Volume 2, No. 2 (2014)

International Review for Spatial Planning and Sustainable Development

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International Review for Spatial Planning and Sustainable Development

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IRSPSD INTERNATIONAL
ISSN 2187-3666 (Online)

International Review for Spatial Planning and Sustainable Development
https://www.jstage.jst.go.jp/browse/irspsd
http://spsdpress.jimdo.com/volumes/
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SPSD

International Review for Spatial Planning and Sustainable Development

Volume 2, No. 2, 2014

SPSD Press from 2010

Editorial Board

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International review for spatial planning and sustainable development, Vol.2 No.2 (2014), 1-13
ISSN: 2187-3666 (online)
DOI: http://dx.doi.org/10.14246/irspsd.2.2_1

Planning Review: Developments and Planning Issues of Land Use Control in Suburban Areas by Local Government's Ordinances in Japan

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Received 19 Feberuary, 2013; Accepted 10 January 2014

Key words: Suburban Area, Land Use System, Development Permission Ordinance, Voluntary Ordinance

Abstract: This study aims to clarify how changes in the legal system combined with changing social, economic, and environmental pressures have affected approaches taken for land use control. Our emphasis is on how historical transitions in the legal system, particularly in the use of local government ordinances (Development Permission Ordinances and voluntary ordinances concerning land use management) have contributed to land use control in suburban areas. Our results show that because of the revision of the City Planning Law in 2000, more municipalities are introducing planned land use control in suburban areas. These are local efforts that consider the local situation. However, planned lands use has also been used to relax regulations, thereby promoting traditional growth and expansion trends. This has been especially true in the Kanto region, where development pressure is high. Therefore, it is necessary to design land use control systems that are consistent with the goals of making compact urban areas and a stable society. To do so, it is critical to clarify planning goals through public participation, evaluate the municipality's administrative abilities and applicant responsibilities, identify those developments that are to be regulated, and guide development with flexibility. It is also recommended that financial and technical support should be provided for public participation.

1. INTRODUCTION

The land use system in Japan is founded upon the zoning (hereafter "Area Division") and Development Permission System that was created under the New City Planning Law enacted in 1968. The system aims to tackle severe urban problems caused by rapid growth of population and industry, urban concentration of population and industry, and urban sprawl in suburban areas. If it is necessary, a City Planning Area is divided by Area Division into an "Urbanization Promotion Area (UPA)," in which urbanization is promoted, and an "Urbanization Control Area (UCA)," in which urbanization and land use activities are controlled through the Development Permission System. By implementing the Area Division and Development Permission System, public facilities have been mainly built in UPAs, environmental standards have been preserved, disasters have been

prevented, and convenience has been enhanced. In addition, at least in principle, developments in UCAs have been prohibited, and urban sprawl has been controlled.

However, the Development Permission System led by the central government was an institutionalized form of minimum standards applied throughout the country with the result that some municipalities have not been able to adequately control land use activities. In particular, it was not possible to control development that was not subject to the Development Permission System. This included small-scale development and non-building development, such as outdoor parking lots and material yards. Consequently, many municipalities around large cities have experienced high development pressures, leading to urban expansion without sufficient public infrastructure but with financial responsibilities that have become burdensome. Furthermore, many central cities in local regions contain Non-Area Divided City Planning Areas and regions other than City Planning Areas. In these areas, land use control is rarely implemented and various problems, including urban sprawl, have arisen.

To deal with these problems, some leading local governments began to control land use activities through voluntary ordinances and planning guidance (development rules that local government established for managing land development). In addition, with the recent trend of decentralization, the relationship between the national government and regional public agencies was re-evaluated fundamentally; this was formalized in 1999 by the "Law Concerning Provision of Related Laws for Promoting Decentralization (hereafter, the 'Omnibus Law of Municipal Sovereign Reform')." Due to the elimination of assigned functions by the central government and expansion of local government ordinance enactment rights, as well as transfers of various authorities, traditional centralized urban planning reached a turning point; thereafter, urban planning was to be mainly handled by local governments.

Along with such institutional changes, Japan entered an era of decreasing population and an aging society. The country must now shift from a traditional centralized "growth/expansion society" to a decentralized and sustainable "mature society." However, to reform the land use system, it is necessary to evaluate not only the existing uniform system but also a detailed land use control system that pertains to individual municipal situations. Such evaluations should consider gaps between the three major metropolitan areas and other local urban areas as well as differences within its own region or city. Particularly among suburban areas (mainly to UCA , a non-use-specified area in the non-Area Divided City Planning Areas and an area outside the City Planning Areas), levels of development control significantly differ, depending on the prevailing form of land use systems. Thus, in addition to common development regulations that are intended to prevent traditional sprawl, it is important to have a perspective that guides development to a regional hub and existing settlements so as to maintain and revitalize such areas.

Therefore, this study focuses on suburban areas and aims to evaluate transitions in land use systems as well as the positions/roles of local government ordinances (it refers to a combination of a delegation ordinance in accordance with the City Planning Law and the Building Standards Law, and a voluntary ordinance which a local government uniquely enacts in accordance with Section 1, Article 14 of the Local Autonomy Act). We also seek to clarify the effects and planning issues by analyzing those local government ordinances that control land use activities in suburban areas.

Existing studies that compare the land use system and its operation specified in metropolitan area of foreign countries with our country, such as Germany, England, the Netherlands, point out necessities for securing of realization of the master plan, and the mutual adjustment between different levels of governmental bodies(Ubaura,et al.,2008;Rai and Marushige, 2006).

In addition, the existing studies that investigate Japanese local government ordinances for land use control are as follows, researches that analyses designation status and actual conditions of Development Permission Ordinances within delegation ordinances (Sections 11 and 12, Article 34 of the City Planning Law) and Special Use Restricted Areas (Tsukamoto and Wada, 2005;Ohkawa, et al, 2009; Asano and Fujiwara, 2010; Kakiuchi, et al, 2010; Fujii,et al, 2009), and researches that analyzes the content, mechanisms, and actual conditions of voluntary ordinances(Uchiumi and Kobayashi,1998; Akita, et al, 2001; Akita, et al, 2003; Nozawa and Hori, 2008;Tadokoro and Kato,2011). Although there are many existing studies that analyze the content of designation of individual ordinances and their actual conditions, and evaluate operational issues and effects, few of them clarify the roles, effects, and issues of delegation and voluntary ordinances in land use systems from the perspective of local government ordinances. Therefore, this study should help clarify the advantages and limitations that can arise when local government ordinances are used to develop land use systems in a future decentralized society.

2. STUDY METHODS

We start by using the existing literature to study (a) the evolution of legal systems as they relate to suburban land use and (b) the positions adopted and roles played by local government ordinances.

To clarify designation status and actual conditions of suburban land use control by local government ordinances, this study focuses on Development Permission Ordinances on the basis of the revised City Planning Law under the enactment of the Omnibus Law of Decentralization. We also study voluntary ordinances for land use management(Uchiumi and Kobayashi,1998); these have been expanded as the ordinance enactment right. Regarding Development Permission Ordinances, this study analyzes the development permission situation after the system was established from 2001 to 2009; we compare three major metropolitan areas and other areas on the basis of Survey on Development Implementation Status (research at the end of March by Development, Planning and Research Office, City Planning Division, City and Regional Development Bureau, Ministry of Land, Infrastructure, Transport and Tourism). Regarding voluntary ordinances for land use management, this study collects examples from websites (using “Ordinance Web”) of local governments to understand the designation status; this study also analyzes actual conditions on the basis of questionnaires[7)] completed by selected municipalities. As a result 77 questionnaires were distributed and 76 were collected, which makes collection rate 99%. Using these processes, the study discusses the effectiveness and planning issues of local government ordinances.

3. TRANSITION OF LAND USE SYSTEMS IN SUBURBAN AREAS

Table 1 documents transitions in land use systems in suburban areas. Regarding the land use systems of Japan, the National Land Utilization Law was enacted in 1974 to promote comprehensive and well-planned national land use and to systemize individual laws, such as the existing City Planning Law and the Law on Establishment of Agricultural Promotion Regions. However, in reality, there are issues that are controlled by individual Laws; an example of such an issue is the specific management of those regions that are categorized as Urban Area, Agricultural Area, Forest Area, Natural Park Area, and Natural Preservation Area. Consequently, the original goal of comprehensive coordination is not working.

Table 1 Transition of Land Use Systems in Suburban Areas(Tsukamoto and Wada, 2005;Ohkawa, et al, 2009; Asano and Fujiwara, 2010; Kakiuchi, et al, 2010; Fujii,et al, 2009)

Period	Laws Related to Urban Planning	Laws Related to Agricultural Land and Decentralization
60'	◆ (New) City Planning Law <68> ・Broadening of City Planning Area, delegation of urban planning discretion, etc. ・Zoning of UPA and UCA, Development Permission System	□Law on Establishment of Agricultural Promotion Regions <69>
70'	◆Revision of Building Standards Law <70> ・Zoning improvement, introduction of floor-area ratio, abolishment of height restriction, etc. ◆Revision of City Planning Law/Revision of Building Standards Law <74> ・Application of Development Permittion System to all City Planning Areas ・Relaxation of regulation for UCA (Existing Housing Lot System, Large-scale settlements) ◆Enactment of National Land Utilization Law <74> ・Land Use Master Plan	□Revision of Agricultural Land Law <70>
80'	◆Revision of City Planning Law/ Building Standards Law <80> ・Establishment of District Planning (application to UPA) ◆Revision of City Planning Law <83> ・Reduction of planned large-scale development areas in UCA	□Revision of Agricultural Land Law <84> □Suburban Community Area Improvement Law <87> △Enactment of Law for Arranging Integrated Recreation Areas <87>
90'	◆Revision of City Planning Law <92> ・Compulsory preparation of municipal master plans, zoning improvement ・Application of District Plan in UCA, etc. ◆Revision of Building Standards Law <92> ・Minimum lot size for housing (Low-rise residential areas) ・Revision of land use regulations in UCA	◇Administrative Procedure Law <93> ◇Revision of Local Autonomy Law <94> ◇Law for Promotion of Decentralization <95> ◇Omnibus Law of Decentralization <99>
00' and after	◆Revision of City Planning Law <00> ・Introduction of Master Plan System for City Planning Area, optional system of Area Division ・Introduction of Quasi-City Planning Area and Specific usage limitation area ・Application of Development Permission Ordinances in UCA, etc. ◆Revision of City Planning Law <06> ・Restriction of site location of large-scale customer facilities, application of Development Permission for public facilities ・Abolition of large-scale Development Permission criteria in UCA, etc. ◆Revision of City Planning Law <11> ・Restict obligations and specifications by the Central Government, and delegate authorities to municipalities	□Revision of Agricultural Land Law <09> ◇Omnibus Law of Municipal Sovereign Reform <11>

* ◆Laws related to urban planning, □ Laws related to agricultural land, ◇Laws related to decentralization, △ Other related laws

Suburban areas are mainly categorized as Urban Areas, Agricultural Areas, or Forest Areas, although some areas have overlapping designations. A district designated as an Urban Area is automatically a City Planning Area, and urban land use activities can be controlled under the City Planning Law. However, if a district is only designated as an Agricultural Area or a Forest Area, regulations controlling urban land use are very limited and disorderly developments tend to occur. Furthermore, land use control under the City Planning Law focuses on Area Division and the Development Permission Systems, as described in Section 1. However, since these systems presume metropolitan cities and their surroundings or local major cities, if an adjacent city falls within an area having lax regulations, such as a non-Area Divided Area or a non-City Planning Area, development tends to

be uneven; this can become a serious issue, especially in local cities. Additionally, since the Law only targets development that includes building activities, outdoor parking lots and material yards that do not accompany building construction are excluded; this can lead to deterioration of rural areas. In light of these problems, some easing measures were introduced to reflect local characteristics, such as the application of the District Planning System (it can be used to regulate in detail building activities and neighboring public facilities such as access roads in a specified area) and the flexible operation of the Development Permission System (Such as the relaxation of development requirements of branch family housing (1982), flexible operation of Reviewing Board of Development (1985), the relaxation of Development Permission System within governor designated areas (1986), etc.) in UCA. However, in principle, uniform and centralized land use systems were implemented that follow trends toward growth and expansion.

As the Omnibus Decentralization Act came into force in 1999, the decentralization movement accelerated. Administrative functions imposed upon local governments by the central government were eliminated, various authorities were transferred to regions, and the ordinance enactment rights of local governments were expanded. Urban planning was placed at the center of decentralization reforms, and in the legal reform of 2000, Area Division was shifted to an optional system, the Quasi-City Planning Area was introduced, the Development Permission Ordinance began to be applied, and the Specific Usage Limitation Area (it can be designated in the area with no designation of Land Use Zones outside UCA and control building activities to preserve favorable living environment and avoid excessive development compared the existing public facilities) was established for land use control in suburban areas. Such changes prompted a big shift that included significantly increased municipal discretion and enabled specific system operations that recognize regional characteristics through local government ordinances. Furthermore, with enforcement of the Omnibus Law of Municipal Sovereign Reform, the legal reform in 2011 accelerated the transfer of authority to municipalities.

In this way, in response to the trend in rapid growth and expansion, the centralized land use regulations with uniform and even minimum criteria played a role in controlling sprawl and in building public facilities. Nevertheless, such regulations have also contributed to various issues, such as those accompanying the increasing age of the contemporary population. These issues require a flexible land use system that considers local situations. The positions, roles, and actual conditions of local government ordinances that have emerged from the recent decentralization are evaluated in the following sections.

4. ENACTMENT BACKGROUND AND ACTUAL CONDITIONS OF DELEGATION ORDINANCES

4.1 Enactment Background and Roles of Delegation Ordinances

Table 2 shows the delegation provisions in laws related to urban planning. Before the revision of the City Planning Law in accordance with

the Omnibus Decentralization Law (2000), authorities of local governments were limited to such activities as holding hearings for District Planning proposals and operating the City Planning Committee and the Reviewing Board of Development. Local governments did not have powers for specifying restrictions on urban planning. However, after the revision, the discretion of local governments was expanded so that local government ordinances could set specific criteria on the basis of the City Planning Law. Especially in suburban areas, Development Permission Ordinances (by Sections 11 and 12, Article 34 of the City Planning Law) can ordain measures that grant permission for development in UCAs. Moreover, Specific Usage Limitation Areas were established for land use control in non-Area Divided Areas; this allows local governments to define target districts and allocate permitted building usage. In this way, laws define the content to be stipulated, while each local government is able to define specific contents and to design a system that corresponds to the regional situation.

Table 2. List of Delegation Provisions Related to City Planning

Basic Law	Relevant Law	Contents of Restriction	Ordinance Enactment
A City Planning Law			
Article 16, Section 3		Oerating of Pulic Hearing for proposals for District Planning, etc.	municipality
Article 33, Section 3		Relaxation and tightening of technical items of Development Permission	municipality
Article 33, Section 4		Minimum lot area of a building in development districts	municipality
Article 33, Section 5		Application of restrictions of developments defined in a Landscape Plan	Landscape Administrative Body
Article 34, Section 1-11		Relaxation of developments in UCA (1)	prefecture, designated citiy, etc.
Article 34, Section 1-12		Relaxation of developments in UCA (2)	prefecture, designated citiy, etc.
Article 58		Regulations on buildings in Scenic Area	prefecture, municipality
Article 75, Section 2		Collection of appointee fees	municipality
Article 77		Operation of Prefectural City Planning Council	prefecture
Article 77, Section 2		Operation of municipality City Planning Council	municipality
Article 78, Section 8		Operation of Reviewing Board of Development	prefecture
B Law of Zoning and District	Building Standard Law		
Special Land Use Districts	Article 49	Restriction of land uses of Special Land Use Districts	municipality
Specific Usage Limitation Area	Article 49-2	Restrictions of land uses in areas without land use zoningn	municipality
Land Use Zone	Article 50	Restrictions of building structure in Land Use Zoning	municipality
Aesthetic area	Article 68	Restrictions necessary for preserving aesthetic in Aesthetic Area	municipality
Preservation District	Article 85-2	Relaxation of Building Standard Law in Preservation District	municipality

Source: Added and revised by the authors based on References(Mizuguchi, 1997;Kobayashi, 1999; Kawakami, et al ,2010)

4.2 Actual Conditions of Land Use Control by Delegation Ordinances

Among delegation ordinances that control suburban land use, this section studies the actual conditions of Development Permission Ordinances for UCAs. Figure 1 shows permitted developments after the legal reform from 2001 to 2009. First, the annual number of permitted developments was approximately 20,000–25,000, and the annual total area was 5,000–8,000 ha (An applicable development for permission is more than 1,000m^2 in UPA, all developments in UCA and development more than 3,000m^2 in non-Area

Divided Area). Regarding development permissions in UCAs, the average permit percentage over the same period was 53% in all developments and 29% in all developed land area, showing increasing trends in both number and area.

Since development permissions in UCAs are granted on the basis of location criteria defined in Article 34, the results (Figure 2) show that most developments were those defined in Section 14, which were examined by the Reviewing Board of Development (81% of all development numbers and 66% of all developed areas) in 2001, just after the legal reform. Thereafter, development permissions by the Development Permission Ordinances by Sections 11 and 12 gradually increased, and the permitted number by Section 11 reached 33% and those by Section 12 reached 30% in 2009. This was due to the transfer of relevant development from Section 14 to Section 12, which covers stylized development and is not necessarily required to be reviewed by a Reviewing Board of Development. In addition, each local government enacted ordinances to utilize Section 11 as an alternative measure replacing the former Existing Housing Lot System. Existing Housing Lot System was established so as to protect the property rights of inhabitants in UCA. Anyone who has an Existing Housing Lot can develop a land lot without Development Permission, where it was confirmed to have already become the residential land in UCA when it was defined as in UCA. Furthermore, large-scale developments that exceed 10 ha and are permitted by Section 10 (District Planning) gradually increased in recent years, although their numbers remain relatively small.

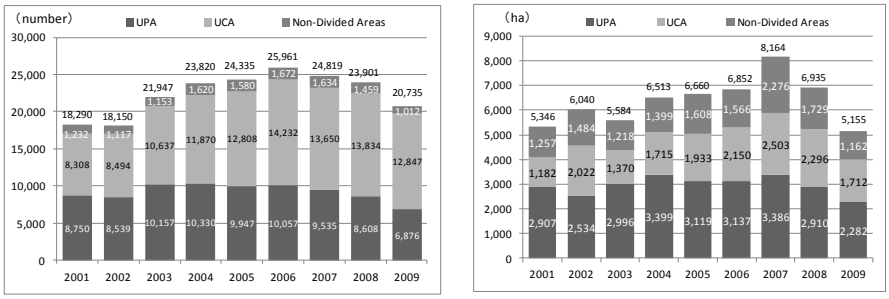

Figure 1. Permitted Development in Each District
(Left: Number of DevelopmentS, Right: Area)

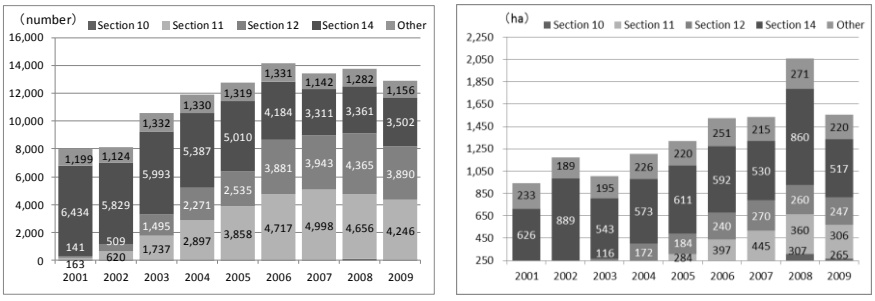

Figure 2. Permitted Development by Article 34 in UCA
(Left: Number of DevelopmentS, Right: Area)

The permitted number by Development Permission Ordinances in urban areas (Figure 3) indicates that permits were mostly given (approximately 60%) in Metropolitan areas. Compared to other prefectures, the number is particularly high in Saitama Prefecture and its designated cities, accounting for approximately 40%. Outside the three metropolitan urban areas, Ibaraki Prefecture and Tochigi Prefecture show large numbers of permits and areas, indicating that the ordinances are especially utilized in areas in the Kanto region, which is under high development pressure. In

Kawagoe City of Saitama Prefecture, the permits by Section 11 were 825 and 85 ha during the same period. Since the development of suburbs significantly increased, agricultural lands and forest areas decreased, and water quality in rivers deteriorated because of poor sewage systems; consequently, Kawagoe City abolished the ordinance in October 2011. Therefore, it is important to pay attention to the level of development pressure and the permitted development regulated by ordinances because its level and contents might encourage sprawl in UCAs.

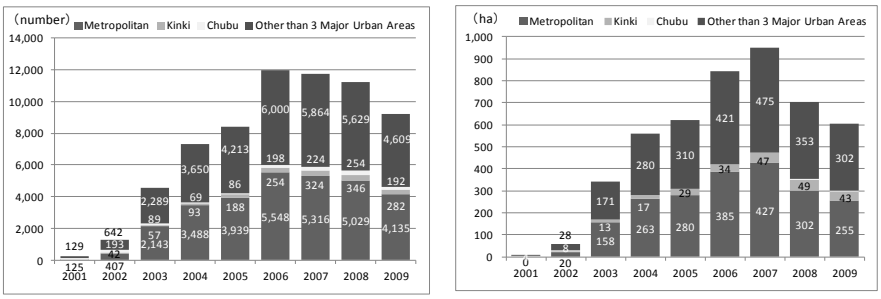

Figure 3. Permitted Development in Urban Area by Development Permission Ordinances (Left: Number of DevelopmentS, Right: Area)

Source: Added and revised by the authors based on Reference (Kobayashi, 2003)

5. ENACTMENT BACKGROUND AND OPERATIONAL CONDITIONS OF VOLUNTARY ORDINANCES FOR LAND USE CONTROL

5.1 Enactment Background and Roles of Voluntary Ordinances for Land Use Control

Although the delegation ordinances in the previous section were intended to materialize the City Planning Law within its defined scopes and subjects, real-world town planning must address the needs of diverse stakeholders as well as address diverse issues concerning cross-sectional fields. When such needs and issues exceed the scope and subject of the Law, delegation ordinances reveal their limitations. Therefore, comprehensive voluntary ordinances have been enacted on the basis of originality and ingenuity of local governments.

The enactment of voluntary ordinances in urban planning started in the 60s as a complement to the development permission criteria for housing development. In the 70s, ordinances were developed to protect the living environment and environmental quality against medium-and high-rise buildings. In the 80s, ordinances were intended to enhance landscapes, including the preservation and protection of historic sites, and to develop public participation by the establishment of the District Planning system. In the 90s, ordinances responded to resort development in areas that relaxed regulations by related laws (Referred to References(Kobayashi, 1999; Kawakami, et al,2010; Kobayashi, 2003;Uchida, 2010). After 2000, because of the expansion of the ordinance enactment rights in accordance with the Omnibus Decentralization Law, comprehensive voluntary ordinances, including delegation and related ordinances, have been enacted. Additionally, diverse ordinances have been enacted, such as penalty

regulations to ensure its effectiveness and clarification of the roles and responsibilities of citizens, administrations, and business owners.

Next, focusing on voluntary ordinances for land use control, ordinances originating from the "Guideline for Regulating Housing Development" and introduced as a supplement for the Development Permission System, were enacted to improve housing standards, meet the increasing demand for housing, and relieve increasing costs for providing infrastructure. Originally, the administrative guidance based on this Guideline had no legal grounds. However, since consultation with a public facility administrator was necessary for the developer to obtain development permission, the Guideline was actually used as a permit requirement. Thus, the Guideline had virtual legal force. Later, since the Guideline could be set down within administrative discretion and was easy to adopt, its application expanded throughout the country. However, the Administrative Procedures Act of 1993 required that the Guideline must convert to an ordinance to make its regulations and responsibilities clear. In addition, in 1995, "Instruction on Re-Evaluating the Guideline for Regulation of Development of Housing," which was a notice by the former Ministry of Construction, demanded that the legal system be followed, excessive guidance be corrected, and fairness and transparency be ensured. Thus, the Guidelines were gradually incorporated into ordinances in each local government.

Since development outside the legal planning system, such as non-building development and small-scale development, does not require any development permission, such development cannot be controlled by the City Planning Law. Therefore, in targeting such development, some ordinances were established to provide a mechanism for shifting such developments into a class that suits a regional situation through prior consultation and coordination. In addition, ordinances that define a mechanism for public participation by establishing District Planning, which incorporates the enhanced intention of residents toward urban environment, have increased. In recent years, comprehensive ordinances have increased to systematize related ordinances.

5.2 Actual Situation of Land Use Control through Voluntary Ordinances for Land Use Management

According to the designation status of 76 voluntary ordinances for land use management, which were surveyed using a questionnaire (Figure 4), between 1981 and 1999—a period before the enactment of the Omnibus Decentralization Law—the number of designations was 13. Between 2000 and 2011 after its enactment, the number increased about five times to 63. Similar to the Development Permission Ordinances, the number of enacted ordinances is highest in the Kanto region where there are high pressures for development; the number in the Kanto region accounts for half the total. Among local governments outside the three metropolitan urban areas, ordinances have been enacted in diverse local governments regardless of size, including large-scale local governments—such as Sendai City, Hamamatsu City, and Kanazawa City—and small-scale local governments—such as Hikawa Town in Kumamoto Prefecture.

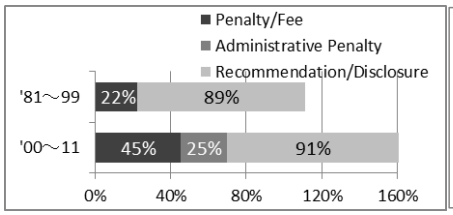

Figure 4. Enactment Area of Ordinances

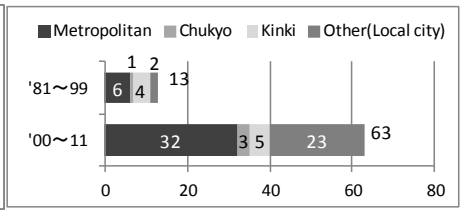

Figure 5. Regulations relating penalties in Ordinances

According to the number of applications and approvals/permits concerning prior consultation in accordance with ordinances (Table 3), local governments with less than 10 applications per year account for 41% (25 local governments), local governments with 50–100 applications account for 26% (16 local governments), and those with more than 100 applications account for 8% (five local governments). Thus, there are differences in scope and content covered by the ordinances. In about half of local governments, one or two applications per year were withdrawn by developers after prior consultations. Approximately 10% of local governments made decisions not to approve or permit in order to reject developments that did not suit their regions. It is assumed that, as indicated in Figure 5, traditional ordinances ~~only~~ had only weak powers, such as admonishment and public notice against developers who did not follow guidance, but by expanding ordinance enactment rights, enforceable ordinances have been increasing in recent years; these ordinances include regulations, such as administrative directions and penalties, when developers are in violation.

Table 3. Average Number of Applications and Their Results Annually

The number of the answer local governments(%)

	Application		Authorization		Withdrawn		Not Authorized	
0 per year	4	7%	5	8%	26	43%	53	87%
1, 2 per year	7	11%	7	11%	29	48%	8	13%
2 - 10 per year	14	23%	15	25%	4	7%	0	0%
10 - 20 per year	4	7%	5	8%	2	3%	0	0%
20 - 50 per year	11	18%	9	15%	0	0%	0	0%
50 - 100 per year	16	26%	15	25%	0	0%	0	0%
100 per year or more	5	8%	5	8%	0	0%	0	0%
Total	61	100%	61	100%	61	100%	61	100%

As to the effects of ordinances (Figure 6), more than 50% of local governments cite “enforcement of regulations appropriately and guide of developments of non-subjected to laws effectively,” recognizing that the ordinances not only supplement laws but also regulate and guide development that is suitable to a regional situation. In addition, there were various opinions, such as by establishing a system of public participation, residents’ awareness toward urban environment will increase and policies and their reasoning to urban planning described in the Master Plan will become clear.

However, some respondents raised concerns about the ordinances (Figure 7); for example, procedures from application to approval are prolonged, and administrative workloads are increased not only for applicants but also for local government officials. Furthermore, development not subject to ordinances could become an obstacle to integrated land use control. Therefore, it is necessary to clarify urban planning goals through public participation, evaluate municipal and applicant responsibilities, and

clearly understand that developments should be regulated and guided with flexibility. Furthermore, some opinions show that public participation mechanisms, although prepared, have not been implemented. Therefore, it is important to incorporate financial support for public participation activities as well as providing professional technical support.

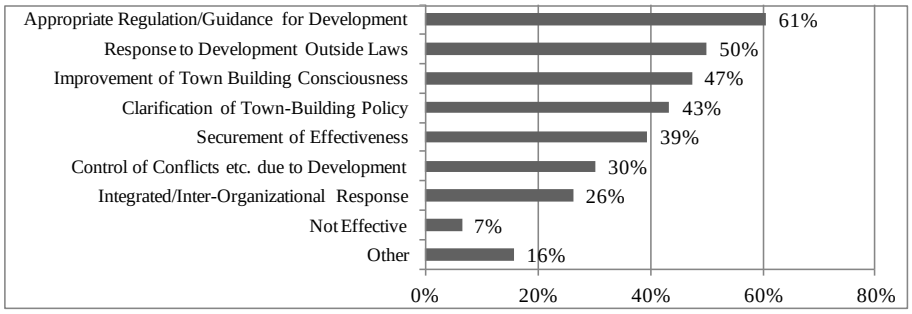

Figure 6. Effects of Ordinances

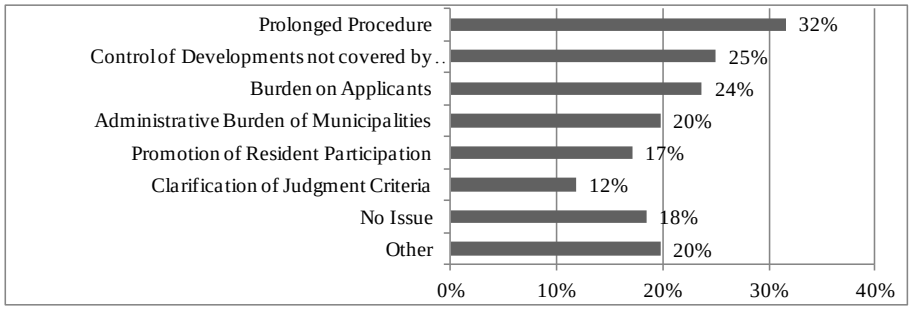

Figure 7. Issues of Ordinances

6. EFFECTS AND PLANNING ISSUES OF LAND USE CONTROL BY LOCAL GOVERNMENT ORDINANCES

The findings of this study on the effects of suburban land use control by local government ordinances and planning issues are summarized as follows.

(1) Effects and issues of land use control by local government ordinances

Since traditional urban planning in the growth/expansion society was required to respond to rapid urbanization, centralized land use regulations with uniform, fair, and minimum criteria were mainly adopted through the Area Division and Development Permission System. However, that traditional system was limited in its ability to respond to more recent changes in society, such as progress decreases in population and diverse local issues.

The legal reform in 2000 promoted decentralization of urban planning powers, and enabled local governments to enact ordinances, including specific regulations that started well-planned land use control in their suburban areas. However, in practice, Development Permission Ordinances, which are typical delegation ordinances for controlling suburban land use, have been used to ease existing regulations in a manner that is consistent with a growth/expansion-oriented society. Such usage is predominant in the Kanto region, which is experiencing high development pressure. A well-planned system design and operation are needed. Therefore, as pointed out

in the existing studies, prefecture government should make the adjustment over a wide area taking account of the intention of the relating municipality.

Voluntary ordinances have the benefit of not only supplementing laws but also guiding development to suit a regional situation, provided there is public participation and prior consultation. However, a more detailed procedure will result in more work to be done by local governments and residents. Then, a balance must be found. In addition, although mechanisms for public participation have been provided, actual activities have not always been implemented. Thus it is necessary to provide financial and technical support for implementation.

(2) Future Land Use Control by Local Government Ordinances

In traditional urban planning, suburban areas were essentially considered to be controlled by development regulations that guided development into urban areas, such as UPAs. However, in today's society where population has been decreasing and communities in rural settlements are increasingly facing difficulties in sustaining, it is thought that local government ordinances can be used to guide development activities into a hub area, such as an existing settlement. In such an approach, it is essential to formulate future planning that considers land use, industries, transportation, and welfare. It is also important to develop an appropriate planning system that suits each local situation. For example, planning must address not only land use systems, such as Development Permission Ordinances and voluntary ordinances, but also cross-sectional issues that promote reorganized living environments, which could be operated in an integrated manner under local government ordinances. Such cross-sectional measures may include prioritizing the maintenance and management of infrastructure, housing policies using "Outstanding Rural Housing System," transportation policies, such as community bus operation, and welfare policies, such as community development through drafting related plans.

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International review for spatial planning and sustainable development, Vol.2 No.2 (2014), 14-38
ISSN: 2187-3666 (online)
DOI: http://dx.doi.org/10.14246/irspsd.2.2_14

Understanding Beijing's Moving Urban Fringe through a Spatial Equilibrium Model

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Received 13 November, 2013; Accepted 26 January 2014

Key words: Computable General Equilibrium, Spatial Modelling, Urban Fringe, Urban Form, Policy Appraisal, Greenbelt, Green wedges

Abstract: The growth of the main built-up area of Beijing is characterised by a pancake like expansion, from 100 km^2 in 1950 to 1210 km^2 in 2005 in successive waves. The approach to future urban expansion will require careful consideration, as economic, environmental and social conflicts at the urban fringe have intensified. Two successive greenbelts have been designated to contain expansion and engender more compact growth. However, the first greenbelt has not been achieved successfully and many areas designated as the second greenbelt is facing implementation challenges. This paper builds on existing research into greenbelt policy implementation and investigates the impacts of alternative urban growth boundary proposals under a systematic modelling framework. It reviews the theoretical insights into growth at the urban fringe, and puts forward a methodology that links development at the urban fringe to the functioning of the entire metropolitan area. It outlines six alternative development scenarios that encompass the existing planning proposals for the urban fringe: trend growth, densification, stringent greenbelt, loose greenbelt, hybrid controls, and green wedges. We use a prototypical spatial equilibrium model to quantify the performance of the development scenarios in terms of production costs, consumer welfare, wages, floorspace rents, and commuting times. The analyses suggest that the physical forms of fringe area development do significantly affect the economic performance of the whole municipality. Alternative proposals, including those that have rarely considered in the past, should be investigated carefully in this light, in conjunction with related studies on social and environmental impacts of urban fringe development.

1. INTRODUCTION

1.1 Background and motivations of the paper

Urban form policies can have important impacts on local environmental quality, economy, and social equity (Echenique et al., 2012). A fringe of a city is a transitional zone where urban land use and rural land use mix and clash. Typically, this is the area where the bulk of new construction takes place, and it therefore plays a crucial role in shaping the city. There have been many attempts to control the development of the urban fringe for a variety of policy objectives. There is a wide variety of planning strategies.

For example, in the UK greenbelt policies have existed for more than 60 years to control the ribbon development and sprawl of London and many other cities (Hall, 1973); urban growth boundary policies have a long tradition in the United States (Staley, 1999; Jun, 2004).

This historic perspective of 50-60 years of past implementations is an enormous resource for planners in fast urbanising, emerging economies. It has the potential to make the complex planning tasks somewhat easier in the fast growing cities today. However, planners in the emerging economies are often discouraged by the fact that policies from the developed country cities such as the greenbelt policy do not seem to lead to the same historic outcomes (e.g. planned greenbelts do not seem to work). Furthermore, even if the policies have achieved the same outcomes today (e.g. the greenbelt policy has contained urban growth), how could we be confident that the same outcome in an entirely different era and socio-economic context is beneficial to the city?

In this regard, Beijing is a typical example of cities encountering such challenges. In the past 60 years, with rapid economic growth, the annual population growth rate in Beijing has reached 3.8% and overall population has reached 19.6 million in 2011 (National Bureau of Statistics of China, 2011). The built-up area has been expanding rapidly from 100.2 km^2 in 1950 to 1210.2 km^2 in 2005 (Ai et al., 2008) following a concentric pattern of expansion (Figure 1).

Figure 1. Expansion of built-up area of Beijing 1951-2005 (Source: Wu, 2010)

Although in Beijing Master Plan 2004-2020 it states clearly that Beijing should abandon the mono-centric sprawl pattern and make a transition into a polycentric pattern, this pancake-like expansion has not shown any signs of abating since this policy was launched. In order to tackle the sprawl pattern, two successive greenbelt policies have been put forward (Beijing Municipal Government, 1994, 2003). The First Beijing Greenbelt policy was introduced in 1994. 125 km^2 of green areas around the fourth ring-road of Beijing were designated as the First Beijing Greenbelt. However, the urban

expansion in the mid to late 1990s spread across this designated greenbelt land. The total built-up area within the designated First Greenbelt increased from 33.3% in 1993 to 49% in 2005, with a corresponding decrease in the green area from 66.7% to 44.3% (Han and Long, 2010). The Second Beijing Greenbelt was introduced in 2003 with a designation of 1556 km^2 of green areas between the fifth and sixth ring-roads. However, new construction within the designated area appears to continue. The greenbelt as a standard instrument for controlling fringe growth in so many cities in the developed countries, including London, Paris, Ottawa, Ontario, Seoul, Frankfurt, Vienna and so on, seems particularly difficult to achieve in Beijing (Figure 2).

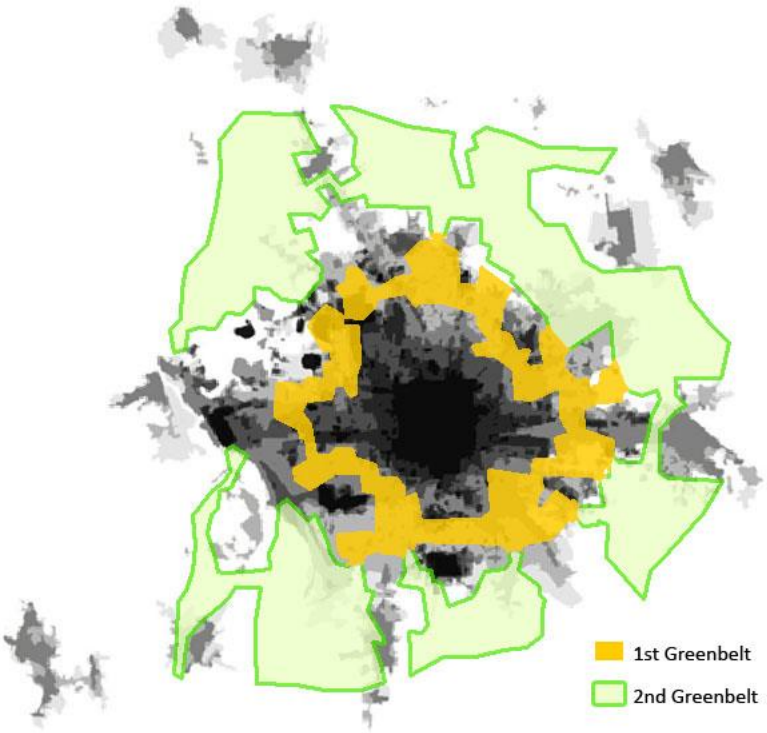

Figure 2. Greenbelt boundaries (drawn by the authors)

It goes without saying that greenbelt designation is not the only planning instrument to control urban growth. The planners in Beijing have explored a wide variety of alternative polices, for example Wu (2010) has identified the Tokyo approach (i.e. densification of the main city) and the Paris approach (i.e. large and intensive suburban new towns) as alternative strategies to the greenbelt proposal.

1.2 Evaluate impacts of urban form policies on the whole municipality

Preferred by many physical planners, Beijing's greenbelt policy is a mainstay of government policy. Current analyses of this policy emphasise the difficulties of putting it into practice: government is facing challenge of providing displaced farmers adequate social welfare (Fu, 2010; Ji, 2011); it is becoming extraordinarily expensive to remove villages and compensate farmers (Fu, 2010); it is extremely hard to control the land use within the

greenbelt, for example, there were criticisms that land within the greenbelt was actually used for luxury villas which are developed under the pretext of golf courses (Tan, 2008; Du, 2011); The housing estates to accommodate displaced farmers are far from adequate (Tan, 2008).

However, these criticisms tend to focus on the immediate issues that are hampering the progress of the greenbelt implementation, and there are relatively few studies that relate the role of the greenbelt and the overall impact of urban growth in Beijing. Of course, the impacts of a greenbelt are felt keenly by the residents and workers within the area. Their homes, livelihood, and future work prospects will all change. What is less discussed is the fact that there may be even greater consequences on the growth, prosperity and welfare of the whole municipality. There are several reasons for examining the wider impacts. First, greenbelt limits the land supply of the main city – it acts as an urban growth boundary at a time when the city is facing high pressures of population and business growth, and huge demand for housing. Secondly, for those people who live beyond the greenbelt, commuting time increases if they still work in the city centre. Congestion happens frequently on roads connecting the city centre and the towns beyond the greenbelt.

Additionally, few of the existing critiques analysed economic outputs of a greenbelt in a quantitative assessment, such as land value, wage and production cost and consumer utility. Comparison of welfares with and without greenbelt is descriptive. Amenity value of a greenbelt is investigated in a qualitative way. There has been no mathematical relation established between Beijing's greenbelt policy and indices regarding economic efficiency. Therefore it is necessary to evaluate existing policies comprehensively within a broader context in a quantitative way and this methodology should also be applied to evaluate other urban fringe development policies.

1.3 Modelling urban fringe development policies

Urban models are often used to predict policy performances in urban planning in developed countries. Some of them provide insights into the complex interactions in the development process and help to evaluate long-term effects of policies. In particular, there have been many studies to model the development of the urban fringe.

Some existing researches focused on the impacts of greenbelt on fringe land prices. Lee and Linneman (1998) analysed the amenity effects of greenbelt over time on land market of Seoul and also examined the impact of land prices due to land supply restriction by using an empirical hedonic model. Knaap (1985) measured the effects of Portland greenbelt on land price by introducing a partial equilibrium model. This model describes the effects of a greenbelt on urban and nonurban land values, the demarcation of where zoning changes and future urban development may take place (Knaap, 1985). Both models emphasised amenity value of greenbelt and its impact on land value; however, both static models ignored human behaviour responding to the fringe control policy.

Lee and Fujita (1997) examined the relationships between the types of amenities generated by a greenbelt and the efficient location of a greenbelt by using Herbert-Stevens model (Herbert and Stevens, 1960). By modelling behaviour and purpose of players, the authors calculate the optimal provision of a greenbelt, subject to utility, land supply and population

constraint. This mono-centric model was a partial equilibrium model and had not shown economic interactions geographically.

Besides mono-centric partial equilibrium models, researchers developed multi-centric spatial equilibrium models to describe urban moving boundaries, focusing on the relationships between urban economy, activity location and spatial costs.

A general equilibrium model was developed by Anas and Xu in 1999 (Anas and Xu, 1999) to test policy performance on urban form: will congestion tolls lead to a dispersed or centralised pattern? This model analyses consumers and producers' responses of location choice to tolls based on the principle of minimising costs and maximising utility. In an equilibrium condition, wages, prices of products and rent can be computed and compared in different scenarios. Model results show that centralising effects dominate on dispersing effects of tolls. It also implies that congestion tolls can shape compact urban pattern efficiently and affect the whole urban economic system. In 2007 Anas and Liu developed the general equilibrium model into RELU-TRAN model to explain the behaviour of supply, demand and price in a city area with several or many interacting markets (Anas and Liu, 2007).

Based on the general equilibrium model, Anas and Rhee wrote up two articles (Anas and Rhee, 2006; Anas and Rhee, 2007) to compare performance of stringent urban fringe growth control versus congestion tolls. Both articles cast doubts on stringent policies of controlling urban fringe sprawl. Anas and Rhee (2006) juxtaposed congestion tolls and urban boundaries as two alternative policies for eliminating sprawl. They got conclusion that in dispersed city a boundary of any stringency is absolutely harmful. Anas and Rhee (2007) established a dual-centric prototypical model and claimed that if there is cross-commuting between city and suburb, congestion tolls can shrink city size by relocating economic activities while boundaries of any stringency can be inefficient.

As shown in the story, not only land price and players' behaviour, but also activities location and urban economy in response to the fringe land use policies can all be modelled in a quantitative way. Models have involved from partial equilibrium to general equilibrium, so that impacts of a policy on every aspect mentioned above could be tested rigorously.

In this paper, we will use a recursive spatial equilibrium model (RSE Model) (Jin, Echenique, Hargreaves, 2013) to test the performance of urban fringe land use policies of Beijing. This model is being developed in Martin Centre for Architectural and Urban Studies, University of Cambridge and shares some similar characteristics with Anas' model. Moreover, it fills the gap of existing models: it can not only examine impacts of policies on economic indices in individual time period, but also examine dynamics of people and investment in response to economic indices. Data required from this model is more approachable, and most cities already have them, for example, census and input-output table. Details of this model could be found in Jin, Echenique, Hargreaves (2013).

1.4 Aims of the paper

We propose in this paper a generic modelling methodology that helps the economic and physical planners to understand and quantify the main effects of urban fringe development and control policies. The computer model that underlies this methodology can incorporate the socio-economic and infrastructure context of the city when calculating the main costs and

benefits of the alternative development strategies. This means that it is possible to assess the planning strategies more precisely in terms of the planned location and intensity of development – not only between the main archetypical alternatives (such as the Tokyo, Paris and London models), but also variants within each main alternatives. The modelling in this paper will be focused on the economic performance of the planning strategies, and it can be extended in future work to cover social and environmental performance. Section 2 proposes a spatial equilibrium model to test spatial options for cities, in order to quantify the impacts of policy levers on urban activities. Section 3 applies the model to the case of Beijing and provides quantitative modelling results. Then model simulation results are compared pair-wise in section 4. In this way, the strengths and weaknesses of each policy option are outlined through quantified evidence. Section 5 presents preliminary conclusions of the research.

2. MODEL DESIGN

In this section, we will propose a generic framework to predict and compare economic performance of large scale urban land use development initiatives, including both the variants of the greenbelt and alternative strategies. We first outline the model structure, and then explain the components of the model.

2.1 Model structure

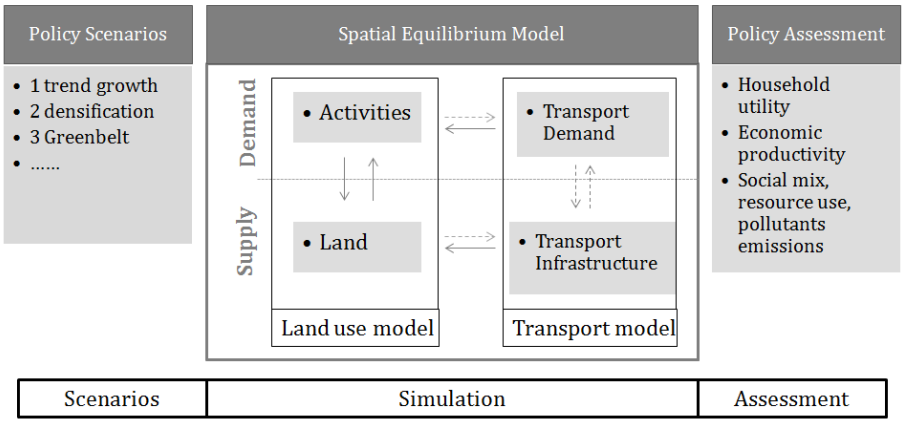

Figure 3. Model structure (drawn by the authors; based on Echenique et al., 2010)

As summarised in Figure 3, firstly, scenarios are identified to explore the policy trend and alternative urban forms. Then the spatial equilibrium model is applied to forecast the likely locational and travel behaviour of households and firms in response to the introduction of policies (Echenique et al., 2010). Finally, modelling outcomes are assessed through economic productivity and household utility.

The spatial equilibrium model focuses on the macro level simulation and explores interactions between urban activities, transport demand, land supply and infrastructure supply. On the demand side, urban activities generate transport demand so that people and goods can move within and between different zones, which also affect urban activities. On the supply

side, land supply incorporates with transport and infrastructure supply. There are interactions linking supply side and demand side until an equilibrium reaches. Traditionally, trips generated by land pattern will be substituted into the transport model while transport model will generate updated travel time, cost and distance which will be feedbacks for land use model. In this way, a feedback loop is formed.

However, this paper only focuses on examining the land use side of spatial equilibrium and transport model is used as an exogenous input. Trips generated from land use model will not be used as endogenous inputs for transport model based on a general assumption that the municipality will do its best to maintain the average peak time travel speeds on the transport network so that they don't radically change from base year. The dash arrow lines between the two sub-models in the picture above show this approach.

As mentioned in section 1.3, the Matlab code of the RSE Model (Jin, Echenique, Hargreaves, 2013) will be applied for simulation. However in this paper, we only use the spatial equilibrium part of the RSE Model, examining and comparing equilibrate results from individual time periods. The recursive part of the RSE Model would be left for future test. Therefore, we investigate equilibrium in different time horizons. Model will be calibrated using base year t data and parameters maintain for the year t+30 in order to function the model and predict outputs in 30 years. No inflation is counted over time.

2.2 Spatial Equilibrium Model

2.2.1 Land use model

In order to simplify the model and show preliminary rules, the authors set up several preconditions:

There are two types of players, namely producer and consumer in this model. There are no government and developer, so consumers do not have to pay tax and all rent dividends is shared equally among households. The self-sufficient city consumes everything it produces so imports and exports have not been taken into consideration yet. The city is divided into zones and land use model reveals interaction among zones.

Producers

Producers can choose any zone to locate. The output function of a certain industrial type r in a zone j is:

$$X_{rj} = E_{rj} K^{\nu} \left(\sum_{\forall f} L_{rjf}^{\theta}\right)^{\frac{\delta}{\theta}} \left(\sum_{\forall b} B_{rjb}^{\xi_1}\right)^{\frac{\omega}{\xi_1}} \prod_{\forall r} \left(\sum_{\forall j} Y_{rj}^{\varepsilon}\right)^{\frac{\tau}{\varepsilon}}$$

In this hybrid Cobb-Douglas CES function, primary inputs are capital K, labour force L, industrial floorspace B and intermediate goods Y. E is scale parameter. This function is rendered constant returns by $\nu+\delta+\omega+\tau=1$. Assuming the city produces only one kind of conceptual goods and service by one type of industry, the intermediate goods are not calculated and therefore $\tau=0$ and r=1. The influence of capital is currently not calculated in our model so $\nu=0$. We did not classify labours types therefore f=1. b represents the number of office building types.

Consumers

Consumers can work in any zone, live in any zone and purchase goods in any zone. Each consumer first decides where to be employed. Then he chooses where to reside and do shopping among zones. Assuming there are Q residential housing types. After he decides all the location-related choices, he will choose how many floorspace he would like to rent, how many hours to contribute to work and how many retail goods to buy. For a consumer who lives in a type Q residential building in zone i, works in zone j and shops in zone k, the utility is represented as:

$$U_{ijk} = \alpha \ln\left(\sum_{\forall k} Z_{ijk}^{\eta_f}\right)^{\frac{1}{\eta}} + \beta \ln\left(\sum_{\forall Q} q_{rjQ}^{\xi_2}\right)^{\frac{1}{\xi_2}} + \gamma \ln L_{leisure_{ij}} + \mu_{ij}$$

Z is the total amount of goods and service a consumer can consume; q is the floor area of his residential place and $L_{leisure}$ is the total leisure time a consumer has in a year, where $1/(1-\eta)$ and $1/(1-\xi_2)$ are respectively the elasticity of substitution between any two retail goods and any two types of housing. μ_{ij} is an idiosyncratic utilities which represents unobserved factors. Since we already set up a precondition that there is only one type of conceptual goods and service, $\eta=1$. $\alpha+\beta+\gamma=1$.

Locational choice

In order to derive the probability of locational choice, a logit model is adopted by specifying the distribution of the idiosyncratic utilities. Assuming μ_{ij} is Gumbel distribution with dispersion parameter λ, the probability P of locational choice can be derived through a discrete choice logit model:

$$P_{ij} = \frac{\exp(\lambda U_{ij})}{\sum_{\forall(st)} \exp(\lambda U_{st})}$$

$$\sum_{\forall(ij)} P_{ij} = 1$$

This probability function can be applied when calculating the probability of consumer's preference of where to buy goods and also where to live and work. It can also compute labour source distribution for producers. The living-working zone pair reveals the spatial distribution of a city.

2.2.2 Transport model

In this paper, as mentioned in section 2.1, transport model is an external component. All the transport information deduced from transport model are used as exogenous inputs for land use model, but outputs regarding transport from land use model will not be feedbacks for transport model yet.

Exogenous transport inputs for land use model include zone to zone travel time, distance and generalised cost. These inputs are utilised when calculating travel disutility, delivered price and deriving utility for consumers and economic mass. Travel disutility T_d is represented as the travel cost plus the value of time in the whole year. Delivered price P_d is mill price plus transport cost.

$$T_d = \eta \times T \times (0.01 \times c + w \times t / 60)$$

$$P_d = 2 \times f_{ratio} \times (0.01 \times c + w \times t / 60) + P_m$$

T is the total number of trips per year. c is travel cost, w is wage and t is travel time. P_d stands for delivered price while P_m stands for mill price. η and f_{ratio} are scaling multipliers.

2.2.3 Spatial equilibrium conditions

We assume that all consumers maximise utility and all producers minimise costs. The model is to find an optimised condition that consumers and producers could both maximise benefit, subject to floorspace constraints. A zero profit condition will be set for producers in an open competitive market. The market is zero excess demands, which means zero excess demand in labour market and product market.

Then in labour market, total working hours equals total hours minus commuting and shopping travel time. In product market, total goods and service equals total goods and service consumed by households.

2.3 Assessment of outputs

The model outputs will show the average economic productivity and household utility under different policy trends and these economic indices can also be presented in quantities in zones, including total productions, product price, wages, rents, household utility and economic mass.

The overall consumer surplus in the city region as a household well-being measure may be defined as the change in average household utility divided by the average marginal utility of money (Jin, Echenique, Hargreaves, 2013).

$$\Delta CS = \frac{U_A - U_B}{\frac{1}{2}\left(\frac{1}{\Omega_A} + \frac{1}{\Omega_B}\right)}$$

Where U is household utility and Ω is household time-money budget in base year B and alternative scenarios year A.

3. CASE STUDY

In this section, we apply the Matlab code of the RSE Model incorporating equations above to test alternative policies in the fringe area of Beijing.

3.1 Model parameterisation

There are already established models which gave us references for parameter values. We also conducted tests for some parameters based on statistical data from Beijing. The following table lists the model parameters that have been specified in the equations.

Table 1. Parameters used in the model

Model parameters	Comment	values	Sources
δ	Labour cost share for producers	0.86	Beijing I-O Table, 2000
ω	Business floorspace cost share for producers	0.14	Beijing I-O Table, 2000
ξ_1	Business floorspace variety effects	0.9	Jin, Echenique and Hargreaves, 2013
ξ_2	Housing variety effects	0.9	Jin, Echenique and Hargreaves, 2013
E_{rj}	Residual total factor productivity multiplier	1	Assumed: urban agglomeration effects not considered at this stage of the study
α	Household utility parameter for goods and service	0.36	Beijing Statistic Yearbook, 2001
β	Household utility parameter for housing space	0.14	Beijing Statistic Yearbook, 2001
γ	Household utility parameter for leisure time	0.5	Assumed by the authors
λ	Scale parameter for locational choice	1	Jin, Echenique and Hargreaves, 2013
N	Total number of working days per year	250	Ministry of Labour and Social Security, 2008
H	Hours per day	24	
η	Ratio of travel disutility in the cost of travel	0.5	Own calibration that determines the η according to the observed mean commuting travel distance and times.
f_{ratio}	Ratio of cost of delivering a unit of conceptual goods and service in a commuting trip	0.1	Assumed by the authors

3.2 Prototypical model

A 12-zone prototypical model is adopted in order to simplify policy trends. Urbanised area locates in the centre with a radius of 15 km. A township locates in a distance of 30 km from the urban core, beyond farmland. This prototypical model is divided into 6 zones in each side. Zone 1 is the central city with a radius of 4km. Zone 2 is the inner city while zone 3 is the outer city. Zone 4 is preserved as greenbelt zone with dispersed built-up land. Zone 5 is a satellite town. Zone 6 represents an open-end wider hinterland symbolically. Zone 7-12 represent the same types symmetrically. Pink dots stand for centres of zones, where population concentrates. Dimensions in metre are shown in the picture below.

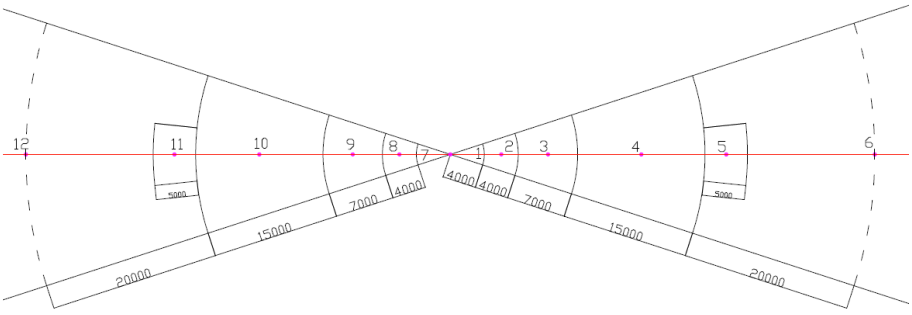

Figure 4. Prototypical model zoning (drawn by the authors)

The prototypical model can then evolve into a model representing situations of Beijing. We classified districts of Beijing into 6 types of city characters according to the prototypical model: the old city centre, inner city, outer city, greenbelt, townships and hinterland. Then data regarding households, floorspace, travel time and distance can be obtained according to this classification.

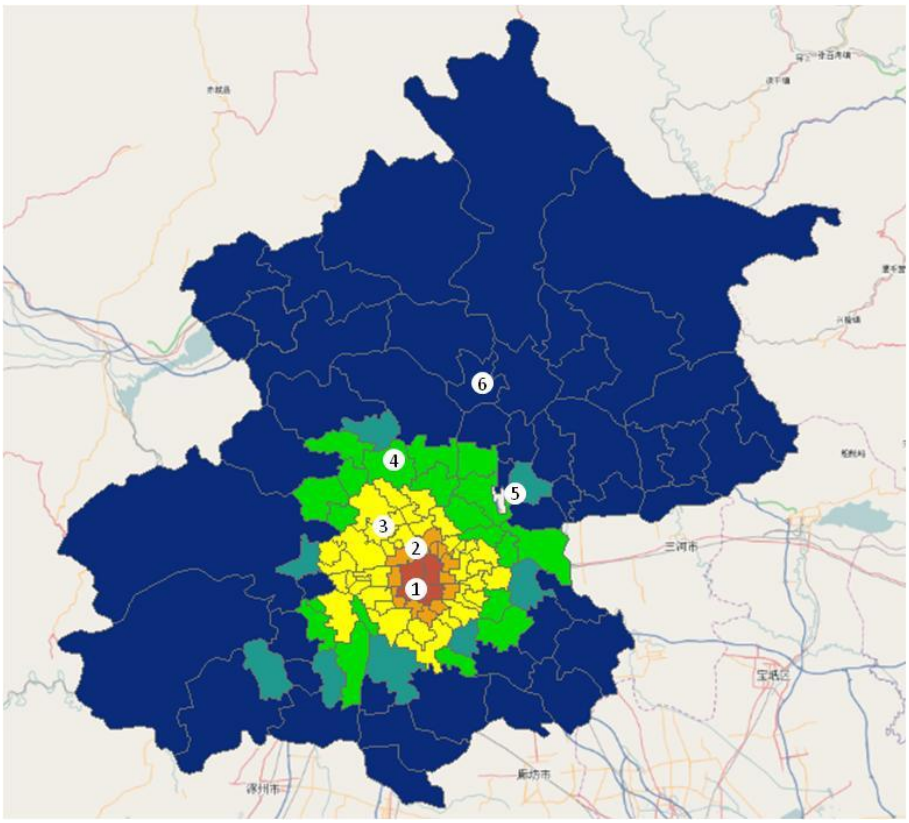

Figure 5. Zone classification of Beijing

We use 2000 as base year to calibrate the model and then run the model for year 2030.

From 2000 to 2010 the total number of population increased by about 1.6 times and we assume from 2010 to 2030, the population number will increase by another 1.5 times. Meanwhile, we assume family size will shrink from 3.1 persons to 2.3 persons per household. Then the total number of

household in 2030 will be 3.2 times as many as that in 2000. The total number of household is 4075110 in 2000 and 13000000 in 2030 according to this demographic projection.

In 2000, each household provided 1.7 workers and this number will drop to 1.3 in 2030. We then calculate the total number of jobs and see an increase about 2.5 times through year, from 6900000 to 16900000.

GDP is assumed to increase by 4 times in 2030 compared with 2000, which implies a growth rate of 4.7% per year from 2010 to 2030 (this is compared with the current growth rate of 8%). It follows that the average money income per household in real terms will increase 1.25 times, from 60000 RMB in 2000 to 75000 RMB in 2030[1]. The model operates in real rather than nominal prices, net of inflation.

Table 2. Demographic settings in base year 2000 and predicted year 2030

Year	2000	2030
Total number of household	4075110	13000000
Total number of jobs	6900000	16900000
GDP	G	4G
Workers per household	1.7	1.3
Income per household (RMB)	60000	75000
Persons per household	3.1	2.3

3.3 Scenario design

There are 6 possible policy scenarios for year 2030. The six scenarios have the same demographic settings for year 2030: the same number of household and jobs, and the same family size and income. Differences are represented only in the total amount and the location of housing and business floorspace supply.

1. Trend growth is to continue current trend of expansion, which indicates massive growth in the outer city, townships and hinterland meanwhile natural growth in the centre city, inner city and greenbelt. This scenario assumes that there is no specific planning policy which is put forward to deal with current expansion pattern.

2. Densification scenario is to increase density in the existing built-up area of the main city. This scenario is based on the concept of anti-sprawl compact city.

3. Greenbelt 1 scenario is to implement a stringent greenbelt. New development will concentrate in new towns beyond the greenbelt and greenbelt land is strictly controlled with zero growth. This scenario is developed from current greenbelt policy with the assertion in Beijing's master plan (Beijing Municipal Government, 2004) of new towns development.

4. Greenbelt 2 scenario is to implement a relatively loose greenbelt. Although still assuming zero growth in the designated greenbelt area, development is allowed in not only new towns but also in city and hinterland. This scenario focuses mainly on the greenbelt land control part and leaves the new town development part tested in greenbelt 1 scenario.

[1] Note that this accounts for both the wages and income from investments (represented by property rents in the model). The increase in household income accounts for both the projected increases in wage and rent income per person (from 35000 to 57700), as well as the reduction in household size (from 3.1 persons per household to 2.3 persons per household).

5. Hybrid control scenario is a combination of densification and loose greenbelt. One side of the city follows a compact pattern and the rest implements a loose greenbelt. Because the expansion of Beijing is likely to be uneven in reality, this scenario tests the existence of mixed development strategies and their implementation.

6. The green wedges scenario breaks the continuity of greenbelt into green patches and allows population concentrating around transport nodes in the greenbelt area. Beijing municipal government is striving to construct railway transit and undergrounds and this scenario comes from this TOD concept.

The table below lists the total number of households and floorspace in each scenario. The following pictures 6-12 show the land use intensity in zones. The darker the colour is, the more intensive the land is used.

Table 3. Constraints in scenarios

Year	Scenario	Total floorspace (housing A+ business B)
2000	Base year	A+B
2030	Trend growth	3.2A+2.5B
2030	Densification	2.7A+2.25B
2030	Greenbelt1	3.2A+2.5B
2030	Greenbelt2	3.2A+2.5B
2030	Hybrid control	2.95A+2.375B
2030	Green Wedges	3.2A+2.5B

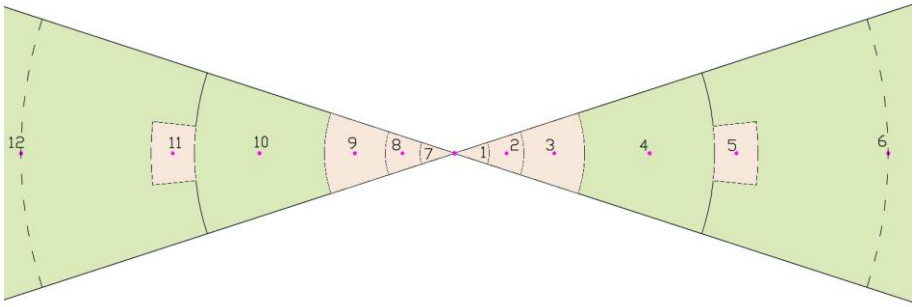

Figure 6. Base year 2000 zonal land use intensity

In the trend growth scenario, the floorspace of central city, inner city and greenbelt, namely zone 1, 2, 4, 7, 8, 10, will increase naturally, for both housing space and business floorspace. Here we define 50% of the total floorspace nature growth. Meanwhile, the floorspace of outer city, townships and hinterland, namely zone 3, 5, 6, 9, 11, 12, will increase more than their natural growth amount, because these areas are currently popular to new development and this trend will continue.

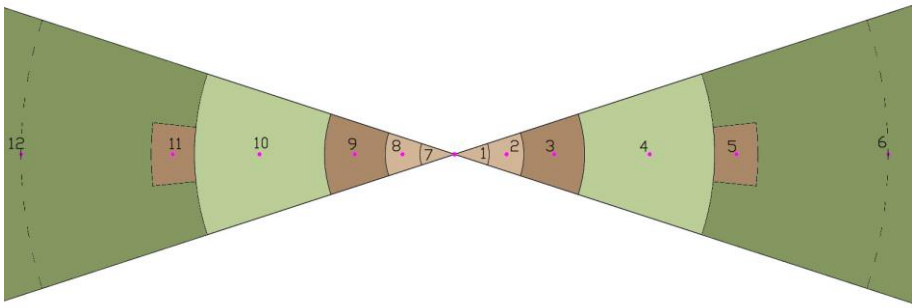

Figure 7. Trend growth 2030 zonal land use intensity

Densification scenario is to confine all new development within main city to control urban sprawl. However, it is not possible to control all the development so we allow 50% of the total built-up floorspace as natural growth in every zone. Then we add the rest constrained growth into zone 1-3 and 7-9 proportionally. Travel time within and between zone 1-3 and 7-9 will then correspondingly increase by 5 to 25 minutes.

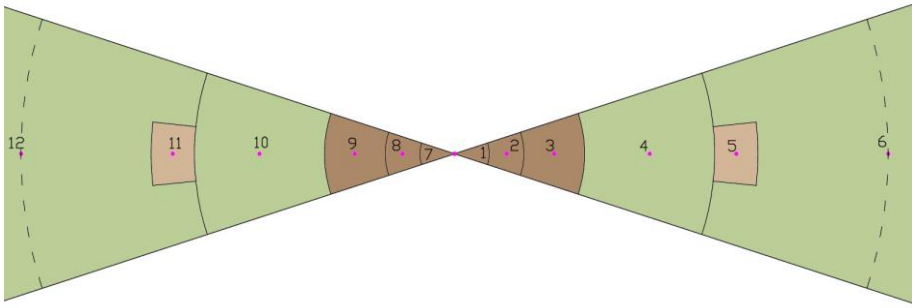

Figure 8. Densification 2030 zonal land use intensity

The Greenbelt 1 scenario is a stringent greenbelt scenario which is to confine the existing boundary of main city and put new development in satellite towns. Similarly, we control the development in zone 1-3, 6, 7-9, 12 and only allow natural growth in these zones. There is zero growth in the greenbelt zones 4 and 10. Then the rest new development will happen in zone 5 and 11. Travel time within satellite towns subsequently increases by 5 minutes. Interzonal travel time increases by 10-20 minutes.

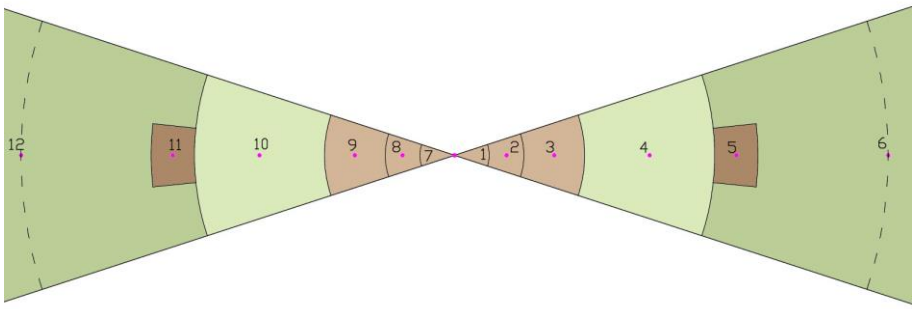

Figure 9. Greenbelt 1 2030 zonal land use intensity

The Greenbelt 2 scenario is a relatively loose greenbelt scenario. In this scenario, growths in zone 1-3, 6, 7-9, 12 are not controlled so the total

floorspace increase proportionally. Zone 4 and 10 is still strictly controlled as greenbelt. Zone 5 and 11 not only proportionally increase floorspace but also absorb the developments which are supposed to be in zone 4 and 10. Intrazonal travel time subsequently increases by 5 minutes while interzonal travel time increases by 10-20 minutes.

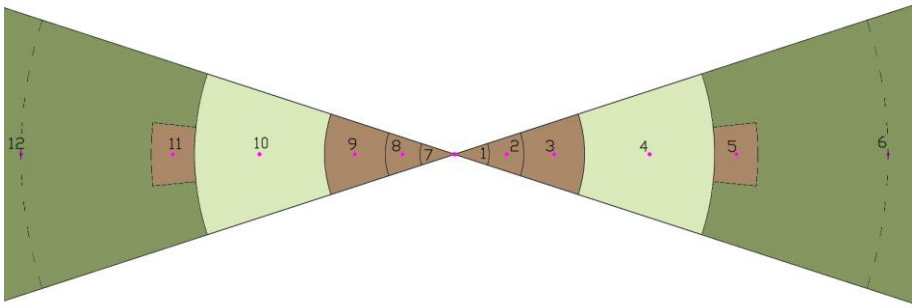

Figure 10. Greenbelt 2 2030 zonal land use intensity

The hybrid control scenario combines densification with the loose greenbelt, as it follows the nature constraint of Beijing: the west of the municipality is a mountainous area and the east is plain. Zone 1-6 is consistent with the pattern of densification scenario. Zone 7-12 is consistent with the pattern of greenbelt 2 scenario.

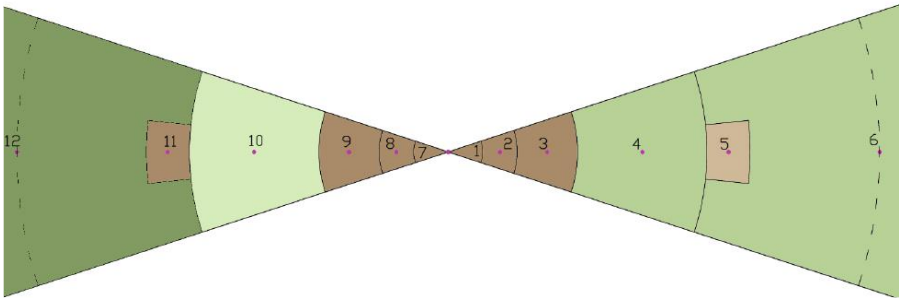

Figure 11. Hybrid control 2030 zonal land use intensity

The green wedges scenario breaks the greenbelt into wedges by allowing new development to happen in the greenbelt zone, around transport node. Nature growth happens in every zone while planned growth happens in not only the satellite towns but the greenbelt zones, namely zone 4, 5, 10 and 11. In zone 4 and 10, new development concentrates around the centroids, which are the transport nodes, and leaves the rest as green wedges. Therefore average travel time decreases in zone 4 and 10 accordingly.

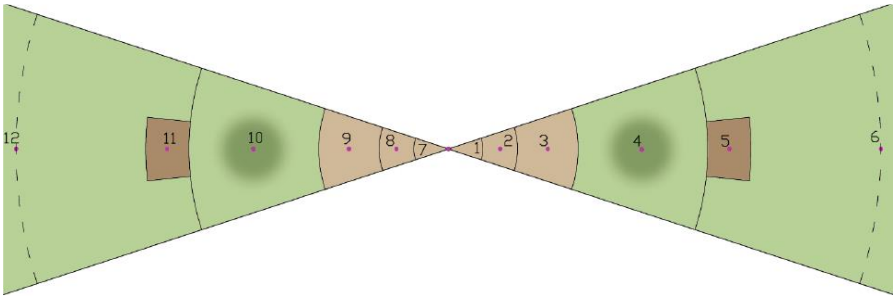

Figure 12. Green wedges 2030 zonal land use intensity

Housing space and business floorspace constraint equations are summarised in the following table.

Table 4. Constraints of zones under base year and 4 scenarios

2000 Base	Housing space	Business floorspace
zone	Total A	Total B
1	A_1	B_1
2	A_2	B_2
3	A_3	B_3
4	A_4	B_4
5	A_5	B_5
6	A_6	B_6
7	A_7	B_7
8	A_8	B_8
9	A_9	B_9
10	A_{10}	B_{10}
11	A_{11}	B_{11}
12	A_{12}	B_{12}
2030 Trend growth	Housing space	Business floorspace
zone	Total 3.2A	Total 2.5B
1	$1.6A_1$	$1.25B_1$
2	$1.6A_2$	$1.25B_2$
3	$1.6A_3+F_3$	$1.25B_3+G_3$
4	$1.6A_4$	$1.25B_4$
5	$1.6A_5+F_5$	$1.25B_5+G_5$
6	$1.6A_6+F_6$	$1.25B_6+G_6$
7	$1.6A_7$	$1.25B_7$
8	$1.6A_8$	$1.25B_8$
9	$1.6A_9+F_9$	$1.25B_9+G_9$
10	$1.6A_{10}$	$1.25B_{10}$
11	$1.6A_{11}+F_{11}$	$1.25B_{11}+G_{11}$
12	$1.6A_{12}+F_{12}$	$1.25B_{12}+G_{12}$
$F_3+F_5+F_6+F_9+F_{11}+F_{12}=1.6A$		$G_3+G_5+G_6+G_9+G_{11}+G_{12}=1.25B$
2030 Densification	Housing space	Business floorspace
zone	Total 2.7A	Total 2. 25B
1	$1.6A_1+F_1$	$1.25B_1+G_1$
2	$1.6A_2+F_2$	$1.25B_2+G_2$
3	$1.6A_3+F_3$	$1.25B_3+G_3$
4	$1.6A_4$	$1.25B_4$
5	$1.6A_5$	$1.25B_5$
6	$1.6A_6$	$1.25B_6$
7	$1.6A_7+F_7$	$1.25B_7+G_7$
8	$1.6A_8+F_8$	$1.25B_8+G_8$
9	$1.6A_9+F_9$	$1.25B_9+G_9$
10	$1.6A_{10}$	$1.25B_{10}$
11	$1.6A_{11}$	$1.25B_{11}$
12	$1.6A_{12}$	$1.25B_{12}$
$F_1+F_2+F_3+F_7+F_8+F_9=1.1A$		$G_1+G_2+G_3+G_7+G_8+G_9=1B$
2030 GB 1	Housing space	Business floorspace
zone	Total 3.2A	Total 2.5B
1	$1.6A_1$	$1.25B_1$
2	$1.6A_2$	$1.25B_2$
3	$1.6A_3$	$1.25B_3$
4	A_4	B_4
5	$1.6A_5+0.6\ A_4+F_5$	$1.25B_5+0.25\ B_4+G_5$
6	$1.6A_6$	$1.25B_6$
7	$1.6A_7$	$1.25B_7$
8	$1.6A_8$	$1.25B_8$
9	$1.6A_9$	$1.25B_9$
10	A_{10}	B_{10}
11	$1.6A_{11}+0.6\ A_{10}+F_{11}$	$1.25B_{11}+0.25\ B_{10}+G_{11}$
12	$1.6A_{12}$	$1.25B_{12}$
$F_5+F_{11}=1.6A$		$G_5+G_{11}=1.25B$

2030 GB 2	Housing space	Business floorspace
zone	Total 3.2A	Total 2.5B
1	$3.2A_1$	$2.5B_1$
2	$3.2A_2$	$2.5B_2$
3	$3.2A_3$	$2.5B_3$
4	A_4	B_4
5	$3.2A_5$+2.2 A_4	$2.5B_5$+1.5 B_4
6	$3.2A_6$	$2.5B_6$
7	$3.2A_7$	$2.5B_7$
8	$3.2A_8$	$2.5B_8$
9	$3.2A_9$	$2.5B_9$
10	A_{10}	B_{10}
11	$3.2A_{11}$+2.2 A_{10}	$2.5B_{11}$+1.5 B_{10}
12	$3.2A_{12}$	$2.5B_{12}$
2030 Hybrid control	Housing space	Business floorspace
Zone	Total 2.95A	Total 2.375B
1	$1.6A_1+F_1$	$1.25B_1+G_1$
2	$1.6A_2+F_2$	$1.25B_2+G_2$
3	$1.6A_3+F_3$	$1.25B_3+G_3$
4	$1.6A_4$	$1.25B_4$
5	$1.6A_5$	$1.25B_5$
6	$1.6A_6$	$1.25B_6$
7	$3.2A_7$	$2.5B_7$
8	$3.2A_8$	$2.5B_8$
9	$3.2A_9$	$2.5B_9$
10	A_{10}	B_{10}
11	$3.2A_{11}$+2.2A_{10}	$2.5B_{11}$+1.5 B_{10}
12	$3.2A_{12}$	$2.5B_{12}$
$F_1+F_2+F_3=0.55A$	$G_1+G_2+G_3=0.5B$	
2030 Green wedges	Housing space	Business floorspace
Zone	Total 3.2A	Total 2.5B
1	$1.6A_1$	$1.25B_1$
2	$1.6A_2$	$1.25B_2$
3	$1.6A_3$	$1.25B_3$
4	$1.6A_4+F_4$	$1.25B_4+G_4$
5	$1.6A_5+F_5$	$1.25B_5+G_5$
6	$1.6A_6$	$1.25B_6$
7	$1.6A_7$	$1.25B_7$
8	$1.6A_8$	$1.25B_8$
9	$1.6A_9$	$1.25B_9$
10	$1.6A_{10}+F_{10}$	$1.25B_{10}+G_{10}$
11	$1.6A_{11}+F_{11}$	$1.25B_{11}+G_{11}$
12	$1.6A_{12}$	$1.25B_{12}$
$F_4+F_5+F_{10}+F_{11}=1.6A$	$G_4+G_5+G_{10}+G_{11}=1.25B$	

3.4 Model runs

We make the following assumptions in this initial version of the model: there is only one type of household; one type of goods; there are 2 types of housing and 2 types of business floorspace. In this model, different types of buildings have same area of floorspace supply.

3.4.1 Model runs for base year 2000 for Beijing

We first run the model in base year 2000 using parameters in Table 1. We input travel matrices and floorspace constraints based on the observed data of Beijing. The solution of the model in terms of the total demands for housing and business floorspace will match the input supply constraints at equilibrium. Constraints in zone 1-12 are summarised in the following chart.

Table 5. Floorspace constraints for base year 2000

Zone	housing space (million sqm)		business floorspace (million sqm)	
	Type 1	Type 2	Type 1	Type 2
1	7.4	7.4	6.0	6.0
2	10.6	10.6	5.7	5.7
3	16.3	16.3	9.2	9.2
4	3.8	3.8	2.3	2.3
5	6.4	6.4	4.1	4.1
6	17.9	17.9	7.3	7.3
7	7.4	7.4	6.0	6.0
8	10.6	10.6	5.7	5.7
9	16.3	16.3	9.2	9.2
10	3.8	3.8	2.3	2.3
11	6.4	6.4	4.1	4.1
12	17.9	17.9	7.3	7.3

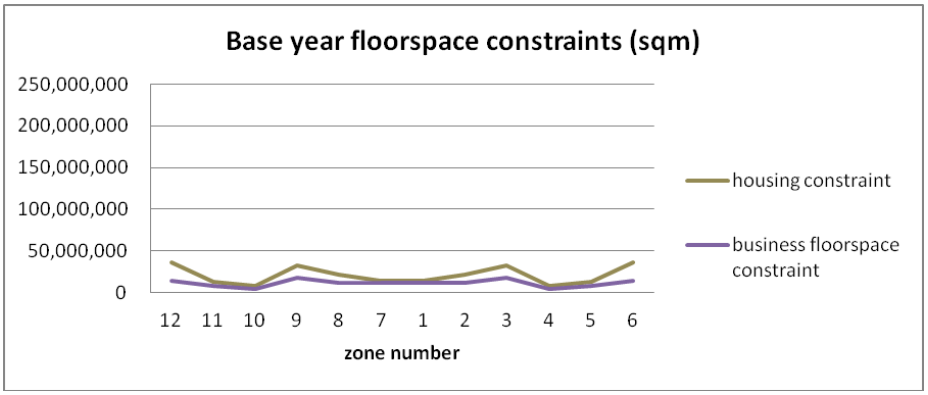

Figure 13. Base year floorspace constraints

The model will output prices, wages, rents, household utilities and industry production in zones. It will also show the locational distribution of households and jobs.

3.4.2 Model runs for 6 scenarios 2030

We then run the model under 6 scenarios in year 2030. Following equations in Table 4, we input zonal constraints for different scenarios based on Beijing's case. Floorspace constraints in each zone to each scenario are summarised in the following pictures and also in appendix.

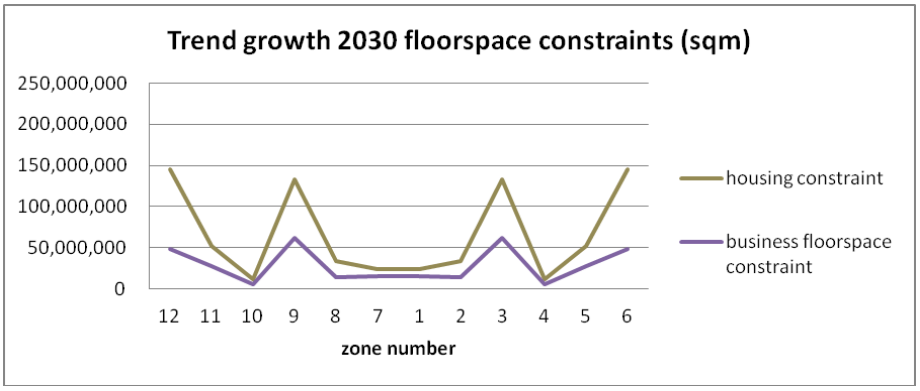

Figure 14. Trend growth 2030 scenario floorspace constraints

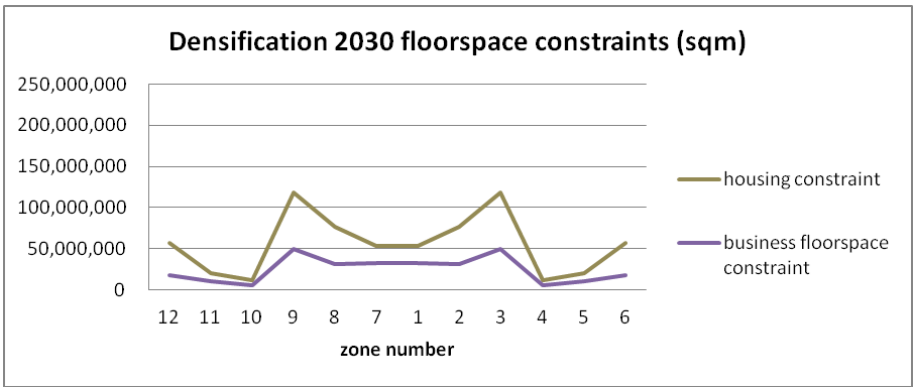

Figure 15. Densification 2030 scenario floorspace constraints

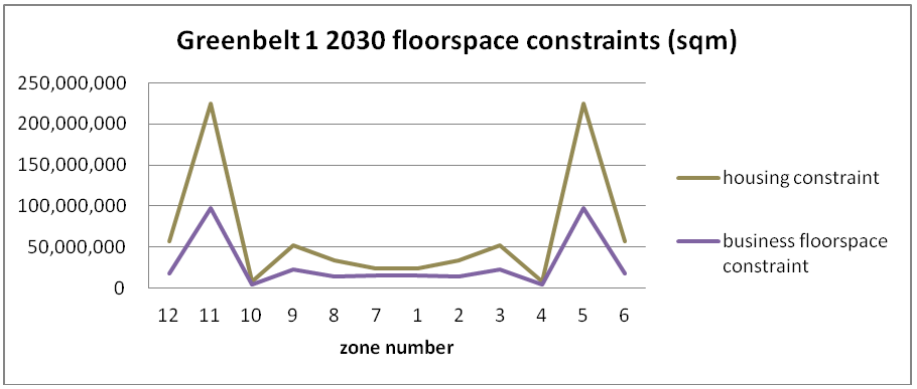

Figure 16. Greenbelt 1 2030 scenario floorspace constraints

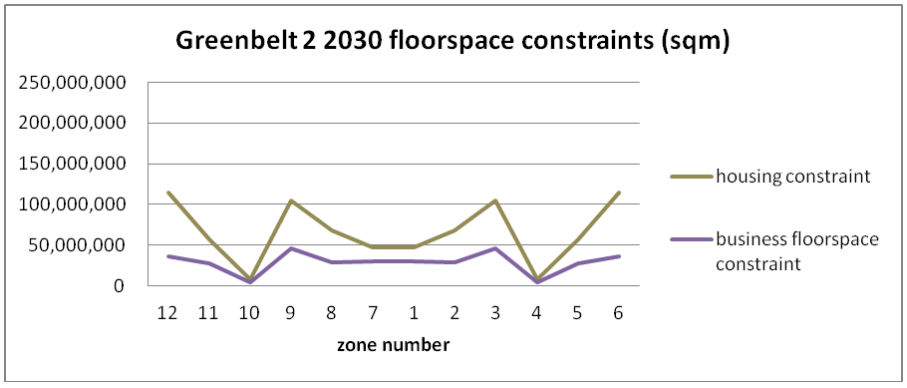

Figure 17. Greenbelt 2 2030 scenario floorspace constraints

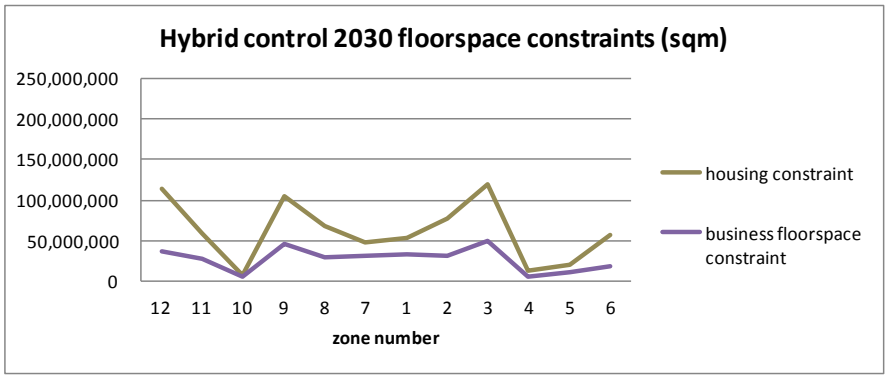

Figure 18. Hybrid control 2030 scenario floorspace constraints

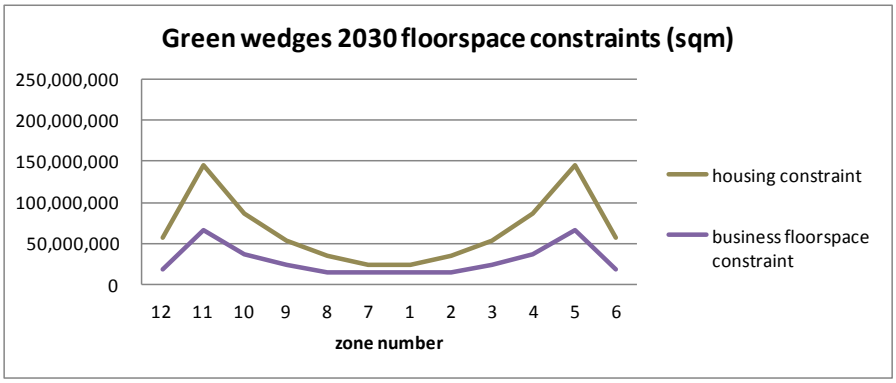

Figure 19. Green wedges 2030 scenario floorspace constraints

Like the base year outputs, the model will reveal differences in prices, wages, rents, household utilities and industry production among different scenarios. It will also show the locational distribution of households and jobs.

3.5 Model results

Table 6 lists main outputs from the simulation.

Table 6. Summary of main modelling results

Scenarios	Base year 2000	2030 trend growth	2030 densification	2030 Green belt 1	2030 Green belt 2	2030 Hybrid control	2030 Green Wedges
Total production(million units)	4697	14512	14084	14446	14541	14318	14744
Average office rent(￥/sqm/year)	174.7	279.0	328.2	279.0	279.2	301.7	279.7
Average product price (￥/unit)	36.8	47.6	49.0	47.8	47.5	48.2	46.9
Average wages (￥/household/hour)	18.0	22.5	22.5	22.4	22.4	22.5	22.1
Average housing rent(￥/sqm/year)	287.1	356.7	419.9	356.6	356.2	385.5	354.7
Average household utility	7.20	7.18	7.14	7.18	7.18	7.17	7.19

Scenarios	Base year 2000	2030 trend growth	2030 densification	2030 Green belt 1	2030 Green belt 2	2030 Hybrid control	2030 Green Wedges
Consumer surplus as percentage of money income %	/	-2.32	-9.68	-3.06	-2.54	-5.95	-0.94
Average commuting time (min/trip)	41.1	40.2	42.0	39.9	38.7	40.3	34.4
Economic mass index	1305	2347	2645	2320	2635	2617	2830

Tables 7-8 list job and population distribution in different scenarios and reveal spatial pattern of the city.

Table 7. Summary of percentage of jobs in zones

Scenarios	Base year 2000	2030 trend growth	2030 densification	2030 Green belt 1	2030 Green belt 2	2030 Hybrid control	2030 Green Wedges
Zones surrounded by the greenbelt (1,2,3,7,8,9)	63%	53%	85%	23%	66%	74%	29%
Greenbelt zones(4,10)	8%	4%	2%	1%	2%	2%	21%
Satellite towns (5,11)	11%	19%	6%	71%	17%	12%	43%
Hinterland (6,12)	18%	24%	7%	5%	15%	12%	8%
Comments on hybrid control					44%jobs in the densification side; 56% in the greenbelt side		

Table 8. Summary of percentage of households in zones

Scenarios	Base year 2000	2030 trend growth	2030 densification	2030 Green belt 1	2030 Green belt 2	2030 Hybrid control	2030 Green Wedges
Zones within the greenbelt (1,2,3,7,8,9)	66%	56%	86%	24%	68%	75%	24%
Greenbelt zones(4,10)	5%	3%	2%	1%	2%	2%	33%
Satellite towns (5,11)	10%	14%	4%	68%	13%	9%	35%
Hinterland (6,12)	19%	27%	8%	7%	17%	13%	7%
Comments on hybrid control					43%households in the densification side; 57% in the greenbelt side		

4. DISCUSSIONS

The modelling results show that the location of floorspace (through construction and redevelopment) and spatial costs (as implied by the urban transport supply) could greatly affect household welfare. In all the scenarios, restricted floorspace supply and rises in congestion will directly impact upon the economic performance of the city as a whole.

The trend growth scenario shows the decentralisation tendency from 2000 to 2030. The percentage of population in the existing main city, which is encircled by the designated greenbelt will fall, and the share of the population in the rest of the municipality (especially the townships and hinterland) will rise. However, because jobs decentralise with households, commuting time does not change greatly. Additionally because travels in the

outer suburban areas are faster, commuters can reach longer distances within the same travel times. Wage, price and rents increase mainly proportionally as the income increase. Household utility level sees a drop of 2.32%. Though not preferred by planners, trend growth is the most likely scenario for the city because of development inertia and also the cost of implementation is low.

In the densification scenario, household welfare level drops by 9.68% due to the reduction of household consumption and dwelling floorspace. The policy increases rent substantially and the price goes up as well, because it pushes people and jobs to the expensive central zones and floorspace supply is limited. It shows clearly the trend of concentration under densification policy: the main city (central + inner + outer) attracts jobs and households from towns and hinterland. Commuting time increases due to congestion when compared with the trend growth scenario. Compact city is considered as a sustainable approach against urban sprawl; however it is a costly scenario as tested in the model. The possibility of increasing floorspace in the centre is much lower than in suburbs because of high spatial costs. Therefore, this scenario can be reckoned as less possible to happen.

The stringent greenbelt scenario fulfils the aim of preserving greenfield in the designated greenbelt, as shown in Table 7 and 8 that the number of jobs and populations in greenbelt are controlled at a low level. Average wages, rents and prices are similar to the trend growth scenario. However, the stringent greenbelt scenario presents a very distinct pattern of household and job distribution. Around 70% households and jobs concentrate in the satellite townships while only 25% in the city area within the greenbelt. This scenario is based on an assumption that developing townships and preserving greenbelt is the priority concern of planners and policy makers. However, implementing such a policy will encounter difficulties, because the aim of zero growth in the greenbelt is not easy to achieve and it is a tough task to meet the high demand of floorspace in townships.

Compared with the stringent greenbelt, the loose greenbelt policy shares very similar characteristics in wages, rents and prices. But the spatial pattern is reversed. It indicates a pattern of concentration since more households and jobs relocate in the city from the greenbelt, compared to the stringent greenbelt and trend growth. Although it is assumed that travel time increase within and between satellite towns, the average commuting time decreases compared with other scenarios (except green wedges scenario). Compared to the stringent one, the loose greenbelt scenario also achieves the goal of preserving the greenfield, but at a higher welfare level. In practice, this policy may also be preferred by planners because it allows natural developments in most parts of Beijing and demands fewer interventions.

The hybrid control scenario combines the densification on one side of the centre with loose greenbelt on the other side. It performs similarly to the densification scenario in average economic outputs but this is a less extreme policy. Due to the reduction of floorspace supply, household welfare also sees a drop by 5.95%. This policy also increases rent drastically and price slightly, because of the concentration pattern on one side of the centre: households and jobs are pushed to the central city where floorspace supply is limited. Meanwhile, more than 55% of the total households choose the loose greenbelt side to live and work because there are more floorspace for dwellings and employments. In reality, Beijing's expansion is likely to be in a hybrid pattern as stated in the master planning. This scenario can be taken as an archetype and in future model, it could involve into a more realistic one.

In the green wedges scenario, populations distribute relatively evenly in the main city, greenbelt and satellite towns. The greenbelt area holds 21% jobs and 33% households in the built-up wedges along transport corridor. Average travel time decreases to 34.4 minutes which is the least compared to other policy options. This TOD pattern attracts people to the built-up wedges which are not far from the main city. This scenario performs the best among all scenarios in household welfare level, for it drops by only 0.94% from 2010, which is the lowest, due to increase of household consumption and leisure time. Implementing such a policy requires a huge amount of public investment in infrastructure; however, investment in public transport is currently the preferred strategy of the policy makers in Beijing.

Data summarised in Table 6 shows that compared with base year 2000 equilibrium, none of the proposed scenarios is able to increase consumer surplus as population goes up. But the last scenario could maintain the reduction at a very low level. When comparing between 2030 scenarios, the green wedges scenario sees least decrease of household utility level while densification scenario sees the largest drop. In practice, densification scenario is also considered as costly while green wedges scenario seems to have the greatest potential to deliver Beijing's growth with the least negative effects upon household welfare.

5. CONCLUSIONS

This model quantifies impacts of policies on individual time periods. The differences of economic indices from modelling results prove that the precise physical forms of fringe area development do significantly affect the whole municipality in economic terms. Wage, rent, price and commuting time change due to the policy levers, and household welfare will be affected. Alternative proposals that have seen fewer applications historically (for example various of options of green wedges) should be considered carefully.

The model proposed in this paper is a parsimonious model and can reveal the basic development trends of policies with fairly small number of parameters. Obviously this model needs to be extended to reflect the socio-economic, land use and transport context of Beijing in greater granularity. Empirical work is on-going which is crucial to provide the full evidence base.

In future work, we will incorporate the time dimension into the model which can link individual time period and recursively predict policy performance. Furthermore, the social and environmental assessments such as carried out in Echenique et al. (2012) may be incorporated in this model for wider assessment of urban sustainability.

APPENDIX

Table 9. Dwelling floorspace constraints in zones (km^2)

	Base year 2000	2030 trend growth	2030 densification	2030 Greenbelt 1	2030 Greenbelt 2	2030 Hybrid control	2030 Green Wedges
1	14.8	23.7	53.8	23.7	47.3	53.8	23.7
2	21.1	33.8	76.9	33.8	67.6	76.9	33.8
3	32.7	132.5	118.8	52.2	104.5	118.8	52.2
4	7.6	12.1	12.2	7.6	7.6	12.2	86.4

	Base year 2000	2030 trend growth	2030 densification	2030 Greenbelt 1	2030 Greenbelt 2	2030 Hybrid control	2030 Green Wedges
5	12.8	52.0	20.5	224.7	57.7	20.5	145.9
6	35.8	145.3	57.3	57.3	114.6	57.3	57.3
7	14.8	23.7	53.8	23.7	47.3	47.3	23.7
8	21.1	33.8	76.9	33.8	67.6	67.6	33.8
9	32.7	132.5	118.8	52.2	104.5	104.5	52.2
10	7.6	12.1	12.2	7.6	7.6	7.6	86.4
11	12.8	52.0	20.5	224.7	57.7	57.7	145.9
12	35.8	145.3	57.3	57.3	114.6	114.6	57.3

Table 10. Business floorspace constraints in zones (km^2)

	Base year 2000	2030 trend growth	2030 densification	2030 Greenbelt 1	2030 Greenbelt 2	2030 Hybrid control	2030 Green Wedges
1	12.0	15.1	32.4	15.1	30.1	32.4	15.1
2	11.5	14.4	31.0	14.4	28.7	31.0	14.4
3	18.4	61.8	49.7	23.0	46.1	49.7	23.0
4	4.6	5.7	5.7	4.6	4.6	5.7	36.9
5	8.1	27.3	10.2	97.9	27.2	10.2	65.6
6	14.6	48.8	18.2	18.2	36.4	18.2	18.2
7	12.0	15.1	32.4	15.1	30.1	30.1	15.1
8	11.5	14.4	31.0	14.4	28.7	28.7	14.4
9	18.4	61.8	49.7	23.0	46.1	46.1	23.0
10	4.6	5.7	5.7	4.6	4.6	4.6	36.9
11	8.1	27.3	10.2	97.9	27.2	27.2	65.6
12	14.6	48.8	18.2	18.2	36.4	36.4	18.2

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International review for spatial planning and sustainable development, Vol.2 No.2 (2014), 39-51
ISSN: 2187-3666 (online)
DOI: http://dx.doi.org/10.14246/irspsd.2.2_39

Earthquake Vulnerability Assessment in urban areas using MCDM

Case study: The central part of 6th district of Tehran Municipality

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Received 11 September, 2013; Accepted 23 January 2014

Key words: Earthquake, Assessment, Vulnerability, Analytic Hierarchy Process (AHP), Fuzzy Logic, Tehran.

Abstract: The earthquake vulnerability is one of the main problems of Iranian cities. This problem is going to be considered because of neglecting updated techniques for vulnerability assessment. There are numerous analytical techniques, in which some of them are useful to reach the responsive solution in software aspects. It is assumed that using techniques such as Analytic Hierarchy Process (AHP) supplementary by Fuzzy Logic can be helpful in this regard. This research is going to experience this technique in a case study in the 6th district of Tehran municipality. AHP is used in order to achieve the importance factor for each criterion which involved in the earthquake vulnerability and the Fuzzy Logic is used to normalize them. At last the consequent vulnerability function due to the criteria has been acquired. As a result, the purposed vulnerability model and map can become a significant software tool for confronting crises resulting from future earthquakes incidences and reduce the probable damages and vulnerabilities.

1. INTRODUCTION

Many of cities are located in areas that are endangered by natural disasters, such as earthquake, flooding, cyclones/hurricanes, landslides, volcanic eruptions, subsidence etc. It is estimated that over 95 percent of all deaths caused by disasters occur in developing countries and losses due to natural disasters are 20 times greater (as percent of GDP) in developing countries than in industrial countries (Kreimer, et al., 2003). Two million people will die in earthquakes in the twenty-first century assuming no increase in the average annual rate of deaths from the twentieth century (Nicholas, 2005). While natural disasters cannot be avoided, there are ways to improve safety, minimize loss and injury, and increase public awareness of the risk involved. One of the most effective ways to lessen the impact of natural disasters on people and property is through risk assessment and mitigation (Tantala, et al., 2008). Earthquakes cause huge loss of lives and infrastructure every year in Iran. Many settlement areas (urban & rural) as well as Tehran, the capital city of Iran are located in hazardous area (Sharifikia, 2011). The disastrous impact of earthquakes has been starkly illustrated in Bam-2003, Ardabil-1998, Ghaenat-1996, Manjil-1990, where thousands of people lost their lives (Sharifikia, 2007). Vulnerability is a new field and analytical tool in the study of urban safety. Analysis and assessment of vulnerability provide a new basis for urban planning (Chunliang, et al., 2011).

Earthquake vulnerability can be assessed and predicted through scientific analysis of earthquake risk map, and thus damages can be decreased through prevention effort (Sharifikia, 2011). For a vulnerability assessment, the goal is obtain a detailed map of distribution of building damage expected for occurrence of a scenario earthquake (Fah, et al., 2001). AHP, as a multiple criteria decision making (MCDM) method, can be used to evaluate and access the vulnerability of earthquake. In the last 20 years, AHP has been used in almost all the applications related to multiple criteria decision-making (Vargas, 1990; Vaidya, 2006)

In this paper, an AHP-based model has been developed for assessing the probable earthquake vulnerability in the studied area, which is located in the central part of 6th district of Tehran municipality.

2. THEORETICAL BASIS OF ANALYTIC HIERARCHY PROCESS

The AHP is a method proposed by Saaty (Saaty, 1980, 2008b). AHP is a well known technique that decomposes a decision making problem into several levels in such a way that they form a hierarchy with unidirectional hierarchical relationship between levels. The AHP uses pair wise comparison to allocate weights to the elements of each level in model, measuring their relative importance by using Saaty's 1 to 9 scales, and finally calculates global weights for assessment at the bottom level. The method also calculates a consistency ratio (CR) to verify the coherence of the judgments, which must be about 0.1 or less to be accepted. Mathematical foundations of AHP can be found in Saaty (1994,1996).

3. AHP-BASED METHODOLOGY FOR THE EARTHQUAKE VULNERABILITY ASSESSMENT

This study represents a conceptual framework for assessing the potential earthquake consequences to estimate the scale and extent of damage and disruption that may result from potential earthquake in the studied area. This model uses AHP, Fuzzy Logic and Probability Function to estimate the probable vulnerability. AHP is used to calculate the importance ratio for each criterion. In continues, the criteria have been converted from classic state to the fuzzy and unscaled condition using the fuzzy logic and the linear threshold function. Finally, the probability function of the vulnerability has been defined base on the criteria in the GIS environment and then the vulnerability values have been calculated for each parcel. A conceptual view of how the purposed model works is shown in the Figure1.

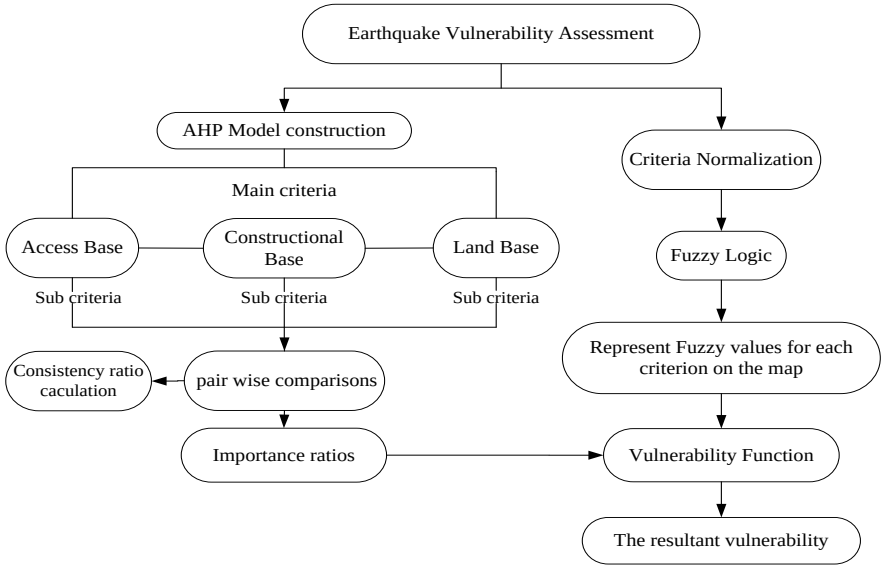


Figure 1.Perposed conceptual framework for assessing the earthquake vulnerability

3.1 Selection criteria

In order to develop an AHP model, a thorough literature review and informal discussions with the officials of the municipality, academics and experts working in the field of earthquake vulnerability were carried out and appropriate criteria for assessment have been extracted and classified (Table1).

Table 1. Description of selection criteria

Row	Criteria	Description and Explanation	Reference	Source
1	Land Use	Land use play a key role in earthquake vulnerability due to its occupy class and its relative dangerous. The vulnerable ratio is difference from one land use to the others. For example, green spaces are less vulnerable than residential lands.	Sengezer & Ercan, 2005; Torabi, 2010	Tehran Municipality
2	Plot Area	Area has an inverse correlation with the earthquake vulnerability. Large lands are less vulnerable than small lands.	Abdollahi, 2004	NICO (National Iranian Cartography Organization)
3	Geometric Shape	The regular shapes have less vulnerability and vice versa.	Hamidi, 1992	NICO (National Iranian Cartography Organization)
4	Parcel location in the block	According to earthquakes damage statistics in Iran, It is believed that parcels which are located in the middle of block have less vulnerability and them which are located in the border, have more vulnerability. It is because of surrounding by other building and their structures that help these building to be more resistant.	Ahadzadeh Roshti, 2010	NICO (National Iranian Cartography Organization)
5	Population	However, it has not a straight relationship to the damages, it is an important criterion	Fakhim, 2006	Tehran Municipality

	Density	in the causalities due to earthquake.		
6	Type of Structure	The Skeleton type of building has a drastic role in the damages. For example, wooden skeleton is more vulnerable than others type like metal and concrete floors.	Hatami Nejad et al, 2009	Tehran Municipality
7	Quality of Construction	It is distinguished that buildings with better quality (new technology in construction) have less vulnerability.	Ahadzadeh Roshti, 2010	Tehran Municipality
8	Building Age	As the building age arises, the probability of its vulnerability goes up.	Hoseini, 2003	Tehran Municipality
9	Number of Stories	It has a straight relationship with the earthquake vulnerability. Tall building are more vulnerable than short ones.	Ahadzadeh Roshti, 2010	Tehran Municipality
10	Occupy Ratio	When in a parcel the occupy ratio raises, it means that the open space in comparison to the mass space decreases and it can increase the vulnerability.	Hamidi, 1992	NICO (National Iranian Cartography Organization)
11	Density	It is the rate of construction in relation with plot area that is the multiple of numbers of stories and occupy ratio.	Habibi et al, 2007	Tehran Municipality
12	Road width	It is important for the access to safe places and rescue vehicles transportation.	Fakhim, 2006	NICO (National Iranian Cartography Organization)
13	Access to Open Spaces	Open spaces as safe places during the earthquake and after that has an important role in lowering the vulnerability and causalities.	Habib, 1992	Tehran Municipality
14	Access to Rescue Centers	Access to rescue centers and other emergency centers during and after earthquake has a significant role in reduction the fatalities.	Habibi et al, 2007	Tehran Municipality
15	Access to Fire Stations	As it is probable to accrue fire after the earthquake appropriate access to fire station is important.	Habibi et al,2007	Tehran Municipality

3.2 AHP model construction

The problem should be stated clearly and decomposed into a rational parts, like a hierarchical model. The AHP model in this paper consists of three levels. The first level is decision problem of accessing the earthquake vulnerability. The second level is the criteria or the determinants upon which the assessment of vulnerability is broadly based. This level is divided into three major components: Land base, Constructional base and Access base criteria. The next level consists of the sub criteria that support the determinants (Figure 2).

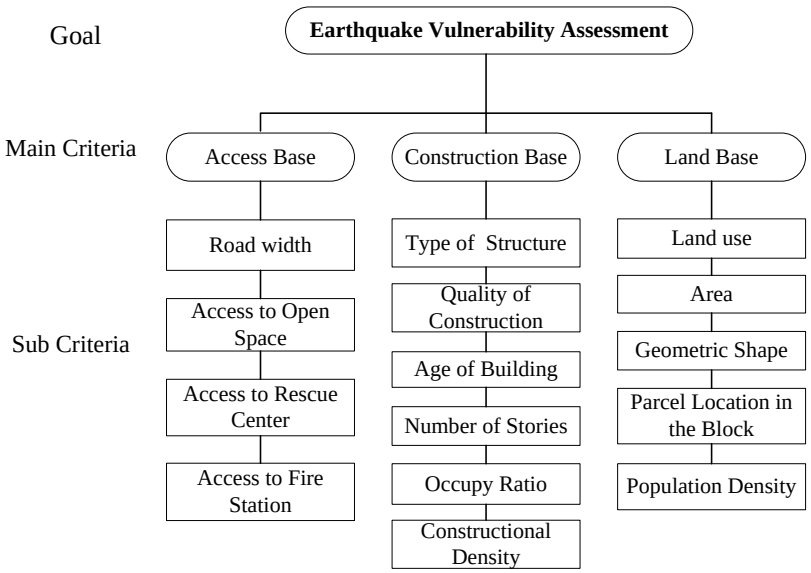


Figure 2. AHP model

3.3 Pair wise comparison and local weights

A pair wise comparison is a numerical representation of the relationship between two elements that discerns which element is more important, according to a higher criterion. Saaty (1980, 1994) proposed a scale of 1–9, where 1 represents equal importance; that is, the two elements contribute equally to the objective, while 9 represents extreme importance that is favours one element (row component) over another (column component). If the element has a weaker impact than its comparison element, the score range varies from 1, indicating indifference, to 1/9, an over whelming dominance by a column element over the row element. For reverse comparison of the elements, the corresponding reciprocal value is assigned, so that the matrix "a_{ij}*a_{ji}" = 1.

Table 2. Saaty's 1-9 scale for AHP preference

Intensity of importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
3	Moderate importance	Experience and judgment slightly favour one over another
5	Strong importance	Experience and judgment strongly favour one over another
7	Very strong importance	Activity is strongly favoured and its dominance is demonstrated in practice
9	Absolute importance	Importance of one over another affirmed on the highest possible order
2, 4, 6, 8	Intermediate values	Used to represent compromise between the priorities listed above
Reciprocal of above non-zero numbers	If activity i has one of the above non-zero numbers assigned to it when compared with activity j, then j has the reciprocal value when compared with i	

(Saaty, 1996)

In the presented model there are about 4 pair wise matrices. In order to perform the pair wise comparisons, about 8 face to face interviews were held with the experts in earthquake and urban planning by making use a comprehensive questionnaire. As a result of these interviews and judgments, weights of the main criteria and subcriteria were determined using Expert choice

software (Version 9.48s25). After carrying out all the comparisons and determining the weights, consistency ratio of all the pair wise comparisons matrices and those of the judgments were calculated. The consistency measure is very useful for identifying possible errors in judgments. If the inconsistency ratios of all the pair wise comparisons matrices are less than 0.1, all comparisons matrices are consistent and judgments are reliable. In this study, the inconsistency ratios (CR) of all the comparisons matrices were less than 0.1 and so all of the judgments were accepted as reliable.

Table 3. Pair wise comparison of main criteria and their weights

Criteria	Land Base	Constructional Base	Access Base	Weights
Land Base	1	0.48	2.9	0.290
Constructional Base	2.1	1	6.2	0.610
Access Base	0.35	0.16	1	0.100
		CR=0		

Table 4. Weights of the sub criteria

Criteria	Subcriteria	Weights		
Land Base	Land use	0.375	-	-
	Area	0.223	-	-
	Geometrical Shape	0.082	-	-
	Parcel location in the block	0.189	-	-
	Population density	0.131	-	-
Constructional Base	Type of the structure	-	0.512	-
	Age of building	-	0.110	-
	Quality of construction	-	0.085	-
	Number of stories	-	0.1	-
	Occupy Ratio	-	0.065	-
	Constructional density	-	0.128	-
Access Base	Road width	-	-	0.560
	Access to Open Space	-	-	0.158
	Access to Rescue Center	-	-	0.197
	Access to Fire Station	-	-	0.085

3.4 Final weights of criterions

Weights of subcriteria are local weights and they must be finalized to apply in assessment. For this, local weights of each subcriteria must be multiplied to weight of related upper level criteria (Eq .1).

$$fwij = wi * wij \ , \ \sum fwij = 1, \ i\&j = 1,\ldots\ldots,n$$

Equation 1. Final weight

Where fw_{ij} = final weight of C_{ij} (subcriteria), Wi= weight of C_i (main criteria).

Final weight of each evaluation factor was determined represented in the Table 5.

Table 5. Final importance ratios of each criterion

Criteria	Value
Land Use	0.10875
Area	0.06467
Geometrical Shape	0.02378
Parcel location in the block	0.05481
Population density	0.03799
Type of the structure	0.31232
Age of building	0.0671
Quality of construction	0.05185
Number of stories	0.061
Occupy Ratio	0.03965
Density	0.07808
Road width	0.056
Open space	0.0158
Rescue center	0.0197
Fire Station	0.0085

3.5 The Criteria Normalization

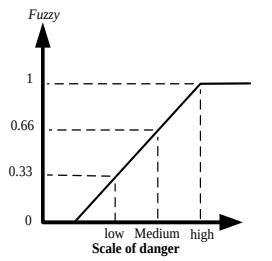
The criteria used in the present paper for the earthquake vulnerability assessment should be normalized. For this purpose the criteria have converted from classic state to the fuzzy and unscaled condition using the fuzzy logic and the linear threshold function. The fuzzy logic function is proposed by a professor LotfiZadeh. This function provides a space for reasoning, control and decision making in uncertainty situation (Habibi, et al. 2007)

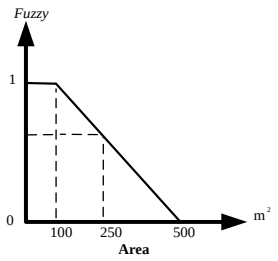
$$fw = \{\ 0 \text{ if } \ x < a\ ,\ (x - x\ \min)/\Delta x \ \text{ if } \ a < x < b\ ,\ 1 \text{ if } \ b < x\ \}$$

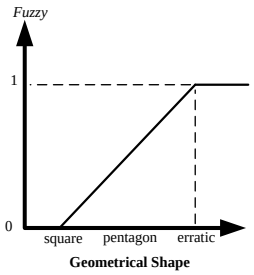
Equation 2. Fuzzy logic function
(Habibi, et al. 2007)

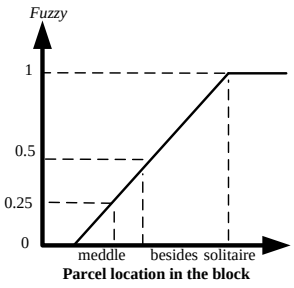
In this equation, $f(x)$ is fuzzy function, x is the criterion, *a* and *b* are the minimum and maximum acceptable value for the specific criteria and Δx is the difference between *a* and *b*. By using the proposal of experts in earthquake and according to the mentioned function, the fuzzy functions for all the criteria have been achieved. Due to brevity, in this section the graphs which show the functions for each criterion are shown in Table 6.

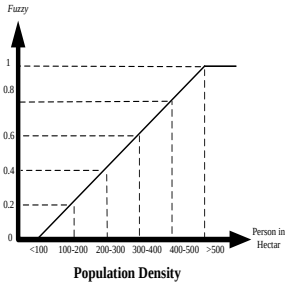
Table 6. Fuzzy functions for the criteria

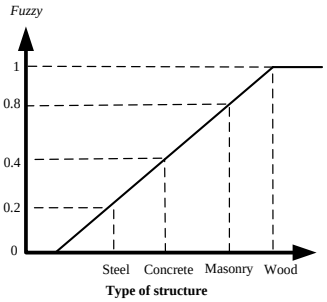


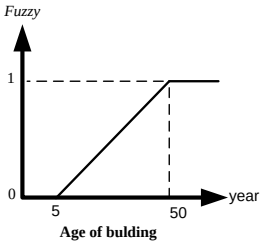


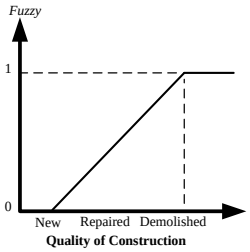


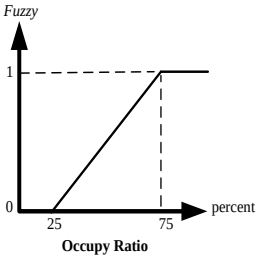


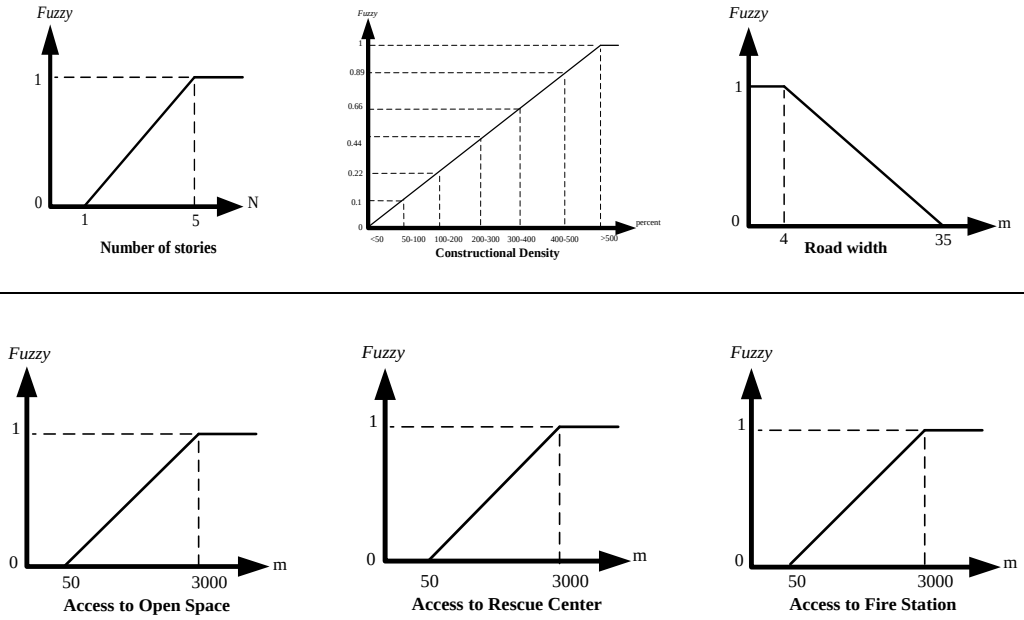












4. DATA ANALYSIS IN THE CASE STUDY

The studied area is located in the central part of the 6th district of Tehran municipality. This area is determinate by Shohadae Gomnan highway in the north and west, the Fatemi Boulevard in the west and the Kargar Boulevard in the south. Its area is 95 hectares and has about 2080 inhabitants (Iran statistical Center, 2006).

Figure 2. Location of the study area

This section surveys the mentioned criteria for earthquake vulnerability assessment in the study area (see Table 1). According to the obtained fuzzy functions in previous section, for each parcel a numerical fuzzy value is acquired. The results of surveys and fuzzy values can be illustrated in the mode of map, chart and graph. So 15 different data layers are produced which show the existent condition of a specific criterion in the studied area. To be concise, in

this section 6 of these 15 maps are shown (Figure 4 to Figure 9).

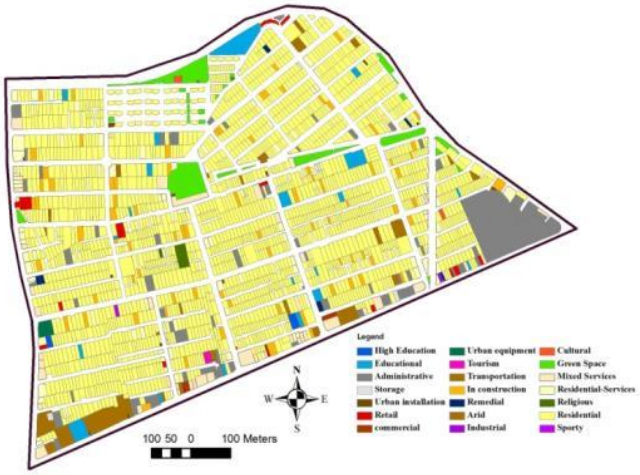


Figure 3. Land use in the studied area

Figure 4. Plot areas in the studied area

Figure 5. Type of Structure in the studied area

Figure 6. Constructional Density in the studied area

It should be noted that for criteria such as access to open spaces, rescue centers and fire stations, the Network Analyst tool in the GIS environment has been used. Its advantage in comparison to similar tools such as Buffer is measuring the real distance in relation to the existent roads, not the direct distance on the map.

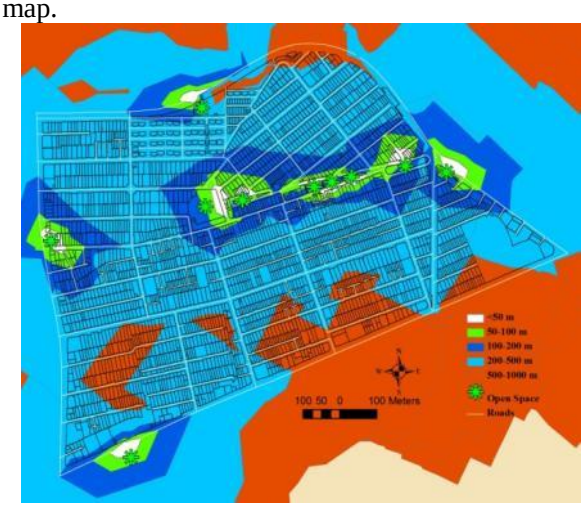


Figure 7. Access to Open Spaces in the studied area

Figure 8. Access to Rescue Centers in the studied area

5. VULNERABILITY ASSESSMENT

The probability function has been used for the earthquake vulnerability assessment. The consequent vulnerability function due to the criteria has been defined. In this function the wi is the importance ratio for a specific criterion, which was calculated by the AHP model (see Table 5) and $f(x)$ is the fuzzy numerical value obtained for the each parcel from the criterion (see Table 6).

$$p(w) = \sum_{i=1}^{n} wi * f(x)$$

Equation 3. Fuzzy numerical value function (vulnerability function) (Habibi, et al. 2007)

The vulnerability function represents a numerical value between 0 and 100 percent for each parcel which shows the consequent vulnerability of each parcel due to the criteria. The parcels with more vulnerability have greater scores. The vulnerability numbers in the studied area are between 0.1 and 0.7. As a parcel doesn't obtain the minimum and maximum numerical fuzzy value for all the criteria, the consequent vulnerability doesn't reach the 0 and 100 percent (Table 7 and Figure 10).

Table 7. The vulnerability numbers for each parcel

Category of vulnerability	Parcels number	Parcels percentage	Parcels percentage
0 – 0.1	2	0.07	1.47
0.1 – 0.2	36	1.4	
0.2 – 0.3	30	1.16	10.7
0.3 – 0.4	246	9.54	
0.4 – 0.5	1606	62.3	87.83
0.5 – 0.6	631	24.48	
0.6 – 0.7	27	1.05	
Sum	2578	100	100

Figure 9. The consequent vulnerability in the studied area

6. CONCLUSIONS

In a real scenario, urban managers, planners and other experts in earthquake vulnerability assessment and mitigation require software tools that produce efficacious results, are easy to use and comprehend, and which require a moderate duration to arrive upon results. Therefore, in this paper an attempt has been made:

I. To develop a comprehensive methodology incorporates divers criteria involved in assessing the earthquake vulnerability.

II. To solve the problem of assessing the earthquake vulnerability in an urban area; in the paper, this problem is solved through the Analytic Hierarchy Process. AHP enables to break the problem up in a systematic and logical way which helps to handle the complexity of the problem.

III. To normalize the criteria and converting theme to an unscaled condition, by using the fuzzy logic and linear threshold function which allocated each parcel a specific numerical value for a criterion.

IV. To establish the vulnerability function and allocating each parcel a specific number which represents the consequent vulnerability due to criteria.

The produced earthquake vulnerability map provides sustainable information for developing the earthquake mitigation programs, the land planning design of future infrastructure, the planning of crises confrontation procedures, etc. Based on the information provided from the earthquake vulnerability map locations with more vulnerability are recognized. This map can provide information concerning the selection of proper location for construction of vital infrastructure during a crises situation. (e.g. a hospital, fire stations, etc).

The above mentioned examples and numerous other application of the vulnerability map's information appoint their importance for the protection of the cities and build environments against earthquakes and justify the obligation of states, municipalities and others, who are responsible for making safe places in the neighbourhoods to provide theme for every city.

There were some limitations in this research that affected on research results. Inaccuracy and being out of date maps were two limitations that caused the vulnerability map be not accurate. These limitations can be removed by providing up to date to achieve useful results. About the criteria that used in assessment procedure, it can be said that there are other criteria that can be used in this model. For example, geological criteria such as adjacency to faults, can be fitted to this model appropriately. By gathering these information, the result of assessment can be more accurate and useful. But the important output of this assessment, is using its result for reducing earthquake damages and deaths. The weights of criteria show that some criteria such as Land use, Type of structure and Density have more weights. By improving these criteria and control of constructional by regulation, the building damages can be reduced. For example, about the land use criterion, the municipality can provide regulation for control construction more effectively. So, providing vulnerability map is first step for reducing earthquake damages and deaths. The urban managers and urban policy making are responsible for the next steps.

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International review for spatial planning and sustainable development, Vol.2 No.2 (2014), 52-63
ISSN: 2187-3666 (online)
DOI: http://dx.doi.org/10.14246/irspsd.2.2_52

Transportation and Sustainable Development in a Mid-Size French City, Dijon

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Received 9 October, 2013; Accepted 14 Feberuary 2014

Key words: City Planning, Streetcar, Bicycles, Sustainable Transportation, France, Dijon.

Abstract: Capital city of the region of Burgundy, Dijon has embarked into a strategy of eco-development, putting sustainability in the center the public discourse of urban planning. As a mid-size city in France, Dijon appears as a good example of the current trends in city greening around Western Europe. The label of « green city »has become essential in the promotion of urban areas for tourism and job creations, as is shown by the city rankings published in mainstream magazines.

City planning, as in other cities of the same size (about 250,000 residents), is run by the Communauté d'agglomération Dijonnaise, « Grand Dijon », with competencies in transportation, housing and land use planning. According to French laws, a greater emphasis is now given to « solidarity » in the governance of urban areas (= social housing in all municipalities, and also to sustainability and «green »urban policies.

Dijon, after about 20 other French cities, is rediscovering the virtues of streetcars (tramways), considered as a cleaner way to carry population than automobiles or fossil fuel-powered city buses. The implementation of a 2-line streetcar scheme means a reorganization of urban centralities in the Dijon area. The main downtown commercial street, where only buses are allowed now, will be fully pedestrianized at the start of tramway service. Only an electric shuttle will be able to run through the inner heart of the city. The train station will be a major hub for multimodal transfer. Spaces devoted to automobiles around the train terminal have been reduced, but areas reserved for public transportation (buses and the future tramway), pedestrians and bicycles have increased. The tramway route has been designed to link all major activity centers of the city (shopping centers, train station, university, administrative center, soccer stadium, entertainment venues …), in order to maximize ridership and minimize the need to use individual vehicles.

The city is also encouraging the use of bicycles, with bike-rental programs, in the downtown area and around the university campus. European countries and cities are promoting its use as an environmentally-friendly way to move around cities. Bicycle is part of the daily-life culture of nations such as the Netherlands or Denmark. It is also making a noticeable comeback in French cities. After a few pioneering cities in the 1990's, many cities have embarked into self-service public bike rental programs, following the 2005 example of Vélov' in Lyon and the powerful impact of the deployment of Vélib in Paris (2007). In most cases, the cities have contracted with a major announcer, JC Decaux for the "Cyclocity" or Clear Channel for the "SmartBike". This early model is evolving, with public transport conglomerates (Transdev, Keolis, Veolia) now getting in the bicycle providing game. The city of Dijon has gone further to enhance the appeal of bicycles with the implementation of a metro-area wide network of bicycle lanes. Plans are underway on campus to establish

new patterns of circulation within the university domain, encourage green mobilities and reduce the use of cars.

1. INTRODUCTION

Sustainable development has become a buzzword for many sets of policies at various spatial levels.

The 1987 Brundtland report and the 1992 Rio de Janeiro's Earth Summit have popularized the notion of sustainable development, with governments, international organizations, non-governmental organizations, decision-makers, developers, academics and the general public. The now well-known idea of a *development that meets the needs of the present without compromising the ability of future generations to meet their own needs* is trying to reconcile economic growth and environmental protection.

At the local scale, many cities in the world have embraced the principles of the Kyoto conference on the reduction of greenhouse gases, even as their national governments were much more reluctant to commit themselves, as was exemplified by the United States' situation (Boquet, Y. (2005)), and « sustainable urbanization » is now a major topic of interest for academics (Actes du séminaire national d'Amiens (2007); Outrequin, P. and Charlot-Valdieu, C. (2006); Traisnel, J.-P. and Merlin, P. (1996).).

The term *sustainable development* goes beyond the boundaries of science and business development and trade to include human development, values, and differences in cultures. In fact, many organizations are referring to *sustainable human development* as opposed to sustainable development in order to emphasize issues such as the importance of gender equality, participation in decision-making processes, and access to education and health.

Cities have become the focal points of sustainability policies, since they are the largest consumers of goods and services, while draining resources out of external regions that they depend on. The ecological imprint of cities therefore extends beyond their geographic locations. During the preparatory meetings for the Urban 21 Conference in Berlin (July 2000), the following definition was developed to define sustainable urban development: *Improving the quality of life in a city, including ecological, cultural, political, institutional, social and economic components without leaving a burden on the future generations. A burden which is the result of a reduced natural capital and an excessive local debt. Our aim is that the flow principle, that is based on an equilibrium of material and energy and also financial input/output, and plays a crucial role in all future decisions upon the development of urban areas.*

Sustainable community/urban development is now widely recognized as the ability to make development choices which respect the delicate relationship between the three "E's": economy, ecology, and equity.

Transportation issues are often at the heart of eco-development policies in cities (Gudmundsson, H. and Höjer, M. (1996); Litman, T. and Burwell, D. (2006); Newman, P. and Kenworthy, J. (1999).).

France has tried to implement a series of measures aiming at urban sustainable development. It has come up with a set of national policies, prepared by the adoption of laws regarding local governance for urban planning and transportation development, as well as a national debate, known as the Grenelle de l'Environnement, which was organized at the request of France's new president Nicolas Sarkozy in 2007. At the local

level, cities have taken a good look at the general concepts and the new regulations and requirements, in order to implement them according to the local conditions and develop their own set of policies aimed at a greener development for the coming years. The last part of this paper will consider the case of Dijon, the authors' hometown, a regional capital of about 250,000 people, in eastern France.

2. THE FRAMEWORK FOR URBAN SUSTAINABILITY IN FRANCE

In recent years, a vast array of laws and measures have modified the institutional governance framework of French urban areas and put in place new goals and methods for a more sustained development, both at local, regional and national level.

2.1 New legislative frameworks on urban governance

The June 1999 LOADDT (*Loi d'Orientation sur l'Aménagement Durable des Territoires*), known as « loi Voynet » set in place tools for territorial projects, global strategies with environmental concerns and the development of « local development contracts ». The July 1999 « loi Chevènement » act on intercommunality (*Loi relative au renforcement et à la simplification de la coopération intercommunale*) defined the structures and the modes of organization for regional cooperation between municipalities. Finally, the December 2000 SRU Law (*Solidarité et Renouvellement Urbain*), or « loi Gayssot », gave some guidelines for an integrated approach on urban development, housing and transportation.

These laws modify the urbanism and land use tools in existence before, such as the SDAUs (Schémas Directeurs d'Aménagement et d'Urbanisme) and POS (Plans d'Occupation des Sols), replacing them with updated versions known as SCOTs and PLUs. Three components stand out in the new policies and regulations:

- the greater role given to « urban areas », redefined by the 1999 Loi Chevènement, with a council made up of officials representing all member municipalities. There is a strong push for integrated development of the entire metropolitan areas and to limit duplicate and separate developments in the same urban area;
- the strong social bent of the SRU law, requiring, for instance, that more social housing be built in affluent municipalities, at least 20% of the housing stock, to prevent a further widening of the gap between rich and poor areas. Non-compliant municipalities could be fined;
- the environmental efforts which are the background of many measures. They include, among others, policies of green sustainable transportation aimed at reducing congestion and pollution.

French metropolitan areas are to implement plans for urban mobilities, known as PDUs (Plans de Déplacements Urbains). The underlying concept is that urban transportation planning must be in a position to accommodate, and even anticipate, the city's continual pace of expansion and transformation, but also to adapt to the changes in behaviours and lifestyles. PDUs have appeared in 1982 with the adoption of a national law covering many facets of French transportation, the so-called LOTI (*Loi d'Orientation sur les Transports Intérieurs*) (law on domestic transportation). They

became mandatory in 1996 after the passage of a law on air (quality) and rational use of energy, nicknamed LAURE (*Loi sur l'Air et l'Utilisation Rationnelle de l'Énergie*) (law on air and rational energy use). The 2000 SRU law made them a part of general urban policy planning.

These plans determine, within the spatial framework of a « perimeter of urban transportation » (PTU), the overall organization of people transport, freight traffic, circulation and parking. All transportation modes are included, and the focus is on the development of alternate modes to reduce the dependency towards the automobile: public transport, 2-wheelers, walking… PDUs are mandatory for urban and metropolitan areas of more than 100,000 inhabitants, their validity is 5 years[1], and they can be modified if the spatial perimeter is changed to reflect the inclusion of new municipalities in the metropolitan area.

2.2 Sustainable transportation in French cities

PDUs are part of a comprehensive urban policy. The SRU law insists on « territorial coherence », through the adoption of schemes known as SCOTs, Schémas de COhérence Territoriale, which have replaced the older SDAU's (*Schémas Directeurs d'Aménagement et d'Urbanisme*). The new PLUs (*Plans Locaux d'Urbanisme*) establish new land-use regulations, replacing the older POS.

A basic tenet is that transportation policy cannot be considered in isolation from other issues, such as social and spatial justice (insuring adequate public transport coverage in richer and poorer neighbourhoods alike), « green environmental policies », as well as programs for new housing developments. Urbanism documents must take into account the expected consequences of new housing on road traffic and give priority to the development of areas already well-served by public transportation. This is the French version of Transit-Oriented Development. The ambition of PDU's is to insure a sustained balance between the mobility needs of inhabitants and the protection of their health and environment. Measures to implement include:

- improving safety in all modes of moving;
- reducing the share of automobile travel;
- reorganizing parking on streets and in parking lots;
- rationalizing the transportation and delivery of merchandise, in order to minimize the negative effects of truck parking while insuring a smooth activity for shops and businesses;
- developing public transportation, with increased use of buses, and development of subway lines in larger cities or a return of streetcars in mid-size cities;
- implementing integrated ticketing schemes to facilitate the daily life of transit users;
- encouraging businesses and public administrations to develop *Plans de Déplacements d'Entreprise* (plans for corporate travel: car-sharing, limitation of parking space, incentives for public transport use) ;
- fostering the use of non-motorized non-polluting modes of transportation: walking (all-pedestrian zones and streets) and bicycling.

Streetcars, once a main element of urban mobility (Allemand, S., Ascher, F., et al. (2005)) and an essential factor in the growth of pre-automobile suburbia, had all but disappeared in the 1950's in France. Twenty years ago,

only 3 cities in France (St Etienne, Marseilles and Lille) still had trams, and each retained only one line. But many French cities have now found that they can increase their attractiveness and improve their transportation sustainability by building a modern tramway system. They were first reintroduced in Nantes, Grenoble, Strasbourg, followed by Paris, Rouen, Montpellier, Lyon, Clermont Ferrand, Orléans, Nice, Bordeaux, Nancy… Existing tram networks are being extended and new ones are being planned (Dijon, Brest).

French cities have also embarked on the promotion of bicycling. After a few pioneering cities in the 1990's, many cities have embarked into self-service public bike rental programs, following the example of Vélov' in Lyon, France's second largest city, in 2005, and the powerful impact of the deployment of Vélib in Paris (July 2007). As of April 2010, such schemes have been implemented in 26 cities in France. In most cases, the cities have contracted with a major advertising company, JC Decaux for the "Cyclocity" or ClearChannel for the "SmartBike": in exchange for being awarded the outside advertising and bus shelters markets, advertisers will provide and maintain the bicycles and the bicycle docking points ("stations") which use a proprietary locking system to ensure that each bike is securely stored. The service is accessible via online subscription. Many cities have accompanied this effort with the development of bicycle paths networks. Sometimes the creation of tramway lines is a good opportunity to redesign the whole street use in order to better accommodate bicycles.

The third element in sustainable transport policies is the importance given to train travel. As France is continuing to develop its national high-speed rail network, regional governments have been given control of the regional trains. The French rail company, SNCF, is working closely with cities to redesign its train station plazas in order to allow intermodality with city public transport a bicycles, at the expense of car parking space.

2.3 The "Grenelle de l'Environnement"

When he came to power in May 2007, president Nicolas Sarkozy created a powerful position in government (considered as n°3 after the Prime Minister and the Minister of Foreign Affairs), which has taken four names in four years and encompasses many domains related to environmental affairs : *Ministère de l'Écologie, du Développement et de l'Aménagement durables* (MEDAD), then *Ministère de l'Écologie, de l'Énergie, du Développement durable et de l'Aménagement du territoire* (MEEDDAT), *Ministère de l'Écologie, de l'Énergie, du Développement durable et de la Mer* (MEEDDM) and now *Ministère de l'Écologie, du Développement durable, des Transports et du Logement* (MEDDTL). This Ministry, currently headed by Mrs N. Kosciusko-Morizet, is in charge of State Environmental Policy (Preservation of Biodiversity, Climate Kyoto Protocol Application, Environmental Control of industries...), Transportation, Infrastructures, Sea, Territorial Development and Housing Policies.

Barely two months into his presidency, in July 2007, President Sarkozy also called for a major conference and public debate to define goals and policies pertaining to sustainable development in France. The "Grenelle de l'Environnement", brought together many actors of public life to draw up a plan of action of concrete measures to tackle environmental issues. Working groups included representatives from the central government, local governments, employer organizations, trade unions, academics and non-governmental organizations. They gathered to debate around the themes of

climate change, energy, biodiversity, natural resources, agriculture, health, ecological democracy, development patterns, environmental employment and competitiveness. Their initial recommendations were presented in late September 2007 and led the government to propose to the parliament 20 environmental policy measures to be adopted as quickly as possible. The main commitments were on low energy consumption standards in housing, the development of alternate energy resources (solar, wind), more control on agricultural intrants and a major program of financing for high-speed rail and local green transportation (tramways and bicycle lanes).

Some of the promises had to give way as the world economic crisis developed shortly afterwards, but the message, albeit less clear in 2010, was to continue local the implementation of sustainable practices, both in the countryside and in urban areas.

3. DIJON'S PLANNING: TOWARDS AN ECO-DEVELOPMENT

Dijon, like many cities, was given a few years to propose new documents guiding the growth of its urban area for years to come, according to the new guidelines of the laws briefly presented above. The general context of « green » awareness, which can also appear as a powerful political tool for elected officials, and the additional push given by the Grenelle de l'Environnement, have led Dijon and its urban area to prepare a new SCOT and a new PLU, implemented in 2010.

These new urban planning documents will shape the city growth at least until 2020, and are the occasion to integrate sustainable development objectives in the process of planning. PLUs differ from the previous land-use plans (POS, *Plans d'Occupation des Sols*), because they must integrate a PADD (*Projet d'Aménagement et de Développement Durable*, project for planning and sustainable development) to the mere zoning regulations.

3.1 Grand Dijon: a regional governance of planning and transportation

The future of the city is not to be decided by itself alone, but also by taking account the perspectives of suburban areas, within the limits of two groupings, « Grand Dijon » (Greater Dijon, formerly known as COMADI, *Communauté d'Agglomération de Dijon*) and the wider perimeter of the SCOT, as well as regional partnerships in eastern France.

« Grand Dijon », created in 2000 in the aftermath of the 1999 Chevènement law, is made up of 22 municipalities[2], totalling 251.000 people. It was the 4th such Communauté d'Agglomération in France to sign with the national government a *Contrat d'Agglomération* (urban area contract), which can be considered as a « road map » for metropolitan development, approved by the central government. It is therefore eligible for national subsidies helping it to implement projects deemed valable. Three priorities have been put forward:

- to promote the attractivity of the urban area and its opening to the outside (investors);
- to encourage sustainable and shared development;

- to develop a friendly, innovative life environment, respectful of identities.

Behind these quite vague and politically correct phrases, a number of projects have been started or achieved: a "Zénith" concert venue, a revamped bus network, a track-and-field stadium, an Olympic-sized swimming pool, a system of selective recycling, several measures to help students, and now the development of a new tram system.

The SCOT, a document guiding the future of a wide area round the city, will be the first such document for the capital of the Burgundy region. An official perimeter including 116 municipalities was defined in 2003. Within this SCOT perimeter, general trends of development are to be implemented. A PADD (see above) is about to be released, the first one ever in France. Its major recommendations are to avoid an excessive concentration of activities on Dijon alone, to keep a balance between city and country, to organize in an efficient way transportation in rural areas, to preserve the quality of urban water through a stricter control of farm inputs, and to protect fragile and valuable landscapes of forests, wetlands and vineyards from excessive urban sprawl and leapfrogging.

The third scale of development of the Dijon area is inter-regional, and even international, through the *Réseau Métropolitain Rhin-Rhône* (« Rhine-Rhone metropolitan network »), where Dijon is teaming up with cities further to the East (Besançon, Montbéliard, Belfort, Mulhouse) and the South (Chalon-sur-Saône, Le Creusot-Monceau), to foster common economic development and avoid excessive competition. It is sponsored by the three regions of Bourgogne, Franche-Comté and Alsace, as well by the Bâle-Mulhouse-Freiburg multinational agglomération (including German and Swiss cities). Two realizations are currently underway: a new high-speed rail line, and a growing cooperation between regional universities (possibly leading to a merger in a few years) and hospitals. Transportation is the key to this intra-metropolitan cooperation

3.2 Dijon's commitment to environment: Eco-PLU

With the objective to preserve its rich cultural heritage, protect its surroundings and improve the quality of life of its citizens, « Grand Dijon », in collaboration with key actors in the region (citizens, associations, companies, institutions and members of the local parliament, *Conseil Régional de Bourgogne*), put forth an environmental Charter in 2004. This Charter, aiming to implement locally the main resolutions from the environmental world summits of Rio de Janeiro, Kyoto and Johannesburg, encompasses four major themes: transportation, urbanism, wter purification, recycling/waste management.

Since 2004, le Grand Dijon has been leading a meticulous water program called "Eauvitale" that includes: constructing two new purification centers that considerably reduce pollution, increasing water usage consciousness and pushing for tap water consumption. Dijon participates in the « *pôle de compétitivité* » cluster « VITAGORA - *Goût Nutrition Santé* » (taste, nutrition, health), with the objective to improve the taste of water to increase tap water consumption.

Dijon aims to optimize waste management through several actions: generalizing selective waste collecting, creating a domestic waste sorting center designed to sort materials (wrappings and papers) and sending this waste to specialized recycling centers, opening a special unit for potentially infectious waste, renovating factory incinerators according to European

regulatory norms, installing a turbo alternator which converts energy produced with combustible waste into alternative energy.

The city has set an objective for carbon balance by 2010 and is following a regional energy climate plan called PCET (plan climat énergie territorial), designed to reduce greenhouse gas emissions. It has also applied for the European City'ergie label 2010.

The PLU will determine precisely land uses for Greater Dijon, by prescribing the types of land use allowed (green space, industrial, commercial, housing ...) and regulations relative to building heights and distance of buildings from streets. It is an opportunity to shape the city according to the wishes of elected officials and to implement the lofty principles mentioned above. Questions during the period of development of the document included: How to contribute to the reduction of the carbon imprint of the urban area? How to provide for needed housing units while saving on space and avoiding further sprawl? How to improve the living environment, while preserving historical heritage in the central area of the city?

The Socialist mayor of Dijon (and president of Greater Dijon), François Rebsamen, has clearly put sustainable development at the center of his planning policies, in a political context of participative democracy and citizens' ecology. The city, already in the past a national leader in historical preservation, aims to become the French reference in terms of urban sustainability. Its PLU will be the first Eco-PLU of the country (Boquet, Y. (2010b)). Official documents insist on the necessary inclusion of environmental criteria in all major projects underway. Eco-PLU was prepared with a first "diagnosis" phase by a consulting firm, then its elaboration was done in close cooperation with regional agency for environment and energy control, ADEME Bourgogne (*Agence de l'Environnement et de la Maîtrise de l'Energie*), using an « environmental approach of urbanism ». Four orientations and three priorities have emerged.

The four main goals are:

- an « eco-development for an evolving city », taking into account the social, demographic and economic challenges of the urban area;
- an « eco-mobility for a mobile city », taking into consideration the challenges of moving around a compact and dense city;
- an « eco-housing for a mosaic city », signalling for the emergence of a new urban model and takes into account the differences between neighbourhoods;
- an « eco-territory for an environmental city », calling for a sound management of sparse natural resources.

The three top priorities for action are:

- to answer the housing needs in the Dijon area, new neighbourhoods responding to environmental criteria must be developed;
- Dijon is working on preserving biodiversity with a policy of promotion of green spaces and plans for green corridors within the metropolitan area;
- for transportation, Dijon, following the lead of other French cities of similar size, has embarked upon the construction of two tramway lines, scheduled for opening in 2013. Their completion will be the opportunity to reorganize the bus system and give back to pedestrians and cyclists more of the downtown area.

A Plan *d'Orientations Stratégiques d'Aménagement Durable, Economique et Responsable* (POSADER) has been adopted by the SEMAAD, the semi-public corporation in charge of coordinating public works in the urban area. It will have to respect urban principles (compact

city, short distances, mixed land-use), social principles (ethnic, economic and generational mixity), as well as environmental principles (low-energy buildings, reduced carbon imprint, city biodiversity) and political principles (participative government, continued interaction with residents, associations, shop-owners).

3.3 Transportation in Dijon

The most visible element of the environmental policy is the reorganization of the transportation policy in the city. Dijon is investing in alternative public transportation modes and several projects are underway including: construction of a tramway with two lines planned for 2013, usage of natural gas in buses, free electric shuttles in the city centre, free bike system, development of bike lanes, increasing car-free areas in the city center, investing in Dijon becoming a central connection city for the TGV network by constructing three branches of the future LGV Rhin-Rhône high-speed railway line.

Local public transportation operator Divia, a subsidiary of the Keolis conglomerate, has redesigned its bus network, widely recognized as one of the best in France for a mid-size city, in terms of ticket price, territorial coverage and service frequency. Efforts are underway to reduce substantially the volume of bus traffic in the very center of the city, to allow better connections between bus lines on the outside of the historical center, and to create dedicated busways to improve the punctuality and speed of buses. This strategy of TCSP (*Transports en Commun en Site Propre*), taking cues from Bus Rapid Transit experiences in other countries, is a first step towards the return of streetcars after a 50 year gap.

During the spring of 2010, preliminary work has indeed begun in preparation for the introduction of tramways in late 2012.

Two tramway lines have been planned, one going from North to South linking major commercial areas at both ends, the other one, West to East, from the city's train station to the convention center and university areas and ending at the third major suburban shopping district. Both lines will share track on the fringe of the historical center, and Place de la République, a major crossroads of the city, will become the new hub of transportation.

The result will be the complete removal of buses from the main commercial street of the downtown area (rue de la Liberté), which will be pedestrianized, allowing for a better city experience for Dijon people and tourists alike. Place Darcy, currently a complicated node of bus lines crisscrossed by several lanes of car traffic, will be largely devoid of motorized circulation after the trams will run through it, and public eyesores linked to car traffic will be removed, allowing for a wider open space open to pedestrians and cyclists. In front of the historic city hall, Place de la Liberté will be 100% pedestrian. On streets not fully pedestrianized, but where trams will run, pedestrians' safety will be greatly enhanced, because they will not have to battle car traffic when they cross the street.

Efforts to reduce transport-generated pollution have been already engaged with the introduction of natural gas-powered buses. The introduction of non-greenhouse gases-emitting tramways will be a further step to a green transport policy, while at the same time it will enhance Dijon's image as a green city. Rainwater stored in an underground reservoir will be used to irrigate the grassy areas that will be lining the route of the tramway.

So is the bicycling policy, based on two converging efforts : the mapping and implementation of a network of bike lanes, and the adoption of a bicycle-rental scheme, nicknamed V'élodi, inspired by the successes of Lyon's Vélo'v and Paris' Vélib (Boquet, Y. (2010a, 2010b)). Local lobbies, such as EVAD, continue to push hard for the implementation of bicycle-friendly policies (Joannis, C. (2008)). As much as will be allowed locally by streets' width, bicycle lanes will parallel tramway tracks across the city.

Dijon's ecology friendly transportation initiatives have received recognition on a national level and, at end of 2008, le Grand Dijon was granted the Ticket vert (Green ticket) by the FNAUT (*Fédération Nationale d'Associations d'Usagers des Transports*), the French consumer association specialized in public transportation.

3.4 Eco-quartiers, a new approach to neighborhood development

The city is also promoting its eco-districts such as those of Junot, Hyacinthe Vincent and the "Grand Sud". The expression « *éco-quartier* » (ecological neighborhood) was first introduced in Scandinavia (Stockholm, Malmö, Copenhagen) and Germany (Hanover and Freiburg-in-Brisgau) (Charlot-Valdieu, C. (2009); Hopwood, D. (2005); Lefèvre, P. and Sabard, M. (2009); Souami, T. (2009).). Sustainable housing practices are also entering the planners' and decision-makers' vocabulary, gaining popularity around the world, even if they are still very loosely defined (Bertrand, V. (2010); Giroir, G. (2007); Priemus, H. (2005).).

The city of Dijon is strongly supportive of ecological urban construction solutions that comply with sustainable development standards such as the French *Haute Qualité Environnementale* (High Environmental Quality) standard for green building, and the *Bâtiment de basse consommation énergétique* (Building of low energy consumption) standard.

Redevelopment activities of former military facilities has often included new housing developments, industrial, training, educational and recreational facilities alongside retail and commercial quarters (Bagaeen, S.G. (2006)). Reconstruction sites must be as « green » as possible. In Dijon, it has been promoted by a political commitment to "sustainable" urban regeneration. On the space previously used by disaffected military barracks, the new Junot neighbourhood (Rouzaut, E. (2007)) has been built largely with recycled materials from the abandoned buildings, in order to minimize the traffic of noisy and polluting trucks in and out of the construction area. The new buildings obey stringent regulations relative to energy consumption. At the same time, it is aimed at encourage social and generational mixity, to avoid ghettoizing of ethnic minorities and the elderly. This 600 housing units projects was built according to principles of high-environmental quality, a green space was created in the center of the new complex, and parking is on the outside, leaving the heart of the area for pedestrians and cyclists. This eco-neighbourhood will be followed by another one in coming years, reflecting the wish for an innovative and evolving city.

An innovative partnership, "Univer-Cités" has been established between the local University and the Grand Dijon, in order to improve the links between the city and one of its main engines of growth and life. The campus is to be expanded (with financial support from the national Grand campus program of universities renovation) and a green area maintained in its center. The tramway route, as it already does in Orléans or Grenoble, will be crossing the campus to insure maximal accessibility from the center of town.

The Board of Regents of the university has put forward its commitment to the development of green policies on-campus, from recycling to cycling (Université de Bourgogne (2010)). The geography department has been charged by the University's president to develop a campus-wide scheme of mobility to reduce the need for car use within the premises of the university domain, and also to think about measures to limit the number of automobiles entering the campus grounds. A thorough reorganization of traffic within campus will be implemented, and the number of bike racks greatly increased. The university, in its own way, is trying to become also an eco-neighbourhood and a model for other universities in France.

4. CONCLUSION

The city of Dijon, at his scale of medium-size regional capital in Europe, has been at the forefront of French sustainable urbanization practices in recent years. Efforts are starting to bear fruits, in terms of national recognition, with many awards and high rankings in "quality-of-life" indexes published in major news magazines. This does not come without difficulties, such as the current obstacles to a smooth flow of circulation, caused by ever-expanding street work to prepare for the arrival of tramways. But there are clearly lessons to garner from Dijon's experience and efforts, even if it may be more difficult to implement in larger cities such as Paris or Hong Kong. Is the experience led by a small (at the world scale) local government to be reproduced in other political context? Dijon benefits also from being a city with relatively little heavy industry, hence no major industrial effluents pollution. As a city dominated by tertiary activities, can it be a model for large metropolitan areas with high population density? Is there a scale limit to the implementation of such virtuous environmental policies?

These are some of the questions arising from the Dijon example. It is interesting to note that most innovative policies have occurred in mid-size cities rather than large ones: Dijon, and not Paris, Portland and not Los Angeles, Freiburg and not Berlin. Another avenue of reflexion would be to ask if this environmental policy is a luxury that emerging and developing nations would have a difficult time emulating, because the priority would be jobs more than air quality.

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Grand Dijon: http://www.grand-dijon.fr/

Société d'Économie Mixte d'Aménagement de l'Agglomération Dijonnaise: http://www.semaad.com/

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International review for spatial planning and sustainable development, Vol.2 No.2 (2014), 64-75
ISSN: 2187-3666 (online)
DOI: http://dx.doi.org/10.14246/irspsd.2.2_64

The Influence of Metro Station Development on Neighbourhood Quality

The Case of Tehran Metro Rail System

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Received 27 September, 2013; Accepted 23 January 2014

Key words: Transit Oriented Development, Spatial Segregation, Neighbourhood Quality, Land Value, Metro Station, Tehran, Iran.

Abstract: Introducing urban public transportation facilities into a region often creates a significant opportunity to accelerate the process of development through affecting on the property values. Better access, more mobility options, and lower transportation costs are important factors that increase the land values of such regions, especially in blighted and poor neighbourhoods. This issue is important in Tehran Metropolis, because during the past decades an obvious kind of spatial segregation has been formed between the rich north (with high spatial quality) and the poor south (with low spatial quality) due to unequal distribution of opportunities and resources. On the other side, according to the population demand, Metro System is being developed rapidly in the city. Thus a comparative field study on the impacts of metro stations on property values in Tehran can represent not only the various impacts of metro station establishing on different urban textures, but also its consequences on reducing the spatial segregation in the city. We presume that the poor areas under discussion (southern regions) have received more benefits than the rich areas in terms of residential property values. So, establishing of metro stations in the poor and blighted regions of the city can improve the development potentials at these areas. Such improvement in spatial quality of the southern neighbourhoods of the city can reduce the spatial segregation in Tehran Metropolis. The hypothesis has been tested with a field study around Shari'ati Street Metro Station (in the northern part of Tehran) and Shohada Square Metro Station (in the southern part) with considering the quantitative (polynomial regression) and qualitative (personal interview) methods of impact assessment. The results show that establishing of metro stations has a consistently higher positive impact on the residential property values at the poor regions compared with the rich areas. Therefore, by means of acceleration in the values of the poor southern regions, Tehran's long-standing segregation will gradually diminish and subsequently the spatial urban integration will show itself, though in a rather long time.

1. INTRODUCTION

A transportation system can make various impacts on surrounding areas. These impacts sometimes appear around stations, sometimes around transit

corridors and in some cases as a combination of both. Metro Rail System is one the most widely used mode of public transportation. So that during the recent decades, development of metro networks in urban regions has significantly affected on spatial flows and urban mobility as well as spatial development of urban areas. Improving availability of employment nucleuses, retail districts and essential facilities for citizens is the most obvious impact of this development. Such positive impacts can raise land values around metro stations and consequently it can provide especial opportunities for urban textures to improve their quality. In fact, metro stations can play an important role to develop their surrounding areas especially in the economic aspects. This opportunity is very important for urban textures, particularly for poor and blighted textures that faced with many obstacles in attracting investment for regeneration and renewal. So an intelligent management around the metro stations can change the state of blighted and run-down textures to livable and dynamic districts.

2. RESEARCH METHODOLOGY

The quality of urban areas is reciprocally associated with land values, so that any change in spatial quality of urban textures shows itself in property prices (especially residential properties) and mutually increase or decrease in the land values due to its impact on the rate of development, can improve or descend the quality of areas. In fact, the property values can be varied according to the spatial quality (social, economic and physical) of their surrounding areas (Tyrvainen, 1997). So that on researches about the quality of life, the housing price is considered as the maximum cost that people are willing to pay for living in a place with better quality and more facilities (Geoghegan et.al, 1997). So it can be stated that Housing Price Index (HPI) is one of the most comprehensive indicators for measuring the level of neighbourhoods' quality (Bourdin, 2008). Therefore, in the present study to assess the qualitative changes in the vicinity of Tehran's metro stations the HPI is analysed using Statistical Correlation Analysis Methods and Polynomial Regression. Comparing the results of the northern regions and southern regions -which are dramatically different in terms of socioeconomic prosperity and physical quality-, can represent the consequence of this development on reducing the spatial disparities in Tehran Metropolis. The data are collected by Semi-structured personal interviews with local communities and real estate agencies and also by reviewing documents.

3. THEORETICAL FRAMEWORK

3.1 Transit-Oriented Development; an Opportunity to Enhance Urban Liveability

Basically, there is a close and mutual relationship between accessing to the transportation facilities and urban development. So that, during development planning the accessibility is considered as an important factor to enhance development opportunities in urban areas. In this context, public transport facilities not only can make positive impacts on the urban traffic flows, but also it may significantly improve the ability of citizens to access

the main activities cores. Improving on accessibility generally leads to spatial development in urban textures. Regarding to this issue, policymakers believe that a suitable planning around urban public transport facilities can improve the quality of urban textures. To address this issue, transit-oriented development (TOD) was introduced as a harmony between transportation planning and land use planning to improve liveability and vibrancy in the vicinity of public transport stations (www.newurbanism.org). In this idea the public transit station is considered as a significant opportunity for spatial developing at neighbourhoods (Arrington & Cervero, 2008). Many definitions are presented about the TOD, but it is generally defined as a mixed- use community that encourages people to live near transit services (Still, 2002). Experts on this notion such as Calthorpe and Cervero define TOD as a "community-based", "mixed- use", "high density", "walkable" and "compact" development which is typically cantered around a public transportation station (such as train station, metro station, tram stop, or bus stop) (Renne, 2009). TODs generally are located within a radius of one-quarter to one-half mile from a transit station where various kinds of housing, retail shops, services and facilities are located in a high quality civic center with an appropriate scale for pedestrians (Guerra & Cervero, 2013). Nowadays, urban governances are using "TODs" in order to promote the economic, social, and environmental well-being of a city by: (CDT, 2002; Arrington & Cervero, 2008)

– Improving the efficiency of public transportation;
– Decreasing auto dependency and exhaust emissions;
– Using serviced land efficiently to help create a more compact urban form;
– Revitalizing blighted and older communities;
– Providing market housing in a variety of forms and price ranges;
– Making identifiable and walkable neighbourhoods;
– Acting as a catalyst for private investment and development;
– Increasing assessment values of vacant and underused land.

3.2 The impact of railway stations on residential property values

Although transit-oriented development is relevant to all types of public transport systems, but Rail Rapid Transit Systems (especially Metro Networks) have more importance than other types considering their special advantages in terms of speed, capacity, safety and pollution. Numerous studies have been conducted about the impacts of railway stations on surrounding areas. The majority of these studies analysed rail's effect on the property values (especially residential properties) as one of the most obvious consequences of urban transport projects (Diaz, 1999). Such studies often recorded positive impacts. The overall consensus among the studies and reports is that proximity to public transit does lead to higher home values and rents in many cases (Wardship, 2011). In fact, these studies confirmed that the wise planning around the public transit stations is commonly accompanied by rising land values" (Debrezion et al. 2007). For example an assessment of the Dallas Area Rapid Transit (DART) light rail transit system on taxable property valuations (ERA, 2006), a study of Central London's Cross-rail on the residential property values (KFC, 2013), a study of the Epping Cross-worth rail line of Sydney (Janet Ge et al. 2012) and also another study of the Jakarta Metropolitan Area (Indonesia) (Syabri, 2011) show that residential properties located within walking distance (up to a half a mile in most cases) of a rapid transit access point were found to enjoy

higher rising values over those away from it. Actually, in such areas transit options and transit accessibility play significant role in housing prices. Cervero and Duncan (2001; 2002) believe that rising in land values after establishing of rail transit facilities is a direct consequence of increased demand which is resulted from improving on accessibility or spatial quality in these areas. Typically, as a location becomes more attractive due to certain characteristics, demand increases and thus the bidding process pushes prices up in a competitive real estate market (Debrezion et al., 2007). Such gradually changes in property values around transit stations can improve the quality of surrounding neighbourhoods by stimulating economic vibrancy in such areas. As Cervero (2003) confirmed in his extensive study, supportive local policies and demographics, well designed stations, efficient and effective transit systems, and a strong real estate market must exist for transit to have a significant effect on property value and development (ERA, 2006).

This pattern was not widely felt, so that some studies such as a study on the Eastside MAX light rail transit line in suburban Portland (Dueker et al. 1998) and another study on the east line of MARTA in DeKalb County (Nelson, 1992) show that, contrary to the general assumption, some negative nuisance factors can also reduce the potential property value impacts. This negative effect may be due to such factors as noise, air and visual pollution, increased bus and automobile traffic and increased perceptions of crime (Diaz, 1999). These various experiences are completed by other studies concluded that rail transit stations made either no effect or very little effect on property values. For example an analysis of single family home prices near the Metro rail system in Miami-Dade County shows that the introduction of Metrorail either weakly increased the property values or almost no relative benefits (Diaz, 1999). Moreover, another empirical study in Beijing (China) concluded that the impact of Batong line on housing prices (whether close to the railway stations or not) is insignificant in the whole study area (Yizhen, 2005).

With regard to the above experiences it can be concluded that the impact assessment of metro stations on property values is an important issue with various results. These results confirm that it is difficult to predict what the long-term effects of development projects will be, because each kind of development (whether macro-scale or micro-scale) could make various impacts on its environs based on the environmental circumstances. Therefore, it is necessary to identify the possible impacts and consequences at before/after/during project implementation to amplify its positive impacts as well as minimizing negative consequences. So a field study entitled this issue in Tehran Metropolis (regarding to the current spatial segregation between the north and the south of the city) can compare the impacts of metro stations in the two different urban textures. This comparison can reveal the subsequent impact of this development on reducing the spatial segregation in Tehran Metropolis.

4. STUDY AREA: TEHRAN; A CAPITAL WITH SPATIAL SEGREGATION

Tehran is the capital city of Iran. It is ranked the eighteenth most populated city and the twenty-seventh largest city in the world which has a population about 8.4 million and a land area around 730 square kilometres.

Furthermore, its outside metropolitan area covers 19,000 square kilometres with a population of 13.4 million (Figure 1).

Figure 1. Tehran Metropolitan Area (TM, 2011)

Since 1920 (early Pahlavi era) Tehran became the main migrant-receptive city of Iran as a consequence of the economy breakdown of villages and small cities in the wake of the Second World War. In fact the main motivation for migration that took place during 1920-1960 was to find jobs with a reasonable income (TM, 2011) As a result, the population of the city began to increase drastically, so that within 40 years, the population became ten times as much and subsequently Tehran experienced a population boom. This process has had negative economic-social as well as bio-environmental consequences for the city, because during these years the speed of infrastructure development has been much slower than population growth. So, the city has faced with many problems such as unbridled physical growth, urban decay, run-down textures, slums, social segregation, heavy traffic congestion and environmental pollutions.

Moreover, during the historical process of development in Tehran, the relative advantages of northern parts of the city in compared with the southern parts (especially in terms of physical quality of textures as well as climatic and topographical conditions) created a significant social segregation between the North and the South, So that the central and southern parts have gradually turned into a residence for low-income people and by contrast the northern parts have embraced neighbourhoods of the middle and upper classes of society. Such dramatic difference in the residents' characteristics shows itself into the quality of texture mutually. So that nowadays the low-quality and run-down buildings have been located in the southern parts against the luxury commercial and residential towers of the northern parts (Figure 2). Unfortunately the spatial segregation between the northern parts (high quality neighbourhoods) and the southern parts (low-quality and run-down neighbourhoods) has been deeper due to unfair resource distribution, despite the urban decay regeneration and renovation plans of Tehran Municipality (TM) in the past decades (Kheyroddin, 2008). Therefore, this paper aims to answer this question: How the spatial segregation (physical and socio-economic) of Tehran Metropolis can be reduced with the Metro Rail System development?

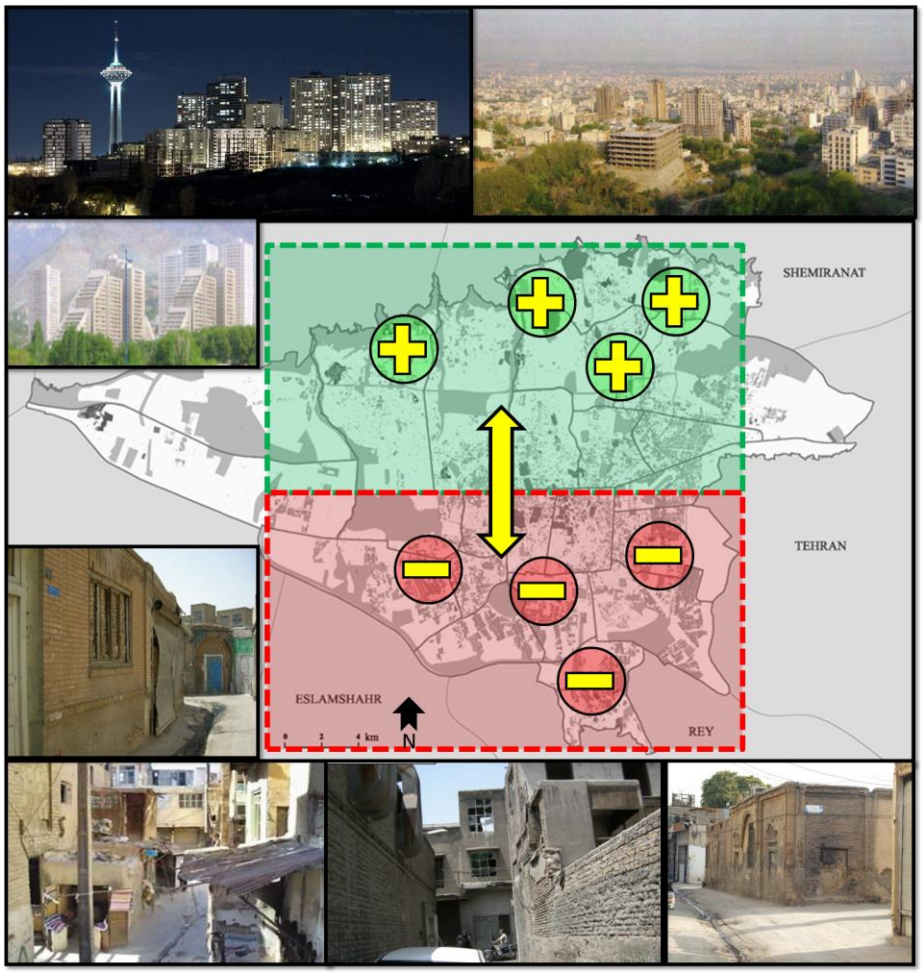

Figure 2. Spatial disparities between the northern and southern parts of Tehran (Kheyroddin, 2009)

In order to answer this question and also to compare the impacts of metro stations on surrounding areas in northern and southern parts of Tehran, two field surveys have been done on the residential properties which are within a quarter-mile of metro stations. In this regard, Shari'ati Metro Station was selected as a case in the North and Shohada Metro Station in the southern parts of the city (Figure 3).

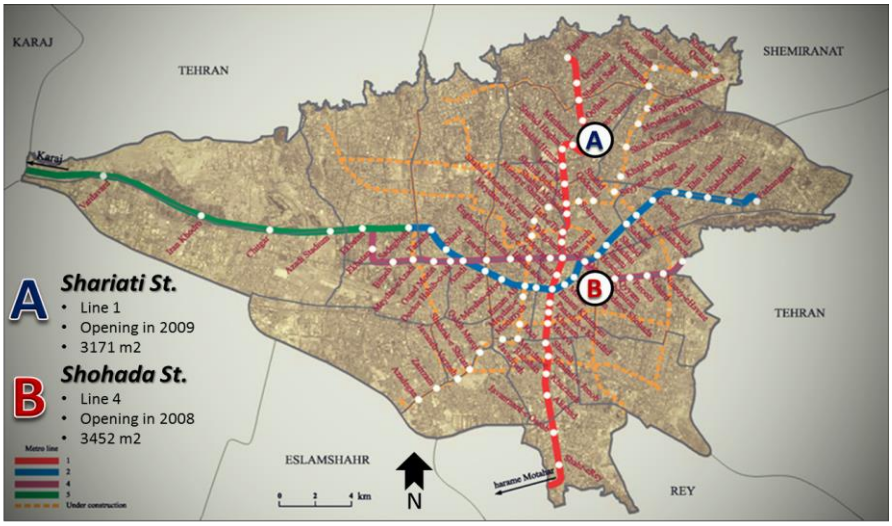

Figure 3. Location of the selected stations on the Tehran's Metro Rail System (TM, 2011. Modified by Authors)

4.1 Data collection

As mentioned earlier, in the present study to assess the impact of selected metro stations on the development rate of surrounding areas and also to understand its consequent qualitative changes, Housing Price Index (HPI) is analysed. In this regard, the average price of the residential properties (within a quarter-mile range of stations) has been collected over the period 2004-2012 (Table 1). The data are collected by means of semi-structured personal interviews with local residents who live in the surrounding neighbourhoods and also with the real estate agencies especially by reviewing their transactions and contracts. Furthermore, in order to authenticate the data, the official statistics are also maintained (Table 2). Comparing the data from the field survey and the official statistics certifies the accuracy and validity of the data collection process. At the end, in order to analyse the data, a proper method of Linear Regression is needed to show the effect of the metro stations' establishing on housing values, whether progressive or regressive. So by comparing the various methods of Linear Regression based on the target of the research and also regarding to this fact that the linear relationship between the independent variable (year) and dependent variable (Price) is a curved line, not a straight line, the Polynomial Regression with the second order is selected as the analysis tool. The analysis is performed by using Excel 2010.

Comparative analysis of the resulted equations and charts can compare the impact of metro stations on property values in two different parts of Tehran (rich and poor neighbourhoods). Subsequently, it can reveal the consequent effect of metro stations in reducing the spatial segregation in the city.

Table 1. Housing prices within a diameter of 1.4 miles from metro stations (Million Rials per square meters)

Year	Shari'ati St.	Shohada St.
2004	0.7	0.3
2005	0.9	0.5
2006	1.5	0.8
2007	2.6	1.1
2008	3.1	1.2
2009	3.2	1.6
2010	3.5	2.2
2011	3.9	2.7
2012	4.1	3.1

Sources: A field study by authors as well as the data from the Management Information System of Real Estate Transactions of Iran.

Table 2. Official statistics on average housing prices (Million Rials per square meters).

Year	No.3 Zone	No.12 Zone	No.13 Zone
2004	1.1	0.4	0.4
2005	1.2	0.5	0.6
2006	1.7	0.6	0.8
2007	2.9	1	1.2
2008	3.1	1.1	1.3
2009	3.5	1.2	1.2
2010	4	1.3	1.4
2011	5	2.2	2.4
2012	5.2	2.6	2.7

Sources: The Ministry of Housing and Urban Development of Iran well as the Management Information System of Real Estate Transactions of Iran

4.2 Analyse and discussion: the role of metro stations on reducing the spatial segregation of Tehran Metropolis

In this section based on the selected analysis method, the field data have been fitted into the polynomial equations with the second order (Figure 4 and Figure 5). The final analysis of the resulted equations and their diagrams (Coefficients Analysis, Partial Deferential Analysis and Concavity Analysis) in two different urban textures of Tehran yields these results: Examination of the effects of proximity to metro station for these two neighbourhoods shows that the proximity to station indicates a positive effect on the property values of the southern part (poor neighbourhoods), but a negative effect in the neighbourhood on the northern part (Rich neighbourhoods) of Tehran. So that, at the neighbourhood on the north side around Shari'ati Station, the residential property values have dropped after establishing of the station and the slope of rising prices has been slowed down. The opposite occurred in southern regions, the residential properties adjacent to Shohada Station have experienced a rise in values after establishing the station and housing prices have increased more sharply.

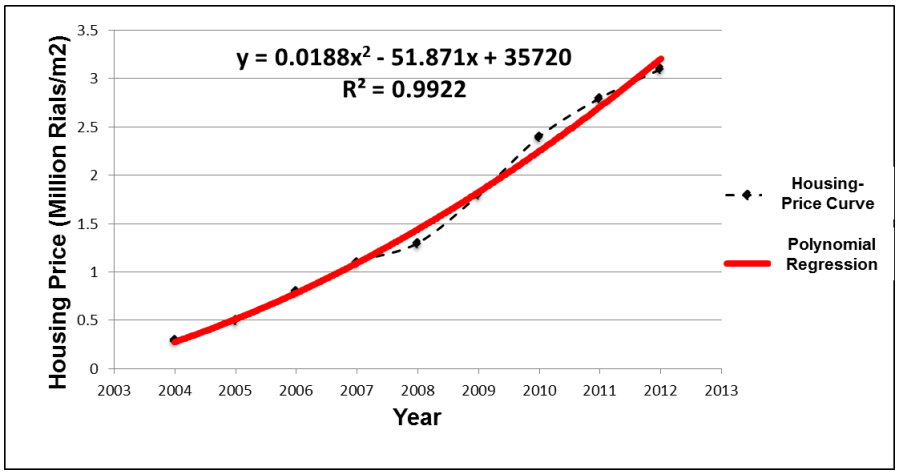

Figure 4. Changes in residential property values near Shari'ati St.
Source: Analyzed based on Table 1.

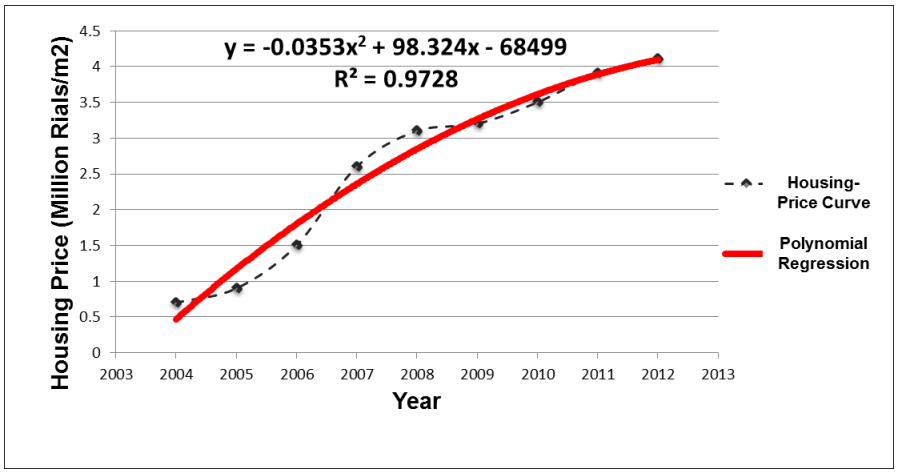

Figure 5. Changes in residential property values near Shohada St.
Source: Analyzed based on Table 1.

The results demonstrate the diversity of possible spatial impacts of metro stations in different urban textures. It means that although these two different neighbourhoods of Tehran have been served by the same transit line and the public transportation facilities are equally provided for them, but its side effects are dramatically different based on the environmental circumstances. Given these results, a speedup in the growth of property values of the southern parts (low-quality and run-down textures) of Tehran can stimulate the economic vibrancy and the public tendency towards development at such areas. In fact, establishing of metro station in such neighbourhoods- that suffer from value depreciation due to physical deterioration or economic obsolescence- can play an important role to attract investment for regeneration and renovation as a development stimulus project. This process can ultimately increase the liveability of neighbourhoods as well as socio-economic welfare in the southern parts of Tehran through improving the development opportunities. Furthermore, these positive impacts can be spread over a broader surrounding area of metro stations by means of applying the appropriate policies in terms of managing, planning and designing. As a result of the process, the spatial quality of southern parts of Tehran will be approached to the northern parts. Afterwards, Tehran's long-standing gap between the poor south and the rich north can be reduced and subsequently, Tehran can close to an integrated or more balanced city, though in a rather long time.

Here, there is an important question: how can we prove that the change in housing values in the study areas is a consequence of the selected metro stations' establishing? To answer this question a comparative market analysis has been done between the values of housing that are within a 1/4 mile range of the stations and housing well outside of station areas (Figure 6). It yields that establishing of Shari'ati Station in 2009 had a negative impact on the values of surrounding residential properties compared with housing that are away from it. Whilst the houses adjacent to Shohada Station have experienced a rise in values after 2008 (the date of station establishing) compared with others. It confirms that the residential property values around the selected stations have been significantly affected by establishing of the metro stations in the both areas.

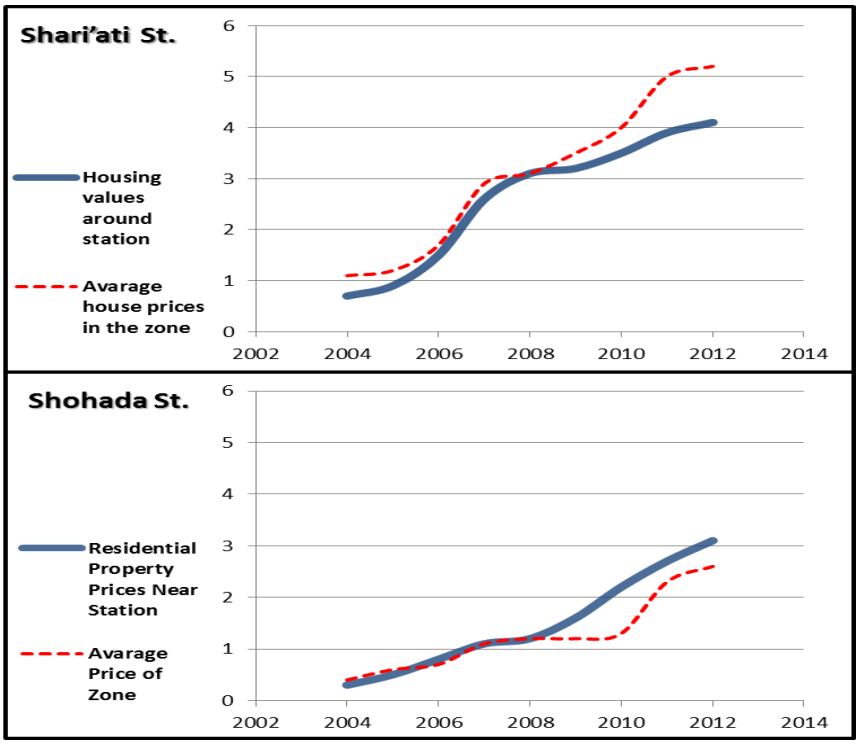

Figure 6. Comparative analysis between the values of residential properties around stations and properties away from them.
Source: Analysed based on Table 1 and Table 2.

These various impacts of metro stations on the property values in the two different neighbourhoods of Tehran can be associated with the desirable level of social-cultural/spatial-physical/traffic changes that may appear subsequent to the stations' establishing. Furthermore, the compatibility level of such development projects with the residents' demand for public transportation facilities is a determinate point to improve the positive impacts of metro stations. On the other side, lack of appropriate planning and management around metro stations not only reduce such positive potential, but also it may turn the stations into the crowded centres with environmental pollutions and social threats. Some factors such as increasing the presence of strangers, social crimes, noise and visual pollutions and traffic congestion as well as degradation of local identities and safety rate, which may appear following the establishing of metro stations can influence negatively on their surrounds.

It should be noted that the present study never confirms the negative impacts of Shari'ati Station in the rich parts of Tehran as a remedy for reducing the spatial gap of the city, but it emphasises on strengthening the positive impacts of metro stations throughout the city (the southern parts as well as the northern parts of Tehran). Although this process provides a greater opportunity for the poor and run-down neighbourhoods of Tehran regarding to their specific conditions and demands.

5. CONCLUSION: DELIBERATE DEVELOPMENT OF METRO STATIONS; AN OPPORTUNITY FOR URBAN REGENERATION AND INTEGRATION

The present study shows that construction of metro station has a greater benefit for the southern parts of Tehran compared with the northern parts in terms of changes in residential property values. In fact, proximity to the metro rail system showed a higher positive effect on property values on the poor and run-down neighbourhoods of the city compared with the rich areas. It can provide a significant opportunity for these areas to enhance their development rate and also to improve the environmental quality. As a result of the process, Tehran's long-standing gap between the poor south and the rich north can be reduced in terms of spatial-physical qualities and socio-economic welfare. On the other hand, management of such impacts is an important matter. A proactive management can establish active, alive and attractive urban cores in run-down parts of Tehran, which can play a significant role in these areas to attract the required capital for regeneration and renovation. In contrast, ignoring its importance may turn the stations to crowded urban cores with noise and visual pollutions and with some social threats. So the present study can be continued in the future by following questions: what factors affecting on the magnitude of metro stations impacts? What kind of planning/designing strategies should be considered to reinforce the positive impacts of metro stations as well as their negative consequences?

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ISSN 2187-3666 (Online)

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