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Extended Abstract

Application of Analytic Network Process (ANP) for Shrimp Culture Sites Prioritization

J.M.V. Samani [1] and M. Delavar [2]*

Introduction

Shrimp farming is one of the high priority programs in the south coasts of Iran because of its potential to increase fishery production, to generate export earnings, and to affect employment in rural areas.

Site selection is a key factor in Shrimp farming It affects both success and sustainability and also helps preventing conflicts between different activities and making rational use of the land. The Analytic Network Process (ANP) was applied to prioritize and select appropriate shrimp culture sites in the context of flood damage in southern coasts of Iran. ANP is the modified version based on the AHP method and its super matrix approach. This method is a flexible analytical program that enables decision makers to find the best possible solution to complex problems by breaking down a problem into a systematic network of interrelationship among the various levels and attributes. In this paper we used the interrelationships of the alternative and flood damage attributes that cannot be considered in other decision making methods like AHP. Therefore, the alternatives will prioritize based on a feedback interrelationship decision structure.

Objectives

In this paper the Analytic Network Process (ANP) is applied to select the best location for the construction of shrimp culture sites and prioritize them in the context of flood damage in southern coasts of Iran.

1- Professor, Water Resources Department, Tarbiat Modares University, Tehran, Iran, Email: samani_j@modares.ac.ir
2-PhD candidate, Water Structures Engineering, Tarbiat Modares University, Tehran, Iran, Email: m.delavar@modares.ac.ir
*- Corresponding Author

Methodology

This paper proposes an Analytic Network Process (ANP) model which sets priorities for Shrimp culture sites. ANP is the generalization of Saaty's Analytical Hierarchy Process (AHP) which is one of the most widely employed decision support tools. AHP is limited to relatively static and unidirectional interactions with little feedback among decision components and alternatives (Sarkis, 1998). On the other hand, ANP and its super-matrix technique can be considered as an extension of AHP that can handle more complex decision structures (Saaty, 1996, 2001), as the ANP framework is more flexible in considering more complex interrelationships (outer-dependence) among different elements.

The ANP modeling process can be divided into five steps for the ease of understanding which are described as follows:

1- Pairwise comparison and relative weight estimation

The determination of relative weights in ANP is based on the pairwise comparison as in the standard AHP. Pairwise comparisons of the elements in each level are conducted with respect to their relative importance towards their control criterion based on the principle of AHP. Saaty (1980) suggested a scale of 1–9 when comparing two components. The score of a a_{ij} in the pairwise comparison matrix represents the relative importance of the component on row (*i*) over the component on column (*j*).

After all pairwise comparisons are completed the priority weight vector (*w*) is computed as the unique solution of

$$w_i = \frac{1}{\lambda_{\max}} \sum_{i=1}^{n} a_{ij}\ w_j \qquad \mathrm{i} = 1, 2, \ldots \mathrm{n} \tag{1}$$

where $\lambda_{\max}$ is the largest eigenvalue of pairwise comparison matrix and n is number of components.

2- Verify the consistency of the comparison matrix

The consistency index (*CI*) of the derived weights could be calculated by

$$CI = \frac{\lambda_{\max} - n}{n - 1} \tag{2}$$

In general, if *CI* is less than 0.10, satisfaction of judgments may be derived (Saaty, 1980).

3- Formation of initial supermatrix

Elements in ANP are the entities in the system that interact with each other. They could be a set of decision makers, criteria or sub-criteria (if exists), possible outcomes, and alternatives etc. The determination of the relative weights mentioned above is based on pairwise comparison as in standard AHP. The weights are then put into the supermatrix that represents the interrelationships of elements in the system.

4- Formation of weighted supermatrix

The initial supermatrix consists of several eigenvectors each of which sums to one. The initial supermatrix must be transformed to a matrix in which the sum of each of its columns equals one. To meet this need each of the elements in the block of the supermatrix is factored by its priority weight to the control criterion. The eigenvector obtained from cluster level comparison with respect to the control criterion is then applied as the cluster weights.

5- Calculation of global priority vectors and weights

In the final step, the weighted supermatrix (w) is raised to a sufficiently large power until convergence occurs to get the global priority vectors. More specifically, given that the supermatrix is irreducible, this involves raising the supermatrix to the power of 2l + 1,which converges if $l \rightarrow \infty$ as in Eq. (3) (Saaty, 1996; Meade and Sarkis,1999):

$$W_C = \lim_{l \to \infty} \mathrm{w}^{2l+1} \tag{3}$$

Results and Discussion

The ANP model in this paper consists of three feedback levels. The first level is the decision problem which is the Shrimp Culture Sites prioritization. The second level is the criteria that influence the prioritization. This level consists of six elements: Daily precipitation (*P*), basin area (*A*), distance to the river (*Dr*), distance to the sea (*Ds*), distance to the channel (*Dc*), and the basin curve number (*CN*).The third level consists of the seventeen alternatives that have to be evaluated through the ANP model.

Table (1) presents the global priority matrix of the Shrimp Culture Site selection problem.

The priority weights obtained from the ANP model shown in Table (1), indicate that the basin curve number (0.271) plays an important role in the Shrimp Culture Site priority in the context of flood damage. Precipitation (0.255) and distance to sea (0.171) are the other elements in the decision model that play important roles.

Site 4 is ranked in the first place (0.083) as the most suitable location for Shrimp Culture. Site 1 and 2 (0.079) are the next suitable locations.

Table 1- Global priority matrix of the Shrimp Culture Site selection problem

	P	A	CN	Ds	Dc	Dr	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
P	0	0	0	0	0	0	0.255	0.255	0.255	0.255	0.255	0.255	0.255	0.255	0.255	0.255	0.255	0.26	0.255	0.255	0.255	0.255	0.255
A	0	0	0	0	0	0	0.109	0.109	0.109	0.109	0.109	0.109	0.109	0.109	0.109	0.109	0.109	0.11	0.109	0.109	0.109	0.109	0.109
CN	0	0	0	0	0	0	0.271	0.271	0.271	0.271	0.271	0.271	0.271	0.271	0.271	0.271	0.271	0.27	0.271	0.271	0.271	0.271	0.271
Ds	0	0	0	0	0	0	0.171	0.171	0.171	0.171	0.171	0.171	0.171	0.171	0.171	0.171	0.171	0.17	0.171	0.171	0.171	0.171	0.171
Dc	0	0	0	0	0	0	0.098	0.098	0.098	0.098	0.098	0.098	0.098	0.098	0.098	0.098	0.098	0.1	0.098	0.098	0.098	0.098	0.098
Dr	0	0	0	0	0	0	0.096	0.096	0.096	0.096	0.096	0.096	0.096	0.096	0.096	0.096	0.096	0.1	0.096	0.096	0.096	0.096	0.096
1	0.079	0.079	0.079	0.079	0.079	0.079	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0.079	0.079	0.079	0.079	0.079	0.079	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0.071	0.071	0.071	0.071	0.071	0.071	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0.083	0.083	0.083	0.083	0.083	0.083	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0.074	0.074	0.074	0.074	0.074	0.074	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0.059	0.059	0.059	0.059	0.059	0.059	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0.055	0.055	0.055	0.055	0.055	0.055	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0.058	0.058	0.058	0.058	0.058	0.058	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0.062	0.062	0.062	0.062	0.062	0.062	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0.055	0.055	0.055	0.055	0.055	0.055	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0.054	0.054	0.054	0.054	0.054	0.054	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0.058	0.058	0.058	0.058	0.058	0.058	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0.048	0.048	0.048	0.048	0.048	0.048	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0.037	0.037	0.037	0.037	0.037	0.037	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0.043	0.043	0.043	0.043	0.043	0.043	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0.039	0.038	0.039	0.039	0.038	0.039	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0.048	0.048	0.048	0.048	0.048	0.048	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Conclusion

This research aimed to use an ANP model to select the best location in the context of flood damage for the construction of shrimp culture sites.

The results showed that ANP is a more powerful technique than AHP in modeling complex decision environments because it can model very sophisticated decisions in real-world problems involving a variety of interactions and dependencies and a complex network of various issues.

Keywords**:** Analytical Network Process (ANP), Analytical Hierarchy Process (AHP), Prioritize, Flooding, Super Matrix, Pair-Wise Comparisons

References

Meade, L.M. and Sarkis, J. (1999), Analyzing Organizational Project Alternatives for Agile Manufacturing Processes an Analytical Network Approach. *International Journal of Production Research* 37 (2), pp. 241–246.

Saaty, T.L. (1996), Decision Making with Dependence and Feedback: The Analytic Network Process. RWS Publications, Pittsburgh

Saaty, T.L. (2001b), The ANP for Decision Making and Forecasting with Dependence and Feedback (ww.Superdecisions.com).

Sarkis, J. (1998), "Evaluating Environmentally Conscious Business Practices", *European Journal of Operational Research* 107, pp. 159–174.