

Selecting the Most Suitable Nebka Species Type for Quicksand Stabilization Using AHP Model (Case Study: Najjar Abad Erg, Northeast of Toroud)

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Introduction

The protection of environment and natural resources has high importance in achieving sustainable development. Nowadays, environmental crisis and loss of natural resources are the principle causes for the creation of environmental management systems. The optimal management of natural resources requires the assessment and classification of ecological and environmental potentials. By this method, we can recognize the abilities and restrictions of resources, and predict their future trends. Thus, according to the present environmental conditions, a suitable method with high accuracy is required in order to evaluate and manage natural resources and environment for achieving sustainable development.

Thirty million hectares of Iran's areas are recently affected by wind erosion processes due to special environmental conditions such as rainfalls being less than 150 mm, lack of vegetation and fast and strong winds. These factors have caused influx of quicksand into infrastructures, settlements, communication ways and industrial and agricultural installations. This problem is considered as one of the most important environmental issues in some parts of Iran, especially in the Northeastern part of Toroud. In this context, the recognition and control of environmental limiting factors is very important.

Nebkas are of condensation forms of wind erosion resulting from sequestration of wind sediments by plants. These features generally appear in regions with average sand amount, and where ground water tables or surface moisture are enough for plant life. The form of Nebka is a function of size, density and growth rate of plant, time, equilibrium form, size and grains sorting, climate and sediment supply source. Nebka, in local scale, shows the efficiency of sand stabilization. Thus, their development can prevent the influx of flowing sand into residential areas and infrastructures. As a result, identification of the most adaptable Nebka species according to its morphology and type of natural conditions will be very important in stabilization plans of quicksand through the development of Nebka landscapes.

The aims of this study include the comparative evaluation of Nebkas of Najjar Abad Erg and the identification of the most appropriate type of them, using their morphometric parameters analysis by the Analytic Hierarchical Process model. The results of this research will be fruitful in systemic management approach of desert regions, and also can be procreator for quicksand stabilization projects.

Materials and Methods

The study area, Najjar Abad Erg, with an area of 2864.886 hectares is situated in the north of great central plateau of Iran. The area is located between the latitudes of 35^o, 25' to 35^o, 30' N and the longitudes of 54^o, 59' to 55^o, 10' E.

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To achieve goals, Nebkas territory in the Najjar Abad Erg was determined. Thereafter, their morphometric parameters were directly measured in the field. Sampling method is based on single-dimensional method and linear sampling unit. For this purpose, to cover the entire study area, transects was considered by GPS, and only Nebkas coinciding with these transects were measured. The most important morphometric parameters being emphasized in this study are volume, height, plant canopy cover, plant height and diameter. Finally, the studied Nebkas were comparatively evaluated using the Analytic Hierarchical Process model, and the most important type of Nebka species was identified and introduced for quicksand stabilization projects.

Theoretical Basis

The Analytic Hierarchical Process is a structured technique for dealing with complex decisions. Rather than prescribing a correct decision, the AHP helps decision makers to find a solution that best suits their goal and their understanding of the problem. It is a process of organizing decisions that people are already dealing with, but trying to do in their heads. The AHP was developed by Thomas L. Saaty in the 1970s and has been extensively studied and refined since then. It provides a comprehensive and rational framework for structuring a decision problem, for representing and quantifying its elements, for relating those elements to overall goals, and for evaluating alternative solutions.

Users of the AHP first decompose their decision problem into a hierarchy of more easily comprehended sub-problems, each of which can be analyzed independently. The elements of the hierarchy can relate to any aspect of the decision problem tangible or intangible, carefully measured or roughly estimated, well- or poorly-understood anything at all that applies to the decision at hand.

Once the hierarchy is built, the decision makers systematically evaluate its various elements by comparing them to one another two at a time, with respect to their impact on an element above them in the hierarchy. In making the comparisons, the decision makers can use concrete data about the elements, or they can use their judgments about the elements' relative meaning and importance. It is the essence of the AHP that human judgments, and not just the underlying information, can be used in performing the evaluations.

The AHP converts these evaluations to numerical values that can be processed and compared over the entire range of the problem. A numerical weight or priority is derived for each element of the hierarchy, allowing diverse and often incommensurable elements to be compared to one another in a rational and consistent way. This capability distinguishes the AHP from other decision making techniques. In the final step of the process, numerical priorities are calculated for each of the decision alternatives. These numbers represent the alternatives' relative ability to achieve the decision goal. Thus, they allow a straightforward consideration of the various courses of action.

Results

In the study area, numerous Nebkas are witnessed, most of which according to the identical plant species, have the same size and form. In general, 67 Nebkas with different species were measured and evaluated. Out of these species, Haloxylon, Tamarix Macatensis, Seidlitzia Florida and Alhagi Mannifera include 16, 18, 21 and 12 Nebkas respectively.

The obtained results from the estimation of Nebkas relative weight using the analysis of their morphometric parameters by AHP model are illustrated in tables 4 to 15 and Figures 5 to 6. Also, obtained results from the calculation of their final weight are showed in equations 7 to 10 and Figure 7. The results indicate four Nebkas with different morphometric parameters. Different range of weights, (maximum 0.505 for Haloxylon Nebka and minimum 0.072 for Alhagi Mannifera Nebka), proves this claim. Also, it shows different aspects of Nebkas and their plant species, because Haloxylon Nebka could has resisted against wind flow by its larger size, and trap more sand through the reduction of wind speed and intensity.

Conclusion

Nebka landscape is the natural reaction of ecosystem against the stress of wind erosion, and ecosystem tries to adjust wind stress by creating this landscape. Therefore, the development of Nebka is the best and the most suitable method for quicksand stabilization in the study area, and the most adaptable type of

Nebka species must be identified and selected for the development of the ecosystem. This important aim will not be achieved except through careful and scientific investigation of Nebka phenomenon. The decision-making model of AHP provides the possibility of fast, accurate and low-cost selection for researchers in this field.

The results show that Haloxylon Nebka, with the weight of 0.505, has the highest importance in quicksand stabilization. Tamarix Macatensis Nebka, with the weight of 0.302, stands in the second order. Therefore, for the implementation of quicksand stabilization projects in the study area, firstly, the development of Haloxylon Nebka and secondly the development of Tamarix Macatensis Nebka is of the highest priority and efficiency. Seidlitzia Florida and Alhagi Mannifera Nebkas, respectively, with the weights of 0.121 and 0.072, have the lowest efficiencies and their development is not suggested.

Key words

Najjar Abad Erg, Toroud, Nebka, AHP model, Sand stabilization.