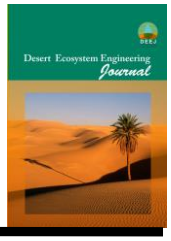
DEEJ (2021) 11 (34) 87-98

University of Kashan

Desert Ecosystem Engineering Journal

Journal homepage: http://deej.kashanu.ac.ir



Monitoring and Evaluating the Atrak River's Ecosystem Functions Using a New Approach to the Application of Multi-Criteria Decision Making Models

Alireza Donyaii[1], Amirpouya Sarraf[2*]

Received: 03/04/2021 Accepted: 12/11/2021

Extended Abstract

Introduction: As the biodiversity of valuable plant and animal species along the riversides –especially the ones located in the arid and semi-arid climate regions- has placed them in the category of sensitive and vulnerable ecosystems, awareness of these natural ecosystem's services could help protect them as much as possible, helping much more citizens benefit from their environmental services. Therefore, classifying different ecosystem services is necessary for identifying main natural ecosystem services, including regulatory, informative, productivity, and habitat services (De Groot et al., 2012). However, although many studies have already investigated issues such as improving the rivers' water quality, improving the riverbanks' landscape, and valuing the rivers' ecosystem services, no study has attempted to prioritize the rivers' ecosystem functions. Therefore, this study sought to do so in one of the Iranian largest rivers, which passes through several towns. In other words, the purpose of this study was to evaluate the function and significance of Atrak River's ecosystem functions as one of the most important northeastern rivers of Iran located in Maraveh Tappeh city, Golestan province, Iran.

Material and methods: As one of the most famous waterlogged rivers located in northeastern Iran with an arid and semi-arid climate, the Atrak River was selected to be investigated in this study. Originating from the high lands of Hezar Masjed mountains, the river is considered the fifth largest river in Iran, acting as the basis of economic activities in Golestan province, especially the Maraveh Tappeh city. Passing through different urban and rural areas, the river also connects different surrounding ecosystems that provide the residents of the neighboring cities with a variety of services (Sarraf et al., 2020), making the identification, weighing, and prioritization of the river's ecosystem functions via scientific models a highly important task.

There are several methods to weight criteria via multi-criteria decision-making (MCDM) approaches, one of which is the entropy method introduced by Shannon. The method refers to a general measure of uncertainty, playing an important role in information theory. However, in cases such as interval data where the data are nondeterministic, the method must be modified to produce correct results. Therefore, this study used Shannon's entropy method to weigh the river's ecosystem functions.

Although the classical TOPSIS is widely used as a simple, reasonable, and flexibly applied calculation method, it has some shortcomings. For instance, the method could not rank the points in the perpendicular of the positive and negative ideal points. Thus, to overcome the shortcomings of the classical TOPSIS, the Improved TOPSIS has been developed as a new method to solve Multiple Criteria Decision-Making-related problems based on relative entropy. Accordingly, as the CODAS method acts more efficiently in resolving MCDM-related problems (Keshavarz-Gharabaee et al., 2016), the current study used the newest multi-criteria decision-making models (i.e., the Improved TOPSIS and the Combinative Distance-based Assessment (CODAS) approaches) to prioritize the river's functions.

The required research data were collected via administering a questionnaire on 149 residents of Maraveh Tappeh in the summer and fall of 2020, asking them their opinion concerning the most important ecosystem

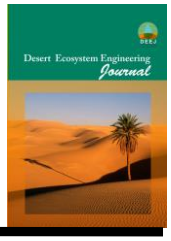
1Ph.D. in Civil Engineering, Water Resources Expert, Golestan Regional Water Company, Gorgan, Iran
2 Assistant Professor, Department of Civil Engineering, Roudehen Branch, Islamic Azad University, Roudehen, Iran
(Corresponding Author; sarraf@riau.ac.ir
DOI: 10.22052/deej.2021.11.34.41

DEEJ (2021) 11 (34) 87-98

University of Kashan

Desert Ecosystem Engineering Journal

Journal homepage: http://deej.kashanu.ac.ir



functions of the river. Moreover, the Cochran formula was used to estimate the questionnaire's sample size. Also, an information brochure was enclosed with the questionnaire to familiarize the respondents with the Atrak River's ecosystem functions.

Results and discussion: According to the results of weighting the river's ecosystem functions with the Shannon entropy method, the weights of habitat, productivity, information, and regulatory functions were found to be 0.2501, 0.2491, 0.2490, and 0.2478, respectively. Moreover, the results of prioritizing the Atrak River's ecosystem functions via the Improved TOPSIS and CODAS models showed that habitat, productivity, regulatory, and information functions ranked first to fourth in terms of priority, respectively. The study's results also showed that the habitat, productivity, regulatory, and information were considered as the most important functions in order of priority for 41%, 26%, 25%, and 8% of the residents, respectively.

Conclusion: Considering what was discussed above, it is suggested that the results of the present study be used as a model for designers and decision-makers of river engineering to implement appropriate plans to guarantee the sustainability of the river's ecosystem and the quality of the urban environment. As other studies such as the one carried out by Chaika et al. (2017) on the Florida River Basin have also found that habitat and productivity services are the most important rivers' ecosystem services from the riverbank residents' point of view, it could be argued that providing people, especially villagers and residents of the Atrak riversides, with the means of livelihood is considered as the highest priority. Therefore, preserving aquatic habitats and creating sustainable development in terms of fishing purposes could help fishermen and local stakeholders continue earning their livelihood.

Keywords: Atrak River, Ecosystem Functions, Maraveh Tappeh, Multi-Criteria Decision Making Models.