environment, and industry development, majority of which goes to urban transportation, sanitation, water supply and power supply. In order to support the traffic during the Olympic Games, the traffic network will be substantially improved, and leading to the increase of accessibility of certain area. Moreover, the amenity of the area around the Olympic sport facility will be improved. In our recent survey, we found that many new developed residential places have already been build near the planning but unfinished subway or near the unfinished Olympic Park. Therefore, planning efforts in Beijing increasingly focus on issues such as “how the 2008 Olympic Games will shape the real estates form” and “how these influenced real estates developments will retroact on urban transportation planning”, to serve the government, residents and real estates developers. Significantly, studying the model of the urban development in Beijing Metropolitan Area is very important to provide appropriate macro control strategies and help supervising the Olympic Games in the sustainability and planning perspective.

In this paper we build an agent based simulation model of urban development in Beijing Metropolitan Area. In this model developers are regarded as agents. A location choice model is designed for developers to identify which location can be selected to for development and explore the effects of 2008 Olympic Games on the Beijing metropolitan area. Using data on actual development patterns in Beijing, we conduct the real simulation and evaluate the impacts of 2008Olympic Games on city growth.

2 THE IMPACT FACTORS OF REAL ESTATE DEVELOPMENT IN BEIJING

Computer-based urban simulation and urban models are useful tools for quantitatively studying urban growth control. With the wide range adoption of computer modeling, great achievements have been obtained in the urban planning field: from static model to dynamic model, from non-geographic reference model to geographic reference model, from non-computer-based model to computer-based model, and from single model to aggregate model. Up to now, urban growth models can be classified into two types based on the scale and the mechanism of models: the first type is macro-level dynamic model, which focuses on the interrelationship among macro variables; the second is micro-level dynamic model, which focuses on the micro mechanism behind macro phenomena. For the second type of model, micro simulation approach of urban growth, further categorization can be made into Cellar Automation Based model and Multi-agent Based model. Many scholars try to build up the micro-level urban model and use the micro simulation approach to simulate the urban development. For example, Torrens (2002) combines the Cellular Automate (CA) and Multi agent System (MAS) to build up an micro-level urban model “SprawlSim” to study the urban sprawl in the North America. He uses the CA to represent the urban infrastructure and natural environment and uses the Agent based Model (ABM) to describe spatial behavior and the interaction of householders and developers in the urban system. Waddell (2002) implemented a prototype metropolitan land use model called UrbanSim to microsimulate the change in location choice of householders and enterprises as well as the change in the real estate markets. Dawn Parker (2003) uses an ABM to simulate the spatial land use change and ecological effects at the rural-urban interface. Daniel Brown (2003) uses an agent-based cellular automaton model to investigate the urban spatial externalities. This paper aims to apply the micro simulation approach to study the urban development under the context of the 2008 Beijing Olympic Games.

Among many micro simulation researches of urban growth, the urban system is a complex one. Urban development is the result of the complex interaction among householders/ individuals, businesses, developers and government in the physical environment. Householder and individuals make decision about whether and where to move or remain in their current residence. Businesses make similar choices about the mobility and location choice. Developers make choices of Greenfield development or redevelopment based on their profitability expectations. Government formulates policies, such as land use policies and open space protection. Their interaction has significant impacts on the distribution of population, employment and land use price.

However, different from most western countries where land freehold is prevalent, all land in China belongs to the state, which controls the land market strictly and makes the land use plans annually. Government sells the land use rights (LURs) to the developers, and developers purchases the LURs through auction or bidding, and the term for the LURs of residential land is usually 70 years. Enterprises usually rent or buy the office from the real estate developers. In this macro control land market, the real estate developer is like a mediator, who makes a location choice to buy the development right of a land from the government and meanwhile build house for the householders/individuals and enterprises. Therefore, the location choice behavior of householders, individuals and businesses do not act explicitly on the land in the urban space like in some western counties, but make implicit influences on the location choice decision of the real estate developers. Based on these influences and their profitability expectations, the developers select the vacant and non-urban use land and develop it into the urban use land. In this paper, we focus on research of the location choice model of the real estate developers in Beijing to predict and simulate the change in land use as an outcome of the development practices in the Beijing metropolitan area.

Our approach in modeling the location choice behavior of real estate developers assumes that all developers are motivated to maximize their profits. Their own resources, the constraints of the land use policy and the physical environment are the possible gap for their location choice (Waddell, 2003). A second assumption is that the government is reasonable enough to make the land use plan. The plan of the quantity of the to-be-developed land is determined by the macro economic and population. Also, the government would approve all the development demand of the real estate developers when they find a suitable land to develop. A third assumption is that the land price is determined only by the advantages of the location and the current macro economics in China. The individual consumers and suppliers can not manipulate land prices directly. The transportation accessibility, public service accessibility, amenities and so on are capitalized into the land value for the location.

We simplify the chain of real estate development in Beijing at two levels: macro level and micro level. The macro level is reflected in aggregate social and economic factors which are currently influenced greatly by the event of 2008 Olympic Games. The micro level involves the decision which real estate developers in Beijing make to develop the location from vacant land to urban use land. The flowchart in Figure 1 presents a structure view of the macro and micro level combination real estate development model in Beijing.

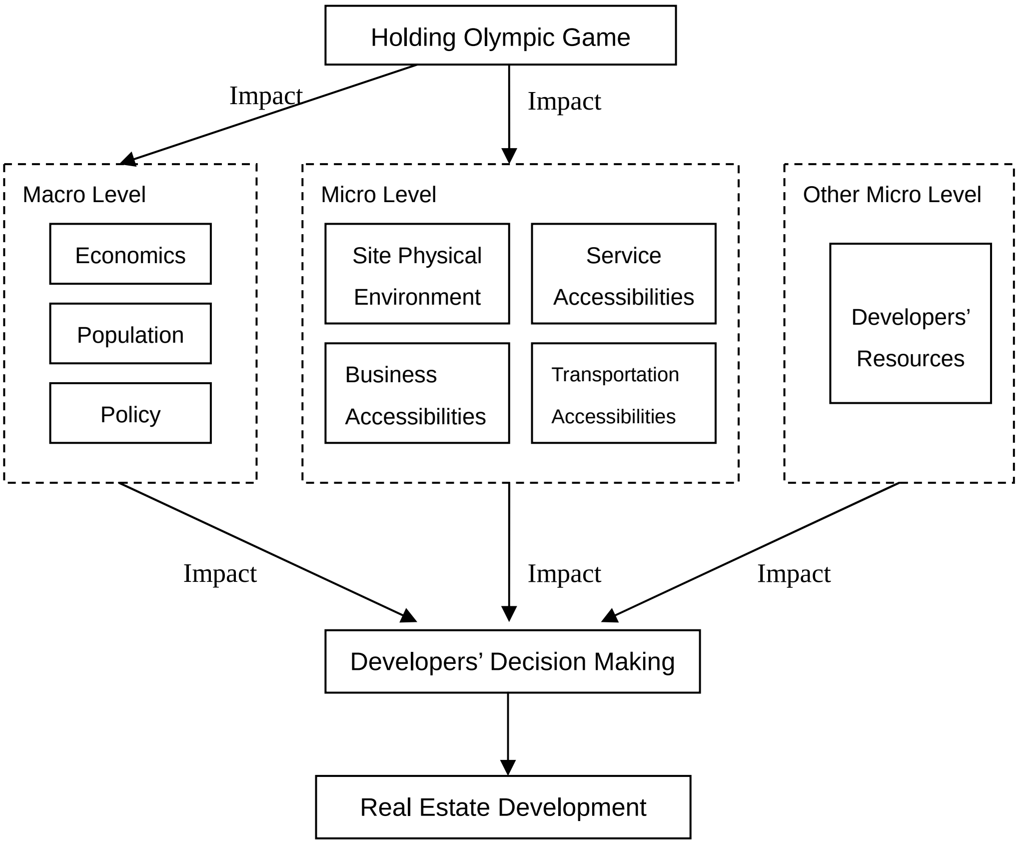


Figure 1: Real Estate Development Structure

At the macro level, the Olympic Games could drive the city economic growth quickly, particularly public service, travel and business industry. The official organization of 2008 Beijing Olympic Games estimates that hosting 2008 Olympic Games will bring about 2-4% GDP increase and 0.3~0.4% increase in economic growth rate, and therefore generate more job opportunities. (http://www.stats.gov.cn/) From 1984 to 2002, the Olympic Games bring about 25,000 new employment opportunities per year in Los Angeles, about 34,000 new employments in Seoul in 1988, about 59,000 new employments in Barcelona, about 77,000 new employments in Atlanta, about 150, 000 new employments in Sydney and about 230,000 new employments in Salt Lake City (http://www.la84foundation.org). It is estimated that there might be 1,940,000 new employments will provided in Beijing 2008 Olympic Games (Y.Tao, 2003; QuanJun, 2004). The rapid growth of the labor market will attract many people to migrate to Beijing from other cities. Those people need to find the place to live , thus leading to the increase of the demand of the housing. Meanwhile, the growth of the population and economy will cause the change of the land price and catalyze the development of real estate industry in the urban area.

At the micro level, real estate development is a collection of choices made by individual developers on individual sites, about whether, when, and how to develop or redevelop those sites (Waddell, 2003). Therefore, it is important to understand the developers' decision-making process in order to design the urban growth model. In the real estate market of China, developers act as the suppliers who sell the use right to consumers, including householders and enterprises. They have to define which location will generate the highest return. Hence, the developers should choose the location where the householders/individuals are willing to live. The functions of the householders or individuals to make the location decision for living need to be considered by the developers, so that the householders/individuals are willing to choose the place where the developer builds the residential building. Therefore, the factors which influence the householders' location choice will also take effect on the developers, and these factors can be identified as: Transportation Accessibilities, Business Accessibilities, Service Accessibilities and Amenity etc (WenZhong, 2002; WenZhou, 2003, ChangQi, 2003; Waddel, 2001) .

According to the above model, we divide the real estate development variables which affect the real estate developers into two major group: 1) Macro Variables 2) Micro Variable. These variables are shown in Table 1.

Variables	Description
Macro Variables	
Economic	GDP, Economic Growth Rate
Population	Demographic
Land Price	Housing Price, Land Price
Policy	Government Global Control, Environment Protection …
Micro Variables	
Developers' Resources	Funds, Experiences, …
Site Physical Environment	DEM, Slope, …
Transportation Accessibilities	Distance to CBD, to Subway Station, to Highway Entry, …
Business Accessibilities	Enterprise number, Employment number …
Service Accessibilities	Education, Medical, …
Amenity	Green Cover, Distance to Park, Stadiums, …

Table 1: Variables for Developers

In Complex Adaptive System (CAS), the components interact while adapting to their environment. Agent based models offer a promising framework for analysis of interactions between autonomous developers and the heterogeneous landscape in the metropolitan area. It essentially simulates the processes in which agents interact with each other but also with the vacant land where the assumption is that all possible feedbacks between land space and agent can, in principle, take place (Batty 2005a). These processes represent the city growth in the time line. We adopt an agent based model approach to better simulate the urban growth of the Beijing metropolitan area at the micro level, In this context, we have already defined two levels – the macro and the micro, and we can thus define the agents, landscapes and their interactions in our agent based model from micro level and control the running of agent based model from the macro level. In terms of agents, we define developer agents who make the location choice and convert the non-urban use land to urban use at the micro level. We can know from the figure 1 that their decision rule is regulated by the macro factors and micro factors.

3 STUDY AREA

Beijing, the capital of China, is located in the north of China, close to Tianjin Municipality and partially surrounded by Hebei Province. (Figure 2) The city covers an area of more than 16,800 square kilometers (6,487 square miles) and has a population of 14.21 million people. The metropolitan area is about 8,710 square kilometers and the population density is about 20,000 people per sq.km. The city economy has growing very quickly. Statistics show that the gross domestic product (GDP) of Beijing in 2001 reached 281.76 billion RMB and 681.45 billion RBM in 2005. Its annual GDP growth from 2001 to 2006 was 11.9 percent according to the revised figures after the first national economic census. The real estate sector grew at a rate of 19.7 percent annually from 2001-2006 and contributed to 7.2 percent of GDP in 2006, compared with 4.6 percent in 2000.

Figure 2: (a) Satellite Image of Beijing (b) Map of Beijing (c) Administrative Map of Beijing

4 METHODOLOGY

In this paper, we build an agent based model of real estate development in Beijing, and we name it as real estate development model. The outline of our agent based model is shown in the figure 3. In this model, developers are represented as autonomous agents. The heterogeneous landscape which the agents interact with is represented as several grid layers.

We present the Beijing area with a two-dimensional square lattice using grid cell of 100 by 100 meters as the space, and each grid space contains about 2,000,000 cells. We use GIS to overlap the parcel data on the grid space, which mainly includes physical environment data, transportation data, economic data and public service data etc.

We evaluate each cell in the grid a set of values from the micro level variables which are described in Table 1. When agents make location choice on these cells, these exogenous characteristics of cells would take effect on agents' final decision. Each cell has one of the two basic states: urban use land and non-urban use land. According to the self-properties of the agents and the attributes of the cells in the grid landscape, the agents could make location choice to transform the selected cell from vacant land to urban use land. This is the interaction that agents act on the grid landscape. Moreover, agents could interact with other agents once they choose in the same location, and we provide a bid model for this kind of interaction among agents. All these agents' actions will be the experience data guide the decisions make in the next time step for the developers. In brief, our model is to simulate discrete developer choice about whether to develop particular sites within a given year, what type of construction to undertake, and the quantity of construction. That means we could build the developer's location choice model in terms of discrete alternatives that represent development events.

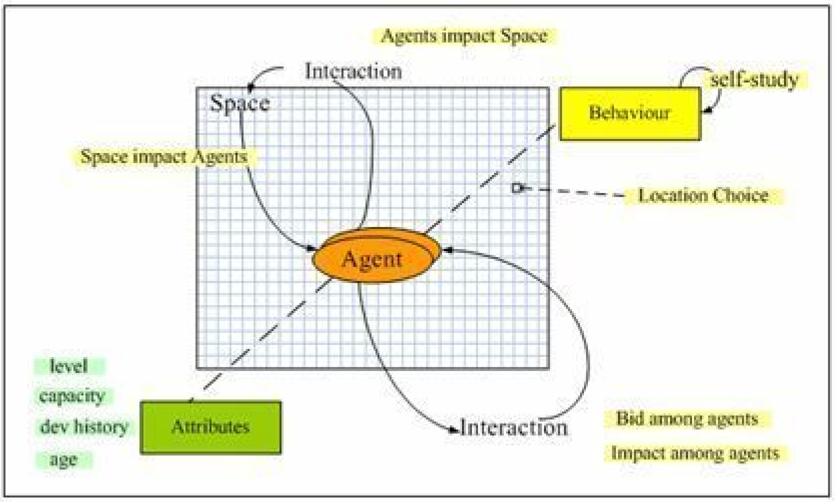


Figure 3: Agent based Simulation of Urban Development

The purpose of this model is to simulate discrete developer choices about whether to develop particular sites in a time period. This model is a yearly based model, which the land use policy and development constraints at the macro level may control the number of alternatives from the estimation stage in each year. We design a macro estimated model to calculate the capacity of the yearly land use and the yearly number of the developers. The developers do the location choice over all grid cells on which developments is allowed for each cell at the micro level in each year. We design a micro location choice model for the developers.

4.1 Global Model Design: The Macro Estimated Model

In this macro estimated model, we discrete the time into several time step, and we focus on the real estate development in one time step. Each time step could represent one year. The time step or the year can be only identified by the population and GDP. For example, if we want to simulate the residential real estate development from 2007 to 2015, we discrete these 8 years into eight time steps, and each time step represents one year. In each time step, we calculate how many residential land space area will be developed by developers, this to-be-developed area At at time step n is defined from the function f{} which specified as:

$$A_t = f(X_{GDP}, X_{Population,} X_{Policy}) \quad (1)$$

Where X_{GDP} , $X_{Population}$ and X_{Policy} are socio-economic drivers associated with economic development and regional policy appropriate to the macro level. The equation (1) is the basis for the estimation of the importance of exogenous variables to the urban use land to be developed which are fitted using linear regression. The vacant space to be developed in fact will determine the number of the real estate developers over the macro-time period T. In this paper, we assume that one agent only can develop one cell (100x100 meters) in each time step. That means, the number of agents equals to the number of to-be-developed cells in every time step. Hence, the number of agents Dt during the time period T is calculated by this equation:

$$D_t = A_t / 10000(sq.m.) \qquad (2)$$

In the macro estimated model, we design a policy control module that allows user to add policies at the specific time step. According to the model structure of the real estate developers’ location choice, this module could execute plan and constraint at the macro and the micro level of the model. The policy control of the macro variables could be implemented through setup the exogenous global variables, such as the global economic growth rate, the population growth rate, and the GDP or population amount in a specific time step. Through dominating these global variables, the planners could indirectly control the supplement of the urban use land. Besides, the policy control of the micro level such as planning a new subway line, an economic development zone or a restrict development area in a specific year is also provided in this module. The planners could use GIS tools to convert these plans or constraints to a new grid layer and replace the old grid layer which is used it in the location choice model for developer. The change and constraint attribute values of the cells will take effect on the developers’ location choice decision.

4.2 Micro Model Design: The Location Choice Model

The micro simulation section focuses on the logic of developers’ decision making process on the location choice. In this model, the developers are treated as agents which we index as j = 1,2,…,I, and each agent enter the grid type landscape and move on the cells which we index as k = 1,2,…K in the study area. To arrive at the location choice model, we assume that (1) each agent only develop one cell at one time step, (2) these agents will only choose vacant area and develop it to urban use land, and (3) they are motivated by maximize their profits. The heart of the process would be a nested decision structure with regards to any given parcel of land shown in Figure 4 below.

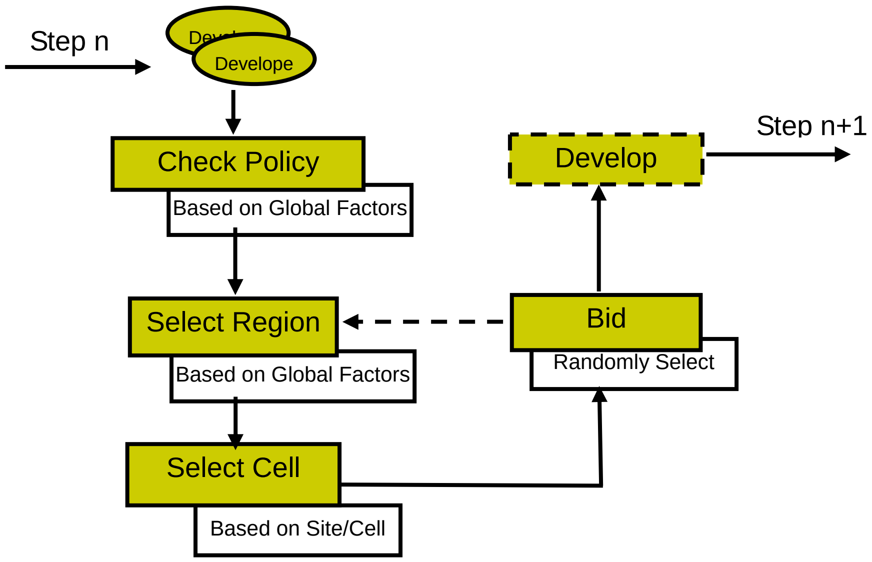


Figure 4: Location Choice Process of Developers

Select Region

The agents would not do a randomly location choice but first select a special region from the eight regions in Beijing. We did this design for several reasons. Firstly, Beijing metropolitan area is composed of eight regions, which is shown in the figure 2 (b). Government makes the land policy based on the unit of region in Beijing, such as the annual capacity of urban use area. In general, it always makes a policy on the supplement of the urban use land yearly in a region to either restrict the exceed growth speed or accelerate the region development. The number of to-be-developed cells is determined by those policies, and so is the number of the agents in each region. Therefore, when a region contains adequate number of agents, other agents are not able to select this region anymore but search for other suitable region. By doing this, the simulation of the real estate development will be factually. For the second reason, the developers in Beijing should cooperate with the local government office in a region to handle the affairs for the real estate development. Once the developers got the successful experience in this region, they will consider this region with the top-priority for next real estate development. At the initial stage of the simulation, all the agents select the region randomly. Then their selection will be recorded as the history data which is used for the region choice at next time step.

To predigest this process, we use a region layer to simplify the region selection of the developers. In this region layer, every region is marked with an identification code and so are the cells in this region. The percentage of the overall real estate development of each region can be configured in the global variables in the model. We can modify these variables when we pause the simulation.

Select Cell

Once the agent selected a region, it should make decision to choose a cell in the region. The agent will calculate the probability of each alternative (vacant to residential area, or vacant to non-residential area include commercial, etc.) of all cells using a discrete choice model. We draw on discrete choice theory and random utility maximizing models (McFadden) to design a multinomial logit model. Many researches used this approaches to model the land cover and land use change. (Landis, 1995; Waddell, 1999; Xia LI, 2004) For each development alternative i, the utility for an agent calculate on a cell can be separated into a systematic part and a random part:

$$U_i = \beta_i \cdot x_i + \varepsilon_i \quad (3)$$

where x_i is the factors that impact the utility U_i, β_i is the estimated coefficients, and ε_i is an unobserved random error that is formed with a Gumbel distribution, which leads to the familiar multinomial logit modal (McFadden)

$$P = \frac{\exp(\sum_{i=1}^{m} \beta_i x_i)}{1 + \exp(\sum_{i=1}^{m} \beta_i x_i)} \quad (4)$$

The probability that an agent choosing to develop one cell to alternative i is represented as P. The estimable coefficients β_i are estimated with the method of maximum likelihood (McFadden). Potential micro level variables that make up the utility function of such model include transportation accessibility, public service accessibility, business accessibility, site physical environment and the amenity.

For each development type (residential and non-residential), we build a multinomial logit discrete choice model. Therefore, two models are built, and the models are estimated using maximum likelihood.

In the time step n, one agent will use the corresponding discrete choice model to calculate two probabilities of all the cells which are vacant land in the landscape: P_1 is the probability that one cell transfer from vacant to urban use land, and P_2 is from vacant to non-urban use land. The agents will get a set of cells which are most suitable for the agents to develop to urban land use. ($P_{1,i} > P_{2,i}$) Then, the agent will do a random choose from the result set to select a specifically cell to develop.

Bid

At last, each agent should have one vacant cell chose. Nevertheless, the situation that some agents might select a same cell would happen. Hence, we add a bid procedure in the developer's decision making model. Once the agent selects a cell which is not occupied by other agent, the cell will be marked "Occupied". We assume that all the agents are the same, and in case two agents select a same cell then a random selection would take place between two bid agents. The selected one will occupy and develop the cell, and the loser would re-select the cell from the result set which was generated in the location choice procedure.

Develop

In this time step n, after all agents "develop" the vacant space to urban use, the time step will increase to n+1, the same logic of the developers' location choice will act again. At the initial stage in time step n+1, the global variables and grid cell data will be reload because of the possible execution of new policies. For this reason, the number of the agents would increase or decrease. The agents will use the new data to do the location choice in time step n+1.

4.3 System Prototype

In our multi-agent based simulation model, we develop the system prototype by using the CitySim, Repast (Recursive Porous Agent Simulation Toolkit) and weka. CitySim is a grid based micro simulation system (Shen and Li, 2007), we extent this library to wrapper the Repast, which is a agent based framework and the Weka, which is a data mining toolkit to implement our system prototype.

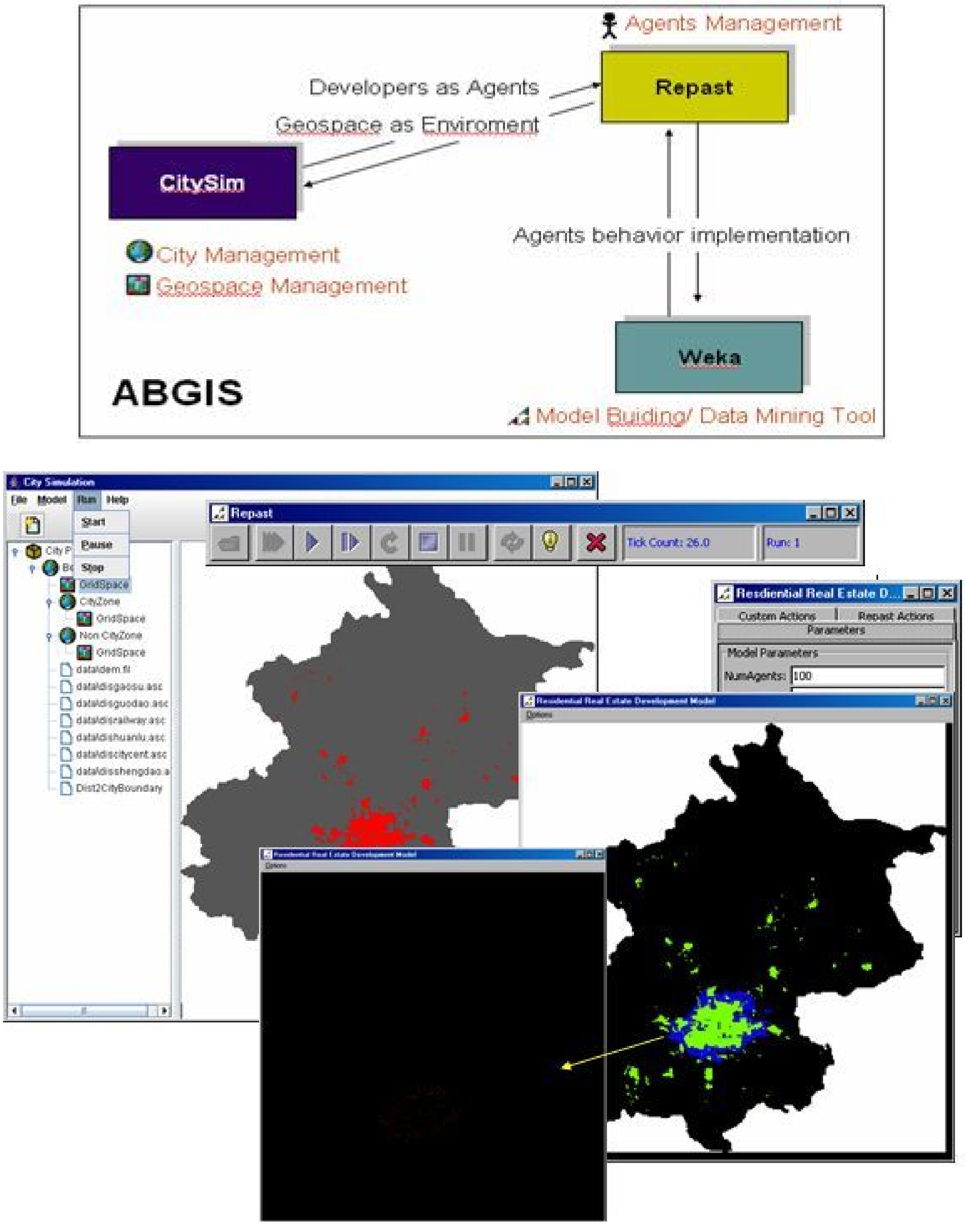


Figure 5: Prototype of agent based Simulation of real estate development

5 SIMULATING DEVELOPMENT IN BEIJING

5.1 Data Preparation

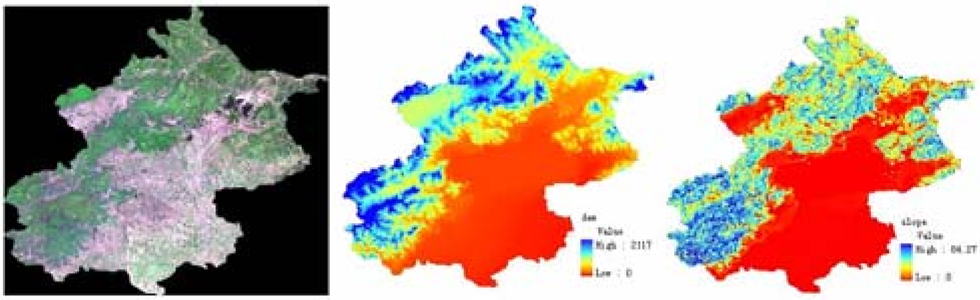
We get the data of the macro estimate model from the Statistical Yearbook of Beijing includes yearly number of developers, gross domestic product, population, real estate development area and the number of the registered enterprises from 1995 to 2005.

Year	Num. Of Developers	GDP (100 Million)	Population (10,000)	Real Estate Area (10,000 sq.m)	Num. Of Enterprises
1995	270	1394.89	1251	21910	51677
1996	304	1615.73	1296	23063	57579
1997	341	1810.09	1285	24315	64278
1998	384	2011.31	1262	25686	74391
1999	516	2174.46	1225	27430	86449
2000	864	2478.76	1382	29109	103799
2001	1345	2817.60	1383	37717	126318
2002	1771	3212.71	1395	40483	153923
2003	2122	3663.10	1407	43122	189247
2004	2369	4283.13	1421	46523	217815

Table 2: Variables for Developers

The GIS data of the distance variables are collected from the State Bureau of Surveying and Mapping (SBSM) or generated from the satellite images. The grid data (100x100m cells) of the physical environment distance and economics is prepared by using ArcGIS, Erdas and CLUE.

The physical environment data includes slope and DEM data of Beijing shown separately in figure 7 (b) and (c).



(a) (b) (c)

Figure 6: Transportation Accessibility Data (Source: SBSM)

The transportation accessibility data includes (a) Distance to Nearest Subway Station (b) Distance to Nearest Ring Road (c) Distance to Nearest Highway Entries (d) Distance to Nearest Province Road (e) Distance to Nearest National Road and (f) Distance to Nearest Railway Station in the figure 8.

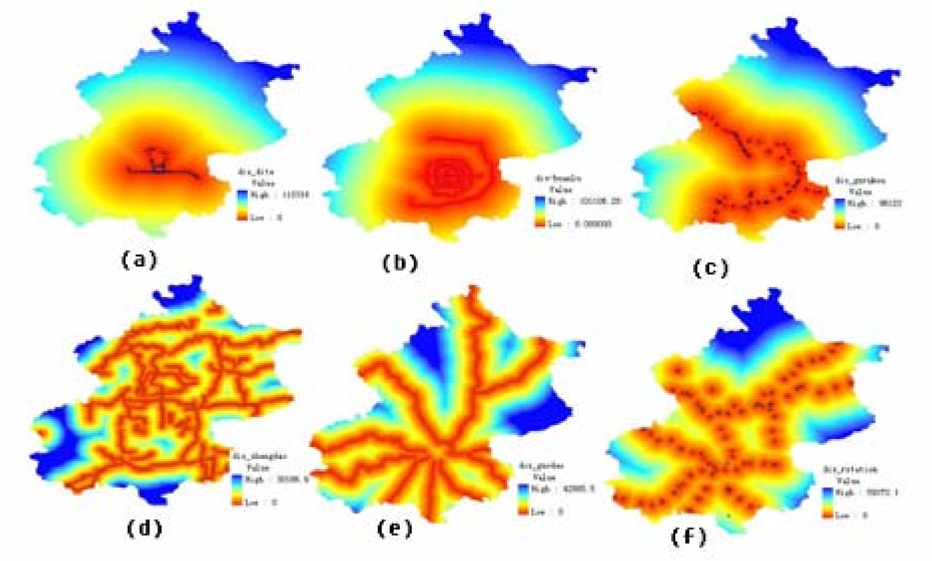


Figure 7: Transportation Accessibility Data (Source: SBSM)

The centric region accessibility data includes (a) Distance to Nearest Region Center (b) Distance to Olympic Park (c) Distance to Nearest Development Zone (d) Distance to CBD and (e) Distance to Airport.

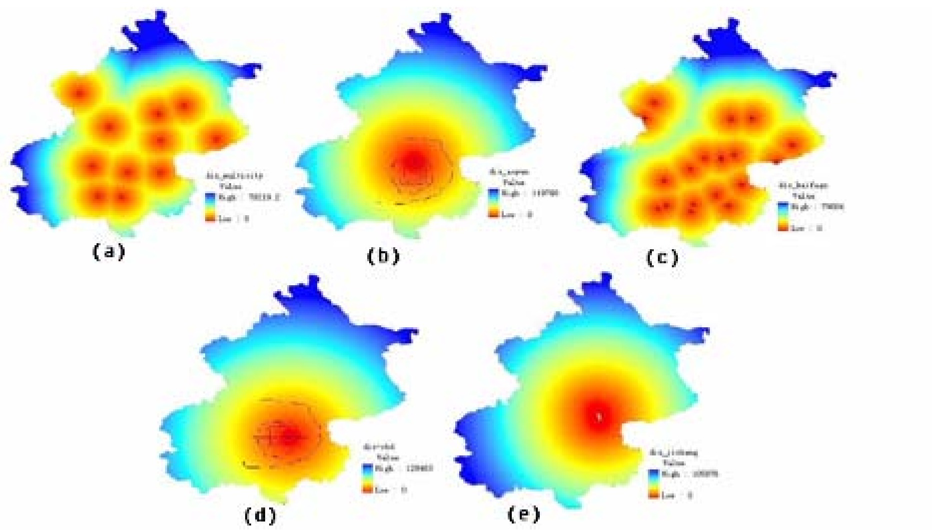


Figure 8: Economic Data (Source: SBSM)

The public service data includes the hospital, school and shop spatial information which are collected from the National Bureau of Statistics of China. (NBSC) Figure 10: (a) Distance to Nearest Hospital (b) Distance to Nearest School (c) Distance to Nearest Shop

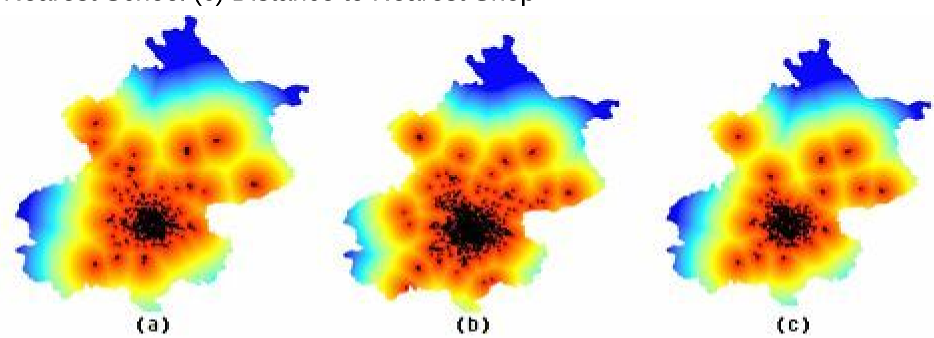


Figure 9: Public Service Data (Source: NBSC)

The economics data includes (a) Employment Density (b) Enterprise Density and (c) Business

Incoming Density in figure 11. These data are collected from the NBSC. We use the inverse distance interpolation in the spatial analysis toolkit in ArcGIS to generate these density maps.

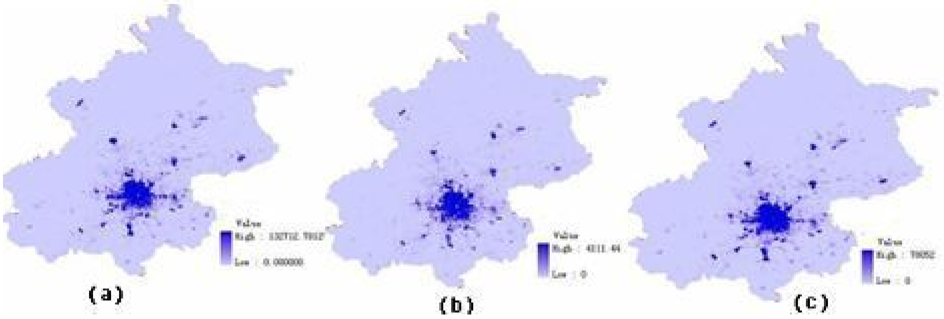


Figure 10: Economics Data (Source: NBSC)

5.2 Model Calibration and Validation

We test the macro estimated model against the history data in the table 2. The regression results are presented in the table 3. The coefficient of determination R^2 is 0.976. The significant value of all variables are less than 0.1 and the significant value of constant is near the 0.1. These coefficients are statistical significance and can be regarded as effective for the macro estimated model.

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	-13347.582	7534.267		-1.772	.120
GDP	3.603	1.091	.613	3.302	.013
Population	16.121	7.731	.387	2.085	.076

Table 3: Linear Regression Results of Macro Estimate Model

We use a modified 2-digit supervised classification schema on the TM (1995) and SPOT (2005) satellite images. The urban use area is assigned with value 1, the non-urban use area and the protected area like the Woodland, grassland and arable land, waters is assigned with value 0. Then we get the binary classification map in 1995 shown in figure 6 (a) and in 2005 shown in figure 6 (b). The red part in the figure 6 (c) shows the growth/changed urban use area in 2005 compared with 1995. These changed cells are used as the urban use sample data. We take a random sample of non-urban use cells to generate a set of similar size as the urban use samples. Given these data, we estimate the multinomial logit model for the location choice by using maximum likelihood algorithm. The regression results are presented in the table 4. The overall percentages of correctness were 84.7%, so the model can be regarded as effective for the location choice behavior for the developers.

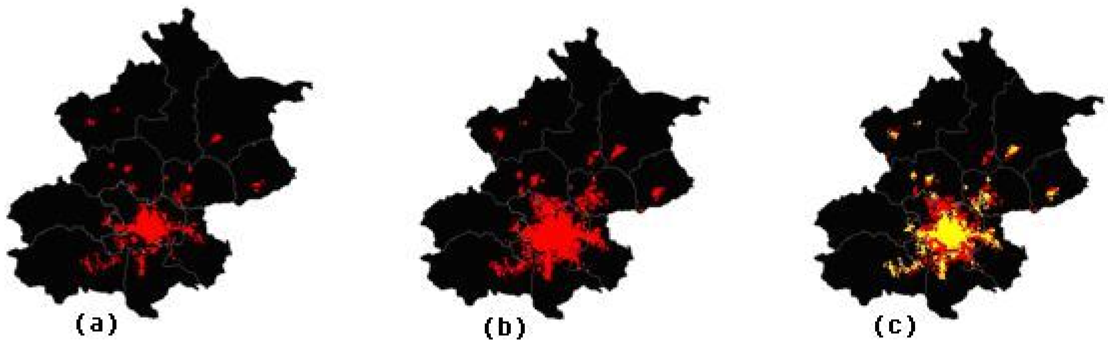


Figure 10: Binary Classification Map of Beijing

	B	S.E	Wald	df	Sig	Exp(B)	95.0%C.I.forExp(B) Lower	Upper
Slope	-0.210	0.003	4306.003	1	0.000	0.811	0.806	0.816
Dist2Subway	-0.521	0.002	54.911	1	0.000	0.985	0.981	0.989
Dist2RingRoad	-1.176	0.136	75.101	1	0.000	0.308	0.236	0.402
Dist2OlyPark	-0.017	0.002	67.209	1	0.000	0.983	0.979	0.987
Dist2Highway	-0.020	0.001	295.002	1	0.000	0.981	0.978	0.983
Dist2DevZone	-0.050	0.001	1296.154	1	0.000	0.952	0.949	0.954
Dist2CityCenter	-0.035	0.001	679.983	1	0.000	0.966	0.963	0.968
Dist2ProvRoad	-0.022	0.002	111.010	1	0.000	0.978	0.974	0.982
Business	0.001	0.000	2954.78	1	0.000	1.001	1.001	1.001
Dist2Job	-0.003	0.001	6.953	1	0.008	0.997	0.995	0.999
Constant	2.337	0.022	10989.295	1	0.000	10.348		

Table 4: Logistic Regression Results of Location Choice Model

We apply our model on the binary classification map of 1995 Beijing City, and simulate the urban growth to 2005 under the control of the macro estimated model. The predicated growth result of 2005 Beijing city is shown in the figure 11 (a). The cells of blue color have the highest calculated probability, and then the green and red. We compare the actual binary classification map of 2005 Beijing with the simulation result, and after analyze the overlay result, there are 75.5 percent matched cells in our predicated result simulated by our model. Visual inspection suggests that overall accuracy of our model is generally faithful.

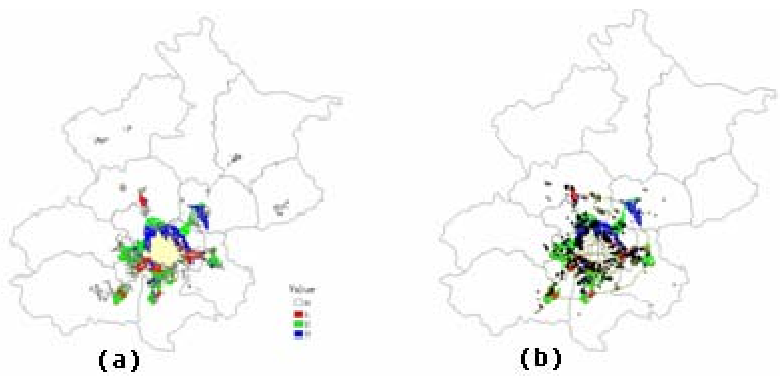


Figure 11: Predicated growth (blue/green/red) and Actual growth (black in b) in 2005

5.3 Experiment

We construct an experiment to simulate the urban growth under the context of 2008 Olympic Games. In current urban plan of Beijing two new ring roads around the city (nearly 260 kilometers) and 11 new subway lines (nearly 264.7 kilometers) will be established from 2006 to 2010. We build the new distance data and replace the old data in the specific time step, so that the agents will accept these data change into their location choice model. At the macro level, the global parameters like the growth rate of population and GDP, which are predicated by the government and also could be specified by user will fix the amount of urban change from 2006 to 2010. After running the model, the result figures below speak for themselves in illustrating how the urban growth under the context of the 2008 Beijing Olympic Games.

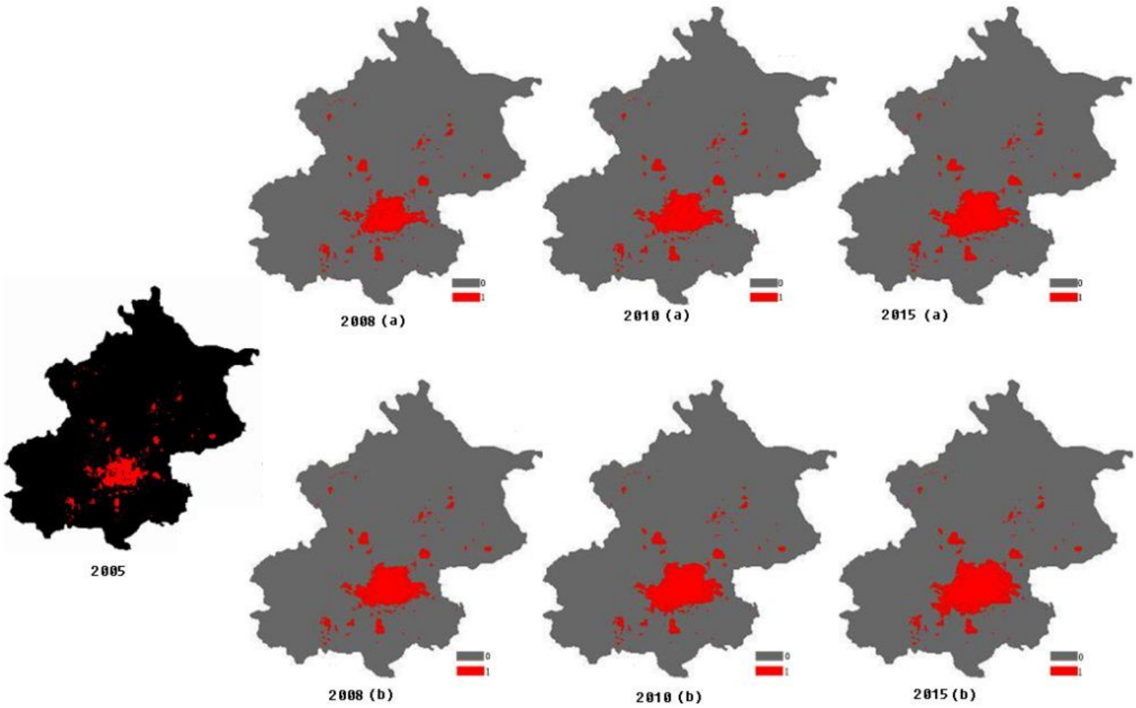


Figure 12: Urban Development through the Time Periods 2005 to 2010 under the Context of 2008 Beijing Olympic Games. (a) Without the impact of the Olympic Games (b) With the impact of Olympic Games

6 CONCLUSION

In this study, we construct an agent-based model to simulate the real estate development in Beijing metropolitan area to predict the impact of the 2008 Olympic Games on city development. We use ABM to build up a complex and interactive process of real estate developers' location choice with the site features: transportation accessibilities, public service accessibilities, amenity and so on. We use a linear regression macro estimation model to control the growth of the real estate development and operate the policies on the growth simulation. These two models in macro and micro level combine to form our agent-based real estate simulation model, which is a powerful tool for simulating the ongoing change of urban development in Beijing metropolitan area.

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