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Application of TOPSIS method in evaluation and prioritization of social stability in rural areas (Case Study: Zidasht Basin)

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ABSTRACT: In recent years, terms sustainability has been becoming a main study field of too many interdisciplinary sciences. Also, it included suitability theory framework on which every planning designed by taking sustainable development should offer a multidimensional image from the study area. Meanwhile, social sustainability serves as one of the sustainable development components along with qualitative aspects which are evaluated by some concepts like human life and welfare feeling in an ambient. The present study deals with social sustainability level and prioritizes them in three rural centers of the Zidasht basin through six indices (Demographic Index, Literacy Index, Poverty Index, Nutrition Index and Food Security, Index Justice and Equality, Ownership Index) and 18 variables. TOPSIS, as one of the multi-criteria decision-making method, was used to prioritize social sustainability. In order to assign weights to corresponding criteria, 20 expertise were used. The result showed that Kalanak has the highest priority with the respective value of 0.7456, followed by Zidasht (0.6003) and Sangbon (0.2303). So that, findings from field studies and observation are in line with these results. Therefore, usage of TOPSIS is suggested in other study areas to prioritize social sustainability. © JASEM

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Rural communities have experienced extensive developments due to recent trends and policies in recent decades, but there is evidence that villages are moving toward instability, especially social instability. The lack of a systematic pattern of rural communities in determining the status quo and lack of optimal design of social stability indices contributes a major role in this confusion (Dasturani *et al*., 2012). In recent years, strategic planning thinking based on a sustainable approach to the planning of rural settlements has received a specific attention. In strategic planning to explain current situation and that what is village's situation now, serves as a starting point. On this basis, the Rural Development Strategy Planning is considered a prospective program that focuses on the study of rural communities and issues (Calabrò and Spina, 2014). The determinant in successful strategic planning based on a sustainable approach is extensive participation of people in development programs. The first step in this way to explain the current situation and analysis of the stability of rural settlements as well as people's that should be involved in the planning process. In fact, to achieve sustainable economic and social and environmental development of rural areas need to recognize and understanding of the resources and opportunities for their exploitation (De Andrade *et al*., 2015; Fabricius *et al*., 2013). Baseline assessment of the sustainability of rural settlements of understanding by identifying strengths and weaknesses and areas for external challenges and opportunities facing the development of rural areas can be obtained. In this context, the explanation of social sustainability of rural settlements, as the most important component of sustainable development, role and special position in its strategic planning (Bogdanov *et al*., 2008; De Andrade *et al*., 2015). In defining social stability, researchers have pointed to four main elements and determinants: social justice, social cohesion, participation and security (Torjman, 2000). In this sense, coupled with factors such as equal opportunities and progress for all people living with cooperation, equal opportunities for all people to play social roles as well as livelihood security and safety of human settlements against natural hazards, social stability criteria (United Nations, 2007).

Managers and rural development planners often face difficulties in making complex decisions. This complexity is mainly due to the fact that a great deal of factors and variables that must be considered in decision-making and since the effects of different factors and internal dependencies, are difficult for managers to understand the problem (Li *et al*., 2014). The amount of information and interaction of factors causes and is not able to view the complete decision making on planning (Witlox, 2005). In this regard, multi-criteria decision-making techniques appropriate way to solve such problems (Jiang *et al*., 2017). In fact, using this technique with different decision-making criteria, the best option or option from the

options on the selection decision and implementation (Dasturani *et al*., 2012). In order to investigate an issue with methods (MCDM), the first step is defining the appropriate form of options and criteria. Next, with respect to each option, do calculations or mathematical models calculated the effect of each option on the criteria for the numbers obtained, then having a table of options and varieties criteria, Prioritization option is. There are three approaches to Prioritization options: 1- Agreement on the distance between the point of ideal methods (TOPSIS) and the option is defined. 2- Methods for exclusion act. So that option, pair wise comparison deleted and the other one remains for the next step. 3- Prioritization based methods to calculate the value based on the most impact value function (Jacquet and Siskas, 1982; Keeney and Raiffa, 1976). Three attitudes, each in turn are several methods that are used on particular issues. But attitudes first and second regardless of the decision, automatically prioritized to do, in the event that the methods are third in attitude, with the intervention of the director and chief executive, in search of top priorities. The advantages and flexibility as an effective tool, especially in decision-making on issues related to nature and ecosystems and economic and social issues can be a good way to prioritize the sub (Kermani *et al*., 2016).

In the present study by taking measurements to determine the Ruralism on the basis of sustainable development will be discussed. Since the indices Ruralism from place to place and from time to time are different, the selection criteria for the study Ruralism should be based on the social, economic, environmental and institutional carried out the study population (Hart *et al*., 2005). The present study aimed to prioritize social sustainability in watershed Zidasht by decision TOPSIS multi-criteria decision.

MATERIALS AND METHODS

The study area is characterized with coordinates "35, '5, ° 36 to" 46, '11, ° 36 N and "46, '37, ° 50 to" 56, '44, ° 50 E. The study area is stretched from north to the river Taleghan and from south to Taleghan Mountain and from east to Barikan sub-basin and from west to Nesasofla basin. (Watershed Management, 1998). The basin has three rural areas (Figure 1).

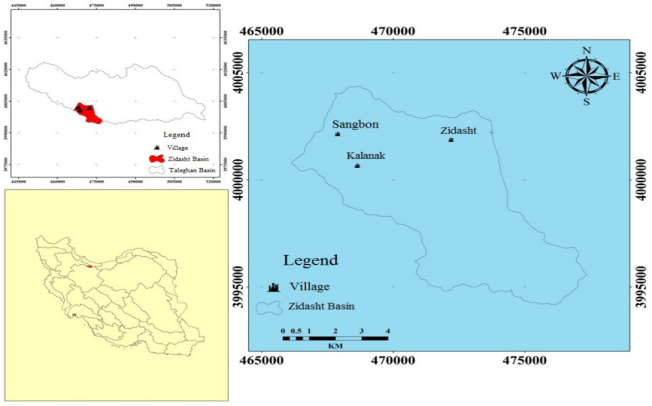

Fig. 1: Location map for Zidasht Basin in Iran

Indices and selected variables (Fig. 2) Demographic Index: In this section of the four variable annual population growths, population density, population density and household size were used. Annual growth is the ratio of annual variation of population to the total population was expressed as a percentage. The population density was calculated from the ratio of population to the area. The average household size was calculated as the ratio of population to number of households. All information and figures on the index of Population and Housing Statistics (President Office, 2006) in 2006 was used.

*Literacy Index***:** In this section the variables of literacy and illiteracy is used than the information in this section of the population and housing statistics have been used in 2006 years.

Poverty Index: This section variables employment and unemployment rates, net dependency ratio and yield major crops were selected and measured. Net of non-working population dependency ratio is the proportion of the population working in the household, village and watershed based on findings Population and Housing Census was obtained. Major agricultural yield in agriculture each year by the Centers for measuring and promulgated.

Nutrition Index and Food Security: Indicators in the field of nutrition and food security important and distinctive that used consisted of agricultural land per capita, per capita number of livestock and agricultural production per capita. They are calculated as the ratio, the level of agricultural lands of the villages,

towns and productivity of the livestock population of the village was obtained.

Index Justice and Equality: In this section, information about the role of women in social and productive activities and women of statistics and scientific capabilities and degree level education and consciousness studied in this paper was valued. The information in this section of the population and housing census statistics for 2006 has been used.

Ownership Index: In terms of land ownership there are considerable differences in terms of legal and customary. National and private ownership of Agriculture statistics derived from previous research projects (Jihad Agriculture Ministry, 2008).

To adjust census data for field studies were conducted that was perfectly fits together. IUCN is the method used for combining variables (Asadi Nalivan, 2012) that incorporates variables for weighting average.

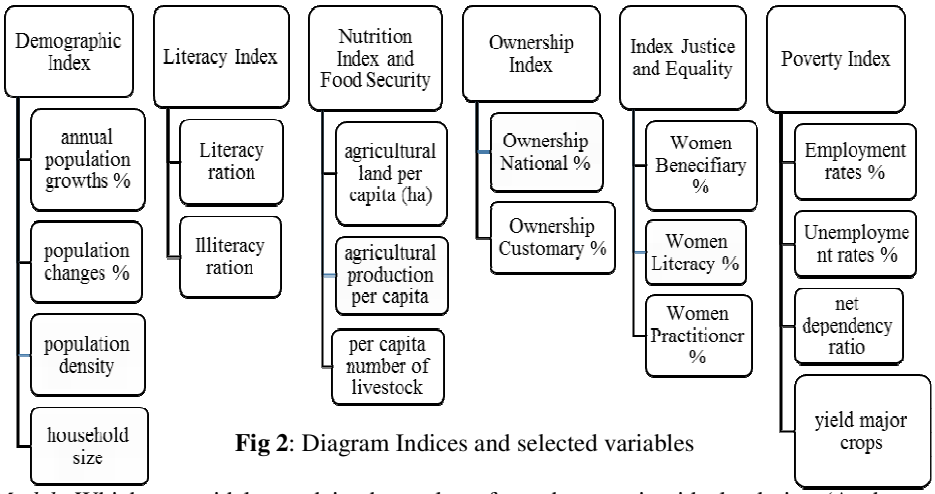

Fig 2: Diagram Indices and selected variables

*TOPSIS Model***:** Which are widely used in the real decision situations (Yang and Hung, 2007). TOPSIS serves as one of the models that compromise subgroups subgroup subgroups compensation model and is itself adaptive. The compensation model allowed the exchange between indices, for example, an indicator of weakness may be offset by other index score (Asgharpour, 1998; Jiang *et al*., 2017). Yang and Huang offered similar method for the best ideal solution. This means that the option should be the shortest distance from the positive ideal solution and at the same time farthest from the ideal is negative (Rezvani *et al*., 2011). Suppose desirability index is rising steadily or in other words only index are positive or negative aspects. The index of the positive aspects of profit and cost index, which has a negative aspect. It is easy to determine the ideal solution. Therefore, the current value of the index indicates a positive ideal and the worst value of that particular ideal would be a negative (Sheng *et al*., 2002). It is an approximation of the geometric point of view an option to be considered the minimum distance from the positive ideal solution and farthest from the negative ideal solution (Asgharpour, 1998). For example, in Figure 3 A1 options are less than ideal both positive and negative ideal solution is another option. TOPSIS assesses both distance option ideal solution both positive and negative ideal solution by the relative closeness to the ideal solution. In fact TOPSIS a strong decision making method using qualitative and quantitative criteria for prioritizing by similarity and proximity to the ideal answer. The option must be the shortest distance from the ideal answer. This method is useful when faced with a number of quantitative and qualitative factors. The overlap some of the criteria in this way have any effect on application logic and conclusions intact (Li *et al*., 2014). TOPSIS take into account information in a way that takes into account a set of weights for the desired criteria. The answer depends on the weighting scheme that is given by the decision-maker. Fortunately some reliable methods for evaluating the weights have been identified that will increase the desirability TOPSIS (Asgharpour, 1998; Kermani *et al*., 2016).

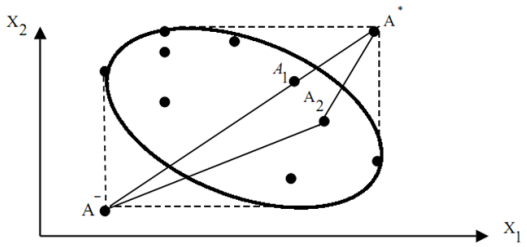

Fig 3: Euclidean distance between the positive and negative ideal solutions in the two dimensional space

Topsis algorithm: TOPSIS method assesses the decision matrix that contains m and n index options.

$$D = \begin{array}{c} \\ A_1 \\ A_2 \\ \vdots \\ A_i \\ \vdots \\ A_m \end{array} \begin{array}{c} \begin{array}{cccccc} X_1 & X_2 & & X_j & & X_n \end{array} \\ \begin{bmatrix} X_{11} & X_{12} & \cdots & X_{1j} & \cdots & X_{1n} \\ X_{21} & X_{22} & \cdots & X_{2j} & \cdots & X_{2n} \\ \vdots & \vdots & & \vdots & & \vdots \\ X_{i1} & X_{i2} & \cdots & X_{ij} & \cdots & X_{in} \\ \vdots & \vdots & & \vdots & & \vdots \\ X_{m1} & X_{m2} & \cdots & X_{mj} & \cdots & X_{mn} \end{bmatrix} \end{array}$$

A_i: Is i_{th} option

X_{ij}: Numerical value of index options j.

In this matrix index, which has been steadily increasing utility (Positive aspects) index, which index interest and favorable steadily declining (negative) indicator costs. Moreover, all results expressed in the decision matrix parameters need to be quantified; and as a benchmark for decision-making is of equal importance and decision presented a set of weights.

For simplicity, TOPSIS is shown by a series of successive steps (Jiang *et al*., 2017):

Step 1: The decision matrix normalization: The process tries scales in the decision matrix without scale. In this way, each vector of values of the index is divided. Each entry r_{ij} of normalized decision matrix R is obtained from the following formula:

$$r_{ij} = \frac{X_{ij}}{\sqrt{\sum_{i=1}^{m} X_{ij}^{2}}}$$

Step 2: weighting normalized matrices: a set of weights $W = (w_1, w_2, \ldots, w_n)$ where $\sum_{j=1}^{n} w_j = 1$ is considered by each index and multiplying j_{th} column from R by w_j, normalized decision V is as follow:

$$V = \begin{bmatrix} v_{11} & v_{12} & \cdots & v_{1j} & \cdots & v_{1n} \\ \vdots & \vdots & & \vdots & & \vdots \\ v_{i1} & v_{i2} & \cdots & v_{ij} & \cdots & v_{in} \\ \vdots & \vdots & & \vdots & & \vdots \\ v_{m1} & v_{m2} & \cdots & v_{mj} & \cdots & v_{mn} \end{bmatrix} = \begin{bmatrix} w_1 v_{11} & w_2 v_{12} & \cdots & w_j v_{1j} & \cdots & w_n v_{1n} \\ \vdots & \vdots & & \vdots & & \vdots \\ w_1 v_{i1} & w_2 v_{i2} & \cdots & w_j v_{ij} & \cdots & w_n v_{in} \\ \vdots & \vdots & & \vdots & & \vdots \\ w_1 v_{m1} & w_2 v_{m2} & \cdots & w_j v_{mj} & \cdots & w_n v_{mn} \end{bmatrix}$$

Step 3: determination of ideal and negative ideal: two virtual options A^+ and A^- as follow:

$A^{\circ} = \left\{ \left(Max_i v_{ij} \,|\, j \in J \right), \left(Max_i \,|\, j \in J' \right) i = 1,2,...,m \right\} = \left\{ v_1^*, v_2^*, ..., v_j^*, ..., v_n^* \right\}$ As positive ideal option.

$A^{-} = \left\{ \left(Max_i v_{ij} \,|\, j \in J \right), \left(Max_i \,|\, j \in J' \right) i = 1,2,...,m \right\} = \left\{ v_1^-, v_2^-, ..., v_j^-, ..., v_n^- \right\}$ As negative ideal option.

$j \mapsto J = \left\{ j = 1,2,3,...,n \right\}$ j for Benefit index.

$j \mapsto J^{'} = \{ j = 1,2,3,...,n \}$ j for cost index.

Two virtual optionsA^{+}, $A^{-}$and best option (positive ideal solution) and least option (ideal negative solution).
Step 4: Calculate the distance: The distance between each option n-dimensional Euclidean method can be measured. I have a positive ideal option are determined by the following formula:

$$i = 1,2,3,...,m$$

$$S_{i*} = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_{j}^{*})^2}$$

Similarly, the distance from the negative ideal option i have is calculated as follows:

$$i = 1,2,3,...,m$$

$$S_{i-} = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_{j}^{-})^2}$$

Step 5: calculation of relative similarity Ai to A* as follow:

$$i = 1,2,3,...,m \qquad 0 \prec C_{i*} \prec 1$$

$$C_{i*} = \frac{S_{i-}}{S_{i*} + S_{i-}}$$

If $A^{+} = A_{i}$, then $C_{i*} = 1$ and if $A^{-} = A_{i}$, then $C_{i*} = 0$

So the closer Ai distance to Ideal option, the closer C_{i*} to unit.
Step 6: ranking options: based on descending order of C_{i*}.

RESULTS AND DISCUSSION

Using the methods mentioned in the Materials and Methods and results obtained, decision matrix indicator is expressed in Table 1.

Table 1: Indicator Decision Matrix

	Indicators					
Village	Demographic Index	Literacy Index	Poverty Index	Nutrition Index and Food Security	Index Justice and Equality	Ownership Index
Kalanak	77	48	52	44	53	48
Sangbon	47	67	65	23	29	60
Zidasht	76	67	56	51	31	41

After making matrix, decision normalized matrix according to Formula 1 we established that for Table 2 it is given. The goal of Scale Indicator Matrix is normal.

Table 2: Normalized Decision Matrix

	Indicators					
Village	Demographic Index	Literacy Index	Poverty Index	Nutrition Index and Food Security	Index Justice and Equality	Ownership Index
Kalanak	0.6528	0.4519	0.5183	0.6182	0.7805	0.5511
Sangbon	0.3984	0.6308	0.6479	0.3223	0.4271	0.6889
Zidasht	0.6443	0.6308	0.5582	0.7165	0.4565	0.4708

Given the relative importance of each indicator to determine, given the weight of the total weights must be equal. The weighting of the index based on a questionnaire among the 20 experts on natural resources and rural development were obtained (Table 3).

Table 3: index weighting Matrix based on the questionnaire results

Indicators	Demographic Index	Literacy Index	Poverty Index	Nutrition Index and Food Security	Index Justice and Equality	Ownership Index
W	0.25	0.15	0.1	0.2	0.2	0.1

After weighting the criteria set weights (W) in normalized matrix multiply the results in Table 4.

Table 4: Cross-product matrix of the weight and normalized matrices

	Indicators					
Village	Demographic Index	Literacy Index	Poverty Index	Nutrition Index and Food Security	Index Justice and Equality	Ownership Index
Kalanak	0.1632	0.0678	0.518	0.1236	0.1561	0.0551
Sangbon	0.0996	0.0946	0.0648	0.0646	0.0854	0.0689
Zidasht	0.1611	0.0946	0.0558	0.1433	0.0913	0.0471

With regard to the above, the ideal solution would be to calculate the positive and negative ideal solution (Table 5)

Table 5: positive and negative ideal solution

	Indicators					
	Demographic Index	Literacy Index	Poverty Index	Nutrition Index and Food Security	Index Justice and Equality	Ownership Index
A+	0.1632	0.0946	0.0648	0.1433	0.1561	0.0689
A-	0.0966	0.0678	0.0518	0.0646	0.0854	0.0471

At this stage, the size of distance in Euclidean method to exchange positive and negative ideal solution is calculated (Table 6 and 7).

Table 6: The size of distance in Euclidean method to exchange positive ideal solution

S_1^+	**0.0383**
S_1^+	0.1234
S_1^+	0.0690

Table 7: The size of distance in Euclidean method to exchange negative ideal solution

S_1^-	**0.1122**
S_1^-	0.0369
S_1^-	0.1036

The ideal solution is calculated relative proximity to the sign C is expressed. After the above steps, ranked in descending order based options for table 8 it is given. The final ranking of the value of a close relative and negative ideal solution is always in the same way. According to the table is that the village Kalanak the first priority and followed by priority Zidasht and the third priority Sangbon were adopted.

Table 8: Villages Final Prioritization

	S^+		S^-		**C**	
Village	Value	Priority	Value	Priority	Value	Final Priority
Kalanak	0.0383	3	0.1122	1	0.7456	1
Sangbon	0.1234	1	0.0369	3	0.2303	3
Zidasht	0.0690	2	0.1036	2	0.6003	2

Conclusion: Studies show that the knowledge level of social stability Quality of life and social well-being of rural communities and with factors such as accessibility to health services, education, housing, security, income and deprivation is measured (De Andrade *et al*., 2015). Thus social stability in rural areas means healthy living by addressing the basic needs of rural society, considering the quality of life and keep pace with the quality of the environment and related services Economic systems defined on course to achieve the highest level of life satisfaction (Torjman, 2000). The results of this study with the results of scholars like (pourtaheri *et al*., 2011; Rezvani *et al*., 2011; De Noronha Vaz *et al*., 2008; Kermani *et al*., 2016) that TOPSIS model as an appropriate method to prioritize social sustainability. In rural areas they introduce are consistent and have spilled over them. Also, in terms of index and selected variables it is in line with results of (Bogdanov *et al*., 2008; Williams *et al*., 2005; Leon, 2005; United Nations, 2007) as well.

In recent years, multi-criteria decision-making techniques in a wide range of economic and social studies has found. the algorithm TOPSIS a very strong fan Multiple Attribute Decision Making to

prioritize villages by the similarity with the ideal answer that very little sensitivity to the type of weighting. This study also influencing TOPSIS and six indicators for Zidasht prioritize social sustainability, which is a part of the watershed basin in Taleghan was performed. According to the results, according to six indicators to rank the villages intended to TOPSIS, Kalanak village the best condition than the other two villages and are the highest priority. Those villages Zidasht and Sangbon are the next priorities. Watersheds integrated management of, the highest impact on economic and social issues and the importance of the area in the long term planning and stability will be a watershed resources. In this regard, appropriate management methods such as TOPSIS help watersheds sustainability. The results of field studies in the Zidasht rural settlements watershed, for example, the study showed that TOPSIS serves as valuable and efficient methods of multi-criteria decision-making techniques, well managed explain social stability in the region, so that the results of field studies and objective observations rural settlements have been matched well with the existing realities. So planned indices can be cited as a model for other rural areas of the country to the level of social stability and be prioritized by TOPSIS.

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