

Physical – Spatial Analysis of Yasuj City for the Purpose of Urban Environment Sustainability

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ABSTRACT: The present study seeks to identify and study the physical-spatial structure condition of Yasuj city and the effective factors on the emergence and evolution of the spatial structure of this city for obtaining a sustainable urban environment. The method used in this paper is descriptive – analytical method and the Shannon entropy, Holdern and interquartile distribution models have been used as well. The obtained results indicate that the city population during the last 40 year has increased about 22 times and also the area of the city in this period have become approximately 30 times. This process has caused the farming land to be turned into residential land and have caused some environmental problems. Based on the Shannon entropy model during 1996 – 2006 the city growth pattern is an ugly urban growth. Based on Holdern model 90.8% of the physical growth of the city during 1976 – 2006 is related to population growth and 9.2% of it is related to horizontal and spiral growth of the city. Based on interquartile distribution model around 48% of the population are living in more than 38% of the area of the city which indicates to the Uneven spatial distribution of the city. Considering the result of the research it is determined that the physical – spatial development of Yasuj city is not proportional with urban sustainability and that we recommend continuous expansion sector model, reduction in the size of the divided lots as well as consistent growth of other land uses with residential land use. In addition, sustainable city through participatory decision-making in designing cities will reduce the consumption of energy, creates a sustainable economy as well as a healthier environment, more comprehensive justice and a better quality life and can make possible sustainable urban development at a local level.

Keywords: Urban Sustainability, Shannon Entropy Model, Holdern Model, Interquartile Distribution Model, Yasuj City

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INTRODUCTION

City as one of the achievements of human from long ago have been the focus of attention of civilizations, in a way that with the arrival of the Industrialization wave to the third world countries, from the beginning of the 20th century production and income increased in cities and following that the demand for urban services increased as well. This trend increased the number and size of cities in these countries and ended in the development of Urbanization (Ebrahimzadeh Asmin et al., 2010). Considering the fact that development of urbanization hasn't been in harmony with the physical development and growth of the cities it has resulted in construction without planning and uncontrollable development and growth of citifies and frequent changes in the spatial structure of cities and have made cities face specific problems including destruction of farming land, combination of villages in cities, environmental problems (Shirmohammadi and Naghibi, 2007). The physical expansion of cities is a dynamic and continuous process during which the physical boundaries of the city and its physical spaces grow in vertical and horizontal directions in terms of quality and quantity (Zangiabadi, 1992). Physical growth and development manifests in the form of Increased city boundaries our horizontal expansion

(Sprawl) and vertical expansion is manifest in the form of importing the city population and the Compact urban growth model (Rahnam and Abbaszadeh, 2008).

Urban sustainability has been introduced after “sustainable development” as the new model in the world. Urban sustainability gradually, in addition to focusing on the dimension of ecology, focused on social and economy dimensions as well (Sarafi, 2000).

In Iran during the half of the recent century, the development of Capitalism, in the oil-reliant economy, caused the Stagnation of agriculture and quick growth of cities. This quick growth of urbanization hasn't been in a balanced way, but the growth in big cities has prevented the growth in small cities and villages. The outcome of this process has resulted in an imbalance in the spatial distribution and regional hierarchy (Nazarian, 1995).

In the planning of the physical – spatial development of cities focusing on measures of urban sustainability is of great importance. Therefore, studying the access to the urban facilities and services as one of the urban sustainability indicators is so much important and the inefficient spatial structure will cause to scatter the different and related land uses and causes higher expenses for exchanges due to the increase in the distance between origin and destination. Scattered development of the residential places in peripheral areas of the city in addition

to creating improper environment for the residents increases the cost of infrastructure development and urban services for urban management (Zanganeh Shahraki, 2007). This form of city is in contradiction with sustainable urban development and hence organizing the horizontal development of cities is a very important and necessary issue. Yasuj city also like most of the cities of Iran in the past due to lack of correct planning and lack of consideration of the public needs and requirements and lack of compliance with acceptable physical rules and criteria lack a logical forethought development and the expansion of the city have been formed in a scattered manner and have created an unsustainable urban environment.

Research objectives

In the present research we are seeking goals such as 1) identifying the physical and spatial structure state of Yasuj city, 2) Studying and understanding the effective factor in emergence and formation and evolution of the physical structure of Yasuj city in order to create a sustainable urban environment.

Review of literature

Numerous studies have been conducted with respect to urban physical and spatial development and growth patterns as well as to urban environment sustainability and sustainable urban development both inside and outside the country that we will mentioned the best of them below:

A research with the title of “25 years of sprawl history in Seattle area: the reactions of growth management and the concepts of protection” by Lin Robinson and he has found that the urban sprawl pattern in Seattle have fragmented the habitats and have endangered the wildlife and environment.

A research have been conducted with the title of “Urban Sprawl and Public Health” by Howard Frumkin which have studied the relationship between sprawl and public health based on 8 dimensions of air pollution, heat, physical activity patterns, motor vehicle accidents, pedestrian injuries, quantity and quality of water, mental health and social centrality and the findings indicate that the horizontal expansion pattern or urban sprawl have a negative effect on all these factors.

Another study has been conducted with the title of “the forces of land market and the role of government on sprawl” by Ting Wei Zhang on cities in China and the findings indicate that from the 5.8 Million hectares of farmland destroyed or with changed land use during 1986 – 1996 one fifth of it have been due to the effect of horizontal expansion pattern and sprawl and have changed into urban structures (Zanganeh Shahraki, 2007).

Abbaszadeh (2005) in his masters Dissertation with the title of “developing the physical pattern of urban fabrics for sustainable development: case study of Mashhad city” after studying the physical growth and development of Mashhad city and comparing Mashhad with the degree of dispersion / density of the City of Sydney in Australia has concluded that the today form of Mashhad city is of horizontal sprawl (Abbaszadeh, 2005).

Zanganeh Shahraki (2005) in his master’s Dissertation with the title of “studying the phenomenon of horizontal dispersion of Tehran and its effect on the

surrounding agricultural lands” has found that Tehran in terms of spatial growth and expansion in the past have had a slow growth and a relative compactness; however, with the beginning of the fast urbanization and uncontrolled migration of villagers to cities the growth and expansion of its area becomes so much fast, in a way that we can imagine a scattered growth pattern or an irregular horizontal expansion for this city (Zanganeh Shahraki, 2007).

Ebrahimzade and Rafiee (2009) have conducted a study with the title of “an analysis on urban physical – spatial expansion pattern of Marvdasht with the use of Shannon entropy and Holdern models” and have found that the city of Marvdasht until the year of 1996 have had a very compact growth and after that have entered in a urban ugly growth (sprawl) and they have recommended Sector - focused model as a suitable model of Marvdasht urban expansion (Ebrahimzade and Rafiee, 2009).

MATERIAL AND METHODS

Considering the nature of the topic and the research objectives, the approach dominating the research atmosphere is “descriptive – analytical” and the type of research is applied research. the research population includes 4 districts as per the physical divisions of the municipality and the tools used for data collection is based on field and document methods and for studying urban physical development and environment sustainability the form of the city with the use of Shannon and Holdern entropy and distribution interquartile models has been studied.

Under study area

Yasuj city is located on geographical coordinates of $30^{\circ} 28'N$ and $51^{\circ} 36'E$ from Greenwich meridian. This city in terms of the political divisions of the country is the center of Center Kohgiluyeh and Boyer-Ahmad Province and the center of Boyer-Ahmad city and is located in the central part of Sarrud-e Shomali Rural District and naturally it is surrounded by Bashar River in south and Mehrian River in west and Dena Mountains in north and east. The urban boundaries of Yasuj city are located at the mountain area of high and folded Zagros. This boundaries have been Surrounded by complex and steep topographical area. Yasuj city in 1964 was established with administrative and political goals and in 1966 was selected as the Central Governor General. The area of this city in 2006 has been equal to 1822 Hectare and its population equal to 100,544 and also the city includes 4 districts and 23 neighborhoods (Hamsou Consulting Engineers, 1996).

RESULTS AND DISCUSSION

A) Physical and spatial development and formation of Yasuj city during 1964 – 1966

Yasuj city in 1964 was established with a State appearance and for achieving the primary social and political goals by the government that due to lacking a physical forethought design during the establishment years have the highest per capita in terms of residential, roads and wasteland and empty land uses and has had the

lowest density among the cities of Iran (Amood consulting Engineers, 2003).

B) Boundaries and characteristics of the physical – spatial development of Yasuj city during 1966 – 1976

In this period, the urban physical development has been continuously focused toward the hilly areas of North and West of the city. In the mentioned directions since the material and type of the ground and land has had the sufficient resistance and constructing buildings didn't face any specific problem has developed gradually with facilities for the supply of land in the south west direction and the development axis in line and around Sisakht road expanded that the area of the city in this period reaches to 60 Hectare and a population of 4524 (Navi, 1975).

C) Physical – spatial characteristics of Yasuj city during 1976 – 1986

In this period the area of the city reaches 860 Hectare that comparing to the previous period has a considerable increase (60 hectare) and has a population of 29992 people. In this period the general course of development of toward north, west north and west of the city.

In this period formation of urban modernization fabrics which are mainly in the forms of Checkerboard lattice start that new neighborhoods mostly are formed in the form of organizational housed beside Checkerboard lattice of streets (Amood Consulting Engineers, 2002).

D) Physical – spatial development of Yasuj city during 1986 – 1996

The axes of city development in this period are:

1st axis: combination of the villages around the city in the city: in this period since the city development toward west due to the availability of open and large area is continued a number of villages that are located on the axis of urban development are combined in the city and are contributing to the fast urban physical development.

2nd axis: in this axis the development of the physical fabric of the city is discontinuous and scattered around the axis of Yasuj – Shiraz which is located at the Southeastern side. This axis due to suitable access, cheap land and the existence of a number of commercial centers and residential and industrial colonies has acted as the attractive point of population and has been formed like a chessboard around the residential units.

E) Physical – spatial development of Yasuj city during 1996 – 2006

The development axes of Yasuj city in this period have been toward south, west south and west of Yasuj city. The major development of the city in this decade has been in the axis of the Esfahan road in the direction of west in Bensenjan neighborhood and toward south-west in Sharaf Abad, Imam Hossein and Jahand neighborhoods. The area of the city in 2006 has been equal to 1822 hectare and its population equal to 100544 people.

Analysis of physical –spatial development pattern of Yasuj city

Today considering that having knowledge from the spatial form and shape of the city can be one of the

significant effective factors in the success rate of the urban planners for responding to the present and future needs of the city, various models such as The Gini coefficient, relative entropy, Moran coefficient, Gary coefficient, Shannon entropy and Holdern and so on are being use for studying urban form and its physical development. In the present paper three models of Shannon entropy and Holdern and Interquartile distribution have been used for physical development analysis of Yasuj city during 1996 – 2006 which has 4 districts.

Table 1. population growth changes and Yasuj city area

Year	Population (people)	Area (Hectare)	Population growth (percent)	Area growth (percent)
1966 - 1964	931	-	-	-
1976 - 1966	4524	60	17.125	-
1986 - 1976	29991	860	20.82	30.50
1996 - 1986	69134	1200	8.70	3.38
2006 - 1996	100544	1822	3.81	4.25

Source: Housing and Urban Development of Kohgiloye and Boyer-Ahmad Province

Shannon Entropy model

This model is used for analysis and determining the level of the phenomenon of ugly urban growth. The general structure of this model is as per the following (Hekmatnia and Mousavi, 2006):

$$H = - \sum_{i=1}^n P_i \times \ln P_i$$

Where, H: value of Shannon entropy; P_i : ratio of the constructed area (total residential area) area i to the total constructed area of the whole region, n: the whole region.

The value of Shannon entropy can be from zero to $\ln(n)$. The zero value indicate to Very dense (compact) physical development of the city, while $\ln(n)$ indicate scattered urban physical development. When the value of entropy is larger than $\ln(n)$ the ugly urban development (sprawl) will be occurred. With the application of this model we can fine the spatial balance of population rate at the level of urban, regional or national network. The entropy coefficient has a range between zero and one; as much as its value is near one it indicates to a better balance and as much as it is near to zero it indicates to imbalance in the distribution of population (Tasi, 2005).

Table 2. calculation of entropy value in the 4 districts of Yasuj city in 1996

District	Area (Hectare)	P_i	$\ln P_i$	$P_i \times \ln P_i$
1	300	0.25	-1.3862	-0.3465
2	200	0.1666	-1.7921	-0.2985
3	250	0.2084	-1.5682	-0.3268
4	450	0.375	-0.9808	-0.3678
Sum	1200	$\sum P_i = 1$	$\sum P_i \times \ln P_i$	-1.3396

H=1.3396; (Source: calculations by author)

Table 3. Calculation of entropy value in the 4 districts of Yasuj city in 2006

District	Area (Hectare)	P_i	$\ln P_i$	$P_i \times \ln P_i$
1	392	0.2115	-1.5366	-0.3305
2	306	0.1680	-1.7837	-0.2996
3	394	0.2163	-1.5310	-0.3311
4	730	0.4006	-1.9147	-0.7670
Sum	1822	$\sum P_i = 1$	$\sum P_i \times \ln P_i$	-1.7282

H=1.7282; Source: author's calculation

Tables 2 and 3 indicate that considering the Shannon entropy, that $\ln(n)$ can take a value between zero and one, and considering the sprawl growth ratio of the 4 districts of Yasuj city, since the maximum value for entropy 4 as per the formula has been calculated to be equal to $\ln(4) = 1.3862$, hence the fact that the entropy of Yasuj city in 1996 is equal to 1.3396 and the closeness of entropy value to the maximum value of $\ln(4) = 1.3862$, indicates to the scattered physical development of the city. And the entropy value in 2006 has been equal to 1.7282 which is more than the maximum value of $\ln(4) = 1.3862$ and therefore, it is concluded that during the past 10 years the physical development of Yasuj city has been of an ugly urban development (sprawl).

Holdern model

One of the fundamental methods for determining ugly urban development is Holdern method. John Holdern in 1991 used a method for determining horizontal development of the city and the population growth. With the use of this method we can determine that how much of the development of the city is resulted from population growth and how much of it is resulted from ugly urban development. In this model he has used the Gross per capita Land formula, which is as per the following (Hekmatnia and Mousavi, 2006):

$$\begin{aligned} & \ln\left(\frac{\text{end of the period population}}{\text{beginning of the period population}}\right) + \\ & \ln\left(\frac{\text{Gross per capita of the end of the period}}{\text{Gross per capita of the beginning of the period}}\right) = \\ & \ln\left(\frac{\text{city area at the end of the period}}{\text{city area at the beginning of the period}}\right) \end{aligned}$$

Regarding Yasuj city the variables of Holdern model are replaced in the model in the following way:

$$\begin{aligned} & \ln\left(\frac{100544}{4524}\right) \ln\left(\frac{0181}{0132}\right) \ln\left(\frac{1822}{60}\right) \\ & \ln(22/22) + \ln(1/37) = \ln(30/36) \\ & 3.10 + 0.314 = 3.414 \end{aligned}$$

Then the share of the percentage of the population growth distribution and the distribution percentage of the Gross per capita growth in urban land with the division of each side of the relation to 3.414 is obtained:

$$\begin{aligned} & \left(\frac{3/10}{3/414}\right) + \left(\frac{0/314}{3/414}\right) = \left(\frac{3/414}{3/414}\right) \\ & 0.908 + 0.092 = 1 \end{aligned}$$

The obtained results from Holdern model regarding Yasuj city indicate that in the distance during 1979 – 2006 around 90.8% of the physical development is related to population growth and 9.2% of the city growth is related to horizontal growth and sprawl growth of the city that has

reduced the Gross density of population and increased the Gross per capita urban land and eventually the expansion of Yasuj city has been in the form of sprawl horizontal urban development.

Interquartile distribution model

Another model for explaining the way of population distribution and the services in terms of balance and imbalance is Interquartile distribution. In this method in order to explain the population distribution at the level of city and determining the pressure of the population on the existing services in different regions of the city, relative density in different regions are calculated. In this method the city is divided into four districts in terms of relative density of population including a region with low density, a region with average density, a region with high density and a region with very high density (Mahdavi, 1998).

Table 4. the population distribution at the city level of Yasuj based on Statistical quartiles

Quartiles	Area (hectare)	Population	Area percentage	Population percentage
1-19	392	24580	21.15	24.44
20-39	306	23002	16.79	22.88
40-59	394	15644	21.62	15.56
60-79	730	37318	40.07	37.12
sum	1822	10054	100	100

Source: author's calculation

Statistical study of Table 4 shows that around 48% of the population are living in over than 38% of the area of this city which indicates to the lack of balance in the regions with low and average density. However, in the region with high and very high density regions, around 52% of the population is living in 62% of the area of the city which indicate to the balance between the population distribution and area in these regions. This study reveals that in general there is an imbalance spatial distribution in the city. Cities like the structure of the human body should be balanced in terms of quality and quantity growth and development during the time. When extremes cases happen in the city population and the infrastructure facilities of the city, an increase or decrease in the population and spaces can cause city disease and its vulnerability. Therefore, we should give more attention to spatial structure of cities.

Urban sustainability is a concept that was introduced in the world following the plan of "sustainable development" as a new model or pattern. The origins of sustainable development attitude go back to dissatisfaction from the outcomes of social – economic growth and development in cities from ecological perspective. Hence, sustainable city can be seen as a city which is the result of a development provided by the subjectivity and the possibility of constant promotion of economic – social and ecological health of the city and region. The physical and spatial development of the city is also a dynamic and constant process that if it will be quick and without planning will not provide a suitable physical combination of urban spaces and will create major problems also on the way of accessing different services by citizens. There are many factors and issues effective in the physical and spatial growth and development of cities that some of

them find the necessary context for physical –spatial development in economic arena and some other in social and political area. Today, continuous immigrations to cities have turned into problems for developing countries including Iran.

For studying the horizontal growth of Yasuj city three models of Shannon entropy, Holdern and Interquartile distribution have been used that in the following the results of these models will be discussed:

1st method (Shannon Entropy model): this method is balanced distribution degree of the population parameter with the use of Shannon entropy coefficient model. The values obtained for this coefficients at two time sections of 1996 and 2006 indicate that the population distribution is imbalanced and considering the fact that the entropy value of the Yasuj city in 1996 is equal to 1.3396 it indicates to a scattered physical growth of the city and the entropy value in 2006 is equal to 1.7282 which indicates that during the past 10 years the physical expansion of Yasuj city has been of a sprawl urban development form.

2nd method (Holdern model): it is the Holdern equation that shows out of the total physical growth of a city how much of it has been as the effect of population growth and how much as the effect of horizontal sprawl. With the application of this model for Yasuj city we can see that during the years 1976 – 2006 around 90.8% of the physical development is related to the population growth and around 9.2% of the city development and growth is related to the city horizontal sprawl which has decreased the gross density of population and has increase the gross per capita of city lands.

3rd method (Interquartile distribution model): based on this model the increase in urban land per capita only doesn't mean the application of urban population from the urban service spaces, but also is influence by the excessive construction of urban development. Constant expansion and the emergence of urban car fabric and destruction of farming and Pasture and mine lands will provide the context for urban instability.

In the assessment of physical – spatial expansion and development of cities the main role of the village – city immigrations can never be denied. Ahlers believes in this regard the villagers for providing their most simple needs are required to move from their village. These necessary movements eventually will accumulate capital in the cities (Ahlers, 2001).

Naturally a fundamental part of this capital are accumulated and spent specially in the surrounding land around the cities. The Uncontrolled immigration to cities quickly increases the population in cities and following that will lead to the unplanned and unintentional physical development and expansion of cities including Yasuj city. Yasuj city in 2006 has been the first city in Iran that was welcoming the immigrants that considering its central political, administrative and servicing role and the injection of public budgets on one hand and Severe deprivation of other small cities and villages around it on the other hand, it is predicated that its population growth and physical expansion will be continued in the future years which has led to the Instability of its urban environment.

CONCLUSION

For reducing the horizontal sprawl in Yasuj city and reducing the problems resulting from it the following recommendations are made:

1. Reducing the size of the breakdown land: this policy is one of the desirable policies for preventing uncontrolled horizontal sprawl in a city.
2. Having more control on city boundaries.
3. Directing the urban development direction toward directions other than farming lands.
4. Using Continuous expansion sector pattern: this pattern can be effective in terms of conformity with the spatial structure of the city and help not to destruct good quality farming lands around the city.
5. In the existing condition the physical development of Yasuj city caused growing development of residential uses of land comparing to other uses of land and considering the spatial distribution of this land use at the city level the provision of services will have higher expenses and will be more difficult. It is necessary that other uses of lands will be developed in harmony with this specific use of land and the shortcomings of this city will be solved in this regard. This in turn would help to the balanced and sustainable urban development as well.
6. Improvement and modification of the urban management policies for achieving sustainability in urban development.
7. Supervision of urban experts and citizens in spatial development of the city so that the city will development proportional to the urban sustainability measures and the wishes of the city residents.

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