مدیریت شهری
فصلنامه مدیریت شهری
(ویژه نامه لاتین)
Urban managment
No.**41** Winter **2015**
65 - 76
Received *23 Sep 2014*; **Accepted** *11 Mar 2015*

Evaluation of the mixed land use and its impact on urban sustainability. A case study: Ahvaz metropolis

Abdonabi Sharifi[1]-*Assistant professor, Geography Faculty, Payame Noor University, Iran*

Abstract
Land use is often referred as the basis for urban planning. Perhaps the main reason is that the discussion of fundamental related to urban planning objectives has play the first role in the land use studies. Basic topics such as proper location, optimal allocation, diversification, functionality and … which are in direct contact with comfort goals, are the last objectives of urban planners and designers. One of the major issue, which has been paid less attention to, is the incorporation of urban land use. In this paper, which were prepared to assess the incorporation of urban land use and its role in urban sustainability, tried to measure the rate of the incorporation of seven metropolitan areas of Ahvaz by using the Shannon entropy and the latest statistics of related to per capita and percentage of exist land use. The results indicate that the region number one is incorporation than the other regions in terms of land use incorporation, but in general this indicator in the seven regions had little effect on urban sustainability.

Key Words: *urban land use, Shannon entropy, incorporation of land use, sustainable development, Metropolis of Ahvaz*

1. Corresponding Author, Tel: 44213288 Email Address: abdonabi40@yahoo.com

Introduction
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Introduction
Advances of man in life with the help of reasoning ability caused primitive man to end up in today's urban societies. In fact, the developing world is undergoing the transition of rural population from a rural-farming society to an industrial urban society. (srinivasan et al, 2013, 299). In a world in which annually 90 million new inhabitants are added (a population equal to Mexico) discussing urbanism without attention to sustainable growth is meaningless. Up to 2050 around 70% of world, population will be living in urban areas. This is while today more than half of populations live in cities. (UN, 2001). New urban planning was formed in early 20th century to respond the specific historical conditions after the industrial revolution. Before that the urbanism and growth of cities were very limited and had relatively limited issues and urban problems. Thus, there was no need for aware and wide interference of man in urban areas. Especially after the late 19th century, the conditions of cities were seriously critical. Factories and industrial groups were places near the cities; villagers rushed to cities and became industrial workers. Marginalism grew and added the vastness of cities. (nasiri, 2012). When planning was mentioned, the discussion of designing also became prevalent in scientific gatherings and various schools began to reveal facts about designing each in some way by writing pamphlets and the plan of their goals of beliefs. In the issue of urban designing which has the goal of real and formal organizing to the man's environment, reaching this goal needs adoption of a series of decisions and doing particular operations that in urban designing are called procedure and substance (bahreini, 2012, 55). Both of them are related to urban sustainability and sustainable city and in three areas of environment, economy and social issues, have value and mutual effect. We can pursue the mixed land use in three mentioned areas seriously and vitally. Firstly, in economic area, the high level of mixed land use will lead to reduction of trip distance, promotion of accessibility, reduction of tripping costs and increase of ownership value. Secondly, in social issues high level of mixed land use will cause the social spatial integration and persuasion of physical activities. Thirdly, in environmental issues it will convince use of non-motor transportations, promotion of transport use, decrease of willingness to use cars that will reduce the greenhouse gases and energy consumption and also earth consumption. (musakwa & niekerk, 2013, 145).
Need to more mixed land use especially more integration of housing growth with commercial, urban and leisure uses has been discussed by planers and experts of public health. The advantages of this issue have been examined in various fields the main of which are promotion of active tripping, increase of ways

replacing transportation, reduction of use of cars and its associated effects, increase of ownership value and helping induce a sense of place for urban areas. This concept means that closeness of land uses or activities are effective on one another throughout a spatial spectrum. Thus, all criteria of measurement of mixed land use implicitly use two concepts of distance and quantity. The index of entropy reflects the ways of quantity and proximity of a type of mixed land use under other uses. (borhani & takabi, 2014, 3).

Research question

1-is the extent of mixed land use equal in all 7 regions of Ahvaz metropolitan?

Research hypothesis

1-it seems that the extent of mixed land use in 7 regions of Ahvaz metropolitan are the same.

Goal of the study

1-measurement of mixed land use and its role in urban sustainability of Ahvaz metropolitan

The realm and ecology of the research

Ahvaz as the political and administrative center of Khozestan province and the center of western south of the country with a population of 1055589 people in 2011 (records of Ahvaz metropolitan, 2013, 10) has a certain political and economic position in a way that it has contained one quartet of the population of urban areas in Khozestan province. Geographically, it is located in 31 degree and 20 minutes of northern width and 48 degrees and 40 minutes of the eastern length. With a space of 220 km it is the second widest city in Iran after Tehran. (Geographic organization of armed forces, 2005, 3). The studied area in this research is all the regions of this oil capital of the country and the 100% space of its land uses.

Method of research

The nature of this study is theoretical applicable and its method is descriptive-analytical. Gathering data was done by two ways of documents-library and workshops. In the library method, the data were found by the records given by central municipality and also the comprehensive plan in Ahvaz and studying and quoting from the latest related books. In the workshop method, the data of the annuals of land uses were updated by ARCGis software and new explanatory maps of land uses in Ahvaz as much as it was possible. Finally, by use of entropy Shanon method we examined the extent of mixed land use and its effect on urban sustainability. The entropy index is a way for measuring variance changes and shows the extent uses are distributed un-homogenously in a unit. (javadi et al, 2013, 24). Entropy index measures the land uses heterogeneously inside a neighboring unit. The spectrum of values is between 0 to 1 in this index. In a way that 0 shows the homogeneity of land use and 1 shows heterogeneity.

Necessity of the research

Without a doubt, discussing sustainability and sustainable growth without attending the urbanism would be meaningless. Cities are the main cause of unsustainability in the world and urban sustainability and global sustainability are the same concepts. Based on that regarding the natural complexity of cities and various aspects of their effects, knowing the main elements in accessing urban sustainability seems necessary. In formal aspect, the extent of mixed land use can cause more benefits for citizens in services and facilities and nearing the social justice in a way that Ahvaz with 40% marginalized needs it. Correct evaluation of urban lands can cause awareness for planers and optimal allocation of uses by them. Also knowing the aspects of indexes of sustainable growth plays an important role in making an environment like Ahvaz metropolis more humane.

Theoretical foundations

Definitions and concepts

Sustainable growth: this concept was first mentioned and was accepted in Brundtland assembly and in Earth summit in Rio (1992). (samadi & ojimehr, 2011, 168). The most accepted definition of this concept is men-

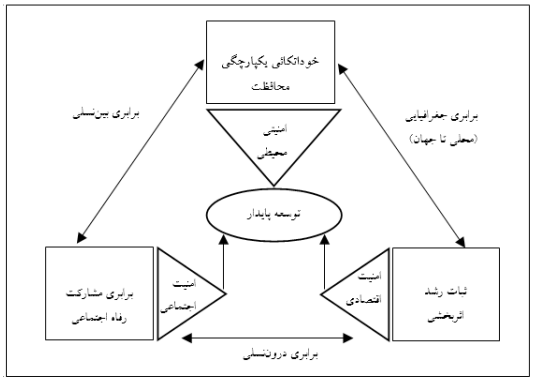

Figure 1. structure of sustainability theory (mojtaba javdan, 2010)

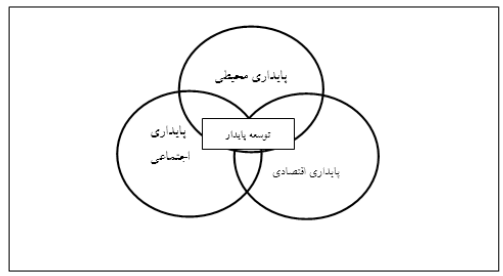

Figure 2. position of sustainability in structural aspects of sustainable growth (mojtaba javdan, 2010).

tioned in Brundtland report which states that it is a growth that fulfills current needs of man without damaging the ability of the next generation in fulfilling its needs. (rahimi, 2004, 15). In a systematic look at this issue, the point is related to more formal, economic, social and environmental functioning that is completely related with the goals of land use. It seems this concept is well adapted to the goals and aims of new urbanism and thus urbanism can use it as an effective tool in realizing the sustainability goals. (bahreini, 2011, 10). Spatial heterogeneity: what we mean here is the fact that there is a difference between the dependent and independent variable in every relation. Thus if this heterogeneity is not considered and same relation be estimated for all regions, it would be an inexact estimation of regional relations. Thus, it seems if there is enough statistical data of the studied areas or neighboring regions and also bordering between the areas, it would be proper that for each region sample observations be gathered from various places. (suri & javid, 2011, 10). Urban planning of land use and urban sustainable growth: urban planning for any city needs understanding and correct knowledge of urban spaces. The space that the mass of people have created its goals and events and create the concept of sustainable urban growth, which emphasizes on correction and improvement of life quality of citizens. This is an issue, which is not much seen in urban plans. (hoseinzadeh dalir, 1999, 192).

Some researchers like Chapin regard urban planning as planning of land use and based on that regard the land use as science of dividing time and space for various uses and life applications. (esmailpor, 2007, 16). In fact, the way of reaching a sustainable and ecologic city is the politics of earth through controlling uses and also policy of intensification of uses or so called concentrated city which can be effective for reaching sustainable city in sustainability of land use. (rahimi, 2003, 12) (masnavi, 2004, 27). Today it is proven that by spread of cities (scatterd use) the cost of urban services also increase (seifodini, 2002, 153). In fact the main goals of policy of intensification of uses is use of land in a more sustainable way by protecting the margins, valuable rural earth, growth of green areas and focus on urban areas especially empty, dirty and deserted lands. (Williams et al, 2004, 56). Thus, based on this theory concentration of cities and increase of it by mixed land use we can direct cities toward sustainable growth. (maleki, 2011, 212).

Review of Literature

Borhani, Kazem, Takabi and Mohamadreza (2014) in a study named measurement of mixed land use and its role in urban sustainability attended to the evaluation and measurement of mixed land use in regions of 2th area of section 10 in Tehran. By use of annual records and percentage of land uses and by using Shanon entropy model, they analyzed the uses and extent of mixed lands. Results showed low extent of mixed land use in three

total	8th G	7th F	6th E	4th D	3th C	2th B	1th A	region use
147.7	14.88	23.86	18.84	22.89	19.86	10.04	37.34	Housing
12.558	0.54	1.67	1.89	0.65	1	0.53	6.28	Commercial and services
847/7	0.78	1.88	0.70	0.92	1.07	0.51	1.99	Educational
722/8	0	0.16	0	7.73	0.31	0.04	0.48	High education
2.492	0.15	0.28	0.08	0.09	0.13	0.04	1	Religious
1.489	0.02	0.02	0.03	0.09	0.93	0.05	0.36	Cultural and artistic
0.896	0.03	0.01	0.06	0.20	0.28	0.16	0.16	Tourism and catering
4.277	0.31	0.58	0.17	1.16	1.11	0.21	0.74	Curative and hygienic
8.82	1.95	2.15	0.37	2.04	1.18	0.17	0.96	Sports
12.278	0.15	4.01	0.55	3.16	1.64	1.42	1.35	Police
30.247	3.91	2	0.41	1.38	17.91	0.04	3.6	Green areas and recreation
39.34	16.36	9.69	8.77	2.98	0.98	0.04	0.52	Industrial and workshops
9.282	0.49	2.19	0.16	0.14	4.85	1.02	0.16	Urban establishments
17.759	2.57	1.81	6.41	0.575	3.44	0.41	2.82	Transports and warehouse
135.830	14.98	23.34	19.13	18.43	19.75	10.52	29.68	Pass ways
0.371	0.04	0	0.11	0.04	0.06	1.03	0.09	Mixed and others

Table 1. quantitative extents of indexes region, Source: calculations of authors

economic, social and environmental areas, which show a challenge in urban sustainability. Samadi, Alihosein, Ojimehr and Sakine (2011) in a study called measuring extent of urban sustainable growth by hierarchical phase deduction system (SAFE) by use of Phase deduction system, calculated the level of sustainable growth of several cities. Results show that among metropolises in Iran in 2007 the most sustainable and non-sustainable cities were respectively Isfahan and Tehran.

Masnavi, Mohamadreza (2002) in an article named sustainable growth, urban sustainability and ecologic attitudes of necessity of common preparation for use of theories, examined the effects of concentration and mixing of uses for tripping pattern, accessing and social issues like security and attraction of the perceived measured region and found that a concentrated area and mixed use is better for reaching the facilities. Low concentrated areas are better for environmental justice, concentrated areas are better for social contacts and have the best state for security, and they suggest that a concentrated city might be able to reduce use of cars 70% and non-business trips to 75% but need for car for some uses won't be reduced.

Javadi, Ghasem, Talei, Mohamad and Karimi Mohamad (2012) also in a study named evaluation of use of indexes of determining the variety in mixed land uses examined the various ways of evaluating the extent of variety of urban uses by GIS and besides signifying the weak and strength points, suggested a new method for evaluating the variety of mixed land uses.

Findings of the study

In use of entropy model that based on variance of the indexes, calculates the weights of each index, there is the capacity that in case decision makers have a primary evaluation of the importance of data, they receive them and modify the weights gained, thus, when the data of a decision making model are completely signified, entropy method can be used for calculating the weights. (momeni, 2003, monfared et al, 2006, 129). Entropy is a very important concept in social sciences, physics and theory of data that is known by distribution of possibility Pi. (hekmatnia, mosavi, 2006, 189). Measuring uncertainty by Shanon

states that the more variance is in the amount of an index, that index is more important. In fact we can regard that a criterion of uncertainty that is shown by distribution of possibility (Pi). Here by having table 1 which is our primary data related to variance of land uses separated by regions, we proceed in calculating Pis through the below relation. (portaheri, 2013, 88).

$$P_i = \frac{a_{ij}}{m}; \forall_{ij}$$

$$\sum_{i=1} a_{ij}$$

This means division of percentage of each use to the total percentages of regions, through which the first matrix, meaning table 1, and second matrix meaning table 2 are found:

After preparing the second table or matrix of Pis we calculate the index of Shanon entropy which is generally gained through the following relation:

$$Entropy = \sum_{i=1}^{m} \{P_i(Ln\ P_i)\}/Ln\ K$$

Pi here is the ratio of each classes of land use in each unit of neighboring or the ratio of space to type of use (studied areas) and Ln is natural logarithm (based on P digit), and K is the number of classes of land uses or the number of variety of uses in each neighboring unit (studied area).

This study has n options and m indexes, therefore, we find the value tables of the relation Pi(LnPi) for each region:

In the next step, we find K from the following relation:

K=Ln (16) → 2.77259

K here is a fixed amount.

In the next step, we find Ej for each region:

E_{j1}=2398911/4-÷(77259/2)= 1-

E_{j2}=279032/2-÷(77259/2)=821/0-

E_{j3}=1966119/4-÷(77259/2)=513/1-

E_{j4}=2209827/3-÷(77259/2)=161/1-

E_{j6}=22937779/2-÷(77259/2)=827/0-

E_{j7}=681201/3-÷(77259/2)=328/1-

E_{j8}=525514/3-÷(77259/2)=127/0-

In the next step, we find the extent of uncertainty or deviation degree (dj) from the below function:

D_i=1-E_i ; $\forall_i$

8th G	7th F	6th E	4th D	3th C	2th B	1th A	region use
0.101	0.161	0.127	0.154	0.134	0.068	0.253	Housing
0.043	0.133	0.150	0.052	0.08	0.042	0.5	Commercial and services
0.099	0.239	0.090	0.117	0.136	0.065	0.254	Educational
0	0.018	0	0.886	0.035	0.004	0.055	High education
0.060	0.112	0.028	0.036	0.052	0.016	0.401	Religious
0.013	0.013	0.02	0.06	0.621	0.033	0.240	Cultural and artistic
0.03	0.011	0.067	0.233	0.3125	0.178	0.178	Tourism and catering
0.072	0.136	0.040	0.271	0.259	0.049	0.173	Curative and hygienic
0.221	0.224	0.042	0.231	0.321	0.019	0.109	Sports
0.012	0.327	0.0455	0.257	0.134	0.116	0.110	Police
0.129	0.066	0.013	0.046	0.592	0.034	0.119	Green areas and recreation
0.416	0.246	0.222	0.076	0.052	0.001	0.013	Industrial and workshops
0.053	0.236	0.017	0.044	0.552	0.110	0.017	Urban establishments
0.145	0.102	0.361	0.0320	0.194	0.008	0.159	Transports and warehouse
0.172	0.114	0.136	0.145	0.145	0.077	0.218	Pass ways
0.108	0	0.296	0.108	0.162	0.081	0.242	Mixed and others

Table 2. standardized extents or matrix Piregion, Source: calculations of authors

(Pi(Ln Pi	Ln Pi	(Pi)	Use
-0.3477	-1.3743	0.253	Housing
-0.3465	-0.6931	0.5	Commercial and services
-0.3480	-1.3704	0.254	Educational
-0.1595	-2.9004	0.055	High education
-0.3664	-0.9137	0.401	Religious
-0.3435	-1.4271	0.240	Cultural and artistic
-0.3033	-1.7259	0.178	Tourism and catering
-0.3035	-1.7744	0.173	Curative and hygienic
-0.2415	-2.2164	0.109	Sports
-0.2428	-2.2072	0.110	Police
-0.2533	-2.1286	0.119	Green areas and recreation
-0.0564	-4.3428	0.013	Industrial and workshops
-0.0692	-4.0745	0.017	Urban establishments
-0.2923	-1.8388	0.159	Transports and warehouse
-0.3320	-1.5232	0.218	Pass ways
-0.3433	-1.4188	0.242	Mixed and others
-4.2398			total

Table 3. total of values of region 1, Source: calculations of authors

Pi(Ln Pi)	Ln Pi	(Pi)	Use
-0.1828	-2.6882	0.0068	Housing
-0.1331	-3.1700	0.042	Commercial and services
-0.17766	-2.7333	0.065	Educational
-0.02228	-5.5214	0.004	High education
-0.06616	-4.1351	0.016	Religious
-0.1125	-3.4112	0.033	Cultural and artistic
-0.30722	-1.7259	0.178	Tourism and catering
-0.1478	-3.0159	0.049	Curative and hygienic
-0.07533	-3.963	0.019	Sports
-0.2498	-2.1541	0.116	Police
-0.1149	-3.3813	0.034	Green areas and recreation
-0.00699	-6.9077	0.001	Industrial and workshops
-0.2428	-2.2072	0.110	Urban establishments
-0.0386	-4.8283	0.008	Transports and warehouse
-0.1974	-2.6539	0.077	Pass ways
-0.2035	-2.5133	0.081	Mixed and others
-2.2790			total

Table 4: total of values of region 2, Source: calculations of authors

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Pi(Ln Pi)	Ln Pi	(Pi)	Use
-0.2693	-2.0099	0.134	Housing
-0.2020	-2.5257	0.08	Commercial and services
-0.2413	-1.9951	0.136	Educational
-0.1173	-3.3524	0.035	High education
-0.1537	-2.9565	0.052	Religious
-0.2958	-0.4764	0.621	Cultural and artistic
-0.3634	-1.1631	0.3125	Tourism and catering
-0.3498	-1.3509	0.252	Curative and hygienic
-0.2693	-2.0099	0.134	Sports
-0.2693	-2.0099	0.134	Police
-0.3103	-0.5242	0.592	Green areas and recreation
-0.0922	-3.6888	0.025	Industrial and workshops
-0.3393	-0.65008	0.552	Urban establishments
-0.3181	-1.6398	0.194	Transports and warehouse
-0.2799	-1.93102	0.145	Pass ways
-0.2948	-1.8201	0.162	Mixed and others
-4.1966			total

Table 5. total of values of region 3, Source: calculations of authors

Pi(Ln Pi)	Ln Pi	(Pi)	Use
-0.2881	-1.8708	0.154	Housing
-0.1537	-2.9565	0.052	Commercial and services
-0.2510	-2.1445	0.117	Educational
-0.1072	-0.1210	0.886	High education
-0.1196	-3.3242	0.036	Religious
-0.1688	-2.8134	0.06	Cultural and artistic
-0.3346	1.5005	0.2223	Tourism and catering
-0.3538	-1.3056	0.271	Curative and hygienic
-0.3384	-1.4653	0.231	Sports
-0.3491	-1.3586	0.257	Police
-0.1416	-3.0791	0.046	Green areas and recreation
-0.1958	-2.5770	0.076	Industrial and workshops
-0.1374	-3.1235	0.044	Urban establishments
-0.1101	-3.4420	0.032	Transports and warehouse
-0.2799	-1.9310	0.145	Pass ways
-0.2403	-2.2256	0.108	Mixed and others
-3.2209			total

Table 6. total of values of region 4, Source: calculations of authors

(Pi(Ln Pi	Ln Pi	(Pi)	Use
-0.2315561	-2.29263	0.0101	Housing
-0.1353015	-3.14655	0.043	Commercial and services
-0.2289509	-2.31263	0.099	Educational
-	-	0	High education
-0.1688046	-2.8134	0.060	Religious
-0.05645648	-4.3428	0.013	Cultural and artistic
-0.1051967	-3.50655	0.03	Tourism and catering
-0.1894684	-2.63108	0.072	Curative and hygienic
-0.33362	-1.50559	0.221	Sports
-0.5307418	-4.42284	0.021	Police
-0.2641846	-2.0479	0.129	Green areas and recreation
-0.3648611	-0.877	0.416	Industrial and workshops
-0.1586586	-2.9374	0.053	Urban establishments
-0.2799981	-1.931156	0.145	Transports and warehouse
0.2403674	2.225	0.108	Pass ways
0.2403674	2.22562	0.108	Mixed and others
3.525114			total

Table 9. total of values of region 8, Source: calculations of authors

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d_j	d_1	d_2	d_3	d_4	d_6	d_7	d_8	$\sum$ dj
$1-E_j$	2.529	1.821	2.513	2.161	2.827	2.328	1.127	14.306

Finally, we find the extent of weight of regions from the following function:

$$W_j = \frac{d_j}{\sum_{j=1}^{n} d_j};\ \forall j$$

$$W_{i1} \rightarrow \frac{2/529}{14/306} = 0/176 \qquad W_{i2} \rightarrow \frac{1/821}{14/306} = 0/127$$

$$W_{i3} \rightarrow \frac{2/513}{14/306} = 0/175 \qquad W_{i4} \rightarrow \frac{2/161}{14/306} = 0/151$$

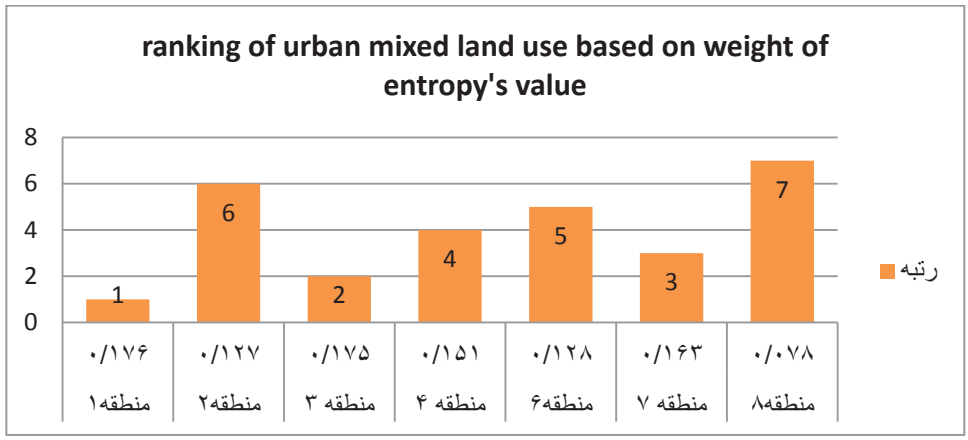
$$W_{i6} \rightarrow \frac{1/827}{14/306} = 0/127 \qquad W_{i7} \rightarrow \frac{2/328}{14/306} = 0/163$$

$$W_{i8} \rightarrow \frac{1/127}{14/306} = 0/078$$

Finally, we should note that $\sum_{j=1}^{n} W_j = 1$

7th G	6th F	5th E	4th D	3th C	2th B	1th A	Region
0.078	0.163	0.128	0.151	0.175	0.127	0.176	weight
7	3	5	4	2	6	1*	rank

Table 10: ranking of urban mixed land use based on the extent of entropy's value,Source: calculations of authors



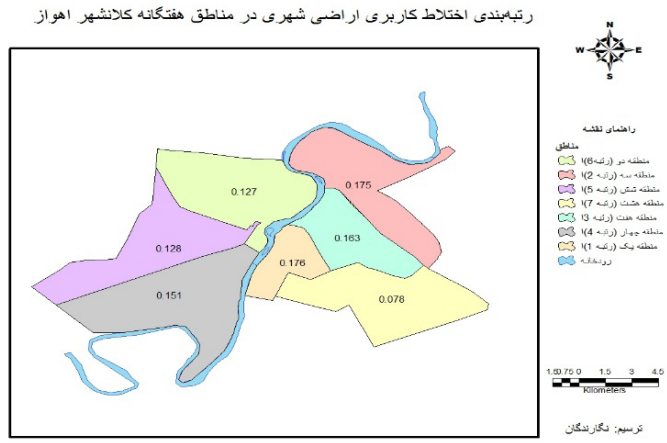


Figure 1. ranking of urban mixed land use in 7 regions of Ahvaz metropolis

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Therefore, we see that region 1 of Ahvaz metropolis has a higher mixed land use compared with other regions.

Testing of hypotheses, conclusion and suggestions

Disorderly and irregular growth of Ahvaz metropolis during the last several decades has been along with the random distribution of uses and urban annuals. The space of various uses besides indicating the concentration and variance of uses and activities among urban regions indicates the extent of people benefiting from urban services. In addition, results of the Shanon entropy model showed there is imbalances and inequities among the 7 regions of Ahvaz regarding benefiting from facilities and urban annuals which requires more attention in the area of just distribution of sources, services and urban facilities among the 7 regions of this metropolis.

In this research by using the Shanon entropy model, we found the numerical value of mixed land use that has three aspects of environmental, economic and social. However, regarding the results gained and also the deletion of two utterly incongruent uses from the calculations meaning the systematic and deserted ones that have a considerable share in 7 regions of Ahvaz, we observe little effect in the sustainable growth of urban lands. Overall, the extent of mixed land use based on the index of entropy is very low in the level of the regions. The domination of housing use and low variety of uses in these regions and low level of other uses has reduced the mixed land use among the 7 regions and has challenged the sustainability of these regions. Thus, the results of testing the research hypothesis are based on rejection of the hypothesis and inequity of mixed land use among the regions

of this metropolis. In this case, urban plans should facilitate the increase of mixed uses and variety of users in various levels of neighbors (regions, sections and urban areas) to realize the goal of attending to regions, which is among the goals of sustainability.

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