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Evaluating Optimal Anti-Desertification Alternatives, Using Special Vector Technique and Bernardo Ranking Model

Mohammad Hassan Sadeghi Ravesh[1]

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Extended Abstract

Introduction: Desertification is the process of ecological and biological reduction of land potential in a natural or unnatural way, mainly affecting arid regions. Moreover, it decreases land efficiency with increasing acceleration. Land resources and human populations exposed to desertification and land destruction are prone to various threats, including loss of land productivity, food insecurity, water scarcity, economic problems, social deprivation, and health risks. Therefore, the complex and important dimensions of this issue prompted the international community to state at the Rio Environment and Development Conference that one of the goals of sustainable development is to fight against desertification, and to stop and reverse land degradation.

Subsequently, the important role of appropriate and appropriate local measures in dealing with global threats, desertification, and land degradation was emphasized at the United Nations Convention to Combat Desertification (UNCCD). Therefore, considering the limited resources and inputs, the sensitivity of ecosystems in desert areas, increasing success in implementing control plans and reducing the effects of desertification and restoration of destroyed lands, today the evaluation of desertification alternatives is considered as a determining factor in executive projects. Thus, it is necessary to design optimal methods for controlling and reducing this process. Therefore, this case study which was carried

1 Associate Professor, Department of Environment, College of Agriculture, Takestan Branch, Islamic Azad University, Takestan, Iran; m.sadeghiravesh@tiau.ac.ir

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out in the Ardekan-Khezrabad plain sought to systematically evaluate optimal alternatives via a group decision model.

Materials and methods: To analyze and present effective alternatives, this study used Delphi method within the framework of multi-criteria decision-making method so that it can consolidate group opinions and use a pairwise comparison questionnaire, followed by a qualitative identification of the most important and prioritized criteria and alternatives. Then the significance of the criteria was estimated via special vector method. Finally, Bernardo's decision-making method was applied to finalize the alternatives and prioritize them. In the framework of this model, a ranking/criterion matrix was formed for each strategy in order to influence the weight of criteria in the selection of alternatives. The weights of the criteria were multiplied in these matrices based on the relation (1), and an agreement line matrix was formed for each strategy.

(1) $$[W_j]\times[n_{ij}]=[q_{i,1}\ldots q_{i,t}\ldots q_{i,m}],\ i=1,2,\ldots n$$

Then, the consensus matrix of the total alternatives was created from the sum of the consecutive line matrices of each strategy. After the formation of the agreement matrix, the total number of times that each strategy ranked in position 1 to k was estimated in the form of a compression agreement matrix according to the relationship 2.

(2) $$R=[r_{ik}]$$

$$r_{ik}=\sum_{j=1}^{m} Q_{ij},\quad i,k=1,2,\cdots m$$

Finally, after influencing the weights of the criteria in the alternatives in the form of a consensual consensus matrix and the formation of an allocation model (Equation 3) for each strategy, the models were solved and the final priority of the alternatives was determined, using Lingo software.

$$\max_k\left\{\frac{1}{kn}\sum r_{ij}.h_{ij},\ k=1,2,\ldots,m\right\} \qquad (3)$$

$$st:\sum_{i=1}^{m} h_{ij}\le 1,\ j=1,2,\ldots,m$$

$$\sum_{j=1}^{m} h_{ij}\le 1,\ i=1,2,\ldots,m$$

$$\sum_{i=1}^{m} h_{ij}-\sum_{i=1}^{m} h_{ik}\ge 0,\begin{cases} j<k:(k=j+1) \\ j=1,2,\ldots m-1 \end{cases}$$

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$$\sum_{i=1}^{m} d_{ig} \sum_{i=1}^{m} h_{ij} \le cg,\ g = 1,2,...,G; \begin{cases} i = 1,2,...m \\ j = 1,2,...m \end{cases}$$

$$h_{ij} = \begin{cases} 1 \\ 0 \end{cases}$$

Results: According to the research literature, the importance of criteria in the desertification process was estimated from a special vector method. The results showed that the criteria of "Proportionality and compatibility with environment" (C7) was at the highest level of importance with a coefficient significance of 0.33877, followed by "Destruction of Resources and Environmental and Human Damages" (C16) with a coefficient significance of 0.3111, "Expert Human Resources" (C6) with a coefficient significance of 0.1571, " Scientific tools and technology available" (C5) with a coefficient significance of 0.1039, and "time" (C2) with a coefficient significance of 0.9090, respectively, indicating the attention of experts and specialists to environmental issues and challenges in the field of environmental degradation. In general, according to the results of the final prioritization of alternatives, the highest value of the objective functions was found to be 6.7. Therefore, "Prevention of unsuitable land-use changes" (A_{18}), "Modification of groundwater harvesting" (A_{31}), and "Vegetation cover development and reclamation" (A_{23}) were selected as the most appropriate subsets of current alternatives.

Discussion and Conclusion: The results of the application of the final prioritization of alternatives based on Bernardo's method showed that this method was catheterized by flexibility, high efficiency, ease of use, the possibility of using software such as Lingo and EC, and evaluation of alternatives based on a set of effective quantitative and quantitative criteria in-group format. In addition to using multiple criteria for decision making, it considers resource constraints in implementing alternatives or projects, providing an opportunity for decision-makers in the field of natural resources to use the limited facilities and capital allocated to control the desertification process in the right and efficient ways for better results while preventing the waste of national capital.

Keywords: Bernardo decision-making model, Hierarchical structure, Multi criteria decision making, Ranking.