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Research Paper

Application of fuzzy analytical hierarchy process (FAHP) for Assessment of de-desertification alternatives in the central of Iran

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Abstract: In order to increase the efficiency of controlling projects, reclamation of disturbed lands and avoiding investment wasting, there is no method to consider different criteria and alternatives and present the optimal alternatives based on systematic and group perspective in de-desertification projects. Usually, proposed alternatives according by experts' are non-systematic and non-comprehensive. There is no record on application of systematic models in de-desertification field including: Multiple Attribute Decision Making (MADM). Therefore in this research fuzzy analytical hierarchy process (FAHP) method has been used for offering the optimal alternatives to de-desertification. In this study the opinion of experts about alternatives and criteria were assessed by using Delphi method and Pirewise comparison. Then final preference for the alternatives was obtained with establish of fuzzy making decision matrix and through FAHP model. The ability of the model was assessed for offering de-desertification alternatives in Khezrabad region in Yazd province in the central Iran. On the basis of obtained results modification of groundwater harvesting alternative with weighted average of %93 was determined as the optimum de-desertification alternative in the study area and other alternatives haven effective role in control of desertification.

Keywords: de-desertification, fuzzy analyzes hierarchy process, multi criteria decision making, pirewise comparative.

Introduction

With respect to importance of desertification issue and complication of this phenomenon because of interaction of different and numerous variables during the time, paying effective attention to the optimum alternatives is vital to prevention of de-desertification or rehabilitation and improvement of degradation lands. So, the losses of limited capitals are prevented and efficiency of control and rehabilitation projects is enhanced.

Study of research sources showed that unfortunately proposed alternatives are superficial and there is not any precedence in application of systematic methods for desertification issues.

the only performed study in application of multi criteria decision method in problem related to management desert area of article" Application of Analytical Hierarchy Process (AHP) in assessment of de-desertification alternatives" therefore, use of method that can present good solution in base of logic and stony principles and proved theatrical basis is important (necessary)in management of desert area. Multi criteria decision making models in clouding AHP model can formulate problem in from of hierarchical. Also it provide possibility of quantitative and qualitative various criteria in presentation of suggestive alternatives, it interference various option in making-decision and meantime is flexible with change of effective factor in future.

In addition if create to base of pirewise comparison that faceplate judgment and calculation. It use systematic group Participation in choose of alternatives and formed from story theatrical base (Bergamp, 1995, Ghodsypour, 2003), also whereas actual phenomena are fuzzy, incorrect and complicate and when there is need to follow of human behavior (decision process) fuzzy logic are more actual and near to human behavior.(Azar and Faraj 2003, Meixner, 2010),therefore in order to achievement to presentation goal optimum alternative for de-desertification in this study base of multi-criteria decision making models, method of fuzzy analytical hierarchy process (FAHP) has been used, this method used for first time by Larrhoven and Padrycz in 1983,that it has been presented in base of logarithmic least square method (Larrhoven and Padrycz, 1983; Jun Zhu et al, 1999, Azar and Faraj, 2002),number of calculation and complication stage cause to this method don't use very much. Change has been present Extent Analytical Method (EAM) that it uses triangular fuzzy number (Chang, 1995; Jun Zhu et al, 1999). This method was developed in domain of various sciences by strong and proved logic. From performed studies in field of FAHP application we can Indicate to following cases: The Assessment of water management plans (Sredjevic and Medeiros, 2008), critical decisions in new product development (Buyukozam and Feyzioglu, 2004), flexible manufacturing systems(Chutima and Suwanfuji,1998), safety management in production(Dagdeviren and Yuksel,2008), selection of enterprise resource planning systems (Cebeci, 2009), evaluate success factors in electronic commercial (Kong and Liu, 2005), weapon selection (Dagdeviren, 2009) and assessment of energy sources(Meixner, 2010).

Material and Methods

Study Area

In this research, Khezrabad region in Yazd province (central Iran) considered for the determination of optimum alternatives of de-desertification. This region, with the area of 78180 ha is located on 10 km west of Yazd. The geographical of the study area is 53° 55′ to 54° 20′ eastern longitudes and 31° 45′ to 32° 15′ northern latitudes. The climate of this region is cold and arid based on Amberje climate classification. About 12,930 ha (16%) of region are hills and the sandy area which is a part of the Ashkezar great erg has located on the north part of the study area. About 9,022 ha (12%) of the area consists of bare lands and infrastructures such as clay plain and rocky masses. Also about 1,995 ha (26.5%) of all agriculture lands of the region consists 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 alternatives (Fig.1).

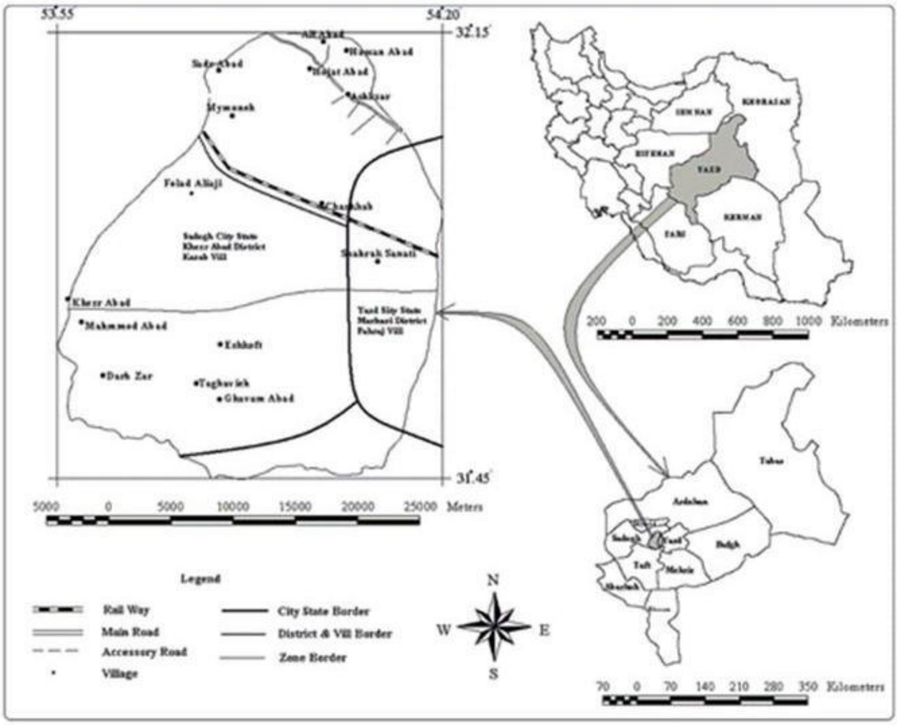

Fig1. Location of Study Area

Therefore ,it use fuzzy logic in base of hierarchical model that is most to present desired multi-criteria decision methods in order to present alternative of desertification. Structure of this model consists of three level goal, criteria and alternatives. That guidelines and criteria levels are important in order to reach goal.

Methodology

Select criteria and alternatives and establish decision hierarchical structure

Due to complexity of desertification process, resulting from various factors, various criteria and alternatives are stated by experts in every area. Since in establishment of a hierarchical structure to reduce comparisons incompatibility, the number of elements at any level should be 7±2 (Saaty, 1980), Therefore, the Delphi method was used to identify important and preferred criteria and alternatives regarding to group, and to establish hierarchical structure (Saaty, 1995). For this aim, a structured questionnaire was designed based on literature and the nine-poit Satty scale, from 1(least important) to 9 (most important) were used to measure the relative importance of criteria and priority of de-desertification alternatives (Table1). The questionnaire was distributed among experts familiar with the study area. In continuation, arithmetical mean was used to calculate the mean of obtained results. Then, the primary statistical community was asked to apply their final changes based on deviations of their primary values from average. Finally, mean values were calculated. In this case, if the mean value was less than 7 ($\overline{X}<7$), related criterion and alternative was removed and if the mean value was more or equal to 7 ($\overline{X} \geq 7$) related criterion and alternative was used to design hierarchical decision structure in three levels: Goal, criteria and alternatives, respectively (Table4, 5, 6 & Fig.2) (Azar and Rajabzadeh, 2002; Sung, 2001).

Table1. Importance and priority degree of nine-point Satty's scale

Score	Importance Degree	Priority Degree
1	Non-importance	Equal
2	Very low	Equal-Moderately
3	Low	Moderately
4	Relatively low	Moderately - Strongly
5	Medium	Strongly
6	Relatively high	Strongly-Very strongly
7	High	Very strongly
8	Very high	Very strongly-Extremely
9	Excellent	Extremely

Calculate local priority of criteria and alternatives by using the Delphi fuzzy method and establish group pirewise comparisons matrix

To achieve local priority, a second questionnaire entitled "pirewise comparisons questionnaire" was designed using the Delphi fuzzy method. Experts were asked to conduct pirewise comparison on obtained results of first questionnaire with three number: minimum, probable , maximum(number of fuzzy triangle)(1,2 relation , and figur2) regarding the nine-point Saaty's scale (Table1) based on importance to goal and priority to each criteria respectively. Thus, pairwise comparisons matrix of each expert about criteria importance and alternatives priority was formed (Table 2) (Ghodsi pour, 2002).

$$\tilde{a}^{t}_{ij} = \left(l^{t}_{ij}, m^{t}_{ij}, u^{t}_{ij}\right), \quad i, j = 1,2,\ldots n_k, \quad t = 1,2\ldots \qquad (1)$$

$$\tilde{a}^{t}_{ji} = \left(\frac{1}{u^{t}_{ij}, m^{t}_{ij}, l^{t}_{ij}}\right), \quad i, j = 1,2,\ldots n_k, \quad t = 1,2\ldots \qquad (2)$$

In this relation $\tilde{a}t_{ij}$ is fuzzy component related to t expert for compare i with j.

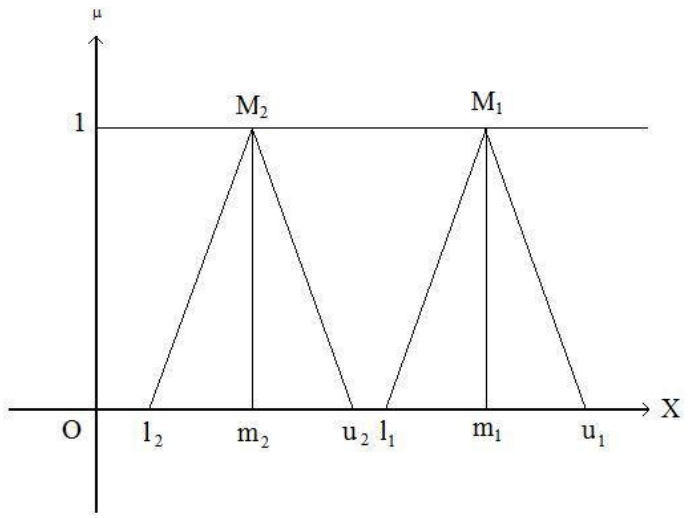

Fig2. Present of two Triangular fuzzy numbers

In continue with use of geometry average and with suppose same vote of all asked person ,from relation(3),they decided to combination fuzzy double compassion of each specialist and establishment of pirewise compassion from group view.

$$M^{k}_{ij} = \frac{1}{T}\left(\tilde{a}^{1}_{ij} + \tilde{a}^{2}_{ij} + \cdots + \tilde{a}^{T}_{ij}\right) \qquad (3)$$

In this relation M^{k}_{ij} is fuzzy component related to k group for compare i with j. Therefore M^{k}_{ij} (geometry average) for all similar fuzzy component gain from relation 3.(zare and ahmadi naseri, 2008) after establish of fuzzy group pirewise comparisons matrix, in order to apply final ideas of specialist our mentioned matrix is between distribution statistical society and wanted them according answer deviations from average, apply final changes on their values in end with gain to given advantages geometry average result for final pirewise comparisons matrixs (Table2).

Table2. Fuzzy pirewise comparisons matrix

$$\begin{vmatrix} M^k{}_{11} & M^k{}_{12} & \cdots\cdots & M^k{}_{1n_{k-1}} \\ M^k{}_{21} & M^k{}_{22} & \cdots\cdots & M^k{}_{2n_{k-1}} \\ \vdots & \vdots & \vdots & \vdots \\ M^k{}_{n_k 1} & M^k{}_{n_k 2} & \cdots\cdots & M^k{}_{n_k n_{k-1}} \end{vmatrix}$$

Value calculation $\tilde{S}_K$ or synthetic triangular fuzzy number for each line of fuzzy pirewise compassion matrix from relation (4)

$$\tilde{S}_K = \sum_{j=1}^{n} M^{K}{}_{Kj} \left[\sum_{i=1}^{n_k} \sum_{i=1}^{n_k} M^{K}{}_{iJ} \right]^{-1}, i = 1,2 \ldots, n_k \quad (4)$$

In this relation k show number of row matrix and i, j show alternatives or criteria respectively.

Calculation of largeness degree value $\tilde{S}_k$ each row from group pirewise compassion matrix relation to each other from relation (5)

$$\begin{cases} V\left(\tilde{S}^k{}_{ij} \geq \tilde{S}^k{}_j\right) = 1, & m_1 \geq m_2, \quad j = 1,2,\ldots,n_k, \quad j \neq i \\ V\left(\tilde{S}^k{}_{ij} \geq \tilde{S}^k{}_j\right) = \dfrac{u_1 - l_2}{(u_1 - l_2) + (m_2 - m_1)} & \text{Otherwise}, j = 1,2,\ldots,n_k, \quad j \neq i \end{cases} \quad (5)$$

Calculation of largeness each of degree synthetic triangle fuzzy number from k other synthetic triangular fuzzy number from relation (6)

$$P^K{}_{ih}\left(A^k{}_i\right) = \min V\left(\tilde{S}^k{}_i \geq \tilde{S}^k{}_j\right), \quad i = 1,2,\ldots,n_k \quad (6)$$

In this relation A_1^K show i criteria or alternative from k fuzzy pirewise comparison matrix.

Number resulted from this process express weights of criteria or alternatives of pirewise compassion matrix from preferred criteria and priority alternatives.

Normalization of weight of criteria and alternatives from relation (7) and gain to preferred and priority criteria and alternatives from point of group (relation 8)

$$P^K{}_h = \frac{P^K{}_{ih}\left(A^k{}_i\right)}{\sum_{i=1}^{k} P^K{}_{ih}\left(A^k{}_i\right)} \quad i = 1,2,\ldots,n_k \quad (7)$$

$$P^K{}_h = P^K{}_{1h}, P^K{}_{2h}, \ldots, P^K{}_{n_k h} \quad (8)$$

This relation express preferred or priority of each criteria and alternative from k fuzzy pirewise compassion matrix is related to criteria or goal of higher hierarchical decision making. Therefore, preferable of criteria related to goal can display as relation 9.

$$c^{K-1} = \left(c^{K-1}{}_1, c^{K-1}{}_2, \ldots, c^{K-1}{}_{n_{k-1}}\right) \quad (9)$$

In this relation preferred (local priority) of each criteria (C) related to goal that express in higher-level (k-1)

Priority of each alternative (A) related to each criterion (C) that it set in higher levels (K) of alternatives present in form of relation 10.

$$a^K{}_{ij} = \left(a^K{}_{1h}, a^K{}_{2h}, \ldots, a^K{}_{n_k h}\right)^T \quad (10)$$

establishment of fuzzy decision making matrix

In base of general form of decision making matrix in AHP and according to 9 and 10 relations, fuzzy decision making matrix formed in order to determine overall priority of alternatives (Table 3).

Table3. Decision making matrix in FAHP

A_i^k	Criterion				P_i^k
	$c^{K-1}{}_1$	$c^{K-1}{}_2$	-----------	$c^{K-1}N_{K-1}$	
A^1	$a^K{}_{11}$	$a^k{}_{12}$	-----------	$a^k{}_{1nk-1}$	p^1
A^2	$a^k{}_{21}$	$a^k{}_{22}$	-----------	$a^k{}_{2nk-1}$	p^2
:	:	:	:	:	:
A^k	$a^k{}_{nk1}$	$a^k{}_{nk2}$	-----------	$a^k{}_{nknk-1}$	P^k

Syntheses local priority of preferred and priority criteria and alternatives by using harmonic mean method or average of each level of normalized matrix (relation11) and estimate priority coefficient of alternatives in base of collection of criterion from group viewpoint.

$$P_i^K = \sum_{j=1}^{n_{k-1}} a^k{}_{ij} c^{k-1}{}_j \qquad (11)$$

Table4. The offering alternatives for de-desertification

– Modification, creation and development of economical–social infrastructure in marginal areas A_1– Reducing population growth rates A_2– Poverty alleviation A_3– Establishment and development of rural organizations A_4– Increasing employment A_5– Increasing participation of local community and supporting NGOs A_6– Application of local forces and technology in projects (local knowledge) A_7– Training people in utilization of new methods and use of new knowledge for optimal use of resources A_8– Approval, promotion and implementation of laws and adaptation punishment with crime A_9– Providing needs of local residents A_{10}– Modification of unsustainable consumption patterns, changing and improving people's livelihood patterns A_{11}– Considering the role of women and youth in de-desertification A_{12}– Organization of urban areas and prevent migration A_{13}– Coordination between responsible agencies and organizations in desertification and environmental protection A_{14}– Raising the literacy rate A_{15}– Development of desert ecotourism A_{16}– Multi-utilization from desert instead of mono-utilization A_{17}– Allocation desertification issues to the private sector A_{18}– Prevention of unsuitable land use changes A_{19}– Mapping land use planning and determination of desert and salt desert boundaries – Vegetation cover Conservation A_{20}– Livestock grazing Control A_{21}– Forage production and increasing economic potential of sustainable husbandry	A_{22}– Prevention of Plant cutting A_{23}– Vegetation cover development and reclamation A_{24}– Protection of *Haloxylon spp.* – Soil Conservation A_{25}– Protection of gravel surfaces (Reg) A_{26}– Prevention and reduction of heavy agricultural and industrial machineries traffics A_{27}– Create living and non living wind break for soil conservation A_{28}– Improvement of soil texture – Development of sustainable agriculture A_{29}– Modification of crop rotation and fallow methods A_{30}– Modification of plowing, fertilization, spraying methods – Development and sustainable management of water resources A_{31}– Modification of ground water harvesting A_{32}– Reduction of water consumption (water optimal consumption in farms) A_{33}– Change of irrigation patterns A_{34}– Changing traditional irrigation systems with low efficiency to modern systems with high efficiency A_{35}– Optimal collecting and harvesting of water resources (including: Rivers isolating, Qanat repairing and dredging, utilization of canals and streams, desalination of salty waters, etc.) A_{36}– Groundwater fed A_{37}– Construction of flood broadcast networks and the use of its alluviums A_{38}– Creation of artificial precipitation to fed aquifers A_{39}– Promotion of greenhouse cultivation A_{40}– Introduction of new plant varieties, resistant to drought and dehydration stress by genetic engineering

Therefore alternatives that have more priority coefficient, it value as best alternative and other alternative is priority respectively.

Results and Discussion

In process of desertification alternatives assessment in study area, at the first, the Delphi method and questionnaire were used to identify the important-preferred criteria and alternatives among 16 criteria and forty-offered de-desertification alternatives according to group (Tables 4, 5 and 6). Then, they were taken to establish hierarchical decision making graphs (Fig. 2) and design a pirewise comparisons questionnaire.

Table5. The offering criteria and their importance mean according to group

Code	C_1	C_2	C_3	C_4	C_5	C_6
Criteria	Expenses - Benefits	Time	Participation of local communities	Beauty of landscape	Access to the technologies and scientific methods and devices	Access to the related experts
Average values	5.38	7.1	5.78	5.1	7.1	7.53
Code	C_7	C_8	C_9	C_{10}	C_{11}	C_{12}
Criteria	Proportion and adaptation to the environment (sustainability)	Traditional management and local Knowledge	Government authority in de-desertification projects	Oil incomes of government	Temporary management of projects	The problems resulted from innovation and method changes
Average values	8.15	5.23	5.28	5.72	2.39	2.84
Code	C_{13}	C_{14}	C_{15}	C_{16}		
Criteria	Indolence State Administrative Systems	Political and social pressures	Emergency issues related to desertification occurrence	Destruction of resources, human and social damages		
Average values	2.29	5.35	6.34	7.99		

Table6. The average of alternative priority according to group

Alternative	A_1	A_2	A_3	A_4	A_5	A_6	A_7	A_8	A_9	A_{10}
Average values	5	5.68	5.35	6.7	6.1	6.56	6.47	5.73	5.89	5.6
Alternative	A_{11}	A_{12}	A_{13}	A_{14}	A_{15}	A_{16}	A_{17}	A_{18}	A_{19}	A_{20}
Average values	4.5	5.23	6.86	4.8	5.32	5.27	3.79	7.5	6.44	7.34
Alternative	A_{21}	A_{22}	A_{23}	A_{24}	A_{25}	A_{26}	A_{27}	A_{28}	A_{29}	A_{30}
Average values	6.6	6.46	7.56	6.76	6.45	5.57	6.86	4.66	5.42	5.1
Alternative	A_{31}	A_{32}	A_{33}	A_{34}	A_{35}	A_{36}	A_{37}	A_{38}	A_{39}	A_{40}
Average values	7.24	6.6	7.49	6.53	6.64	6.08	5.3	3.47	6.2	6

After selecting important-preferred criteria and alternatives according to group, the fuzzy delphi method of group pirewise comparisons matrices was used to determine relative weight of criteria and alternatives for achieving the goal of "offering optimal de-desertification alternatives". Here, only fuzzy pirewise comparisons matrices of criteria based on goal of “offering optimal de-desertification alternatives” (Table 7) and group pirewise comparisons matrix of alternatives priority according to criteria of “Time“ are expressed (Table 8). The matrices of alternatives priority to other criteria were designed like Table 8.

Table7. Fuzzy pirewise comparisons matrices of criteria based on goal of “offering optimal de-desertification alternatives”

criteria	C_2	C_5	C_6	C_7	C_{16}	sum
C_2	0,0,0	0.67,076,0.89	0.21,0.49,0.60	0.17,0.3,0.33	0.23,0.32,0.38	2.57,287.32
C_5	1.12,1.31,15	0,0,0	0.54,0.57.60	0.36,0.33,041	0.29,0.33,0.35	3.31,3.6,3.86
C_6	2.56,3.08,4.34	1.66,1.74,1.86	0,0,0	0.34,0.39.0.46	0.35,0.43,0.58	5.01,5.6,6.32
C_7	3.50,3.38,371	2.43,2.55,2.78	2.17,2.55,2.93	0,0,0	0.59,1.24,1.91	9.24,10.72,12.33
C_{16}	2.65,3.08,4.34	2.87,3.07,3.40	1.71,2.33,2.87	0.52,0.81,1.60	0,0,0	8.75,10.29,13.3

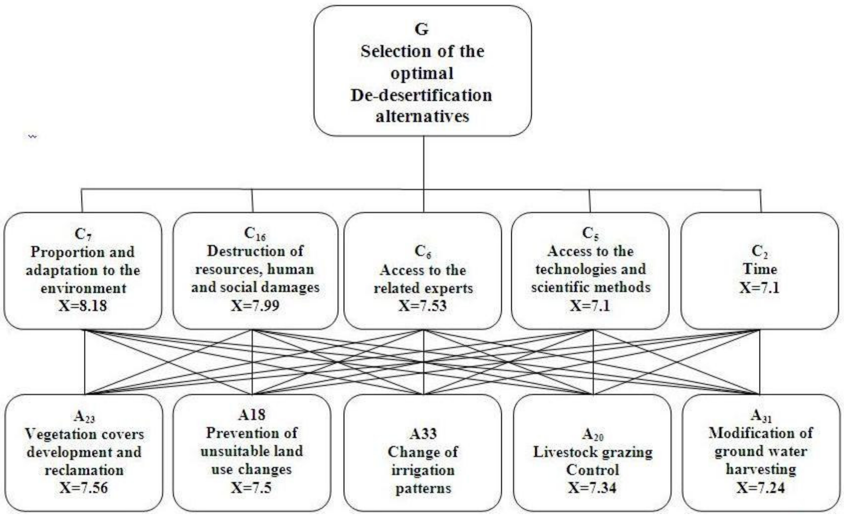

Fig3. Decision making hierarchical graph in order to do fuzzy pirewise compassion in Kezr Abad region

Table8. Fuzzy pirewise comparisons matrices of alternatives priority according to the criteria of "Time "(C_2)

Alternative	A_{18}	A_{20}	A_{23}	A_{31}	A_{33}	sum
A_{18}	0,0,0	1,1.08,1.2	0.54.0.68,0.95	0.78.1.06,1.35	1.08,1.23,1.42	4.4,5.05,5.29
A_{20}	0.83,0.93,1	0,0,0	0.72,0.81,0.92	0.88,1.64,2.24	0.83,1.47,4	4.26,5.85,9.16
A_{23}	1.05,1.46,1.86	1.09,1.23,1.38	0,0,0	1.30,1.39,1.5	1.18,1.34,1.53	5.62.5.42,7.27
A_{31}	0.74,0.94,1.28	0.25.0.61,1.14	0.67,0.72,0.77	0.0.0	0.64,1.09,1.16	3.8,4.36,5.35
A_{33}	0.7,0.81,0.93	0.25,0.68,1.2	0.65,075,0.85	0.86,0.92,10.06	0.0.0	3.46,4.16,5.04

In continue for each row of fuzzy pirewise comparison of matrix value of $\tilde{S}_k$ is calculated by 4 relations that it is synthetic triangle fuzzy number is gain as sample result come from $\tilde{S}_k$ value from table 7 and 8 (Example 1, 2).

Example1. Value of $\tilde{S}_k$ is gained from group pirewise compassions matrix of criteria importance based on goal of "offering optimal de-desertification alternatives in Kherz Abad region"

$$\tilde{S}_2 = (2.57, 2.87, 3.20) \times (0.0346, 0.0302, 0.0256) = (0.089, 0.087, 0.082)$$

$$\tilde{S}_5 = (3.31, 3.60, 3.86) \times (0.0346, 0.0302, 0.0256) = (0.114, 0.109, 0.098)$$

$$\tilde{S}_6 = (5.01, 5.60, 6.32) \times (0.0346, 0.0302, 0.0256) = (0.173, 0.169, 0.162)$$

$$\tilde{S}_7 = (9.24, 10.72, 12.33) \times (0.0346, 0.0302, 0.0256) = (0.320, 0.324, 0.316)$$

$$\tilde{S}_{16} = (8.75, 10.29, 13.3) \times (0.0346, 0.0302, 0.0256) = (0.302, 0.310, 0.340)$$

Example 2. Value of is gained from group pirewise compassions matrix of alternatives priority according to the criteria of "Time "

$$\tilde{S}_{18} = (4.4, 5.05, 5.92)\times(0.0346, 0.0302, 0.0256) = (0.204, 0.195, 0.181)$$
$$\tilde{S}_{20} = (4.26, 5.85, 9.16)\times(0.0346, 0.0302, 0.0256) = (0.198, 0.216, 0.279)$$
$$\tilde{S}_{23} = (5.62, 6.42, 7.27)\times(0.0346, 0.0302, 0.0256) = (0.261, 0.248, 0.222)$$
$$\tilde{S}_{31} = (3.8, 4.36, 5.35)\times(0.0346, 0.0302, 0.0256) = (0.176, 0.168, 0.163)$$
$$\tilde{S}_{33} = (3.46, 4.16, 5.04)\times(0.0346, 0.0302, 0.0256) = (0.161, 0.160, 0.154)$$

Now according to gained value of $\tilde{S}_k$ for each fuzzy group pirewise compassions matrix, compared of value each synthetic triangle fuzzy number ($\tilde{S}_k$) relation to each other from relation (5). And high degree of the was estimate in continue higher degree of any synthetic triangle fuzzy number estimated from K=4 synthetic triangle fuzzy number by 4 relations (Example3 ,4)

Example3. Uninformative weights of criteria preferred related to goal of "offering optimal de-desertification alternatives"

$$\min V\left(\tilde{S}_7 \geq \tilde{S}_2, \tilde{S}_5, \tilde{S}_6, \tilde{S}_{10}\right) = (1,1,1,1) \quad = 1$$
$$\min V\left(\tilde{S}_{16} \geq \tilde{S}_2, \tilde{S}_5, \tilde{S}_6, \tilde{S}_7\right) = (1,1,1,0.61) = 0.61$$
$$\min V\left(\tilde{S}_6 \geq \tilde{S}_2, \tilde{S}_5, \tilde{S}_7, \tilde{S}_{16}\right) = (1,1,4.44,-141) = -141$$
$$\min V\left(\tilde{S}_3 \geq \tilde{S}_2, \tilde{S}_6, \tilde{S}_7, \tilde{S}_{16}\right) = (1,5.22,35.67,102) = 1$$
$$\min V\left(\tilde{S}_2 \geq \tilde{S}_5, \tilde{S}_6, \tilde{S}_7, \tilde{S}_{16}\right) = (3.31,10.47,396.66,-67) = -67$$

Example 4. Uninformative weights of alternatives priority related to time criteria

$$\min V\left(\tilde{S}_{18} \geq \tilde{S}_{20}, \tilde{S}_{23}, \tilde{S}_{31}, \tilde{S}_{33}\right) = (-4.25,2.82,1,1) = -4.25$$
$$\min V\left(\tilde{S}_{23} \geq \tilde{S}_{18}, \tilde{S}_{20}, \tilde{S}_{31}, \tilde{S}_{33}\right) = (1,1,1,1) = 1$$
$$\min V\left(\tilde{S}_{33} \geq \tilde{S}_{18}, \tilde{S}_{20}, \tilde{S}_{23}, \tilde{S}_{31}\right) = (3.13,-4,5.35,1.46) = -4$$
$$\min V\left(\tilde{S}_{20} \geq \tilde{S}_{18}, \tilde{S}_{23}, \tilde{S}_{31}, \tilde{S}_{33}\right) = (1,0.36,1,1) = 0.36$$
$$\min V\left(\tilde{S}_{31} \geq \tilde{S}_{18}, \tilde{S}_{20}, \tilde{S}_{23}, \tilde{S}_{33}\right) = (-30,-2.69,-5.44,1) = -30$$

After reach to uninformative weights, these weights were normative from relation 7 and gained of criteria preferred and alternatives priority from group viewpoint.(example 5,6)

Example5. Normative weights of criteria preferred related to goal of "offering optimal de-desertification alternatives"

$$P_{\tilde{S}_k} = (0.326,\ -0.00296,\ 0.686, -0/0048, -0.00296)$$

Example6. Normative weights of alternatives priority related to time criteria

$$P_{\tilde{S}_k} = (0.115,\ -0.00976, -0.027, 0.813, 0.108)$$

At end with estimation of all Normative weights of criteria related to goal and alternatives related to each criteria, in general form of matrix decision making in FAHP (table3), fuzzy decision making matrix of optimal de-desertification alternatives from group viewpoint were formed like Table 9

Table9. fuzzy decision making matrix of optimal de-desertification alternatives from group viewpoint

Criteria importance (C) ► Alternatives priority (A) ▼	C_2 0.326	C_5 -0.00296	C_6 0.686	C_7 -0.0048	C_{16} -0.00296	$\bar{P}i$
A_{18}	0.115	-0.035	-0.299	-0.11	0.186	0.018
A_{20}	0.0098	0.768	0.075	-0.172	0.177	0.052
A_{23}	-0.027	-0.035	-0.0299	0.051	0.186	0.030
A_{31}	0.813	0.279	0.972	0.209	0.076	0.93
A_{33}	0.108	0.023	0.0125	0.102	0.373	0.038

After establishment of fuzzy decision making matrix in order to final chose of alternatives and degreasing of their priority, synthesis process on the weights these matrix by using harmonic mean method or average of each level of normalized matrix (relation11) and final alternatives ranking was obtained.

In base of result from alternative research process, Adjustment in use of underground water resources (A_{31}) with preference degree of 0.93 is more important alternative in control and decrease effects of desertification and reclamation of destructed ground in base of collect of criteria in studied area.

During performed studied, note that watershed of yazd- ardakan desert that is one studied part of it have unsuitable water budget and with fractional of budget equal to $187\times10^7 m^3$ and this in time that studied area much from highland and bar pediment in southern area that have lower desertification and sensitivity got covered pediment and playa that have more sensitivity related to desertification, decrease of underground water level is more that at least additional water is harvest. That have effective role in increase process of desertification of grounds so that during done estimation, average decrease of underground water level in southern area 30 cm in year and in northern area each to 45 cm.

drawdown of ground water resource in result factors in studied area has accrued that in order to reach optimal result with more assured that in order to reach optimal result with more assurance coefficient in order to control of desertification is necessary to be attention that we can indicate territorial irrigation method with low yield and consume more water(73.8 percent of farmers use traditional irrigation systems) ,increase of cultivation cooperative and increase of depth well drilling, existence of open pit and stream with high permeability and low efficiency(efficiency less than 40 percent, because 77 percent of irrigation networks is without vegetation cover) extent of farming lands (On average less than 10 acres to each farmer). increase of industry with high use of water such as sand and dyeing and weaving industry, increase of harvest in result of that well have engines, unsuitable dimension of harts, increase of harvest in order to watering of cultivated area with Haloxylon spaces that it has develop in recent years in order to control windy erosion in clay grounds and sandy dune and so on.

Conclusion

The Results of FAHP show that among sixteen effective criteria in presentation of alternatives and fourthly suggested alternatives in order to control and decrease deserting phenomena of grounds in studied areas, only the alternative "Adjustment in use of underground water resources (A_{31})" with preference degree of 0.93 is more important alternative of de-desertification in studied area. and other them play unimportant role in control and decrease this phenomena, therefore with focus on this alternative can perform this act in from of effective and controlling measurement .

From other hand, results of this research show efficiency of FAHP model in presentation of optimal alternatives in control and decrease of desertification phenomena and reclamation of destructed grounds. Results from this research give this possibility to manager of desert that use equipment and limited capitals that specialize in order to control of desertification method in efficiency and correct ways and it can with this prevent from wasting of national capitals.

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