A Health Assessment of the Ecosystem in Shuangtaihekou Wetland

Abstract: Shuangtaihekou Wetland is typical estuarine wetland in the north of China. In order to understand the current health status of the ecosystem in Shuangtaihekou Wetland, Pressure-state-response assessment model is adopted and analytic hierarchy process is used to carry out a comprehensive assessment of it. The assessment results show that the ecosystem health index of the wetland is 0.646, indicating a sub-health level. In general, 25.9% of the entire ecosystem in the region is in excellent health; 21.4% of it is healthy; 19.6% of it is in sub-health state; 15.3% of it is in morbid state and 17.8% of it is in severe condition. So all in all, Shuangtaihekou Wetland is in a sub-health condition.

Keywords: Shuangtaihekou wetland; Health assessment; Ecosystems; P-S-R assessment model; Analytic hierarchy process.

1 Introduction

Wetland, along with forest and ocean is one of the major ecosystems on the earth. It has great potential for natural resources and is performing vital environmental functions [1]. However, with the rapid development of economy and society, human being is making revolutionary changes about the nature, wetland included [2]. As a consequence, its ecological function is declining and the kinds of species are shrinking. Facing this problem, how to develop and exploit wetland at the minimum cost and realize the harmonious coexistence of human and nature is inevitably a major subject for study in this world [3].

Shuangtaihekou wetland is at the southern tip of Liaohe River delta and is the biggest wetland along the beach in Liaoning province, including the shallow water regions (the depth of water is below 6 meters in dry seasons), the tidal flats, the salt marshes, the estuarine waters, the permanent river and artificial wetland [4]. This whole region is rich in plantation and animal species and is a relatively well-preserved natural reserve [5] (Figure1). However, the agricultural and industrial production activities in the upstream reaches in recent years have seriously affected the ecological environment here. This study is to make scientific assessment of the ecosystem condition in this region so as to specify the health condition in this eco-
system and take proper measures to restore and rebuild a healthy wetland ecosystem and secure the sustainable development of this region.

![Panoramic view of the Shuangtaihekou wetland](image)

**Fig. 1: Panoramic view of the Shuangtaihekou wetland**

## 2 Methodology

### 2.1 P-S-R Assessment Model

P-S-R (pressure-state-response) assessment model was first employed in analyzing the relationship between environment pressure, its reflections and people’s response to them. This model was originally put forward by Tony Friend and David Rapport. In view of its rationality, the environmental reports given by OECD started to adopt this model in 1970s. After that, it has been accepted by many governments and organizations [6]. The P-S-R assessment model is able to reflect the cause and effect relations that result in a certain ecological state in a region. It can indicate the pressure on the ecological environment caused by natural disasters or human production activities. Under this pressure, the environment may change its original nature or quality due to the co-effect of physical, chemical and biological influence. In reaction, human society should take correspondent administrative or manage-
ment strategy to reduce the stress on environment in case the environment should degenerate.

2.2 The Principle of Assessment Index Selection

To evaluate the ecosystem health of the wetland, the essential characteristics of the wetland ecological system must be reflected by the index system that is established. And the system must be systematic, complete, comparable and operable. The fundamental principles that must be followed while constructing this index system are as follows [6,7]:

1. The principle of systematization and integrity. The index selected must form a complete assessment system and can reflect the essential nature of the wetland ecosystem in an all-rounded way. That is, the index must be able to indicate the ecological status, the socio-economical effect and human’s influence with clear hierarchical structure.

2. The principle of scientific rationality. The index selected must be rational and scientific and can truly reflect the health condition of the ecosystem, so as to ensure the veracity and objectivity of the assessment result.

3. The principle of representativeness. The index selected must be representative. In view of the important position that Liao He Oilfield (the third biggest oilfields in China) holds in Pan Jin, the assessment index must include the effect that oil exploitation has on the wetland so that the selected index can better reflect the health status of the ecosystem in Shuangtaihekou Wetland.

4. The principle of operability. The index selected must be simple and operable and the statistics can be acquired in the working period. The operability can ensure scientific and effective information for the assessment result. So the assessment index includes the original data obtained by investigation or surveillance, secondary data obtained by processing original data and some state index of qualitative description.

2.3 The Constitution of Assessment Index System

Based on the above principles, and in reference to the assessment system in item 10 of the reference list, the assessment index system framework can be established. The assessment system of the current health status of the ecosystem in Shuangtaihekou Wetland can be divided into 4 layers: 1. the aim layer: the comprehensive assessment of wetland ecosystem health. 2. The criterion layer: pressure index, state index and response index. 3. The assessment element layer. 4. The index layer: the specific index for each assessment factor.
The assessment system of the current health status of the ecosystem in Shuangtaihekou Wetland is based on the above mentioned principles and the previous researcher’s experience, after the collection of various information data of geographical, cultural, economic, social and other specific circumstances in Pan Jin [8–11]. 32 indexes are selected from the 3 respects: pressure, state and response.

### 2.4 Basic Steps of Fuzzy Comprehensive Assessment

The basic assessment steps includes: Wetland health classification, division of index weight, construction of membership fuzzy relationship matrix and lastly the calculation and assessment of the results. According to reference [6] and [7], the health status of the ecosystem in Shuangtaihekou Wetland is rated as in excellent health, in good health, in sub health, defected and diseased. Assume the five rates are named in order from the excellent to the worst.

### 2.5 AHP Weighting

Whether the division of assessment index weight is rational is of vital importance to the assessment result. After making reference to [5–9] and some experts’ grading, the assessment index weight is obtained through AHP, and in case of the Shuanghekou Westland, some relevant analysis and adjustment are made.

### 2.6 Fuzzy Comprehensive Assessment Method for Health

In the course of fuzzy comprehensive assessment, construction of membership fuzzy relationship matrix is a key step. First, the degree of membership according to different standards of various influencing factors must be ascertained according to the standard of Wetland health level as stated above. And based on that, the fuzzy assessment matrix can be established in order to avoid the unreasonable inshot assessment phenomenon resulted from the small differentiation between different levels. To ensure that membership functions can transit smoothly between rates, the membership functions should be fuzzified. The membership function adopted in our study is in reference to Membership function formula in [7].
3 Results and discussion

The comprehensive fuzzy assessment of the health condition in Shuanghekou Wetland ecosystem needs to process each specific index. Because of the 32 assessment indexes, some are qualitative and some are quantitative, and the standards also vary. But each index is involved in the assessment and has some weight influence on the result of the assessment. So the processing methods should be different, so is the result of the assessment result. In this study, improved weighting summation model is employed.

The comprehensive health index in this ecosystem is 0.6464. According to the health assessment standard of Wetland, currently Shuangtaihekou Wetland is in a sub-health condition. In terms of rating system, in general, 25.92 % of the entire ecosystem in the region is in excellent health; 21.42 % of it is healthy; 19.59 % of it is in sub-health state; 15.31 % of it is in morbid state and 17.76 % of it is in severe condition. In terms of sub-system, the health index of the pressure system is 0.565, close to the state of sub-health, which indicates that the wetland’s ecosystem is undergoing some pressure, which poses as a threat to the entire system. Supreme importance should be attached to the increasing rate of population, population density, and the intensity of human activities, the amount of chemical fertilizer, water pollution and sewage discharge and so on. Since the average income in Pan Jin is rather high in LiaoNing province, it’s advised to increase the investment in the disposal of sewage water. The assessment value of Shuangtaihekou Wetland’s ecosystem is 0.724, which indicates a healthy condition. This reflects that in spite of the all the negative influence, the ecosystem itself has a certain sustainable ability. Although the change in the wetland area and dominant plants coverage have been greatly influenced by human activities, the ecological and functional state of the region is still in rather good condition: its response system’s health index is 0.764, a sub-health situation. Due to the high quality of the people and the good awareness of environment protection of the wetland, as well as the increased investment made by the city, the enhanced enforcement of the law, the improved policy, the wetland and its ecosystem is better protected.

4 Conclusion

Now, the ecosystem of Shuanghekou Wetland is in sub-health. The future of it depends on many factors like the pressure it has to undergo, the investment it can receive and the enforcement of all the protective and managing methods. With scientific protection of the region, the resources in the wetland can be used sustainably. Regional industrial adjustment must be made. Protection should be as important as exploitation. More investment should be made to increase the protective and man-
agement level, restore the impaired area and improve the structure of the ecosystem in the region. To protect Shuanghekou in the long run, a dynamic monitoring should be applied. Before any exploitation is made, assessment should be made about the negative effects it may bring about on the wetland. To restore and rebuild the impaired parts, successful cases can be used for reference. Different ecoengineering activities must be done while taking into consideration in the geographical advantage of Pan Jin.

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References


