A Suitable Development Trend in Linear City Based On Smart Growth

A Case Study in Lanzhou Urban Area

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DEDICATION

To my beloved mother and father

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ABSTRACT

"Smart growth" strategy as a new urban development theory originated from United States as a way against urban sprawl. However, urban sprawl also threatens China's urban spatial expansion process on certain extent. In this research, the issues come from spatial layout, and construction land structure is irrational in Lanzhou City, so the main purpose is to find an appropriate development trend for future development. The result should push forward an influence on introducing Smart growth theory into China's planning system as well as assist Lanzhou city get a better development direction.

A survey of developing urban growth model with raster analysis function under GIS software based on smart growth strategy to simulate several visual scenarios. Noteworthy, a simple questionnaire contributes to ranking the relative principles in Smart growth for measure the weight in each scenario, and those scenarios emphasize economic efficiency, environmental preservation and social equity respectively. After a series of evaluation between different scenarios and general plan in 2020, the final output should select a scenario which either involves the implication of smart growth in urban spatial development or suitable to the actuality of Lanzhou city.

ABSTRAK

Strategi “Pertumbuhan Pintar” sebagai teori pembangunan bandar baru telah diketengahkan oleh Amerika Syarikat sebagai tentangan kepada rebakan bandar. Namun, rebakan bandar juga mengancam proses pengembangan kawasan bandar China pada tahap tertentu. Dalam kajian ini, isu-isu dari susun atur ruang dan struktur tanah pembinaan adalah tidak relevan di Bandar Lanzhou, maka tujuan utama ialah untuk mencari kecenderungan pembangunan yang sesuai untuk pembangunan pada masa hadapan. Hasil kajian seharusnya mengenengahkan pengaruh terhadap pengenalan teori Pertumbuhan Pintar ke dalam sistem perancangan China serta membantu Bandar Lanzhou mendapatkan arah pembangunan yang lebih baik.

Satu kajian dibuat untuk membangunkan model pertumbuhan bandar dengan fungsi analisis raster dalam perisian GIS berdasarkan strategi pertumbuhan pintar untuk mensimulasikan beberapa senario visual. Perlu diberi perhatian bahawa soal selidik mudah menyumbang kepada penarafan prinsip-prinsip relatif dalam Pertumbuhan Pintar untuk mengukur berat dalam dalam setiap senario, dan senario-senario tersebut menekankan kepada kecekapan ekonomi, pemeliharaan alam sekitar, dan ekuiti sosial. Selepas beberapa penilaian antara senario-senario yang berbeza dan pelan umum pada tahun 2020, output akhir harus memilih sama ada melibatkan implikasi Pertumbuhan Pintar dalam pembangunan ruang bandar atau bersesuaian dengan keadaan sebenar Bandar Lanzhou.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

In the past century, many parts of our physical environment were getting a gradual outward migration from urban area to rural area and becoming metropolis eventually. In 2008, it was the first time the number of urban population exceeded the rural areas. The United Nations predicts that by 2050, the number of urban dwellers will reach 70% of the global population. (http://www.godeyes.cn)

With the progress of human civilization, subsequently, it is an unstoppable process that most of cities are involved in growth with different type and extent. However, if we know the connection between urban growth and smart growth concept, to face up to urban growth can be a challenge, an opportunity rather than a disaster for human beings, and this research tries to evaluate the trend of urban

development based on smart growth concept. Furthermore, the research formulates a development scenario with regards to finding a sustainable mode for future development.

1.2 Background of Study

Recalling the past few years, the view of the Earth has been constantly changing as human beings' development, some images which were shot in different time periods can reveal the impact of cities around the world due to the large population migration and intensive urbanization.

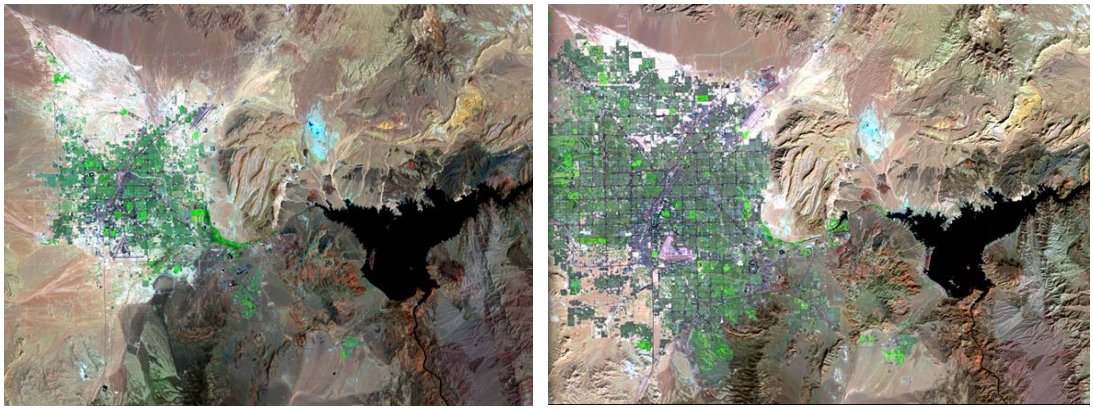


Figure 1.1: The urban expansion in Las Vegas, Nevada, the United States, from 1990 to 2010 (Source: Made by U.S. National Aeronautics and Space Administration's Earth Resources Satellite, 2012)

Figure 1.1 demonstrates that Las Vegas has already extended to the desert under the pressures of increasing population. The construction and operation is a challenge for humans, such as to meet the water needs from residents.

The global population explosion accelerates urbanization and urban sprawl, as a result, a lot of urban areas are already expanding into the surrounding countryside, and urban sprawl is often directly linked with serious environmental consequences (Bo, 2008). Because the expansion of the city inevitably destroys wildlife habitat, aggravates energy inefficiency, and increases the dependence on motorized transport, many urban issues emerge into people's view (Freudenberg, et al., 2005).

Undoubtedly, urbanization as a key process is in progress in most of the developing countries. China is a typical country which has experienced a very drastic urbanization since 1987, and all the cities are full of enthusiasm to be a mega city which means consuming more resources and bringing more power into play (Yue, 2012). So, under the authorities and citizens' great ambition, every city goes into a competition mechanism with each other and is becoming increasingly intense. As a result, urban sprawl comes to our view, for pursuing GDP growth and depending on car very much, outward spreading of a city and its suburbs forms a high segregation between residential and other uses growth. It brings a series of serious drawbacks which make many negative impacts on urban development.

We can discuss those existing and potential issues into three aspects. Firstly, from economic efficiency aspect, for government, urban sprawl leads to a large number of land resource wastes by the inefficient urban land utilization rate. For citizens, they suffer from an increment of tax imposition due to increased investments in infrastructure and utilities. Secondly, from the view of ecological protection aspect, urban sprawl increases vehicle-dependency and leads to air pollution and traffic congestion which damage public health and decrease people's life quality. Moreover, over-exploitation and unreasonable develop natural resource will lose a lot of agricultural land and open space. Thirdly, in the social equity aspect, the wealth gap between the rich and the poor become more and more wide,

community lose its vitality by crime and poverty (Freudenberg, et al., 2005).

All in all, those cities are facing up to an ordeal from fast development, how to solve the problems become more and more urgent. The linear city under a unique urban form which if suffer from urban sprawl will be heavier than other urban forms (Yang, 2009). Because the distribution of the city may create more distance in the travel, people need to spend more time and energy with vehicles to reach their destination in daily life. This study takes Lanzhou city as an example, to explore a way of making the city's development more sustainable in the future.

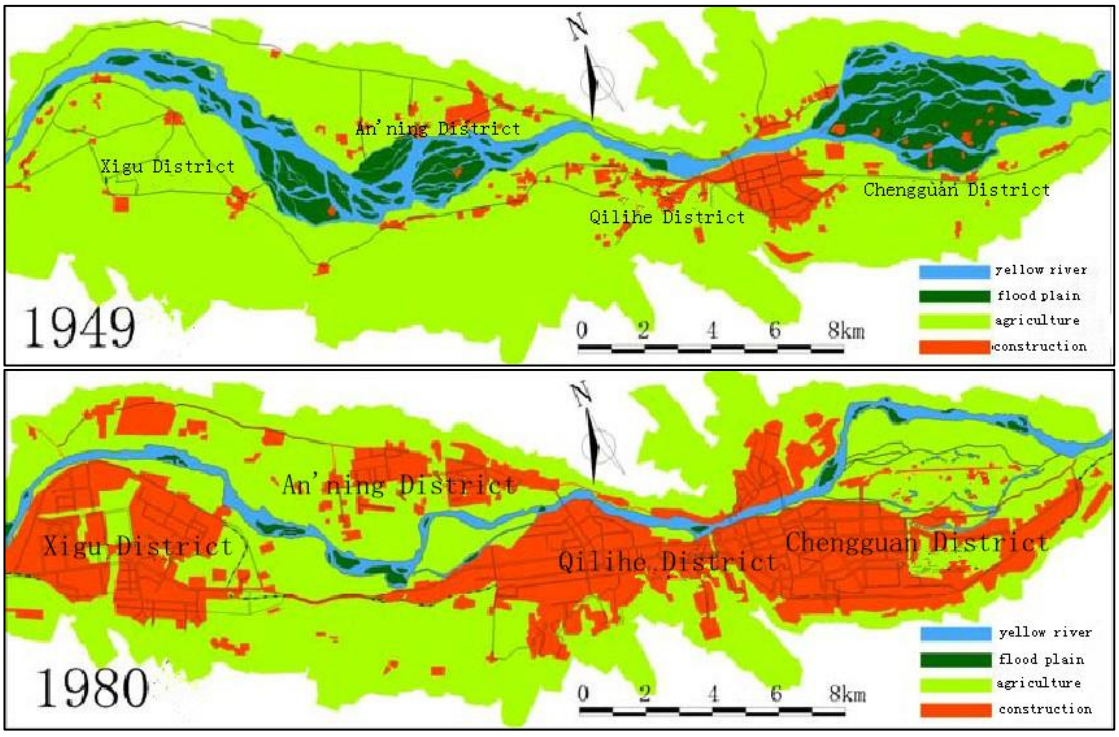
Any research cannot be in progress without concept to support. Since this study focuses its efforts on finding a useful way for urban growth, the main considered concept is "smart growth" which idea was introduced in the U.S. against urban sprawl specifically. Smart growth concept was mentioned by environmentalists and planners in early phase, compared with new urbanism, and it is more concerned with overall environment. This research not only shows respect to traditional planning ideal, but also to integrate urban development into the ecosystem, human life quality and society equity accomplishing a harmonious and sustainable development. What is more, in different manage level and field, smart growth also shows a good example to build mutual connection. So this concept may lay a scientific foundation for the future development of Lanzhou city.

1.3 Problem Statement

This section presents issues of this study, it is the reason why this study should be conducted, and there are two issues exist in Lanzhou city as below:

1.3.1 Urban Area is suffering from An Uncontrolled Growth

According to the statistic data from Lanzhou city statistic department on built-up area (2010), Lanzhou City is almost going to finish the existing 1670 square kilometers of urban land. Figure 1.2 shows that one of the most significant phenomenon is the floodplain and the river park which planned in the first version of the master plan was substituted in the second edition to agricultural land and cultivation base, and keep changing to construction land in the third Edition. Obviously, reserved green corridor and ecological construction land have being gradually eroded while ecological space is undermined. On the other hand, Figure 1.3 shows that Lanzhou city has oriented itself into 4 functional districts at the beginning. However, as time gone, some districts had been already contiguous with each other and will form an entirety result of the physical isolation was destroyed eventually.



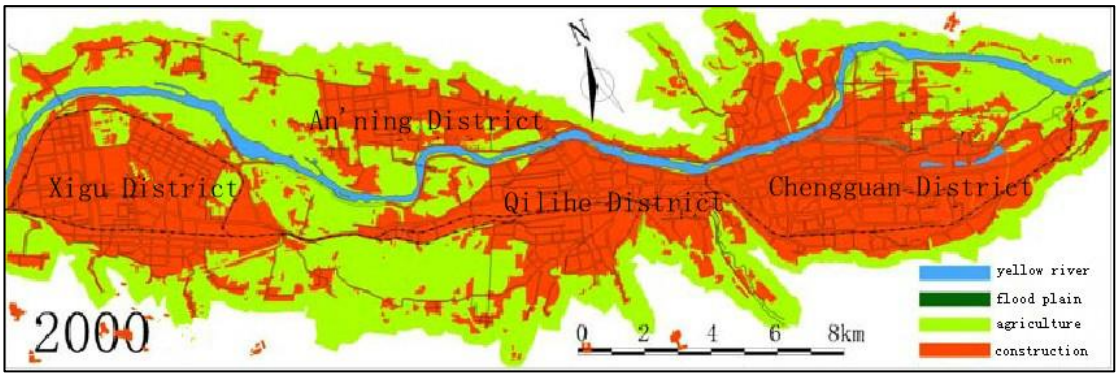


Figure 1.2: Change of the Yellow River from 1949 to 2000

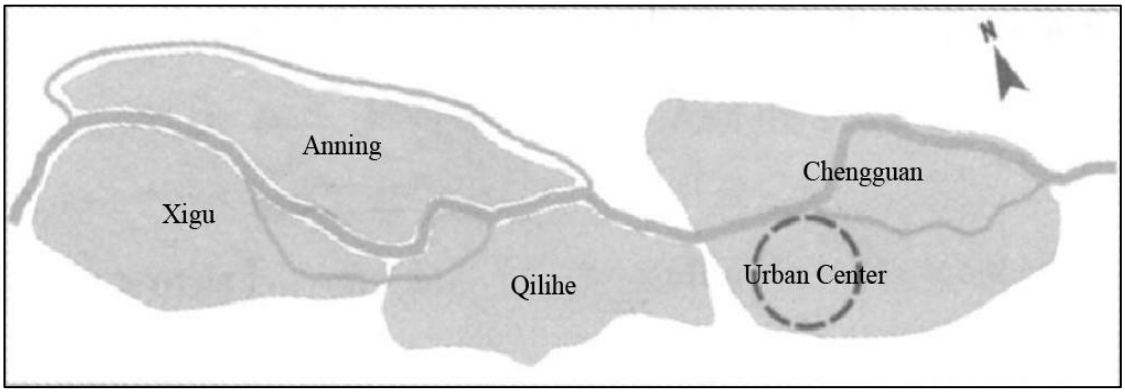


Figure 1.3: Illustration of Four Districts (1)

Lanzhou city is a typical linear valley city, to imagine the city is around 50 kilometers long only 1.8 kilometers in the narrowest area. Linear city has always distributed and extended in a strip shape. Naturally, the urban spatial shape is narrow and small with a weak sense of integrity. It means that once the city has unlimited expansion from east to west where along the direction of the Yellow River, this situation will be heavier and difficult to control than common urban sprawl, because people will waste more time and energy in such a long distance reaching to their destination in their daily life. Thus, how to develop in a rational way in the insufficient space for urban development become more and more crucial.

Nowadays, in Lanzhou city, the development is suffering from an unprecedented land shortage. With the rapidly economic increase year after year, the urban space, natural resources, ecology and different class industries are all involved in huge mountain, deep valley and small basin inevitably. Consequently, a high density population occupies limited land and traffic congestion has frequently

happened. Since the city has no way to grow, to find a way relieve the inner growth pressure is necessary.

1.3.2 The Current Urban Layout is Less Local Integrity

This issue is the reason which makes this kind of urban sprawl intensive and aggravated. In the four districts, each of them has distinctive characteristics which are so strong that neglect the development of other land use. Table 1.1 shows the basic land use in each zoning and highlight the main function.

Table 1.1: The Main Function of Each Zoning

Cluster name	Main function
Cheng guan	Lanzhou city's political, economic, commercial and cultural center and main residential zoning.
Qi lihe	Lanzhou city's railway hub, some light industries like machinery industry and textile industry and residential area
An ning	Education zoning, several universities distributed there, mixing some electronic industry, building material processing and some new residential area
Xi gu	Heavy industry zoning, a spot of residential area

Figure1.4 shows the current master plan of Lanzhou city, we can easily find that the land use in the four districts are not comprehensive and unbalanced. For example, the yellow area stands for residential land use, and most of them concentrate on the urban center while few of them distribute on other districts separately. Moreover, except Chenguan district land use is relatively comprehensive while other districts are single and simple. Based on smart growth principles, mix land use should combine of residential, commercial, cultural, institutional, or industrial uses, where those functions are physically and functionally integrated, and that provides pedestrian connections. However, here does not reach to the goal which make use of land intensively and reasonably while has a strong need of land and spatial expansion.

Figure 1.4: Lanzhou City's Master Plan (2001-2010)

1.4 Research Question

In general, this research starts with the purpose which tries to find the answers about these questions below:

I. To what extent is Lanzhou city's urban area spatial expansion sustainable?

II. How can the smart growth concept contribute to create an optimal development scenario in Lanzhou city?

III. Which kind of urban growth type is suitable for Lanzhou city to consider in the future?

1.5 Research Objective

Since urban sprawl has a heavy and undeniable effect to linear city, to know the current situation and changed tendency about Lanzhou city is very important. According to Lanzhou city's comprehensive plan in which four districts which were decided previously, the general research aim follows the existing situation to go through and find an appropriate development trend for Lanzhou city and make the city more sustainable. In order to answer the research question and reach to the main aim, three research objectives are necessary.

I. To build scenarios for urban growth representing economic efficiency, environmental protection and social equity by questionnaire result.

II. To build on models for land use allocation that explains the urban growth by using several land uses as necessary inputs.

III. To evaluate the processed data based on smart growth principles.

1.6 Research Framework

This research follows four main steps to explain the structure which is shown in Figure 5.1. It stats from inputting defined issues and basic data and information, by using GIS software as processing tools and combine with other techniques to analyze the input. After that, the analysis result is evaluated with the help of conceptual and theoretical basis as well as both quantitative and qualitative view. At the end, the outcome is an optimal scenario in alternatives with justification.

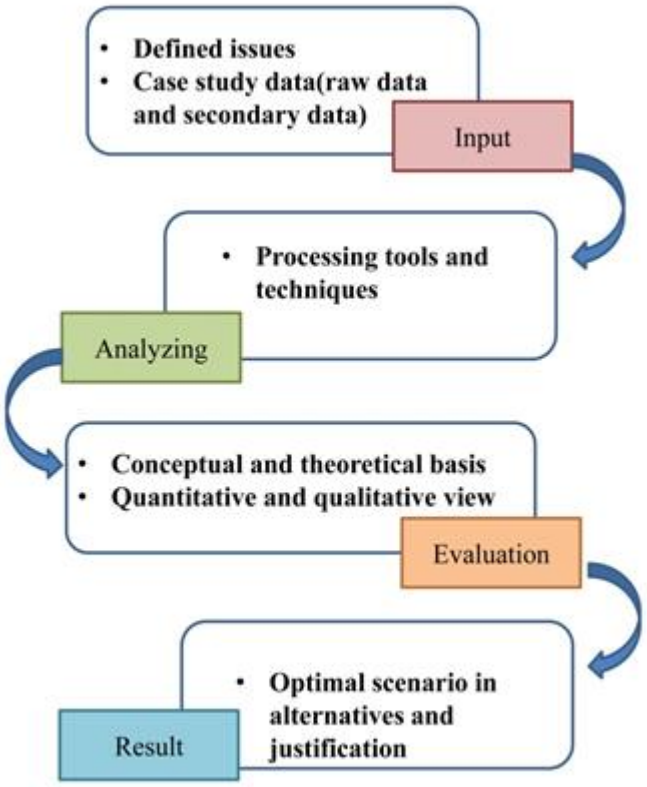


Figure 1.5: Research Framework Structure

1.7 Significance of Study

"Smart growth" strategy was thrown up with in the early 1990s in the United States in order to solve urban problems brought from spatial structure extension after suburbanization (Daniels, 2001).

In the United States, suburbanization was derived from the high income level had escaped from urban diseases, under the premise of improving the traffic conditions, as a result, suburban transferred from single residential function to multi-functions area.

However, the suburbanization in China is mainly created by the proliferation of urban fringe and where have backward infrastructures and utilities, as a result, the

unreasonable transportation flow leads to constructed area sprawl little by little.

Obviously, there is a remarkable difference between the United State and China in suburbanization which happened in a distinct way, motivation, as well as mechanically.

Despite all this, smart growth concept has advocated compact development, land use intensification, stressed on public transportation and set reasonable growth boundary as core principles. It is according with the development direction and goal in China. Thus, this study uses smart growth concept as a source of reference for formulation the scientific and rational strategy of urban spatial development in Lanzhou city, and it will bring a certain sense of inspiration and a good sample for future.

1.8 Research Organization

This study is divided to 6 chapters, each of these chapters will cover an aspect of the study; the deviation is as follow:

For chapter 1, the discussion is focus on overall view of this study, to address general issue and research objective and mention research question as well. At the end, a short description talks about study significance.

For chapter 2, a brief background covers the difference and similarity between the United States and China urbanization process. After that, to make a connection with smart growth strategy by reviewing its definition and application. Meanwhile, some case study reviews also contribute to the understanding of the methodology.

For chapter 3, it is more toward the research structure and methodology that

binding the thesis, this chapter also contains the tools and research methods used in data processing in this study. As a result, three intended scenarios will be built with the explanation in each step.

For chapter 4, is considering the solution of raised research question, it concentrates on support finding of the analysis with related literature review. The purpose of this chapter is to find the best scenario for Lanzhou city from alternatives.

For chapter 5, sums up the research finding and makes a conclusion to describe this study. In addition, come up with some recommendations regarding the research limitation and propose some potential possibility of this study in future research works.

REFERENCE

Alkheder, S., Wang, J., Shan, J., Drive, S. M., and Lafayette, W. (2006). Change Detection-Cellular Automata Method for Urban Growth Modeling.

Atkinson, M., & Kersten, M. (2010). Data-Intensive Research Theme.

Barbara, S., and Site, D. (1998). GIS and Spatial Data Analysis: Converging Perspectives, 1 2 1., *44*(0), 1–26.

Batty, M., Xie, Y.,and Sun, Z. (1999). Modeling Urban Dynamics Through GIS-based cellular automata. *Computers, Environment and Urban Systems*, *23*(3), 205–233.

Behan, K., Maoh, H., and Kanaroglou, P. (2007). Evaluating Smart Growth Strategies with Simulations : Evidence from Hamilton , Ontario, (September).

Behan, K., Maoh, H., and Kanaroglou, P. (2007). Evaluating Smart Growth Strategies with Simulations : Evidence from Hamilton , Ontario.

Bo, L. (2008). Urban Sprawl Risk Assessment Based on Ecological Infrastructure : An Approach to Smart Conservation, (2), 1–10.

Burchell, R. W., Listokin, D., and Galley, C. C. (2000). Smart Growth : More Than a Ghost of Urban Policy Past , Less Than a Bold New Horizon. *Housing Policy Debate*, *11*(4), 821–879.

Carlson, T. N., and Traci Arthur, S. (2000). The impact of land use — Land Cover Changes Due to Urbanization on Surface Microclimate and Hydrology: A Satellite Perspective. *Global and Planetary Change*, *25*(1-2), 49–65.

Chang, K. *Introduction to Geographic Information Systems*, sixth edition, Chapter 12, Ryan Blankenship, 2012

Cheney, T. (2010). Raster Identification of Areas for Urban Village, Smart Growth Development, from http://www.gis.unbc.ca/courses/geog413/projects/2010/cheney/index.htm

Craig W. Kelsey,(2001). Smart Growth Planning Principles and Recreation. http://resources.arcgis.com/en/help/main/10.1/index.html#//009z0000009s000000

Chen, X., (2010). The history of American urbanization, Features and Implications.

Choi, S., Wang, P., Delgado, E., and Ryu, S. H. (2007). Monitoring Small Area Growth with GIS : An Application to the City of Los Angeles, 1–27.

David W. Allen. *GIS Tutorial 2: Spatial Analysis Workbook*, Chapter 5, ESRI press, 2009.

Daniels, T. *Smart Growth: A New American Approach to Regional Planning*, Planning Practice and Research, Volume 16, Issue 3-4, 2001

Enzmann, D. R., Beauchamp, N. J., and Norbash, A. (2011). Scenario planning. *Journal of the American College of Radiology : JACR*, *8*(3), 175–9.

Ewing, R. (n.d.). Best development practices : A Primer for Smart Growth.

Freudenberg, N., Galea, S., & Vlahov, D. (2005). Beyond Urban Penalty and Urban Sprawl: Back to Living Conditions as the Focus of Urban Health. *Journal of Community Health*, *30*(1), 1–11.

Geymen, A., and Baz, I. (2008). Monitoring Urban Growth and Detecting Land-Cover Changes on the Istanbul Metropolitan Area. *Environmental Monitoring and Assessment*, *136*(1-3), 449–59.

Goldstein, S. M. (2000). The United States and the Republic of China, 1949–1978: Suspicious Allies, (February).

Gu, C. *Economic Globalization and Urban Development in China*, the Commercial Press, 1999:201.

Haeuber, R. (2000). Sprawl tales : Maryland ' s Smart Growth Initiative and the Evolution of Growth Management, 131–147.

Harnish, M., (2010). San Joaquin Valley Blue plan process.

Herbert J. Gans (1967) "Levittown and America" from the levittowners.

Hu, Z., and Lo, C. P. (2007). Modeling Urban Growth in Atlanta Using Logistic Regression. *Computers, Environment and Urban Systems*, *31*(6), 667–688.

Huang, H. (2007). United States“Smart growth” Strategy-A Case Study of Application and Reflection in China.pdf.

Huang.Y. (2010). Urban Development and Government Land Ownership : *Global Development Outlook 2010*, (March).

ICCMA (1998), Why Smart Growth: A Primer, International City/County Managem ent Association, Smart Growth Network and USEPA from www.epa.gov/smartgrowth .

Jantz, C. a, Goetz, S. J., and Shelley, M. K. (2004). Using the SLEUTH Urban Growth Model to Simulate the Impacts of Future Policy Scenarios on Urban Land Use in the Baltimore -- Washington metropolitan area. *Environment and Planning B: Planning and Design*, *31*(2), 251–271.

Jantz, C. a., Goetz, S. J., Donato, D., and Claggett, P. (2010). Designing and Implementing A Regional Urban Modeling System Using the SLEUTH Cellular Urban Model. *Computers, Environment and Urban Systems*, *34*(1), 1–16.

Jerzy M. Kozlowski, Ann Peterson, *Integrated Buffer Planning: Towards Sustainable Development ; with The Guide*, illustrated, Ashgate Publishing, Ltd., 2005.

Kelsey, C. W., (2001). Smart Growth Planning Principles and Parks and Recreation.

Kityuttachai, K., Tripathi, N., Tipdecho, T., and Shrestha, R. (2013). CA-Markov Analysis of Constrained Coastal Urban Growth Modeling: Hua Hin Seaside City, Thailand. *Sustainability*, *5*(4), 1480–1500.

Kim, S and Margo, R. (2003). "Historical Perspectives on U.S. Economic Geography," NBER Working Papers 9594, National Bureau of Economic Research, Inc.

Kung, K., Xu, C,. and Zhou, F. (2009), From Industrialization to Urbanization: The Social Consequences of Changing Fiscal Incentives on Local Governments’ Behavior1, (March).

Liu, L. L. (2012). An Analysis of the Influencing Factors in New Urban Planning under the Conception of Smart Growth. *Applied Mechanics and Materials*, *174-177*, 2433–2439.

Margaret H. Carr, Paul Dean Zwick, *Smart Land Use Analysis: The LUCIS Model Land-use Conflict Identification Strategy*, illustrated, ESRI, Inc., 2007

Meyers, N. (2010). Using GIS Identify Suitable Areas for Smart Growth and Transit Oriented Development for Specific Areas with the City of Minneapolis, Minnesota, *12*.

Natural Resources Defense Council, *Solving Sprawl: Models of Smart Growth in Communities across America*, illustrated, Island Press, 2003

Nelson, K., Nisenson, L., Kay, M., Sobel, L., Sprague, E., Torma, T., Epa, P. A., et al. (n.d.). *Getting to Smart Growth II :*

Niemeier, D., Bai, S., and Handy, S. L. (2011). The Impact of Residential Growth Patterns on Vehicle Travel and Pollutant Emissions. *Journal of Transport and Land Use*, *4*(3), 65–80.

Paul A. Longley, *Michael Batty, Spatial Analysis: Modeling in a GIS Environment*, illustrated, John Wiley and Sons, 1996

Piper Rae Gaubatz, *Beyond the Great Wall: Urban Form and Transformation on the Chinese Frontiers*, illustrated, Stanford University Press, 1996

Pullar, D., and Corcoran, J. (2005). Urban Growth Scenarios – Is the Aim to Fit Into Urban Spaces or Live in Them? David Pullar and Jonathan Corcoran, *2026*(Seq 2005).

Racine, P., Cumming, S., and Denver, F. (2011). Intcing PostGIS Raster • Support for Rasters in the PostGIS Spatial Database, (September).

Ratti, C., and Richens, P. (2004). Raster Analysis of Urban Form. *Environment and Planning B: Planning and Design*, *31*(2), 297–309.

Riefler, R. (1979). Nineteenth-Century Urbanization Patterns in the United States

Schmidt, E., and Kedir, M. (2009). Urbanization and Spatial Connectivity in Ethiopia : Urban Growth Analysis Using GIS.

Song, J., Li, X. (2006). The U.S. Urbanization Process and the Enlightenment. *Urban Issue*, 129, 88-92.

Sturm, B. C., and Heater, N. (2012). Preserving Land through Compact Growth : Case Studies of Noncontiguous Clustering in New Jersey, (April).

Sun, J. (2010). The Revealation of Smart Growth Practice in The United States.

Daniels, T. *Smart Growth: A New American Approach to Regional Planning*, Planning Practice and Research, Volume 16, Issue 3-4, 2001

Town, O., and Arcmap, S. (2011). Lab 7 : Data Vector Spatial Analysis, 1–23.

USEPA (2003), Smart Growth Index (SGI) Model, US Environmental Protection Ag ency from www.epa.gov/smartgrowth/sgipilot.htm

Varela, O. J., and Consultant, G. I. S. (2008). Integrating Spatial Analysis in Decision Modeling for Smart Growth Initiatives, (414).

VTPI (2005), Online TDM Encyclopedia, Victoria Transport Policy Institute from www.vtpi.org.

Walker, W. T., Gao, S., and Johnston, R. a. (2007). UPlan: Geographic Information System as Framework for Integrated Land Use Planning Model. *Transportation Research Record: Journal of the Transportation Research Board*, *1994*(-1), 117–127.

Wan, T., Gu, Y., and Xu, J. (2011). On Spatial Layout Patterns of Harbin Songbei New District Under the Guidance of Smart Growth Theory. *Applied Mechanics and Materials*, *105-107*, 1628–1633.

Wong, C. (2012). Paying for Urbanization in China: Challenges of Municipal Finance in the 21st Century. *Economic Research Guide*, (August).

Wu, Y. (2009). The Historical Process of Urbanization in China, the Status Quo and Countermeasures. *Economic Research Guide*, 4-10.

Yang, F. (2009). if ’ Smart ' is ' Sustainable '? An Analysis of Smart Growth Policies and Its Successful Practices.

Ye, L. (2005). What Is “Smart Growth?”--Really? *Journal of Planning Literature*, *19*(3), 301–315.

Yue, H. and Liu, A. (2004) Control of Urban Land Expansion Progress. *China Land Science,* Vol. 25, No. 25, (May).

Zhang, X., Tim D., Mount and Richard N. Boisvert, (2000). Industrialization, Urbanization, and Land Use in China. 2000 *International Food Policy Research Institute* (March).

Zhiling Lui, Jjiangfeng Li, J. G. (2006). Urban Spatial Expansion and smart Growth Chinization, *2031*, 7–10.

Zhou, Y. and John R. Logan. (2005). Suburbanization of Urban China: A Conceptual Framework

Zhu, B., Li, X., Lei, J., and Zhang, X. (2009). Urban Spatial Expansion Based on "Smart Growth". *2009 First International Conference on Information Science and Engineering*, 4613–4617.