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The Study of the Environmental Sustainability of Rural Housing in Lorestan province, Iran

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Abstract

The present study has assessed the environmental sustainability of rural housing in terms of quantitative and qualitative indicators, according to the latest information resources from the Statistical Center of Iran and the Housing Foundation of Islamic Revolution, together with analytical and technical methods. Data collection was conducted using TOPSIS method, the coefficient of dispersion, and cluster analysis. Results from the TOPSIS method, which was used for analyzing the application of environmental indicators of rural housing, show that the CLi values of this index in the cities of Dorood and Aligoodarz are 0.461376 and 0.103033, respectively. Delfan, Azna, and Khoramabad, as wealthier cities, are next in the ranking, following the city of Dorood. The CLi values obtained from environmental measures of rural housing reveals the existence of gaps and divergence between the cities of Lorestan province. Coefficient of dispersion indicators show that the ratio of housing with appropriate sewage system (wastewater) by a factor of 1.153702734 has the highest coefficient of dispersion and the ratio of housing with appropriate sewage system (toilet) with a coefficient of determination of 0.02354327 has the lowest coefficient of dispersion among the indicators. The results show that the environmental indicators in the cities such as Aligoodarz, Poldokhtar, and Koohdasht, where there are livestock activities, are in more unsustainable situation, as compared to other cities of the province.

Keywords: Index, TOPSIS, cluster analysis, the coefficient of dispersion, rural housing, Lorestan Province

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Introduction

According to Brundtland report in the conference "the Earth" (1987), sustainable development means meeting the needs of the present generation without jeopardizing the ability of the future generations to meet their own needs. Sustainable development is a multidimensional process that links the environmental protection with the economic, social, and cultural development. These links are mentioned as a four-dimensional approach to sustainable development, which emphasizes on a harmonized connection between the environmental, economic, social, and cultural dimensions (UN-Habitat, 2012). Much of the existing literature on the fundamental paradigm of sustainability puts its emphasis on three major dimensions of environmental, economic, and social. In the theoretical explanation of the sustainable development that presses upon the interaction of the three social, economic, and environmental dimensions, certain other approaches, such as protectionism, socialism, environmentalism, are formed. In economic development, the ultimate goal is thus defined as the very ensuring of the sustainable economic growth, economic development, the maximizing of the benefits, the expansion of the market, the minimizing of the costs, the development of the environmental capacity, conservation and recycling of the resources, waste reduction, and increase of the self-reliance in community development (Rodrigue, 2009). One of the three major areas that the sustainable development emphasizes upon is the environmental issues (Rogers, 2005). To this end, evaluation of the environmental indicators is one of the important aspects of man's assessment of himself. Environmental indicators address the issues related to noise pollution, air, environment and their consequences and, too, the way the constructions are done on the platform of the environment and the related consequences, such as destruction of plants, mountains, and plains and the related issues to earthquakes, floods and the consequences of these destructive human activities. Moreover, other related components that are considered in the environmental indicators are the human access to open and green spaces, parks, gardens, access to public sewage, disposal of household and industrial wastewater, health issues, prevention of diseases, etc.

Housing, as one of the basic needs for human survival, more is an institution with multi-dimensional performance, such as architecture, physical, economic, social, financial, psychological and medical dimensions (see Culling Worth, 1997). Formation of rural areas is mainly dependent on special forms of housing and access to them (Cloke et al. 2006). While housing is a basic need for welfare and social security of the rural household (Tiwari, 2007), rural housing in the broader political issues has been marginalized, inasmuch as due priority goes for urban housing. Here it may be argued that there is no separate policy on rural housing. The existence of much heterogeneity across different regions would let in local dimensions in the process of policy making. It can be argued that much of the failure in many rural initiatives is rooted in lack of attention towards the rural housing sector. If we put aside the possibility of having a separate rural housing policy, the question of the definition of rural areas would then be inevitable. What is needed is an awareness of the role the local dimension and housing indicators play in solving the housing issues inside the housing area (Tiwari, 2007).

The gap among the cities of Lorestan province in having the rural housing environmental indicators makes addressing of this issue crystal clear. The present study aimed at assessing the environmental status of rural housing in rural areas of the cities of Lorestan, as well as making clear the status quo of the environmental situation of the rural housing and its evolution in recent years, and, moreover, making levels and rankings of the rural housing in the cities of Lorestan province so as to attract the attention of the policymakers towards the above indicators.

Research questions

- What is the status quo of the rural housing environmental indicators among the cities of Lorestan province?
- How is the distribution of environmental indicators of rural housing in the cities of the Province?
- How is the leveling of the cities of the Province in terms of environmental indicators of rural housing?

Literature Review

Chen et al (2005) in an article entitled "Environmental challenges of post-reform housing development in Beijing", put the environmental challenges in the housing development as following: inefficient use of land, water shortages, air pollution, traffic congestion, environmental damage, high energy consumption, and waste management. This study argues that environmental concerns at the planning and design level must be addressed urgently so as to maintain a high level of housing activity.

Seong-Kyu Ha (2008) in an article entitled "Social housing estates and sustainable community development in South Korea" describes the characteristics and problems of housing and addresses the issues of sustainable development in South Korea. The results of their research show that there is no necessity in providing any specific solution, and the government, private sector, and civil society should be closely involved in order to provide a comprehensive housing program.

Asfour (2012) in an article entitled "Towards an effective strategy to cope with housing land scarcity in the Gaza Strip as a sustainable development priority " assesses the shortage of housing land in the Gaza Strip due to the population growth in the region, so as to highlight the role of housing congestion and coping with it. The results show that providing solutions to maintain the balance between dense housing patterns and urban environment is essentially required.

Theory

For most households around the world, housing is assumed as the most expensive and valuable asset; moreover, for most families, it is a determining factor for the quality of life. Housing in most developed countries and some emerging market economies is desirable (Stren & White, 1989; Khoury, 1996). According to Rappaport, the culture and the human understanding of the universe and life has an important role in housing and its division of space (Rappaport, 1969).

According to Le Corbusier's viewpoint, both the physical and psychological needs of human must be met in the organizing of the house space. He also believes that social institutions outside the house are complementary to the house and should provide favorable conditions for the life of civil society (Yagi, 1987). According to Fletcher, house is a paradoxical playground for both tenderness and violence. In *The Poetics of Space*, Gaston Bashlard calls house as the "atmosphere of happiness", where rest, self-discovery, tranquility, and maternity become important (Gaston Bachelard, 1968).

Maintenance and improvement of the environment would be finally met through environmental responsibility and guarantee, which is a matter of reducing reliance on natural resources, minimizing pollution, avoiding contamination of the ground, practicing energy efficiency, enhancing biodiversity and reusing or cleaning the burned lands (Strong & Hemphill, 2006). Since environmental problems often are within the mechanisms, structures, and organisms, looking for their effect after their emergence is very much delayed. Identifying an environmental issue is a result of reliance on the scientific methods and tools, such as the credit, social, cultural, and political systems (Beck, 1992).

Identifying the study areas

Lorestan province is located in west Iran at 46 degrees 50 minutes east to 50 degrees 2 minutes east of the Greenwich meridian, and 32 degrees and 38 minutes to 34 degrees 22 minutes north latitude. The province with an area of over 28559.5 square kilometers is located in west Iran, in Zagros mountain range and includes about 1.8 percent of the total area of the country.

Methodology

The present study is an applied research and the method is descriptive-analytic. Data collection was conducted via library research; including detailed results of the General Census of Population and Housing, 2006, the rural housing characteristics survey, 2008, as well as the documents and reference books on the subject.

Indicators used in research

Housing indicators are the variables by which the qualitative and quantitative analyses of housing issues are conducted. These indicators represent different economic, social, cultural and physical aspects. Since the raw and primary required research data are obtained from the public census, it therefore has good validity and reliability. To this end, the researcher has made the indictors according to the research needs and the available data.

Table 1. Environmental indicators of rural housing

Index	symbol	Index	symbol
The ratio of high-density housing	X1	The average number of views	X7
The ratio of housing has spread towards the lands and gardens	X2	Reverse of the residential units lacking porch	X8
The ratio of the use of local materials in housing	X3	The ratio of the use of the public transport network	X9
Reverse ratio of the villages lacking responsible organizations for the collection and disposal of waste	X4	The ratio of housing with an appropriate sewage system (kitchen)	X10
Reverse of the use of wood for fuel consumption	X5	The ratio of housing with an appropriate sewage system (toilet)	X11
The average number of average openings	X6	The ratio of housing with an appropriate sewage system (wastewater)	X12

Survey of the status of environmental indicators of rural housing

After designing 12 appropriate indicators for checking the status of rural housing environment in Lorestan province, data collection was conducted through the given methods, so as to analyze the environmental situation of rural housing. Following is the process of data analysis in TOPSIS model.

1st step: forming of the place decision-making matrix

Options (rows) in this matrix include the cities of Lorestan province; the indicators are the 12 used indicators (X1 to X12) in the research. Table 2 shows the matrix of place decision-making related to the cities of Lorestan province, wherein the used indicators in the assessment of environmental sustainability of rural housing are listed in the rows of the matrix and the cities in the columns.

Table2. Matrix of raw data of place decision-making

Cities / Index	Azna	Aligoodarz	Borujerd	Poldokhtar	Khoramabad	Delfan	Dorood	Selseleh	Koohdasht
X1	47.77	17.17	12.71	37.07	10.72	62.73	100	20.22	72.69
X2	24.44	66.48	17.95	13.10	22.56	16.43	81.88	58.39	39.36
X3	17.7	9.97	0.99	32.95	50.62344	74.07	7.24	4.58	20.31
X4	1.11	0.27	19.57	7.11	3.74	0.23	48.55	0.38	8.25
X5	0.40	30.31	1.95	18.25	11.34	6.77	3.19	6.77	5.66
X6	3.27	4.18	3.33	3.28	3.26	4.07	3.35	3.63	4.05
X7	2.19	1.84	1.45	1.21	2.93	1.14	1.09	1.58	1.49
X8	43.19	24.76	15.00	29.65	15.57	42.9	82.32	3.62	28.47
X9	57.77	21.88	20.32	45.31	51.24	50.92	65.94	100	64.76
X10	3.66	6.48	6.73	2.49	22.39	10.07	40.02	0.92	3.52
X11	99.42	91.41	97.27	95.23	96.61	96.33	96.68	98.05	98.02
X12	4.87	6.247	5.27	2.10	28.92	39.21	40.22	1.64	1.36

Source: authors' calculations, 2015

2nd step: calculation of the normalized values

An important point in the matrix of multi-criteria decision-making is the presence of positive and negative indicators with different scales is in a matrix. Hence, in order to allow comparison of the indicators, it is necessary to find the potentiality of comparability through normalization (see Jin, 2005). In this step, the existing decision-making matrix becomes a "non-scaled" matrix via the following formula:

(1) $$f_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{n} x_{ij}^2}} \quad , i = 1,2, \dots, m: j = 1,2, \dots, n$$

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Where, X_{ij} is the initial value and f_{ij} is the normalized value of i and then$j$.

Table3. Matrix of normalized geographical

Cities / Index	Azna	Aligoodarz	Borujerd	Poldokhtar	Khoramabad	Delfan	Dorood	Selseleh	Koohdasht
X1	0.477778	0.171745	0.127182	0.370787	0.107232	0.627315	1	0.20229	0.726984
X2	0.536261	0.197175	0.730077	1	0.580835	0.797595	0.160088	0.224474	0.333001
X3	0.24	0.134626	0.013466	0.444944	0.683416	1	0.097826	0.061832	0.274286
X4	1.23E-06	1.23E-06	1	0.086613	0.046268	1.23E-06	0.610981	1.23E-06	0.133251
X5	1	0.013257	0.205846	0.022015	0.035437	0.05934	0.125693	0.059311	0.070907
X6	0.781763	1	0.796462	0.784033	0.780236	0.973792	0.801994	0.868517	0.968748
X7	0.749667	0.627397	0.496019	0.413507	1	0.389532	0.373066	0.539171	0.509569
X8	0.083821	0.146202	0.241255	0.122069	0.232427	0.08433	0.04398	1	0.127129
X9	0.577778	0.218837	0.203242	0.453184	0.512469	0.509259	0.65942	1	0.647619
X10	0.091581	0.162078	0.168201	0.062295	0.559433	0.251616	1	0.023188	0.088129
X11	1	0.919485	0.978376	0.957892	0.971726	0.968912	0.972463	0.986262	0.985909
X12	0.121107	0.155316	0.131234	0.052346	0.719022	0.974986	1	0.04102	0.033988

3rd step: calculating the weight of indicators

Standard deviation is used for weighting the indicators. Indicators x1, x3, x5, x10 and x12 with 0.10, 0.10, 0.10, 0.10 and 0.13, respectively, have the highest weight among the indicators, which indicates the importance of these indicators in environmental sustainability for rural housing is. In this method, x11 has the minimum weight. Table 4 shows the results of the relative weight of each of the indicators:

Table4. Indicators weight based on Standard Deviation

X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12
0.10	0.09	0.10	0.08	0.10	0.03	0.06	0.09	0.07	0.10	0.007	0.13

Source: authors' calculations, 2015

4th step: **calculating the weighted normal matrix**

In this step, in order to give weight to each indicator, the values of normalized matrix (Table 2) of each of the options is multiplied by the weights of the indicators (4), thus to obtain the weighted normalized matrix (Table 5).

Table5. Matrix of normalized weight

Cities / Index	Azna	Aligoodarz	Borujerd	Poldokhtar	Khoramabad	Delfan	Dorood	Selseleh	Koohdasht
X1	0.030	0.011	0.008	0.023	0.006	0.040	0.064	0.013	0.046
X2	0.030	0.011	0.041	0.056	0.032	0.045	0.009	0.012	0.018
X3	0.018	0.010	0.001	0.034	0.053	0.077	0.007	0.004	0.021
X4	0.01	0.014	0.077	0.015	0.015	0.014	0.028	0.014	0.016
X5	0.097	0.001	0.019	0.002	0.003	0.005	0.012	0.005	0.006
X6	0.009	0.011	0.009	0.009	0.009	0.011	0.009	0.010	0.011
X7	0.027	0.022	0.017	0.014	0.036	0.014	0.013	0.019	0.018
X8	0.006	0.012	0.019	0.010	0.019	0.006	0.003	0.082	0.010
X9	0.025	0.009	0.009	0.020	0.022	0.022	0.029	0.044	0.028
X10	0.007	0.013	0.014	0.005	0.047	0.021	0.084	0.001	0.007
X11	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
X12	0.010	0.012	0.010	0.004	0.060	0.081	0.083	0.003	0.002

Source: authors' calculations, 2015

5th Step: determining the highest and lowest values for all functions of the indicators

The greatest value of each indicator as a positive ideal (A+) and the lowest value of each indicator as a negative ideal (A-) will be determined in this step.

Table6. Determining the highest and lowest values of the matrix of normal weight

	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12
S+	0.064	0.056	0.077	0.077	0.097	0.011	0.036	0.082	0.044	0.084	0.002	0.08
S-	0.006	0.009	0.001	0.014	0.001	0.009	0.013	0.003	0.009	0.001	0.002	0.002

Source: authors' calculations, 2015

6th step: the calculation of the relative closeness of A_i to the ideal solution and the ratings of the options

In this step, together with the 5th step, the Euclidean distance of each stage from the ideal choices of positive and negative responses of each indicator question is calculated via equations 2 and 3: from the equation 2 and 3, is calculated:

(2) distance from the positive ideal $D_i^+ = \sqrt{\sum_{j=1}^{n}(V_{ij} - V_j^+)^2} \longrightarrow$ i=1,2,…m

(3) distance from the negative ideal $D_i^- = \sqrt{\sum_{j=1}^{n}(V_{ij} - V_j^-)^2} \longrightarrow$ i=1,2,…m

In order to organize and prioritize the options, the obtained values of CLi are organized in order of the magnitude of the numbers. Therefore, the priority and importance of options depend upon the greatness of their numbers: the greater the number, the more prioritized and important.

Table7. The calculation of the relative closeness of A_i to the ideal solution

Cities	D^+	D^-	CL_i	Rank
Azna	0.163469287	0.105312	0.391814	3
Aligoodarz	0.19739884	0.022675	0.103033	9
Borujerd	0.176052788	0.076489	0.302876	6
Poldokhtar	0.187619768	0.062239	0.249096	7
Khoramabad	0.153525307	0.097875	0.389319	4
Delfan	0.153885489	0.122956	0.444138	2
Dorood	0.154173063	0.132062	0.461376	1

Selseleh	0.189131195	0.087051	0.315193	5
Koohdasht	0.187122619	0.051406	0.215513	8

Table8. Rating the areas under study according to the environmental indicators of sustainable rural housing

Indicators	Environmental indicators		Scale of richness
Cities	TOPSIS rating	Ultimate ranking	–
Azna	0.391814	3	Semi-sustainable
Aligoodarz	0.103033	9	VeryUnsustainable
Borujerd	0.302876	6	Sustainable
Poldokhtar	0.249096	7	Unsustainable
Khoramabad	0.389319	4	Semi-unsustainable
Delfan	0.444138	2	Semi-sustainable
Dorood	0.461376	1	Semi-sustainable
Selseleh	0.315193	5	Unsustainable
Koohdasht	0.215513	8	Unsustainable
Mean	0.319151		–
Standard deviation	0.11656		–
Dispersion coefficient (Percentage)	0.365218		–

According to calculations, the average TOPSIS rating in 9 cities of Lorestan was 0.319, and considering that the ideal in this model is 1, the cities of the province, in terms of environmental sustainability indicators of rural housing, are below the average. Dispersion coefficient of 0.3652 represents a relative divergence between the cities in terms of the enjoyment of these environmental indicators.

Results from the TOPSIS method, the method that was applied for evaluating and analyzing the environmental indicators of rural housing in 2008, show that the CLi values of these indicators in the cities of Dorood and Aligoodarz are 0.46 and 0.10, respectively, having the best and the worst situations. The cities of Delfan and Azna, as the wealthiest cities are next in rank, after Dorood. In general, 5 cities out of the 9 cities of Lorestan province rank lower than the average, and in terms of environmental sustainability of housing are inappropriate.

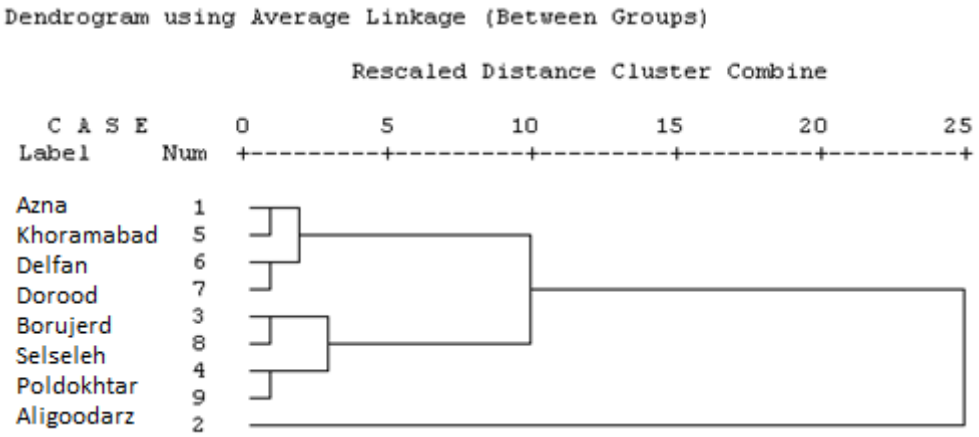

Figure1. The tree diagram of environmental sustainability of the cities of Lorestan province, using TOPSIS and clustering

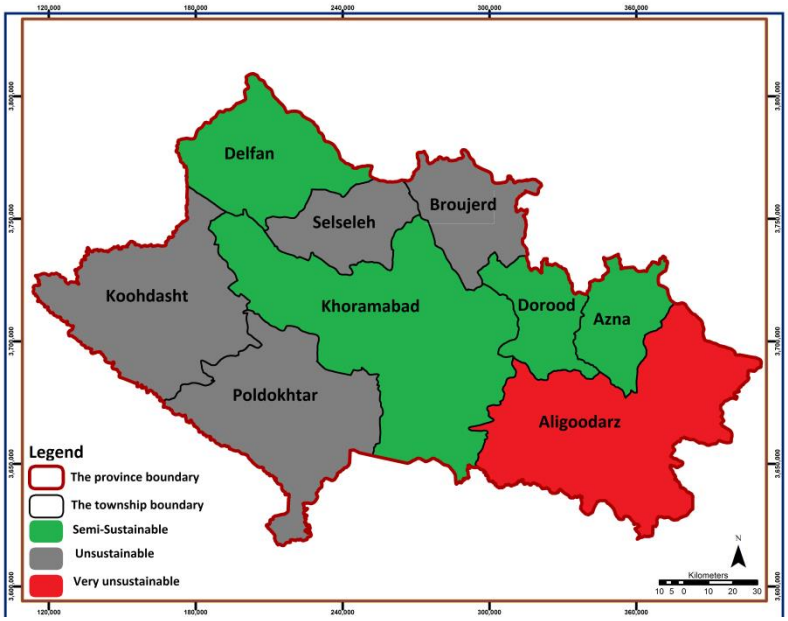

Figure2. The map of environmental sustainability of the cities of Lorestan province

The coefficient of dispersion

The coefficient of dispersion was obtained through the calculations, which shows difference and dispersion in the enjoyment of the indicators in the cities of the province. The ratio of houses with appropriate sewage system (wastewater) by a coefficient of dispersion of 1.153702734 has the highest dispersion coefficient, and the ratio of houses with appropriate sewage system (toilet) with a coefficient of determination of 0.02354327 has the lowest coefficient of dispersion among the indicators (Table 9 shows the results from dispersion coefficient of indicators).

Table9. Calculating the coefficient of dispersion for different indicators

Indicator	X1	X2	X3	X4	X5	X6
Dispersion coefficient	0.73348872	0.66467157	1.001524113	1.59055781	1.009880576	0.108610409
Indicator	X7	X8	X9	X10	X11	X12
Dispersion coefficient	0.356530832	0.723063161	0.453269434	1.188484877	0.02354327	1.153702734

Conclusion

Developing a comprehensive housing program, especially the rural housing, requires full recognition and in-depth analysis of large-scale dimensions of housing and the factors affecting it. In this regard, addressing the housing indicators as the main planning tool seems necessary. The present study has assessed the environmental sustainability of rural housing in terms of quantitative and qualitative indicators according to the latest information resources of the Statistical Center of Iran and the Housing Foundation of Islamic Revolution and using analytical and technical methods. Data collection was conducted using TOPSIS method, the coefficient of dispersion, and cluster analysis. What the present research findings indicate is that Lorestan province, with 1.2 percent of Iran's housing, has 1.8 percent of urban housing and 2.8 percent of rural housing in 2011. The number of rural houses in the province in 1390 has been 145,091 units, as compared to 2006, with 210,622 units, has had an annual growth of 5.15 percent.

Results from TOPSIS method for analyzing the qualitative and quantitative indicators of rural housing shows that the CLi values of these indicators are 0.461376 and 0.103033, respectively, in the cities of Aligoodarz and Dorood, having the best and the worst situations. The cities of Delfan, Azna, and Khoramabad are next in rank after Dorood, as being the wealthiest cities of the province. Cli values obtained from environmental indicators of rural housing indicate the gap and divergence between the cities of the province.

According to the carried out investigations, all the cities in terms of the enjoyment of the indicators (mentioned in table 1) are in semi-sustainable and unsustainable situations.

Analyzing the results from cluster analysis based on selected indicators and rankings of the cities of Lorestan province showed the city was divided into 3 levels, wherein the cities of Dorood, Delfan, Azna, and Khorramabad are in the first cluster and thus are assumed as the semi-sustainable cities of the province in terms of environmental indicators of housing. Similarly, the cities of Borujerd, Selsele, Poldokhtar, and Koohdasht are in the second cluster and thus are in unsustainable situation. The city of Aligoodarz, alone, is in the third cluster and is assumed as very unsustainable in terms of environmental indicators of housing.

The calculation of the coefficient of dispersion showed that the ratio of houses with appropriate sewage system (wastewater) by a coefficient of dispersion of 1.153702734 has the highest dispersion coefficient, and the ratio of houses with appropriate sewage system (toilet)

with a coefficient of determination of 0.02354327 has the lowest coefficient of dispersion among the indicators.

The results show that the environmental indicators in the cities such as Aligoodarz, Poldokhtar, and Koohdasht, where there are livestock activities, are in more unsustainable situation, as compared to other cities of the province.Most sustainable cities of the province are located in the central and northern parts of the province. Therefore, it is suggested that the main focus of planning and rural housing policies to be in southern areas of the province. This is nevertheless should not put other cities in negligence, but the development of environmental indicators in order to achieve sustainable rural housing requires attention to all areas.

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