

Investigation and analysis of spatial structure of metropolitan Hamadan using Alen Bertod model

Masoud Asadollahi *, Kianoush Zakerhaghighi

Department of Urbanism, College of Arts and Architecture, Hamedan Branch, Islamic Azad University, Hamedan, Iran

Abstract: One of the basic problems facing urbanism is the uncontrolled growing and development of metropolises. At present, many efforts made in order to situation and direct and control of urban transformation are ineffective. This failure is because urban transformation formed based on complex and mutual effect of market forces, public investment, and regulations is not investigated and as a result, major inefficiencies from weak spatial structure are ignored. Hamadan metropolis is not excluded, so that if today quick growth and development are not controlled in different directions especially marginalization, it can lead to numerous urban problems in the short – time. So, analysis of Hamadan spatial structure is studied using descriptive – analytical method and documental – library using Alen Bertod model. Results obtained from research indicate that wastelands available in north and west north are used for planning future development of the city that cause lowest damage for gardens and reinforcement of CBDs of urban north area for doing such a development. On the other hand, reform of internal ring of city can lead to improve urban performance with respect to options.

Key words: *Urban development; Spatial structure; Alen Bertod; CBD; Hamadam Metropolis*

1. Introduction

Uncontrolled growth of cities is a problem that makes busy thoughts and minds of urbanism specialists. An experience that is unable to prevent disturbed and mismatched development and growth of cities (Yu-Hsin, 2005). Today, it is cleared that reason of failure of the city builders in achieving this is inattention of complex market forces, public investment and existing regulations governing on the city. So, understanding the spatial structure of cities increasingly is of importance. In fact, complexity of urban spatial structure prevent many efforts for analyzing it and also, introducing solutions for comprehensive urban development. Without attention to urban spatial structure, comprehensive plans preparation that is provided by attitude to achieve predetermined objectives in a time frame is filed (Bonham-Carter, 1994; glaster, 2001). While today, it is cleared to all urbanism specialists that cities as living creatures are dynamic and unpredictable, and factors involved in and effective on them are not completely predicted from before. It means that they are never made by per – drawn map.

Understanding of urban spatial structure is of high importance in the case of metropolises than other cities because metropolises, in turn, have more problems than other cities. High population, presence of high vehicles, air pollution all provide inappropriate urban development if non – attention to its spatial structure. Today, Hamadan city with

population amounted to 520 000 is announced as one of the metropolises. A city where has leaved behind the growth and development with high speed and velocity. Attack of population to Hamadan, growing motor vehicles and increasing sound and air pollutions in the city are observed. These conditions provide city for being converted to a high problem metropolis, and one can govern urban city guide only with attention to understand the urban spatial structure and prevent inappropriate urban development caused by leaving the city and increasing current and capital costs in the city and make city non – competitive economically (Hadly, 2000). Investments in the infrastructures are influenced by introducing strategies for urban development and implementation of integrated system and lands regulations. In long-term, shape of the city is depends on interaction among forces can act as incentives and incentives. Due to permanent change of spatial structure of cities and non – existence of clear views about urban spatial development, lands regulations, investment in the infrastructures are incompatible and their effects and feedbacks are not integrated and aligned. So, it is necessary to conduct permanent supervise on urban spatial development procedure and doing preventive activities and regulations if this procedure is inconsistent with objectives considered for the city (Beneson & Torrens, 2004; Yeh & Li, 2006).

2. Materials and methods

Aim of present research is to investigate the urban spatial structure of Hamadan using Alen

* Corresponding Au thor.

Bertod model along achieving to a solution for improving urban spatial structure effectiveness, improvement of transportation system effectiveness, decreasing pollution and introducing strategies for future urban development. Research method is descriptive- analytical and documental – library study that was using Alen Bertod model that led to prepare combinational maps such as map of urban center and maps related to density along achieving the research aim.

3. Theoretical Foundation of Research

Geographic space includes nature and all resources can encounter with human needs directly and indirectly and make new face of ground surface. So, geographic space is a habitat area that forms by natural conditions and social structure of society. Urban spatial structure results from historic process and changing economic, social and political conditions. Urban spatial structure is relative sustainable method of elements formation and urban factors that organizes how to deploy and connection method between them with given degree of regulation and performance capacity (Burton, 2000; Hess, 2001).

Christopher Alexander and B.V. Dooshi are most important urban planners who have explained their views about urban spatial structure. These two researchers place basic urban structure against fillers and believe that we can search for several factors or elements to understand urban building through them. These factors or elements are main network of access, main centers of activity and basic elements of city. Adapting these three elements, urban structure map is recognized (Clarke et al., 1997).

Physical patterns introduced for spatial structure of cities are:

A) Horizontal pattern: Development and urban extension is conducted by ground surface occupation and more space. Urban problems such as traffic density, air pollution, sound pollution, time waste are decreased by extension of urban wide plain. Appropriate land is found for different uses.

Poverty or class conflict is not prevented land access and free air. All people of society have freedom and selection right for achieving interested housing. Astrton says about land allocation for poor and wealthy people in Australia cities that is possible with urban horizontal development pattern. Naturalism and believing to social justice is evident in this pattern. Los Angeles of America and wide plain city of Brodiker is a type of the city with horizontal development pattern (Elkin et al., 1991).

B) Vertical expansion pattern: Urban existence philosophy is contrast with the nature. Not being peaceful coexistence of the city and the nature leads to heavy damages to the nature and environment and destruction of farming lands, high level of road rubbish and increasing uses per capita are the results of urban horizontal development. Air pollution arising from car traffic in a large area is

decreased by reduction of urban wide. Environment protection and access to sustainable development in urban environment is only possible with limited city. Increasing building density and activities density and change in the form of city building have prevented high horizontal development of the city. Dense New York City is fallen into this group (Ewing, 1997; Lin Robinson, 2002; O'Sullivan, 2001).

C) Detached extension pattern: different urbanization centers are prepared around the metropolis due to core nature and centralization of cities for assigning housing to different social strata and also problem solving of crowding in the metropolises. With decentralization according to ideas and proposed views related to spatial structure, most theorists emphasis that the city is a complex phenomenon having building, that is, existence composed of related and interactive elements that relation and interaction give it a kind of generality and totality and sustainable relation exist among components and its elements (Howard, 2002; Nozzi, 2003). With respect to the mentioned material, urban spatial structure has high importance and it is necessary to study and identify it and urban decision making along this understanding. Only in such conditions, policies and strategies will be effective. In order to recognize structure of cities, different models are explained that they try to facilitate this procedure with introducing the indexes. Following this understanding and limitations and opportunities certain spatial structure of any city creates, urban planners will be able to guide urban development using their tools such as urbanism regulation investment in the infrastructures and taxation (Wassmer, 2002; Zhang, 2000).

4. Results and discussion

Hamadan city is located in longitude 48° and 31/ east and width 34° and 48/ north and 180 m in height from sea level. Deployment of the city on foothill plain has given special morphological feature to the city. On the other words, development and urban networks are accepted following slope and / or more adaptation with the environment. Generally, slope of Hamadan city is from the south to the north and comply with Alvand foot of mountain slope.

4.1. Physical development procedure of Hamadan city in Qajar ear (Qajar to 1920)

In Qajar ears, there were large damages to the gardens of the city because of the uncertain prevailing in a long period after the First World War. One part of non – built lands where tourists visit it is related to these gardens and another part is related to non – built lands on ruined places of old royal castle that yet is not possessed by those who returned to the city after war.

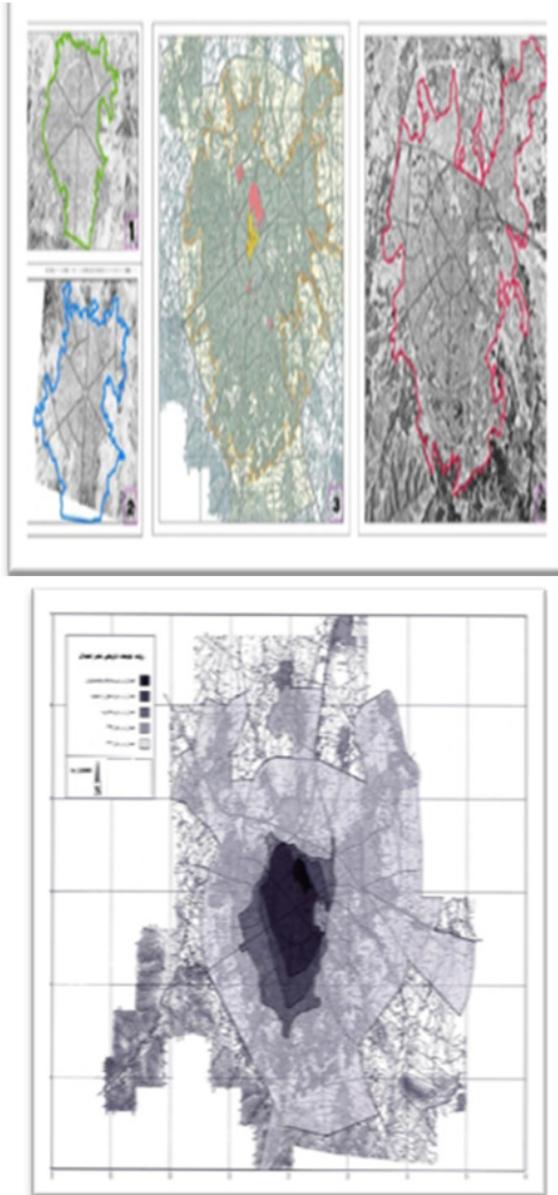


Fig. 1: The historical development of Hamadan

Extending city with population is estimated at least twice the past; it is one of the causes and determinants of urban organization. But, emergence of spatial interventions of new employment and then relation that is necessities of this employment and new social organization has main share in shaping urban spatial organization. Emergence and spatial intervention of new mechanical elements of transportation cause changes. These changes are both in social fields and in spatial limit, because most leading vehicle in the past, that is, horse owned by government and officers and need not to large allocation, but new vehicle needs to new allocations. This change of value give opportunities to the part of people who have more and faster possibility of relative domination on this new phenomenon to change social coordinates and emergence and / or required spaces changes proportional to these changes is the necessity that appeared following intervention of "car" phenomenon. Traditional trade

transactions depression and trade regime change have created changes in spatial organization that on the one hand, is proportionate to working people to trade and on the other hand, was the method of doing trade. Because these transactions are changed based on specification from method of observing objects and direct selection in order way, and these changes fulfill in less limits in terms of spatial quantity, but qualitatively, that is, space organization, are quite different. As a result, main volume of transactions in terms of amount is occurred in spaces such as commercial firms and market, in fact, is translated in to goods supply place for consumer of inner city.

4.2. Procedure of physical development of Hamadan city in Pahlavi ear (1920 to 1978)

Hamadan city with its main relational lines, trade center and finally, general divisions of social strata encountered with new elements that most of them have their place in existing structure of the city. Offices and justice organizations are located in Mesopotamia region, that is, former Bu Ali Street. Financial centers are located in the adjacent of market and commercial firms are also located within market and / or in the adjacent of old neighborhoods. But, what creates problems gradually was growing communications of these elements and old elements together that they didn't find appropriate place for themselves. Missionaries' centers, on the one hand and governmental centers on the other hand were added to this aggregation and special composition. Since these two centers need independent connection way with outside the city, on the other hand, cars enter into life and community of people, a road was used where previously was relational device of city and villages and / or farms? Gradually and with increasing traffic in this road that is the same pasdaran, mirzadeh Eshghi streets to Bakhtiyari neighborhood and Taleghani street to Chapar Khaneh, it translated into main road where provided access to new elements development (center of missionary) gendarmeries, big governmental centers. This era, in fact, is known as a beginning of scattering of urban spatial organization. Exactly, the dispersion arising from non-symmetry of urban structural growth with established system has created reason of government interventions. In the other words, urban organization is changed proportional to its physical growth. Trade center and market were providers of the main needs and established centers in grasses and/or series of shops were responsible for daily needs of the city and relational regime connected different elements and areas of the city to each other. So, growth of population after world war I, on the one hand and adding single-purpose and disparate social groups to urban society, on the other hand, accordance with providing facilities for vehicles and finally "solving problems of city" have caused central government shows its presence and power in the city in addition to intentioned problems through

organizational interventions. In 1976, grass density in Hamadan city was equal to 258/4 people in hectare and this number was increased to 216 and 135 people in hectare respectively in 1966 and 1976. Apparently, this procedure is desired, but when being added city surface per person, above procedure has another meaning. In 1976, only 35 m² of urban surface was allocated per Hamadani citizenship. By 1966, 24258 individuals had added to Hamadan population and 93 m² had added to urban surface per individual had added to the population of the city during that time. This relation was worsening during 1966 to 1976. What is clear is that main changes have not occurred in central limits of the city, although exploitation of the service, being more diverse of all kinds of services includes part of these additional levels.

4.3. Physical development procedure of Hamadan city after revolution (1978 to 2013)

A) From 1978 solar to 1984 solar: If basic works of government reform programs started in 1961 to 1978 were not quite evident, it is because Hamadan attractiveness is not comparable to other cities for attracting working forces. Increasing income of oil and its focus on cities created such attractiveness for smaller cities including Hamadan. Only half of all non-born in Hamadan city have migrated to the city before 1978. With respect to brightness power of the city in the region from 1966 onwards, effects of government reform programs are quite evident, because only 18/5% of immigrants to Hamadan city have resided in the city before the date. This quickly migration is represented as a problem when its effects are considered in job creating. Independent staff growth to 19% in distance less than 9 years necessarily is thinkable. Effects of these changes are perceived in Hamadan city either for extent or size and either for urban structural bases. Exactly, due to economical-cultural determinants, suburb neighborhoods of the city are only points where accepted immigrants. These structural changes of society which Hamadan is sample of it, became field of revolution victory and tune of these changes continued to 1981 s for mentioned reasons. Although forced war and making government policies was relatively more effective in the control of population movements. Dichotomy in economic and social organization of the city has effect on urban organization. Old market of the city, in the spite of bearing surgery done on it by Karl Frisch plan, is only center of meeting the Hamadani citizenship needs, and regions have created new extent of the city after 1966 have not exploited minimum facilities and interestingly, irrespective to financial facilities of habitants or neighborhood antiquity, only neighborhoods have maximum facilities and urban installations where established by the government, and this is not related to special

neighborhood or period. Villages combined with the city have intensified this problem. Being out of limit is equal to being cheap of land price and this creates adequate attractiveness for attracting immigrants in years after 1976.

B) From 1984 solar to 2013 solar: After the end of comprehensive plan horizon of 1983, its revision is done by consultant engineers of the plan and collection in 2002 to 2004. But, detailed revision plan of the city lacks comprehensive studies and influence area, so, mentioned plan has emphasized on physical structure of the city. In spite of selecting Hamadan as the one of five cultural and his historical cities of Iran and selection of the city in Zagros region plan as a regional center about 1996 which economic power of the country was more spent to reconstruction of war scars and improving the economic structure of the country, significant investment was made in Hamadan city.

4.4. Explaining the spatial structure of Hamadan city

At first, three main features will be investigated that Alen Bertod believes that they explain spatial structure of cities:

- Land consumption per capita
- Spatial distribution of population in built areas
- Pattern of daily trips of inner city.

Land consumption per capita determines an area that one city needs to its development. This rate is usually measured with reverse of consumption per capita of land, person density in hectare of built area of the city. Density in built neighborhoods located in the built limit of Hamadan city (full context of the city) with 4/6257 population and area about 5200 ha is equal to 78 people in hectare. Compared to the built densities of relative high, this density is relative high. But, when the density is compared to the density of other big Asian cities, Hamadan density is lower. From these results it is seemed that density of Hamadan city can, irrespective to the important environmental or infrastructural problems, be more or less than this amount. Population distribution in Hamadan complies with its pattern and usual procedure, that is, density with being away the city center since trade center of the city is attracted more than 30% of inner city trips, so, it can be considered as a CBD of the city. Old texture of Hamadan city has the highest density, but with development of the city after 1951 toward around the city, now highest density is created 3 km from the city. Because majority of buildings are related to the market and office centers and public buildings within central ring of Hamadan city, density is decreasing and highest density of the city is within second ring of the city. But, with respect to compression of urban texture within second ring and increasing building densities by municipality, population density is moving to out of second ring in distance of 3 km from city center. Profile of Hamadan density, as

shown in following figure, has verified this subject. Densities are increased to the distance of 2 km from the city center, and then decreased toward around of the city. This pattern has shown a strong and prevailing trader and business center, suggesting presence of a strong trade center.

Table 1: Density profile, in the ring of Hamadan

Density	Loop area (ha)	Population (87 years)	Reel number
111	312	34549	1
119	946	113015	2
110	1178	130258	3
75	1293	97163	4
41	1166	48179	5
43	305	13093	6
0	Outside the city limits	2565	7
78	5200	406257	Sum

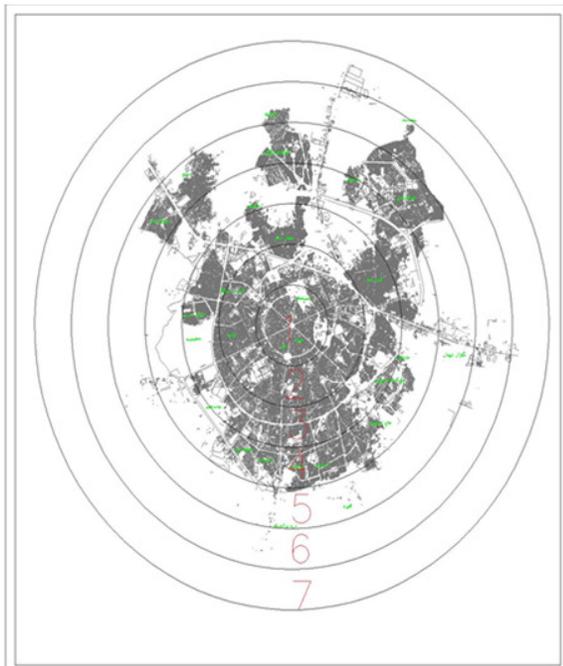


Fig. 2: The population density in the area and density profile of Hamadan

Profile of Hamadan density, as shown in above figure, has confirmed above recognition. Densities are increased in the distance of 2 km from the center, and again decreased to the round of the center that is different from of the crater. In distance of 6 km from neighborhood city such as Madani town and villages added to the city limit has caused little increase of the population and in the distance of 7 km from city center population density is reached to zero, confirming pattern of mountain cities that cities are built dense. Graph of density profile and land price in Hamadan city are relatively coincident to each other and pattern of land prices has approved past findings: Hamadan has powerful CBD trade center that is absorbent of jobs and retail. Land prices in the city center is more expensive than land prices in

other points of the city, in most cities of the world, profile of land price complies with density profile; numerous findings and writings, theoretically and empirically, are available about this subject. Density profile and price profile in Hamadan is also the same (Figure 6). This graph also approves that trade center of the city is powerful absorbent and the city is mono nuclear in which jobs (employment) and retail are concentrated in the city center. Also, highest price of land exists within second ring of the city (distance of 2 km) and price of land is gradually decreased outside the second ring of the city. What is clear in the map is that central parts have highest price of land due to presence of trade uses and jobs and southern regions of the city have highest price of land due to more suitable quality of life and services. Also, some regions in eastern parts of the city have high prices due to industrial uses. What is concluded from the graph is that the highest price of land is in distance of 4 km from the city and with respect to limited makeable lands within the city limit, land price will be increased in the future years in the whole city that this increase will be higher in distances of 5 and 6 km.

Table 2: Density profile, in the ring of Hamadan

Density	Average price (million in Rial)	Population (87 years)	Reel number
111	2600	34549	1
119	2300	113015	2
110	1600	130258	3
75	1500	97163	4
41	1100	48179	5
43	700	13093	6
0	400	2565	7
78	***	406257	Sum

Matrixes of origin and destination for job daily coming and going using motor vehicles and coming and goings done in order to shop show that neighborhood number 1 or city center is similar to what can be proposed as a trade center of Hamadan city. This region attracts more than 30% of total job travels. Central square of Hamadan city, with respect to its design by Karl Fresch, is designed, so that when citizenship who wants to go every point of the city will be passed once through city center. With respect to the detailed plan of Hamadan city defining number 1 neighborhood as a pavement and majority of trade and service uses are centered in this part, distribution of trips and access to the neighborhood will be changed in the future. From table of trips distribution it is clear that one powerful trade center is approved as an absorbent with high density and also, high price of land in the region.

5. Conclusion

Spatial structure of a city has important effect on economic effectiveness and urban environment quality. But, developmental flow of urban from that is shaped by complex interactions of market forces, public investment and regulations, is not monitored. As a result, important ineffectiveness arising from a weak spatial structure is often ignored, so that time is wasted for any action. Urban planners have often documented to comprehensive plans. These plans are prepared every 10 years and for ensuring that cities are developed with the aims of municipality. One city is not like a very big building and never constructed corresponding to technical drawing. Development of a city is affected by external forces of economy.

Table 3: Kidney amount travels attracted to the metropolitan area of Hamadan

Absorption of the inner regions	Area
75871	1
9566	2
12195	3
4477	4
9482	5
10800	6
8653	7
131044	Sum

Survival of cities is related to find quickly imagery solutions for new problems that previously has not predicted by author of comprehensive plans. From economic point of view, one city is a big market of manpower and consumer, bigger size the market and lower prices of transactions, more prosperity the economy. An ineffective spatial structure has divided manpower markets and consumers into smaller ineffective markets. This structure helps increase the exchanges cost with unnecessary increasing distance between people and places. An ineffective spatial structure increases length of the city infrastructure network and hence increases its capital cost and operational cost. An ineffective spatial structure can make city uncompetitive economically. For example, more jobs in Hamadan are administrative and service that has not appropriate growth in the area of industry that it needs to economic jump for urban sustainable growing. From environmental point of view, an ineffective spatial structure decreases the quality of life with increasing spent time on transportation, increasing air pollution and with help to unnecessary extension of urban regions in natural places. Weak environmental quality can also help to being uncompetitive of the city economically. In Hamadan city, with respect to its placing position and gardens available on suburb and rivers passing through the city can affect structure and skeleton of the city, and use of this potential can have positive and negative effects on life quality. In market economies, municipalities can affect urban development not through direct design, but through implementation of an integrated and similar system from regulations of land use, infrastructure investments and taxes

related to the land. In long-term, shape of the city depends on a way that real estate market reacts to encouragers and inhibitors established by these regulations, infrastructure investments and taxes. Since external economic conditions are regularly changing and in long term are not predictable, part of municipalities planning should monitor their spatial structure continually and finally, equilibration and nature of incentives and defectives adjust and confirm regulator, formulate new and different infrastructure investments, and reform local taxes, if necessary. Spatial structure of a city is continually developing. Land use regulations and infrastructure investments are often incompatible due to lack of political consensus and lack of clear vision about spatial development and maybe their combinational effects violate each other. So, it is important that municipality monitors spatial procedures of development and if this procedure violates objectives of municipality, regulatory measures should be done for solving this problem. Hamadan has high potentials that can be used for converting the city to an important economic, historical and cultural pole in the country in the future. Urban management now is placed on junction in its spatial development that can continue Hamadan development as a city with middle density and powerful CBD or can reinforce CBDs available in the city through formulated investments in public and infrastructure transportation to reduce established limitations. Selected transportation system for future which is both dense network of taxi and bus and completed network of new transportation systems, will make decisions about future of urban spatial development. Both options are possible. However, it is better that urban management implements integrated set of land use regulations reform, infrastructure investments, and tax on the real estate that is compatible to selected spatial option. In following, large part of Hamadan pollution problem can be solved by changing fuel of public transportation and cars about 60%. These measures are cost receiving in expense of the market, for parking aside of streets kerbs and receiving more and more density toll on urban high ways. Finally, unutilized lands available in the north and northwest of the city are used for planning for future of city development that have lowest damage to gardens of Hamadan and necessity of doing such a development is the reinforcing the CBDs of north area of the city. Also, reform of internal ring of the city can improve performance of the city with respect to the options ahead.

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References

- Beneson I., Torrens P., (2004). Geosimulation: Automata-based modeling of urban phenomena; John Wiley.
- Bonham-Carter G.F., (1994). Geographic information systems for geoscientists modeling with GIS; Pergamon.
- Burton E. (2000), 'The Compact City: Just or just compact? A preliminary analysis' *Urban Studies*, 37(11): pp. 1969-2007.
- Clarke K. C. S. Hoppen, Gaydos L., (1997). A self-modifying cellular automaton model of historical urbanization in the San Francisco Bay area *Environment and Planning B*, 24: pp. 247-261.
- Elkin, T et al., (1991). *Receiving the city towards sustainable urban development Friends of the Earth*, London.
- Ewing, R., (1997). Is Los Angeles-style sprawl desirable? *J. Am. Plan. Assoc.* 63. pp. 107-127.
- Glaser, G et al., (2001). Wrestling sprawl to the ground defining and measuring an elusive concept, housing policy debate" volume 12, issue 4.
- Hadly, C.C., (2000). "Urban Sprawl: Indicator, Causes and Solutions", www.city.bloomington.in.us/planning/edv/ec/index/html.
- Hess, G.R., (2001). "Just what is Sprawl Anyway?" www.4.ncsuedu/grhess.
- Howard, Frankin. (2002). "Dispersion urban and public health", www.City.Bloomington.
- Lin Robinson, (2002). "Twenty and five years of Dispersion experience in the Seattle region: reactions growth management and protection concepts", *Urban Studies*, 33(1), pp. 7-35.
- Nozzi, D., (2003). *Road to ruin: an introduction to sprawl and how to cure it*, Prayer, Westport Connecticut.
- O'Sullivan, D., (2001). Exploring spatial process dynamics using irregular cellular automaton Models, *Geographical Analyses*, No. 33, pp. 1-18.
- Yu-Hsin, Tsai, (2005). "Quantifying urban form: Compactness versus Sprawl", *Urban Studies*, Vol. 42, No1, pp141-161.
- Wassmer, R. W., (2002). Influences of the Focalization of Land Use and Urban-Growth Boundaries, www.csus.edu/individ/w/wasmerr/sprawl.html
- Yeh A., Li X., (2006). Errors and uncertainties in urban cellular automata, *Computers, Environment and Urban Systems*, No. 30, pp. 10-28.
- Zhang, T. (2000), "Land Market Forces and Government's Role in Sprawl", *Cities*, Vol.17, No. 2.