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Ranking and Level of Development According to the Agricultural Indices, Case Study: Sistan Region

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Abstract

Sistan region is one of the most important agricultural areas in the province of Sistan and Baluchistan. Therefore, given the heterogeneity in agriculture and recognizing these differences, the aim of this study was to obtain the level of development of agriculture in the Sistan region. To obtain this purpose Fuzzy Analytical Hierarchy Process (FAHP) and the numerical taxonomy were used in a view of 20 indicators in the agricultural sector in the region. The required data were achieved by filling out the questionnaire certified experts and statistical yearbooks in the agricultural sector. Data analysis was used by Matlab and SPSS softwares. Results of numerical taxonomy showed that Markazi, Shibab and Poshteab sectors component parts were less developed. Also, Jazinak and Miyankangi are in the category sections were undeveloped. The results of Fuzzy Analytical Hierarchy Process (FAHP) model indicated that Markazi, Shibab and Poshteab sectors are in the first rank of development, in terms of agricultural indices in the region. Jazinak and Miyankangi are in the fourth and fifth ranking. Therefore, in general, it is clear that the level of development of agricultural in Sistan region isn't in good condition. In this regard it is suggested that appropriate planning to promote agricultural development is on the agenda should be applied.

Keywords:
Levels of Agricultural Development, Numerical Taxonomy, Fuzzy Hierarchical Analysis (FAHP), Sistan

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INTRODUCTION

During the past decade, agricultural development has been considered as one of the main objectives of development policies in many countries. Development policies, such as agricultural development, specifically in developing countries, are considered as the center of development projects. Considering the fact that agricultural development is a highway for improving the quality of rural life, welfare, food security and etc., balancing them with respect to levels of agricultural development necessitates categorizing and rating of districts (Moradi *et al*., 2015).

Agricultural development denotes the quality of agricultural system of a region; it is a multi-dimensional concept which mainly includes development in a real strength of cropped land, improvement in farm practices/system, improved farm implements, irrigation system and irrigated area, high yielding improved varieties of seeds, chemical fertilizers, insecticides and pesticides, intensity of cropping and specialization and commercialization of agriculture (Mohammed, 1980).

Many economic activities depend on agriculture, including marketing, processing, and export of agricultural products. Because of this fact, development of the regional economy heavily depends upon the speed with which agricultural growth is achieved (SardarShahraki *et al*., 2014). Accordingly, the different development programs gave due to the emphasis of development of the agricultural sector with a view to stimulating rapid growth in total production and improvement in productivity (Badri *et al*., 2007). Nonetheless, development agents have been found to differ in perception and performance of their roles and satisfaction on their job (Peet, 1999). In Sistan region majority of its population depend upon agriculture. So a vast rural mass tries to earn their livelihood from agricultural land. With fast increasing pressure of population on agricultural land, old methods and techniques of production cannot cope with growing demand. As a result, new technologies and commercial crops are adopted to develop agro-economy. For these reason emphases on the diffusion of agricultural innovation are stressed.

MCDM approaches were developed in 1960s to assist decision-makers to incorporate many options, reflecting the opinions of the actors concerned, into a potential or retrospective framework. They were designed to define the relationship between the data input and the data output. MCDM can be separated into main two main groups of methods; multi objective and multi attribute (Malczewski, 1999).

Shafiee *et al*. (2012) in research of optimum selection of integrated marketing communication tools with FAHP approach, this result is achieved that advertisement has the highest rank among marketing communications channels in "product-market" of interest. Thus, it is the main channel in marketing communications of that "product-market". Shafaiyanfard *et al*. (2015) were examined superior options exploitation of water resources by using WEAP model and analysis and multiple attribute decision making. According to results of this research, the scenario of further development in summer planting was selected. Sasikumar and Mujomdar (1998) proposed a multi objective fuzzy model for quality management Systems River. In this research, qualitative goals of the organizations responsible for river water quality protection and dump various contaminants considered in the form of models fuzzy multi attribute decision making.

Chuntian (1999) used fuzzy multi-criteria optimization model to manage water resources in times of flood. Fu (2008) used Fuzzy multi-criteria decision-making method and their application in management and flood control in the agricultural sector. SardarShahraki *et al*. (2014) in determining the level of development of agriculture and economy in rural of Iran by using 68 economic indicators and 46 indicators of agriculture in rural areas using two numerical taxonomy and factor analysis were studied. The results of their study showed that thatprovincialIsfahan,Tehran,Mazandaran,Fars,Iran,Yazd, Qomprovincescategoriesdevelopedintermsofagricultureandruralsector,ofwhichonlythreeprovincesofTehran,FarsandYazdeconomicdevelopmentsaid. The results of their study showed that Isfahan, Tehran, Mazandaran, Fars, Golestan, Yazd and Qom in the developed provinces in terms of agriculture in the rural sector, of which, only three provinces of Tehran, Fars and Yazd have economic development. Khakpoor and BavanPoori (2009) analyzed inequity in development level in the regions of mashed city using 32 general indices, the obtained results showed that 25% urban regards of Mashhad are in very ownership class, 25% are in ownership class, 25% regions are in deprived class and 16.7% are in very deprived class. Ebrahimzadeh and Eskandarisani (2011) explain spatial pattern of urban-region development level in Iran during 1996 and 2006 using analytical- comparative method. In this study 35 different indices of development have been used. Curies of country class if 4 developed (32 cities), half to high developed cities (46 cities), less to low developed (126 cities), deprived (106 cities). Ramatu and Xinshen in 2007 with the application of factor analysis to examine regional disparities Ghana paid during the period 2000-1990. The results showed that the gap between the more developed northern regions of the South of Ghana.

Sharama in 2004 to investigate regional disparities in the state of Indian coefficient of variation using principal component analysis is paid.

Sistan region with abundant natural resources, skilled labor and manufacturing capability of diverse products has not been able to fit their abilities and opportunities relative to other regions earn appropriate development and development level of the region is very improper. Therefore, evaluating the level of development of this region in terms of having agricultural development indicators for suitable regional planning is important.

Purpose of study

Studyof development situation in the Sistan region with factor on agricultural development by numerical taxonomy and FAHP methods.

Present suitable solutions and strategies to eliminate shortage in developed and less developed sectors.

MATERIALS AND METHODS

Numerical Taxonomy

Data matrix includes table that its columns consist of indices and its lines consist of all economical sections or field of economic activities. Correlation matrix is used to have internal communication of indices, the values of the main diameter of matrix are 1 and numbers below its diameter are the: repetition of the numbers upper diameter, because correlation of each index is 1 and correlation of index 2 to 1 is always index 1 to 2.Extracting factors obtained using correlation matrix between indices. Using factor matrix, comma on factors of each index is known. Then specific vectors computed nunzero for all specific values. In fact, specific vectors are elated to loading value corresponds to each index that are called factor loads. Interpretation of factors will be simple, if each index, curries on one factor and or loaded values in factor are big, positive or close to zero, interpretation of factors will be hard, if the loads values of each index are average values on multi-factor and are given to obtain simple structure. In this research, varimax method has been used to ratite factors. According to the correlation amount of each index, we can select suitable titles or names for each one of them (SardarShahraki *et al.*, 2014).

Numerical taxonomy is one of the best ranking methods of various activities to use some indices. This method is also suitable to rank and compare various areas regarding development degree. This method can divide one set to more or less homogenous set and present suitable scale to recognize enjoying considered indices and social and economic development degree that has been used in the analysis of activities. Taxonomy analysis is performed in several phases that are as follows:

1. To from data matrix
2. To standardize data matrix
3. To from distance matrix
4. To determine homogenous distances
5. To rank homogenous activities for the studied indices.
6. To calculate ownership degree of homogenous activates (SardarShahraki *et al.*, 2014).

In this phase, we designed matrix for all series of activities according to the studied indices, So that matrix dimensions have been n×m namely this matrix has line for the number of activity series and column for indices number. As an example, $X_{n\times m}$ element indicates index m of n activity series:

$$A\,ij = \begin{bmatrix} x_{11} & \dots & x_{1m} \\ & \dots & \\ x_{n1} & \dots & x_{nm} \end{bmatrix} \qquad (1)$$

I=1, …., n; j=1 , …., m

In this matrix, columns indicate the used indices and lines showed the studied sub-section. As an example X_{ij} shows the related value to sub-section and indicate.

Considering that indices are measured with various units, thus, to delete the effects of these units and substitute unit scale and also to delete the effect of origin, first mean Z_{ij} is calculated, And in first step, the mean of columns is obtained:

$$\bar{x}_1 = \frac{1}{n}\sum_{1}^{n} x_{ij} \tag{2}$$

At the next step, standard derivation is obtained for each column for matrix X_{ij}.

$$S_j = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(X_{ij} - \bar{X}_j)^2} \tag{3}$$

The third step is that to standardized members of matrix A_{ij} from a new matrix framework called standard matrix to be calculated (Sardar-Shahraki *et al*., 2014).

$$z_{ij} = \frac{\bar{x}_{ij} - x_j}{s_j} \tag{4}$$

Matrix Z has n×m dimension and is a standard matrix, different matrices of indices have been converted to unit scale, when variable changes. It is clear that statistically average each column of standardized matrix Z is equal to zero and its standard deviation is equal to 1:

$$\text{z ij} = \begin{bmatrix} z_{11} & \cdots & z_{1m} \\ & \cdots & \\ z_{n1} & \cdots & z_{nm} \end{bmatrix} \tag{5}$$

i=1… , n ; j=1,…, m

By standard matrix, the next step is to give difference value or distance value of two points from each other (1, 2, ,…, n) for each m variable or index that formed distance matrix. In this step combined distances between different activities is obtained as n for m indices and follows according to standardized numbers in standard matrix z. these distances are same Euclidean distance generalization that presented as follows:

$$c_{ab} = \sqrt{\sum_{k=1}^{m}(z_{ak} - z_{bk})^2} \tag{6}$$

a,b = 1, 2, ….,n

Which Cab is the distance between two activity a and b. If the distance of activity series in Paris be obtained then the combined distance matrix shows as follows:

$$C_{ab} = \begin{bmatrix} c_{11}c_{12} & \cdots & c_{1n} \\ c_{21}c_{22} & \cdots & c_{2n} \\ & \cdots & \\ c_{n1}c_{2n} & \cdots & c_{nm} \end{bmatrix} \tag{7}$$

Because distances matrix is a symmetric matrix, we can conclude distance of activity series is equal to b to from a to b is equal to b to a and the distance of each activity series of itself is also equal to zero:

$$C_{aa} = C_{bb} = \ldots = C_{nm} = 0\ ,\ C_{ab} = C_{ba} \tag{8}$$

$$C_{ab} = \begin{bmatrix} 0 \; c_{12} & \cdots & c_{1n} \\ c_{21} \; 0 & \cdots & c_{2n} \\ & \cdots & \\ c_{n1} c_{n2} & \cdots & 0 \end{bmatrix} \tag{9}$$

As it is identified this matrix has been symmetrical and its diameter is zero. Also it is square matrix by n×n dimension. Each element of matrix Cab indicates the distance between each two activity strings in the considered index. In this matrix, it is the least distance between two activity strings in each line and it is written in the separate column (for example column) then we compute mean and standard deviation of the least distances of each line namely same column.

$$d_j = \begin{bmatrix} d_1 \\ d_2 \\ \vdots \\ \vdots \\ d_n \end{bmatrix} \tag{10}$$

$$\bar{d} = \frac{1}{n}\sum_{i=1}^{n} d_j \tag{11}$$

$$S_d = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(d_j = \bar{d})^2} \tag{12}$$

Distances of high limit d (+) and low limit d (-) is calculated according below relation to identify homogenous activity series. It is necessary to mention that number 2 is the Z of normal distribution here that has been determined in 95 percent level:

$$d(+) = \bar{d} + 2S_d$$
$$d(-) = \bar{d} - 2S_d \tag{13}$$

In this step, activity series that are the least distances between two high and low limit, have been homogenous and are in one group. If the least differences between two activates strings are higher than high limit and or less then low limit, then the series of abode activates must be deleted as inhomogeneous.

Ranking homogenous activity series from the studied standers. If all activity series aren't in one homogenous group, then it forms data matrix for homogenous activity strings, then it standardizes and considers ideal case in standardized indices matrix for each one of indices and the desired ownership for each activity series for is computed to find ideal values:

$$C_{io} = \sqrt{\sum_{i=1}^{m}(Z_{ik} - Z_{ok}} \quad (14)$$

i= 1, 2, …, n

Z_{ok} is ideal quantity for k standardized index, Z_{ok} is the standardized index for I activity and C_{io} is desired ownership for i activity. We consider as ideal the highest number in each column and if index direction is negative, the bigger number shows lack of ownership that we select as ideal value the smallest. Value in this phase, combination index in traduced as ownership degree that it had limited range and is between zero and one values. If ownership degree of I choice shows with f_i , then we have:

$$f_i = \frac{C_{io}}{C_o} \quad (15)$$

C_o is called high limit of the desired ownership and obtain from relation:

$$C_o = C_{io} + 2\ S_{cio} \quad (16)$$

So that C_{io} is average desired ownership for all I activity and S_{cio} is their standard deviation:

$$S_{cio} = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(C_{io} - \bar{C}_{io})} \quad (17)$$

Whatever f_i is near to zero, the considered activity string is more ownership it is near to one, it indicates lack of ownership of related activity string (SardarShahraki *et al*., 2014).

Fuzzy Analytical Hierarchy Process (FAHP)

Fuzzy AHP method is a popular approach for multiple criteria decision-making. In this study the extent fuzzy AHP is utilized, which was originally introduced by Chang (1996). Let X = {x_1, x_2, x_3,…, x_n} an object set, and G = {g_1, g_2, g_3,….., g_n} be a goal set. Then, each object is taken and extent analysis for each goal is performed, respectively. Therefore, *m* extent analysis values for each object can be obtained, with the following signs:

$$\tilde{M}_{g_i}^{1}, \tilde{M}_{g_i}^{2}, \ldots, \tilde{M}_{g_i}^{m} \quad (18)$$

Where $\tilde{M}_{g_i}^{j}$ *(j= 1,2,3,…, m)* are all triangular fuzzy numbers. The steps of the Chang's (1996) extent analysis can be summarized as follows:

Step 1: The value of fuzzy synthetic extent with respect to the it objects is defined as:

$$S_i = \sum_{j=1}^{m}\tilde{M}_{g_i}^{j} \otimes [\sum_{i=1}^{n}\sum_{j=1}^{m}\tilde{M}_{g_i}^{j}]^{-1} \quad (19)$$

Where ⊗ denotes the extended multiplication of two fuzzy numbers. In order to obtain $\sum_{j=1}^{m}\tilde{M}_{g_i}^{j}$, we perform the addition of m extent analysis values for a particular matrix such that,

$$\sum_{j=1}^{m}\tilde{M}_{g_i}^{j} = (\sum_{j=1}^{m} l_j, \sum_{j=1}^{m} m_j, \sum_{j=1}^{m} u_j) \quad (20)$$

And to obtain $[\sum_{i=1}^{n}\sum_{j=1}^{m}\tilde{M}_{g_i}^{j}]^{-1}$ we perform the fuzzy addition operation of $\tilde{M}_{g_i}^{j}$ *(j= 1,2,3,…, m)* values such that,

$$\sum_{i=1}^{n}\sum_{j=1}^{m}\tilde{M}_{g_i}^{j} = (\sum_{j=1}^{n} l_j, \sum_{j=1}^{n} m_j, \sum_{j=1}^{n} u_j) \quad (21)$$

Then, the inverse of the vector is computed as,

$$[\sum_{i=1}^{n}\sum_{j=1}^{m}\tilde{M}_{g_i}^{j}]^{-1} = (1/\sum_{i=1}^{n} u_i, 1/\sum_{i=1}^{n} m_i, 1/\sum_{i=1}^{n} l_i) \quad (22)$$

Where $u_i, m_i, l_i \succ 0 (22)$

Finally, to obtain the *Sj*, we perform the following multiplication:

$$S_i = \sum_{j=1}^{m}\tilde{M}_{g_i}^{j} \otimes [\sum_{i=1}^{n}\sum_{j=1}^{m}\tilde{M}_{g_i}^{j}]^{-1} = (\sum_{j=1}^{m} l_j \otimes \sum_{i=1}^{n} l_i, \sum_{j=1}^{m} m_j \otimes \sum_{i=1}^{n} m_i, \sum_{j=1}^{m} u_j \otimes \sum_{i=1}^{n} u_i) \quad (23)$$

Step 2: The degree of possibility of $\tilde{M}_2 = (l_2, m_2, u_2) \geq \tilde{M}_1 = (l_1, m_1, u_1)$ is defined as:

$$V(\tilde{M}_2 \geq \tilde{M}_1) = Sup[Min(\tilde{M}_1(x), \tilde{M}_2(y))] \quad (24)$$

This can be equivalently expressed as,

$$V(\tilde{M}_2 \geq \tilde{M}_1) = hgt(\tilde{M}_1 \cap \tilde{M}_2) = \tilde{M}_2(d) = \begin{cases} 1 & If \quad m_2 \geq m_1 \\ 0 & If \quad l_1 \geq u_2 \\ \dfrac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)} & Otherwise \end{cases} \quad (25)$$

Step 3: The degree of possibility for a convex fuzzy number to be greater than k convex fuzzy numbers M_i $(i=1, 2, \ldots, k)$ is defined as:

$$V(\tilde{M} \geq \tilde{M}_1, \tilde{M}_2, \ldots, \tilde{M}_k) = Min\, V(\tilde{M} \geq \tilde{M}_i)$$

i= 1, 2, ..., k (26)

Step 4: Finally, $W= (Min\ V\ (S_1 \geq S_k),\ Min\ V\ (S_2 \geq S_k),\ ..,\ Min\ (S_n \geq S_k))^T$, is the weight vector for K=1,…, N (Rafiee *et al*., 2013).

Indicators used

InTable1shown the index used by the Department of Agriculture in Sistan region.

RESULTS AND DISCUSSION

The results of numerical taxonomy and Fuzzy Analytical Hierarchy Process method are presented in this section. In numerical taxonomy, first, it was determined homogeneous sectors and then, they were classified. In this regard, the lower and upper limits to determine the homogeneity sectors in the Matrixes intervals were calculated. Section that minimum distances from other sectors outside the contour was 1.87222<d<5.1521, Heterogeneous sectors deemed and from ratings are removed. According to the results in Table 3, heterogeneous section did not exist. The first column in table 3 is section name, second column is cumulative relative frequency, third column is degree of development and fourth columnist level of development. The results of the ranking in terms of development of agriculture in the Sistan region shown in Table3.

According to the results in Table 3, parts that cumulative frequency there is from 0- 0.25. In batches developed part is that, no part was not in this category. Also, Parts that their Cumulative Frequency is at intervals of 0.25-0.5, 0.5-0.75, 0.75-1, in batches relatively developed, less developed and underdeveloped placed, Respectively. Hence, Poshteab, Shibab and Markazi sectors are in the category of less developed. Jazinak and Miyankangi sectors are in the category of underdeveloped. In Figure 1, the results of FAHP technique shown.

According to the results of FAHP medal, Matkazi sector is the first rank. Poshteab and Shibab sector are in second and third ranking. Jazinak and Miyankangi are in Fourth and fifth ranking.

Table 1: List of indicators of development in agriculture

	Indicators
1	Yieldof barley (kg/ha)
2	Yieldof forage plants (kg/ha)
3	Yield of wheat (kg/ha)
4	Yield of Watermelon (kg/ha)
5	Yieldofrapeseed (kg/ha)
6	Yield of Melon (kg/ha)
7	Yield of tomato (kg/ha)
8	Yieldofpotatoes (kg/ha)
9	Yield of grain (kg/ha)
10	Yield of herb (kg/ha)
11	Yield of bean (kg/ha)
12	Yield of pea (kg/ha)
13	Yield of Grapes (kg/ha)
14	Yield of corn (kg/ha)
15	Percapita production of banana seach operation (kg)
16	Cultivation of flowers and ornamental plants (ha)
17	Average production of Beehive
18	Yield of fish of water cold (kg/ha)
19	Proportion of agricultural lands and horticultural cooperatives covering a area under cultivation (ha)
20	The employment rate per hundred thousand rural industries (person)

Table 2: Section of Sistan

No	Sector
1	Poshteab
2	Shibab
3	Markazi
4	Miyankangi
5	Jazinak

Table 3: Ranking of the Sistan region of agricultural development

Section Name	Cumulative relative frequency	Degree of development	Level of development
Poshteab	0.5425	0.8797	Less Developed
Shibab	0.5874	0.8897	Less Developed
Markazi	0.5412	0.9254	Less Developed
Jazinak	0.7547	0.9745	Underdeveloped
Miyankangi	0.8745	0.9547	Underdeveloped

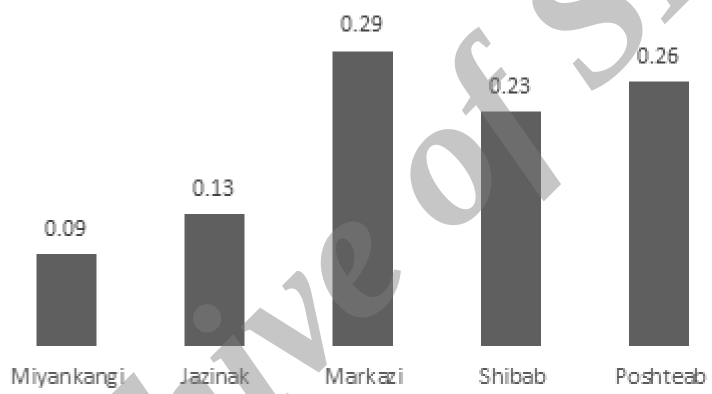

Figure 1: Ranking of the Sistan region in terms of agricultural development

CONCLUSION AND RECOMMENDATIONS

Sistan region is very complicated in terms of agricultural development. The present study reveals that the spatial distribution of variables and agricultural development is not uniform in this region and it provides very significant information about the level of agricultural development.In the present study, Parts of Sistan region were ranked according to 20 indicators agriculture regarding development using fuzzy hierarchical analysis and numerical taxonomy. According to the results, the following suggestions are offered:

Adequate planning for improve the status of agricultural development to be performed areas such as Jazinak and Miyankangi. One of the objectives of the regional plan, a balanced distribution of development in different areas of a region; Look for in a systematic, spatial inequalities in deprived areas and back ward areas of the country led to the creation of infrastructure facilities and services, employment, income, welfare. In other words, the uneven distribution of development, causing transmission problems in disadvantaged areas is rich areas. Therefore, the plan to eliminate the gap between different areas of the development is considered as a necessity. Regional planning, agricultural development, in coordination with other economic sectors (industry, services) as well as future plans are. However, before anything else, an urgent need for regional planning of agricultural gains knowledge of the state to draw favorable conditions.

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