Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Vol 3 Spl Issue III 2014: 118-125

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD
Global Impact Factor 0.533
Universal Impact Factor 0.9804

Full Length Article

Fractional Management of Watersheds by Using the ANP, Study Case: The Basin Of Khanzenyoon in Fars

Ali Asghar Bazrafkan*[1] and Ali Salehpour[2]
[1] M.sc Student of Watershed Management Department, university of Yazd, Iran
[2] M.sc Student of Rangeland Ecology, ARSENJAN University of Technology Natural Resources College.

ABSTRACT
When the number of alternatives and criteria is high, human mind will not be able to prioritize them. So, an Analytical Network planning techniques (ANP) are suitable for solving such problems. In this study, it has been tried to represent appropriate strategies and approaches to improve water resources management systems and to increase the employment rate of those get. In analytical network method, at the outset, clusters were determined at the base of the criteria, and then questionnaires were designed at the base of DEMATEL model, and the type of relation between elements and clusters has been examined by using EXCELL and MATLAB software packages. Then, 3 clouds of weight, non-weight and limited matrixes were formed, and the strategies were prioritized. The results show that the strategy of developing low-irrigation methods for using of irrigated agriculture, the strategies of plowing perpendicular to the slope and changing cropping pattern of cereals to the other crops for using of dry-land agriculture, the strategies of low-irrigation and pressure methods and cultivating species being resistant to cold, drought and salinity for using of garden lands and the strategy of using biological approaches (planting, cutting, working-hill) for pasture were selected as the best option.
Key words: watersheds management, decision making, prioritizing, hierarchical analysis, ANP, khanzenyoon

Received 29.03.2014 Revised 13.05.2014 Accepted 10.06. 2014

INTRODUCTION

In the matters of all-round management of watersheds at different usages, managers and decision makers usually meet some strategies and indexes or criteria to evaluate them, and one of the most important challenges of managers is to choose the best and most appropriate strategies and/or to prioritize them being at the base of criteria which have been defined. When the number of alternatives and criteria is high, human mind will not be able to prioritize them. Hereon, multi-criteria decision making approach is suitable to solve such problems [15].

Alipour and Malekian (2012), by examining the role of people's cooperation at watersheds projects, have concluded that the participation of watershed managers and exploiters seems to be essential and unavoidable in watersheds and natural sources plans at watershed basin.

In the study with topic of bases and principals of integrated management approach of watersheds basin, Payamani and Veiskarami (2012) consider to participatory and integrated concepts of watershed basin management. They believe that public participation has a determinative role in watershed projects.

Samadi et al. (2012) have used hierarchical technique towards overall management of watersheds in Zanjan, so that, they have at first chosen several options for solving these problems, such as mechanical operations (constructing delayed structures, increasing roughness coefficient of passage of flood in the upstream catchment, decreasing roughness coefficient along with cleaning the passage of flood), biological operations (planting, cutting, working-hill), development and service operations (constructing fuel station, communication lines and entertainment centers). At next stage, 4 criteria, expenditure, soil protection, implementation facility and flood decrease, have been purposed for choosing the best option. Thus, according to the opinions of different natural resources and administrative experts, it is attempted to evaluate options through comparative matrix that finally, after calculating, expenditure and biological operations have been introduced as the most important criterion and the first priority, respectively.

Fazel Beigi (2010) ascribes that protection, reconstruction and improvement of watersheds are essential to achieve development purpose in his article named examination on the role of native knowledge in

permanency rural development. Also, he knows that one of the strategies of watershed improvement is to use native traditional knowledge of every region that match with ecosystem though gradual appearance and holism which can be a great step in order to environment protection.

In ANP, Faraji Sabokbar (2007) used analysis network process model of locating sanitary interment location of rural trash in Ghoochan. In his study, he has applied several criteria (social, economical, environmental and technical) for choosing the appropriate location to bury trash. Distinguish process of proper units have been used at several steps for burying trash that final conclusion is determination of proper units to bury trash. Results show final location has been determined as a bad which are mainly on fertile and high penetrable plains, and good regions mostly locate in hills where have high soil diameter, and are good agriculture fields and population center.

Khalghi (2002) has applied MCDM method in order to control flood in watershed of Kan River in west-north of Tehran. Results illustrate that this method can effectively be applied in such projects, and accordingly, it is prevented from frustrated expenditure in sub-catchment being at lower priority.

In the study of Reimale watershed locating in Lorestan, Rostamizad et al (2008) used several options including mechanical operations (Gabion and Chkdm, construction of earth dam), biological operations (planting, cutting and ...) and integrated operation at the base of AHP approach for solving problem or problems of region, then they presented 4 criteria consisting expenditure, soil protection, agricultural and bestial productions and flood decrease, to choose the best option, thus, according to the viewpoints of different administrative and university experts, options were assessed through the paired comparison matrix, and after calculating, expenditure and biological operations have been introduced as the most important criterion and the first priority, respectively.

Wolfslehner et al. [10] have represented program of European Forest Management in study named ANP application in multi-index analyses of forest proper management. He has used AHP and ANP approaches for 4 options comparison of management at one cluster with 6 indexes and 43 criteria. He has discussed the difference of ANP and AHP assessments as blind and strength spots of both. Final conclusion of his study showed that needs and requests will be applied to successful applied programs in forestry content in the future.

MATERIAL AND METHODS

The study area:

The study area is Khanzenyoon watershed basin where has been located at 35 KM from Shiraz and the south of Kheir Abad village. Features of this area are as follows (Dehno Ghalandari):

Study range of Dehno Ghalandari allocates at west of Fars's province, west-north of Shiraz, in 52 8' – 52 15' eastern median longitude and 29 40' – 29 45' northern latitude. Also, this area is a part of Arzhan and Khanzenyoon village. The maximum height of scope is 2845 meters and the minimum height is 1939 meters. Rainfall average of this area is 660 mm.

Analytical Network Process (ANP)

ANP is one of the decision making multi-criteria techniques presented by MR Saati in order to represent a solution for a kind of multi-criteria decision making questions which in exist reciprocal relations and correlations at decision making levels (aim, decision making criteria, its sub-criterion and alternatives). Analytical network process is expanding of AHP or Analytical Hierarchical Planning approaches [13]. In 1980, AHP has been represented by MR Saati for solving multi-criteria decision making questions. Basic hypothesis of this technique is that relations are hierarchical and unilateral among decision making levels. It means that each decision making level only depends on upper level [12]. But, some multi-criteria decision making questions cannot be regarded as a hierarchical structure because of internal and external relations and transactions among elements of clusters at decision making levels.

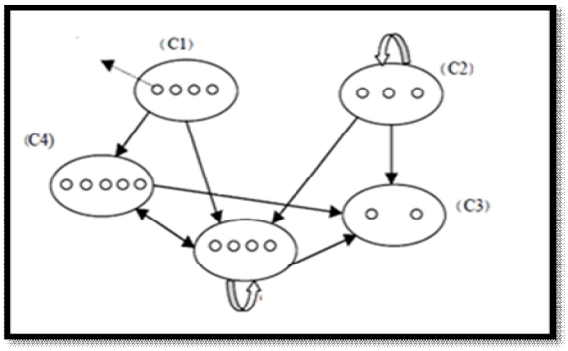

Chart 1: Internal and External Relation among Elements

Thus, ANP approach can consider to all transactions and relations between decision making levels which constitute a network structure (13). Clusters define decision making levels, and show direct lines or arches of transactions among decision making levels. It distinguishes the relations to arches, and loops show the internal correlation of elements of each cluster. In ANP approach, super matrix is used for showing the correlations and transactions among decision making levels, determining the relative importance of criteria and prioritizing the alternatives of decision making question. In fact, one super matrix is a partitioned matrix which in each matrix shows the relation of two loops (decision making level) in total of decision making question (12). The standard form of a super matrix can be seen as follows which has been introduced by MR Saati in 1996 that C and e expresses loops and inter-loops elements, respectively. In matrix, vectors W are weight vectors get from paired comparisons of loops elements with each other.

$$W = \begin{array}{c} \\ C_1 \\ C_2 \\ C_3 \end{array} \begin{array}{c} \begin{array}{cccc} C_1 & C_2 & \cdots\cdots & C_n \\ e_{11}e_{12}\ldots e_{1m1} & e_{21}e_{22}\ldots e_{2m2} & & e_{a1}e_{a2}\ldots e_{amn} \end{array} \\ \begin{pmatrix} W_{11} & W_{12} & \cdots\cdots & W_{1n} \\ W_{21} & W_{22} & \cdots\cdots & W_{2n} \\ W_{n1} & W_{n2} & \cdots\cdots & W_{nn} \end{pmatrix} \end{array}$$

All relations and transactions being between elements of decision making levels become evaluated through paired comparisons in super matrix method. But, when we enter the paired comparisons done, sum of the columns become more than one that it is named non-weighted super matrix. Weight super matrix is attained by multiplying the weight of each cluster in corresponding elements with them. Finally, super matrix should be calculated for obtaining final weight of alternatives of question and decision making criteria of question resolution (12). By using probability matrix and Markov chains, Saati illustrates that final weight of element is obtained as follows (1):

$$W = \lim_{K \to \infty} W^{2K+1} \qquad (1)$$

Also in ANP, incompatibility rate is calculated according to the formula represented by Saati. According to him, if the value of incompatibility is less than 0.1, we can trust to the paired comparisons data (14).

$$C = \sum_{\substack{\text{control} \\ \text{criteria}}} K_c \sum_{\substack{\text{all} \\ \text{chains}}} \left(\sum_{j=1}^{h} \sum_{i=1}^{m_{j+1}} w_{ij} \mu_{ij+1} \right) + \sum_{\substack{\text{control} \\ \text{criteria}}} K_c \sum_{k=1}^{s} \sum_{j=1}^{n_k} w_{ik} \sum_{h=1}^{|c_h|} w_{(k)(h)} \mu_k(j,h) \qquad (2)$$

N_i is the number of element level I of hierarchy and J=1,2,...,h is the number of hierarchy levels. W_i is a weight of criterion I, $n_{i,j+1}$ is the number of elements in j+1 level of hierarchy which have became the paired comparison in relation with I criterion of I level of hierarchy, $\mu_{i,j+1}$ is the incompatibility rate of elements in j+1 level of hierarchy which have became the paired comparison in relation with I criterion of I level of hierarchy, C_s is a incompatibility rate of all network, K_c is the weight of control criterion or control hierarchy, n_i is a number of element in I cluster which has became the paired comparison related to criterion, $W_{(k)(h)}$ is a weight priority of effectiveness in H cluster on K cluster, W_{jk} is a limited priority (limited weight) of I element in K cluster and $\mu_{(j,h)k}$ is a incompatibility rate of elements of H cluster which have became paired comparison about their effectiveness on J criterion of K cluster.

In this research, super decision software used in order to implement ANP model. At the outset, general information of the studied scope was taken from Fars watershed and national resources department, and general view of area is obtained to technical experts who mostly were professor and experts of watershed and national resources department and local and native experts. At the next step, the most important criteria and strategies in each user is determined at the base of the ideas of experts and by inspiring from Delphi method, and finally, the questionnaires were codified. At the next step, at first, the number of questionnaires was extracted at the base of Michael and Carson relation for supplementing the questionnaires. The base of Michael and Carson relation is the error percent (Ghorbani). Regarding to decision making done about all users, so, error percent was 15%. 37 questionnaires were made and codified, then for completing the questionnaires, people asked were sit at two groups, university experts

(experts of Fars watershed and national resources department who was familiar with the region) and native experts (people lived in that watershed ad were more than 45 years old), and study method, the way of supplementing questionnaires and study purposes were clarified for each person. After completing the questionnaires, data was analyzed. According to MR Satti's suggestion, weight average method was used in order to obtain the general results of questionnaires. EXCELL Software was used to do this purpose. Thus, raw data of the paired comparisons model was get.

At the next stage, results of analyzing the questionnaires have used in super decision software, so that at the outset, 4 general clusters: 1- alternatives (consisting options and alternative strategies), technical cluster (consisting criterion of loan resources), economical cluster (including the criterion of the value of governmental support) and social cluster (including criteria of public cooperation and ability of teaching and learning) were deducted for each user at the base of purpose and subject. At the next stage, according to the results, DEMATEL model of relations among elements used at the base of results and Matlab software was applied for this purpose. At final stage, the results of paired comparisons between elements and options were exerted in software, and super matrixes were calculated, and priority was extracted about each user at the base of ANP model.

RESULTS

At the beginning, the most important strategies, criteria and clusters were specified and chosen for each user according to expert viewpoints. Situation of clustering of each user has been showed in figure 1 to 4.

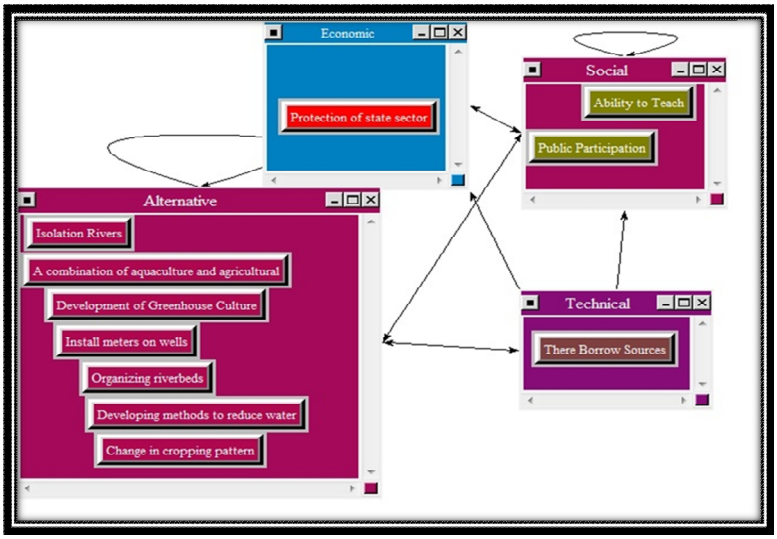

Figure 1: Determination of clusters and elements about irrigated agriculture at the base of ANP model in Khanzenyoon basin

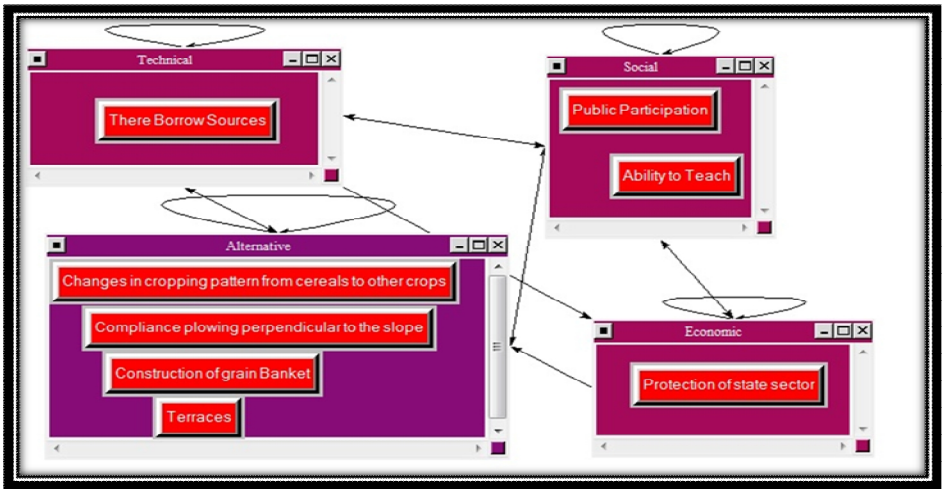

Figure 2: Determination of clusters and elements about Dry land agriculture at the base of ANP model in Khanzenyoon basin

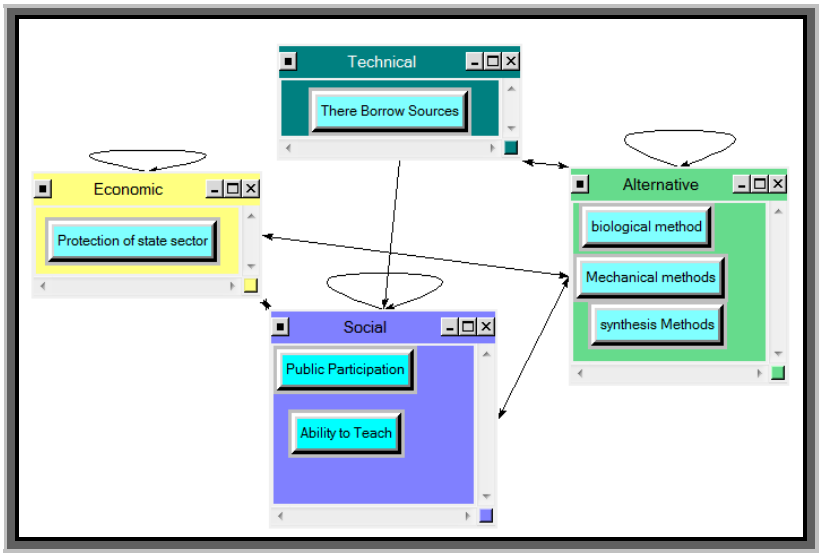

Figure 3: Determination of clusters and elements about pasture at the base of ANP model in Khanzenyoon basin

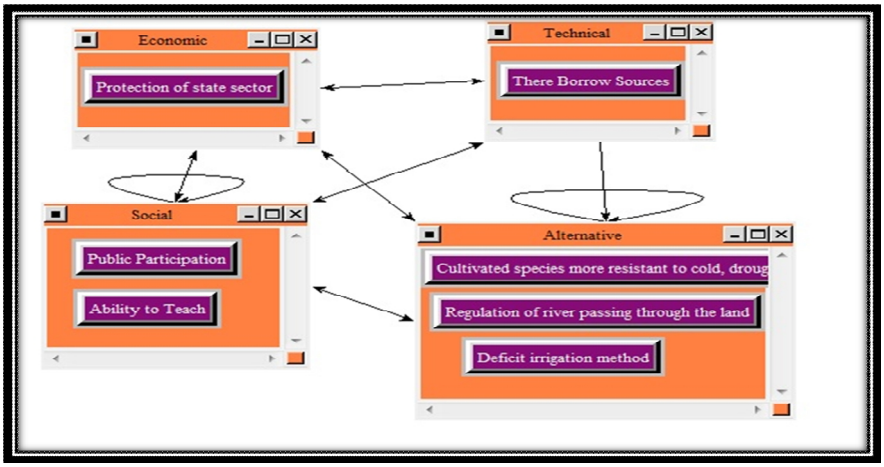

Figure 4: Determination of clusters and elements about garden at the base of ANP model in Khanzenyoon basin

In general, 4 criteria were sat in 3 clusters of criterion and one cluster of alternative relative to strategies existed in each using. Then, by using super decision, EXCELL and MATLAB software, the final weight of each element was obtained. First, the existence or inexistence of relation among elements was determined by using DEMATEL model. The results of DEMATEL model being about approaches and elements at basin have been represented in tables 1 to 4. As it is clear, the type of relation has been shown in the form of 0 and 1 in this model, so that, cells having number 0 show the inexistence and the cells having number 1 show the existence of relation between the desired element and element of its column.

Table 1 : matrix of relation among elements existing in the part of irrigated agriculture at the base of DEMATEL model

	A	B	C	D	E	F	G	H	I	J	K
A	0	1	1	0	1	1	1	0	1	0	1
B	1	1	1	0	1	1	1	0	1	0	1
C	1	1	0	0	1	0	1	0	1	0	1
D	1	1	1	0	1	0	1	0	1	0	1
E	0	1	0	1	0	1	1	0	1	0	1
F	0	1	0	0	0	0	1	0	1	0	1
G	0	1	0	0	0	0	0	1	1	0	1
H	0	0	0	0	0	0	0	0	0	0	0
I	1	1	1	0	1	0	1	0	1	0	1
J	0	0	0	1	0	0	0	1	0	0	0
K	1	1	0	0	1	0	1	0	1	0	0

A: Governmental support, B: public participation, C: Education Capability, D: Credit Resources, E: Development of Greenhouse Culture, F: Installation of Meters on Wells, G: Change of Cropping Pattern, H: Isolation of Rivers, I: Development of Low-Irrigation methods, J: Regulation of River passing through Farm lands and K: integration of Aquaculture and agriculture

Table 2 : matrix of relation among elements existing in the part of dry land agriculture at the base of DEMATEL model

	A	B	C	D	E	F	G	H
A	0	1	1	0	0	0	0	0
B	0	0	0	0	0	1	0	0
C	1	1	0	1	0	0	0	0
D	1	1	1	0	0	1	0	0
E	1	1	1	1	0	1	1	0
F	1	1	1	1	1	0	1	0
G	0	1	1	0	0	0	0	0
H	0	1	1	1	0	0	0	0

A: perpendicular plowing to the slope, B: Change of cropping pattern, C: Grain Bank, D: Tracing, E: Governmental Support, F: Public Participation, Education Capability, H: Credit resources

Table 3 : matrix of relation among elements existing in the part of garden at the base of DEMATEL model

	A	B	C	D	E	F	G
A	0	1	0	0	0	1	0
B	1	1	1	0	1	1	1
C	0	0	0	0	0	0	0
D	1	1	1	0	1	1	1
E	1	1	0	0	0	1	0
F	1	0	0	0	0	0	0
G	1	1	0	0	1	1	0

A: Governmental support, B: public participation, C: Education Capability, D: Credit Resources, E: Cultivation of Varieties being resistance to Heat, Drought and Salinity, F:Using of Low-irrigation Methods, G: Regulation of River passing through Gardens

Table 4 : matrix of relation among elements existing in the part of Pasture at the base of DEMATEL model

	A	B	C	D	E	F	G
A	1	1	1	0	1	0	1
B	0	1	1	1	1	1	0
C	1	1	1	0	1	0	1
D	1	1	1	1	1	1	0
E	1	1	1	1	1	0	0
F	0	0	0	0	0	0	1
G	1	1	1	1	1	0	0

A: Integrated Methods, B: Mechanical Methods, C: Biological Method Governmental support, B: public participation, C: Education Capability, D: Credit Resources s,

After determining the kind of relation among elements, The final weight of each option was extracted, and proper approach was chosen. in Figures 5 to 8, The graphical results of the most suitable element have been represented in different usages with ANP model in watershed basins.

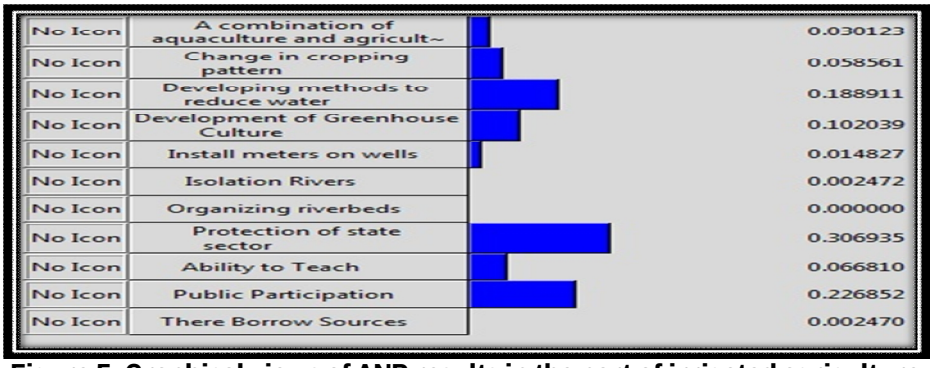

Figure 5: Graphical views of ANP results in the part of irrigated agriculture

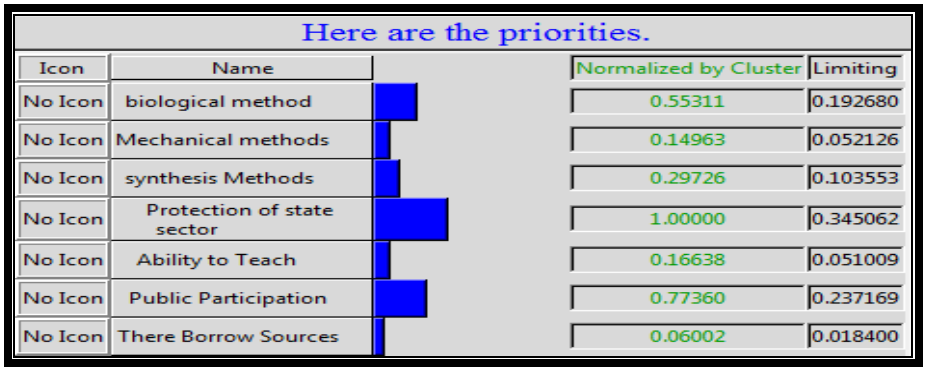

Figure 6: Graphical views of ANP results in the part of dry land agriculture

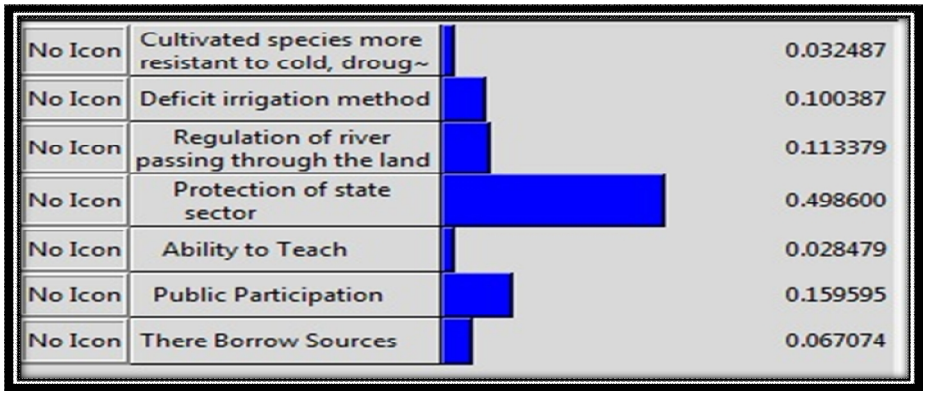

Figure 7: Graphical views of ANP results in the part of garden lands

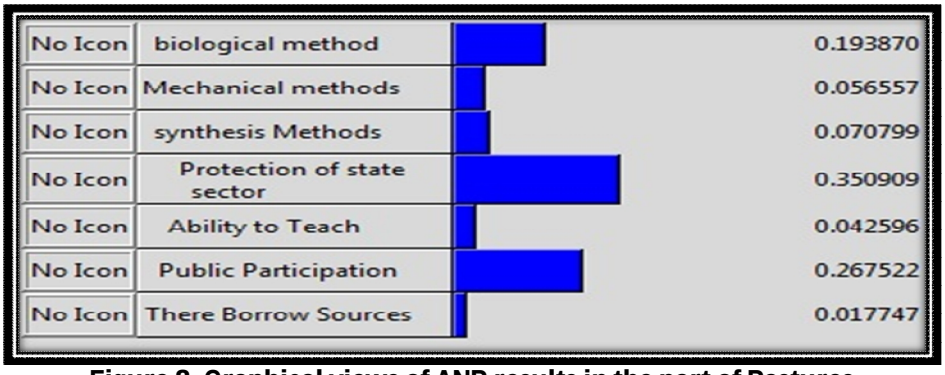

Figure 8: Graphical views of ANP results in the part of Pastures

DISCUSSION AND CONCLUSION

Choosing the best option and rating the plans of watershed management are very important in different usages. Uncertainty in some parameters, purposes and multiple criteria and the multiplicity of decision makers make this problem more complicated. There are different models for solving such problems, and the choice, assessment and priority of various options of watershed management plans have been developed such as, structural and non-structural methods. In general, these models are divided into 2 main categories:

A) Multi - Object Models (MODM)

B) Multi – Criteria Models (MADM)

Different methods have been developed at the base of general concepts of these models, that it can be referred to reparative and non-reparative methods which have been multi-criteria models. Among various kinds of multi-criteria decision making methods, analytical network approach is one of the most famous and strongest methods which can be used for multi-criteria decision making, management and engineering complex plans. In this study, 4 management criteria of watershed included 3 clusters, technical, economical and social clusters have been regarded with several strategies according to different usages existed at scope for choosing and prioritizing methods. In analyzing the network, elements were arranged in clusters at the base of subject, and then, clusters, elements and options were compared with each other. Finally, regarding to final weights extracted from ANP model, development of greenhouse cultivation and low-irrigation methods about agriculture usage, strategies of staple plowing towards slope, changing cropping pattern of grains to other crops about dry land agriculture usage, strategies of low irrigation methods, cultivating varieties being resistance to cold, drought and salinity about pasture usage have been chosen as the best option and support criteria of government, and education capabilities have been chosen as a more important criteria in all users. Furthermore, following matters are represented as the research findings in comparison with findings of other research:

- In all usages, governmental support criterion defining the expenditure of projects implementation has been chosen s the most important criteria that this finding is consistence with findings of Rostamizad et al. and Samadi.
- The criterion of the value of public participation is numerated as the most important criterion in implementing watershed projects in various usages, and if independent validity is not conducted for public participation project and there is not enough coordination among various administrative devices in the ministries of Agriculture jihad and out of that, the possibility of implementing proper administrative activities wont be appeared. These findings are consistence with findings of Payamani and Veiskarami [1] and Alipour and Malekian [6].
- In this method, several ANP methods ere used as a important and appropriate criterion for subject regarding to the feature of being network, and the process of determining important elements and strategies have been done during several stages at the base of DEMATEL. This finding is consistence with finding of Faraji Sabokbar [8].

REFERENCES

1. Payamani K. and Veiskarami, M., 2012. Bases and Principals of Integrated Management Approach of Watershed area, set of articles of 8th national seminar of watershed sciences and engineering
2. Kholghi, M., 2002. , Procedure application, MCDM for flood structural Control in prioritization of Sub-area, the journal of pastures and watersheds, Volume 55, number 4, 479-491
3. Rostamizad Gh., Jaliliyan H., Ozhan M. 2008. AHP, a Strategy towards Comprehensive watershed management, 3th Conference of Iran water resources management
4. Cooperative Company of Dehno Ghalandari, 2011, Detailed and administrative report of Dehno Ghalandari's Area, First and second Volume, 320
5. Samadi H., Ghashlaghchai M. and Ghasemi, M. 2012, using of hierarchical Analysis Technique towards comprehensive watershed management (Study case: Watershed area in Ghidar City in Zanjan), set of articles of 8th national seminar of watershed sciences and engineering
6. Alipour H., and Malekian A. 2012. the role of public participation in watersheds projects of Ivar watershed area, set of articles of 8th national seminar of watershed sciences and engineering
7. Fazel Beig. M., 2010. Examination on Native knowledge of watersheds at rural sustainable development, Rural development's Magazine, number 4, 14-25
8. Faraji Sabokbar H., 2007. Location of Sanitarian Burying of rural trashes through using ANP (Study Case: Rural Areas of Ghoochan), Rural development's Magazine, number 5, 10-21
9. Ghorbani M., and Zare A. 2008. An introduction of Environment Valuation, Publication of Mashhad Ferdosi University