

Analysis of Urban Systems of Sistan Region (1996-2011) (By using the models of rank and size, the elasticity, entropy and Lorenz curve)

Maryam Karimian Bostani¹, Neda Golpayegani², Hamed Shahraki Moghadam², Ali Riki²

¹Assistant Professor, Department of Geography and Urban Planning, Faculty of Humanities, Islamic Azad University, Zahedan Branch, Zahedan, Iran, ²Ph. D. Student in Department of Geography and Urban Planning, Faculty of Humanities, Islamic Azad University, Zahedan Branch, Zahedan, Iran

Abstract

In scientific discussions and theories of urban planning, the best form of organizing the space and creating a hierarchy is creating a city in which the distribution of goods, services, transfer of new technologies and ways of life will be taken place in the whole community. In this regard, the goal of this research is the analysis of urban systems of Sistan region (1996-2011). The research method is descriptive-analytic based on library, documentary and field studies and the models of rank and size, the elasticity, entropy and Lorenz curve are used to analyze the data. The results of the rank and size showed that the actual size of the population of the second city has a great different from the fifth one and the city of Adimi is the most balanced and the city of Zehak is the most unbalanced cities in the region. The assessment of elasticity analysis in cities of Sistan region during 1996-2011 showed that during this period of time, the cities with more 100 thousand of population in the region have had a high elasticity level. The results of entropy model showed that the spatial distribution of cities in urban classes of Sistan in 1996-2006 has been more balanced compared to 2011. Finally, the results of Lorenz model showed that throughout all the period of study, the difference can be felt in taking distance of cities of Sistan region from the normal distribution.

Key words: Urban systems, Rank and Zize, Elasticity, Entropy, Lorenz curve, Sistan

INTRODUCTION

Cities have an important role in the distribution of population and economic development. By using of policies that are applied in urban systems, spatial patterns of economic development will be formed (Chen, 1991: 346). Formation of economic development models will be led to the creation of special urban systems in the different geographical spaces. Studies have shown that the passage of time indicates the increasing inequality in the size of cities (Pumain, 2003: 8). Urban settlements are classifiable on any space according to geographical conditions and are influenced by economic, social and political issues in other words, it is classifiable according to quantitative

and qualitative dimensions in terms of population, role, function and... (Bikmohammadi, 2000, 65). Hence the recognition of urban system has a fundamental importance as an index for the manner of urban spatial order and balanced distribution of facilities and services among urban centers particularly in small and medium-sized cities and that is why the urban hierarchy is best form of organizing space (Abedindorkosh, 2003, 86). Thus, in other words, the urban hierarchy is classification of cities of the network in terms of their importance (Farid, 1996, 488).

The study of the urban hierarchy is the most effective way of knowing the organization of urban systems and helps their space management considerably. On the one hand, the lack of attention to the urban hierarchy and the manner of distribution and distribution of urban centers at a region and on the other hand, the growth of urbanization will be led to the imbalance and fragmentation in the urban spatial structure (Malekhossaini et al, 2014). In general, the emergence of an urban network and the formation of spatial patterns in a region or a country which takes place throughout history is related to multiple economic,

Access this article online



www.ijss-sn.com

Month of Submission : 05-2017
Month of Peer Review : 06-2017
Month of Acceptance : 07-2017
Month of Publishing : 08-2017

Corresponding Author: Maryam Karimian Bostani, Assistant Professor, Department of Geography and Urban Planning, Faculty of Humanities, Islamic Azad University, Zahedan Branch, Zahedan, Iran. E-mail: Maryam_karimian55@yahoo.com

social, climatic and geographical conditions. In Iran, the emergence of the urban network has been subordinated to this rule completely.

Iran's urban network has had a relative homogeneity for decades ago, it means that there has been an organizational relationship between the towns and cities of the region on the one hand and cities and rural centers on the other hand without the existence of a major metropolis which attracts all activities and effects a particular impact on network. The study of urban network of Iran shows that it has not a hierarchical function and the number of centers of biological spatial distribution and population size does not comply with a functional hierarchical system and urban network is still changing in the direction of centralization. Such a case with strength and weakness, but predominantly can be seen in many parts of Iran. In total, ten large cities and regional metropolitan have been disconnected from capital in urban system of Iran.

Now, network and urban systems of Sistan region has been experiencing imbalances due to the dominance of Zabol and the lack of strong performance relations in its centers and its unbalanced and uneven process is still increasing. The existence of concentrated functions and activities in this main city of the region has assigned all facilities and has prevented other areas, small towns and rural communities to be developed. In such circumstances, population settlement patterns and biological centers in the region will not comply with exploitation system appropriate to the present capacity and talent and they will not provide an appropriate image of population settlement.

As a result, the urban network of Sistan has not hierarchical function. and its spatial distribution and population size does not comply with a hierarchical functional system.

In this regard, the goal of this research is the analysis of urban systems of Sistan region (1996-2011).

THE HISTORY OF THE RESEARCH

Behfroz (1992) has studied spatial distribution of population in urban Systems of Iran and has offered a model that can be a good model in most developing countries and urban systems. This formula can be used in urban systems with prime city model.

Sarvar (1993) has studied the manner of establishment of urban centers and urban areas in the southern coast of Iran and believes that in spite of the lack of compliance with the regional urban hierarchy from rank-size rule, population distribution and distribution of cities in the study area is unbalanced.

Rad (2001) has studied the urban network of Ilam and shows that urban network system of this province is in compliance with the administrative-political centers.

Razai (2004) has studied imbalances in the urban hierarchy of Fars province and suggests strengthening for growth poles to balance the urban network of this province.

Rakhshainasab and Baikmohammadi (2007) have assessed inequality in the urban hierarchy of Sistan and Baluchestan province and proves that high difference of cities of the province with Prime City of region in 1986 and an increase in the small towns from 90s have caused the imbalance and a gap of cities from the balance level.

Sarai et al (2014) in a research have studied the determination of hierarchical system in the cities of Lorestan province by using neighborhood, entropy and stratified difference limit models in 1956-2011.

The results of the research showed that Lorestan Province's urban hierarchy in term of nearest neighborhood index tends to the balance of (2.15). Entropy coefficient in most of the studied periods tends to 1 and has had normal manner. Therefore, based on the results of the two models of the spatial distribution, urban areas in the province of Lorestan v balanced during 1956-2011. According to stratified difference limit model, urban population distribution in Lorestan province has a disintegration and imbalance during the study period. The city of Khorramabad with having the political, administrative and economic center and the city of Boroujerd with history, natural conditions and industry growth have attracted the most population and have significant population difference with small cities.

MATERIALS AND METHODS

The research method is descriptive-analytic based on library, documentary and field studies. The latest data published by the Statistical Center of Iran and the relevant provincial authorities were also used to obtain the required quantitative data of the research and the models of rank and size, the elasticity, entropy and Lorenz curve are used to analyze the data.

The Elasticity Coefficient

This model is an index that it will make it possible to estimate the percentage of urban population in the total population. This means that for every one percent increase in the total population (country, province and city) in the specified period; what is the rate of increase or decrease of urban population (in the desired city). Through this index, it will also be possible to compute the trends in the regional

space and the amount of the elasticity of population and then compare them with other population centers at the regional scale. The formula of this index is as follows:

Elasticity coefficient is obtained from the following equation:

$$E_{(t,t+10)} = \frac{Y_U(t,t+10)}{r(t,t+10)}$$

E: Is the elasticity coefficient in the interval time of $t, t+10$

YU: annual growth rate of urban population.

R: The annual growth rate of total population.

Entropy Index

Entropy theories are derived from the laws of probability and models based on it. This model originally was used by physicists to identify the order and disorder in nature. This theory demonstrates the amount of lack of steadiness in any system and its variations change from zero (maximum concentration) to one (maximum degrees of separation). The index is used for determining the degree of concentration or dispersion of the distribution of phenomena in the spatial organization. The basis of this theory is predicting the probability that can be effective to predict the future direction of their organization in accordance with the order or the disorderly of studied phenomena behavior in the past. It will be more possible to predict a more acceptable form for the future if the form and transformation and development of Phenomena in the past has more order. The theory and methods are used for the characterization of settlements and the distribution of population in a geographical space and also for the degree of concentration of population in an area.

Entropy Coefficient is obtained from the following equation:

$$H = - \sum P_i \text{Log} P_i$$

$$G = \frac{H}{\text{log} K}$$

H: Total frequency in Nehprii frequency logarithm,

Pi: frequency,

Log: Nehprii frequency logarithm,

K: number of Classes,

G: The amount of entropy

If the entropy tends to zero, it will indicate a greater focus or concentration or an imbalance in population distribution between cities and a movement to the number one and above it, it Shows a more equalized distribution in regional areas.

The Pattern of Rank -Size

Rank-size model is one of the oldest patterns that analyzes urban sizes in urban system. Felix Auerbach was a German geographer in 1913 was the first person who provided a useful pattern in relation to the hierarchy of settlements. In his opinion, if the city be considered in terms of row and extent (first, second, third, fourth and nth, $1/n$ is the largest city of the world. Thus, the population of the fourth largest city is approximately $1/4$ of the population of the largest city. This inverse relation between population and rank among a group of cities is called urban rank in terms of population (Hagt,1996, 184). George Zipf in 1944 defined This mathematical equation as the following logarithmic relationship which is known as rank-size rule (Hekmatnia and Mavsavi, 2006:193).

$$\text{Log} P_r = \text{Log} P_1 - b \text{Log} R \quad b = \text{Log} P_1 - \text{Log} R$$

$$\text{Log} P_r$$

R: the rank of the city in the region

b: the slope of the rank - size line

P1: population of the prime city in the region

Pr: the population of city in the desired rank or the population of the nth city

It is obvious whatever b tends to 1, the balance has been most established in urban system and Hierarchy of cities will lead towards a total normal distribution and the population of r city will be $1/r$ of the largest prime city. With the help of this equation, we will be able to study the size and rank of the cities. In this theory, the cities will be studied in a statistical hierarchy of a region or country and in a mathematical order.

Lorenz Curve Model

Lorenz curve is the best graphic tools for representing the amount of difference between the populations and the number of urban centers. The cumulative percentage of the number of cities and the cumulative percentage of the population of urban centers are used to draw Lorenz curve.

AREA OF STUDY

Sistan region with an area of 15,197 sq km in the geographic range between $30^{\circ}C$ and 5 minutes to $31^{\circ}C$ 28 minutes' latitude and 60 degrees 15 minutes to 61 degrees 50 minutes' longitude in southeastern Iran and the northern part of the province Sistan and Baluchestan by about one eighth of the total area allocated to the province. Average annual rainfall in the region 6/59 mm,

mean annual temperature of 22°C and the average annual relative humidity is 38.

Sistan region includes the cities of Zabul, Zahak, Doost Mohammad, Mohammad Abad Adimi has an area of 15917 square kilometers.

THE RESEARCH FINDING

The Rank-Size Model

According to the population of the prime city of a region, the population of other cities (the first, the second, the third,..... cities) must be 1/2, 1/3, 1/4,..... Of the first city. at first, the cities are arranged based on population from top to bottom then amounts of the ideal population are computed for the second, third and. Cities. The result is a table and graph below.

As it is seen in the graph, the cities have relatively a large distance with the ideal population size according to the rank-size theory. The population of the second city to the fifth one has a great distance with the actual size. According to the obtained results, Adimi is the most balanced city and Zehak is the unbalanced city of the region.

The Elasticity Level

Cognition of the amount of ability to absorb population is one of the model which is used to identify the ability of cities to absorb population.

Table 1: Rank-size model results

Cities	Population: 2011	The ideal population
Zabol	152370	152370
Zehak	14323	76185
Doost Mohammad	6774	50790
Mohammad Abad	5470	38092
Adimi	3328	30474

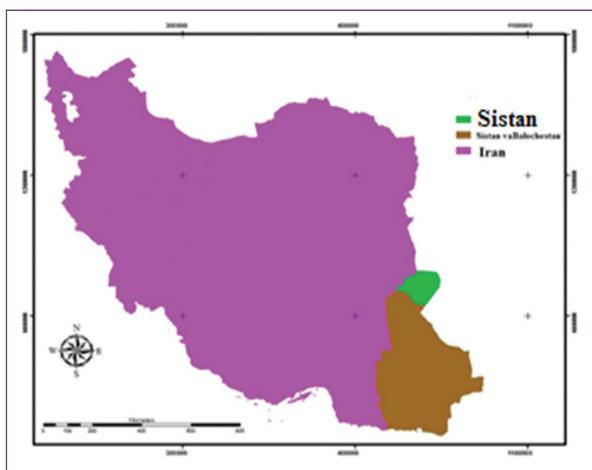


Figure 1: Map of the study area

Assessing elasticity level in the cities of Sistan region during 1996-2011 indicates that the cities with more than 100 thousand have a higher elasticity level. It should be noted that the city of Zahak which is in the group of cities with population between 10 to 20 thousand has been faced with declining growth.

Entropy Coefficient

This model is for assessing urban population distribution of Sistan region and for the distribution of cities in urban classes of the region. The amount of spatial balance can be identified through this model.

The results showed that the spatial distribution of the number of cities in urban classes of Sistan has been more balanced in 2006 compared to 2011. The results tend to zero in 2006 and it means that the population system has been more balanced in this period of time.

Lorenz Curve

Using Lorenz curve in cities of Sistan region is one of the methods to measure urban hierarchy and the distribution of population in cities in a region.

Lorenz curve is used to determine the imbalance between population and urban centers. In this model, the more the curve will lead to the normal line, the balance between the number of cities and the population will be more. In table above, the normal and density percentage of classes and the population of urban centers in Sistan region has been set.

Table 2: Elasticity level results according to the city and urban class

Cities	2006-2011	1996-2006
Cities with more than 100 thousand (Zabol)	1.24	0.75
Cities with population between 50 to 100 thousand (Zahak)	-	-
Cities with more than 20 thousand (Zabol)	-	-
Cities with population between 10 to 20 thousand (Zahak)	0.64	1.42
Cities in under 10 of thousands (Dost Mohammad, Mohammad Abad, Adimi)	1.2	-

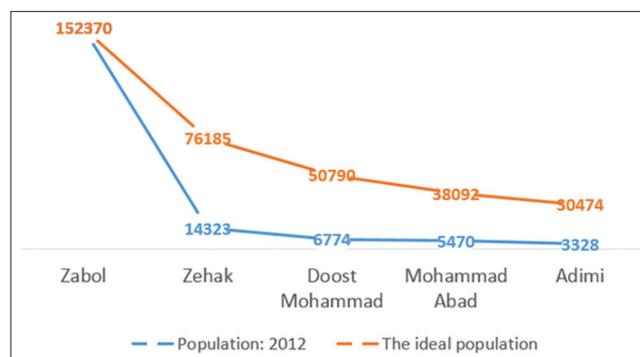


Figure 2: The rank-size model results

Table 3: Entropy coefficient in the cities sistan region in the years 1996-2011

Raw	Urban class (thousand)	1996			2006			2011		
		Pi,lnpi	lnpi	Pi	Pi,lnpi	lnpi	Pi	Pi,lnpi	lnpi	Pi
1	Under 50	-	-	-	-	-2.00	-3.11	0.200	-2.81	-6.10
2	50-100	1	-	-	-	-	-	-	-	-
3	100-150	-	-	-	-	-2.12	-3.18	-	-	-
4	150-200	-	-	-	1	-	-	0.800	-2.23	-4.24
5	200-250	-	-	-	-	-	-	-	-	-
Σ		-	-	-	1	-4.12	-6.29	1	-5.4	-10.34

Table 4: Lorenz curve results in during the period under review in the cities of Sistan

Raw	Urban class (thousand)	1996				2006				2011			
		Cities		Urban population		Cities		Urban population		Cities		Urban population	
		Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
1	Under 50	-	-	-	-	18.6	18.60	80	80	20.1	20.1	80	80
2	50-100	100	100	100	100	-	-	-	-	-	-	-	-
3	100-150	-	-	-	-	100	81.4	100	20	-	-	-	-
4	150-200	-	-	-	-	-	-	-	-	100	89.9	100	10

Table 5: Lorenz curve in the year 2006

80	18.60
100	81.4

Table 6: Lorenz curve in the year 2011

80	20.01
100	89.9

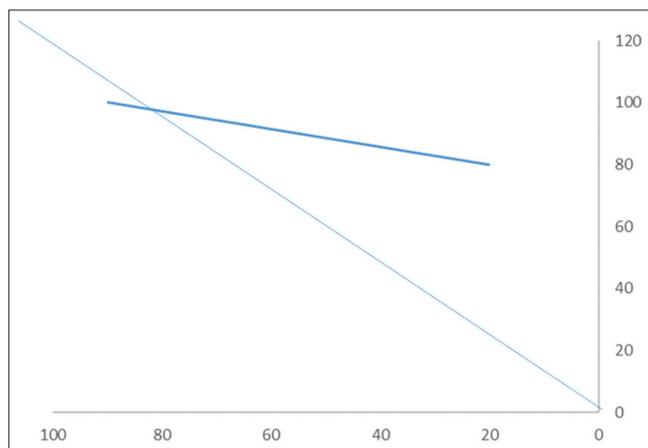


Figure 3: The Lorenz curve in the year 2006

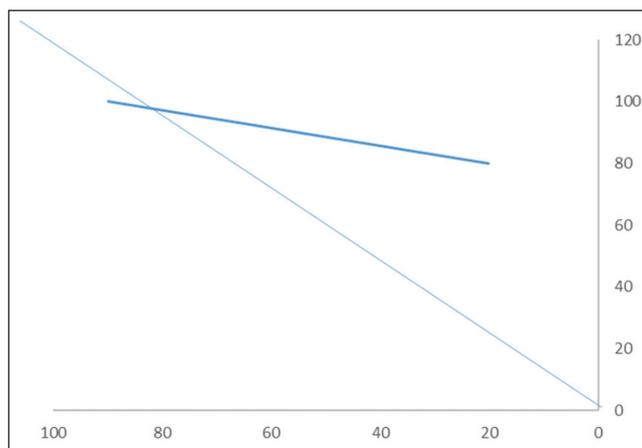


Figure 4: The Lorenz curve in the year 2011

During the whole period of the research, Lorenz curve has considerable convexity and concavity which this difference could be felt in cities in Sistan from getting distance from the line of normal distribution.

CONCLUSION

On the one hand, the lack of attention to the urban hierarchy and the manner of distribution and distribution of urban centers at a region and on the other hand, the growth of urbanization will be led to the imbalance and fragmentation in the urban spatial structure. Determining the manner of the spatial organization

of urban settlements will help their space management considerably.

In this regard, the goal of this research is the analysis of urban systems of Sistan region (1996-2011). The research method is descriptive-analytic based on library, documentary and field studies and the models of rank and size, the elasticity, entropy and Lorenz curve are used to analyze the data. The results of the rank and size showed that the actual size of the population of the second city has a great different from the fifth one and the city of Adimi is the most balanced and the city of Zehak is the most unbalanced cities in the region. The assessment of

elasticity analysis in cities of Sistan region during 1996-2011 showed that during this period of time, the cities with more 100 thousand of population in the region have had a high elasticity level. The results of entropy model showed that the spatial distribution of cities in urban classes of Sistan in 1996-2006 has been more balanced compared to 2011. Finally, the results of Lorenz model showed that throughout all the period of study, the difference can be felt in taking distance of cities of Sistan region from the normal distribution.

The cognition of the problems and the economic, social and cultural dilemmas of cities is undoubtedly one of the most important solutions that will contribute the balance of the cities of Sistan.

In terms of development indices, this region is located in a low national and regional level. It is suggested that by studying various indices of development and the opportunities and existing bottlenecks, facilities and services of cities, they shall be leveled. Moreover, the cities should be prioritized according to the possibilities of the cities in the form of short-term, medium term and long term plans.

SUGGESTIONS

- Creating balance in distribution of economic and social resources and facilities at all levels of settlements hierarchy in the region.
- Strengthening economic ties between low-ranking cities (Adimi, Mohammad Abad and Dost Mohammad) and their sphere of influence.
- Strengthening the health, economic and transportation

infrastructure for smaller cities of the region.

- The cognition of environmental and human potential of each city and planning for the emergence of them.
- Formulating of Short-term, long-term and medium-term planning in order to create infrastructure and public service facilities in the cities of the region.

REFERENCES

- Abedindorkosh S, 2003, Introduction to Urban Economics, Tehran, publisher of academic publishing.
- Behfroz F, 1992, Experimental and theoretical analysis of balance creation of spatial distribution of population in cities of Iran, geographical research journal, No. 28.
- Bikmohammadi H, 1996, An introduction to the urban system in Iran, Tehran, Sepah Quarterly Journal, No. 19, p. 96.
- Chen X, 1991, Chinas City Hierarchy, Urban Policy and Spatial Development in the 1980s, Journal of Urban Studies, Vol. 28, No. 3.
- Farid E, 1996, Geography and urbanization, Tabriz, Tabriz University Press Publications.
- Malekhossaini A et al, 2014, Analytical Hierarchy Process(Ahp) of Gilan province in 1986-2011 (using the log, rank - size model, Lorenz curve and the Gini coefficient), the quarterly of planning environment, Number 30.
- Pumain D, 2003, Scaling Laws and Urban Systems, available at: <www.santafe.edu>.
- Rad P, 2011, Geographic analysis on the urban network of Ilam, master thesis Geography and Urban Planning, Faculty of Literature and Human Sciences, University of Isfahan.
- Rakhshanasab H.R, Bikmohammadi H, 2007, Imbalances and inequalities in the urban hierarchy in Sistan and Baluchestan, social welfare Quarterly, No. 29.
- Razai M.R, 2004, Geographical analysis of the urban network of Fars province, master thesis of Geography and Urban Planning, Faculty of Literature and Human Sciences, University of Isfahan.
- Sari M.H, Shahkarami N, Fatai M & Soltani M, 2014, Determining the hierarchy of cities of Lorestan province between 1956-2011 by neighboring models, entropy and the stratified difference, Journal: Regional Planning, Volume 4, No. 13.
- Sarvar R, 1993, The spatial distribution of the manner of establishing and the urban hierarchy in southern coast of Iran, Sepehr Quarterly, No. 20.

How to cite this article: Bostani KM, Golpayegani N, Moghadam HS, Riki A. Analysis of Urban Systems of Sistan Region (1996-2011).- By Using the Models of Rank and Size, the Elasticity, Entropy and Lorenz Curve. Int J Sci Stud 2017;5(5):210-215.

Source of Support: Nil, **Conflict of Interest:** None declared.