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By Dr. M.H.Ramesht , Alireza Arab Ameri & Hamideh Beigi
Isfahan University, Iran

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SELECTION OF MOST APPROPRIATE AREA TO ESTABLISH SOIL DAMP FOR THE PURPOSE OF SUSTAINABLE DEVELOPMENT OF WATER RESOURCES USING TOPSIS AND ELECTRE METHODS A CASE STUDY ZARAND-SAVEH WATERSHED

Selection of Most Appropriate Area to Establish Soil Damp for the Purpose of Sustainable Development of Water Resources Using TOPSIS and ELECTRE Methods
(A Case Study: Zarand-Saveh Watershed)

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One of the management methods for water resources is Multi Criteria Decision Making. The result and findings of different studies show that in TOPSIS method, zone 3 with (0/8) point promotes in first rank among 7 studied zones and thus it is the most appropriate zone to establish the proper soil damp, in contrast zone 1 with (0/15) point goes down to the last rank and so it isn`t suitable for establishing soil damp and zones (4,2,5,6,7) with (0/79, 0/73, 0/46, 0/32, 0/21) points are located in next ranks. In ELECTRE method, zone (4) dominated (5) times and defeated (1) time, so it is located in the first rank with (4) points and is the most suitable zone for artificial recharge. In contrast, zone (1) defeated (6) time and dominated no time, therefore it is located in the last rank with (-6) points and is not the most suitable zone for artificial recharge. And, zones (3, 5, 2, 6, 7) dominated (4, 4, 2, 2, 1) times and defeated (5, 4, 2, 2, 4) and located in other ranks with (-4, -2, -2, 2, 2, 2) points respectively. Also, zones (7, 6, 2, 1) should be omitted because their defeated times are more than dominated times.

Keywords : Watershed, Zarand-Saveh, ELECTRE method, TOPSIS, GIS technique, zoning.

I. Introduction

Due to continuous decline in per capita water and the importance of nutritious preparation for people it is necessary to control the surface water using damp building or artificial recharge methods. Researchers of water sciences have studied the damp building and artificial recharge projects all over the world, drawn logarithm curve for cost against the amount of savable running water and concluded that it is frugal economically to accomplish artificial recharge projects especially flood distribution instead of damp building for the volume less than 30 million cube meter (Bize, et al., 1972). Food and Agriculture Organization described sustainable development as below:

> ''Sustainable development is the management and conservation of basic natural resources and direction of technical and organizational changes to achieve and prepare requirements for generations at the present and in future. Such a development in agriculture section leads to the conservation of water, soil and plants and it is nondestructive environmentally, proper technically, frugal economically and acceptable socially. Similar to under development countries, our country needs to compress and develop agriculture in order to carry out enormous requirements of under growth population.''

However, the experiences of under developed countries show that compressing the agriculture caused quick output purposes but they destroy the basic resources for a long term. It can be noticed in pasture destruction, forest resources reduction, deserts increase, reduction and destruction of surface water resources and ground water and exponential compress to the basic resources.

In our country, planning in agricultural, rural and natural resources development has always been founded at the level of political development. This traditional attitude toward planning and development caused instability in using basic resources. During 2 previous decades, our country has taken activities to develop agriculture and natural resources comprehensively. Although these activities were slow and sluggish, they can develop a new attitude among experts, connoisseurs and decision makers in agriculture section. Based on this attitude, casual, one-direction and one-dimensional activities can solve part of short term problems and difficulties related to agriculture section and have pathetic effects on this section in long term. In recent years, water exploitation has become greater for many reasons such as

Author : Isfahan University, Iran. E-mail : alireza.ameri91@yahoo.com

population growth, industrial development, urbanization growth and consequently increased demand for food products. Hence the rate of exploitation and consumption ground water become greater than recharge of them, in other words input of ground water system is less than its output and system with negative balance sheet has positive feedback and it is collapsing. Thus it is very significant to determine and assign the suitable position for this case.

Water resources management is a set of various management activities aimed at the optimum utilization of water resources and reduction of economical, social and environmental damages and losses. Decision making issue in water resources management is very complex and complicated because of several decision indicators and criteria. Achieving a determine purpose, there are a lot of solutions with different priorities for various issues such as environmental, social, organizational and political problems. These necessities leads to use of multiple criteria decision making aimed at selection of best solution among different solutions.

There are several studies on ground water and their artificial recharge all over the world. For example, Krishnamurthy et.al (1995, 1996) used RS and GIS techniques to find a suitable position for artificial recharge of ground water in India. Also, they investigated the effects of geomorphologic and geological factors on the behavior of ground water and stated that there is a special unevenness in each area for recharge of ground water.

Saraf and Choudhury (1998) used remote sensing capabilities in extracting different layers like land usage, geomorphology, vegetation, and their integration in GIS environment to determine the most suitable area for artificial recharge of ground water.

Mahdavi (1997, 16) investigated water management and artificial recharge of ground water in Jourm city and indicated that controlling usage and recharge of water tables by the watershed management is the main management technique.

Abdi and Ghayoumian (2001, 86) prioritized the suitable areas for storing surface water and reinforcing ground water based on geophysics data, land usage, topography, their integration and analysis in GIS environment.

Kia Heyrati (2004) studied the function of flood distribution system in recharge of ground water in Moughar plain in Isfahan.

Mahdavi et.al (2005) attempted to find the best position for artificial recharge of ground water by RS and GIS techniques in watershed Shahr Reza in Isfahan and introduced this tool for this case efficiently.

Also, Noori et al (2004, 635) tried to find the appropriate areas for artificial recharge of ground water by recharge pools (recharge pools) and GIS technique in watershed Gavbandi and introduced alluvial fans and plain head (Dashtsar) as the best area for artificial recharge.

Mousavi et al (2010) found the potential appropriate areas for artificial recharge of ground water in the vicinity of Kamestan anticline by integration of remote sensing and GIS techniques and introduced broken formations, alluviums and river canals as the best position for artificial recharge.

Mianabadi and Afshar (2008) investigated and ranked the project of water supply in Zahedan using three methods: Induced Ordered Weighted Averaging (IOWA), Linear Assignment and TOPSIS methods, and then they compared the findings of these methods with the results of adaptable planning method (Mianabadi, 2008: 34-45).

Limon and Martinez (2006) used Multi Attribute Utility theory for optimum allocation of agriculture water in north of Spain (Limon, 2006: 313-336).

Ahmadi et al (2002) used multiple criteria decision making to rank different projects of refining agriculture water to reuse them (Ahmadi, 2002: 339-352).

Also, Anand Raj and Kumar (1996) ranked management options of river basin by ELECTRE method (Anand, 1996: 326-335).

The purpose of this study is zoning the best area for artificial recharge of underground basins in Zarand-Saveh watershed using effective factors in recharging underground water table by ELECTER method, TOPSIS and GIS technique. In another way, this study aimed at the selection of most appropriate area to establish soil damps for the purpose of sustainable development of water resources using Multi Criteria Decision Making methods (ELECTRE and TOPSIS) and classify the best areas in considered watershed.

a) *Methods and materials*

i. *Mathematical situation of studied area*

Being situated in the north part of central province, Saveh province is bounded by 34º, 45' latitude to 35º, 34' north latitude and 49º, 15' to 50º and 56' longitude. It has access to Ghazvin province in north, to Tafresh and Qom provinces in south, to Tehran province in east and to Hamedan province in west. Globally, Saveh is located at 1250 meter height above sea level and its extent is 1027 square kilometers.

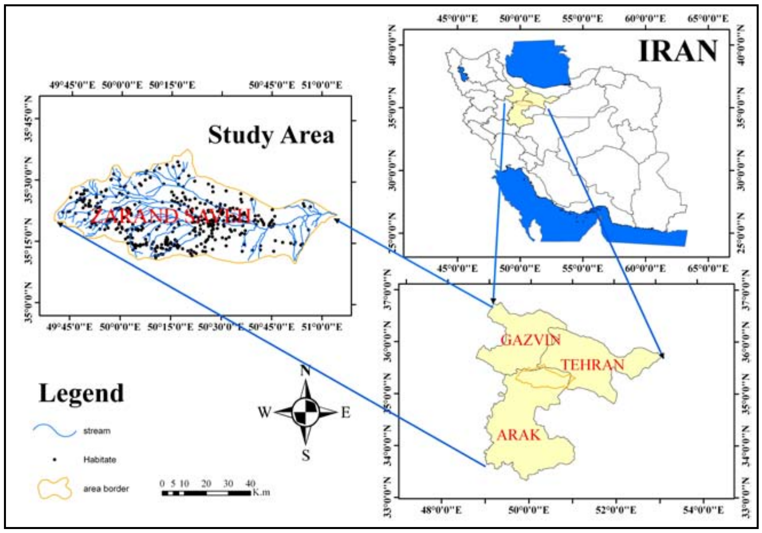

Figure 1 : Mathematical situation of studied area.

II. Methods

Firstly, studied area was investigated by the satellite images of Google Earth and its limitations were determined. Then digital elevation model of area was separated from its digital elevation model in Iran in the environment of soft ware GlOBAL MAPER and the output was received. Required data layers for zoning in the environment of software Arc GIS 9.3 was prepared as following:

First, digital elevation model classified in to 7 elevation classes based o natural breaks in the heights of the area. Mentioned classes represent the studied zones in the area and subsequent calculations were done in each of these classes. Slope layer prepared base on digital elevation model o the area by surface analyses tool in 3D analyses. There were different processes to prepare drainage density layer and habitual density such as digitizing main and minor waterways layers on the topographical map1:50000 of the area, digitizing main and minor fault on geological map 1:100000 of area and density tool in Spatial Analyses. Iso-Precipitation layer prepared by interpolating method like cringing technique and linear relationship between rain-height using Interpolate tools in 3D analyses (Figure 3 to 9).

Second, the investigated criteria for each height zones were calculated (Tables 2 , 10) and their layers prepared separately. After achieving a few numbers in each layer, the numbers were analyzed by ELECTRE and TOPSIS methods. Then considered watershed was ranked to select the best area for establishing soil damp.

a) Theoretical principles of ELECTRE and TOPSIS method

In recent decades, several researchers attempt to use Multi Criteria Decision Making (MCDM) in complex and complicated decisions. These decision methods divide into two parts;

1. MODM = Multi Objective Decision Making
2. MADM = Multi Attribute Decision Making

Multi Criteria Models use to select the best options. Evaluative Models for MADM classify into two models;

1. Compensatory Model
2. Non- Compensatory Model

Non-compensatory model includes methods which don`t need to achieve data from DM and lead to objective answer. Exchanging between indictors is permitted in Compensatory model. It means that for example, a weakness in an indicator may be compensated by option of other indicators.

TOPSIS algorithm is a Multi Criteria Decision Making, a type of compensatory model and an adaptable subgroup with strong ability to solve multi alternative problems because of having ability to overlap indicators in weak and power points (Kohansal and Rafiei, 2009-93). In this model, if quantitative criteria can change in to qualitative criteria, qualitative criteria can be used besides quantitative criteria. In aforementioned model, it is supposed that each indicator and criterion has steady increasing and decreasing utility in decision making matrix; it means if criteria gain more positive amount, they will be more appropriate, on the contrary the more negative amount, the less appropriate.

Electrical Method is a type of available methods in Compensatory Models. In this method whole options evaluate by non-ranked comparisons. All stages of this method are established based on coordinated and uncoordinated sets and thus this method is known as ''Coordination Analysis''. Banayoun established the Electrical Method and Delft, Nijkamp, Roy and their colleagues developed it. In Electrical method, the

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concept of domination uses implicitly. In this method, options are compared in pairs, then dominant and weak (dominant and defeated) options determined and weak or defeated options omitted (Roy, 1991. 49-73).

b) Problem solving process using ELECTRE and TOPSIS method

➢ Problem solving process using TOPSIS method

TOPSIS model includes 8 processes which are described in the following parts (Olson, 2003-2).

1. Establishing data matrix based on alternative n and indicator k:

Generally, in TOPSIS model, matrix **n**×**m** with **m** alternative and **n** criteria is evaluated. In this algorithm, it is supposed that each indicator and criterion in Decision Making matrix has steady increasing and decreasing utility.

$$A_{ij} = \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ . & . & & . \\ . & . & & . \\ a_{m1} & a_{m2} & \dots & a_{mn} \end{bmatrix}$$

2. Standardizing data and preparing normalized matrix (matrix R) by Equation (1):

Since it is possible that quantitative amount of criteria and indicators don`t have equal unit , the dimensions of their units should be omitted. Thus, all amounts of entries of Decision Making matrix should be changed into dimensionless amount with following formula:

$$R_{IJ} = \frac{a_{ij}}{\sqrt{\sum_{i=1}^{m} a_{ij}^{2}}} \qquad (1)$$

$$\begin{bmatrix} r_{11} & r_{12} & \dots & r_{1n} \\ r_{21} & r_{22} & \dots & r_{2n} \\ . & . & & . \\ . & . & & . \\ r_{m1} & r_{m2} & \dots & r_{mn} \end{bmatrix}$$

3. Determining weights for whole indicators (w_j) by equation (2) and modifying calculated (w_j) by equation (3):

In this process, the weights of all indicators are calculated by expertise theories and approaches, Linmap method, AHP model, Antropi model and based on the importance of criteria. It is considerable that sum of criteria weights should be equal to 1. In this study, AHP model has been used to calculate the amount of ( ) 9Table 3).

$$\sum_{j=1}^{n} w_j = 1 \qquad (2)$$

$$= \frac{\lambda_j . w_j}{\sum_{j=1}^{n} \lambda_j . w_j} \qquad (3)$$

4. Creating dimensionless weighted matrix (V) to implement vector W as an input for algorithm:

In order that the amounts of entries in matrix R gain equal value, , sum of weights of parameter (w_j) are multiplied to the column of this matrix one by one. The acquired matrix is normalized and weighted matrix which is shown by sign (V) (Table 4).

$$V_{ij} = R_{ij} . W_{n\times n} = \begin{bmatrix} v_{11,\dots} & v_{1j,\dots} & v_{1n} \\ . & . & . \\ . & . & . \\ v_{m1,\dots} & v_{mj,\dots} & v_{mn} \end{bmatrix}$$

5. Determining positive ideal (A+) and negative ideal (A-) by equations (4) and (5) respectively:

$$\sqrt{\sum_{j=1}^{n} \left(V_{ij} - V^{+}{}_{j}\right)^2} \; ; i = 1,2,\dots,m \qquad (4)$$

$$\sqrt{\sum_{j=1}^{n} \left(V_{ij} - V^{-}{}_{j}\right)^2} \; ; i = 1,2,\dots,m \qquad (5)$$

6. Calculating distance size of i-alternaive with ideals and using Euclidean method, by equations (6) and (7):

$$d_{i+} = \text{dictance of i} - \text{alternative from positive ideal} = \sqrt{\sum_{j=1}^{n} \left(V_{ij} - V^{+}{}_{j}\right)^2} \; ; i = 1,2,\dots,m \qquad (6)$$

$$d_{i-} = \text{distance of i} - \text{alternative from negative ideal} = \sqrt{\sum_{j=1}^{n} \left(V_{ij} - V^{-}{}_{j}\right)^2} \; ; i = 1,2,\dots,m \qquad (7)$$

7. Calculating relative closeness for i-alternative (Ai) i to ideal solution using equation (8):

$$cl_{i+} = \frac{d_{i-}}{d_{i+} + d_{i-}} \; ; 0 \le cl_{i+} \le 1 \; ; i = 1,2,\dots,m \qquad (8)$$

As you can see, if Ai=A+ , then di+=1 and cli-=0, on the contrary if Ai=A¯, then di+=1 and cli-=0. In sum, the more alternative Ai is closer to ideal solution, the more value of cli+ is closer to unit.

8. Ranking alternatives based on descending order of cli+ :

This amount is fluctuating between 0 and 1. Thus, cli+ =1 represents the highest rank and cli+ =0 the lowest rank.

- Problem solving process using ELECTRE method

1. Establishing Decision Making Matrix:

According to the criteria and numbers of options and evaluation of whole options for the different criteria, Decision Making Matrix develops as follow;

$$X = \begin{bmatrix} x_{11} & \cdots & x_{1n} \\ \vdots & \cdots & \cdots\cdot \\ x_{1m} & \cdots & x_{mn} \end{bmatrix}$$

In which the Function of Xij (i = 1,2, ..., M) is in relation to the criteria I j (j = 1,2,3, ..., n).

2. Scale down the Decision Making Matrix:

In this stage, all criteria with different dimensions is changed into the dimensionless criteria and matrix R defined as follows. There are several methods to scale down, but generally the following equation used in electrical method (Tille: 2003, 19-21).

$$R = \begin{bmatrix} r_{11} & \cdots & r_{1n} \\ \vdots & \cdots\cdot & \cdots \\ r_{m1} & \cdots & r_{mn} \end{bmatrix} \qquad r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{1}^{m} x_{ij}^2}} \tag{9}$$

3. Determining Weighted Matrix of criteria:

$$W = \begin{bmatrix} w_1 & \cdots & 0 \\ \vdots & w_2 & \cdots \\ 0 & \cdots & w_n \end{bmatrix}$$

As you can see, Weighted Matrix (W) is diagonal matrix in which the elements on main diameter are not zero and amount of these elements equal to importance coefficient of the related vector.

4. Determining Weighted Normalized Decision Matrix:

Weighted Normalized Decision Matrix is obtained by multiplying Scale down Decision Making Matrix into the Weighted Matrix of criteria.

$$V = R \times W = \begin{bmatrix} v_{11} & \cdots & v_{1n} \\ \vdots & \cdots & \cdots \\ v_{m1} & \cdots & v_{mn} \end{bmatrix}$$

5. Establishing agree and disagree criteria set

The criteria set J = (1, 2... m) divides into two subsets; agree and disagree for each pair of options e, k (k, e = 1,2, ..., M, k # e) . Agree Set (SKe) is a set of criteria in which option K is preferred to option e. and its complementary set is the opposite set (IKe) in mathematical language;

$$S_{ke} = \left\{ j \middle| v_{kj} \geq v_{ej} \right\} \tag{10}$$

$$I_{ke} = \left\{ j \middle| v_{kj} \prec v_{ej} \right\} \tag{11}$$

6. Establishing Agree Matrix:

To establish agree matrix, its elements, agree indicators, should be calculated. Agree indicator is sum of weight of criteria in agree set. Thus, indicator Cke is between option k and option e equals to (Roy, 1991, 49-73):

$$c_{ke} = \frac{\sum_{j \in s_{ke}} W_j}{\sum_{j=1} W_j} \tag{12}$$

For total normalized weights equals 1 so:

$$c_{ke} = \sum_{j \in s_{ke}} W_j \tag{13}$$

Agreement represents the superiority of options k on option e which its amount changes in the range of zero to one (0-1). After calculating agree indicator for all options, matrix which is a m×m matrix is defined as follows. Generally, this matrix is not symmetrical.

$$C = \begin{bmatrix} - & c_{12} & \cdots & c_{1m} \\ c_{21} & - & \cdots & c_{2m} \\ \vdots & \vdots & - & \vdots \\ c_{m1} & \cdots & c_{m(m-1)} & - \end{bmatrix}$$

7. Determining Opposite Matrix

Disagreement indicator (opposite) is described as follows (Roy: 1991, 49-73):

$$d_{ke} = \frac{\max_{j \in I_{ke}} \left| v_{kj} - v_{ej} \right|}{\max_{j \in J} \left| v_{kj} - v_{ej} \right|} \tag{14}$$

The amount of disagreement indicator changes from zero to one. After calculating disagree indicator for all options, matrix which is a m×m matrix is defined as follows. Generally, this matrix is not symmetrical.

$$D = \begin{bmatrix} - & d_{12} & \cdots & d_{1m} \\ d_{21} & - & \cdots & d_{2m} \\ \vdots & \vdots & - & \vdots \\ d_{m1} & \cdots & d_{m(m-1)} & - \end{bmatrix}$$

It noticed that the data including in agreement matrix, are different from data in opposite matrix and in fact these data are completed each other. The difference between the weights is developed through agreement matrixes, while the difference between determined values is obtained through opposition matrix.

8. Establishing agree dominant matrix:

In the sixth step, it indicated how to calculate agreement indicator Cke. Now there is a determined amount for agreement indicator in this step which is called agreement threshold . If Cke is larger , option k is preferred on option e, otherwise it is not. Agreed threshold is calculated by the following equation (Roy, 1991, 49-73):

$$\bar{c} = \sum_{\substack{k=1 \\ k \neq e}}^{m} \sum_{\substack{e=1 \\ e \neq k}}^{m} \frac{c_{ke}}{m(m-1)} \tag{15}$$

Agree Dominated Matrix (F) is developed based on the amount of agreement threshold and its elements determined in the equation bellow (Vami, 1992).

$$f_{ke} = \begin{cases} 0 & c_{ke} \geq \bar{c} \\ 1 & c_{ke} < \bar{c} \end{cases} \tag{16}$$

9. Establishing Opposed Dominance Matrix :

Opposed Dominance Matrix (G) is established the same as Agree Dominated Matrix. First, decision makers should express opposite threshold which is for example the mean of opposite indicators (disagreement) (Roy, 1991, 49) -73):

$$\bar{d} = \sum_{\substack{k=1 \\ k \neq e}}^{m} \sum_{\substack{e=1 \\ e \neq k}}^{m} \frac{d_{ke}}{m(m-1)} \qquad (17)$$

Similar to seventh step, it is better that the amount of opposite indicator (dke) become less, because opposite amount (disagreement) expresses superiorities dimension of option k on option is acceptable. In contrast, if (dke) were larger than , opposite amount would be very great and it would not be ignored. Thus, Opposed Dominance Matrix is defined as follows (1991, 49-73):

$$g_{ke} = \begin{cases} 0 & d_{ke} \geq \bar{d} \\ 1 & d_{ke} < \bar{d} \end{cases} \qquad (18)$$

Each element in the matrix (G) shows the dominant relationship between options.

10. Establishing Final Dominant Matrix:

Final Dominant Matrix (H) is developed after multiplying each element in Agree Dominated Matrix (F) into elements in Opposed Dominance Matrix (G) (Roy, 1991, 49-73).

$$h_{ke} = f_{ke} . g_{ke} \qquad (19)$$

11. Removing less satisfaction options and selecting the best option:

Final Dominant Matrix (H) indicates detail preferences of options. For example, when amount of hke equals 1, it means that option k is preferred on option e in both agree and disagree situation (it means its preference is larger than the agree threshold and its opposite or weakness is less than disagree threshold), but option k may be dominated by other options yet. The options should be ranked in a way that the more dominated options are selected than the more defeated one.

Determining the importance coefficient of options than the other, criteria are compared in pair by time suggested method.

Table 1 : Weighting the factors based on preference in paired comparison (Ghodsi Poor, 2009, 14)

I9	Preferences (judging verbal)
9	Extremely preferred
7	Very strongly preferred
5	Strongly preferred
3	Moderately referred
1	Equally preferred
2،4،6،8	Intervals between strong preferences

After the formation of paired comparison matrix, relative weights of criteria can be calculated. There are different methods to calculate the relative weight based on paired comparison matrix. The most important ones are the "least squares method, least squares logarithmic method, special vector method and approximate method. The special vector method is the most accurate one. In this method, Wi is determine in the equation12:

$$A \times W = \lambda \max W \qquad (20)$$

In this equation, λ and W are special amount and special vector of paired matrix respectively. If dimensions of matrix were larger, calculation would be too time-consuming. So, to calculate λ, the amount of Dtrmynal λIA- matrix will be equaled to zero. Considering the greatest value of λ in equation (13), the amount of wi is calculated. (2001, 315: Saaty).

$$A - \lambda \max . I = 0: \qquad (21)$$

III. Research Findings

The results of ELECTRE and Linear Assignment methods to find the most suitable area for artificial recharge of groundwater aquifers of Zarand-Saveh watershed showed in figures (2) to (9) and tables (3) to (19). Therefore, a matrix is formed with rank (49) for data matrix, with 7 alternatives (height zones) and 7 related indicators (rainfall, stream density, habitual density, extent, land area facies, slope, height) (Tables 2 ,10).

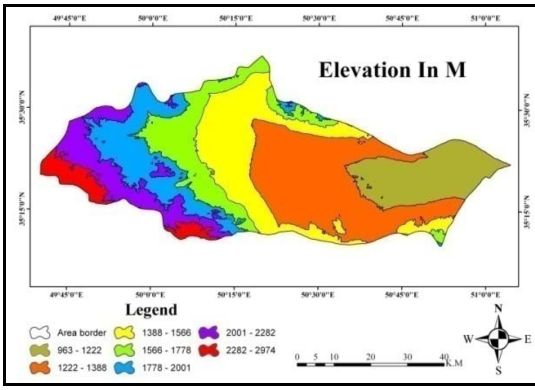
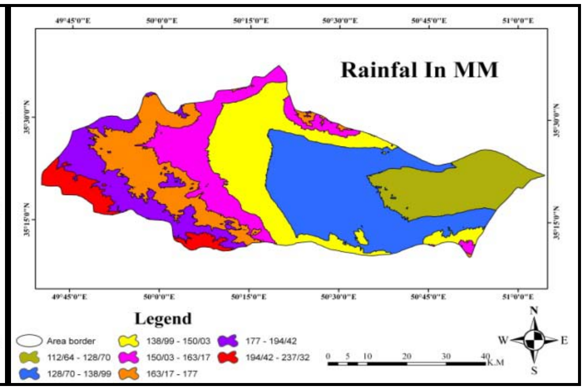


Figure 2 : Elevation Map of studied area.



Figur 3 : Rainfall Map of studied.

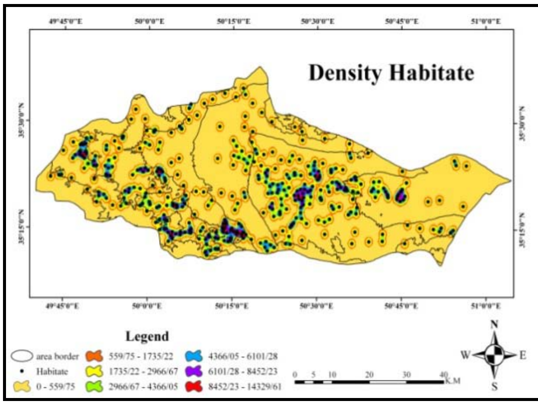


Figure 4 : Habitual Density Map of the studied area.

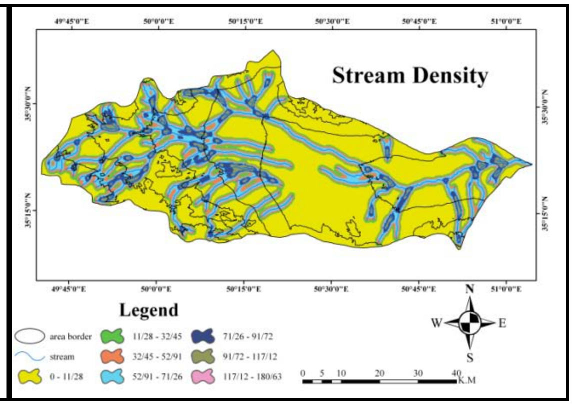


Figure 5 : Stream Density Map of studied area.

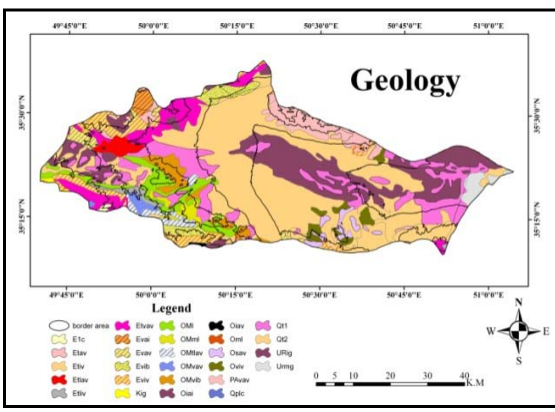


Figure 6 : Land Area Facies Map of the studied area.

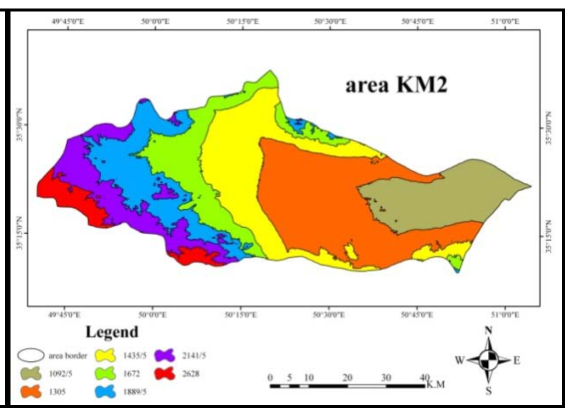


Figure 7: Area Map of study area.

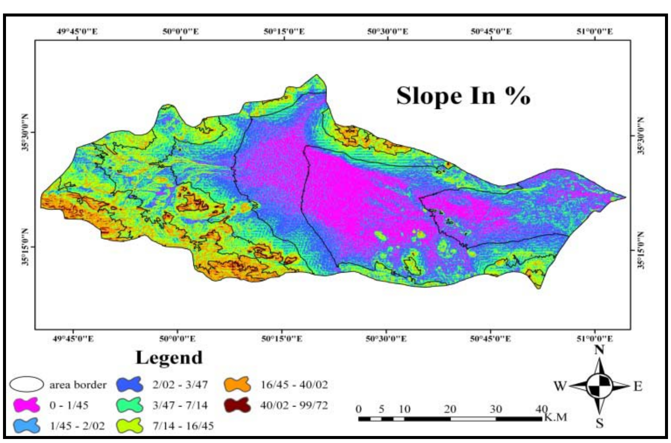


Figure 8 : Slope Map of the studied area.

IV. Problem Solving Matrixes in Topsis Method

Table 2 : Decision Matrix (X).

Regions	Materials	Precipitation	Stream density	Slope	Habitual density	Elevation	area
1	2	121.29	90.31	13.28	4975.46	1092.5	484.85
2	5	134.22	63.91	22.09	5696.15	1300.5	958.1
3	9	144.66	76.99	26.71	3268	1435.5	695.27
4	8	157.28	79.115	31.68	7164.8	1672	461.46
5	7	169.62	85.42	49.86	5911.25	1889.5	478.64
6	3	185.58	62.23	48.73	4692.22	2141.5	363.41
7	1	214.41	61.19	36.61	3163.1	2628	149.57

Table 3 : Dimensionless Matrix (Matrix R).

Regions	Materials	Precipitation	Stream density	Slope	Habitual density	Elevation	area
1	0.1310	0.2801	0.4553	0.1433	0.3646	0.2288	0.3245
2	0.3276	0.3099	0.3222	0.2384	0.4175	0.2723	0.6412
3	0.5896	0.3340	0.3882	0.2883	0.2395	0.3006	0.4653
4	0.5241	0.3632	0.3989	0.3420	0.5251	0.3501	0.3088
5	0.4586	0.3916	0.4307	0.5382	0.4332	0.3957	0.3203
6	0.1965	0.4285	0.3137	0.5260	0.3439	0.4485	0.2432
7	0.0655	0.4951	0.3085	0.3952	0.2318	0.5503	0.1001

Table 4 : Paired Comparison Matrix of different criteria (S).

Criteria	Materials	Precipitation	Stream density	Slope	Habitual density	Elevation	area	Weight vector
Materials	1	3	5	5	7	7	9	0/3868
Precipitation	0.33	1	3	5	5	7	7	0/2349
Stream density	0.2	0.33	1	3	5	7	7	0/1585
Slope	0.2	0.2	0.33	1	3	5	7	0/1028
Cleft density	0.14	0.2	0.2	0.33	1	3	5	0/0603
Elevation	0.14	0.14	0.14	0.2	0.33	1	3	0/0353
Area	0.11	0.14	0.14	0.14	0.2	0.33	1	0/0214
Inconsistency rate: 0/0252 (due to being less than 0/1 compatibility matrix indices are acceptable)								

Table 5 : Weighted dimensionless Decision Matrix (V).

Regions	Materials	Precipitation	Stream density	Slope	Habitual density	Elevation	area
1	0.0506	0.0658	0.0721	0.0147	0.0221	0.0081	0.0070
2	0.1265	0.0728	0.0510	0.0245	0.0253	0.0097	0.0138
3	0.2277	0.0785	0.0615	0.0296	0.0145	0.0107	0.0100
4	0.2024	0.0853	0.0632	0.0352	0.0318	0.0125	0.0066
5	0.1771	0.0920	0.0682	0.0553	0.0262	0.0141	0.0069
6	0.0759	0.1007	0.0497	0.0541	0.0208	0.0160	0.0052
7	0.0253	0.1163	0.0489	0.0406	0.0140	0.0196	0.0022

Table 6 : Amounts of positive and negative ideals (highest and lowest function of indicator).

Ideals	Materials	Precipitation	Stream density	Slope	Habitual density	Elevation	area
A+	0.2277	0.1163	0.0721	0.0147	0.0318	0.0081	0.0138
A-	0.0253	0.0658	0.0489	0.0553	0.0140	0.0196	0.0022

Table 7 : Distance o i-alternative by ideals using Euclidean method.

regions / distance	1	2	3	4	5	6	7
D_i^+	0/189	0/116	0/050	0/046	0/057	0/154	0/205
D_i^-	0/035	0/103	0/203	0/180	0/161	0/073	0/057

Table 8 : Relative distance of i-alternative(A_i) to ideal solution.

Cl_i	C1	C2	C3	C4	C5	C6	C7
Amount	0/15	0/46	0/8	0/79	0/73	0/32	0/21

Table 9 : Points and Ranks of zones.

Region	1	2	3	4	5	6	7
Point (Fuzzy Logic)	0/15	0/46	0/8	0/79	0/73	0/32	0/21
Rank	Seventh	Fourth	First	Second	Third	Fifth	Sixth

Table 10 : Decision Making Matrix (X).

Regions	Materials	Precipitation	Stream density	Slope	Habitual density	Elevation	area
1	1	121.29	90.31	13.28	4975.46	1092.5	484.85
2	5	134.22	63.91	22.09	5696.15	13.5	958.1
3	9	144.66	76.99	26.71	3268	1435.5	695.27
4	9	157.28	79.115	31.68	7164.8	1672	461.46
5	7	169.62	85.42	49.86	5911.25	1889.5	478.64
6	3	185.58	62.23	48.73	4692.22	2141.5	363.41
7	1	214.41	61.19	36.61	3163.1	2628	149.57

Table 11 : Scale down Decision Matrix (R).

Regions	Materials	Precipitation	Stream density	Slope	Habitual density	Elevation	area
1	0.0636	0.2801	0.4553	0.1433	0.3646	0.2378	0.3245
2	0.3181	0.3099	0.3222	0.2384	0.4175	0.0029	0.6412
3	0.5727	0.3340	0.3882	0.2883	0.2395	0.3124	0.4653
4	0.5727	0.3632	0.3989	0.3420	0.5251	0.3639	0.3088
5	0.4454	0.3916	0.4307	0.5382	0.4332	0.4112	0.3203
6	0.1909	0.4285	0.3137	0.5260	0.3439	0.4661	0.2432
7	0.0636	0.4951	0.3085	0.3952	0.2318	0.5719	0.1001

Table 12 : Paired Comparison Matrix of different criteria (S).

Criteria	Materials	Precipitation	Stream density	Slope	Habitual density	Elevation	area	Weight vector
Materials	1	3	5	5	7	7	9	0/3868
Precipitation	0.33	1	3	5	5	7	7	0/2349
Stream density	0.2	0.33	1	3	5	7	7	0/1585
Slope	0.2	0.2	0.33	1	3	5	7	0/1028
Cleft density	0.14	0.2	0.2	0.33	1	3	5	0/0603
Elevation	0.14	0.14	0.14	0.2	0.33	1	3	0/0353
Area	0.11	0.14	0.14	0.14	0.2	0.33	1	0/0214
Inconsistency rate: 0/0252 (due to being less than 0/1 compatibility matrix indices are acceptable)								

Table 13 : Weighted Normalized Decision Matrix (V).

Regions	Materials	Precipitation	Stream density	Slope	Habitual density	Elevation	area
1	0.0246	0.0658	0.0721	0.0147	0.0221	0.0085	0.0070
2	0.1229	0.0728	0.0510	0.0245	0.0253	0.0001	0.0138
3	0.2212	0.0785	0.0615	0.0296	0.0145	0.0111	0.0100
4	0.2212	0.0853	0.0632	0.0352	0.0318	0.0130	0.0066
5	0.1720	0.0920	0.0682	0.0553	0.0262	0.0146	0.0069
6	0.0737	0.1007	0.0497	0.0541	0.0208	0.0166	0.0052
7	0.0246	0.1163	0.0489	0.0406	0.0140	0.0204	0.0022

Table 14 : Agreement Matrix (C).

Regions	Materials	Precipitation	Stream density	Slope	Habitual density	Elevation	area
1	0.0000	0.1940	0.2189	0.1799	0.1799	0.2404	0.6266
2	0.8059	0.0000	0.0820	0.0215	0.0215	0.6266	0.6266
3	0.7810	0.9179	0.0000	0.4077	0.4077	0.5661	0.6266
4	0.8200	0.9784	0.9784	0.0000	0.4467	0.6266	0.6266
5	0.8200	0.9784	0.5922	0.5532	0.0000	0.7294	0.7294
6	0.7595	0.3733	0.4338	0.3733	0.2705	0.0000	0.7294
7	0.7595	0.3733	0.3733	0.3733	0.2705	0.2705	0.0000

Table 15 : Opposite Matrix (D).

Regions	Materials	Precipitation	Stream density	Slope	Habitual density	Elevation	area
1	0	1	1	1	1	1	1
2	0.214494	0	1	1	1	0.601495	0.442481
3	0.054111	0.109532	0	1	0.522695	0.165727	0.192437
4	0.045479	0.072698	0.194701	0	0.410479	0.128322	0.157619
5	0.026487	0.140366	1	1	0	0.088066	0.164765
6	0.456288	1	1	1	1	0	0.318163
7	0.460453	1	1	0.1028	1	1	0

Table 16 : Agree Dominated Matrix (F).

Regions	Materials	Precipitation	Stream density	Slope	Habitual density	Elevation	area
1	0	0	0	0	0	0	1
2	1	0	0	0	0	1	1
3	1	1	0	0	0	1	1
4	1	1	1	0	0	1	1
5	1	1	1	1	0	1	1
6	1	0	0	0	0	0	1
7	1	0	0	0	0	0	0

Table 17 : Opposite Dominated Matrix (G).

Regions	Materials	Precipitation	Stream density	Slope	Habitual density	Elevation	area
1	0	0	0	0	0	0	0
2	1	0	0	0	0	0	1
3	1	1	0	0	1	1	1
4	1	1	1	0	1	1	1
5	1	1	0	0	0	1	1
6	1	0	0	0	0	0	1
7	1	0	0	1	0	0	0

Table 18 : Final Dominated Matrix (H).

Regions	Materials	Precipitation	Stream density	Slope	Habitual density	Elevation	area
1	0	0	0	0	0	0	0
2	1	0	0	0	0	0	1
3	1	1	0	0	0	1	1
4	1	1	1	0	0	1	1
5	1	1	0	0	0	1	1
6	1	0	0	0	0	0	1
7	1	0	0	0	0	0	0

Table 19 : Number of dominant and recessive of each selected areas.

Difference	Number being defeated	Rule number	Regions
-6	6	0	1
-2	4	2	2
2	2	4	3
4	1	5	4
2	2	4	5
-2	4	2	6
-4	5	1	7

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V. Discussion and Conclusion

Having Systematic attitudes toward geography as a science distribution indicates that geography is depending on Mathematical Sciences (Shakoeei, 1999, 43). Generally, model (1) is a schematic but accurate description about a system which is corresponded with its previous behavior and therefore, there is hope that it will be used to predict the future behavior of the system (Hekmat- Nia and Moosavi, 2007, 29).

In recent decades, researchers have used Multi Criteria Decision Making in complex and complicated decisions. In these models, several criteria are used to measure instead of a desirable criterion (Taherkhani, 2008, 62). Nowadays, prioritizing and selecting appropriate substitutions out of different elements and deciding about them is significant in environmental planning and management. In other words, it is necessary to use suitable methods which are combined different indicators in order to achieve better results and to do the best job for environmental planning and management.

In previous decades, decision making in water management problems and selection of better option among suggested options to solve a watershed problems was only done based on economical criteria - profit in relation to cost- and on changing social and environmental criteria in to the economical criterion. However, today using Multi criteria decision making, it is not necessary to use financial equivalent of social and environmental criteria to select the best option. In fact, various qualitative and quantitative criteria can be used to prioritize and select the best options for water resources management.

Nowadays, because of uncontrolled exploitation of ground water, water shortage is became doubled. Accurate control and management of these water resources can alleviate the problem of drought approximately. One of the management techniques of ground water resources is artificial recharge of basins and determination of the most appropriate place for it. The ground water resources are the largest and most importance reservoirs of fresh water on the earth for human being after glaciers and glacial zones (Freeze, 1979). Since these resources are 99% of whole available fresh water, it is necessary to determine and exploit the ground water (Kouthar, 1986- 19).

Furthermore, it includes 80% of being used resources in arid and semi-arid areas in most countries (Sedaghat, 1994). Due to Iran`s situation in desert and semi-desert area and its average annual rainfall about 250 mm, so there were many ways to prepare fresh water for agriculture, drinking and industry in different parts of country from a long time ago. Therefore, determination and zoning the most appropriate area for artificial recharge of underground aquifers should be considered in this plain.

In recent years, water exploitation has become greater for many reasons such as population growth, industrial development, urbanization growth and consequently increased demand for food products. Hence the rate of exploitation and consumption ground water become greater than recharge of them, in other words input of ground water system is less than its output and system with negative balance sheet has positive feedback and it is collapsing. Thus it is very significant to determine and assign the suitable position for this case.

Water resources management is a set of various management activities aimed at the optimum utilization of water resources and reduction of economical, social and environmental damages and losses. Decision making issue in water resources management is very complex and complicated because of several decision indicators and criteria. Achieving a determine purpose, there are a lot of solutions with different priorities for various issues such as environmental, social, organizational and political problems. These necessities leads to use of multiple criteria decision making aimed at selection of best solution among different solutions.

This study aimed at ranking the water resources potential in Zarand-Saveh watershed by two methods; ELECTRE and TOPSIS methods and compared the results and findings of them. TOPSIS algorithm is a Multi Criteria Decision Making which combines quantitative and qualitative indicators, weights each indicator in relation to its importance and helps decision makers to select the best alternative. And ELECTRE method is one of the available compensatory models. In this method, all options are analyzed and evaluated by non-ranked comparisons. Whole stages of this method are based on coordinated and uncoordinated sets and thus it is called ''coordination analysis''. The result and findings of different studies show that in TOPSIS method, zone 3 with (0/8) point promotes in first rank among 7 studied zones and thus it is the most appropriate zone to establish the proper soil damp, in contrast zone 1 with (0/15) point goes down to the last rank and so it isn`t suitable for establishing soil damp and zones (4,2,5,6,7) with (0/79, 0/73, 0/46, 0/32, 0/21) points are located in next ranks. In ELECTRE method, zone (4) dominated (5) times and defeated (1) time, so it is located in the first rank with (4) points and is the most suitable zone for artificial recharge. In contrast, zone (1) defeated (6) time and dominated no time, therefore it is located in the last rank with (-6) points and is not the most suitable zone for artificial recharge. And, zones (3, 5, 2, 6, 7) dominated (4, 4, 2, 2, 1) times and defeated (5, 4, 2, 2, 4) and located in other ranks with (-4, -2, -2, 2, 2, 2) points respectively. Also, zones (7, 6, 2, 1) should be omitted because their defeated times are more than dominated times.

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