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Evaluation of De-Desertification Alternatives by shannon entropy method and ORESTE model

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Abstarct: Desertification is defined as land degradation in arid, semi-arid and dry sub-humid that happens as a result of various factors including climatic variations and human activities. Despite the serious environmental, social and economic impact of desertification phenomenon, few studies have been done in providing optimal alternatives. This paper tries to provide systematic and optimal alternatives in a group decision-making model. At first in the framework of Multiple Attribute Decision-making (MADM), indices preference was determined using shannon entropy, then alternatives priority was evaluated by ORESTE model. The results showed that alternative of vegetation cover development and reclamation (A23) with general rating of $R(m) = 46.5$ is the most important alternative in de-desertification prosess in the study area, and alternatives of prevention of unsuitable land use changes (A18) and Livestock grazing Control (A20) were in the next priority with general rating of 53.5 and 69, respectively. Therefore, it is suggested that the obtained results and ranking should be considered in projects of controlling and reducing the effects of desertification and rehabilitatyion of degraded lands plans.

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1 Introduction

Desertification refers to the land degradation phenomenon and process in arid, semi-arid and dry sub-humid areas (the humid index between 0.05 and 0.65) resulting from various factors including climatic variations and human activities (Glantz and Orlovsky, 1983; CCICCD, 1994; Ali, 1998). This phenomenon has faced the environmental and food security with crisis. It causes the loss of soil quality and is one of the main concerns of FAO (1979). So the necessity of attention to the optimal alternatives to prevention of desertification, or reclamation and reconstruction of destroyed areas is essential in order to avoid investment wasting and increasing the efficiency of controlling, reclamation and reconstruction of natural resources projects.

The history of the use of decision making models for optimal alternatives presentation, in the context of desert area management is limited to Grau et al and Sadeghravesh et al researches. Grau used Elimination Et Choice Translating Reality (ELECTRE), Analytical Hierarchy Process (AHP) and PROMETHEE models in his research in order to select optimal alternatives for providing an integrated plan for erosion and desertification control (Grau et al, 2010). His study results indicated high- performance of these models in providing optimal alternatives for de-desertification, and the results were the same despite the use of complex methods in each model.

Sadeghravesh also used AHP (Sadeghravesh et al, 2010) Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) (Sadeghravesh et al, 2012) ، Electera (Sadeghravesh et al., 2015) and fuzzy analytical hierarchy process (FAHP) (Sadeghravesh et al., 2015) and prioritized de-desertification alternatives in Khezer Abad. The results of these studies were identical and also similar to the results of the present study. Studying methods that can present optimal alternatives for desert area management is essential therefore the goal of this study was providing an appropriate model in order to present optimal solutions in study area.

Many studies have been done about the use of ORESTE model for decision making in different science. Prioritize optimal methods for nuclear waste disposal (Delhaye et al, 1991), Selecting a set of factors in order to achieve desired quality in final result in chemistry (Bourguignon and Massart, 1994), Prioritize alternatives for searching land mine (Leeneer and Pastijn, 2002), Research centers ranking (Mohamedpor and asgharizadeh, 1999), Prioritize outlined alternatives for procurement of military equipment (Pastijn and Leysen, 2009), Evaluation of vegetable cultivation methods in agriculture investment projects (Matejcek et al, 2011), structural analysis of Important criteria for industry (Dinçer, 2011), Identifying and prioritize of different methods risk for grain evacuation (Jafari, 2013) and choosing flexible production system (Chatterjeea and Chakrabortyb , 2014) are samples of these studies.

I all of these studies, researchers designed hierarchical structure at first, then by the use of weighting techniques like AHP, Entropy method, the least squares method and Eigenvector method assessed weight value of criteria and alternatives and finally by the use of ranking techniques including ORESTE Method prioritized existent alternatives. So far, application of ORESTE model for issues relating to desert area management including selection of optimal and systematic alternatives for control and reduction of desertification has not been seen either in Iran or other countries.

The main advantages of this method are briefly: 1- Involving both quantitative and qualitative criteria simultaneously in decision making process, 2- easiness and simplicity to use, 3- involving many criteria for decision making process, 4- ability to change input and also assessment of system answer based on this information, 5- expressing results as absolute ratings that are final weight of criteria in prioritize

2 Materials and methods

2.1 The study area

Khezr Abad region with the area of 78,180 ha is located on 10 km west of Yazd. Geographical position of the study area is 31º 45´ to 32º 15´ northern latitudes and 53º 55´ to 54º 20´ eastern longitudes. The climate of this region is cold and arid based on Amberje climate classification. About 12,930 ha of the region are hills and the sandy area which is a part of the Ashkzar great erg, located on the north part of the study area. Also, about 1,955 ha of all agriculture lands of the region consist of destroyed lands resulting from human activities and natural processes, which shows absolute typical condition of desertification in the study area and presents the necessity of following effective and optimum de-desertification solutions and alternative.

2.2 Methodology

2.2.1 Selection of effective alternatives and criteria

Choosing criteria and alternatives from a lot of proposed criteria and alternatives in de-desertification process could be done both, according to the experience of the expert, information sources and field studies or by the use of Delphi technique and preparation of questionnaire then asking experts familiar with the study area to express effective alternatives and criteria and also score them form 0 to 9. Finally by gaining the average of all criteria or alternatives any alternative with the mean value less than 7 ($\bar{X}$<7), would be removed but alternatives with the mean value more or equal to 7 ($\bar{X}$≥7) would be used (Azar and Rajabzadeh, 2002).

2.2.2 Calculate local priority of criteria and alternatives and establish group pirewise comparisons matrix

In continuation, to achieve local priority, a second questionnaire entitled "pirewise comparisons questionnaire" was designed and Experts were asked to conduct pirewise comparison on obtained results of first questionnaire regarding the nine-point Saaty's scale (Table1) based on importance to goal and priority to each criteria respectively. After forming pairwise comparisons matrix of each expert about criteria importance and alternatives priority (Table2), by the use of geometric mean and assumption of uniform expert's opinion, pirewise comparisons of each expert were composed according to Eq. 1; and pirewise comparisons were formed regarding to group (Azar and Rajabzadeh, 2002, Ghodsipour, 2002). (1)

a_{ij}^{k} = component of k expert to comparison i and j

Table1. Importance and priority degree of nine-point Satty's scale (Azar and Rajabzadeh, 2002)

Importance Degree	Definition
1	Equal importance
3	Moderately preferred or slightly better
5	Extreme importance
9	Extraordinary importance or well-preferred
2,4,6,8	Preferences between above Intervals
1/4, 1/5, 1/6, 1/7, 1/8, 1/9	Mutual Values

Table2. pirewise comparisons matrix (Azar and Rajabzadeh, 2002)

$$A=\begin{vmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ a_{m1} & a_{m2} & \cdots & a_{mn} \end{vmatrix}$$

$A=[a_{ij}^{\dagger}]$, i = 1,2,.....m
j = 1,2,.....n

2.2.3 Extracting the weights of effective alternatives based on group pirewise comparisons tables

At this stage, the numbers of group pirewise comparisons matrix, values of criteria importance and alternatives priority to each criterion, (table.2) were imported in EC software (Godsipour, 2002). After normalization by using Eq. 2, importance and priorities percent were showed as bar graphs using harmonic mean method or average of each level of normalized matrix.

$$\bar{P}_{ij}=\frac{\bar{a}_{ij}}{\sum_{i=1}\bar{a}_{ij}} \qquad (2)$$

In this equation

$\bar{P}_{ij}$ = normal component

$\bar{a}_{ij}$ = group pirewise comparison component of i to j

$\Sigma\bar{a}_{ij}$ = total column of group pirewise comparisons

2.2.4 Formation of Normalized Decision Matrix (NDM)

At this stage, the Weighs of alternatives priority (P_{ij}) based on each criteria, were entered according to decision matrix (Tab.3).

Table3. Normalized Decision Matrix (NDM), (Asgharpour, 2010)

Alt	Criterion				
	C_1	C_2	C_3	-----------	C_n
	W_1	W_2	W_3	-----------	W_n
A_1	P_{11}	P_{12}	P_{13}	--------	P_{1n}
A_2	P_{21}	P_{22}	P_{23}	-----------	P_{2n}
:	:	:	:	:	:
A_m	P_{m1}	P_{m2}	P_{m3}	-----------	P_{mn}

In this matrix m= the number of choices or alternatives, N= number of criteria, C= title of criteria, P_{ij} = weight value that each alternative gains in relation to related criteria, $W_{i=}$ Weight value that each criteria gains in

2.2.5 Determining the importance of criteria by the use of Entropy- Shannon method

Entropy- Shannon model that is gained from Information theory was provided by Shannon for the first time (Shannon, 1948). Entropy is a measure of disorder in a system (Bednarik et al, 2010) and it is a criterion for amount of expressed uncertainty by discrete probability distribution (P_i) (Soleimani-damaneh and Zarepisheh, 2009, Asgharpour, 2010). Relating to the weighting of criteria, Entropy provides a powerful approach for determining the weight of criteria when data are not zero (Qi et al, 2010) and also can provide useful information among data for determinant (Wu et al, 2011). This method can reflect results better, because of personal judgment avoidance (Zhao et al, 2010).

In order to determine the importance of criteria, after forming decision matrix that is a normalized matrix, alternatives entropy relating to criteria was calculated by using Eq. 3 and two-dimensional matrix was formed (table.4).

$$E_{ij}=P_{ij}\times\ln P_{ij} \quad ;\forall j \qquad (3)$$

E_{ij} = Alternatives entropy relating to each criterion

P_{ij} = Normal weight of each alternative relating to each criterion

$\ln P_{ij}$ = Napierian logarithm of normal weight of each alternative relating to each criterion

Table.4. alternatives entropy matrix relating to criteria

Alt	Criterion				
	C_1	C_2	C_3	....	C_N
A_1	E_{11}	E_{12}	E_{13}		E_{1N}
A_2	E_{21}	E_{22}	E_{23}	....	$\mathbf{E_{2N}}$
:	:	:	:	....	**:**
A_M	E_{M1}	E_{M2}	E_{M3}	....	$\mathbf{E_{MN}}$

In continue, alternatives entropy (E_j) was calculated by using Eq. 4

$$E_j=-K\sum_{i=1}^{m}\left(P_{ij}\times\ln P_{ij}\right) \qquad (4)$$

E_j = each criterion entropy

K= Fixed Coefficient that is calculated by Eq. 5

$$K=\frac{1}{\ln M} \qquad (5)$$

In this equation:

$\ln_M$= Napierian logarithm of alternative number

Then, amount of d_j (degree of diversification) was calculated by using Eq. 6. This factor expresses that how much useful information is offered to determinant by relevant criteria (j). Whatever the amount of a criterion is closed to zero, indicates that different alternatives are not significantly different for that criterion. So, for decision making, the role of that criterion must be reduced as much.

$$d_j = 1 - E_j \quad ; \forall j \qquad (6)$$

Then, amount of criteria weight was calculated by Eq. 7

$$W_j = \frac{d_j}{\sum_{j=1}^{n} d_j} ; \quad \forall j \qquad (7)$$

Based on this method, any criterion with the most weight has the maximum role in decision- making (Azar and Rajabzadeh, 2002).

2.2.6 Calculating final weight of alternatives by the use of ORESTE model

If, in a multiple attribute decision-making question, the goal is ranking m- alternatives based on k- criteria and for each criterion a Weak Order is difined on all alternatives and also relative weight of each criterion is expressed with another Weak Order, ORESTE model, one of MADM methods, is better to use.

This method provides a tool that is able to rank alternatives completely and shows different between alternatives (Pastijn et all, 1989).

In 1979, in a conference that was about multiple attribute decision-making, Marc Roubens, professor of polytechnic in belgium, provided his first idea about a new multiple attribute decision-making method named ORESTE, and developed it until 1982.

Befor explaining the process of ORESTE, we express Besson ranks Since we need the average of Besson ranks during alternatives ranking by the use of ORESTE.

2.2.7 The average of Besson ranks

In ORESTE model, a criterion or an alternative preference is not identified with its weight but also it's provided with a preferred structure on all criteria or all alternatives relating to each criterion (*j= 1,...,k*) named Weak Order. This structure is expressed as complete and transitive relations and also relations of I and P. Relation P shows preference and relation I shows indifference among criteria and alternatives relating to each criterion.

After forming preference structures of criteria and all alternatives relating to each criterion, numbers 1 to k and 1 to m are allocated to all criteria or alternatives, respectively. Then the average of maximum and minimum of allocated number is calculated and given to both criteria instead of allocated numbers.

For exmaple, if the number order of n and k be 1 and 2 respectively, and both of them are in a same preferecne level, their mean rating is calculated by Eq. 8.

1+2/2=1.5 (8)

So, in this method, priorities change into rakns, and obtained rank for each criterion is shown as r_k and obtained rank for an alternative relating to each criteria is shown as $r_k(m)$.

ORESTE method has three basic steps for ranking including:

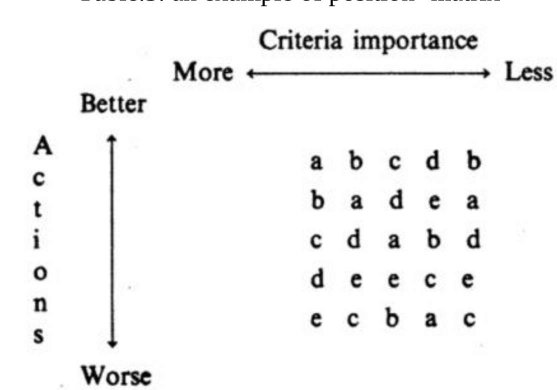
1-Projection of alternatives distances d (0, m_k):

Projection in ORESTE method is based on Position- matrix. In Position- matrix, decision alternatives are ranked from the best to the worst in each column, and columns are arranged based on criteria ranking (table.5). By imagining the matrix members, better positions are located on main diagonal left and worse positions are located on its right. Then, a zero point is considered on the end of main diagonal left and all created images and d (0, m_k) is determined:

$$if \quad a P_k b \quad then \; d(0,a_k) < d(0,b_k) \qquad (9)$$

$$if \quad r_1(a) = r_2(b) \quad and \; 1 p 2 \; then \; d(0,a_1) < d(0,b_2) \qquad (10)$$

Table.5. an example of position- matrix



Projection of distances is done for different states including:

A- Direct linear projection:

In this state, we use Eq. 11 for projection of distance $d(0,m_k)$ from $r_k(m)$, r_k for alternative m in criterion k.

$$d(o,m_k) = \tfrac{1}{2}\left[r_k + r_k(m)\right] \qquad (11)$$

B- Indiretc linear projection:
In this situation, distances are calculated by Eq.12:

$$d'(o,m_k)=\alpha r_k+(1-\alpha)r_k(m) \quad (12)$$

C- Nonlinear projection:
For determining desired distances in this state, Eq. 13 is used:

$$d''(o,m_k)=\sqrt[2]{\left(r_k^{\,2}+r_k(m)^2\right)} \quad (13)$$

Eq. 14 is used in order to obtain more general conditions:

$$d''(o,m_k)=\sqrt[R]{\left(r_k^{\,R}+r_k(m)^R\right)}$$

(14)

Finally Eq. 15 is obtained by adding normalized weights α, (1-α) :

$$d''(o,m_k)=\sqrt[R]{\left(\alpha r_k^{\,R}+(1-\alpha)r_k(m)^R\right)} \quad (15)$$

In this regard, according to some values R, distance d is defined as follow:

Geometric mean: $R=-1\rightarrow d''$

Weighted arithmetic mean: $R=1\rightarrow d''$

The mean square: $R=2\rightarrow d''$

$$R=-\infty\rightarrow d'':\min(r_k,r_k(m))$$

(16)

$$R=+\infty\rightarrow d'':\max(r_k,r_k(m))$$

(17)

2.2.9 Global ranking of alternatives distances r(m$_k$)

Global ranking is done by determining images distance. Selecting any of the above conditions or different amounts of R for determining distances d(0,m$_k$) is done with the goal of influence on their position relative to each other. In continue, distances are ranked by the use of Besson ranks average.

The result of this ranking is equal to obtained rank of Besson method that is assigned to distance d(0,m$_k$) as r(m$_k$). For example:

$$R(a_1)\leq R(a_2) \;\; if \;\; d(o,a_1)\leq d(o,b_2)$$

(18)

Obtained ranks are named Global ranks and all of them are located in the following classes:

$$1\leq R(m_k)\leq mk$$

(19)

m= number of alternatives
k= number of criteria
R(m$_k$)= absolute ranks

2.2.10 Aggregation

After calculating and determining all of global ranks, they are collected separately in each of the criteria for all alternatives and for each alternative like m final collection is calculated by Eq. 20:

$$R(m)=\sum_{k=1}^{k}R(m_k) \quad (20$$

Thus, an incremental and sequential structure is defined based on R(m) and in regard to Eq. 21, 22.

$$if \;\; R(a)<R(b) \quad then\; aPb$$

(21)

$$if \;\; R(a)=R(b) \quad then\; aIb$$

(22)

Any alternative with a lower amount of R(m) is more appropriate and better rank is assigned to it. This means that the absolute ranks summation of the best alternative is less than other alternatives ranks in all criteria (Roubens, 1982).

3. Results

3.1 Selection of important criteria and alternatives

In order to obtain important criteria and alternatives, Delphi method was used (Sadeghravesh et al, 2010) and hierarchical decision structure was designed in order to provide optimal de- desertification alternatives (fig.1).

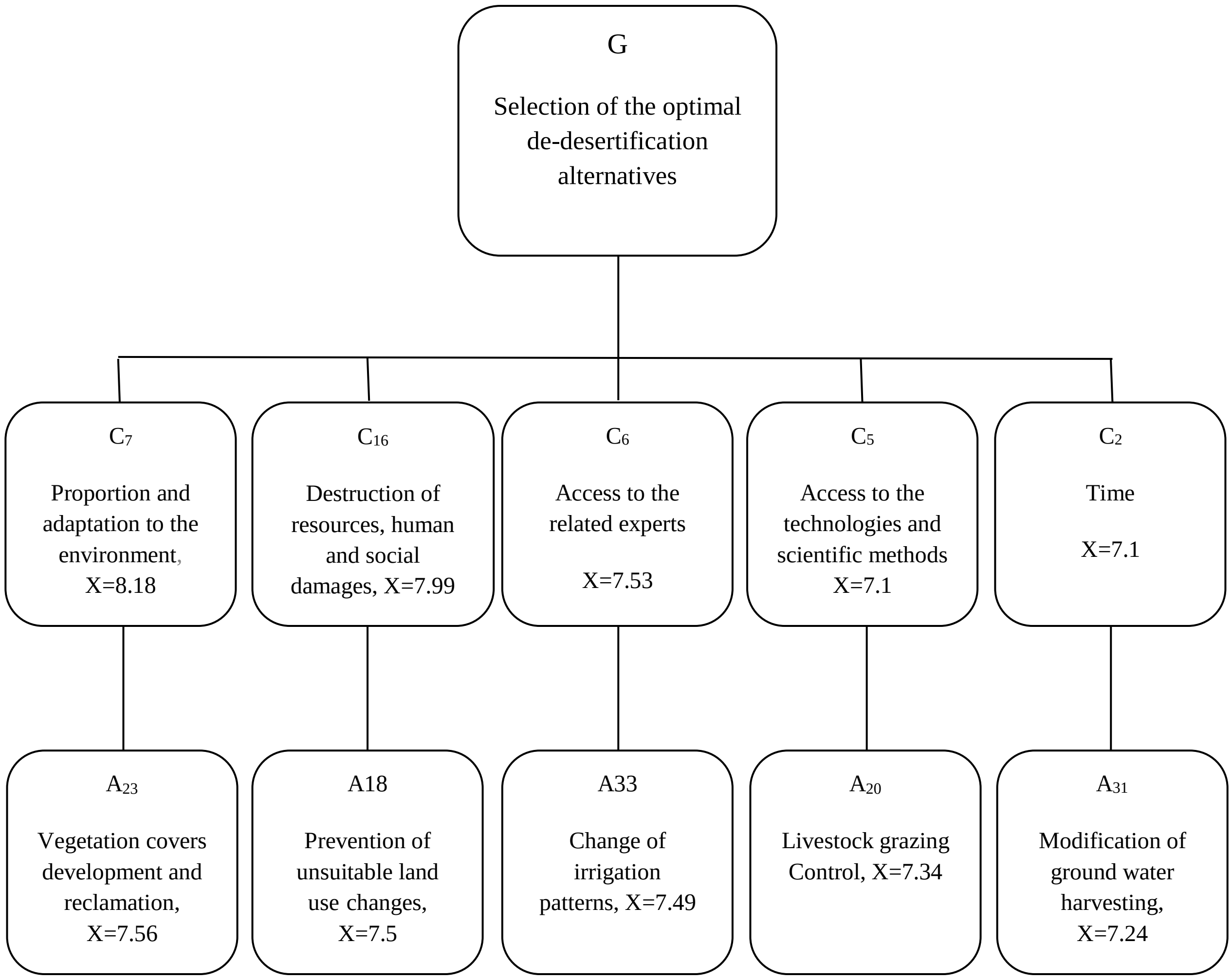


Fig.1. Hierarchical decision structure for providing optimal de-desertification alternatives in study area

3.2 Calculate relative weight of criteria and alternatives and format group decision matrix (DM)

After identifying important criteria and alternatives, pirewise comparison method was used in order to calculate local priority or relative weight for providing the optimal de- desertification alternatives. In this equation, group pirewise comparisons matrices and graphs of alternatives priority relating to each criterion were formed. Here, matrix and graph of alternatives priority relating to proportion and adaptation to the environment are provided (table.6 and fig.2).

Table.6. Group pirewise comparisons matrix of alternatives priority relating to proportion and adaptation to the environment

alternatives	A_{23}	A_{31}	A_{33}	A_{20}
A_{18}	(1/1)	1/3	2/4	1/6
A_{23}		(1/1)	1/6	1/3
A_{31}			(1/1)	1/2
A_{33}				1/2

Fig2. Alternatives priority comparison in regard to the criteria of proportion and adaptation to the environment (C_7)

According to figure 3, it was observed that selective alternatives are different according to each criterion. So, decision matrix of optimal de- desertification alternatives was formed (table.7) for final selection of alternatives and their prioritized in the form of decision matrix in AHP and alternatives priority relating to each criterion was defined. Then the importance of the famous criteria for providing de- desertification alternatives was determined by the use of Entropy Shannon method. Finally, final priority of alternatives was determined based on ORESTE model.

Table7. Decision matrix of optimal de-desertification alternatives according to group

Criteria importance (C) ▶ Alternatives (A) ▼	C_2	C_5	C_6	C_{16}	C_7
A_{23}	0.2509	0.2387	0.2488	0.1805	0.2257
A_{18}	0.1960	0.1635	0.1983	0.2383	0.2643
A_{33}	0.1620	0.2565	0.2093	0.1510	0.1599
A_{20}	0.2229	0.1762	0.1608	0.2209	0.1582
A_{31}	0.1682	0.1633	0.1826	0.2092	0.1918

3.3 The importance of the famous criteria determination in de- desertification process by the use of Entropy Shannon method

After forming normalized decision matrix (table.7), de-desertification alternatives entropy relating to famous criteria was calculated by Eq. 3 and its two-dimensional matrix was formed (table.8).

Table.8. matrix of de- desertification alternatives entropy relating to famous criteria (E_{ij})

Criteria importance (C) ▶ Alternatives (A) ▼	C_7	C_{16}	C_6	C_5	C_2
A_{23}	-0.3359	-0.3090	-0.3461	-0.3419	-0.3469
A_{18}	-0.3517	-0.3417	-0.3208	-0.2961	-0.3194
A_{33}	-0.2931	-0.2854	-0.3273	-0.3490	-0.2948
A_{20}	-0.2917	-0.3335	-0.2938	-0.3059	-0.3345
A_{31}	0.3167	-0.3273	-0.3105	-0.2959	-0.2998
Total (sum)	-1.5892	-1.5969	-1.5985	-1.5888	-1.5954

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Then, famous de-desertification criteria entropy was calculated by Eq. 4 and by calculating deviation degree (d_j) and criteria weight (W_j) by Eq. 6 and 7, criteria importance for selection of de- desertification alternatives in study area was calculated according to table.9.

Table.9. famous criteria entropy, deviation and weight for providing de- desertification alternatives in study area

Criteria (C) ►	C_7	C_{16}	C_6	C_5	C_2
E_j	0.9874	0.9922	0.9932	0.9872	0.9913
d_j	0.0126	0.0078	0.0068	0.0128	0.0087
w_j	0.2587	0.1602	0.1396	0.2628	0.1786

3.4 Final ranking of de- desertification alternatives priority

3.4.1Creating preference structure on all criteria and alternatives

For final ranking by the use of ORESTE model, at first we should create two types of preference structure for all criteria and alternatives. In order to create preference structure for criteria, we used weights that were obtained from Entropy Shannon method (table.9), so the following structure was obtained:

$$C_5 \, P C_7 \, P C_2 \, P C_{16} P C_6$$

Similarly, the preference structure was formed for all alternatives based on each criterion by the use of decision matrix data. Thus, the following subsidiary structures were formed:

$$C_7 = A_{18} P A_{23} P A_{31} P A_{33} P A_{20}$$
$$C_{16} = A_{18} P A_{20} P A_{31} P A_{23} P A_{33}$$
$$C_6 = A_{23} P A_{33} P A_{18} P A_{31} P A_{20}$$
$$C_5 = A_{33} P A_{23} P A_{20} P A_{18} P A_{31}$$
$$C_2 = A_{23} P A_{20} P A_{18} P A_{31} P A_{33}$$

3.4.2 determination of primary ranking on all criteria and alternatives

By having the above structures and relations and also using the average of Besson ranks, the primary ranking of criteria and alternatives was done. So that, the numbers 1 to 5 were assigned to all criteria and the primary ranking was calculated for all criteria (r_k) as following:

$$r_5 = 1, \; r_7 = 2, \; r_2 = 3, \; r_{16} = 4, \; r_6 = 5$$

Above operations was also done for subsidiary structures (table. 10).

Table.10. primary ranking of alternatives relating to all criteria r_k (m)

Criteria (C) ► Alternatives (A) ▼	C_7	C_{16}	C_6	C_5	C_2
A_{23}	2	4	1	2	1
A_{18}	1	1	3	4	3
A_{33}	4	5	2	1	5
A_{20}	5	2	5	3	2
A_{31}	3	3	4	5	4

3.4.3 Distances calculation d(o, m_k)

In this section, direct linear projection (Eq.11) was used for distances calculation. In this equation, the arithmetic mean was calculated among criteria rating (r_k) and also alternatives rating in each criterion r_k(m) and the results was shown as distance from origin point for all alternatives relating to each criterion (table.11). For example alternatives distances from origin point in the first criterion is as following:

$$d(o, A_{23}) = \frac{\lfloor r_7 + r_7(A_{23}) \rfloor}{2} = \frac{2+2}{2} = 2$$

$$d(o, A_{18}) = \frac{\lfloor r_7 + r_7(A_{18}) \rfloor}{2} = \frac{2+1}{2} = 1.5$$

$$d(o, A_{33}) = \frac{\lfloor r_7 + r_7(A_{33}) \rfloor}{2} = \frac{2+4}{2} = 3$$

$$d(o, A_{20}) = \frac{\lfloor r_7 + r_7(A_{20}) \rfloor}{2} = \frac{2+5}{2} = 3.5$$

$$d(o, A31) = \frac{\lfloor r7 + r7(A31) \rfloor}{2} = \frac{2+3}{2} = 2.5$$

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Table.11. distances calculation for all alternatives relating to all criteria

Criteria (C) ► Alternatives (A) ▼	C_7	C_{16}	C_6	C_5	C_2
A_{23}	2	4	3	1.5	2
A_{18}	1.5	2.5	4	2.5	3
A_{33}	3	4.5	3.5	1	4
A_{20}	3.5	3	5	2	2.5
A_{31}	2.5	3.5	4.5	3	3.5

3.4.4 Global ranking of alternatives distance in each criterion $R(m_k)$

In this stage, obtained results from the previous section was ranked by the use of Besson ratings average method and global ranking of all alternatives in each criterion $R(m_k)$ was calculated between 1 to 25 by Eq. 19 (table. 12).

$$mk = 5 \times 5 = 25 \rightarrow 1 \leq R(m_k) \leq 25$$

Table.12. absolute ranking of alternatives distance in each criterion $R(m_k)$ and absolute ranking of alternatives distance in total criterion R(m)

Criteria (C) ► Alternatives (A) ▼	C_7	C_{16}	C_6	C_5	C_2	R(m)
A_{23}	5	21	13	2.5	5	46.5
A_{18}	2.4	8.5	21	8.5	13	53.5
A_{33}	13	23.5	17.5	1	21	76
A_{20}	17.5	13	25	5	8.5	69
A_{31}	8.5	17.5	23.5	13	17.5	80

3.4.5 Aggregation or absolute ranking of alternatives distance in total criterion R(m)

This stage should be done after gaining $R(m_k)$ for all alternatives relating to each criteria (table.12), it means that absolute ranking of alternatives distance in total criteria R(m) should be calculated. The amount of this is equal to all calculated $R(m_k)$ for all alternatives relating to each criteria(table.12).

3.4.6 Comparison of the results and determining the best alternatives in ORESTE method

Finally, in order to determine the best alternatives, obtained results from absolute ranking of alternatives distances in total criteria R(m) were compared according to study method. In this section, alternative with the lower distance has the higher rating. So, final ranking for decision alternatives by the use of ORESTE model shows that alternative of vegetation cover development and reclamation (A_{23}) with general rating of $R(m)$ = 46.5, alternatives of prevention of unsuitable land use changes (A_{18}) with general rating of $R(m)$ = 53.5, Livestock grazing Control (A_{20}) with general rating of $R(m)$ = 69, Change of irrigation patterns (A_{33}) with general rating of $R(m)$ = 76 and modification of ground water harvesting (A_{31}) with general rating of $R(m)$= 80 are the most important alternative in de-desertification prosess in the study area, respectively.

4. Discussion and conclusion:

In this study a new method was represented in order to rank alternatives priority for de-desertification process. Obtained results from ORESTE method for final prioritizing of alternatives, like AHP, TOPSISSs, ELECTREA, WSM methods, have characteristics including flexibility, high efficiency, easy application and also possibility of the use of software such as EC and MS EXCLE and evaluation of alternatives based on total effective criteria. ORESTE method has the limitation of ignoring determinants fuzzy judgment like above mentioned method. Also some criteria have unknown structure or qualitative structure and cannot be measured accurately. In this situation, in order to achieve evaluation matrix, we can use fuzzy numbers. So the mentioned prioritizing method can be developed by the use of fuzzy numbers.

In continue, the results were presented as decision matrix in the framework of Multiple Attribute Decision-making (MADM) (table.5). As we can see in the table 5, selective alternatives are different based on each criterion. So, impact of criteria importance on de-desertification was calculated by the use of Entropy-Shannon method (table.7) for participation of criteria importance in decision- making and also determining final priority. Obtained results showed that criteria of scientific and technological tools (C_5) and adaptation and proportion with environment (C_7) are the most important criteria with importance coefficient of 0.2628 and 0.2587 respectively. It shows the importance of available scientific and technological tools for determination of optimal alternatives and experts effort toward environment issues. Finally, aggregation was done by the use of ORESTE model for final selection of alternatives and their prioritized. So the alternatives priority based on criteria R(m) was formed.

In general, according to the results, the alternative of vegetation cover development and reclamation (A23) with general rating of $R(m) = 46.5$ is the most important alternative in de-desertification prosess in the study area, and alternatives of prevention of unsuitable land use changes (A18) and Livestock grazing Control (A20) were in the next priority with general rating of 53.5 and 69, respectively.

Pasture types density is 6 to 15 percent that is influenced by human actions strongly, and 40 to 50 percent of vegetation cover is destroyed because *cutting* shrubs in order to secure fuel for firewood, cooking and building materials.

Land use change is developing strongly as a result of population grows, unemployment, industrial and urbanization grows. Usually land use change has occurred as conversion of pasture land to farm and garden because of deep and semi-deep wells development, conversion of garden to agriculture land on the effect of successive droughts and conversion of pasture land to urban and industrial land because of industrial and urbanization grow in recent years.

So following executive suggestions are recommended in the framework of discussed macro alternatives:

- Land use planning and estimating the ecological potential in national, regional and local levels and land use conformity with land potential.
- Preventing inappropriate conversion of poor pasture land to garden with low efficiency and high potential for degradation and erosion.
- Preventing development of industrial infrastructure in sensitive lands of desert areas and marginal areas.
- The use of resistant and native pasture species and modern irrigation systems with high efficiency for vegetation cover development and reclamation.
- Prevention of *Haloxylon*-planted destruction and trying for their reclamation
- Observance of balance between number of livestock and pasture capacity
- Conformity between livestock type and pasture condition should be considered and the number of goats should be reduced in poor pastures, because these animals increase pastures destruction, potentially.
- Prevention of premature grazing because of weak vegetation potential for damage.

Finally it is suggested that de- desertification projects should be focused on these alternatives in the study area in order to prevent wealth losses and increase efficiency of control and reclamation projects.

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