Prioritizing Crecive Plant Species in Choghart Iron Mine Desert Region (Used method: Fuzzy AHP)

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Abstract: Mining operations as an activity have an important role in environmental changes. In addition to, it is possible to decrease the loss is inflicted to environment using of novel technologies. Mine reclamation is the most important plan to restore the mining lands to its initial state and then the region be reclaim by different methods. One of the most essential reclamation operations is implanting of vegetation. The Choghart Iron ore mine is located in the desert area of Bafgh city from Yazd province of Iran. Seven different criteria are considered for selecting of appropriate plants for implanting in this area, which plants are harmonized with type of post-mining land-use, climate condition and the region soil. Then it has been prioritized among the various plants, by Fuzzy AHP method, and finally, palm and tamarisk were selected as the best cover crop. Species of eucalyptus and pine are suitable too.

Key words: Mine reclamation, Choghart iron ore mine, Fuzzy AHP, Cover crop, Tamarisk, Palm.

INTRODUCTION

The revival of plant covering in the destructed areas could be having prodigious influence on decrease erosion and the destruction of areas. Plants are affected on the soil and are caused physical and chemical changes in soil (Tavili., 2010). Generally can say that the preservation of properties and nutritious material resources in the soil intensively is depended on plant covering (Belsky and Canham, 1994). Mining operations have an important role in environmental variations, in addition to basically exploitation of them, by using of novel technologies, it is possible to decrease the inflicted damages to environment and restrict it. Mine reclamation is very important case in tow aspects in region:

i) The decrease in the pollution and the creation of suitable lands for growing and breeding plant and animal species.

ii) The creation of prospect and fitting perspective for the mine reclamation and the subsequent utilization of the impacted lands and environmental area preservation, one of the important stages is the choosing and planting of plant species (Xia, et al., 2007). The selected plants should be resistant against the adverse conditions of mine waste and mining regional soil, because the parameters play a basic role in reclamation of mining soil (Haque, et al., 2009). The best pH for plant growth assumed to be 6.5 to 7.5 (Akbari, et al., 2007). Native plant species have the harmony to the environment and with increasing fertilizer and reinforce the growing condition will be better (Redente and Baker., 1996). (Coppin and Bradshaw, 1982; Carrick and Kruger; 2007) have evaluated the factors limiting plant growth on mined soils and mentioned the most serious soil limitations. (Alexander, 1996; Paschke, et al., 2003) have studied the planting impact on the mining (soil and akbari, et al., 2007; soltanmohammadi, et al., 2010) have surveyed the possible utilizations from the post-mining lands by decision making method. (Alavi, et al., 2011) have selected, proper Plant Species for sarcheshmeh Copper Mine Reclamation by fuzzy AHP method. Rasouli reported that in the Tehran- Qom highway road border, with the planting of tamarisk, the quantity of nitrogen, phosphorus, potassium and electric conduction in soil has been increased (Rasouli., 2005). This study was done by fuzzy AHP with the purpose of survey and selection of suitable species for reclamation of Choghart Iron Mine and the reviving of plant coverage and the regional soil.

MATERIAL AND METHODS

Case Study:

Choghart mine is located in 12 km northeast of Bafgh city and 125 km southeast of Yazd city and 75 km of western south of bahabad and the border of Dore-anjir Desert. Bafgh have very hot summers, which average
rainfall is 53 mm. The average relative humidity is very low. Desired plants should be compatible with this deserted dry climate. In this area iron, sulfur, phosphorus and salt in the soil are high (Kasmaee, 2010).

**Research Methodology:**

The selection of plant species is one of the important steps for reclamation. Plant types selecting, is one of the major steps in achieving to the goals of reclamation project. Superior plant type selection in every reclamation program, have the many benefits which contains: health protection and environment restoring, preparing suitable perspective for the region, economic benefits, the welfare for local people, pollution reduction of soil and water and air, protection of underground water supply, prevention of soil erosion (Bangian and Osanloo, 2008). Effective factors upon selecting of plant species include two groups of considerations. First group which are called as primary factors (Type of post mining land use, Regional climate condition, Local soil nature) play main role to select the consistent species with the condition of application that basis on their, were selected A1.eucalyptus, A2.palm, A3.pine and A4.tamarisk. Secondary factors (criteria) play side role to evaluate and define priorities of the alternatives which have consistency with primary factors (Osanloo, 2001). Secondary factors are: Perspective of the region, resistance against disease and insects, strength and method of growth, availability to plant type, economic efficiency, Protection of soil and storing water, prevention from pollution (Alavi et al, 2011). In this step, firstly questionnaires forms were provided according to the expert and decision-maker oral opinion and qualitative judgments. Then matrixes are provided by the help of table 1. The second factors are the same criteria, are compared pair-wise to each other respect to goal. Also, the selected species in the first stage to respect the each criterion have been compared with each other by the fuzzy AHP method and then they will be prioritized and then their relative weights was estimated with respect to their criterion. Then with the conflation of relative weights, the final weight for each plant species was determined. The conversions of linguistic comparative important coefficient to fuzzy triangular absolute number are appeared in the following table (Alavi et al, 2011).

<table>
<thead>
<tr>
<th>linguistic variable</th>
<th>fuzzy number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,2,3</td>
<td>Very low</td>
</tr>
<tr>
<td>2,3,5</td>
<td>Low</td>
</tr>
<tr>
<td>3,5,7</td>
<td>Medium</td>
</tr>
<tr>
<td>5,7,9</td>
<td>High</td>
</tr>
<tr>
<td>7,9,9</td>
<td>Very high</td>
</tr>
</tbody>
</table>

**Fuzzy AHP Method:**

The theory of fuzzy provides a suitable condition for reasoning, deduction, control and making decision especially in the vague conditions and it converts the quality judgment to quantitative number. Chang introduced a new approach for handling fuzzy AHP with the use of triangular fuzzy numbers for pair-wise comparison scale of fuzzy AHP, and the use of the extent analysis method for the synthetic extent values of the pair-wise comparisons (Chang, 1996). This method is done by hierarchical tree structure. The stage of the fuzzy AHP method is presented as the following (Alavi et al, 2011):

1- Making hierarchy
2- Making comparison dual matrix
3- Determination any matrix relative weight
   Step 1: The value of fuzzy synthetic extent with respect to the object is defined as:
   
   \[ S_i = \sum_{j=1}^{n} M_{gi}^{j} \otimes \left( \sum_{j=1}^{n} \sum_{i=1}^{m} M_{gi}^{j} \right)^{-1} \]  
   (1)

   To obtain \[ \sum_{j=1}^{m} M_{gi}^{j} \], the fuzzy addition operation of extent analysis values for a particular matrix is performed such as:

   \[ \sum_{j=1}^{m} M_{gi}^{j} = (\Sigma_{j=1}^{m} l_{ij}, \Sigma_{j=1}^{m} m_{ij}, \Sigma_{j=1}^{m} u_{ij}) \]  
   (2)
and to obtain \[
\left[ \sum_{i=1}^{n} \sum_{j=1}^{m} M_{g}^{j} \right]^{-1},
\]
the fuzzy addition operation of \( M_{g}^{j} \), (\( j=1,2,...,m \)) values is performed such as:

\[
\sum_{i=1}^{n} \sum_{j=1}^{m} M_{g}^{j} = (\sum_{i=1}^{n} l_{i}, \sum_{i=1}^{n} m_{i}, \sum_{i=1}^{n} u_{i})
\]

(3)

And then the inverse of the vector above is computed, such as:

\[
\left[ \sum_{i=1}^{n} \sum_{j=1}^{m} M_{g}^{j} \right]^{-1} = (1/\sum_{i=1}^{n} u_{i}, 1/\sum_{i=1}^{n} m_{i}, 1/\sum_{i=1}^{n} l_{i})
\]

(4)

Step 2: As \( M_{1}= (l_{1}, m_{1}, u_{1}) \) and \( M_{2}= (l_{2}, m_{2}, u_{2}) \) are two triangular fuzzy numbers, the degree of possibility of \( M_{2}= (l_{2}, m_{2}, u_{2}) \geq M_{1}= (l_{1}, m_{1}, u_{1}) \) is defined as:

\[
(M_{2} \geq M_{1}) = \begin{cases} 
1 & \text{IF } m_{2} \geq m_{1} \\
0 & \text{IF } l_{1} \geq u_{2} \\
1-u_{2}/(m_{2}-u_{2})-(m_{1}-l_{1}) & \text{for } l_{1} < u_{2} \text{ and } m_{1} > m_{2}
\end{cases}
\]

(5)

Step 3: for \( k=1, 2, ..., n; k \neq i \) and \( A_{i}= (i=1, 2,... n) \) are \( n \) elements, the weight vector is given by:

\[
d'(A_{i}) = \min V(S_{1} \geq S_{2})
\]

(6)

Step 4: Via normalization, the normalized weight vectors are:

\[
W' = (d'(A_{1}), d'(A_{2}), ..., d'(A_{n}))^{T}
\]

(7)

4- Determination alternatives final weight

\( A_{1}= (A_{1} \times C_{1} \times C_{1} \times \text{GOAL}) + (A_{1} \times C_{2} \times C_{2} \times \text{GOAL}) + (A_{1} \times C_{3} \times C_{3} \times \text{GOAL}) \ldots \ldots + (A_{1} \times C_{n} \times C_{n} \times \text{GOAL}) \)

\( n \) is the number of criteria

Results:

At first, with respect to the numbers of criteria, one questionnaire form and comparative matrix among the criteria respect to the goal, and then seven questionnaire forms and comparative matrices among the alternative respect to each criterion have been provided. For example, in the table 2 and 3 is presented the questionnaire form and matrix which is related to the pair-wise comparison of alternative respect to the economic efficiency criterion. The way of calculation of matrix numbers from linguistic variables, is based on that firstly by the using of table 1, in the questionnaire form, the substitution is done and then with fuzzy-division of the triangularity numbers against each other, the pair-wise comparison is reached (Alavi, et al., 2011):

Table 2: Alternatives questionnaire respect to economic efficiency criterion.

<table>
<thead>
<tr>
<th>Economic efficiency criterion</th>
<th>Very low</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
<th>Very High</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1. Eucalyptus</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A2. Palm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A3. Pine</td>
<td>▲</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A4. Tamarisk</td>
<td>▲</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Table 3: The Alternatives fuzzy dual comparison matrix respect to economic efficiency criterion.

<table>
<thead>
<tr>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A1. Eucalyptus</td>
<td>1,1,1</td>
<td>0.556, 0.778, 1.285</td>
<td>1, 2.333, 4.5</td>
<td>1, 2.333, 4.5</td>
<td>0.348</td>
</tr>
<tr>
<td>A2. Palm</td>
<td>0.778, 1.285, 1.8</td>
<td>1,1</td>
<td>1,4, 5, 4.5</td>
<td>1.4, 4.5</td>
<td>0.392</td>
</tr>
<tr>
<td>A3. Pine</td>
<td>0.222, 0.428, 1</td>
<td>0.222, 0.333, 0.714</td>
<td>1,1</td>
<td>1,1</td>
<td>0.130</td>
</tr>
<tr>
<td>A4. Tamarisk</td>
<td>0.222, 0.428, 1</td>
<td>0.222, 0.333, 0.714</td>
<td>1,1</td>
<td>1,1</td>
<td>0.130</td>
</tr>
</tbody>
</table>

Alternative weights are obtained by conflating of relative weights of each eight matrixes. Results of values are: 1. A2. Palm= 0.259, 2. A4. Tamarisk= 0.258, 3. A1. Eucalyptus= 0.250 and 4. A3. Pine= 0.214.

Discussion of Results and Conclusions:

Today mining engineering and preservation of environment, correlate together. In this research Decision-makers face up to the uncertainty and vagueness from subjective perceptions and experiences in the decision making process. By using fuzzy AHP, uncertainty and vagueness from subjective perception and the
experiences of decision-makers can be effectively represented and reached to a more effective decision. Firstly around the Choghart Iron Mine desert region, are surveyed, for choosing the best plant type. Then a series of tests, including testing of soil, water and native plants growing in the area are performed. Samplings in this study were several cresive plant types in near the Choghart Iron Mine, which have been evaluated. According to opinions of the natural resources and environmental administration experts and bafgh mining engineers expertise in questionnaire form and by using fuzzy AHP method, results show that the best plant types according to the regional conditions and criteria, are Palm and Tamarisk. Control programming of water resources, soil erosion, environment pollutions and region plant cover, should apply, because role of mining operation decrease in environment pollution. Because Bafgh region have high heat and shortage of water and being of saline soil, Plants that grow in these areas, are halophyte usually and resistant and prevent of soil erosion. Significant addition of carbon and potassium, proportion of carbon against nitrogen, organic material of soil and improvement perspective of region, is positive results of implanting tamarisk.

REFERENCES


