Study about Ecological Security Assessment of Beijing Valley Region Based on PSR Model——A Case study of Puwa Valley Region in Fangshan District

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Abstract: The analytic hierarchy process (AHP) was used to evaluate the ecological security of Beijing valley region. Based on the concept model of PSR (Pressure-State-Response), and referred to the current assessment methods of the ecological security evaluation, relating AHP to construct evaluation system, this study combined the impact factors of natural, social and economic on Valley Region ecological security, the mutual influence and restraint law of the internal system between various factors, AHP was used to establish the ecological security assessment indicators system of Beijing Valley Region. Compared with 2010 increased 0.08, The score of ecological security about Puwa Valley Region was 0.63 which attained general status. At last, this study promoted corresponding advices.

1. Introduction

Mountainous valley areas economic is a new concept which combines the characteristic of agricultural development in Beijing mountain area and regional economic [1]. As an important part of the mountainous area in Beijing, mountainous valley areas not only is a solid ecological barrier of the livable city construction in Beijing and a environment friendly special industry, is also an important resource to support the sustainable development of Beijing [2]. At present, a few pilots have been successfully explored and carried out which have become a new light-spot for the development of the mountainous area in Beijing suburbs.

In fact, the contradiction between environmental protection and economic development is still the current outstanding problems with the Beijing mountainous area economy development [3]. The resources and environment has become a hard constraints for the sustainable development of mountainous area. The importance of ecological security is being gradually recognized. With a number study of valley region in Beijing mountain, the valley region as a unit to carry out the economic and ecological research has become a construction in the mountainous area of the development of the basic ways and means [4]. Due to more and more load of the ecological environment in valley region, self-regulation and restore functions of the ecological environment have fallen sharply, which has caused the increasingly serious ecological security problems [5]. How to deal with the contradiction between regional economic development and ecological security has become the key problem in regional development.

This study took the Beijing fangshan district puwa valley region as a study object and built a set of ecological security evaluation index system to highlight the ecological security situation of Beijing.
valley region. The quantitatively comprehensive evaluation of ecological security in Puwa valley region had completed by selection of mature mathematical model and the method, which was in order to provide a reference basis for the sustainable development of scientific management for Puwa valley region.

2. Ecological Security Connotation
Ecological security of valley region refers to the ecological environment and resources situation in the valley region can continue to meet the needs of the social and economic development. Social and economic development is not affected or threatened by or less from the restriction of resources and the ecological environment [6]. The relationship between resource supply and the human society demand is the core content of ecological security. The concept contains two layers of meaning, first of all, the research object in the valley region is natural - social - economic compound ecological system, which includes the natural ecosystem and social economy system. Second, the service function provided by natural ecosystem and the positive response provided by the social and economic system interact with each other which is both mutual restriction and organic connection [7]. The organic connection reflected common breed ideal status of ecological safety according to the natural ecosystem health and social economy system sustainable development for the connotation of generalized sustainable development.

3. Study Area
Puwa valley region of Fangshan District is located in the northern section of Taihang mountain and the northwest border with Laishui county of Hebei Province, which is 90 kilometers away from the government of Fangshan District and about 120 km away from Beijing city. Puwa valley region of Fangshan District consists of eight administrative villages with a total area of 96 square kilometers, the shallow mountain with the highest elevation of 1870 meters and the lowest elevation of 407 meters. Soil types mainly contained mountain meadow soil, mountain brown soil and brown soil. It had 4670 people and 1497 employees in 2015. The cultivated land has 78.46 acres and the orchard covers an area of 1210 acres.

4. Ecological Security Evaluation Model and Evaluation Index System

4.1 Evaluation Model
On the basis of the model framework at the United Nations environment programme (UNEP) and the organization for economic cooperation and development (OECD) and other departments of the "pressure - state - response" (P - S - R), the ecological security evaluation model of valley region had been built which included the key elements by the "resources - social - economic pressure index", "nature-ecology-environment status indicators" and "the humanities - society" response state. P - S - R conceptual model can comprehensively reflect the relationship between nature, social and economic factors of the valley region ecosystem safety [8]. Therefore, the application of the model of the valley region of the compound system of ecological security evaluation is reasonable.

4.2 Evaluation Index System
Based on the evaluation principles and evaluation model, the Analytic Hierarchy Process was used and the ecological security evaluation index of valley region had been divided into 4 levels of 18 evaluation factors(Table 1). Pressure indicators showed that root of the ecological environment problems in valley region which referred to the pressure from human activities. Status indicators characterize the status of the economic, natural resources and ecological system under pressure, which refers to the current status and trends of the valley region. Response indicators measured the ability to restore human environmental quality and prevent environmental degradation, which refers to the current environmental condition of cultural policies and measures taken by the part can be quantified such as ecological environment protection and pollution control [9].
Table 1. Evaluation index system of ecological security and the targets

| Target layer | Advanced indicators | Lower indicators | Unit       | Targets |
|--------------|---------------------|------------------|------------|---------|
|              | Population Pressure(0.2) | Population Density | Person/km² | 468     |
| “Resources - Social - Economic” Pressure Indicators(0.403) | Natural Population Growth Rate | % | 0.7 |
|              | Water Resource Pressure(0.3) | Per Capita Water Resources | M³ | 1730 |
|              | Land Pressure(0.3) | Per Capita Arable land | Ha | 0.05 |
|              | Social Pressure(0.2) | Per Capita Road Area | m² | 13.75 |
|              | Resource State(0.6) | Proportion of Non-agricultural Urbanization Rate | % | 97 |
| Ecological Security Index of Beijing Mountain Valley Region | Green Coverage Rate | % | 56.8 |
|              | Environment State(0.4) | Proportion of Agricultural Water-saving Irrigation Area | % | 95 |
|              | Policy Response(0.3) | Water Quality of Drinking Water Source Success Rate | % | 100 |
|              | Economic Response(0.4) | Secondary Air Quality and Good Days in Secondary Success Rate | % | 76 |
|              | Ecological Environment Response(0.3) | Water and Soil Erosion Intensity | t/(km²·a) | 200 |
|              |                    | Environmental Protection Investment as a Share of GDP | % | 2.5 |
|              |                    | Per capita net income of farmers | yuan | 20119 |
|              |                    | Per Capita of GDP | Ten Thousands of Dollars | 0.85 |
|              |                    | Hazard-Free Treatment Rate of Household Garbage | % | 90 |
|              |                    | Rural Sewage Concentration Rate | % | 80 |
|              |                    | Soil and Water Loss Rate of Effective Governance | % | 73.3 |

4.3 Determination of Weights about Evaluation Index

The determination of each index weight was an important and indispensable part. It directly determined whether the evaluation results fit for the real situation or not.

In this study Delphi method was used to determination the weight of the indexes [8]. Two rounds of questionnaire surveys were conducted with 15 specialists to ensure that the index weight was scientific and objective. The results of the second round were the weight of each index.
4.4 Determination of the Targets
Based on previous research results, related planning and other international and domestic materials, the targets were determined by four aspects:(1) assessment index about ecological city construction;(2) city construction standards of developed countries;(3) optimum value or a good values of domestic cities;(4) development present situation of domestic cities.

4.5 Division of Ecological Security Criteria
Space method was used to determine evaluation criteria about ecological security[10]. Evaluation criteria will be divided into five intervals and five state levels correspondingly[11] (Table 2).

| Level and Assignment | Characterization State | Characteristics of the indicators |
|----------------------|------------------------|----------------------------------|
| I (<0.4)             | Bad State              | Resources bearing capacity is lower. The ecological environment is very fragile and the ecological process is irreversible because the destruction of human disturbance is very severely. Ecological disaster hazard-affected ability is poor and the environment pollution is severe. Natural disasters are frequent and development is unsustainable. |
| II (0.4-0.6)         | Poor State             | Resources bearing capacity is low. The ecological environment is fragile and ecosystem disaster hazard-affected ability is poor due to man-made destruction. Environmental pollution is heavier and natural disasters are more. The sustainable development ability is weak. |
| III(0.6-0.8)         | General State          | Resources carrying capacity is strong. The ecological environment is better. Ecological structure has been changed by certain damage. Ecosystem disaster hazard-affected ability is good and environmental pollution is lighter. Sustainable development ability is strong. |
| IV(0.8-0.9)          | Better State           | Resources carrying capacity is stronger and ecological environment is excellent. Ecosystem disaster hazard-affected ability is stronger and pollutants can self-purification by less damage. Sustainable development ability is stronger. |
| V (>0.9)             | Ideal State            | The relation of person and land is harmony. The problem of ecological security was not significant and development is sustainable. |

5. Ecological security evaluation results and analysis

5.1 Ecological security level
According to the results of ecological security evaluation, the value of Puwa valley region increased from 0.55 in 2010 to 0.63 in 2015. The ecological security level of Puwa valley region in 2010 is at a poor state and at a general state in 2015, which showed Puwa valley region presented upturn in ecological security level.

According to the analysis process, the “humanities - society” Response indicator and “nature-ecology-environment” status indicators were the largest contribution to the value from three rule layers, which increased 32.0% and 18.3% respectively year-on-year. The contribution of “resources - social - economic” pressure indicators is lesser, which decreased 7.7% year on year.

5.2 Specific results analysis

5.2.1 Rule layer analysis. A. Pressure of Ecological Environment Pressure: The ecological environment pressure of Puwa valley region gradually reduced. The value of pressure was from 0.56 in 2010 to 0.52 in 2015. The reduction of land pressure and social pressure was an important contributing factor.
B. State of the Ecological Environment: The state of ecological environment in Puwa valley region reflected improving trends. The state value was from 0.67 in 2010 to 0.82 in 2015. Farmland drought and flood insurance yield, the success of drinking water resource and secondary air quality and good days in secondary success rate and other indicators closed to safety standards, which played an important role in ecological environment of Puwa valley region. Ecological environmental conditions of Puwa valley region continue to improve as the security value of the indicators enhances unceasingly.

C. Response of the ecological environment: The value of ecological response was from 0.34 in 2010 to 0.5 in 2015 which showed that the human response of ecological environment continuously strengthened. Although per capita net income of farmers and per capita GDP were declining, the ecological environment of the humanities response was still strengthening constantly because the increase of intensity of pollution control investment, hazard-free treatment rate of household garbage, rural sewage concentration rate, increase of soil and water loss rate of effective governance.

5.2.2 Factor layer analysis. A. Pressure factors layer: Land pressure and social pressure were higher than the overall level, which were 0.14 and 0.33 respectively higher than the overall level in 2015. The pressure of “resources - social - economic” decreased 7.1% in 2015 compared with 2010. Land pressure had the greatest contribution which reduced 0.27 level. Population pressure and water pressure had a smaller contribution[12], which reduced 0.03 and 0.02 level respectively. The society pressure improved the pressure of “resources-social-economic”. The value of social pressure was rather than a fall, which increased 0.27 in 2015 compared with 2010.

B. State factors layer: The value of the resource state and environmental state layer was close to or higher than the overall level of the state of “nature- ecology-environment” in 2015. The value of “nature-ecology-environment” increased 22.4% from 2010 to 2015. Among them, the index of resource state and environment status had increased 0.16, which increased 23.5% and 23.9% respectively from 2010 to 2015.

C. Response factors layer: The value of policy response and ecological environment response were higher the overall level of the “humanity-society” response status in 2015, which was higher 0.26 and 0.20 respectively. The response of policy had the largest contribution to the overall level of “humanity-society” response from 2010 to 2015, which had increased 1.4 times in five years. The economic response level had restricted the overall response level, which was lower 0.35 level to the overall level.

5.2.3 Indicators layer analysis. The score of six index was more than 0.8 and the number of indicators was 33.3% of the total number of indicators in 2015. The number of indicators whose value between 0.6 and 0.8 was also 33.3% of the total number of indicators. Lower scores of indicators had water resources quantity, per capita cultivated land, per capita net income of farmers and per capita GDP which were the important and difficult of sustainable and healthy development in Puwa valley region.

The score of 18 indexes were compared with the overall level of ecological security, it could be seen that the number of index higher to the overall level was 10, accounting for 55.6% of the total number of indicators, which had played a positive level in ascending ecological security level in Puwa valley region. The number of index lower to the overall level was 8, accounting for 44.4% of the total number of indicators and six index score was below 0.5. It showed that the health development of Puwa valley region is still very difficult.

6. Conclusion
The results showed that the health and stability of Puwa valley region came from the coordinated development of natural ecology, economic ecology and social ecology. In order to achieve the best overall function, it was necessary to take into account the coordinated development of social, economic and natural systems. In the future, a series of measures would be taken in the areas of resource utilization system, ecological environment system, economic development coordination and
social regulation. The level of ecological security in the Puwa valley region has been significantly enhanced to achieve the sustainable development of the Puwa region ecosystem.

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